Literacy Studies: Perspectives from Cognitive Neurosciences, Linguistics, Psychology and Education 23

Ronit Levie · Amalia Bar-On · Orit Ashkenazi · Elitzur Dattner · Gilad Brandes *Editors*

Developing Language and Literacy

Studies in Honor of Dorit Diskin Ravid

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Literacy Studies

Perspectives from Cognitive Neurosciences, Linguistics, Psychology and Education

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While language defines humanity, literacy defines civilization. Understandably, illiteracy or difficulties in acquiring literacy skills have become a major concern of our technological society. A conservative estimate of the prevalence of literacy problems would put the figure at more than a billion people in the world. Because of the seriousness of the problem, research in literacy acquisition and its breakdown is pursued with enormous vigor and persistence by experts from diverse backgrounds such as cognitive psychology, neuroscience, linguistics and education. This, of course, has resulted in a plethora of data, and consequently it has become difficult to integrate this abundance of information into a coherent body because of the artificial barriers that exist among different professional specialties.

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A Path Less Traveled

This volume is an extraordinary tribute to an extraordinary scholar. Dorit Diskin Ravid is a linguist, developmental psycholinguist, and educator who has established herself as a leading international authority on morphology, language acquisition and literacy development. To reach this summit, however, involved negotiating a path strewn with obstacles likely to dissuade any but the truly courageous.

When Dorit began her study of Hebrew morphology, contributions to linguistics from languages outside the family of European languages were dismissed as mere esoteric curiosities. According to the generativist orthodoxy that dominated the second half of the twentieth century, the task of the linguist is to uncover the universal architecture of human language in its primary, that is, spoken form. Research into written language, into the specifics of particular languages, and empirical investigation of their acquisition and variation over time within the individual (ontogeny) and across time within communities (phylogeny) was frowned upon as inconsequential and unworthy of the attention a “serious” linguist. Today, this work has taken on a new significance as a growing number of linguists, psycholinguists, and social scientists voice concern about the many forms of insularity and ethnocentrism that plague research into many aspects of human behavior, including language, and call for a broader, more inclusive picture.

Undeterred by the naysayers, Dorit followed in the footsteps of her mentor, Ruth Berman, and chose to pursue the study of Hebrew morphology and morphological acquisition. As she noted in her 1995 masterpiece, *Language Change in Child and Adult Hebrew: A Psycholinguistic Perspective*, the study of language, with its deep evolutionary roots, cannot afford to ignore the fact that the key to evolution itself is variation and change. (And written language and literacy learning, a quintessentially cultural tool lacking any evolutionary basis, is, almost by definition, fundamentally variable across individuals and cultures.) Above all, this first monograph underscored the fact that language is a living, breathing, ever-evolving organism, resplendent in its phylogenetic and ontogenetic diversity.

The following decade, Dorit and Liliana Tolchinsky co-authored *Developing Linguistic Literacy: A Comprehensive Model*, in which they expounded a broader vision of language development emphasizing that language does not cease developing in early childhood but is an ongoing lifelong synergy between spoken *and* written language. Again defying tradition, Dorit and Liliana argued that written language is not a shadowy, insignificant reflection of spoken language, but in many ways, the epitome of language proficiency in literate societies. Their influential notion of *linguistic literacy* regards literacy development as an inseparable part of later language development. The constant interweaving of spoken and written language in a literate community requires users to deploy language flexibly in a broad range of communicative contexts. Becoming linguistically literate means gaining command of a rich array of language forms, registers, and genres in a multitude of spoken and written contexts used for a wide range of communicative purposes. Again, variety, variation, and adaptive variation, is the keynote here.

Continuing her work on the interplay between spoken and written language, Dorit's next magnum opus, *Spelling Morphology* (2012), joined a growing movement of literacy researchers and educators cautioning us that writing systems do not just encode sound (phonology), but represent phonology *and* morphology, and this has profound implications for literacy learning and teaching across all languages, even those with only a sparse morphology such as English and Dutch.

Pursuing her long-range vision of language development (from infancy to adulthood) and inclusive approach covering spoken and written production, the past decade culminated in another *tour de force* by Dorit (and her students) on Hebrew verb acquisition based on a meticulous and innovative analysis of a massive corpus of spoken and written productions. This 2020 mega-study provides a definitive account of how Hebrew verb families and their components—verb lemmas, roots, and binyan patterns, emerge and develop from toddlerhood to adulthood, highlighting the role of the interaction between child speech and child-directed speech in the emergence of morphological systems.

And the next chapter? A new line of research growing out of the past decade (and perhaps setting the stage for the coming decade) currently focuses on the emergence of syntactic systems in early development. Employing fine-grained and advanced analytical tools, this work aims to show how a grammatical system dynamically emerges out of experience, and how the system's components interact with each other, forming a complex network of cognitive connections, processes, and effects.

All these and innumerably more of Dorit's contributions have been framed by the usage-based approach to developmental psycholinguistics. Central to the mission of usage-based linguistics is the compilation, description, and analysis of naturalistic language corpora drawn from real-world language use. Systematic description and classification, of course, is the first task of any scientific endeavor. And, as is often the case, empirical inquiry, as Dorit herself has demonstrated on several occasions, can unearth findings that run counter to popular untested intuitions. The descriptive-empirical approach that Dorit's work exemplifies not only provides the foundation for future theory-testing, but also an invaluable applied-translational resource for researchers and educators wishing to build ecologically valid assessment tools and norms for clinicians and educators concerned with language and literacy development, teaching materials, curriculum development, and policy formulation. And true to the usage-centered study of the meaningful use of language across a variety of authentic real-world contexts, Dorit has been (hyper-)active putting this knowledge to use in schools and clinics, overseeing national and international language and literacy testing initiatives, curriculum design and development, and even the development of interventions for socially and culturally disadvantaged groups.

It is not surprising therefore that Dorit's counsel has been highly sought after in policy formulation and agenda-setting fora concerned with language and literacy in almost all avenues of clinical and educational practice, contributing at every level, from preschool to high school, college, and university on the national and international stage.

Her boundless energy and passion for understanding language and its development has generated a prodigious number of scholarly articles, books chapters, colloquia, and grants, including collaborations with so many leaders around the world, as this volume bears witness. Her generosity in sharing her knowledge explains the staggering number of research dissertations she has supervised (over 150!), inspiring a new generation of researchers who have been privileged to work with or under this exceptional scholar.

Dorit's achievements were not only forged in an era when empirical inquiry into her chosen topics was considered apocryphal by the linguistic establishment, but are all the more remarkable when seen against the narrative of an individual who was a latecomer to academia, a woman who took an unconventional and circuitous route to the summit of what still is a male-dominated profession.

Kol HaKavod to the editorial team and the distinguished contributors who have come together to offer this wonderful and worthy tribute to an extraordinary woman.

David Share

A U-Shaped and Dynamical Story of an Inspirational Career

Dorit Ravid was born in 1952, just four years after the establishment of the State of Israel. She began her professional life in 1971—just four years after the establishment of the Department of Linguistics at Tel Aviv University, about a decade after the birth and rise of modern linguistics. Israel and academia, these are the two homes in which she grew up. Dorit is deeply connected and committed to both, as she is identified and identifies with their cultural and social foundations, with the local language. Critical thinking and clear sight are the lifeblood of democracy, necessary tools for the constant examination and judgment of the regime as well as of the scientific discipline. In both cases, Dorit is well equipped with these tools.

The 1970s in the United States, as well as in the Department of Linguistics at Tel Aviv University—a distinctly Chomskyan hub—were the heyday of generative linguistics. In every approach and theoretical framework, there are principles that are considered taboo. The list of these issues in the context of Chomskyan linguistics is long and extensive. They include data collection, interest in written language, research into the acquisition of a specific language, interest in special populations and development. All these topics, deemed irrelevant and considered "not interesting" for generative linguistics, actually became the center of Dorit's work from her early days in the department.

The theoretical linguist (sometimes referred to as an armchair linguist) would argue that linguistic knowledge and human linguistic ability are not acquired through empirical experience but derive from innate universal grammar. In a sense, the hypotheses of theoretical linguistics have become facts and dogmas, and have not been tested empirically.

As is well known, the object of research for the generative linguist is the spoken language—human cognitive ability. It is considered as the only aspect of language that deserves independent research, as it is the primary and natural form that everyone masters, whereas writing is only seen as a secondary phenomenon. The generative linguist is interested in the universal profile of human language and does not work on specific languages.

Another irrelevant issue is variability between speakers, whether due to environmental factors or language impairments. Last and perhaps most prominent of all is the study of development. The language acquisition process is admittedly incredibly automatic and fast, but it is not characterized by random leaps, as one would expect if it were strongly predetermined by an innate program.

Chomskyan linguistics, therefore, does not deal with the question of language acquisition from a developmental point of view, since its premises and the answers it provides are different. Yet, all the components of the aforementioned "forbidden list" were in fact what preoccupied Dorit already in her doctoral studies and at the beginning of her professional path. Generative linguistics has offered an array of methods to answer the question of what is the linguistic ability of each person and how it is acquired. Not only did Dorit not rely on those methods, but she also questioned the correctness of the questions asked by this approach, which dominated the place where she was trained.

Criticism and inquisitiveness are an integral part of scientific research; they provide strength and independence. However, questioning basic premises and research methods might also produce an experience of loneliness and difficulty when the surrounding academic environment speaks a different "language."

Fortunately for Dorit, she met Prof. Ruth Berman, who was her thesis advisor, teacher and mentor, and later became her colleague. Prof. Berman, who is considered the mother of developmental psycholinguistics in Hebrew, has researched Modern Hebrew in a variety of fields and is one of the pioneers of research in Israel and in the world of language acquisition from a cross-linguistic perspective, with an emphasis on Hebrew as a mother tongue. Ruth mentored Dorit and gave her full support and legitimacy to engage in all the components of the "forbidden list."

Dorit is a linguist and a developmental psycholinguist. Remarkably, and perhaps not coincidentally, one cannot miss the parallel lines and similarities between her areas of research, and especially the characteristics of her particular developmental approach to language acquisition, and the unique nature of the development of her path as a researcher.

We can mention two key concepts in Dorit's approach to development that are also metaphorically applicable for her own academic research journey: U-shaped learning and Dynamical Systems. They both describe the dynamic, non-linear, and non-monotonic nature of her own professional development.

True to her belief in the richness of linguistic input and the ability of children to learn from it, she examined this empirically from the very beginning. Among other things, she recorded her own children, Sivan, Asaf, and Itamar—examples that many of her students have heard over the years. These recordings were used as part of the research tools in her doctoral dissertation that dealt with the relationship between language acquisition, socio-economic status (SES) and linguistic change, with the focus on the morphophonology of inflection.

Just as linguistic knowledge emerges, and as items are organized into dynamical systems while revealing features that were not in the system before, so over the years Dorit continued to explore many specific systems of the Hebrew language and build up a vast body of knowledge. She studied the acquisition of Hebrew and the development of linguistic literacy, the establishment of lexicon and grammar throughout early childhood, the school years and adolescence. There was almost no stone she left unturned in order to discover the features of the system. Because the building blocks of linguistic knowledge include both spoken and written language, she applied linguistic theory and methodology to the study of spelling and its acquisition in Hebrew through an in-depth psycholinguistic analysis of the interface between morphology-phonology and orthography. Thus, she showed that spelling is a significant and inseparable part of cognitive science.

Over the years, Dorit has always used to point out the main question that drives her in her research work: “What makes an adult’s language such?” An essential part of the path to the answer included a rich body of research that dealt with the development of producing spoken and written texts in various genres—mainly expository and narrative—across the school years, with special focus on mature discourse abilities in adults.

In recent years, the research pendulum is moving on a U-shaped curve and returning to the early years—starting small once again. After all, what happens in later language development rests on elements that first appear in the spoken language of early childhood.

Dorit is part of a new generation of linguists who provide new answers to old questions with new tools in a usage-based framework. She plays an important part in the current revolutionary paradigm shift in the way we understand language and its acquisition.

Although the structure of this book is neither chronological nor narrative-like, I believe that the various chapters and especially the categories and sections manage to tell the rich, varied, and complex story of Dorit’s numerous fields of research.

It seems that if a definition and example of a teacher and mentor were included in the dictionary of academic terms, Dorit’s picture would appear under this entry. She does not keep to herself the vast, varied, and rich knowledge described here. Many students grew and matured under her wise and generous wings. Borrowing from the vocabulary we have learned from the recent pandemic, we can say that the number of Dorit’s research students has grown exponentially, and it is closely linked to her highly contagious enthusiasm and passion for her fields of research. The successful combination of embracing wings and the encouragement to spread one’s wings is not common. Dorit raises independent researchers who are also experts in friendly, generous, and fruitful cooperation, just as they learned from her …

This book does not intend to summarize Dorit’s work. Perhaps it is a kind of interim summary of the journey she has taken so far. We, who know and love Dorit, are sure that new and surprising adventures await her and us.

Anat Hora

Introduction

Dorit Ravid is our mentor, teacher, and dear friend. She is our role model. The way we think, teach, research, and supervise our own students is tremendously inspired by her. It is our privilege to edit this festschrift in honor of her impressive academic and scientific achievements, celebrating her formal retirement on her 70th birthday.

Through the years, Dorit has collaborated with numerous leading researchers around the world, many of whom became her long-time friends. This was reflected in the widely enthusiastic response to our invitation to contribute a chapter to this volume. The 29 chapters comprising this book attest to her worldwide academic and personal relationships. Moreover, the wide variety of topics conveyed in the book well represents the breadth of Dorit's research interests, as described later in the book's parts.

The book's chapters are organized in six parts: Developmental Psycholinguisitics, Language and Cognition, Linguistic Literacy, Social and Environmental Diversity, Clinical Perspectives, and finally, Hebrew Linguistics. We are confident that this book will be of interest to scholars as well as to lay people curious about language in its wide context, including linguists and psycholinguists, speech-language pathologists, developmental psychologists, teachers, and students of these fields.

The Book's Parts

The first part concerns **developmental psycholinguistics**, which is Dorit Ravid's deepest passion, especially the aspect of Hebrew morphological and morpho-lexical development. She is considered a leading researcher and expert in this topic both in Israel and around the world, sharing her theoretical ideas and collaborating in research with many leading psycholinguists. She started with experimental studies spanning the full range of Hebrew morphological structures, outlining their development in children, adolescents, and adults, being one of few researchers who studied later language development at the time. As she found her theoretical habitat in Usage-Based language learning theories, she and her students moved on to investigate the emergence of linguistic structures such as noun plurals and verb morphology in the lexicon, in corpora of natural parent-toddler interactions and peer talk, as well as in texts written by non-experts from primary school children to adults. These studies encompass a large age range, reflecting her perception of language acquisition as a bottom-up process, starting with small units and notions and dynamically developing into a complex multi-dimensional knowledge system. Recently Dorit has started leading an innovative and comprehensive research on the emergence and development of Hebrew syntax in toddlers, while looking at both child's speech (CS) and child-directed speech (CDS) in this process. This research reflects her never-ending quest for gaining knowledge on the process of language development.

It is only fitting that this part starts with a chapter written by Dorit's mentor, teacher, and dear friend, Ruth Berman. The chapter focuses on the morpheme *še-* (that), analyzing it across development. The changes in its usage are attributed to the combined impact of factors of linguistic and cognitive development, the typology of Hebrew as the ambient language, and the effect of individual and diachronic language change. In the following chapter, Eve Clark compares the acquisition of subjects to the left of verbs in English and in French from a communicative perspective. Edy Veneziano examines the relation between the comprehension and production of articles and subject clitic pronouns in two-year-old French-acquiring children. Elena Tribushinina and her colleagues present an experimental study on the incremental processing of prenominal modifiers by three-year-olds, examining the effects of prototypicality and contrast. Finally, Marilyn Nippold and Valencia Perry provide a review of studies on the use of past tense counterfactual (PTCF) sentences by English-speaking children, adolescents, and adults.

The relationship between **Language and Cognition**, constituting the second part of this book, is a topic that fascinates Dorit and has guided her research in the last decades. Dorit conceptualizes language as a cognitive system that is highly related to general cognitive capacities and language development as channeled through developing (socio-)cognitive abilities. Dorit's research on written and spoken language advocates a Usage-Based approach to language, providing numerous illuminating arguments for the non-modularity of language within the cognitive system. This part consists of six chapters, covering a wide range of topics within the language and cognition interface. Virginia Gathercole and her colleagues examine the encoding of figure and ground in motion events, showing that memory is affected by particular linguistic encoding. Sven Strömqvist sketches a general model of language production, highlighting the dynamic interaction of language and thought. Dominiek Sandra examines spelling errors, focusing on the interplay between low-frequency morpho-orthographic rules and high-frequency verb homophones, showing how they are affected by attentional resources in working memory. Eva Smolka and Wolfgang Dressler account for the processing of complex words in German, through the morphological lens of roots and stems. They argue for the psychological reality of these linguistic constructs, highlighting the importance of cross-language comparisons. Francesco Gardani and Chiara Zanini touch on the subject of numerical cognition and its manifestation in language contact. They argue that the higher borrowability of high numerals (relative to lower ones) can be explained by their being less deeply anchored in cognition. Finally, Sidney Strauss discusses the pro-social roots of teaching, proposing a complex model of teaching that considers it as more than just information transfer.

Another field of study which Dorit Ravid has been a key contributor to is **Linguistic Literacy**. Starting from the 1990s, she has been among the scholars whose work pushed the boundaries of language development research forward from its original focus on early acquisition into later stages—that is, from late childhood, through adolescence, and into adulthood. Extending the scope of research to these later stages has naturally led to its extension in terms of modality as well, sparking an interest in the development of written language and literacy. An important milestone in the formation of literacy as a field of psycholinguistic inquiry was Dorit Ravid and Liliana Tolchinsky's seminal 2002 paper titled "Developing Linguistic Literacy: A Comprehensive Model." The paper offered a highly influential account of linguistic literacy as hinging on one's ability to flexibly draw on a wide variety of both spoken and written styles of discourse in order to accommodate different communicative circumstances.

Six chapters comprise the part on literacy. Very fittingly, the part starts with a chapter by Liliana Tolchinsky, where she goes back to examine her and Dorit's aforementioned paper precisely 20 years after its publication, reviewing the advancements that have occurred in the field of linguistic literacy during the last 20 years. Just as fittingly, the part is concluded with a chapter by David Olson, whose work is extremely important for our understanding of literacy and the relationship between spoken and written language, and who deeply influenced Dorit's thinking and work. Here, Professor Olson provides us with a thought-provoking paper on the concept of understanding and its role in reading and reasoning. The remaining four chapters deal with further, important aspects of literacy. The chapter by Shuai Zhang, Bing Han, Alida Hudson, Karol Moore, and R. Malatesha Joshi examines the role of morphological awareness in learning to read and write in different languages and types of orthographies. Lior Laks, Ibrahim Hamad, and Elinor Saiegh-Haddad focus on the Arabic verbal system, examining how the distribution of verbal patterns in narrative texts is affected by the language variety on the one hand (Palestinian Arabic vs. Modern Standard Arabic) and production modality on the other (spoken vs. written text production). Dorit Aram and Iris Levin's paper describes an intervention program offered to mothers from low socio-economic backgrounds which was successful in improving the quality of their shared book reading activities with their children. Finally, Davide Crepaldi, Marcello Ferro, Claudia Marzi, Andrea Nadalini, Vito Pirrelli, and Loukia Taxitari compare two methods used for tracking the reading behaviors of adult readers in real time, namely, tracking eye movements and tracking finger movements.

Social and Environmental Diversity captured Dorit's interest from the beginning of her research career when she compared low and high SES subjects' morphological and morphophonological abilities in her PhD. In the 2000s, suggesting possible language and literacy gaps due to low SES sounded outrageous, but leaning on Usage-Based language acquisition theories, the equal importance of cognitive abilities and of the environment for a robust development of these domains became very clear to Dorit. With her colleagues and students she kept on researching the impact of social and environmental deprivation in both experimental and corpus studies, finding critical differences between low and high SES subjects. These gaps were apparent in the input to infants and toddlers and in their own output, as well as that of older children, adolescents, and adults. This part examines the effect of the environment from three different perspectives: SES, migration of work seekers and refugees, and bilingualism. From the SES perspective, Ayhan Aksu-Koç and Burçak Aktürk Arı examine the resilience of Turkish vocabulary, inflectional morphology, and morphosyntax, based on cross-sectional maternal report data of a large sample of 16- to 36-month-old toddlers from three SES backgrounds. Katharina Korecky-Kröll, Sabine Sommer-Lolei, Veronika Mattes, and Wolfgang U. Dressler compare the use of morphological verb families in German-acquiring children from high and low SES, using a model developed by Dorit Ravid and her colleagues. Elite Olshtain and Ester Cohen Sayag present literacy intervention programs and their challenges in Hebrew, Arabic, and English, targeting low SES students. Moving on to the topic of migration of work seekers and refugees, Shira Cohen, Bonnie Levin-Asher, Mor Levi, Anat Hamburger, and Liat Kishon-Rabin discuss a language intervention program designated for children from disadvantaged ethnic minorities belonging to political asylum-seeking and refugee families in the Tel Aviv area. The program was initiated by the Tel Aviv University School of Communication Disorders and was carried out by speech-language clinicians and students, taught by Dorit in her many years of serving as a faculty member in this school. From a slightly different perspective, Michal Tannenbaum and Ayelet Rimon Stern examine the complex interactions between language and education, emotional aspects, and family relations in this population. Finally, on the third perspective of bilingualism, the acquisition of noun plurals in four- to eight-year-old Hebrew-Russian speaking children was examined by Sharon Armon Lotem and Julia Reznik, looking into the impact of bilingualism on morphological processing.

It has always been important to Dorit to make sure that her research does not remain purely theoretical but is used to improve the work of educators and clinicians in the field of language. During her career of over 30 years as Professor in the School of Communication Disorders in Tel Aviv University, she has mentored generations of speech-language pathologists, many of whom went on to become influential clinician-researchers in their own right. The research she has done with her students over the years has made an invaluable contribution to the understanding and treatment of language and communication disorders. The part **Clinical Perspectives** is a tribute to this important aspect of her work. It comprises three chapters, focusing on three different clinical populations. Jolien Faes, Joris Gillis, and Steven Gillis examine the development of morphosyntactic abilities in profoundly hearing-impaired children who had been implanted with an auditory brainstem implant. Rachel Schiff, Shani Kahta, and Ayelet Sasson compare the performance of dyslexic adults on an auditory and a visual lexical decision task, concluding that morphological priming effects are observed only with an auditory presentation. Esther Dromi and Yonat Rum provide an outline of the clinical profile of children with autism spectrum disorder, describing the various cognitive, linguistic, and behavioral characteristics of this population.

Dorit's work on language is rooted in many territories, as evidenced by the variety of topics covered in this book. The last part of this Festschrift concerns one of the most basic arenas shaping Dorit's research interests, namely, **Hebrew Linguistics**. As a researcher of Modern Hebrew, Dorit has always emphasized the importance of knowing the structure and history of the language in accounting for its current psycholinguistic usage by native speakers and development in children. And with her being an avid poetry reader, the Hebrew language breathes through her teaching and lecturing. The last part of the book, dedicated to Hebrew Linguistics, consists of three chapters. Shmuel Bolozky discusses the role of suffixes in the formation of Hebrew nouns and adjectives, showing that productive derivation of Hebrew nouns and adjectives very often involves patterns with suffixes. Ora (Rodrigue) Schwarzwald focuses on the morphophonological and semantic aspects of a particular nominal pattern in Hebrew. Discussing root and pattern combinations, Schwarzwald shows that although the phonemic shape of a word might not indicate its basic pattern, a comparison with other (morphological) processes may indeed reveal its underlying pattern. Finally, Have Bat-Zeev Shyldkrot explores expressions of life and death in Hebrew, tracking their development from Biblical to contemporary usage. Bat-Zeev Shyldkrot shows that these expressions tend to acquire a great number of meanings, and that the most considerable changes took place only recently, in Modern Hebrew.

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Orit Ashkenazi
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Contents

Part I
Developmental Psycholinguistics

Developmental Pathways in Child and Adult Hebrew: The Case of the Subordinator *še-*

Ruth A. Berman

Abstract The paper is dedicated in affection and esteem to my former student, valued colleague, and dear friend, Dorit Diskin Ravid (The title of this paper deliberately echoes that of Ravid's (Language change in child and adult Hebrew: a psycholinguistic perspective. Oxford University Press, 1995) book *Language Change in Child and Adult Hebrew.* Oxford University Press. I am grateful to Sarah Winkler for editing the manuscript and to Dalit Assouline for help with transcriptions.). Focusing on a single multifunctional morpheme in Modern Hebrew—the quasi-equivalent of 'that' of English or *que* ~ *che* of Romance languages—it reflects themes from work of mine over the past several decades (including with Dorit), based on two principles: that language has a long developmental route well beyond preschool, and that general facets of this route can be illuminated by in-depth analysis of a particular linguistic construction. The chapter starts by noting changes in use of the grammatical morpheme *še-* and its alternatives between Biblical and Modern Hebrew, followed by description of the developmental trajectories it displays in different syntactic constructions and discursive contexts from early childhood to adolescence. Distribution and functions of this morpheme and its alternatives are analyzed in adult–child interchanges, extended texts, and structured elicitations to demonstrate how use of a single form changes across development. These findings are explained as due to the combined impact of factors of general linguistic and cognitive development, the typology of Hebrew as the ambient language, and the relationship between language change across time in individual development and in the history of the language.

Keywords Biblical Hebrew · Clause-combining · Language development · Register · Modern Hebrew · *še-* · Subordination · Usage-based

The author is indebted to Bracha Nir of Haifa University and to three anonymous reviewers for valuable feedback on earlier versions of this paper. Inadequacies which remain are mine alone.

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The paper is dedicated in affection and esteem to my former student, valued colleague, and dear friend, Dorit Diskin Ravid. Many of the ideas framing this study echo themes in Ravid's (1995) pathbreaking book on language change in child and adult Hebrew. Based on analysis of some dozen grammatical systems in Modern Hebrew, Dorit investigated ten different groups of participants divided by age-schooling level and SES background to provide a thoroughgoing, evidence-based study of variation in Modern Hebrew. In diachronic perspective, she points to "the fact that Biblical Hebrew continues to constitute the major source of Israeli Hebrew morphology and lexicon"; sociolinguistically, her study provides an illuminating comparison between "normative and linguistic reality" in current Hebrew usage; and, psycholinguistically, she proposes that "literacy and cognitive maturation go hand in hand" to explain her findings for language development from age 3 years to adulthood.

The present study embraces these ideas in analyzing the morpheme *še-* (translated for the time being as 'that') in Modern Hebrew (MH). Underlying the analysis are two complementary principles: That language development follows an extended route "from emergence via acquisition to mastery" (Berman, 2004a) and that this path can be illuminated by in-depth examination of a particular linguistic form from toddlerhood to adolescence.

A major finding of psycholinguistic research over recent decades, spearheaded by the "frogstory" project on narrative development in different languages (Berman & Slobin, 1994), including Hebrew (Berman & Neeman, 1994), was that gaining mastery of language use extends well "beyond age 5" (Karmiloff-Smith, 1986). This insight has is at the core of studies in what has come to be called "later language development" (Berman, 2008; Tolchinsky, 2004). The present chapter aims to contribute to this domain by tracking developmental changes in use of the morpheme *še-*, which corresponds roughly to the English form 'that' or *que* ~ *che* in Romance languages.[1] As such, the grammatical marker *še-* joins earlier research of this author in tracking developmental trajectories in different domains of Hebrew linguistic structure and language use.[2]

The paper begins by comparing Biblical versus Modern Hebrew (MH): Relying on prior research in this area: Historical changes in the use and distribution of *še-* are noted by examples from Biblical Hebrew (Sect. 1.1) followed by data-based

[1] This correspondence applies to Hebrew *še*-functioning as a subordinating marker, not as a question word or demonstrative, demonstrating that seeming similar grammatical functors are rarely *equivalent* across languages. For example, the Hebrew genitive marker *šel*, translated as 'of', never functions as a preposition, unlike English *of* or Romance *de* (as in English *learn of*, *be afraid of*), while in the linguistics literature, Hebrew *še* is translated variously as 'that' (Ariel, 1978; Glinert, 1989) or as 'that, which, who' (Maschler, 2020). Nir (2020) avoids translating Hebrew conjunctions including "due to their functional non-equivalence to apparently corresponding terms in English as well as at different periods in the history of Hebrew."

[2] My inquiries into language development from early childhood to adolescence include: inflectional morphology (Berman, 1986), narrative construction (1988), null subjects (1990), the verb-pattern *binyan* system (1993), use of the coordinating conjunction *ve-* 'and' (1996), impersonals (2011), and infinitival constructions (2018).

evidence surveying functions of the target form in current adult Hebrew (Sect. 1.2). The chapter then analyzes the distribution and functions of *še-* across three periods of development: early emergence among toddlers (Sect. 2.1), school-age acquisition in middle childhood (Sect. 2.2), and consolidation of grammar and usage in adolescence (Sect. 2.3). The study concludes (Sect. 3) by discussing what these changes reveal from the point of view of Hebrew typology, language acquisition, and the relationship between diachronic change and linguistic register (Sect. 3).

1 Linguistic Description of Hebrew *še-*

It might seem odd to pin so much on a single monosyllabic item like Hebrew *še-*, which is written as part of the next word, hence as a bound morpheme.[3] Yet *še-* plays an important role in Modern Hebrew syntactic structure and discourse. Glinert (1989, p. 309) defines the form *še-* rather loosely, but quite accurately, as "the 'unmarked' all-purpose conjunction". The present study aims to show that the morpheme *še-* serves both across the history of Hebrew and in child language development (i) as a *pre-clausal subordinating conjunction*, which (ii) marks *syntactic dependence* in clause-combining complex syntax, and (iii) represents a *multifunctional* marker of different grammatical and semantic relations.

1.1 Occurrence of Alternatives to še- in Biblical Hebrew

Studies of Biblical Hebrew demonstrate, as argued for example by Nir (2020), that "the following four conjunctions are typically found in the Biblical texts as markers of dependency … : *ašer*, *še-*, *im*, *ki*", challenging the common view that Biblical syntax was mainly paratactic (and see, too, Givón, 1991). Below, use of three of the items mentioned by Nir, together with the definite marker *ha-,* is illustrated from Biblical Hebrew (BH), as background to key themes of the present study: (i) Largely the same repertoire of forms is found in both early and current Hebrew, but (ii) they differ in distribution and in function from Biblical to Modern Hebrew, and (iii) older

[3] In written Hebrew, the morpheme *še-* is prefixed to the following word, not separated by a space, as are six other grammatical markers in Hebrew that are written as separate words in many European language: the coordinator *ve-* 'and,' the prepositions *mi-* 'from,' *be-* 'in, at,' *ke-* 'as, like,' *le-* 'to,' and the definite marker *ha-*. It is not clear whether preliterate children regard *še-* as a separate "word," on a par with non- attached "word-like" items such as the genitive marker *šel* 'of,' or the prepositions *al* 'on,' *im* 'with.' Preliminary psycholinguistic investigation into placement of *pauses* in extended spoken discourse suggests that speakers perceive *še-* as a *separate* item in the stream of speech (Nir & Berman, 2010). In-depth psycholinguistic study (beyond work on "reading prosody," for example, of Koriat et al., 2002), could demonstrate whether literate adults regard *še-* as a bound form in speech as well.

forms, where retained in current usage, characterize more formal, elevated registers, which are largely irrelevant to the language of young children.

The first set of examples illustrates alternation of different markers of Relatives Clauses in BH, all roughly translatable as ‘that’: *ʔašer* in (1) and (2) *, še*-in later Biblical Hebrew in (3), and the definite marker *ha-* in restricted contexts in (4). The first set of examples show uses of the Biblical Relative Clause marker *ʔašer,* variously translated as ‘whom,’ ‘that,’ ‘which’ (in the Gideon, 1974, translation based on the authorized King James version) in examples from the Pentateuch in (1a) to (1c) below.[4]

(1)

a. וַיֹּאמֶר יְהוָה אֶמְחֶה אֶת הָאָדָם אֲשֶׁר בָּרָאתִי מֵעַל פְּנֵי הָאֲדָמָה b(בראשית ו ז)
wayyōʔmer YHWH ʔemḥē ʔet hāʔādām ***ʔăšer*** *bārāʔtī mēʕal pənê hāʔădāmā* (Genesis 6:7)
‘And the Lord said I will destroy man **whom** I have created from the face of the earth’

b. וַיֹּאמְרוּ כֹּל אֲשֶׁר דִּבֶּר יְהוָה נַעֲשֶׂה וְנִשְׁמָע (שמות כד ד)
wayyōʔmərū ***kōl ʔăšer*** *dibber YHWH naʕăśē wənišmāʕ* (Exodus 24:7)
‘And they said **all that** the Lord hath said will we do, and be obedient’

c. וַיַּקְרִבוּ לִפְנֵי יְהוָה אֵשׁ זָרָה אֲשֶׁר לֹא צִוָּה אֹתָם (ויקרא י א)
wayyaqrib̲ū lifnê YHWH ʔēš zārā ***ʔăšer*** *lō ṣiwwā ʔōtām* (Leviticus 10:1)
‘And (the sons of Aaron) … put incense thereon, and offered strange fire before the Lord, **which** he commanded them not’

The same form *ʔašer* also occurs, more restrictedly, as an *adverbial* conjunction, preceded by a bound preposition, as in the comparative markers *meʔašer* ‘from-that = than’ and *kaʔašer* ‘as-that = as, in the way that,’ as in (2).

(2)

וִיבָרֵךְ אֶתְכֶם כַּאֲשֶׁר דִּבֶּר לָכֶם (דברים א יא)
wiyb̲ārēk̲ ʔetək̲em ***kaʔăšer*** *dibber lāk̲em* (Deuteronomy 1:11)
‘and will bless you **as** He hath promised you’

In later books of the Bible, *ʔăšer* was increasingly replaced by *še* as a Relative and occasionally an Adverbial marker. Givón (1991) points out that gradual change in tense-aspect and word order “across the BH dialectal continuum is closely paralleled by the phonological reduction of the clausal subordinator *ʔăšer*, predominant in Early Biblical Hebrew (…e.g. Genesis), to *še-,* predominant in Late Biblical Hebrew (…e.g. Song of Songs) and Mishnaic Hebrew”. The examples in (3) are taken from Givón, and follow his transcription of written Hebrew and his free translations.

(3)

a. *ve-sane'áʔš-ti ʔani ʔet-kol ʕamal-i* ***še-*** *ʔani ʕamel*
‘And I hated all toil **that** I toiled
še- *ʔaniaħ la-ʔadam* ***še-****yiħye ʔ'aħar-ay*
‘that/because I will leave it to someone **who** would come after me’ [Eccl., 2.18]

b. *ma dod-ekh mi-dod* ***še****-kakha hišbaʕ-t-anu*
‘…what is so special about your lover **that** you have thusly sworn us?’ [SoS. 5.11]

[4]The phonetic transcription in examples (1), (2), (4), and (5) observes the traditional conventions of Biblical scholars. The examples in (3), also based on the written language, adopt the version used by Givón (1991).

In contrast, across Biblical Hebrew, when directly followed by a *benoni* participial form of a verb, the preferred relativizer is *ha-*, the same form as the definite marker meaning 'the,' as in (4).

(4)
וְהַזָּר הַקָּרֵב יוּמָת (במדבר א נא)
*wə**ha**zzār **ha**qqārēb̲ yūmāt* (Numbers 1:51)
'and **the** stranger **that** cometh shall be put to death'

In some current usage, too, the form *ha-* occurs as a relativizer, when immediately preceding a verb in the *benoni* participial form (Berman, 1978, pp. 143–145), just in case the relativized noun is understood as the subject of its clause (Glinert, 2004).

As for the subordinator *ki*, this served both as an adverbial marker and to introduce Complement Clauses in Biblical Hebrew, as in (5a) compared with (5b), both from the same passage.

(5)
a. וַיְהִי כִּי עָלִינוּ אֶל עַבְדְּךָ אָבִי (בראשית מ כד)
*wayhī **kī** ʕālīnū ʔel ʕab̲dək̲ā ʔāb̲i* (Genesis 40:24)
'And it came to pass **that** we went up to your servant my father'
b. אַתֶּם יְדַעְתֶּם כִּי שְׁנַיִם יָלְדָה לִּי אִשְׁתִּי (בראשית מ כו)
*ʔattem yədaʕtem **kī** šənáyim yāldā lī ʔištī* (Genesis 40:26)
'You knew **that** my wife gave birth to two sons of mine'

As demonstrated below, these three markers of clause-combining—*ʔašer*, *ha-*, and *ki*—occur in Modern Hebrew, too, but they differ in distribution as well as in syntactic and discursive functions (Sect. 1.2). Moreover, in language addressed to and produced by children, the form *ʔašer* is totally absent; *ha-* functions only as a definite marker, rarely as a relativizer; and *ki* serves to mark adverbial clauses of reason, not to introduce complement clauses (Sect. 2.1).

1.2 Directions of Change: The Spread of še-

This section notes differences between Biblical and Modern Hebrew (MH), in the sense of current usage of educated, non-Hebrew-language experts, native-speaking adults.[5] The key motif here is the spread of *še-* in contemporary Hebrew, already noted in studies of different periods in the history of the language (e.g., Ariel, 1978; Nir, 2020; Reshef, 2004). The present analysis is based on two corpora of authentic, unedited data elicited from university students and graduates: (a) Ten lengthy oral interviews conducted between linguistics students and their friends or family

[5] Many of these were attested in later Biblical and early post-Biblical periods (Ben-Hayyim, 1953; Givón, 1991; Rubinstein, 1985).

members telling about their life history, collected in the Berman Lab, and (b) texts produced by Hebrew-speaking university students in the study of Berman and Ravid (1999). In the latter sample, each participant produced four texts on the topic of violence in schools: (i) an oral personal-experience narrative recounted to a friend, (ii) a story written in class on the same topic; (iii) a talk to be given in a class setting discussing the problem; and (iv) a written essay on the topic. The present study compares texts of Type (iv) and Type (i) produced by the same speaker-writer, since written expository passages (iv) represent the most elevated and monitored style of usage, while oral narratives about personal experiences recounted to a peer use less formal, more colloquial forms of expression.[6]

This section details the extension of *še-* as the marker par excellence of the three main types of dependent clauses in Hebrew: Relative Clauses (Sect. 1.2.1), Complements (Sect. 1.2.2), and Adverbials (Sect. 1.2.3).

1.2.1 Marking of Relative Clauses (RCs)

Four changes are noted between Biblical and Modern Hebrew marking of RCs: (i) Replacement of *ʔašer* by *še-*; (ii) restricted use of the definite marker *ha-* to introduce RCs*;* (iii) unmarked asyndetic RCs; and (iv) headless RCs.

(i) **Marking relative clause by *še-* in place of Biblical *ʔašer***
In MH, the Biblical relativizer *ʔašer* – as in (1a) to (1c) – is confined to formal usage.[7] The ten oral interviews between Hebrew-speaking adults (sample (a) above) contained not a single use of *ašer*; nor did the corpus of personal-experience oral narratives told by university students (in sample (b). But in the expository essays written by the same students on the same topic (violence in schools), two-thirds of the participants used the form at least once, as in (6a) and (6b).[8]

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[6] A hierarchy from least to most formal and elevated register of the four text types emerged across different languages in a cross-linguistic project along similar lines as our 1999 study (Berman, 2008), as described for register in English (Bar-Ilan & Berman, 2007) and Hebrew (Berman & Ravid, 2009).

[7] The relativizer *ʔašer* is represented with an initial *alef* for Biblical Hebrew, but as *ašer* for current usage, where the glottal stop is generally not pronounced.

[8] Modern Hebrew forms are represented in *broad phonemic* script (see Berman, 2020a, Appendix, Tables 2 and 3). Phonetic symbols for non-English phonemes are as follows: ***c*** for English *ts* as in ***ts****unami*, *ha****ts***; ***x*** for the velar fricative as in *lo****ch***, *Ba****ch***, standing for both the velar and pharyngeal letters *chaf* and *het;* ***š*** for English *sh* as in ***sh****eep*, *pu****sh***. The guttural elements *alef* and *ayin* are not represented, since they are rarely pronounced in General Israeli Hebrew. Word stress is marked by an acute accent when non-word final (compare the verb *paam* 'throbbed' with word-final stress and the noun *páam* 'time' with word initial stress). Orthographically bound morphemes (see footnote 2), except for the target form *še-,* are separated from the following word by a hyphen, e.g., *ha-iš* 'the man,' *ba-báyit* 'at home.' Non-normative but colloquially common spoken usages are retained (for example, a young man pronounces 'in Jerusalem' as *be-yerušaláyim* in place of normative ***bi****rušaláyim.* And see, too, the example in footnote 16 of mixed register, which has a common agreement error: *haya*-SING *li hamon* ***tauyot****-*PLUR 'I had [literally, there was to me] tons of errors.'

(6)

a. *le-maase ha-alimut ha-milulit ha-"tmima" ve-ha-lo mazika šel ha-yom,* ***ašer*** *ke-negda lo poalim be-oda be-iba, hoféxet la-alimut ha-fízit šel maxar*
'In fact, the "innocent" and non-harmful verbal violence of today, against **which** people fail to act when it is still in the bud [= at its early stages], turns into the physical violence of tomorrow'

b. *benisayon lehavin et ha-nose* ***še*** *be-yamim trufim eyle hafax le-kauv … yeš le-havin et ha-mitanim* ***še*** *itam magiim ha-yeladim … be-derex klal kayamim xaverim …* ***ašer*** *"mexamemim" et ha-avira*
'In an attempt to understand the topic **that** in these crazy times has become painful … we need to understand the handicaps with **which** children arrive … usually there will be some students … **who** "heat up" the atmosphere'

As shown by (6b), use of *ašer* alternates with *še-* in the written essays of these adult speaker-writers. In contrast, the oral stories that these two women told to a friend used only the subordinator *še-* for marking relative clauses. And this was true across the oral interviews and narratives produced by young adults talking to their peers, indicating that Biblical *ašer* is confined to the more formal and monitored context of expository writing.

(ii) **Use of *še-* as a relativizer in place of Biblical *ha-* preceding a *benoni* form**

The definite article marker *ha-* 'the', as in the Biblical example in (4), is infrequent for marking RCs in colloquial Hebrew, and is rare across our corpus. The excerpts in (7), from university graduate students, show that in their written essays, adults occasionally use *ha-* as a relativizing conjunction preceding a verb in the *benoni participial* or present-tense form.

(7)

a. *barur* ***še*** *yéled* ***ha-gadel*** *mul masax ha-maxšev… yitkaše lehaciv et ha-gvul* ***kaašer*** *hu mesaxek im yeladim amitiyim ve-lo im dmuyot virtuáliyot al ha-mirka*
'(It is) obvious **that** a child **who grows up ~ growing up** in front of a computer screen … will find it difficult to set a boundary **when** he plays with real kids and not with virtual figures on the screen'

b. *gam* ***kaašer*** *hem mabiim bikóret nokévet al more* ***še*** *yeš tofaot šel Mafia, protékšen, šxitut ve-xadome be-kérev ha-talmidim … amura lehitkayem bahem alimut be-hetem la-alimut* ***ha-rováxat*** *bi-xlal ha-oxlusiya*
'Even **when** they express biting criticism of a teacher **that** there are Mafia-like incidents, protection, corruption, and so on among the students, … there is supposed to exist among them violence in keeping with the violence **that prevails ~ prevailing in** the population at large'

c. *mitparsemim yoter ve-yoter mikrim šel alimut be-mosdot …* ***še amurim*** *lihyot ha-mexanxim klapey ha-mitxanxim … rabim me-ha-anašim* ***ha-oskim*** *be-xinux eynam anšey xinux*
'More and more incidents of violence are publicized in institutions … **that are-supposed** to be the educators vis-à-vis the educatees … many of the people **that work ~ working** in education are not educators'

The excerpt in (7c) demonstrates inconsistent use of *še-* alternating with *ha-* as a relative marker before a *benoni* passive participle: *mosdot …* ***še amurim*** 'institutions that (are) supposed …' versus *anašim* ***ha-oskim*** *be-xinux* 'people that work in education' with the *benoni* serving as a present tense verb, similarly to ***ha-rováxat*** 'that prevails' in (7b). This tendency to avoid *ha-* as a marker of RCs except in formal or literary context*s* reflects contemporary speaker-writers' perception of what was originally the nominal *benoni* participle: Today it functions predominantly to mark present tense on verbs, alternating with person-inflected past and future tense verbs (Berman, 2014). Earlier structurally- motivated observations (Berman, 1978, pp. 146–149) are confirmed by usage-based evidence that today, *ha-* is increasingly confined to its function as a definite marker of nouns, rarely to mark RCs that open with a *benoni* form participle.[9]

In sum, two main differences emerge between MH usage compared with Biblical Hebrew in marking syntactically dependent clauses: First, historical forms—like the relativizers *ašer* and *ha-* as well as the adverbial conjunctions ***kaašer*** 'when,' ***meašer*** 'than' (see below)—are used only restrictedly by speaker-writers of MH, and only in the formal context of expository writing. Second, when they do us them, speaker-writers tend to intersperse these forms with the preferred subordinating conjunction *še-*.

(iii) **Asyndetic relatives**

RCs that are not introduced by an overt relative marker are common in English relatives on an object noun phrase (e.g., *students* ***0*** *the lecturer praised; the man* ***0*** *we were talking about*). In Hebrew, the corresponding construction would be an RC that is joined directly to its main clause, without any marking (e.g., *ani roce šaon* ***ose tik-tak*** 'I want (a) clock **goes tick-tock'** from a two-year-old boy). Not a single such example occurred in the adult corpus, since a clear property of relative clauses (in fact of dependent clauses in general) in Hebrew is that they must be overtly marked by a subordinating conjunction with *še-,* as the default case for this purpose.

MH has three ways of marking RCs, differing in how far they conform to the dictates of prescriptive norms (Mor, 2020). These are shown in (8): The examples in (8a) illustrate asyndetic RCs; those in (8b) and (8c) are constructed examples based on (8a), with (8c) the most approved by purists.[10]

[9] An additional constraint on use of *ha-* as a relativizer is that it is ungrammatical in *in situ* asyndetic RCs, as in the example below in (8ii), where *ha-baxurim še dibarnu itam* 'the-boys that we-spoke with-them' cannot be replaced by a *benoni* form verb preceded by *ha-*—the corresponding RC *ha-baxurim* **ha-medabrim** *itam* 'the-boys that-talk [PLURAL] to-them' refrs to the head noun as Subject, not Object, meaning 'the boys that are talking to them' and not 'the boys that they are talking to.'

[10] Examples of asyndetic RCs from our database:

(i)	*ani ba bemaga im yeladim* ***otam*** *ani melamed nosim be-ekologiya*
	'I come in touch with kids **them = whom** I teach topics in ecology'
(ii)	*lemoxorat ima šeli halxa la-xéder* ***bo*** *raínu televízya*
	'The next day my mother went to-the-room **in-it = in which** we saw television'

(8)

a. ASYNDETIC

(i) *ha-raayon **oto** heelénu*
‘the idea it [Accusative] we-raised = the idea we suggested’

(ii) *ha-baxurim **itam** dibárnu*
‘the-boys with-them we-spoke = the fellows we spoke to’

b. CLAUSE-INITIAL še-

(i) *ha-raayon **še** heelénu*
‘the-idea **that** we-suggested’[11]

(ii) *ha-baxurim **še itam** dibárnu*
‘the fellows **that with-them** we-spoke’

c. IN SITU RESUMPTIVE PREP+PRO:

(i) *ha-raayon **še** heelénu **oto***
‘the-idea **that** we-suggested **it**’

(ii) *ha-baxurim **še** dibárnu **itam***
‘the people **that** we-spoke **with-them**’

Reshef’s (2004) detailed study of type (8a) RCs, based on written sources, describes the Modern Hebrew asyndetic clause as “the rise of a new syntactic mechanism,” one that was not attested in earlier stages of the language. Her intuition that speaker-writers consider the asyndetic type of RC in (8a) to represent formal, elevated usage is confirmed by seminar papers submitted to the author by university linguistics majors, while in the current database, asyndetic RCs were, again, confined largely to the written expository texts. The most widespread usage across the corpus was type (8b), with an introductory *še-* followed by an object-marking preposition (excluding nominative contexts like *ha-raayon še huala* ‘the-idea that was-raised,’ *ha-baxurim še azvu* ‘the boys that left’). The prescriptively favored *in situ* version of (8c) occurred only occasionally, once again only in written essays.[12]

Consistent findings emerged from Nir’s (2015) analysis of Relative Clause usage in written and spoken texts analogous to the ones analyzed here, produced by another group of Hebrew-speaking adults (Berman, 2008). Nir found that RCs were the most common type of (bi-clausal) subordination in both the narrative and expository texts she examined, with high-register *ašer* and subordinating *ha-* as well as asyndetic relative clauses being relatively rare, and occurring mainly in the written essays.

(iv) **Headless RCs**

MH makes wide use of *non-referential* or ‘headless’ *RCs*. These typically replace Biblical forms like *kol ʔašer* ‘all which,’ as in (1b). Today, these constructions

[11] Hebrew RCs require a resumptive pronoun with prepositional objects, as in example (i) in (8b). This may be used but is generally not required when the verb takes a direct object, as in (8a-i) versus (8b-i).

[12] A personal anecdote. When the authorities at Hebrew University insisted that I have a Hebrew language expert edit my doctoral dissertation (Berman, 1973) for style and usage, almost the only change she made across the lengthy two volumes was to switch all relative clauses to the *in situ* type illustrated in (8c).

generally take the form of a grammatical question word followed by *še-* {Q + *še-*}, as in the following documented examples: From young preschool children—***ma*** *še ani lokáxat* ‘**What** that-I take [= what I take’]; *hu kara* ***kol ma*** *še ha-horim kanu lo* ‘He read **all what** [= everything that] his parents bought him;’ and from older schoolchildren—*tivxar* ***mi*** *še ata roce* ‘choose **who**(ever) you want’; *xipásti* ***efo*** *še amárta li* ‘I looked **where** that [= wherever] you told me’; *ani avo* ***matay*** *še tagid li* ‘I’ll come **when** that [= whenever] you’ll tell me.’

These constructions are of interest for several reasons. While frowned on by purists, such extensions in contexts for using *še-* occur from early childhood. They can be seen to compensate for the lack of relative pronouns in Hebrew. In more normative usage, the question word in these {Q + *še-*} constructions is replaced by generic nouns such as *kol* ***davar*** *še* ‘any **thing** that,’ *kol* ***adam*** *še* ‘any **person** that,’ *kol* ***makom*** *še* ‘any **place** that,’ *kol* ***páam*** *še* ‘every **time** that,’ particularly in adverbials of place or time. But these are relatively formal in style, while the {Q + še} construction is well established in current usage of children and adults alike.

To reiterate, our usage-based records underscore the preference in MH for employing *še-* to mark different types of RCs at different levels of usage in MH.

1.2.2 Use of še- Replacing ki to Mark Complement Clauses

In Biblical Hebrew, as shown earlier in (5a) and (5b), the form *ki* served to introduce both Complement and Adverbial Clauses. Today, *ki* still may be used to mark complement clauses, as in (9).

(9)
a. *kvar az yaxoltem* ***lehivaxax ki*** *en li hamon ma lomar ba-nose ve-****še*** *deotay enan maftiot klal*
‘Even then you could **recognize that** I do not have much what [=a lot] to say on the matter, and-**that** my opinions are not at all surprising’
b. ***nire ki*** *yeš lehasbir la-morim* ***še*** *alehem limnóa kol akt šel alimut*
‘(it) appears **that** (one) needs to explain to teachers **that** (it) is incumbent upon them to prevent any act of violence’

Examples like those in (9) of ***ki*** introducing a complement clause were few and far between across the corpus.[13] And, again, they alternate in the same context with *še-* functioning as the predominant marker of complement clauses across the corpus. Instead, *ki* is commonly used to mark **adverbial clauses of reason** as in (10).

[13] These are termed *noun clauses* in traditional grammars and *content clauses* in Hebrew language studies (e.g., Zewi, 2008.)

(10)
a. ***kanire še*** *en brera ela lehitmoded im ha-alimut be-draxim metuxkamot*
‘**(it) seems that** (there‘s) no alternative but to deal with violence in sophisticated ways’[14]
b. *ha-baxur hitakeš ve* ***amar še*** *hu xayav livdok* ***ha-im*** *yeš li néšek o lo*
‘the guy insisted and **said that** he had to check **the if [= whether**] I had a gun or not’
c. *kday* ***še*** *nizkor* ***ki*** *higánu kvar le-xama ve-xama mikrey récax*
‘(it’s) worthwhile **that** [= we should] remember **that** we’ve already arrived at several cases of murder’

The morpheme *še-* is not only the favored marker of Relative clauses at all levels of style, it is also the main way of introducing Complement clauses in today’s Hebrew.[15] One reason for this spread is that the function of *ki* has shifted largely from marking complements in Biblical Hebrew to marking adverbials of **reason** in MH, from ‘that’ to ‘because’ as shown below.

1.2.3 The Construction {PREP + še-} Introducing Adverbial Clauses

The form *še-* also functions to introduce adverbial clauses in MH, in the distinctive construction {PREP + *še-*}. These are illustrated, by no means exhaustively, from our corpus, starting with reason clauses.

(i) **Adverbial clauses of reason or causation**
Different prepositions serve to express causal relations, having the same meaning, as shown by the translations in (11a) to (11d).[16]

(11)
a. *giluyey alimut madigim* ***mekevan še*** *toceoteyhem alulot liheyot xamurot*
‘signs of violence are worrying **because (that)** their results may be severe’
b. *hi kaasa alay meod* ***mipney še*** *hi hidpísa rov ha-avoda*
‘she was very angry with me **because (that)** she printed most of the paper’
c. *ha-pekida lo azra lanu* ***mišum še*** *ha-davar lo hitafšer la*
‘the-clerk didn’t help us **because (that)** it wasn’t possible for her’
d. *ani mecayer beikar* ***biglal še*** *ani ohev et ze*
‘I draw mainly **because (that)** I like it’

Structurally, the bolded causal conjunctions are morphologically complex, taking the form {PREP + STEM + *še-*}. The preposition must be one of the four basic

[14] The modal expression *ka-nire še* ‘as seems that = it seems that’ is frowned on by purists, who advocate either omitting the preposition (> *nire* ***še*** + CLAUSE) or the conjunction (> *kanire* + CLAUSE) in this context.

[15] Indirect question complements are marked by a question word like *ha-im* ‘whether’ in (10b) or other interrogative morphemes in information-question complements like *hu lo yada* ***ma*** *kara ve-***madúa** <u>*hu nimca*</u> *šam* ‘He didn’t know **what** happened and **why** he was there.’

[16] The etymologies of the introducing Prepositions may be suggestive in this connection, but these are known only by Hebrew language specialists and so not accessible to ordinary, even educated speaker-writers.

prepositions that serve to construct adverbial phrases in MH (Nir & Berman, 2010), illustrated in (11a) to (11c) by ablative *mi-~ me* 'from, than' and in (11d) by locational *be-* 'in, at'. Except for *mi-pney* in (11b), where the preposition is followed by a genitive form of the noun *panim* 'face,' translatable as 'in the face of', the bound stems *-kevan,- šum, -glal* are opaque. The bound stem may sometimes serve as a preposition, as in elevated *mišum hitnagduto* 'because-of his opposition,' *biglal ha-ráaš* 'because-of the-noise.'[17] The four {PREP + STEM + *še-*} expressions in (11) differ in level of formality: *mekevan še* was restricted to written essays, *mipney še* occurred only once or twice in the oral materials, *mišum še* was distributed fairly evenly across the various samples—suggesting it is the most neutral in terms of usage.[18] The expression *biglal še* in (11d) occurred only in the oral conversational materials, not in the extended texts. While it is common in everyday usage, speaker-writers perceive it as less suited to more formal contexts. And, indeed, *biglal še* is a recent extension of the {PREP + *še-*} construction, a sign of how available it is to innovation, although the usage is still frowned on by purists as not documented in ancient Hebrew sources.

Reason clauses are the only adverbials that are marked not only by the complex {PREP + *še-*} construction but also by monomorphemic *ki* as in (12). The special status of *ki* as a marker of cause rather than in its Biblical function as introducing complement clauses is illustrated in (12a), where a 4th-grade girl asked to talk about problems of interpersonal conflict uses both *biglal še* and *ki* to mark reason clauses in the same context (with the text divided into clauses). The example in (12b) is taken from the conversation of a young man telling the investigator (a friend of his) what he thinks about current Hebrew.

(12)

a. *le-xavera yeš šináyim im géšer*
'A friend of mine has teeth with braces [literally, a bridge]
ve ani lo roca liyot ita, ***biglal še*** *yeš la géšer*
'and I don't want to-be with her **because (that)** she has braces
az ze meod maaliv, ***ki*** *ze klum, géšer.*
'and it's very insulting, **because** it's nothing, braces,
géšer ze stam le-yašer et ha-šináyim ***še-*** *yihyu briyot*
'braces are just to-straighten the teeth (so) that they'll be healthy'.

[17] Hebrew prenominal prepositions and pre-clausal conjunctions contrast morpho-syntactically with their counterparts in English. Compare ***biglal*** *ha-ráaš* '**because-of** the noise' ~ ***biglal še*** *hu asa ráaš* '**because (that)** he made a noise.'

[18] This observation is underlined by the mixed register usage in a statement like the following, from a man in his 20s telling about his experiences in high school, where what are considered non-acceptable or very colloquial usages are **bolded**: *lo hicláxti* ***afílu*** *lehagía la-ciyun* ***haxi*** *namux ba-kita mišum še* ***haya*** *li* ***hamon*** *tauyot* 'I didn't manage **even** to get to the **lowest** grade in the class because there **was** to me [= I had] **lots** of errors.'

b. *ani xošev* ***še*** *šoxaxim kcat et ha-makor*
'I think that (people) forget the origin a bit
ki *yeš hevdel ben sleng le-ben le-daber ivrit mekulkélet*
'because (there) is (a) different between slang and speaking bad Hebrew
ze kvar inyan šel xinux …
'It's a matter of education
ki *efšar ledaber ivrit im sleng*
because you can talk Hebrew with slang …
aval ledaber ota naxon.
'but to-speak it correctly'.

The excerpts in (12) show how *ki* can alternate with complex {PREP + *še-*} constructions in reason clauses. Yet *ki* was used for this purpose only occasionally, as against the common use of *biglal še*, both in texts produced by younger children, as in (12a) and in adult spoken interchanges in (12b). And *ki* was rare in the classical function to introduce complement clauses, confined to the written essays of adults.

In sum, given the variety of forms available to MH speaker-writers for expressing causal relations between predications, we found that (i) even children prefer a lexically complex construction to monomorphemic *ki*, and (ii) in everyday usage *ki* expresses cause rather than to introduce complements.

(ii) **Adverbial clauses expressing temporal relations**

Temporal clauses also use {PREP + *še-*} constructions, but unlike reason clauses, these express different semantic relations (e.g., *ad še* 'until (that),' *lifney še* 'before (that),' *axarey še* 'after (that),' *bi-zman še* 'at-the-time that = while,' *kol od še* 'all more that = as long as.)' These illustrate the multifunctionality of complex {PREP + *še-*} constructions as prototypical pre-clausal conjunctions in Modern Hebrew. Thus, expressions of simultaneity, in the sense of English *when, while,* alternated in the data-base between Biblical *kaʔašer*, reduced nowadays to neutral *kše-* 'as that' = when,' commonly further reduced to unmarked *še-*—in (13) to (15) respectively.

(13)
a. [Repeated from (7b)] *gam* ***kaašer*** *hem mabiim bikóret nokévet al more … amura lehitkayem bahem alimut*
'Even **when** they express biting criticism of a teacher … there is bound to exist among them violence'
b. [From the same speaker as (6a)] ***kaašer*** *ani xošévet al ha-mila "alimut" ani miyad xošévet al šimuš be-koax ha-zróa o be-xol emcai axer al mnat lifgóa ba-zulat pgia fízit*
'**When** I think of the word "violence" I immediately think of use of bodily force as another means to hurt others by physical injury … '
c. *ha-more im gabo la-kita* ***kaašer*** *ani roa ha-kol be-hištakfut ba-xalon*
'the teacher has his back to the class **when ~ while** I can see everything reflected in the window'

Use of *kaašer* occurred several times in adult written usage. Elsewhere, reduced *kše-* 'as that' was the most common means of expressing simultaneity between co-occurring events across the sample, in all types of usage, as in (14).

(14)

a. Written expository: ***kše-****hem niklaim lemacavim éle, hem ponim le-gorem samxuti*
'**When-**they get caught in such situations, they turn to an authority … '

b. Written narrative: ***kše-****hikarti ota ze haya axarey še hi yaca mi-tkufa kaša meod*
*'**When**-I met her, it was after she had come out of a very tough time'*

c. Oral interview: ***kše-****xazárnu mi-xuc la-árec … hi hitxíla laxšov lo lehišaer ba-mošav*
'**When-**we returned from abroad … she began thinking not to stay in the village'

A noteworthy feature is the further bleeding from *kaašer* > *kše-* > *še-* yielding an **underspecified** means of expressing 'when', as in (15).

(15)

a. Adult, oral narrative: ***še*** *hitxálti lilmod hexláteti lirkoš ofnóa*
'**that [= when]** I began studying, I decided to buy a motorcycle'

b. 17-year-old, written narrative: rávnu, ve-***še*** *hu nigen, kibíti lo et-ha-magber …*
'We argued, and-**that [= when]** he started playing, I turned off his amplifier'

c. 9-year-old boy, written narrative: *yom lemaxarat* **še** *báti la-betséfer, nixnásti …*
'The next day, **that [= when]** I came to school, I went into … '

This under-specification of Main Clause / Dependent Clause relations is thus not confined to small children or to spoken usage, even though it leads to semantic opacity, since omission of the prepositional *k-* to indicate 'as, at the time' extends use of bare *še-* from post-nominal RCs and Complements to Adverbial clauses. Usages like those in (15) lack a preposition that explicitly specifies the semantic (causal) content and syntactic (adverbial) function of *še-*, even though, as shown earlier, the {PREP + *še-*} construction is readily available in varied contexts.

(iii) Purpose Adverbials

Expression of a relation of purpose between the main and dependent clauses is of interest like the reason clauses noted earlier, it uses different lexical options in the {PREP + *še-*} construction without a change in meaning. This is shown in (16) from written adult texts.

(16)

a. *hu nizhar bidvarav* ***al mnat še*** *lo yipagu*
'He was caution in his-words **on-account that** [=in order that] they would not be offended'

b. *hem panu la-mora* ***kdey še*** taazor lahem
'They turned to the teacher so that (she) would help them'

Purpose can also be expressed with the preposition *bišvil,* literally 'in/on path = benefactive for', is *bišvil še* 'for that = so that'. As a recent innovation, not puristically acceptable, this form was found only in the spoken narratives, among younger speakers. As we saw for reason clauses, choice of preposition preceding *še-* to express purpose is a matter of level of style, from elevated *al mnat* to more common and everyday *kdey* followed by non-normative *bišvil*.

Purpose clauses in MH often replace the {PREP + *še-*} construction with a non-tensed infinitival clause, as in (17), from picture-based stories told by schoolchildren (Berman & Neeman, 1994).

(17)

a. *ha-yéled tipes al ha-ec* ***le-xapes*** *et ha-cfardéa*
'The boy climbed the-tree **0** to-look for the frog'

b. *ha-yéled tipes al ha-ec* ***kdey le-xapes*** *et ha-cfardéa*
'The boy climbed the-tree **so as to**-look for the frog'

c. *ha-yéled tipes al ha-ec* ***al mnat le-xapes*** *et ha-cfardéa*
'The boy climbed the-tree **in order to**-look for the frog'

The examples in (17) alternate in level of usage and associated frequency. Unmarked infinitives expressing purpose (Berman, 2018) are common across the sample, usually with the purposive preposition *kdey* 'as-enough = so that'. Moreover, again across the sample, purpose clauses favor the non-tensed infinitival form, unlike other types of adverbial subordination.[19]

In sum, current Hebrew makes extensive use of *še-* in a range of tensed subordinate clauses (Relatives, Complements, and Adverbials), with occasional exceptions: Alternating with zero in Asyndetic Relatives; with *ki* in reason clauses; with non-tensed infinitives in purpose clauses; with other markers in conditional constructions.[20] It is also occasionally replaced by the coordinator *ve-* 'and' in some restricted contexts.[21]

In interactive contexts, *še-* may introduce a clause that is not directly adjacent to its main clause, in what Evans (2007; Evans & Watanabe, 2016) terms "insubordination," where nonfinite clauses serve as main clauses. In her study of "the insubordinate – subordinate continuum" in Hebrew conversations, Maschler (2020) defines "insubordination" as "syntactically un- or loosely-integrated še- clauses."

These are contextually rather than syntactically dependent constructions and so confined to conversational interactions, and—as shown in the next section—play a role in early child language through the "supportive contexts" provided to toddlers by their caretakers (Berman & Lustigman, 2014).

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[19] This disregards other adverbial relations that are also subordinated by {PREP + *še-*} constructions, including adversative (*lamrot še*, *af al pi še*), comparative (*kmo še, kfi še*) , quantitative (*ad kama še*, *kexol še*). In all three cases, the two examples differ in register rather than in meaning, the first being more colloquial, the second more formal.

[20] The main type of adverbial clause that does not rely on this construction in MH is conditionals, with factual conditionals introduced by *im* 'if, whether' and hypotheticals by *lu, ilu* 'in case.'

[21] A few complex causative constructions replace normative *še-* by the coordinating conjunction *ve-*, e.g., *heyot še* 'being that' versus everyday *heyot ve-*, *meaxar še* 'from after that = seeing that' ~ *meaxar ve-*.

2 Developmental Trajectories

This section addresses what is termed “acquisition of complex sentences” by Bowerman (1979) and Limber (1973) and, more recently, by Diessel (2004), while Clark (2012, pp. 229–253) heads this section as “combining clauses – more complex constructions” (2012). We take as our basic unit of analysis the *clause*—defined as a unified predication expressing a single situation (event, activity, or state)—so as to avoid attributing the abstract construct of “sentence” to early child utterances (possibly to oral language in general).

Here, we track changes in the distribution and functions of *še-* and its alternatives in three types of data as playing a role in *clause-combining* from toddlerhood to adolescence. Use of *še* is examined in different contexts—adult–child interchanges, extended texts, and structured elicitations—across three developmental stages (Berman, 2004a): *emergence* at ages 1–3 years (Sect. 2.1), *acquisition* in middle childhood at ages 7–10 years (Sect. 2.2), and *mastery* in adolescence and beyond (Sect. 2.3).

2.1 Emergence in Toddlerhood: Ages 1–3 Years

The database for this section derives from the following sources: (i) work with Lyle Lustigman (2016a, b, 2021; Berman & Lustigman, 2014, 2016, 2020) on longitudinal samples of four Hebrew-acquiring children between ages 1;0 to 3;6 years, supplemented by two cross-sectional corpora; (ii) Dafna Kaplan’s (1983) masters’ thesis analyzing the grammatical development of children clustered in six age-groups starting from 1;9–2;0 years and up to age 3;6 years (Klein, 2021); and (iii) cross-sectional recordings of 20 children at each of the year-groups 1–2 years, 2–3, 3–4, and 4–5 (Dromi & Berman, 1986).

The first finding is that *še-* emerges in Hebrew children’s usage at the same time as has been documented for early clause-combining in other languages, around age 2 years. Second, it occurs together with other markers of clause-combining, particularly the coordinator *ve-* ‘and,’ (Berman, 1996), together the two most neutral and widespread means of combining predications in Hebrew. That is, initial evidence of subordination and coordination co-occurs. in Hebrew at all events. These two markers of clause-combining are soon followed, usually well before age 3 years, by two other markers of subordinate and coordinate clauses, respectively: *ki* meaning ‘because’ and *aval* ‘but’ (Lustigman, 2021; Lustigman & Berman, 2016).

A second, Hebrew-specific observation is as the following. Across the large and varied database, from the youngest age on, there was almost **no** *omission* of an overt marker of clause-combining, by ungrammatical juxtaposition of two clauses (like the one mentioned earlier from a 2-year-old boy *ani roce ša'on*] ***ose tik-tak*** ‘I want (a) clock] goes tick-tock’). Hebrew-speaking children appear to realize from the outset that the second of two predications which are linked together in a single intonational contour must be overtly marked as a single utterances. In this, Hebrew complex syntax contrasts, for example, with English—in finite complement clauses like *the people 0 we spoke to, the stories 0 they told us* or in nonfinite relative clauses like *the people 0 speaking to us, the stories 0 told about us.* The corresponding Hebrew clauses would in each case be marked by *še-* in place of zero.

A third observation is non-Hebrew specific. Initially, *še-* like other markers of coordinated and subordinated clause-combining, does not occur autonomously in children's speech, but is *scaffolded* by various types of contextual input from caretakers. This helps to foster early clause-combining abilities as it does for other, less advanced areas of grammar, including verb inflections (Clark & de Marneffe, 2012) and stringing successive single-word utterances (Scollon, 1976; Veneziano, 1999). Of the different kinds of "supportive contexts" in our corpus (Berman & Lustigman, 2014), the example in (18) illustrates what we called *co-constructed clause combining*, where the adult provides an utterance that triggers the child's dependent clause.

(18)

a. ADULT: *az ma at roca miméni?*
'So what (do) you want from-me?'
CHILD: ***še*** *taazri li*
'That you'll help me'

b. CHILD: *ze gam li* [Lior, aged 2;3]
'That (is) also for me'
MOTHER: *ma amart, xamuda?*
'What (did) you-say, sweetie?
CHILD**:** ***še*** *lo yihiye li kar,* ***še*** *lo naim li ba-roš*
'(so) that I shouldn't be cold, **that** my head isn't comfy'

c. ADULT: *láma uga ktana*
'Why (do you want) small cookie?'
CHILD: ***še*** *en la uga gdola* [Leor, 2;7].
'That-there's-no for-her (a) big cake (= because she does not have big cake)'

Such co-constructions of clause-combining sequences triggered by the adult (usually in the form of question–answer adjacencies as in "why–because" sequences) provide support to young children en route to autonomous formation of complex syntactic constructions. They reflect what in adult interactive conversation is termed "insubordination"—where a dependent clause, in this case introduced by *še-,* aids children in constructing clause linkages.

Lustigman identified four shared *developmental stages* for the children whose language she analyzed between ages 1;6 to 3: (i) Initially, children juxtapose clauses as separate utterances, without grammatical marking of the relations between them. (ii) At Stage II, they introduce a second clause in a single utterance, most often by the basic coordinating marker *ve-* 'and' as well as to a lesser extent by *še-*. At this early stage, *še-* often occurs as an unspecified "general purpose" marker of an ambiguous or vague relationship between the main and dependent clause, as in (19b) below. Subsequently, in Stage III, children use *še-* increasingly, and more conventionally, to introduce complement and adverbial clauses (mainly in the sense of 'when,' alternating with *ki* meaning 'because'). Later, around age 3 years, at Stage IV, *še-* serves to mark Relative and non-temporal Adverbial clauses with {PREP + *še-*} complex conjunctions, mainly *biglal še* for reason, *kdey še* for purpose, and *ad še* 'until' for time.

These developments are illustrated in (19) from the corpus analyzed by Lustigman, combined with data from the cross-sectional sample, which confirmed the same developmental trends. Here, a hashtag # stands for the end of an utterance and a bracket] marks clause boundaries in a single utterance, and children's age are indicated by year and month.

(19)

Stage I

a. **Sequential, Unmarked Simple Clauses**
(i) *ze misxak. # oy, hu nogéa be-ze*.
'It's (a) game. # 'Oh, he's touching it' [Lior, 2;0]
(ii) *hu hitxil laléxet # et mi hu raa šam*?
'He started to-leave, who (did) he see there?' [Hagar, 2;6]

b. **Unspecified, General Purpose Marking**
(i) *ani rak yoréket* ***še*** *ha-dúbi b*axuc [Lior, 2;6]
'I only spit **that** the (gummy) bear's out(side)'
(ii) *at roa*, ***še*** *ze šaṭúax* ***še*** *ani yaamod al ha-ricpa ve-ani etgaleš* [Leor, boy, 2;10]
'You see, **that** it's flat **that** I'll stand on-the-floor and I'll slip'
(iii) *ani srufa] me-ha-šémeš* ***še*** *ani yašávti al ha-kise*. [Naama, 2;7]
'I'm burnt from the sun **that** I sat on the chair'

Stage II

a. **Complement Clause**
(i) *hu roe* ***še*** *ha-bank sagur*
'He sees **that** the bank's closed' [Leor, 2;11]
(ii) *hi amra* ***še*** *hi lo roca*
'She said **that** she (does) not want (to)' [Maayan, 2;8]

b. **Reason Clause** [with *ki*]
gam lánu yeš ***ki*** *Nican tinok*
'We also have (one), **because** Nitsan's (a) baby' [Lior, 2;9]

c. **(Unspecified) Purpose Clause**
tasimi po ***še*** *Nican iga'*
'Put (it) here **that** Nitsan will-touch' [Lior, 2;7]

Stage III

a. **Reason Clause** with {PREP + ***še-***}
hu boxe káxa ***biglal še*** *hu rak tinok*
'he cries like that **because** he's only a baby' [Lior, 2;11]

b. **Temporal Clause**
nelex la-bank ***kše-****yiftexu et ha-manul*
'We'll-go to-the-bank **when**-(they)-will-open the-lock' [Leor, 2;11]

c. **Relative Clause**
(i) *hu min zeev* ***še*** *ose hav hav*
'he's a kind of wolf **that** goes bow-wow' [Leor, 2;11]
(ii) *ani roca buba* ***še*** *sáfta kanta li*
'I want (the) doll **that** granny bought me' [Naama, 2;10]

Stage IV

Adverbial Extensions with {prep **+** ***še-*}**
(i) *hi noténet li svéder* ***kdey + še*** *ani lo eheye xola*
'she gives me (a) sweater **in order that** I won't be sick' [Ofra, 3;1]
(ii) *elex lišon* ***axarey še*** *aba yavo habáyta*
'I'll go to sleep **after** Daddy will-come home' [Yiftach, 3;2]

Both the longitudinal and cross-sectional corpora show that once toddlers begin to use the morpheme *še***-**, between ages 2 to 3 years, they do so increasingly, in a more conventional and explicit manner, and in a wider variety of syntactic and semantic contexts. Ages 3–4 years show a clear increase in such uses. This is shown in (20), from a girl named Maayan, aged 3;9 years talking to an investigator.

(20) (i) *hu ba la-báyit šeli* ***biglal še*** *hu xaver šeli, rak* ***mi še*** *xaver šeli (h)u ba elay*
‘He came to my house **because** he’s a friend of mine, only (someone) **that (is)** a friend of mine comes to me.’
(ii) *naxzor le-bet séfer* ***axarey še*** *yigamer (h)a-Pésax*
‘We’ll go back to school **after** Passover ends’.

The basic uses of *še* **thus** seem to be commanded early on in development. But they are confined to stringing two or three clauses together in a largely linear fashion. Only later do children make greater and more varied uses of *še***-** by linking together longer syntactic packages.

2.2 Acquisition in Middle Childhood: 8–10 Years

By grade-school age, Hebrew-speaking children use *še-* in various syntactic and semantic contexts. This section illustrates a middle level of the developmental route in use of the target morpheme, based on **compositions** written by 4th-grade Israeli children asked to discuss the problem of violence in schools. This communicative context represents the most advanced and sophisticated type of language usage of the four text-types elicited (see Sect. 1.2) in both the Hebrew-based and cross-linguistic oral and written, narrative and expository texts analyzed (e.g., Bar-Ilan & Berman, 2007; Berman, 2008; Berman & Ravid, 2009). The excerpts that follow are from children aged 9 to 10 years: Clauses are numbered consecutively; clause-boundaries are marked by]; angle brackets <…> indicate embedded clauses that are inserted into another dependent clause; and double brackets]] indicate a separate syntactically and/or thematically linked “clause package” (Berman & Nir-Sagiv, 2009). Subordinate and coordinate conjunctions with a clause-linking function, including *še-*, are marked in **bold**.

(21)

Gili, 4th grade girl, aged 9 [1st 10 of total 23 clauses]

1–2 *ani xošévet*] ***še*** *lo carix alimut ba-olam*] …
‘I think] **that** there should not be violence in the world]]’

3–10 ***im*** *ata rav im mišhehu*]*ve hu matxil lehakot otxa*] ***az*** *ata lo carix lehakot oto be-xazara*]
‘**If** you quarrel with someone] and he starts to hit you] **then** you shouldn’t hit him back]
ata rak carix lehasbir lo] ***še*** *ha-alimut zo lo ha-dérex ha-nexona*]
‘you just have to explain to him] **that** violence is not the right way]
še *hi lo tiftor davar*] *ve še* <*im hu yarbic*> ***az*** *zot ha-dérex ha-kaša yoter ve-ha-lo nexona.*]]
‘**that** it doesn’t solve anything] and that **<if** he hits> **then** that’s the hardest and not correct way.’

The text in (21) shows relatively advanced use of *še-* for a child in 4th grade. She begins with a discourse-marking introductory *complement* clause in the form *ani xošévet še* 'I think-FEMININE that'. corresponding to English 'I think that,' French *je trouve que* … in stating personal opinions (The phrase occurs no fewer than four times in her 23 clauses, to segment her text by each new idea she expresses). Second, most uses of *še-* in (21) mark **complement** clauses. These are a more linear, less complexly embedded form of clause-combining than Adverbials and Relatives, since they function as arguments of the Main Clause verb (Noonan, 1985, p. 42) and so are semantically and syntactically "highly integrated" in the sentences in which they occur (Cristofaro, 2003; Croft, 2001). [22] Third, she alternates use of complement clauses with *conditionals* marked by *im … az* 'if … then' sequences, noted earlier as the main type of dependent clause in Hebrew that does not make use of *še-*. Fourth, and relatively rare at this age, she links together as many as seven coordinated and subordinated clauses in a single syntactic package surrounding the main clause *ata rak carix lehasbir lo* 'you just have to explain to-him.' Moreover, also rather unusual at this age, this package includes a dependent clause embedded inside a coordinate clause, both complements of the same predicate 'explain' in the main clause: 'you have to explain to him] that violence is not the right way] **and that** it does not solve anything.' Finally, she alternates use of *še-* with *ki* for cause and *im* for condition.

To show that these are not isolated instances, consider the excerpt from another 4th grade composition in (22).

(22)

	Dana, 4th grade girl, aged 9 [Total 17 clauses]
7	*alimut yexola ledaati lifgóa mi-bxina nafšit yoter* ***me-ašer*** *mi-bxina gufanit*]]
	'Violence can in-my-opinion harm emotionally **more than** physically]]
8–10	***kaašer*** *šney xaverim ravim*] *kol exad mehem yipaga*]
	'**when** two friends quarrel each one of them will-get-hurt
	ve-yeraxem al acmo]]
	'and feel sorry for himself'
14–17	*ani betuxa*] ***še*** *yeš od hamon yeladim xuc miméni*
	'I am sure] **that** there are lots of other kids besides me
	še *xošvim*] ***še*** *olam bli alimut yiheye yoter yafe*]]
	'**that** think] **that** a world without violence would be nicer'

This child uses a self-consciously high register style of language, noted earlier for adult essays. For example, she uses elevated *le-daati* 'in my opinion' in place of the common *ani xošev/et* 'I think/FEM' and Biblical *ašer* in place of everyday *še-* in clauses 7–8. She, too, uses *še-* mainly in complement clauses, giving the passage a linear type of clause-linkage compared with the more complexly embedded constructions in (21). This may a function of the expository genre of discussion in (21) and (22), which presents grade-schoolers with considerable difficulty (Berman &

[22] In contrast to complement clauses, Adverbials and Relative Clauses function as optional **Modifiers** of Main Clause verbs (Thompson & Longacre, 1985) and Noun Phrases (Keenan, 1985), respectively.

Nir-Sagiv, 2007). In contrast, the personal experience narratives of these and other 9-year-olds contained numerous instances of Adverbial {PREP + *še-*} constructions, as well as several Relative Clauses, as in (23).

(23)

a. **Gili [cf. (21)]:**

1–2 *ha-banot rávu im Nikol*] ***lifney še*** *báti* [TIME ADVERBIAL]
'the girls quarreled with Nicole] **before** I came'

19 *raíti šam kama banot*] ***še*** *báu lesaxek itánu* [RELATIVE CLAUSE]
'I saw there some girls] that came to play with us'

b**. Dana [cf. (22)]**

8–12 *axar kax raíti et ha-album]* ***kaašer*** *ha-madbekot axat al ha-shniya*]
'Afterward I saw the album] **when** the stickers were on top of each other]
ve-madbekot axerot be-makom] *še lo ahávti*] ***še*** *yiheyu*]]
'and other stickers (were) in a place] that I didn't like] that (they) will-be.'

13–14 *hitragázti alehem]* ***afílu še*** *lifamim asíti lahem carot gdolot yoter]]*
'I was mad at-them] **even that [= though]** I sometimes caused them worse trouble]]

18–20 *hayiti merugézet aleyhem harbe zman*] ***mišum še*** *ha-madbekot* < *še ahávti*>
I remained mad at-them a long time] **because** the stickers <that I liked>
hayíti crixa lizrok]]
'I had to throw out']].

21–23 *le-vasof hišlámti itam]* ***lamrot še*** *kolkax kaásti]*
'Eventually I made up with them] **even though** I was so angry.']]

22–23 *aval ad hayom ani kcat koéset*] ***al ma še*** *hem asu li*]]
'but to this day I am a little sore] **about what (that)** they did to me']]

The excerpts in (23) show that the same girls who used *še***-** primarily to introduce Complement clauses in writing expository essays in (21) and (22), use it to mark a variety of Adverbial relations—cause, time, adversity, contradiction—as well as different types of Relative Clauses in writing stories describing experiences with interpersonal conflict or violence. These comparisons demonstrate the impact of *genre* on use of *še***-** *in* subordination by schoolchildren well as adults (noted in Sect. 1.2). The question then is what remains, if anything, en route to mastery in use of this item in adolescence.

2.3 Mastery of Expressive Options: Adolescents Aged 16–18 Years

High-school students use the target element *še-* in more diverse syntactic contexts to express more varied lexico-semantic relations than younger children. *Complement* Clauses are introduced by a wider range of matrix clause predicates, in addition to basic *xošev* 'think,' *amar* 'said', to include *verba dicendi* and cognitive verbs like *taan* 'claimed,' *savar* 'assumed,' *teer le-acmo* 'describe to-himself = imagine.' Second, in *Adverbial* clauses, adolescents use {PREP + *še-*} constructions beyond basic clausal and temporal expressions to include higher-register terms for 'because' like *mipney še, mikevan še*, and more specific temporal markings like *ba-réga še* 'at the minute that = as soon as,' *kol páam še* 'each time that = whenever.' High schoolers also referred to more types of semantic relations, including *bimkom še* 'in place that = instead of,' to express alternatives, *kmo še* 'like that' or higher-register *kfi še* 'as that' for comparisons or to mark similarities, and *lamrot še* 'in-spite that' or high register *af al pi še 'even that = although'* for adversatives. With age, young people exploit their larger lexicon to express numerous alternative possibilities in linking Main Clauses to the circumstances restricting or depicting when, how, and why events did or did not take place.

Relative Clauses in the high school texts included more headless relatives beyond basic *ma še-* 'what that' (e.g. *lo hiskámti im* ***ma še*** *hu amar* 'I didn't agree with **that [= what]** he said' to *kol mi še* 'all who that = whoever,' and with general purpose nouns like *kol davar še* '*any thing that*,' *kol adam še* 'all person that = anyone.' They also make occasional use of asyndetic relative clauses, perceived as a higher register of usage—e.g., *ha-šulxan* ***alav*** *ani noheg lixtov* 'the-table [MASC] **on-it** [MASC] I usually write = on which I write'; *ha-xinux še kiblu me-ha-sviva* ***ba*** *hem xayim* 'the education that they received from-the-environment [FEM] **in-it** [FEM] they live = the environment in which they live.' That is, the written essays of high-school students reflect greater sensitivity to register distinctions and different genres than do younger schoolchildren (Berman, 2016).

A particularly sophisticated usage found almost only in adolescence and beyond replaces tensed subordinate clauses with *še-*, not only in asyndetic Relative Clauses, but by means of abstract verb- or adjective-derived *nominalizations*. Examples include *lamrot kaasi* 'despite anger-my = in spite of my anger' (cf. *lamrot še kaásti* 'although (that) I was angry'), *biglal ha-hitkahalut* 'because (of) the gathering' (cf. *biglal še hitkahalu* 'because that they gathered together'), *mipney ha-hitnagdut šeli* 'because-of my opposition' (cf. *mipney še hitnagádeti* 'because I was opposed').

Finally, the sophisticated syntactic strategy of inserting one dependent clause inside another, as in the embedded clauses produced by younger schoolchildren in (21), reflect advanced cognitive abilities at preplanning and advance organization of what the writer links together in a single chunk of information. High schoolers package larger bits of information by stringing thematically related clauses together in a single syntactic chunk as in (24) below, and they do so in more varied ways, for example by embedding or inserting, say, a complement clause inside a coordinated clause, or a relative clause following the initial subject noun of a complex sentence, as in (25). Again, clauses boundaries are marked by], embedded clauses are enclosed in angle brackets < … > and the entire chunk is marked off by]].

(24)

11th grade girl, age 17

17–18 *hi amra li] še hi maadifa linsóa la-festival*]
'She told me] that she prefers to go to-the festival]
bimkom še nisa kulánu le-Eilat]]
'instead that we all go to Eilat']]

9–23 *ha-meriva nimšexa ke-šloša yamim*] ***ad še*** *le-va-sof nigmar be-xax*]
'the quarrel lasted some three days] **until** eventually it-ended in-it]
še *Keren ve-xaverta nasu ba-sof la-festival*] *ve-lo higíu le-Eilat*]
'**that** Keren and her friend eventually went to-the-festival] and never got to Eilat]
kfi še *nikba me-roš*]]
'**according that** = as had-been decided in advance']]

(25)

11th grade girl

4–9 *ba-sof nocar macav*] ***še*** *kol axat me-itánu hevína zot le-xivun šone*]
'In the end (there) arose a situation] that each of us understood it differently]
kax še <kše *higía ha-réga le-haavir et ha-inyanim> kol axat nora kaasa al hašniya*]
'so that <when the time came to transfer matters > each of us was mad at the other]
še lo hevánu naxon] *ve heevárnu méşer axer*]]
'that we hadn't understood right'] and we'd sent a different message']]

We conclude by considering implications of the changes we have traced in use of *še-* in the history of the language (Sect. 1) and of individuals (Sect. 2) in a range of communicative contexts.

3 Discussion

, Three major findings emerged from this study: First, the same forms occur in both Biblical and current Hebrew; second, across time, these forms change in frequency and function; and third, older forms tend to be confined to more formal registers of use, hence confined to later, more literate stages of language development. Here, we the implications of these findings from three points of view: Hebrew typology (Sect. 3.1), Developmental trends (Sect. 3.2), and the interplay between Diachrony and Linguistic Register (Sect. 3.3).

3.1 Hebrew Typology

The forms reviewed in this study were largely recorded as far back as Biblical Hebrew, although changed in both frequency and function in MH. This underlines the typologically 'mixed' or 'fused' character of MH as drawing concurrently on forms taken over from different periods in its history. The Hebrew scholar Ben-Hayyim (1953), argued that nothing in Modern Hebrew has died, but rather that different chronological layers exist and are used in the language alongside rather than on top of one another, unlike in languages with a historical continuity. This claim was subsequently illustrated in rich research on MH, in such domains as genitive relations and compounding in MH (reviewed in Berman, 2020b). That is, MH uses elements from earlier stages in the history of the language (here Biblical Hebrew), but it both expands and condenses the repertoire of forms available, as argued by Nir (2020) and Zeldes (2013) in discussing whether MH has retained its Semitic sources in syntax as well as in morphology. The present study, too, shows that Hebrew retains clear traces of its antecedents, with changes evident more in functions than in forms, analogously to changing form-function relations in child language development (Slobin, 2001).

Findings of this study underscore from a usage-based perspective features noted in structuralist research on the morpheme *še-*. (i) It is *multifunctional*, (ii) serves to mark syntactic dependency in all and only the three major types of *tensed* subordinate clauses: Complements, Adverbials, and Relatives; (iii) it alternates with two types of nonfinite subordination in Modern Hebrew, infinitives (Berman, 2018) and, more restrictedly, *benoni participles* (Berman, 2014; Dubnov, 2015); and (iv) has largely replaced Biblical *ʔašer* in all but formal contexts.

Multifunctionality, in the sense of one-to-many and many-to-one form/meaning relationships is not confined to *še-*. It is quite typical of grammatical markers in Hebrew (Berman, 1996, 2018) as in other languages. For example, Culicover and Jackendoff (1997) point out that "the English subordinator *that* serves to mark both complementation and relativization, while the coordinator *and* (like French *et*) may express both additive and conditional interpretations (e.g., *You drink another can of beer <u>and</u> I'm leaving*). And the same type of connection may be expressed by different connectives, such as *but* and *although*." On the other hand, Hebrew *še-* differs from its counterparts in Germanic and Romance languages in that, first, it serves exclusively as a (multifunctional) subordinator, never as a question-word or demonstrative;[23] and, second, it combines with prepositional items to form the major class of complex adverbial conjunctions in the unique {PREP + *še-*} construction. These clause-combining constructions both differ from and share properties with Prepositional Phrases of the form {PREP + NP}: Compare the PP *ad ha-érev* 'until the-evening' with the clause *ad še yaxšix* 'until that (it) will-get dark,' *biglal maxalato* 'because (of) his illness' / *biglal še hu xole* 'because that he (is) ill', *lamrot ha-ráaš* 'despite the-noise' / *lamrot še haya roeš* 'although (it) was noisy'.

The study also reiterates the interplay between morphology and syntax as a feature of MH typology, noted elsewhere for such areas as compounding and genitive constructions, for voice, valence and transitivity, nominalizations, and case-marking pronominals (Berman, 2020a). The present analysis combines considerations of syntax, discourse, and register to show, for example, that complex conjunctions are distributed differently by genre: The {PREP + *še-*} construction is widespread in personal experience narratives, compared with use of largely logically related atemporal commentary in expository texts. And analysis shows that selection of subordination markers reflects more general differences in MH usage between written and spoken language, and between more elevated and informal styles of usage.

[23] Generative accounts of Hebrew syntax often refer to a non-existent class of *wh- words* in the language. True, as noted in Section 1.3, question words like *ma* 'what,' *mi* 'who,' *efo* 'where,' *ha-im* 'if = whether' can serve as non-referential heads of relative clauses, and they also introduce indirect question complements (e.g, *raca ladaat* ***efo*** *hayínu ve* ***ma*** *asínu* 'He wanted to-know **where** we were and **what** we did'). But this by no means turns them into a coherent and phonologically related grammatical category.

3.2 Developmental Trends

Given the by now well-established domain of “later language development” as a recognized facet of psycholinguistic research—one to which Dorit Ravid has made a rich contribution—it should come as no surprise that development in use of *še-* demonstrates a lengthy developmental route from early childhood to adulthood. The study also provides evidence for Slobin’s (2001) ideas on changes in form-function relations across time: The same linguistic form (in this case *še-*) comes to serve new functions, and previously acquired functions are met by new forms (unmarked *še-* to explicit *kše-* ‘when’ on to more formal, classical *kaašer*, or marking of causal relations initially by *ki*, extended to *biglal še*, *mipney še*, *mekevan še*). Another developmental theme reinforced by this study is that grammatical elements do not develop in isolation: In the case in point, the morpheme *še-* plays a key role in clause-combining syntactic complexity, to express complementation, adverbial relations, and relative clause modification, while at the same time being elaborated to meet purposes of connectivity in discourse by packaging together several thematically segments of a text.

The study shows that *še-* as the prototypical marker of clause-combining complex syntax in Hebrew emerges at an early age, between 2 and 3 years, along with the coordinator *ve-*, at the time when, across languages, command of the native grammar flourishes. As in early grammar in other languages, subordination first emerges as non-autonomous, in adult-supported scaffolding contexts. Specific to Hebrew are two phenomena in this connection: There are almost no instances where, once clause-combining is autonomously produced, children fail to mark the dependent clause by ellipsis of *še-*. Rather, *še-* serves widely as an *underspecified* marker of subordination, ambiguous between different adverbial senses or as marking relative clauses.

By school-age, such ambiguities are restricted to the neutral temporal adverbial, corresponding to English ‘when.’ This takes the form of a shift from (i) Biblical *kaašer* ‘as that = when’ restricted to more formal, high-register contexts to (ii) the standard, reduced form of *kše*, and (iii) on to unmarked, nonspecific bare *še-*, which occurs widely not only among young children but also in the casual usage of older speakers. This trend may eventually take over in everyday Hebrew, so that bare *še-* will stand for marking relations of time as well as complement and relative clauses.

A noticeable change between Biblical and Modern Hebrew is use of the conjunction *ki* (Ariel, 1978). This formerly served to introduce complement clauses, today a function shown here to be restricted to occasional high-register contexts. Current use of *ki* to mean ‘because’ in adverbials of reason emerges very early in child language, even before age 3 years. And it shows an unusual developmental route: In toddlers around age 3 years, it occurs along with the coordinator *aval* ‘but,’ as a semantically more specific means of clause-combining than ubiquitous *ve-* ‘and’ *še-* However, from school age, and increasingly in adolescence and among adults, it is again used occasionally to introduce complement clauses. Yet at these later developmental levels, *ki* is less favored as a reason conjunction. Rather, it is replaced by *complex conjunctions* in the prototypical {PREP + *še-*} construction highlighted repeatedly in this paper. Toddlers prefer use of monomorphemic *ki* to mark reason, but by later preschool age around 4 or 5 years, *ki* gives way to the non-normative yet common combination of *biglal še*, which in older speaker-writers alternates with higher-register alternatives like *mipney še*, *mekevan še*, *mi šum še* meaning roughly 'because, since, as.' Increasing diversity in use of the {PREP + *še-*} construction is by way of being a litmus test for development of clause-combining in MH.

Understandably enough, adolescent and adult usages show greater variety and sophistication at all levels. Increased diversity in use of complex conjunctions reveals not only a larger lexical repertoire, but a grasp of differing semantic relations between situations and events and the temporal and logical circumstances with which they are associated. Older speaker-writers also make more sophisticated use of *še-* to mark relations of clause-combining, by means of longer and denser packages of syntactically and thematically related chunks of discourse, including use of embedded or "nested" subordinate clauses inserted into other dependent clauses. This latter ability is not only beyond the processing and preplanning capacities of younger children, it is one that distinguishes typically from non-typically developing language users—as shown for Hebrew middle-school students by Davidi (2014) and for English-speaking children and adolescents by Scott (2004). Taken together, these developments reveal the use of *še-* at different stages in the life history of speaker-writers of MH as deriving from a combination of factors: greater familiarity with and command of a larger and more varied range of lexico-semantic means of linguistic expression; greater cognitive capacities in embedding the target morpheme in complex chunks of syntactic clause combining and in segmenting extended pieces of discourse into thematically related blocks of information;[24] and, as shown in the next section, the impact of literacy on language development in this as in other areas.

3.3 Diachrony and Register

First addressed by Roman Jakobson's (1968) visionary work on phonology, the issue of principles common to child language development, linguistic variation, and diachronic development is germane to the present study. As articulated in Stephen Jay Gould's (1977) book "Ontogeny and Phylogeny", the idea of recapitulation aims to explain the relationship between the development of individual organisms and the evolution of the species as a whole. The issue has been tackled from different perspectives by psycholinguists (e.g., Friederici, 2012; Slobin, 2004) in terms of

[24] Tightly cohesive packaging of extensive chunks of syntactically and thematically related pieces of information demands advanced executive abilities such as extended working memory, advance planning, organization, and monitoring of the kind that Paus (2005) sees as marking "the shift from a caregiver dependent child to a fully autonomous adult … anchored in an increase in higher-order cognitive capacities and greater executive control."

the relationship between the development of language in the individual and in the history of human language, and by Nir (2020) for clause-combining strategies in MH in light of the history of the language since Biblical times. The findings of the present study combine with research by Nir (2015, 2020) and Zeldes (2013) to make a less extreme claim: The forms reviewed here for purposes of syntactic and discursive clause-combining in MH nearly all occur diachronically as far back as Biblical Hebrew.

Three features of the relationship between earlier and current Hebrew are noted in this connection. First, they manifest a marked change both in frequency and function, as in the alternation between use of *ki* in Biblical and MH, respectively, while the preferred subordinator, Biblical *ʔašer*, has fallen largely into disuse in everyday Hebrew. Second, there is greater diversity in *alternative* forms for marking particular syntactic constructions and semantic relations, as noted earlier for the three types of Relative Clauses analyzed from different perspectives by Nir (2015) and Reshef (2004). A third development across both child language and the history of Hebrew is the pervasiveness of the {PREP + *še-*} construction in Adverbials. Together, this variety of forms provides speaker-writers of MH with *expressive rhetorical options* not available at earlier stages in the history of the language or of individuals.

A major usage-based finding of the present study is that, while older Biblical means of expressing subordination remain in use, today they serve as indicators of higher, more formal *registers*. This is shown by three sets of comparisons: Biblical alternatives are largely if not exclusively confined in our samples to (i) written rather than spoken usage; (ii) expository more than interactional or narrative genres of discourse; and (iii) among older speaker-writers from adolescence, mainly among adults. Such elevated usages are illustrated in (27) and (28), excerpted from essays written by male university graduates. Use of Biblical *ʔašer* is bolded, while other high-register usages are indicated in the translated versions in small caps—[VS] stands for Verb-Initial clauses; [PASS] for Passive voice; [LX] for high-level Lexical usage; [LW] for Loan Word; [NOM] for Nominalizations— and angled brackets < … > indicating nested dependencies.

(27)
rešit, btox bet séfer yeš hevdelim gdolim yoter be-GÓDEL u-ve-XÓZEK šel yeladim ***me-ašer*** *btox ha-uxlusiya ha-bogéret.*]]
'First, inside a school (there) are greater differences in size [NOM] and strength [NOM] **than** in the adult population.']]
yeladim gam yeš lahem paxot AKAVOT be-dérex klal be-NEKITAT alimut ***me-ašer*** *le-mvugarim*
'Children generally have fewer inhibitions [LX] in undertaking [NOM] violence **than** adults.']][25]

[25] The last clause package or "sentence" of the four very long stretches marked by]] in (25) are the same as the excerpt given earlier in example (6).

(28)
ba-šanim ha-axaronot HAFXA HA-SVIVA *liheyot* KOXANIT *yoter,* ALIMA *ve-*BOTA ***meašer*** *ba-avar*]]
'In recent years, has-become the environment [VS] more power-driven [LX], violent and aggressive [LX] **than** in the past']]
ba-zman ha-axaron afílu HUAC TAHALIX *ze, be-ikar* ÉKEV XADIRAT *ha-televízya, arucey ha-kvalim ve-misxakey+ha-maxšev be-xol báyit*]]
'In recent times even has-been-accelerated [VS, PASS], this process, mainly due to [LX] the penetration [NOM] of television, the cable channels, and computer games in every home'
ha-gormim ha-lálu makifim yeladim u-vney nóar KIMAT BE-*méšex kol šeot ha-yom ve-mešadrim kimat* LE-LO HÉREF *mesarim šel alimut*]]
'Those factors surround children and young pople during [SYN] nearly all the hours of the day and broadcast virtually without cease [LX] messages of violence.']]
barur še yéled < ***ha-****gadel mul masax ha-maxšev* > <*ve-asuk be-*HAŠMADAT *dmuyot* TOX KDEY *misxak* > *yitkaše lehaciv et ha-gvul* ***kaašer*** *hu mesaxek im yeladim amitiyim ve-lo im dmuyot virtualiyot al ha-mirka*]]
'Clearly a child <**who** grows up in front of the computer screen> <and is occupied with destroying [NOM] figures in the course of [LX] playing [NOM] > will find it difficult to establish a boundary **when** he plays with real children and not with virtual [LW] figures on the (electronic) screen [LX].']]

We see, thus, that alternations in the use of the target morpheme *še* occur in tandem with a range of other morpho-syntactic and lexical usages characteristic of formal, elevated linguistic expression in MH – signaling a high point in the non-literary language use of educated, but non-expert speaker-writers of the language.[26] Many of these forms, like Relative Clause *ha-* and *(ka)ašer,* can be traced back to Biblical Hebrew. This is not true across the board. For example, verb-derived action nominals marked as NOM in the previous examples (e.g, *nekita* 'undertaking', *haašmada* 'destruction') were rare in the Bible, yet play an important role in elevated usage of MH.

Finally, to round off this discussion, some suggestions for *directions of future research* by younger generations of scholars of MH. One would be carefully controlled psycholinguistic investigation of speakers' perception of *še-* along with other orthographically bound morphemes that take the form of separate "words" in SAE (see footnote 2). Another line of research would be to show how Biblical Hebrew to this day constitutes a major source of more elevated, literate if not necessarily literary styles of usage in MH. Also called for is a more carefully controlled analysis—across types of discourse, age groups, and populations—of the nature and distribution of *nested dependencies* in which coordinated and subordinated clauses are embedded in one another in a way that contrast markedly with accepted claims for the linear nature of clause-combining in Hebrew (like other Semitic languages) as compared with, say, Spanish or English.

Such analyses would benefit by adding other independent variables to the developmental criteria and the genre- and modality-based comparisons touched on in this study. The factor of *literacy* in general, and of linguistic literacy in particular (Ravid

[26] In an earlier study, we defined "advanced" or sophisticated usages as those which occurred only, if not in all) adult texts (Berman & Slobin, 1994).

& Tolchinsky, 2002; Tolchinsky, this volume) seems critical here. This issue is importantly allied to variables such as level of education and socio-economic background addressed by Dorit Ravid in her doctoral research on Modern Hebrew and the book it engendered nearly three decades ago.

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Adding Subjects on the Left

Eve V. Clark

Abstract Children acquiring English and French do not initially produce any subjects with the verbs that appear in their early two-word utterances. Instead, in both languages children depend heavily on the communicative context for interpretation of what they are trying to say. But they appear to realise early on that subjects are required in these languages. They begin to produce occasional fillers, usually a schwa vowel, in the preverbal slot, and then progress to pronouns and a few lexical nouns in this slot as they produce longer utterances. In this chapter I track the progress children make as they master the options available in English and in French, and show how the forms in adult speech offer somewhat different models in the two languages for how to express subjects. I suggest that the patterns of omission and later use are in large part an effect of information structure, determined by what is given versus new in the current exchange.

Keywords Construction · Early omissions · Subject · Object · Given and new information

1 Introduction

How do we identify early subjects in children's utterances? Can we distinguish grammatical subjects from topics? Where might we expect to find evidence that children are producing subjects early on? To what extent does this depend on the language being acquired and the constructions available that children hear from others? And how is the notion of subject related to information structure? Notice that subjects are typically 'given', that is, they represent information known to the speaker and to the addressee, but speakers use verbs and predicates more generally to convey information that is 'new' for the addressee. One could argue therefore that

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young children might be expected to produce what is new over what is given in their utterances, and that this could result in emphasis on new information at the expense of information that is given. What is given in the context of a specific exchange would be treated as part of common ground for the child and the interlocutor. In considering emerging constructions in young children's speech, it is important to take into account both the syntactic elements—here the use of pronouns, nouns, and demonstratives as subjects—and their function in the subject slot from an informational point of view.

In this chapter, I will look at the general role of information structure in children's gradual acquisition of how to mark the subjects of verbs in their speech, with emphasis on similarities and differences between children acquiring English versus French. Information structure and, in particular, observance of the given-new contract (Haviland & Clark, 1974) influence how speakers organize their utterances. They typically start with given information, known to both participants in an exchange, and then add something new. Early on in acquisition, though, given information is often omitted. This includes the omission of subjects or agents of action (e.g., Huttenlocher et al., 1983; Graf et al., 2015; Jourdain et al., 2020a). Children add new information with their early utterances but often do not link that information to what is already given in the physical or linguistic context. Even when children mention both given and new information in their utterances, the adult ordering of given followed by new may also be violated by young children (e.g., Narasimhan & Dimroth, 2008). Furthermore, when young children initiate an exchange, it may be unclear what is (already) given information, known to both participants. One way children can resolve this is to introduce a topic as the information to be shared first, so adding this starting point as their common ground. They can then add new information in the form of a comment or predication added to that topic (Atkinson, 1979; De Cat, 2009).

When very young children use verbs, how soon do they indicate the role of agent explicitly, and do they distinguish talk about their own actions from talk about actions by others? In most cases, as we'll see, children do not produce grammatical subjects for their verbs until they are past the two-word 'stage', yet in some early utterances containing a verb, they occasionally produce certain elements in the preverbal slot in English and in French, two languages where the grammatical subject typically appears before the verb, on its left. This suggests that young children are already aware that they need to produce something in the subject-slot, even though they have yet to work out how to convey what is given compared to what is new.

In this chapter, I examine some of the steps children take as they come to mark subjects of various kinds as they gradually acquire not only core, present tense, verb forms, but verbs inflected for tense and complex verb forms constructed with modals and auxiliaries. I will look in particular at some differences children display in the acquisition of English and of French. English requires that speakers produce subjects with verbs, typically subjects in the preverbal slot, in most utterances, although certain subjects can be dropped in casual speech. Spoken French rarely drops subjects altogether, but it does allow speakers to distinguish topics from subjects with left-dislocation where the topic is then followed by a clitic pronoun designating the subject, and commonly relies, for example, on tonic and clitic pronoun combinations like *moi je* or *lui il*, for this purpose. Right dislocations, also common in spoken French, often serve to clarify the reference of the pronoun for an addressee, much as in English. Compare French *Il leur lit une histoire, le père* 'he's reading them a story, the father' and English *He ran up the stairs, John (did)/I mean John*'. I will look first at subjects and their antecedents in the speech of children acquiring English, and then turn to the patterns found in children acquiring French. In both languages, I will consider how information structure affects children's choices as they come to consistently produce subjects with their verbs.

2 What Do Children Hear from English-Speaking Adults?

In spoken English, adult speakers normally use subjects with both transitive and intransitive verbs, as illustrated in (1):

(1) a. **Jan** is putting the books on the shelf.
 b. **The children** run into the garden.
 c. **The dog** barks at the squirrel.

These subjects agree in number with present tense verbs, singular or plural, but there is no number agreement in English for past tense forms. Pronoun subjects identify the person involved, first-, second-, or third-person (*I, you, he/she/it* in the singular, and *we, you, they* in the plural), as illustrated in (2).

(2) a. **She** ran up the stairs.
 b. **We** played in the garden.
 c. **They** threw stones into the pond.

Imperatives are generally used without an explicit subject, as in (3):

(3) a. Pick up the crumbs.
 b. Go outside.
 c. Look at the birds.

But speakers of English can also omit a subject on other occasions too (Quirk et al., 1985, pp. 896–897), as in the utterances in (4):

(4)	a.	Wonder what they're doing.	e.	Think I'll go now.
	b.	Beg your pardon.	f.	Serves you right.
	c.	Hope he's there.	g.	Looks like rain.
	d.	Told you so	h.	Should be some coffee in the pot.

With (4a–e), the omitted subject is 'I'; in (4f and 4g), it is 'it', and in (4h), it is 'there'. Some of these subject-less forms have become formulaic, e.g., *Told you so* or *Serves you right*, and are produced, for example, in both adult and child disputes. Others are rather less frequent, but all are readily interpretable, and fully acceptable, in spoken English.[1]

English speakers can also omit subjects, often along with auxiliaries or modals, in *yes/no* questions where auxiliary and subject are canonically inverted, as in *Are you coming?* Some examples of such *yes/no* questions are given in (5). Some parents produce the non-canonical forms in (5a) and/or (5b) as well as canonical question forms like the one in (5c). This variation has an effect on how children acquire subject-verb inversion in *yes/no* questions (Estigarribia, 2010), with children exposed to omissions of the modal or auxiliary taking longer to adopt canonical inversion.[2]

(5)	a.	Think that's a panda bear?	(Shem's mother at 2;10,25, CHILDES)
	b.	You about ready to eat?	(Abe's father at 2;10,12, CHILDES)
	c.	Do you want your lunch?	

Note that the variation exhibited in such forms is entirely acceptable in colloquial spoken English. Estigarribia (2010) pointed out that parents also frequently use uninverted questions, marked with rising intonation in English, as in (6):

(6) You don't like it?

Noncanonical questions are frequent among the many questions addressed to young children in English (Cameron-Faulkner et al., 2003).[3]

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[1] Some subjectless forms also appear in writing, in what has been called 'diary' style, e.g., *Spent the day in the barn*, or *Have been thinking about last summer* (see Schmerling, 1973; Thrasher, 1977).

[2] Researchers in the past have counted noncanonical question forms in children as errors (e.g., Brown, 1973, p. 180; Nakayama, 1987, p. 124).

[3] None of the parents whose speech Estigarribia (2010) analyzed reached a 90% criterion on canonical question use, the criterion often used to assess children's acquisition of specific syntactic forms (Brown, 1973).

Adult speech offers children extensive information about different structures in the ambient language, structures that they pick up on as early as 2;6 when they receive extensive exposure (e.g., Nelson, 1977). One result is that young children tend to rely on frequent frames in adult speech, frames that provide cues to the grammatical status of new words, whether they are nouns or verbs (see Mintz, 2003; Weisleder & Waxman, 2010), and they show sensitivity in comprehension from as young as 12 months to grammatical morphemes like *the* (e.g., Cartwright & Brent, 1997; Pine & Lieven, 1997; Kedar et al., 2017). In short, children attend to how adults talk with them, and they attend, in particular, to the words and constructions adult speakers use when they reformulate child errors within conversational interactions (e.g., Chouinard & Clark, 2003; Clark & de Marneffe, 2012; Clark, 2020). Finally, adults tend to distinguish subjects that refer back to given information with a pronoun, say, compared to choices of lexical nouns or names as subjects when the speaker is contrasting the present subject with the previous speaker's proposal, or is correcting the previous speaker, as in the examples in (7) and (8).

(7) A. Jan arrived rather late yesterday.
B. Yes, Peter did arrive late. vs. He did, didn't he?

(8) A. Jan arrived rather late yesterday.
B. Peter did, you mean.

That is, a speaker may produce a noun rather than a pronoun for what would generally be given information when adding some further contrast or when correcting the previous speaker.

3 When Do Children Start to Produce Subjects in English?

After a period of producing just one word at a time, children start to combine two or more words in some utterances.[4] Many, often most, early word combinations consist of two nouns, and only a few initially consist of a noun and a verb. But are the nouns in those noun + verb combinations already subjects, or even precursors to subjects? In data from the acquisition of English, children produce very few potential subjects or precursors-to-subjects early on. They generally omit subjects, but occasionally produce a filler of some kind, usually a schwa vowel, in the slot just before the verb

[4] Their ability to combine two words in such utterances depends in part on motor ability as they become more fluent in production (Clark, 1993) and probably in part on the ability to retrieve the words on time from memory.

(see Peters & Menn, 1993; Bottari et al., 1993/1994; O'Grady et al., 1989; Pepinsky et al., 2001).

Early noun + verb combinations, though, are themselves rare. In Braine's (1963) analysis of early two-word utterances, there were no instances of noun + verb sequences in Gregory's (1;7–1;11) 89 early two-word combinations; just 3 instances of ***I*** + verb in Andrew's (1;7–2;0) 102 two-word combinations (2%), and only 5 instances of noun + verb sequences in Steven's (2;0–2;1) 82 two-word combinations (6%). In a further study, Braine (1976) presented data for two additional children acquiring English: Jonathan, recorded at 1;11 and again a month later at 2;0, and David, recorded at 1;9 and then 1;10. Jonathan had no noun + verb forms in his 73 combinations at 1;11, but a month later, he produced 12 noun + verb sequences out of 197 combinations (6%). David at 1;9 had one noun + verb sequence in 61 combinations (2%), and a month later, produced 10 such sequences in 149 combinations (7%). Bowerman (1973a), in her analysis of Kendall's (1;11) early word combinations, found 32 noun + verb sequences out of 102 word combinations (31% at MLU 1.10), and, a month later, 47 such sequences out of 152 two-word combinations at age 2;0 (27% at MLU 1.48). These early but rare pronoun and noun uses could have represented possible precursors to subjects, but they lacked any marking of agreement with the verb. And without singular or plural agreement in English, on noun and verb, as Bowerman (1973b) argued, one cannot be sure of the status of the noun preceding the verb in such utterances (see also Bloom, 1990, 1993; Gerken, 1991).

In summary, of the five children studied by Martin Braine, the first three produced potential precursors to subjects in two-word utterances on only 8 occasions in 273 two-word combinations, that is, just 3% of the time. The other two children that he recorded twice, a month apart, produced a noun in combination with a verb on 23 occasions in 480 two-word combinations, on average 5% of the time. Lastly, the child Kendall produced noun + verb combinations slightly more frequently, in 79 of her 254 two-word combinations, a higher rate of potential precursors to subjects of 31%.

What about children's two-word combinations without a verb? Do they also contain precursor-subjects? That is, should we consider a two-word utterance like *Dog ball*, said by a child watching a dog chasing a ball, or a dog sniffing a ball, say, as having the noun *dog* as its subject? Or is the child simply identifying the agent as a topic of interest, and then predicating some action of it by producing a noun for the entity acted upon? And in an utterance like *Shoe bed*, said of a shoe on the bed, should we count the noun *shoe* as a precursor subject? Or is *shoe,* the object placed (the locatum), simply being identified as a topic in this locative utterance? The latter interpretation would appear to offer a more reasonable account in the absence of any subject-verb agreement or of any other evidence for constituent structure (Bowerman, 1973b). Indeed, Gruber (1967) argued that children acquiring English initially produce such nouns as *dog* or *shoe* in early word-combinations (noun+noun or noun+verb) as topics, often followed by a brief pause, and only at a later stage begin to produce true grammatical subjects. These early word combinations, in the form noun+noun, therefore, should not be considered candidates for early subject uses in English either (see also Keenan & Schieffelin, 1976).

Valian (1991) looked at more extensive data from 21 children aged from 1;10 to 2;8, divided into four groups by MLU. In her youngest group (n = 5, age range 1;10-2;2, mean MLU 1.77), children used a verb form in 27% of their utterances, with a precursor-subject in 69% of these. Of the potential subjects the children produced, most were pronouns (69%), and a smaller number were nouns (19%). At all four MLU levels (1.77, 2.49, 3.39. and 4.22), children favoured pronouns (75% or more), generally in nominative form, with ***I*** their most frequent choice, followed by second and third person pronouns—*you, he, she,* and *it* (see also Girouard et al., 1997; Charney, 1980; Clark, 1978; Deutsch & Pechmann, 1978). They produced few or no pronouns for objects in their early utterances, but they produced nouns as direct objects with transitive verbs 95% of the time (Valian, 1991; see also Graf et al., 2015). Lastly, with one exception in the youngest group, children at all four MLU levels produced some modal verbs, starting with occasional uses of English *will* and *can*. When they produced these, they were also very likely to produce a subject preceding the modal form (94% at MLU 1.77; 95% at MLU 2.49; 98% at MLU 3.39, for 99% at MLU 4.22) (Valian, 1991, p. 59).

Further to these findings, in an analysis of the dense Manchester corpus for English, Chen and Valian (2016) reported that the presence of modals, auxiliaries, or inflections on verb forms all upped the probability of young English-speaking children producing a subject in the preverbal slot. (As already noted, inflections in English mark singular versus plural agreement between subject and verb in present tense verb forms.) They also observed that children's initial production of inflections and of longer verb phrases (with a direct object and/or a locative phrase) emerged before children began to produce subjects consistently.

Finally, in a further study of English acquisition, Valian and her colleagues tracked the uses of subjects by two-year-olds and their parents in a year-long study, and found that both adults and children attended to the same syntactic conditions. For example, both were more likely to produce subjects in utterances where the verb was inflected (Valian et al., 2020-ms). Their findings suggested that, by age two, children acquiring English know that subjects are generally required before verbs.

Overall, studies of English suggest that children aged 2;0 and under produce terms for potential subjects (generally agents) in fewer than 10% of their first two-word combinations. Moreover, their early multiword uses of verbs are functionally limited and closely linked to the verb uses they hear in the speech addressed to them (see Cameron-Faulkner, 2012; Ninio, 1992; Halliday, 1975). The data on spontaneous production in English-speaking children between 1;10 and 2;3 suggest that they may initially produce utterances containing verbs about 25% of the time. As they get older and produce more utterances containing verbs, with inflections added to those verbs, they also begin to produce more forms, mainly pronouns, that are candidate subjects. When they do this, they produce a potential subject, usually a pronoun, about 70% of the time. At the same time, children acquiring English do not omit the objects of transitive verbs: these are typically realised as lexical nouns, sometimes combined with locative phrases. These are also the elements that result in children's production of longer, and more complex, verb phrases.

Consider the initial absence of subjects in early utterances from the perspective of information flow. Entities in joint attention, for example, need not be mentioned because they are already known, visible, to the participants in a conversational exchange.[5] Speakers could simply omit all reference to them, or they could use a less salient form of reference, by using a pronoun say, rather than a lexical noun. At the same time, speakers on occasion need to identify entities *not* in joint attention for their addressees, so there we might expect some attempt to refer to such entities more explicitly, with a noun or a demonstrative, say. And where speakers introduce contrasting information, to correct some earlier utterance for instance, there too one would expect speakers to mark a new, contrasting referent with a lexical noun in subject position (Graf et al., 2015; Baker & Greenfield, 1988; Greenfield & Smith, 1976). But any entities a speaker has already identified can be re-referred to with a pronoun or demonstrative.

These pragmatic factors largely predict patterns of subject omission vs. subject production in young children acquiring English, as well as in other languages that require subjects (see Hughes & Allen, 2006, 2013; Schmitz, 2007). They also account for children's overt subject uses in languages that otherwise allow subject omission.[6]

One further factor here: young two-year-olds' first uses of verbs in English are typically used for talk about their own actions (Huttenlocher et al., 1983) and only later extended to talk about the actions of others. And some 90% of such early verbs uses for their own actions (e.g., *walk, eat, throw*) lack subjects. This observation is consistent with omitting reference to the subject (the agent) when that information is given or known in context. At the same time, when observing others carrying out an action, children at this stage are more likely to refer overtly to the agent with a pronoun or lexical noun.

This *décalage* from talking about their own actions to talking about the actions of others where they need to identify the agent, and so produce a subject, suggests that early subject-omission is also supported here by the pragmatic context. But children must also take into account whether adult speakers talking with them generally produce subjects with their verbs or not. In some languages subjects are obligatory; in others, person, number, and tense are all signalled by inflections added to the verb, so there is little need to add a pronoun, demonstrative, or lexical noun to identify the subject unless the speaker is making some added distinction: a contrast, a contradiction, a reminder of a referent identified earlier and now being re-referred to, and so on. In the case of children acquiring English, adult speakers consistently produce subjects with verbs, so children come to realize that

[5] Such entities are also likely to be identified with gaze or gesture as being in joint attention, within an exchange.

[6] See, for example, Allen and Schröder 2003 (Inuktitut); Narasimhan et al. 2005 (Hindi); Serratrice 2005 (Italian); Guerriero et al. 2006 (Japanese); Clancy 2003 (Korean); Huang 2011 (Mandarin), and Gürcanli et al. 2007 (Turkish).

grammatical subjects are an obligatory feature of the language. As they begin to produce inflected forms of verbs and to add modal and auxiliary forms to their verbs, they also begin to produce more subjects, at first mainly in the form of pronouns, the forms favoured for information that is given, rather than new, for the addressee. And a final observation: when children construct personal narratives or re-tell familiar stories, they are more likely to use lexical noun phrases as subjects, and do so more often as they get older (e.g., Umiker-Sebeok, 1979; Peterson, 1990).

I turn now to the early steps children take in French as they too learn to produce grammatical subjects with their verbs.

4 Getting to Subjects in French

Children acquiring French also omit subjects when they produce verbs in their two-word utterances. But they also give some indication quite early that they know something belongs in the slot immediately before the verb, and so could be using some grammatical information in comprehension before any production (Shi & Melançon, 2010; Sebastian-Gallés, 2007; Bernal et al., 2010). Evidence of this is that towards the end of their second year, they begin to make sporadic use of fillers, usually a schwa, in the pre-verbal slot in some two-word combinations (Veneziano & Sinclair, 2000), but they do not initially produce such fillers with any regularity. They also start to produce two forms of some verbs, and so potentially distinguish between present tense forms (e.g., *donne/s* 'give/gives'), that appear with the occasional preceding filler, and infinitival (*donner* 'to give') or participial (*donné* 'gave, given') verb forms, that do not.[7]

Children acquiring French focus on the left edge of the verb, perhaps because the right edge of the verb offers few clues by way of inflectional distinctions. In regular class-1 *-er* verbs, all three singular present tense forms (first, second, and third person) sound the same, and the third person with impersonal *on* serves in spoken French for first person plural, as in *on part maintenant* 'we're off now'. The third person plural is also often homophonous with these other forms. The left edge of the verb, though, offers information about number and tense through uses of auxiliary (***avoir***: *ai, a, ont;* ***être****: suis, es/est, sont*) and modal (***vouloir***: *veux/veut, veulent;* ***pouvoir***: *peux/peut, peuvent*) verb forms, and about person and number through the choice of clitic pronoun (e.g., *je, tu, il, on,* etc.). But before considering the stages children go through as they learn to consistently produce subjects on the left edge of the verb in French, I will look first at what children hear from the adults speaking with them.

[7] In French class 1 verbs (ending in *-er*), these two forms, infinitival (INF) and participial (PP), are homophonous.

5 What Do Children Hear from French-Speaking Adults?

Utterances in colloquial spoken French rely on three main types of subject: clitic pronouns, demonstrative pronouns, and lexical noun phrases. Clitic pronouns like *je* 'I-1Psg' (first person singular)*, tu* 'you-2Psg'*, il/elle* 'he/she-3Psg-masc/fem'*, on* 'impersonal 3Psg (commonly used for 'we-1Ppl' in spoken French)'*, vous* '2Ppl, you-formal sg/pl'*, ils/elles* 'they-3Ppl-masc/fem', serve to mark person and number on the subject of the verb, as in (9).

(9) a. **Je** lave la poupée. 'I'm washing the doll'
b. **On** part le matin. 'We'll leave in the morning'
c. **Ils** ouvrent les portes. 'They're opening the doors'

Clitic pronouns like *je, tu, il*, *elle*, and *on* are typically used when there is repeated reference to the same entity, that is, to information that counts as given, known to both speaker and addressee.

The main demonstrative subject type in colloquial spoken French is *ça* 'that', generally in the form *ça* + Verb, or *ça c'est* + Noun/Adjective 'that is…', where *ça* is combined with the neutral deictic *ce* and the third-person singular copula *être* 'to be'. These demonstrative subject forms generally appear where one finds *it* or *that* as subject in English, as shown in (10).

(10) a. **Ça c**'est le mien. 'that's mine.'
b. **Ça** tombe. 'that/it's falling down'
c. **Ça c**'est rouge. 'that's red'

Demonstrative subjects can be grouped with impersonal 3P uses of the clitic *il,* used with weather verbs and certain impersonal modal constructions, as in (11).

(11) a. **Il** pleut. 'it's raining'
b. **Il** faut manger. 'we/you need to eat'

Tonic or strong pronouns can be used in combination with clitics as subjects for emphasis, as in *moi je, toi tu, lui il*… with the adjacent pronouns agreeing in person and number, immediately before the verb, as in (12).

(12) a. **Moi je** viens à midi. '*I*'m coming at noon'.
b. **Lui il** aime lire les histoires. '*He* likes reading stories'

These combined forms can be used for emphasis, for identifying a topic (*moi,* say) followed by the subject clitic (*je*), for contrasting with a preceding speaker's utterance, and for answering questions, as in the exchange in (13).

(13) A: Quand est-ce que tu arrives demain? 'When do you arrive tomorrow?'
B: **Moi je** viens à midi. 'I'm coming at noon'.

Given information is normally presented first in an utterance, followed by new information. So when lexical NPs alone are used to identify a new referent, speakers may do this with an initial *Il y a* 'there is/are', as in (14a), to avoid placing an indefinite NP presenting new information in initial position. Definite lexical NPs such as *la forêt* 'the forest' or *les enfants* 'the children' can be used as subjects in utterances like those in (14b-c), where the definite nominal presents given information:

(14) a. **Il y a** un chien dans le jardin. 'there's a dog in the garden'
b. **La forêt** paraissait tranquille. 'the forest seemed quiet'
c. **Les enfants** jouent dans le jardin. 'the children are playing in the garden'

In an analysis of spontaneous French adult-to-adult speech, Blanche-Benveniste (1994) reported that 81% of the grammatical subjects adults produced consisted of clitic pronouns (as in (9) above), 13% consisted of an NP + clitic (as in (15) below), and just 6% consisted of a lexical NP on its own (as in (14b and 14c) above) (see also Ashby & Bentivoglio, 1993; Lambrecht, 1981).

Names and lexical NPs are also commonly combined with clitic pronouns, especially when the speaker wishes to highlight the referring expression by using a construction with left dislocation to identify the topic, as in (15), or with right dislocation, when the speaker feels the need to supply further information about the referent of the clitic pronoun, as in (16).[8]

(15) a. **La forêt, elle** paraissait tranquille. 'The forest seemed quiet'
b. **Le chien, il** dort au soleil. 'The dog is sleeping in the sun'
c. **Les enfants, ils** jouent au jardin. 'The children are playing in the garden'

[8] The combination of lexical nouns and clitic pronouns as subjects has led some researchers to consider clitic pronouns as inflectional elements (e.g., Jakubowicz et al., 1997; Auger, 1995) but others have advanced compelling theoretical and empirical arguments against such an account (see, e.g., Côté, 2001; De Cat, 2005).

(16) a. **Elle** grimpe sur le banc, **la petite fille**. 'she is climbing onto the bench, the little girl, that is'
b. **Il** leur lit une histoire, **le père**. 'he read them a story, the father I mean'

In child-directed speech, adults generally produce shorter utterances with very young children and, upon hearing errors, check up on their meaning by offering them a conventional way to express what they apparently intend (e.g., Chouinard & Clark, 2003; Leroy-Collombel, 2009), as in (17):

(17) Child (2;2.1): [e kujun]
Mother: une grenouille. (= a frog)

They also consistently produce clitic pronouns as subjects, often with left dislocations (see, e.g., Culbertson, 2010; Legendre et al., 2010; Fonseca-Greber & Waugh, 2003). That is, young children acquiring French are exposed from early on to the patterns of use found in adult colloquial spoken French. Only later do they also acquire the patterns found in Standard French, used in more formal settings and in writing, as described in such grammars as Grévisse and Goosse (2011).

Choice of a subject form depends on information flow, to distinguish information that is given and therefore in common ground, from information that is new—not yet known to the addressee (see, e.g., Haviland & Clark, 1974; Chafe, 1976; Firbas, 1992; Lambrecht, 1994; Arnold & Tanenhaus, 2011). Entities in joint attention, for example, need not be fully identified because they are already known to the participants in a conversation, and so may be indicated with just a pronoun or a demonstrative, *ça,* as in *Ça je l'ai vu déjà* 'that I've already seen'. Entities previously identified can be re-referred to with a pronoun or a demonstrative (see further Salazar Orvig et al., 2010; Marcos et al., 2021). But speakers do need to identify entities *not* in joint attention with a referring expression, typically a lexical noun phrase, so their addressees can understand what they are talking about. Here one often finds left-dislocated forms, with the lexical noun phrase that identifies a particular referent produced first, followed by a clitic subject pronoun and a verb. The initial dislocated noun phrase flags the topic that will be talked about, and the clitic pronoun links that topic to the verb (see further Jourdain et al., 2020a; Virbel, 1975).

Lastly, children must take into account whether the adult speakers around them generally produce subjects with their verbs or not. In some languages subjects are obligatory; in others, person, number, and tense are marked by inflections on the verb, so there is no need to add a pronoun, demonstrative, or lexical noun to identify the subject further unless the speaker is making some added distinction: a contrast, a contradiction, a strong reminder of a referent identified earlier, and so on. I return to these issues as we examine the early steps children take in French while learning to produce grammatical subjects with their verbs.

6 When Do Children Start to Produce Subjects in French?

Children acquiring French appear to go through several stages as they learn to produce subjects with their verbs, stages that show up first with subjects gradually increasing in number with their early present tense verb forms, and that they then reprise with subjects being added to more complex verb forms containing auxiliaries and modals. In the case study of one child, Augustin, recorded monthly from 2;0.2 to 2;9.30, Hamann et al. (1996) found that verbs appeared in nearly a third (33%) of his early utterances (721 of 2191 recorded utterances). In the first recording at 2;0.2, Augustin produced 57 of 270 utterances with a verb (21%), and by the final recording (2;9;30), he produced 155 of 288 utterances with a verb (54%). In the first five monthly recordings, Augustin's production of subject clitic pronouns ranged from 4 to 17 per session. In the second set of recordings (from 2;4.22 to 2;9.30), his clitic subject uses ranged from 11 up to 99 in the final recording session (Hamann et al., 1996, p. 320). The commonest subject clitics used were *il* and demonstrative *ce (c')* (accounting for 24% and 25% of clitic uses respectively). In the final session, *je* (22 instances) and *c'* (27 instances) were the two subject clitics Augustin produced most frequently. These clitic forms generally preceded present tense verb forms, but they were not produced before possible infinitival or participial verb forms. This is consistent with the observation that children acquiring French only produce subjects on the left in complex verb constructions *after* they have acquired the relevant auxiliary or modal forms. Before that, their only clitic subjects are produced with present tense verb forms (Veneziano and Clark 2016).

As in English, children initially produce no subjects at all with their early verbs. They then begin to produce the occasional filler, usually a schwa vowel, immediately to the left of the verb (Bassano et al., 1998; Clark, 1998; Veneziano & Sinclair, 2000), as shown in (17).[9]

(17)	a.	/ə/ veux pas	'FILLER don't want'
	b.	/ə/ pas là papa	'FILLER not there, daddy'
	c.	/e pik/	'FILLER sting(s)'
	d.	/ə/ a ba	'FILLER the ball'

The verb itself at this stage is usually a singular present tense form. The next development is the production of two forms of the same verb: a present-tense form, and an infinitival or participial form, e.g., *saute* 'jump(s)-PRES' and *sauter/sauté*-INF/PP 'to jump/jumped' (the latter two forms are identical phonologically for all class 1 verbs). From this point on, children begin to produce both clitic pronouns and

[9] See also Bottari et al. 1993/1994 (Italian); and Christofidou and Kappa 1998 (Greek).

demonstratives, although not yet consistently, to the immediate left of their present-tense verb forms, as in (18):[10]

(18)	a.	**je** ferme	'I shut'
	b.	**moi** vois	'me see'
	c.	**Pierre i** casse	'Pierre (he) breaks [it]' (used in self-reference)
	d.	**ça c**'est mon livre	'that is my book'

But they do not do this yet with infinitival or participial verb forms (Veneziano & Clark, 2016; Clark & Veneziano, 2013). First, children have to add auxiliary verbs to participial forms (e.g., *ai mangé* 'have eaten/ate', *suis tombé* 'have fallen/fell') and modal verbs to infinitival verb forms (e.g., *veux sortir* 'want to go out', *peux faire* 'can do [it]'). It is only after this stage that children start to add clitic pronouns to the left of their auxiliary and modal verbs in more complex verb-form constructions as well, as in (19).

(19) a. **j**'ai trouvé 'I have found'
b. **je** veux voir le métro 'I want to see the train'
c. **moi** ai couri 'I ran'

Which clitic pronouns do children add? They appear to favour *je* and *tu* over other clitic pronouns (Girouard et al., 1997; Legerstee & Feider, 1986). They also rely heavily on demonstrative *ça*, as in (20):

(20)	a.	est à Marie **ça**	'that belongs to Marie'
	b.	**ça** c'est la tasse.	'that's the cup'
	c.	c'est à moi **ça**?	'that's mine?'

And they also start to use a few tonic + clitic pronoun combinations, as in (21):

(21) a. **Toi tu** joues ordinateur 'you play computer..'
b. et et et **moi je** joue aux voit- aux voitures d'accord?
'and I('ll) play with cars, okay?'
c. **Toi tu** joues à ça. 'you play with that'

At this stage young children produce very few lexical noun phrases in the preverbal slot, which supports the view that they treat these early subjects as given information—hence their reliance on pronouns. Their early dislocations serve to flag

[10] Most of the examples cited come from children between 1;6 and 3;0.

topics that from then on are 'given', and to which they then go on to add further information in the predicate. By using a tonic pronoun combined with a clitic pronoun, or a proper name or lexical noun in combination with a clitic, children can identify what they are planning to talk about, and then add a predication of some sort, as in the examples in (22), from slightly older children:

(22) a. **La voiture il** attend dix minutes. 'the car waits for 10 minutes'
b. **Marie elle** téléphone. 'Marie is calling'
c. **Fanfan il** a eu le cadeau comme ça. 'and Fanfan got the present like that'

In her study of early dislocations, Jourdain (2020) pointed out that children early on produce both left- and right-dislocations, as in (23) and (24):

(23) a. **ça c'**est les bleus 'that's the blue ones'
b. et **lui il** fait quoi? 'and what's he doing?'
c. **Marie elle** met là Marie 'Marie puts [it] there'

(24) a. où **il** est **le papillon**? 'where's the butterfly?'
b. est très lourd **ce bouchon** 'this cork is very heavy'
c. **c**'est un seau **ça** 'that's a bucket'

These dislocations appear to be built initially on a small number of frequent fixed items from adult speech (Jourdain et al., 2020b; Lieven et al., 1997). Many early dislocations are in fact right-dislocations, where children seem to be relying on demonstrative *ça* to point to the element being talked about. That is, the demonstrative typically flags the entity in joint attention. Children also produce *ça* on the left edge, again selecting what is in joint attention (e.g., Morgenstern & Parisse, 2012; De Pontonx et al., 2014), as in (25):

(25) a. **ça** c'est des pigeons 'those are pigeons'
b. **ça** aussi j'aime. 'that I like too'
c. **ça** c'est train. 'that's a train'

Lexical NPs in the preverbal slot, however, are still rare at this stage, especially in comparison with lexical NPs *after* the verb, that is NPs that refer to a direct object as in (26a) and (26b) or to an object and its location as in (26c):

(26) a. j'aime pas **les avions et tout**. 'I don't like planes and all'
b. Minou laver **les dents**. '[Minou-self-reference] do my teeth'
c. mette **pelle dans seau**. 'put spade in [the] bucket'

Remember that the direct objects of transitive verbs typically convey new information. This would account for why young children are more likely to produce lexical nouns to refer to direct objects and to locations, as well as for combinations of object and location, from early on. These referring expressions all present new information to the addressee. This asymmetry between subject forms, where children produce few or no lexical noun phrases, and object forms with many lexical noun phrases holds for both French and English in children's early utterances (see Hamann et al., 1996; Graf et al., 2015).

Later on, children start to produce some lexical-noun-phrase-plus-clitic constructions, classic left dislocations, where the initial lexical noun phrase identifies the topic of the predication that follows (Jourdain et al., 2020a).

(27) a. **Bébé il** dort. 'baby is sleeping'
b. **Marine il** avait ça. 'Marine had that'
c. **Le canard il** prend le train. 'The duck is taking the train'

Children therefore gradually arrive at a match with adult forms as they come to construct different types of left and right dislocation in spoken French.

In summary, children acquiring subjects in French begin by building on the left edge of their verbs. Once they can produce both a present and a non-present form for a verb, they start to add clitic pronouns to the left of their present-tense verb forms. They also start to produce early left- and right-dislocations. They then begin to add some auxiliary verb forms on the left of past participles and also add various modal verb forms to infinitival verb forms (Veneziano & Clark, 2016; Dye, 2011). Only after the addition of such auxiliary and modal verb forms to the left edges of non-present verbs do children start to produce subjects marked by a clitic pronoun, a demonstrative, a lexical noun, or some combination of these options, in their complex verb constructions.

7 Topics, Subjects, and Information Structure

Left dislocations in French offer a device for specifying the topic and then following up with a grammatical subject (a clitic pronoun) in spoken French. Such constructions are very frequent in adult speech (Blanche-Benveniste, 1994), so it should not be surprising that children acquiring French pick up on this construction early on. But it takes some months for them to settle on the general form such constructions take, and to distinguish the general pragmatic functions of left- vs. right-dislocations. Left dislocations typically identify the topic about to be addressed in the rest of the utterance, while right dislocations can serve a clarification function, further identifying the referents of the clitic pronoun or pronouns just produced, much as in (28) (Ashby, 1988; see also Geluykens, 1987, 1993; Couper-Kuhlen & Ono, 2007).

(28) Il leur donne du fruit, le père les enfants.
'He gave them some fruit, the father the children'

Later, as children learn to read and become exposed both to more formal spoken French and to written French at school, constructions with a noun phrase subject rather than a dislocation also become quite common in their speech (see Virbel, 1975). And, possibly under the influence of stories that have been read to them, from about age 3 or so on, children also become more likely to produce lexical nouns as subjects in their narratives, in particular when the relevant referents are not the main protagonists (see further Karmiloff-Smith, 1981; Hickmann & Hendriks, 1999; Rozendaal & Baker, 2010).

8 Conclusion

As children acquire language, they build up their constructions in several ways. For subjects, they add to the left edge of their verbs in languages like English and French, and to the right edge of their verbs for conveying additional, new, information about direct objects and locations, for example, as well as about other types of information about such elements as conditions, timing, and causation (Jourdain & Lahousse, 2021). But acquisition of these more complex constructions takes time. Even in simpler constructions, though, children attend early on to how to establish a topic (what is to be talked about) and then to say something about that topic. In English, children may start with a bare noun, and after a slight pause, go on to predicate something of it. In Spoken French, young children make early use of dislocation to identify a topic, often with demonstrative *ça*, before they add a predication of some kind. In both cases, children use such forms to establish joint attention on the topic chosen before they talk about it. By first establishing a topic, they identify that information as given and therefore known to both participants in the exchange. They can then go on to add some information that is new for the addressee. This is one of the early steps children take as they learn to add subjects to their verbs when they talk about objects and events. But once they can do this, they can expand their options to include different kinds of subjects, and start learning how to design appropriate referring expressions for conveying information that is given versus new for their addressees (Marcos et al., 2021; Matthews et al., 2010, 2012). Mastering information structure and the syntactic means available for conveying given and new is an essential ingredient in children's acquisition of constructions. Here we have looked at one of the first elements they master in relation to verbs, namely the subject.

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Nominal and Verbal Morphology in the Early Acquisition of French: A First Study of the Relation Between Comprehension and Production

Edy Veneziano

Abstract The chapter presents a study of the relation between the comprehension and production of articles and subject clitic pronouns in 2-year-old French-acquiring children. The production of grammatical morphemes occurring in the spontaneous speech of ten children was related to the performance these same children obtained in a comprehension task testing the children's understanding of the grammatical morphemes in question. Success in the task required children to retrieve the meaning of homophonous or nonce words on the sole basis of the category-specific grammatical morpheme preceding them – a definite article for nouns and a third person subject clitic pronoun for verbs. Overall, results indicate that comprehension and production are closely related. For the majority of the children, a high level of comprehension corresponded to a high level in production. The profile of one participant, and to a lesser degree that of two others, suggests that production might be ahead of comprehension. It should be noted, however, that in this study comprehension could not be assessed with the same degree of detail as spontaneous production. To shed further light on this issue, future studies should find a way to assess children's comprehension in finer detail, include additional participants, as well as plan studies that assess both production and comprehension longitudinally. Moreover, in order to better evaluate what children have acquired and how they have acquired it, it is suggested that studies of early language acquisition should include both comprehension and production as a standard method of analysis.

Keywords Acquisition of French · 2-year-olds · Production and comprehension · Grammatical morphemes · Articles · Subject clitic pronouns

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1 Introduction

As this volume attests, Dorit Ravid is a leading figure and a source of inspiration to many researchers in the field of language acquisition, to which she has extensively contributed. Among the topics she has tackled are the acquisition of oral and written grammatical morphology and the relationship between them (e.g., Bar-On & Ravid, 2011; Ravid & Zilberbuch, 2003). This paper relates to this line of research by presenting a first study of the relation between the comprehension and production of grammatical morphemes – in particular articles and subject clitic pronouns– in 2-year-olds acquiring French.

One way of looking at children's grasp of these morphemes is to consider how they comprehend and use them in nominal and verbal contexts. In French, as in many other languages, articles usually precede nouns. In contrast, subjects, particularly subject clitic pronouns, precede verbs, either immediately – as in simple verb forms such as the indicative present (e.g., *il mange* 'he eats') – or distanced from the verb by one or more intervening elements – as in compound verb constructions when, for example, an auxiliary verb occurs between the subject and the past participle form (e.g., *il a mangé* 'he has eaten').

Consequently, the morphosyntactic context in which words occur is considered to largely contribute to determining their grammatical category (e.g., Clairis, 1984; Lazard, 1984; Maratsos & Chalkley, 1980). Thus, if children understand the function of grammatical morphemes, they will also be able to assign noun or verb status to words they encounter for the first time and disambiguate the meaning of words in the event of homophony (e.g., for English, *the meat* vs. *they meet*; for French, *le* /li/ 'the bed' vs. *je* /li/ 'I read'). Furthermore, although there is no one-to-one relationship between word category and meaning, as words that are nouns tend to refer to objects and entities, while words that are verbs tend to refer to actions or states.

In a recent study of 2- to 4-year-old children acquiring/speaking French, Veneziano and Parisse (2018) (hereafter referred to as V & P) assessed the children's understanding of grammatical morphemes such as definite articles and subject clitic pronouns by considering the meaning that children attributed to the word immediately following either the article (the nominal context) or the subject pronoun (the verbal context). The words were either homophonous in French or were nonce – invented, therefore novel – words that could thus function as either nouns or verbs: only the preceding grammatical morpheme could be used to attribute either an object or an action/state meaning to them. So, if a child attributed the meaning suggested by the preceding grammatical morpheme to a homophonous or nonce word, and did so in a consistent and statistically significant way over the items proposed, we considered that the child understood the function of the grammatical morpheme in the utterance presented. The results of that study, as well as of earlier preliminary ones (Veneziano & Parisse, 2011; Veneziano et al., 2010), showed that, at all ages, children were able to retrieve the object or action meaning of homophonous or nonce words on the sole basis of the information provided by the type of grammatical morpheme preceding them. Although 4-year-olds outperformed the 2- and 3-year-olds, as a group, these younger children succeeded in the task as well. Wide individual differences were however observed, particularly in the younger group.

In the present study, we analyzed the relation between comprehension and production of the above-mentioned grammatical morphemes by some of the 2-year-olds who participated in the V & P study. Comprehension was assessed using the results that children obtained in the comprehension task of the V & P study (see Sect. 2.1 below for more details on the task). Production, consisting of the spontaneous speech the same children uttered while interacting with the experimenter before and during the comprehension task, was evaluated using a detailed method devised specifically for the present study (see Sect. 2.2 below for details).

The relation between comprehension and production

Adults' comprehension and production of their native language tend to be at the same level of proficiency. Such coincidence does not seem to be present during children's language acquisition, and the level of concordance between the two modes of language functioning can itself be considered a developmental variable (e.g. Clark & Hecht, 1983).

In studies comparing production and comprehension where the latter was assessed in controlled situations, comprehension seemed to be either ahead of the children's production or the children behaved differently in the two modes. For example, Sachs and Truswell (1978) found that children who only produced single-word utterances in their spontaneous speech could understand the meaning of word combinations even when their comprehension involved performing unusual or improbable actions on objects. Thomson and Chapman (1977) found that children who overextended words in production did so to a much lesser extent in comprehension.

Comprehension also appears to be ahead of production for grammatical morphemes. Several experimental studies have shown some comprehension of grammatical morphemes before children are assumed to be able to systematically produce them in their speech. Perception studies have shown that infants are sensitive to the grammatical morphemes of the language they are exposed to (Höhle et al., 2004; Kedar et al., 2006; Shi & Melançon, 2010; Shi et al., 2006). In studies requiring the active response of the children, comprehension also seems to be ahead of production. Children in their second year of life, whose utterances did not contain function words, responded better to instructions expressed by utterances that contained grammatical morphemes than to utterances that did not (Petretic & Tweney, 1977; Shipley et al., 1969), or to utterances that contained ungrammatical function words (Gerken & McIntosh, 1993). More recently, several experimental studies have shown that children can assign meaning to nonce words according to the syntactic context in which they occur: an object meaning when nonce words occur in a nominal context and an action meaning when they occur in a verbal context (Bernal et al., 2007; Cauvet et al., 2014; Naigles, 1990; Waxman et al., 2009).

Studies of perception and of early comprehension of grammatical morphemes therefore indicate that children have sensitivity and later some understanding of grammatical morphemes before they are assumed to produce them at all or produce them appropriately. However, these studies, for the most part, report group results and very little data exist on the development of both comprehension and spontaneous production of grammatical morphemes in the same children considered individually. The present study is a first attempt to fill this gap by providing data on the relation between comprehension and production in 2-year old children acquiring French. The study compares the results obtained in the V & P comprehension task by ten 2-year-olds to their production of grammatical morphemes as it occurred in their spontaneous speech. As will be made clearer later, five of these children successfully completed the V & P comprehension task (this group will be called Group S) and the other five did not successfully complete the task (this group will be called Group NoS).

Results of the present study will thus provide empirically founded data on how knowledge of this aspect of language stands in the two modes of functioning. In particular, we will test the hypothesis about the priority of comprehension relative to spontaneous speech production. If this hypothesis is correct, we should expect that the spontaneous production of articles and subjects by children in Group NoS should not show proficiency, whereas the children in Group S could have either low or high levels of production. In fact, given that the study provides only a snapshot of children's comprehension at one particular time, it is not possible to determine when they achieved their understanding. If this happened close to the time of participation in the task, production should not yet be mastered; instead, if comprehension was achieved some time before participation in the task, then production could be of a higher and similar level of mastery to that of comprehension. Moreover, given that the children who did not successfully complete the comprehension task are less advanced in their understanding of grammatical morphemes than the children who successfully completed it, it is expected that the level of production of children in Group NoS will be lower than that of the children in group S. In Sect. 2.2 below we describe the method of analysis devised in this study to classify children's production of grammatical morphemes at four levels of proficiency.

In addition to testing the hypothesis about the developmental priority of comprehension over production, the study of both modes of functioning in the same children will provide a more precise view of children's knowledge of nominal and verbal French grammatical morphemes, compared to analyzing only one mode of functioning, as is usually the case in early language acquisition studies. Moreover, the comparison will also enable us to assess the level of coincidence between the two modes of functioning: when a child shows a high level of proficiency in one of the two modes of functioning, the distance between it and the other mode will provide insights into the child's overall level of mastery of the language aspect under study, the coincidence between the two being itself considered an additional indicator of mastery (Campbell et al., 1982; Clark & Hecht, 1983).

In what follows, we will first provide details about the V & P comprehension task, as well as about the criteria used therein to consider that a child successfully completed it and their application to the present study. Then, we will consider the theoretical and empirical background to the analysis of production and present the method devised here to evaluate the children's use of grammatical morphemes, from the early production of *fillers* (known in the literature as underdetermined elements occurring where grammatical morphemes would be expected) to the production of the appropriate morphemes in 90% of the places where they are required, which is the acquisition criterion proposed by Roger Brown and his colleagues (e.g., Brown, 1973; Cazden, 1968), still in use today as the criterion for acquisition. Finally, we will present the results obtained in this first study and discuss their significance.

2 Evaluating the Early Acquisition of French Grammatical Morphemes

2.1 Comprehension of Grammatical Morphemes

2.1.1 General Properties of the V & P Comprehension Task

The comprehension task appplied by V & P, the results of which are used in the present study, has several original features that strongly suggest children's understanding of the grammatical morphemes involved when the task is successfully completed (see, for more details, Veneziano & Parisse, 2018):

1. In addition to nonce words – usually presented to the children in comprehension situations of a similar kind – it uses homophones, words existing in spoken French and found in a large sample of French child-directed speech (CDS).[1] These words can have either action or object meaning in the language. In the task, the meaning can be disambiguated only by correctly processing the grammatical functors preceding the homophonous word. For example, /pus/ can correspond to either the noun *pouce* 'thumb' or the verb *pousse* 'push', depending on whether it is preceded by the definite article /lə/ – /lə pus/ – in which case it

[1] In the V & P study, participants were not tested on their knowledge of the homophonous words used in the task. This knowledge in fact was not expected, since these kinds of comprehension tasks usually use only nonce or invented words which are by definition unknown to the children. Nonetheless, V & P analyzed a large sample of French CDS (child-directed speech) to examine whether the words were likely to have been heard by the children. French CDS from CHILDES (MacWhinney, 2000) and from the samples analyzed in Veneziano & Parisse (2010) (the two data sets containing in all 1,913,796 words), showed that, with the exception of the verb *trancher* [to slice], all the French words used in the V & P comprehension task were present in the CDS samples analyzed, some occurring with greater frequency than others. Homophones were used similarly as nouns and verbs, with the exception of *marche* for which the verb ('walk') occurred more frequently than the noun ('step' in a stairway).

is interpreted as 'the thumb'[2] – or by the subject clitic pronoun /il/ – in which case it is interpreted as /il pus/ 'he pushes'. The use of extant homophonous words that have everyday meanings in the language has the advantage of providing the children with a more natural setting compared to a task where only nonce words are presented. Moreover, the use of homophones provides a good glimpse on how children process words that they are likely to encounter in their everyday interactions. The identification of homophones did not seem to render the task easier or more difficult for the 2-year-olds as the V & P study did not find significant differences in performance between the homophones and the nonce items;[3]

2. The grammatical context necessary to distinguish nouns from verbs – and in the task, object from action meaning – was kept to its minimally contrastive expression: only a definite article for nouns or a subject clitic pronoun for verbs distinguished the two utterances;
3. Each child in the study dealt with equivalent numbers of noun and verb contexts for homophonous words. This allows a good assessment of children's capacity to provide differential interpretations according to the respective, minimally contrasted, grammatical contexts;[4]
4. The behavior on which children were evaluated required their active choice between two images, one representing the object meaning and the other the action meaning of the homophone or nonce word.

2.1.2 The Participants in the Comprehension Task of the V & P Study

Ninety children participated in the V & P comprehension study, 30 in each of three age groups: 2, 3 and 4 years old. All children came from monolingual, French-speaking, middle-class homes and were interviewed in a quiet room of either the daycare center (for the 2-year-olds), or the public kindergarten (for the 3- and

[2] In French /lə/, /la/ and /le/ may be definite articles, respectively, masc. sing (*le*), fem sing (*la*)., and plural (*les*), or object clitics that occur before the verb. In the context of the V & P task, however, the interpretation of /lə/ and /la/ as preposed object clitics is not plausible for the structure presented – *le X* ---e.g., *le /pus/* -- where *le* as a preposed object clitic pronoun would imply an ungrammatical subjectless structure (*__*le pousse* '__it –masc sing – push(es). Such a structure is unlikely to be heard by the children: no such structure was found in several samples of CDS addressed to children of the same age range as that of the participants. Moreover, in many items, the clitic, if considered as a preposed object pronoun, would not be appropriate to refer to the object of the action pictured (e.g. le /pus/ would be inappropriate to refer to the table being pushed by a boy as it should have been *la* /pus/. In addition, in the V & P study, there was no statistically significant difference in the number of identification errors when the word in the la/le+word structure was a homophone whose interpretation was a transitive vs an intransitive verb.

[3] The percentage of 2-year-olds successfully identifying the required numbers of items was 17% for nonce words and 23% for meaningful words, a difference that is not statistically significant (tested by a 2 × 2 contingency table: $\chi 2$ (1, N = 60) = 0.104, p = 0.747, ns.)

[4] The same lexical item was however not presented in the two grammatical contexts to the same child as that would have involved in addition the capacity for categorial flexibility.

4-year-olds) that the children attended in Paris. All the children were described as typically-developing by their professional caretakers or teachers. The parents of the participants gave their consent to their child's participation by signing an authorization form.

2.1.3 The Material of the Comprehension Task in the V & P Study

The children were presented with 15 items, 12 containing homophonous words and three nonce words (the entire list is given in Table 1 by type of word and alphabetical order within each type).[5] The meanings of the words presented in the noun and verb contexts were represented by pairs of pictures shown on a computer screen. For the homophones, one picture represented the word's object meaning and the other

Table 1 The 15 items used in the study, divided into homophonous and nonce words, and listed in alphabetical order within each category

Homophones	Noun context	Phonetics	English meaning	Verb context	Phonetics	English meaning
Homophonous words						
/bwa/	le bois	/lə bwa/	the wood (pieces of)	elle boit	/ɛl bwa/	she drinks
/kuʁ/	la cour	/la kuʁ/	the courtyard	il court	/il kuʁ/	he runs
/fɛʁm/	la ferme	/la fɛʁm/	the farm	elle ferme	/ ɛl fɛʁm/	she closes
/ʒu/	la joue	/la ʒu/	the cheek	ils jouent	/il ʒu/	they play
/li/	le lit	/lə li/	the bed	elle lit	/ɛl li/	she reads
/maʁʃ/	les marches	/le maʁʃ/	the steps	ils marchent	/il maʁʃ/	they walk
/mɔ̃tʁ/	la montre	/la mɔ̃tʁ/	the watch	elle montre	/ɛl mɔ̃tʁ/	she shows
/pɔʁt/	la porte	/la pɔʁt/	the door	il porte	/il pɔʁt/	he carries
/pus/	le pouce	/lə pus/	the thumb	il pousse	/il pus/	he pushes
/ʁi/	le riz	/lə ʁi/	the rice	elle rit	/ɛl ʁi/	she laughs
/tɛlɛfɔn/	le téléphone	/lə telefɔn/	the telephone	il téléphone	/il telefɔn/	he telephones
/tʁɑ̃ʃ/	la tranche	/la tʁɑ̃ʃ/	the slice	elle tranche	/ɛl tʁɑ̃ʃ/	she slices
Nonce words						
/ʃim/	la chime	/la ʃim/		elle chime	/ɛl ʃim/	
/dav/	le dave	/lə dav/		elle dave	/ɛl dav/	
/gɔt/	la gotte	/la gɔt/		elle gotte	/ɛl gɔt/	

[5] A pilot study indicated that 15 was the total number of items that the children could reasonably attend to. The proportion of nonce words (20%) seemed appropriate so as not to compromise the naturalness of the experimental setting aimed at by the use of homophonous words.

a) Choice for */li/* ('bed/read')*:* on the left, the correct choice when presented in noun frame (*le lit* 'the bed'); on the right, the correct choice when presented in verb frame (*elle lit* 'she reads').

b) Choice for nonce word /ʃim/*:* on the left, the correct choice when presented in noun frame (*la chime*); on the right, the correct choice when presented in verb frame (*elle chime*)

Fig. 1 Examples of screen displays for the items presented to the children. (**a**) Choice for */li/* ('bed/read'): on the left, the correct choice when presented in noun frame (*le lit* 'the bed'); on the right, the correct choice when presented in verb frame (*elle lit* 'she reads'). (**b**) Choice for nonce word /ʃim/*:* on the left, the correct choice when presented in noun frame (*la chime*); on the right, the correct choicewhen presented in verb frame (*elle chime*)

its action meaning, performed by a person. For nonce words, one picture represented an unfamiliar object that did not have a specific name in adult language, and the other represented a person performing an action that could not be described in French by a single existing verb (see Fig. 1, which is a snapshot of the screen presented for (a) a homophonous word; (b) a nonce word). The children were asked to point to the picture corresponding to what they heard (see the procedure below).

Four lists of the same 15 items were compiled. Taken together, the lists were constructed in such a way as to control for the order in which the items were presented, for the noun or verb context for each homophonous or nonce word, and for the position on the screen of the picture corresponding to the requested item (on the right or on the left of the screen). In each age group, over all the participants, the four lists were presented the same number of times.

2.1.4 The Procedure of the Comprehension Task in the V & P Study

During the administration of the task, the children were seated beside the Experimenter and in front of a computer screen. With each item, the corresponding two pictures – an object and an action -- simultaneously appeared side by side on the screen (see Fig. 1). For each item, children were asked either: *montre-moi* 'show me': [definite article] X or [third person clitic pronoun] X, where X was either a homophonous or a nonce word both sounding the same in the two contexts (see Table 1). For example, for the homophonous word /li/, the item presented was either *montre-moi: le lit* 'show me: the bed' or *montre-moi: elle lit* 'show me: she reads'. The pictures appearing on the screen were the same for both the noun and the verb context of the word.

The test items were preceded by four training items. The first two presented a single picture and were meant to ensure that the children knew how to point to pictures on the screen. The next two items presented, like the test items, two pictures simultaneously – first two objects, and then an object and an action performed by a person. These items were intended to ensure that the children understood the instruction and could point to one of the two pictures depending on what they heard. The testing phase began immediately after with the presentation of the 15 test items, one after the other, and for each item the experimenter asked the child to show either 'the X' or 's/he X' (see the example provided above), which the children did by pointing to the picture they thought corresponded.

All the sessions were videorecorded. The pointing responses of the children were coded during the experiment and were double-checked later from the video recordings.

2.1.5 The Criteria of Success for the Comprehension Task in the V & P and in the Present Study

Items were considered to be correctly identified when children pointed to the picture of an object for items presented in noun contexts, and to the picture of an action for items presented in verb contexts. An individual child was considered to have successfully completed the comprehension task beyond chance level when s/he correctly identified at least 12 out of the 15 items proposed.[6] In the V & P study, this criterion was reached by 30% of the 2-year-olds, 33% of the 3-year-olds and 67% of the 4-year-olds, with statistically significant differences between the older group and the two younger onss. For meaningful homophones, the minimum number of items that children needed to correctly identify was 10 out of the 12 presented.[7]

In the present study, we considered that a child had successfully completed the comprehension task when all the following criteria were met: 1. Success in at least

[6] The probability of correctly identifying 12 out of 15 items by chance is .011, with $p = q = 0.5$.

[7] The probability of correctly identifying 10 out of 12 items by chance is 0.019, with $p = q = 0.5$.

12/15 of the *total number* of items; 2. Success in at least 10/12 of the *meaningful homophone* items; and 3. Success in at least 2/3 of the *nonce word* items. Although this number of nonce items does not reach the .05 probability level set to guarantee success beyond chance level,[8] this requirement prevents success to be granted on the exclusive basis of the successful identification of homophones and, together with the other two criteria, provides additional evidence that it is the grammatical context that determines the child's interpretation.

2.2 Production of Grammatical Morphemes

2.2.1 Acquisition in French-Acquiring Children

Children start by producing grammatical morphemes sporadically and only later on produce them systematically where they are expected (for French, e.g., Bassano, 2008; for Spanish, e.g., López-Ornat, 1997; for Italian, e.g., Pizzuto & Caselli, 1992; for cross-linguistic studies see for example, Dressler, 1997). Following the early studies by Brown and collaborators (e.g., Brown, 1973; Cazden, 1968), it is customary to consider that a grammatical morpheme is acquired when it is appropriately produced in at least 90% of the contexts where its presence is required.

For French, articles are considered acquired when children produce them in at least 90% of the required prenominal positions and use the forms appropriately, conforming to the requirements of gender, number and definiteness -- that is, *le* /lə/ (masc. sing. def), *la* /la/ (fem., sing., def), *les* /le/ (fem/masc, pl, def), *un* /œ̃/ (masc, sing, indef), *une* /yn/ (fem, sing, indef), *des* /de/ (masc/fem, pl, indef).[9] Subject pronouns are considered to be mastered when they are produced in preverbal contexts appropriately and in at least 90% of the cases where they are required, either in the immediately adjacent position for simple verb forms (as in *il part* 'he leaves') or before an auxiliary or modal verb in compound verb forms (as in *il a couru* 'he has run' or *elle veut dormir* 'she wants to sleep').[10]

For determiners, some data suggest that the 90% criterion is attained between 2;5 and 3;3, the latter age being when all the children in a cross-sectional study attained the criterion (Bassano, 2008; Bassano et al., 2008). For the production of subjects, the few studies that have specifically looked at this aspect for the entire child's production suggest that the age range is higher. At 2;9, the criterion was not attained in the longitudinal study of one child (Bassano, 2008). In the longitudinal study of 4

[8] The probability of correctly identifying all the three items by chance is 0.112, which is greater than the α level set at 0.05. In the Veneziano & Parisse study, all the three items were correctly identified by 17%, 37% and 57% respectively of the 2-, 3- and 4-year-olds.

[9] There are also the partitive articles *du* (masc, sing), *de la* (fem, sing), used to refer to an unspecified quantity of food, liquid, or other uncountable matter.

[10] The subject and the main verb may be separated by more than one element as, for example, when an object pronoun occurs in preposed position: *je l'ai pris* 'I it have taken –>I have taken it'.

children, none of them showed that accomplishment by the end of the studies (between 2;0 and 2;7) (Veneziano & Clark, 2016), and in a study of 3 children analyzed longitudinally until 2;7, only one child had attained the 90% criterion for subjects (Salazar Orvig et al., 2021).

2.2.2 Development before the Attainment of the Acquisition Criterion

Is it possible to evaluate the production of elements occurring in prenominal and preverbal contexts before children attain this high level of mastery?

In their second year of life, children start using syllabic, mostly vocalic, underdetermined elements – referred to in the literature as *fillers* – in prenominal and preverbal positions (e.g., Kilani-Schoch & Dressler, 2000; Lléo, 1997; Pepinsky et al., 2001; Veneziano, 2003, 2017; Veneziano & Sinclair, 2000). While most studies consider fillers a single transitional phenomenon towards full-fledged grammatical morphemes, others show that fillers themselves undergo a progression, during which their meaning and function for the child develops (e.g. Kilani-Schoch & Dressler, 2000; Peters, 1997; Peters & Menn, 1993; Veneziano, 2001, 2017; Veneziano & Sinclair, 2000). Concerning the early acquisition of French, previous studies have shown that it is possible to distinguish three periods in the production of fillers, all occurring before articles and subject clitic pronouns attain the Brown acquisition criterion mentioned above (Veneziano, 2017; Veneziano & Sinclair, 2000). The three periods of filler production for French-acquiring children were described as follows:[11]

1. Premorphological period, in which fillers are phonologically underdetermined (essentially /ə/, /e/ and /a/ sounds) and occur in the immediately adjacent prenominal and preverbal positions. At this time, there is no significant difference between the fillers produced in the two positions, either in terms of the percentage of positions presenting a filler, or in terms of the types of elements produced in the two positions. Children appear to follow the dominant phonoprosodic characteristics of the language – in French, an iambic pattern constituted by a first unstressed syllable followed by an accented one of the consonant-vowel type (e.g., Demuth, 2001, 2019; Kilani-Schoch & Dressler, 2000; Pepinsky et al., 2001; Veneziano, 2017; Veneziano & Sinclair, 2000; Vihman et al., 1998) – as well as the dominant distributional co-occurrences present in the input (Taelman et al., 2009; Veneziano & Sinclair, 2000).
2. Protomorphological period, in which both fillers and phonologically well-formed grammatical morphemes (henceforth WFGM) are produced. There is now a significant difference between the elements produced in prenominal and in preverbal positions: For example, /i/ is produced only in preverbal position and /o/ mainly in that position, while /ɛ̃/ and /yn/ are produced only in the prenominal one (e.g., Veneziano, 2017);

[11] The terms were also used by Dressler and collaborators (e.g., Dressler, 1997) to describe periods in the overall development of children's grammar.

3. Quasi-morphological period: This period is characterized by the predominance of WFGM over fillers. While the elements of this period are produced differentially before nouns and verbs, specific grammatical morphemes – in particular, articles and subject clitic pronouns – do not yet reach Brown's acquisition criterion of required presence (90% of obligatory contexts) and their use is not yet completely appropriate (i.e., they present errors of commission).

2.2.3 Method for the Evaluation of the Early Production of French Grammatical Morphemes Used in this Study

In the present study, the developmental path described above provided the basis for the evaluation of the spontaneous production of elements in prenominal and preverbal positions by children. We distinguished four levels (from low to high) in the production of these elements, each level being characterized by a number of features, as specified below:

Level 1 –

(a) Fillers are the most frequently produced elements in prenominal and preverbal positions;
(b) There is no significant difference between the elements produced in the two positions;
(c) The elements occurring in preverbal subject position are only found in the immediate preverbal position of simple forms, such as the indicative present form, and not in the subject position of complex forms (Veneziano & Clark, 2016, 2021).

Level 2 –

(a) Both fillers and phonologically well-formed articles and subject clitic pronouns are produced;
(b) The types of elements produced in prenominal and in preverbal positions are significantly different;
(c) The elements occurring in preverbal subject position are only found in the immediate preverbal position of simple forms, such as the indicative present form, and not in the subject position of complex forms (Veneziano & Clark, 2016, 2021);

Level 3 –

(a) Phonologically well-formed articles and subject clitic pronouns[12] are more frequent than fillers;
(b) The types of elements produced in prenominal and in preverbal positions are significantly different;
(c) There is some variety in the articles and subject clitic pronouns produced in the prenominal and preverbal positions, respectively;

[12] We included the phonologically close form /i/ for /il/ 'he' found in certain variants of everyday French, one of which is heard by the participants in the study.

(d) The elements occurring in preverbal subject position are also found in larger constructions containing past participles preceded by an auxiliary verb (e.g., *on a donné* 'we have given') and/or infinitives preceded by a modal verb (e.g., *il veut boire* 'he wants to drink').

(e) Neither articles nor subject clitic pronouns attain the criterial level of 90% of production in required contexts.

Level 4 –

To credit a child with this level, the child's production needs to show features a, b, c and d **of** level 3 above, as well as

(e) the appropriate presence of the target elements in 90% of contexts that require them.

3 Participants in the Present Study and Analysis of the Data

Before starting the comprehension task, each child in the 2-year-old group conversed with the experimenter about daycare and home activities, as well as about a picture book. This period of familiarization helped these young children to be more at ease during the comprehension task and allowed us at the same time to collect a sample of spontaneous speech from them.

For this first study, from the sample of thirty 2-year-olds who participated in the V & P comprehension task, we took the first two sets of five children that could be included in each of the following two groups:

1. Group Success (Group S) constituted by five children who succeeded in the comprehension task. These children reached the criterion described earlier for overall items (at least 12/15 correctly identified items), for meaningful homophones (at least 10/12 correctly identified items); and for nonce words (at least 2/3 items correctly identified). The age range of this group was 2;3 – 2;9 (age expressed in years;months), the mean age 2;7, and the SD 2 months and 6 days;
2. Group No Success (Group NoS) included five children who did not successfully complete the task. These children did not attain the criterion of success on the items: They correctly identified fewer than 12/15 total items, fewer than 10/12 homophone items and fewer than 2/3 nonce items. The age range of this group was 2;3 – 2;10, the mean age 2;6, and the SD 2 months and 6 days.

The children in the two groups were presented with the same number of nominal and verbal contexts.

The spontaneous speech of the ten children – transcribed in CHAT format and linked to the videorecordings – was analyzed for the elements present in the prenominal and preverbal positions where respectively determiners and subjects are required. These positions were coded for the presence/absence of elements, and elements were then coded as being fillers or WFGM, as well as for appropriateness to the specific context. We also coded for types of verb forms (mostly, indicative present, infinitive and past participle) and listed all the different types of determiners and subjects produced.

4 Results

4.1 Relation between Comprehension and Production in Group S

Table 2 presents the relevant data for Group S: from left to right, the sex and age of each child, the number of total and meaningful items successfully identified, and the production score obtained for articles and for subjects, and in parentheses the number of nouns or verbs on which the production level was based. As the table shows, four out of the five children in this group had a production score at level 4 (the maximum obtainable here) for both articles and subject clitic pronouns, the two grammatical morphemes used contrastively in the comprehension task. The fifth child, the youngest in this group (2;3), reached level 3: his production shared all the features with the other children with the exception of the criterion of 90% of presence in contexts where the morphemes were required. Thus, on the whole, the spontaneous speech of children who successfully completed the comprehension task shows a level of mastery of at least the same level as that suggested by the children's performance on the comprehension task. Indeed, level 3 differs from level 4 only on the attainment of Brown's acquisition criterion. However, the proficiency level tested by the comprehension task shows an understanding of the function of nominal and verbal grammatical morphemes, not the obligatoriness of their presence. Thus production level 3 should be taken to show a similar level of proficiency as that manifested by successful completion of the V & P comprehension task.

4.1.1 Details on the Spontaneous Production of Grammatical Morphemes in Group S

Level 4 of grammatical morphemes in spontaneous speech production can be exemplified by the profile of participant 1, which is representative of the profiles of the other three participants who obtained the same score.

For articles, all the elements were WFGM (criterion a)**;** consequently, the elements occurring in prenominal position were different from those occurring in

Table 2 Group S: Results obtained on the comprehension task and on the spontaneous production of the children who succeeded the comprehension task

			Comprehension task		Production level	
Participants	M/F	Age	All items	Meaningful homophones	Articles	Subj cl pro
P1	**F**	**2;9**	14	12	4	4
P2	**M**	**2;9**	14	11	4	4
P3	**M**	**2;9**	13	12	4	4
P4	**M**	**2;3**	13	10	3	3
P5	**F**	**2;8**	12	10	4	4

preverbal position (criterion b); the child produced a variety of article types: both definite and indefinite articles, masculine and feminine, as well as singular and plural forms (criterion c). In the relatively small sample of speech there was a large variety of articles such as *la, le, les* (the); *des* (some); *un* (a), and articles were produced in 100% of the contexts where they were required (criterion e of level 4).

Concerning subject clitic pronouns, 88% were WFGM (including acceptable /i/ for /il/ (he) (criterion a); the child produced a variety of subject clitic pronouns as well as a subject NP (criterion c): *je* (I), *il* (he),, *elle* (she); subjects occurred before indicative present V-forms but also in a larger construction with an auxiliary between the subject and a past participle (*j'ai fait* 'I have made') (criterion d); and subjects were produced in 94% of the contexts where they were required (criterion e for level 4).

The four children in group S who show this profile might even have, in production, compared to comprehension, a better understanding of how the grammatical morphemes tested in the V & P comprehension task work in their language. To clarify this point a comprehension task testing obligatoriness of use should also be devised and administered to 2-year-old children.

4.2 Relation between Comprehension and Production in Group NoS

Table 3 presents the same kind of data as Table 2 for the children in Group NoS. As the table shows, in contrast to the children in Group S, none of the five children in this group reached level 4 in the spontaneous production of articles and subject pronouns and only one child reached level 3 for both grammatical morphemes. For articles, two more children scored at level 3; one child reached level 2 (predominance of fillers; differentiation in types between prenominal and preverbal positions) and one child scored at level 1 (the elements produced in the preverbal and prenominal positions were not significantly different from each other). For subject pronouns, in addition to the child who scored at level 3 for both articles and subjects, three children scored at level 2 and one child at level 1.

Table 3 Group NoS: Results obtained on the comprehension task and on the spontaneous production of the children who did not succeed in the comprehension task

			Comprehension task		Production level	
Participants	M/F	Age	All items	Meaningful homophones	Articles	Subj cl pro
P6	**M**	**2;5**	10	8	2	2
P7	**F**	**2;7**	9	8	3	2
P8	**F**	**2;3**	9	8	1	1
P9	**F**	**2;10**	9	7	3	2
P10	**M**	**2;7**	7	5	3	3

4.3 Comments on the Results of Spontaneous Production

The results on the production of articles and subject pronouns are in line with those reported in the literature for French, where articles are reported to be acquired between 2;5 and 3;3 and subject pronouns from 2;7 and later. The analysis of the ten children studied here shows that levels 3 or 4 were attained for articles by children aged 2;3 to 2;10 and for subject clitic pronouns by children aged 2;3 to 2;9, within the range of the earlier studies. Moreover, here also the acquisition of articles seems to occur before that of subjects: eight of the ten children attained level 3 or 4 for articles but only 6 children did so for subjects.

4.4 Comparison between Children in Groups S and NoS on the Level of Production of Grammatical Morphemes in their Spontaneous Speech

The level of production of articles and subject clitic pronouns of the children in Group S was significantly higher than that of the children in Group NoS. The mean level of Group S was 3.8 (SD = 0.447) and that of Group NoS was 2.4 (SD = 0.894). **A** t-test showed that the difference between the two groups is statistically significant ($t = 3.13$, $p < 0.01$, $df = 8$, one-tailed). This result indicates that children who are shown to have a good comprehension of grammatical morphemes also have a high score of production and, reciprocally, those who do not provide evidence of compehending the grammatical function of these morphemes also have a lower level of production in spontaneous speech.

5 Summary and Discussion

The aim of this study was to provide some data on the relation between the comprehension and production of grammatical morphemes such as articles and subject clitic pronouns in French-acquiring children. To this end, we created two groups of 2-year-olds who had either successfully completed (group S) or not (Group NoS) the comprehension task in the V & P study and analyzed in detail the same grammatical morphemes as they occurred in the same children's spontaneous speech.

For *comprehension*, the children's correct choice in a sufficient number of items (statistically beyond chance level) revealed their ability to interpret the nominal and verbal grammatical contexts contrastively, considered clear evidence of the children's understanding of the nominal and verbal grammatical morphemes involved.

The spontaneous *production* of these same grammatical morphemes was analyzed for the children in the groups S and NoS using a coding system specifically devised for this study. This scoring system, based on previous work on the development of fillers, allowed assessment on four levels: level 3 presents enough features to consider that the relevant grammatical morphemes are used as appropriately and contrastively as in comprehension, while level 4, the highest level of the system, shows in addition the attainment of Brown's acquisition criterion (appropriate production of the grammatical morpheme in at least 90% of the positions where it is required). Results of the analysis of the production of the ten children showed that six of them attained level 3 or 4 for both articles and subject clitic pronouns, two children attained level 3 only for articles and had lower scores for subject pronouns, while the remaining two children scored at levels 1 or 2 for both.

The distribution of the children over these production scores is related to their results on the comprehension task. All the children in group S showed proficiency in the production of the targeted grammatical morphemes: Four attained the highest score of 4 and one attained level 3 on both articles and subject pronouns. In contrast, none of the children in Group NoS attained the highest level of production, whether for articles or for subject pronouns, and only one attained level 3 on the two morphemes. For the other four children in this group, two attained level 3 but only for articles, while the other scores were at levels 1 or 2. Consequently, the level of production attained by the children in Group NoS was significantly lower than that attained by the children in Group S.

The relation between comprehension and production

What do these results tell us about the relation between comprehension and production?

Does comprehension precede production?

Given that all the children in Group S have a production score of level 3 or 4, our results do not provide clear evidence that comprehension precedes production; rather, they suggest that good comprehension and good production of grammatical morphemes go hand in hand. It should however be noted that these results offer only a snapshot of the children's abilities at a particular time. Consequently, we do not know whether the children in Group S would have successfully completed the comprehension task before their production scored at level 3 or 4, a possibility that cannot be totally excluded.

Is there evidence that production precedes comprehension?

The results of the children in Group NoS present a mixed picture: As for the two children whose production scored at levels 1 or 2 for both articles and subject clitic pronouns, results indicate that production is not ahead of comprehension but, as for the children in group S, that comprehension and production correspond, here at a low level of understanding. For the child whose production scored at level 3 for both articles and subject pronouns, production appears to be ahead of comprehension. Concerning the two children whose production scored at level 3 for articles but scored at lower levels for subject pronouns, it might appear that the production of articles is ahead of comprehension. However, the comprehension task involves contrastive understanding of the *two* kinds of grammatical morphemes, something that is not involved in the appropriate and diversified use of articles only, so that, in these cases, the priority of production over comprehension cannot be established. These intermediate cases are nevertheless interesting in that they reveal some issues about how the two modes of functioning are assessed as well as the importance of the joint analysis of production and comprehension for a more comprehensive understanding of the way acquisition proceeds, points that are taken up again below.

For Group S, it might be supposed that the four children whose score was at level 4 for both articles and subject clitic pronouns showed a higher level of proficiency in production than what was revealed by the successful completion of the comprehension task. It should be noted, however, that the V & P comprehension task does not provide information about this feature and thus it could be the case that, if tested appropriately, these children would have manifested understanding of that requirement as well. Thus, although it might seem that production shows a higher level of mastery than that manifested in comprehension, further investigation is needed to to clarify whether production precedes comprehension for this particular issue.

Thus, on the whole, the results of the two groups indicate that comprehension and production are closely related: For nine of the ten children studied here, a high level of comprehension corresponded to appropriate and diversified production of grammatical morphemes, while a low level of comprehension corresponded to a low level of production in at least one of the two grammatical morphemes under study.

One of the participants (Participant 10 in Group NoS) does not fit this overall trend. This child, whose production is at level 3 for both articles and subject clitic pronouns, seems to provide a counterexample to the general hypothesis that production is not ahead of comprehension, as he appears to have a higher level of performance in production than in comprehension. And two other participants in Group NoS might appear to be more advanced in production than in comprehension for the production of articles, showing a level 3 of appropriateness and diversification for these morphemes.

Although, as discussed above, these cases call for further research, it should be noted that production and comprehension could not be evaluated with the same degree of detail. While it was possible to assess children's production of grammatical morphemes in a relatively fine-grained way, this was not possible for comprehension. The comprehension task could only be scored dichotomously as pass or fail. This is because, below the criterial number of items, success by chance alone could not be excluded. Thus, either children showed high level understanding of the grammatical function of both morphemes, or they could not be considered to have that understanding. Consequently, it was not possible to determine whether the children who did not reach the criterial number of items might have nevertheless used the immediately preceding syntactic context to attribute object or action meaning to the homophonous or nonce words, without yet having sufficient mastery to generalize their knowledge to the criteiral number of items. In the case of Participant 10, however, this seems unlikely as this child correctly identified the lowest number of overall and of meaningful homophonous items in Group NoS (7 and 5, respectively): his case seems a genuine counterexample that only future research on a larger sample can clarify.

The joint study of production and comprehension in early language acquisition

The study presented here highlights the relevance of analyzing both production and comprehension, not only to better assess the overall level of acquisition of particular language aspects, but also to gain further insights into the acquisition process.

Cases such Participant 10, and to a lesser degree Participants 7 and 9, discussed above, reveal the limitations of taking into account only the results of one mode of functioning. On the basis of comprehension alone, these children, having failed the task, were considered to have no understanding of the grammatical morphemes involved. Instead, on the basis of production alone, Participant 10 would have been credited with knowledge of the appropriate and diversified use of both articles and subject clitic pronouns, and the other two participants with having acquired articles and noun phrase structure. Taking into account both comprehension and production results calls instead for a more nuanced approach to these children's knowledge and for further investigation. For example, it would be necessary to check whether other kinds of comprehension tasks would result in better performance, or whether the children's appropriate production reflects a genuine understanding rather than knowledge about surface regularities or heavy dependence on conversational support. In any case, assessment based on only one modality will be interpreted differently in view of the results obtained on the other, while further insights into how these children might go about acquiring the grammatical morphemes under study could be gained.

Another issue for which the analysis of both production and comprehension in the same children would provide interesting data is that of the degree of coincidence between the two modes of functioning. This is assumed to be lower in the language-acquiring child than in the expert language user. In the present study, production and comprehension appear for the most part to be close to each other at both the high and the low end of proficiency. Although these initial results need to be confirmed in a larger study, they nonetheless suggest that even in the early period of language acquisition there might be more coincidence between the two modalities than would have been expected.

Issues for future research

As already mentioned, in the present study production could be assessed in greater detail than comprehension. Indeed, in order to guarantee that a child's correct responses were not due to chance, performance on the comprehension task could only be scored as pass or fail. Future research should find ways to provide a more nuanced evaluation of children's performance in the comprehension task. One possibility could be to increase the number of items, and/or the number of pictures to choose from (while keeping the task still manageable for young children), thus allowing the attribution of different scores according to the number and type of items correctly identified beyond the minimum number required. To make performance on comprehension and production more comparable, it would also be useful to introduce items that could check whether the children understand that the presence of grammatical morphemes is necessary within the nominal and verbal phrases.

Moreover, to precisely address the issue of the priority of one mode of functioning compared to the other, longitudinal data would be helpful. At the moment, we know of only one case study in which comprehension and production data on the acquisition of French grammatical morphemes are reported longitudinally (Veneziano, 2017; Veneziano & Parisse, 2018). The study concerned one French-acquiring child who was administered the V & P comprehension task at home on a monthly basis, while the naturally-occurring spontaneous interactions between the child and familiar partners were recorded in hourly sessions. The results of that study showed that the child successfully completed the comprehension task for the first time four months after she attained level 2 in production and two months after the number of WFGM was greater than that of fillers. However, since the coding system for the analysis of the production of grammatical morphemes was not the same as that devised for this study, her level of production for articles and subject clitic pronouns should be reassessed to find out whether level 3 for both articles and subjects was attained before or after the successful completion of the comprehension task. This longitudinal approach would better enable us to determine the developmental relation between the two modalities. Note however, that this approach would not be exempt from problems such as the increasing familiarity with the task items given their successive presentations.

As a final note, it should be pointed out that the results reported here concern the acquisition of French and thus they cannot be generalized cross-linguistically. Languages vary considerably in how they distinguish noun from verb contexts, in particular in relation to the degree to which they rely on nominal and verbal morphology, on the presence of nominal determiners, the obligatory or non-obligatory requirement of subjects (i.e., whether a language is pro-drop or not, e.g., Rizzi, 1982), the use of serial verb constructions or whether a language is agglutinative or not. As a function of such language-specific features, children encounter different configurations that may lead them to pay attention to different cues that impact differently on how they go about learning grammatical morphology and the distinction between nouns and verbs. The complexity of verb morphology in Hebrew makes its acquisition a particularly interesting case in point (e.g., Ashkenazi et al., 2016).

Nonetheless, the present study can provide insights for language acquisition in general. The acquisition of category-specific grammatical morphemes and of the related noun-verb distinction is a process that spans over time and this likely applies to most languages as well as to both production and comprehension. Moreover, since production and comprehension data alone are likely to over- or under-estimate children's knowledge of the relevant features (e.g. Clark & Hecht, 1983), future studies of early language acquisition should integrate information from both modalities as a standard method of analysis in order to better evaluate what children have acquired and still need to acquire, as well as to understand how they have acquired this knowledge.

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Incremental Processing of Prenominal Modifiers by Three-Year-Olds: Effects of Prototypicality and Contrast

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Abstract Adults often use prenominal adjectives for predicting the upcoming referent, either based on one's knowledge of prototypical exemplars (e.g., elephants are always big) or based on the contrasting properties of objects (e.g., big box *vs.* small box). This paper seeks to determine whether Dutch-speaking three-year-olds can also process adjective-noun phrases incrementally and use the information provided in the adjective to identify the target referent even before the noun is pronounced. In order to test this, we conducted an eye-tracking experiment using the Visual World Paradigm. The results replicate previous research by showing that three-year-olds are able to identify the target referent through their knowledge of prototypical exemplars as fast as adults, even before the noun is pronounced. However, our results reveal that the ability to use contrastive information for referent identification is far more limited at that age, indicating that contrastive (relative) processing of prenominal adjectives is more demanding than prototype-based (absolute) interpretations.

Keywords Language processing · Adjective-noun phrases · Visual World Paradigm · Toddlers

1 Introduction

An important aspect of adult linguistic competence is the ability to process language incrementally by integrating incoming linguistic cues with the information available from the previous discourse, world knowledge and referential context.

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Furthermore, adults can predict the upcoming discourse based on the cues already available in the unfolding sentence. For example, adults hearing a sentence starting with *Could you pass me the tall …* in the visual context of a tall glass, a short glass, a tall pitcher and a key can predict that the speaker wants to have to tall glass even before the noun *glass* is pronounced (Sedivy et al., 1999). Since adjectives are often used to identify members of the same category based on their different properties (e.g., *Give me the blue beaker, not the red one*), adults assume that the speaker intends to ask for one of the glasses rather than another tall object (pitcher) that has no same-kind competitor in the visual scene. In languages such as English and Dutch, where attributive adjectives are always prenominal, adjectives play an important role in predicting the upcoming referent.

Anticipatory processing is of paramount importance to efficient communication. However, our understanding of how this ability develops in children is not sufficient. For one, we do not know whether toddlers can use contrastive information in the prenominal adjective for predicting the intended referent. The advent of eye-tracking research opened the possibility of examining rapid mental processes involved in language comprehension. The Visual World Paradigm is a particularly suitable method for research with young children, since it only relies on the listener's tendency to look at relevant parts of the display as the adjective-noun phrases are pronounced. This study uses eye-tracking in the Visual World Paradigm (VWP) in order to determine whether three-year-old children can use information conveyed by prenominal adjectives for rapid identification of the intended referent.

We focus on two kinds of adjective processing in two types of contexts: absolute uses in prototypical contexts as in *big elephant* (elephants are prototypically/intrinsically big, irrespective of contexts) and relative uses in contrastive contexts as in *big chair* (a chair is not intrinsically big, but can be called *big* compared to another chair in the visual array or to an average chair). Our focus is motivated by the recurrent findings that prototypical and contrastive uses play an important part in early adjective acquisition. In what follows we briefly review the literature demonstrating that adjective use in prototypical and contrastive contexts facilitates adjective acquisition in toddlers. After that, we discuss prior research on anticipatory adjective processing in children. Based on these two research lines, we formulate our research questions and hypotheses that are tested in a VWP experiment.

2 Adjectives in Child Language and Child-Directed Speech

2.1 Contrastive Uses

Adjectives, such as *red, big* and *round*, enable a child to make distinctions among referent objects and classes of objects on the basis of their properties (Nelson, 1976). Despite their communicative significance, they usually emerge in child speech later than nouns and verbs (Barrett, 1995; Ravid et al., 2003; Tribushinina et al., 2014), and have a protracted acquisition course throughout school years well into adolescence (Ravid & Levie, 2010; Ravid & Schiff, 2012, 2021), especially when it comes to more abstract and morphologically complex adjectives (Ravid et al., 2016). Toddlers have been shown to have difficulty mapping adjectives onto relevant properties (Booth & Waxman, 2009; Klibanoff & Waxman, 2000; Tribushinina, 2017; Waxman & Markow, 1998). For example, if a child sees a rabbit and hears the mother saying *Look, the rabbit is blicky,* how does the child know which of the many properties of the rabbit are referred to? One useful strategy helping a child attend to a specific property is to provide contrastive information. For example, it is easier to understand the meaning of the adjective *big*, if two same-kind objects are contrasted in size (e.g., a big and a small teddy bear). An ideal situation for learning adjectives would be a contrastive context in which two objects are identical and differ only in the target dimension such as color (Au & Laframboise, 1990; Carey & Bartlett, 1978; Klibanoff & Waxman, 2000). Research by Waxman and associates shows that in the absence of such a within-category contrast, children as old as 3 years of age are not able to extend the meaning of a novel adjective across basic-level categories. For example, they can extend the meaning of *transparent plate* to another transparent plate, but not to a transparent cup. However, if the adjective is presented in a within-category contrast (e.g., a transparent plate *vs.* an opaque plate), three-year-olds are also able to extend the novel adjective across the basic-level category (Klibanoff & Waxman, 2000; Waxman & Klibanoff, 2000).

Longitudinal case studies of spontaneous conversations between parents and 2- to 3-year-old children (the age at which children acquire adjectives at a high pace) have shown that there are significant individual differences in the use of the *contrastive strategy* in child-directed speech (Murphy & Jones, 2008; Tribushinina et al., 2013; Tribushinina et al., 2015). Some parents often use adjectives in contrastive contexts such as *This ball is red and that one is blue*, whereas other parents barely use adjectives contrastively. Notably, a high frequency of contrastively used adjectives by the parents is associated with a higher rate of adjective learning by the children, which indicates that contrastive contexts facilitate adjective acquisition (Tribushinina et al., 2013). Facilitation through contrast appears to be a universal cognitive strategy that does not depend on the specific properties of adjectives in typologically different languages. Tribushinina et al. (2013) predicted that adjectives may be acquired faster in languages in which attributive adjectives are postnominal (Hebrew and to some extent French), because it is easier to interpret an adjective relative to the noun if the noun has already been introduced (Yoshida & Hanania, 2013). However, no cross-linguistic differences in the pace of adjective acquisition were found between languages with A-N and N-A orders (Tribushinina et al., 2013).

In a recent study, Davies et al. (2020) used a large corpus of child-directed speech and found that caregivers mainly used adjectives in descriptive contexts, whereas contrastive uses were extremely rare in parental speech. Thus, despite the usefulness of contrastive contexts found both in the lab (Au & Laframboise, 1990; Carey & Bartlett, 1978; Klibanoff & Waxman, 2000) and in naturalistic acquisition (Tribushinina et al., 2013), most parents seem to be insensitive to the facilitating role of contrasts in adjective learning. Based on this result, Davies and colleagues hypothesize that "hearing relatively few contrastive adjectives may delay the development of contrastive inference" (Davies et al., 2020: 176). This prediction will be tested in our experiment.

2.2 *Prototypical Uses*

A strategy that is attested in child-directed speech quite often is restricting adjective use mainly to best exemplars (or prototypes) of a property. Picture books aimed at teaching children adjectives often make use of prototypical exemplars. Across languages, the meaning of *big* is commonly illustrated by a picture of an elephant, *small* by a mouse, and *tall* by a tower. Such prototypes are also the most common referents of dimensional adjectives in interactions between parents and toddlers (Tribushinina, 2013b). It is interesting to note that such adjective-noun combinations are very infrequent in adult-directed speech, probably because it is redundant to call elephants *big* and towers *tall*. To illustrate, Tribushinina (2008) reports that only 1% of all tokens of *tall* in the British National Corpus (adult-directed speech) is used with reference to towers. In contrast, 32% of tokens of *tall* refer to towers in the Manchester corpus of parent-toddler conversations. Likewise, the Dutch adjective *hoog* 'high/tall' is used to describe towers in only 1% of its uses in the Spoken Dutch Corpus (adult-directed speech), in contrast to 36% in child-directed speech in the Groningen Corpus in the CHILDES archive.

Production data also suggest that toddlers are conservative adjective users; they keep track of adjective-noun pairings in the input and initially only use adjectives with reference to a restricted set of referents attested in child-directed speech. This explains why there are almost no incorrect adjective-noun combinations in the speech of 2-year-olds. The most frequent referents of adjectives in early child speech are best exemplars from the child-directed speech (Tribushinina, 2008, 2013b). Later on, children generalize over different adjectival uses and start using adjectives productively, applying them to a broader set of referents (Tribushinina, 2013b).

There is recent experimental evidence that three-year-olds also use their knowledge of prototypical exemplars in the online processing of adjective-noun phrases. Using the Visual World Paradigm, Tribushinina and Mak (2016) examined toddlers' processing of adjective-noun phrases and their ability to predict the upcoming noun on the basis of the meaning of a prenominal adjective. Dutch-speaking three-year-olds and adults heard adjective-noun phrases while two objects were displayed. On ambiguous trials, the adjective could refer to either of the objects (e.g., *green* in the visual context of a green house and a green candy). On informative trials, the participants saw a best exemplar of the property and another object. For example, they saw a pillow and a book, and heard *een zacht kussen* 'a soft pillow'. The reasoning was that if children were able to process the attributive meaning of the prenominal adjective, they would immediately link the adjective *soft* with the picture of the pillow, and thus look at the pillow before hearing the noun. Indeed, in the informative condition, the proportion of looks to the target already increased upon hearing the adjective, whereas in the ambiguous condition it only happened after the noun was pronounced. Remarkably, three-year-olds were as fast as adults orienting towards the target upon hearing an informative adjective. These findings demonstrate that toddlers, like adults, interpret adjectives incrementally and use their knowledge of prototypical referents in the processing of adjective-noun phrases. Since attributes such as 'soft' were not visible in the pictures, prediction of the upcoming referent required the children in this experiment to rely on their knowledge of prototypical properties of objects, in this case the knowledge that pillows are prototypically soft, whereas books are not. Hence, learning adjectives through prototypical objects, as established by corpus-based studies, is also reflected in the online processing of adjective-noun phrases.

The current study will add to this research by establishing whether three-year-old children are also able to predict the upcoming noun based on contrastively used prenominal adjectives and by investigating whether toddlers would have a preference for one of the strategies (use of prototypical exemplars *vs.* contrastive information) when both are available in the visual context. Before reporting the experiment, we will briefly review relevant eye-tracking research on the processing of adjective-noun phrases by young children, with a focus on the ability to use contrastive information for processing prenominal adjectives.

3 Children's Ability to Use Contrastive Information for Referent Identification

In the study reported by Sekerina and Trueswell (2012), six-year-old Russian-speaking children saw displays with nine objects and were asked to drag one of the objects (e.g., red butterfly) to a container also depicted on the screen, as their eye gaze was tracked. The display included two red objects (e.g., a butterfly and a fox) and an object of a different color either from one of the categories (e.g., a purple butterfly), or from both categories (e.g., a purple butterfly and a grey fox). In the former case (one-contrast condition), it is possible to predict the noun based on the adjective if adjectives are interpreted contrastively, since there are two butterflies and only one of them is red. In the latter case (two-contrast condition), the participants have to wait until the noun is pronounced, since there are two possible referents of *red* (i.e., butterfly and fox), both of them contrasted with a same-kind object of a different color. In this experiment, adults indeed started looking at the target upon hearing the adjective in the one-contrast condition, but waited until the noun was pronounced in the two-contrast condition (Sekerina & Trueswell, 2011). However, the child results showed no anticipatory eye movements to the target object before the noun was pronounced (Sekerina & Trueswell, 2012). On the one hand, this seems to suggest that it might be too difficult for 6-year-olds to use contrasts to identify the referent when hearing a contrastively used prenominal adjective. On the other hand, this finding might be a result of task complexity, as a visual-search task with nine different objects might be too demanding for 6-year-olds.

The study by Huang and Snedeker (2013) suggests that the latter explanation is more likely. They examined the ability of five-year-old English-speaking children to use referential contrast for identifying the referent based on an adjective cue. Their experiment included displays with four objects and the participants were asked to point to, for instance, *a big coin*. The experiment contained two- and one-referent trials, that is, trials in which the contrast item belonged to the same object category (two-referent), or to another object category (one-referent). Within two-referent trials, the visual array included two same-category objects of different sizes (e.g., a big and a small coin), a distractor of the same size as the target object (e.g., big stamp) and an irrelevant object (e.g., marshmallow). Only in the two-referent trials, i.e. when the visual context contained a contrasting object from the same category, the children started looking at the target earlier, even before the noun was pronounced. Thus, the five-year-olds inferred that the adjective *big* was more likely to be used with reference to the coins (rather than to the big stamp), since a contrast of a big and a small coin was present. However, the children were slower than adults to orient towards the target.

To the best of our knowledge, the only study that has compared the processing of contrastively used prenominal and postnominal modifiers is Arunachalam (2016). This study examined the processing of referential expressions within a mixed-age sample of three- and four-year old English children, by using their parents' language input. A visual array with six depicted objects was used and children were instructed to point to the correct object (e.g., a striped umbrella) as fast as possible. The experiment showed that children around age 3 looked faster to the target object when parents used postnominal modifiers (e.g., umbrella with stripes), compared to when they used prenominal adjectives (e.g., striped umbrella). This suggests that children this young may have difficulties processing prenominal adjectives. There was however no adjective competitor present in this experiment: There was only another umbrella but not another striped object. Hence, the participants did not need to hear the noun to identify the referent. There is evidence in the literature that three-year-olds look at the correct referent when hearing an informative adjective. For example, upon hearing *blue car* in the visual context of a red car and a blue car, they look at the blue car before the noun is pronounced (Fernald et al., 2010). The finding that the participants in Arunachalam's study did not look at the striped umbrella upon hearing the adjective might indicate that the adjective was too complex (or infrequent) for this age group. Thus, it is still unclear whether children this young are able to use contrastive information in the prenominal adjective for referent identification.

4 The Current Study

Prior research has shown that toddlers seem to have no trouble with the incremental and anticipatory processing of prenominal adjectives in their absolute use, i.e. in cases where adjectives denote intrinsic properties of objects (e.g., elephants are always *big*, towers are always *tall*). The first aim of the present study is to replicate the finding that three-year-olds use the knowledge of prototypes for predicting the upcoming noun based on the adjective, and are as fast as adults in doing so (Tribushinina & Mak, 2016).

The second aim of this research is to determine whether three-year-olds can also predict the upcoming noun in relative contexts, where adjectives do not denote intrinsic (context-independent) properties of objects, but rather depend on the contextual information. More specifically, we focus on relative contexts where adjective use is supported by a visual contrast. For instance, a glass is not intrinsically tall: the same glass can be described as *tall* if presented next to a shorter glass or *short* when the visual context contains a taller glass. Previous research (Huang & Snedeker, 2013) has shown that five-year-olds are able to identify a referent based on the adjective cue and the visual contrast. Our study aims to establish whether this ability is already present at an earlier age.

Even though contrastive contexts facilitate adjective learning, relative (contrast-based) interpretations are supposedly more demanding than absolute (prototype-based) interpretations because relative processing is flexible and context-dependent, whereas absolute interpretations hinge on context-independent noun-adjective (or object-property) associations (Smith et al., 1986; Smith et al., 1988; Tribushinina, 2013a). Accordingly, the eye-tracking experiment performed by Sekerina and Trueswell (2012) suggests that rapid use of contrastive information for referent identification might be demanding for children as old as six years of age. In a similar vein, the findings reported by Arunachalam (2016) reveal that anticipatory processing of referential contrast may not be available to three-year-olds. For this reason, we opted for a design that is less complex than the one commonly used in the literature on the processing of referential contrast. Typically, in such studies there are two same-category objects (e.g., a tall glass and a short glass) and a number of other objects including a competitor that is (on its own) also compatible with the adjective (e.g., a tall pitcher). Adult-like use of referential contrast involves the ability to predict the target noun (in this case *glass*) based on the fact that there are two glasses and only one pitcher in the visual array. We reckoned that this design might be too demanding for three-year-olds. Furthermore, we do not yet know whether three-year olds possess a more basic ability to use contrastive information in the anticipatory processing of adjectives. In other words, are they able to apply a relative interpretation to an adjective when presented with a pair of same-kind entities differing in the target property? To test this more basic ability to use contrastive information for anticipatory processing, we adopted a simpler design with only three objects in the visual array, including two objects of different sizes (the target object and its contrastive counterpart) and an unrelated object that is not associated with the target property at all. This means that in our design there is no other object that might in principle be described by the adjective in the given visual context (like the big stamp in Huang and Snedeker's study or the tall pitcher in Sedivy et al.'s experiment).

If three-year-olds can successfully predict the target object in contrastive contexts, then it is also relevant to investigate whether the children use contrastive information to the same extent as prototypicality. Since relative interpretations are generally more complex than absolute interpretations, it is reasonable to assume that prototype-based anticipatory processing could be more readily available to children. The third question addressed by this study is how three-year-olds identify referent objects in an ambiguous context where both a prototype match and a contrast match are present.

The three research questions were examined by means of the Visual World Paradigm, in which children each time saw three objects and heard an adjective-noun phrase. The displays included either a prototypical target (research question 1), or a contrastive target (research question 2), or an ambiguous context in which a prototypical and a contrastive target were present (research question 3). Adult controls were included in the experiment in order to determine a baseline for the children's performance.

5 Method

5.1 Participants

In total 60 monolingual Dutch children participated in the experiment. Data of 15 children were not included in the analyses based on the quality of the eye-tracking record (see below), resulting in a final sample of 45 children (60% female). Their mean age was 3 years and 5 months (*SD* = 3.53 months, range 36–47 months). The children were recruited by contacting a preschool in a small city in a rural area in The Netherlands.

In addition, 38 adults (63.2% female) participated in the experiment as a comparison group. A diverse sample of adults was recruited by means of convenience sampling, varying in age, educational level and living environment (both rural and urban area). The mean age of the adults was 36 years (*SD* = 15.60 years, range 19–63 years).

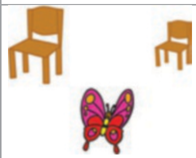
5.2 *Materials and Design*

The materials were displayed in three different conditions: (a) prototypical, (b) contrastive, and (c) ambiguous (see Table 1). A within-subjects design was used in which each participant took part in all three conditions. As will be described below, three lists with trials were created to which participants were assigned randomly.

Twenty-one items were designed in which three objects were displayed in a triangle shape while simultaneously a pre-recorded adjective-noun phrase was heard. Each adjective-noun phrase consisted of a definite article, an adjective and a noun, for instance *de hoge toren* 'the tall tower'. Of each item there were three versions, corresponding with the three different conditions. See Table 1 for an overview of the kind of objects that were displayed in each condition, with example displays of the three different versions of one item. The complete list of items is attached in the Appendix.

Three different lists with 21 items each were created in such a way that each list contained one version of each item. Participants were randomly assigned to one of the three lists, so that each participant saw only one version of an item. For example, participants saw the high chair in either the prototypical, contrastive, or ambiguous condition. The position of the target object was randomized for all the items in every list. The three lists contained seven items from each condition.

Table 1 Overview of the three conditions with example displays

Condition	Object 1	Object 2	Object 3	Example display and pronounced phrase
Prototypical	Prototype	Non-prototype	Unrelated	 *de hoge toren* 'the high tower'
Contrastive	Contrast target	Opposite contrast	Unrelated	 *de hoge stoel* 'the high chair'
Ambiguous	Contrast target	Prototype	Opposite contrast	 *de hoge stoel/toren* 'the high chair/tower'

Note. Object 1 is in the upper-left corner, the other objects follow clock-wise

Conditions In the prototypical condition, participants could identify the target object based on their knowledge of prototypical properties of objects. In this condition, the following three objects were depicted: (a) a best exemplar (prototype) of the property denoted by the adjective (e.g., a big hippo), (b) a non-prototypical object, that is, an object that is not intrinsically related to the adjective used but can be described by this adjective, (e.g., a big present), and (c) an unrelated object, that is, an entity for which the adjective is not a fitting attribute (e.g., sand).

In the contrastive condition, there were two same-kind objects differing in size (e.g., big present and small present) and an unrelated entity of a different category (e.g., sand). The unrelated entity was not associated with the property in question (e.g., sand cannot be big or small).

In the ambiguous condition, which is a combination of the prototypical and the contrastive condition, two possible target objects were present. This condition consisted of the following three objects: The best exemplar from the prototypical condition (e.g., a big hippo), and the two contrasting objects of the contrastive condition (e.g., a big present and a small present). There were thus two possible targets that both corresponded to the adjective (e.g., a big hippo and a big present, equally-sized in the pictures), and on the basis of the adjective it was impossible to predict which one was the target. The noun that was pronounced corresponded half of the time with the prototypical object and half of the time with the competing contrast object. The goal of the ambiguous condition was to examine what information the participants would use to predict the referent: the prototypical properties of objects or the contrastive information, or possibly both.

Visual Stimuli Picture books for children were scanned for familiar objects from the experiential world of young children and child-friendly images were created using clipart and graphic programs. For the contrastive objects, the same picture was used twice, only the property denoted by the adjective (e.g., size) was different. Since Dutch definite articles give away information about the gender of the upcoming noun, the three objects always corresponded to same-gender nouns. In this way, participants could not establish reference based on the article used. The adjectives *hoog* ‘high/tall’, *groot* ‘big’, *klein* ‘little’, *lang* ‘long’, *dik* ‘thick’, and *dun* ‘thin’ were used, since these are among the first adjectives acquired by young children (Tribushinina, 2013b) and the ones commonly used for referent identification (Nelson, 1976).

Auditory Stimuli Adjective-noun phrases pronounced by a native female Dutch speaker were pre-recorded. In each sound file, the onset of the adjective was set at 3 s, so that children had enough time to get familiarized with the displayed objects. The onset of the noun was always at 4.5 s. The total duration of each sound file was 7 s.

5.3 Apparatus

The portable Tobii X2–60 eye-tracker was used to record the eye movements of participants. The sampling rate was 60 Hz. The Tobii Studio 3.4.5 software was used for the presentation of the items and for the recording of the eye-movements.

5.4 Procedure

For the children, the experiment took place in a small and quiet room at their own daycare. The stimuli were presented on a laptop to which the eye-tracker was connected. The children were seated on a comfortable chair in front of the laptop. Then, a child-friendly calibration procedure was performed, consisting of five calibration points. After successful calibration, the experimenter gave a neutral instruction "Listen and look carefully". Then, the experiment started and the 21 items were presented one after another. Although no task was given to search for the target referents, some children spontaneously started to talk or point to the screen. This was not discouraged, unless it compromised their looks at the screen. The experiment lasted in total approximately 5 min per participant. All children were thanked afterwards and received a small reward.

For the adults, the experiment followed a similar procedure. The experiment took place in different locations, in both home and university settings. In each setting, a quiet room was used for testing. For the calibration procedure, also consisting of five calibration points, adult settings were used.

5.5 Analysis

Preparation of the Data For each trial, three areas of interest (AOIs) were defined that covered the fixation patterns of participants to the three objects of the display. The locations of fixations were determined in 100-ms steps from the eye-tracking data. For each time-step it was determined which AOI a participant looked at. Fixations outside the AOIs were not included in the analyses. Trials were excluded when there was more than 25% missing data within the critical time interval from the onset of the adjective until the onset of the noun (3–4.5 s). In addition, for each participant a minimum of 4 trials per condition had to remain in order to include that participant in the final data sample. Data of fifteen children were excluded based on this criterion.

Before analysis, necessary assumptions were checked. Scatterplots indicated that assumptions of homoscedasticity and logit linearity were met.

Statistical Analysis The final dataset was analyzed by means of multilevel binary logistic regression (Barr, 2008). Since a multinominal type of multilevel logistic regression was not feasible considering current methodological advancements, binary analyses were conducted: the dependent variable was whether the participant fixated the target referent or fixated elsewhere. The analysis was performed in R (version 3.3.2), using the lme4 package (Bates et al., 2015). Time was included as a predictor to be able to model change over time. The model predicted the probability of fixating on the target picture. Participants and items were included as random factors, and Time and Group (child/adult) as fixed factors. In each condition, the proportions of looks at two different objects were compared. For the prototypical condition, the outcome measure was defined by the probability that the participants fixated on the prototypical object (e.g., high tower) compared to the non-prototypical object (e.g., high chair). Similarly, in the contrastive condition, the looks at the contrast target (e.g., high chair) were compared to the looks at the opposite contrast (e.g., low chair). In the ambiguous condition, the following three pairwise comparisons were performed: (1) the contrast target versus the prototypical object, (2) the prototypical object versus the opposite contrast and (3) the contrast target versus the opposite contrast. Because we performed multiple comparisons, a Bonferroni correction was applied, resulting in an alpha-level of .017. All analyses were performed on the critical time interval from the onset of the adjective until the onset of the noun (3–4.5 s), which we named the adjective time window. The children were the reference group in each analysis.

6 Results

6.1 Prototypical Condition

The proportions of looks (henceforth, *looks*) at the three different objects over the duration of the trials are shown in Fig. 1a for the children and Fig. 1b for the adults (the lines present averages across participants). The first vertical line indicates the onset of the adjective and the second vertical line indicates the onset of the noun.

At the start of the adjective window (at 3 seconds) the division of looks at the three objects was roughly equal in both groups. When the adjective was pronounced, however, the looks at the different objects started to diverge, for both children and adults. The model is presented in Table 2.

There was a significant positive effect of Time for the children. During the adjective window, their looks at the prototype increased significantly over time compared to the looks at the non-prototypical object. There was no interaction effect of Group by Time, indicating that the increase in looks at the prototype compared to the non-prototypical object for the adults was similar to that of the children.

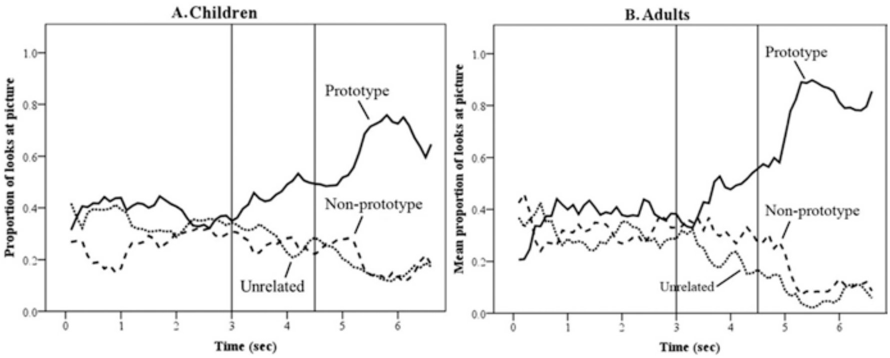


Fig. 1 (**a** and **b**) Proportion of looks at the objects over time in the prototypical condition, by group

Table 2 Parameter estimates for the prototypical condition

	Fixed effects		
Parameters	*Estimate (SE)*	*z*	*p*
Intercept	0.59 (0.13)	4.51	< .001
Time[a]	0.42 (0.10)	4.33	< .001
Group (Adults)	−0.24 (0.16)	−1.53	0.13
Time * Group	0.13 (0.14)	0.93	0.35
	Random effects		
Parameters	*Variance*	*SD*	
Participant	0.41	0.64	
Item	0.11	0.33	

[a] Children were used as reference group

6.2 Contrastive Condition

For the contrastive condition, Fig. 2a displays the looks at the different objects over the duration of the trial for the children, and Fig. 2b for the adults. For both children and adults, the division of looks at the three objects was not equal in the baseline time window (before adjective onset). For both groups, the one different-kind object (e.g., a butterfly) attracted more attention than the two objects of the same kind (e.g., two chairs).

The model is presented in Table 3. There was no effect of Time for the children, indicating that looks at the Contrast Target did not increase faster than the looks at the Opposite Contrast in the adjective window. The significant interaction shows that looks at the Contrast Target did increase for the adults.

To summarize the results thus far, the behavior of the three-year-olds was comparable to that of the adults in the prototypical condition, but the children were not able to discern the target referent on the basis of the adjective in the contrastive condition.

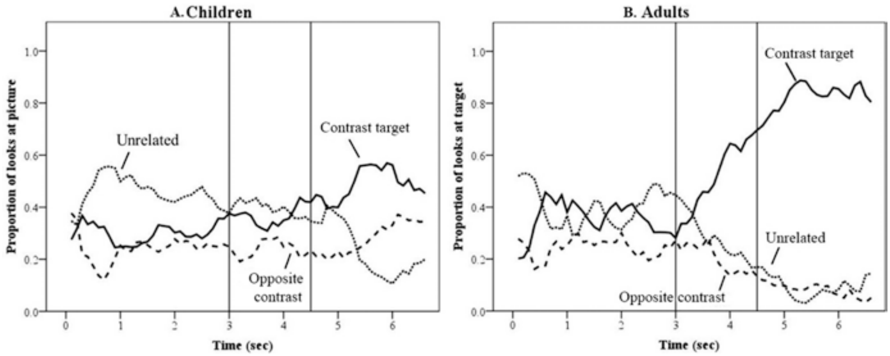


Fig. 2 (**a** and **b**) Proportion of looks at the objects over time in the contrastive condition, by group

Table 3 Parameter estimates for the contrastive condition

	Fixed effects		
Parameters	*Estimate (SE)*	*z*	*p*
Intercept	0.47 (0.13)	3.48	.001
Time[a]	0.17 (0.10)	1.72	.09
Group (Adults)	0.54 (0.15)	3.68	< .001
Time * Group	1.10 (0.15)	7.46	< .001
	Random effects		
Parameters	*Variance*	*SD*	
Participant	0.34	0.59	
Item	0.16	0.41	

[a] Children were used as reference group

6.3 Ambiguous Condition

For the ambiguous condition, the looks at the three different objects over the duration of the trials are displayed in Fig. 3a and b for respectively children and adults.

In the ambiguous condition, two objects were possible referents on the basis of the adjective (either the prototype or the contrast target). Therefore, three pairwise comparisons were performed. Firstly, the looks at the prototype (e.g., high tower) were compared with the looks at the opposite contrast (e.g., low chair). Secondly, the looks at the contrast target (e.g., high chair) and the opposite contrast (e.g., low chair) were compared. These two comparisons examine whether children filter out the opposite contrast and focus on the target object. Next, a third comparison was conducted in which the looks at the prototype (e.g., high tower) were compared with the looks at the contrast target (e.g., high chair), thus the two possible referents. With this comparison it could be examined whether participants prefer one strategy over another: using prototypical exemplars or visual contrast. Table 4 displays the parameter estimates of the three pairwise comparisons.

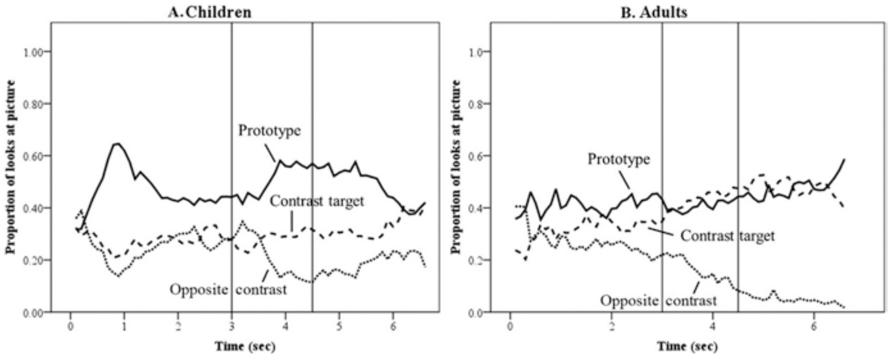


Fig. 3 (**a** and **b**) Proportion of looks at the objects over time in the ambiguous condition, by group

Table 4 Parameter estimates for the three pairwise comparisons of the ambiguous condition

	Prototype versus opposite contrast			Contrast target versus opposite contrast			Prototype versus contrast target		
Fixed effects									
Parameter	Estimate (SE)	*z*	*p*	Estimate (SE)	*z*	*p*	Estimate (SE)	*z*	*p*
Intercept	1.14 (0.19)	6.08	< .001	0.43 (0.19)	2.32	.02	−0.73 (0.16)	−4.62	< .001
Time	1.15 (0.11)	10.87	< .001	1.07 (0.12)	8.87	< .001	−0.04 (0.09)	−0.40	0.69
Group (Adults)	0.04 (0.19)	0.18	.85	0.76 (0.21)	3.69	< .001	0.78 (0.18)	4.36	< .001
Time * Group	−0.43 (0.16)	−2.61	.009	−0.01 (0.18)	−0.09	.93	0.13 (0.13)	1.06	.29
Random effects									
Parameter	*Variance*	*SD*		*Variance*	*SD*		*Variance*	*SD*	
Participant	0.63	0.79		0.71	0.84		0.57	0.75	
Item	0.36	0.60		0.30	0.55		0.20	0.45	

Prototype Versus Opposite Contrast When comparing the prototype to the opposite contrast, we found a main effect of time for children. There was an increase of looks at the prototypical object compared to the opposite contrast. The interaction shows that this effect was weaker for the adults. The latter effect is probably due to the fact that the looks at both possible targets for the adults already increased before the adjective was pronounced: the adults probably realized that these were the two possible referents given the three objects in the picture and divided their attention between them.

Contrast Target Versus Opposite Contrast When comparing the contrast target and the opposite contrast, there was also an effect of Time for the children: whereas the proportion of looks at the opposite contrast decreased, the looks at the contrast target remained stable. There was no interaction, indicating that the effect for the adults was similar to that of the children.

Contrast Target Versus Prototype The third comparison examined the proportion of looks at the two possible referents in order to see whether children make more use of visual contrast or of their knowledge of prototypical exemplars in establishing reference. The dependent variable was the probability of looking at the contrast target. No significant main effect of time was found for children. This means that during the adjective window, the increase of looks at the prototypical target was not significantly stronger than for the contrastive target. Note that although the slope does not significantly differ, there is a difference in the intercepts, due to the increased attention to the prototypical object in the baseline time window. There was no significant interaction effect of Group by Time. This means that the increase of looks at the prototypical target compared to the contrastive target does not differ between adults and children.

7 Conclusion and Discussion

Previous research has shown that early adjective acquisition may be facilitated by two strategies: learning adjectives through prototypical instances of a property (e.g., elephant for *big*) and learning through contrastive information (e.g., big plate *vs.* small plate). Tribushinina and Mak (2016) have shown that three-year-olds can predict a referent based on the prototypical associations between a prenominal adjective and a noun. The present study aimed to replicate this finding and to determine whether three-year-olds can also use visual contrast for predicting the upcoming noun. In addition, an ambiguous context was included in which both types of information could be used to identify the referent, in order to explore possible preferences or differences in strategy use. We will discuss the findings for each context below.

7.1 Prototypical Context: Three-Year-Olds' Reliance on Prototypes

The results of the prototypical condition demonstrate that three-year-olds process adjective-noun phrases incrementally and use their knowledge of prototypes to predict the upcoming referent. Before the noun was even pronounced, children looked at the target referent (e.g., elephant) based on the prenominal adjective (e.g., 'big'), even though at least one other object in the visual array could potentially be described by means of the adjective (e.g., a dog, which was as big as the elephant in the picture). This result replicates an earlier finding reported by Tribushinina and Mak (2016) and extends it to a more complex visual array (of three rather than two objects). Both in the current study and in Tribushinina and Mak (2016), children were as fast as adults in attending to the target picture.

The results of these two eye-tracking studies corroborate the findings from prior corpus research demonstrating that best exemplars are among the most frequent referents of adjectives both in early child speech (between ages 2 and 3) and in child-directed speech (Tribushinina, 2008, 2013b). Frequent exposure to best exemplars of a property through child-directed speech and stories/pictures in children's books probably leads to the development of this strong knowledge of (and reliance on) prototypes already at a young age.

7.2 Use of Contrastive Information

In this section, the results of the contrastive and ambiguous condition are discussed together because of the coherence of the findings. Previous research by Huang and Snedeker (2013) demonstrated that five-year-olds can use referential contrast (e.g., big coin *vs.* small coin) to predict the upcoming referent, even in the presence of a competitor that shares the property with the target (e.g., big stamp), but lacks a contrastive counterpart. The contrastive condition in our experiment aimed to determine whether the prerequisite of this ability, i.e., anticipatory processing of contrastively used adjectives in an array without a plausible competitor, is present at age 3.

The results of the contrastive condition show no evidence that three-year-olds can use visual contrast for predicting the target referent. When the visual array contained two same-kind objects that differed only in the aspect described by the adjective (e.g., high chair *vs.* low chair), the children did not narrow the set of possible target objects before hearing the noun, contrary to the adults whose looking patterns showed strong sensitivity to contrasts. There are several possible explanations for this result. First, this finding might indicate that three-year-olds are not able to use contrastive information in online adjective processing; so this capacity develops somewhere between ages 3 and 5. A second possibility is that toddlers *are* sensitive to contrastive information, but need more time to integrate visual contrasts in adjective processing. If this is the case, a larger time window between the adjective and the noun might have resulted in anticipatory looking.

Finally, it is possible that three-year-olds are to a certain extent able to use visual contrast for referent identification, but have difficulty inhibiting the difference bias. In the contrastive condition, both the target and the contrast belong to the same category (e.g., both chairs), whereas the third (unrelated) object (e.g., butterfly) is more interesting by virtue of belonging to a different category. Such different-category pictures attracted more attention, already in the window preceding the adjective. The same pattern was observed in the ambiguous condition, where the prototypical target (e.g., tower) was of a different category than the contrast target (high chair) and the opposite contrast (low chair). At the moment the adjective was pronounced, the proportion of looks to the prototypical object was significantly higher than the proportion of looks to the two same-kind objects. This difference in intercept may explain why the increase in the proportion of looks to the prototype and the contrastive target was the same; in this case growth was relatively small for the prototypical objects because many children already focused on the prototype in the baseline time window.

It is noteworthy that upon hearing the adjective (e.g., *hoog* 'high/tall') in the ambiguous condition, the children were able to filter out the opposite contrast object (low chair): The proportion of looks to the opposite contrast object decreased in the critical time window, which was not the case for the contrast target (high chair). This finding indicates that children might, at least to a certain extent, make use of the visual contrast for referent identification. The looking patterns of the adults in the ambiguous condition showed strong signs of sensitivity to contrasts, since they already filtered out the third object in the first seconds of the baseline window. Regarding the performance of adults in the ambiguous condition, it is noteworthy that prototypical interpretations were as frequent as contrastive interpretations, even though contrastive uses appear more natural and more informative from a pragmatic point of view (avoidance of redundancy and maximal informativeness for referent identification). This pattern might be due to the fact that the participants were not given a task to find a referent, and the contexts might have been interpreted as purely descriptive. Furthermore, there is recent evidence suggesting that over-specification in adjective use (as in *tall tower*) does not hinder comprehension and may even facilitate it under certain conditions (Tourtouri et al., 2019). Also, the adult participants might have developed certain looking patterns (or strategies) after repeated exposure to both contrastive and prototypical contexts of adjective use in the experiment. In other words, they might have figured out that in half of the trials the adjective would redundantly refer to a best exemplar of the property.

7.3 First Prototypes, Then Contrasts

The results of this study clearly show that the developing ability to use contrastive information in adjective processing lags behind the capacity to process adjectives based on knowledge of prototypes. Three-year-olds are as good as adults in predicting the upcoming referent based on their knowledge of best exemplars of the property. However, their ability to use visual contrast for adjective interpretation is far more limited. With contrasts, they perform significantly worse than adults and only reveal some signs of the emerging ability to rely on contrastive information for referent identification.

Why is contrastive processing of prenominal adjectives more demanding than prototype-based interpretations? Difficulty with contrastive interpretations may be related to the paucity of contrastively used adjectives in child-directed speech (Davies et al., 2020). As against this, parental speech contains plenty of descriptive uses highlighting prototypical adjective-noun or adjective-object associations (Tribushinina, 2008, 2013b). It is plausible to assume that the early-emerging ability to use knowledge of best exemplars in online adjective processing and the protracted acquisition of contrastive inference is related to this asymmetry.

It is also possible that this difference is related to the complexity level of relative versus absolute interpretations, respectively. Absolute interpretations are not context-dependent or, at least, significantly less context-dependent than relative interpretations. Developmental work on the interpretation of relative adjectives using offline comprehension experiments has repeatedly shown that children younger than age 4 tend to apply relative adjectives only to the extremes of a visual array (Ehri, 1976; Smith et al., 1986, 1988; Tribushinina, 2013a). Such interpretations are inherently absolute, because they are not based on context-dependent comparative judgments. Only around age 4, children seem to discover the common reference point for antonymous adjectives and start using a relative standard located around the midpoint of a series in their judgments; and from age 5 onwards they adjust the position of such a reference point to the properties of a specific reference class (Smith et al., 1986; Tribushinina, 2013a).

Adjective processing based on prototypes is an example of absolute interpretations (e.g., tallness is an inherent property of towers). In contrast, non-prototypical entities, such as dogs, may only be dubbed *big* in a relative way (e.g., compared to another dog or compared to an average dog). Contrastive information is not automatically available, but needs to be derived relative to a context-dependent reference point. These differences provide a plausible explanation for the developmental pattern observed in our study: Processing in prototypical (absolute) contexts appears fully-developed at age 3, whereas the development of relative/contrastive processing is still ongoing.

It is plausible to assume that three-year-olds would be more successful in processing contrastive inference if we had used regular intersective (absolute) adjectives that are less context-sensitive than the scalar relative adjectives used in our study. For example, toddlers might be more successful in anticipatory processing of the adjective *red* when presented with a visual array containing a blue car and two red objects (a red bike and a red car). Even though anticipatory processing of contrastive reference is still demanding, the processing of intersective adjectives is presumably less taxing than the processing of intrinsically relative size terms whose interpretation heavily depends on context and comparison class (cf. *a tall lamppost* vs. *a tall boy*).

7.4 Limitations and Directions for Future Research

In this study, we did not focus on individual processing strategies. However, it is possible that some children are more prone (and/or better able) to use contrastive information in adjective processing. Longitudinal studies of contrastive adjective use have revealed remarkable individual differences between children and between caregivers. Some parents favor heavy antonym use, whereas other parents barely use opposites when talking to children (Murphy & Jones, 2008; Tribushinina et al., 2013). There is a positive correlation between antonym use in child speech and child-directed speech (children of heavy antonym users also often use adjectives in contrastive contexts), but the source of this correlation is unclear. It is plausible to assume that the individual differences in contrast use by children and their caregivers may have consequences for adjective processing in real time. Children of heavy antonym users and/or children who favor the use of antonyms may have an advantage in the use of visual contrast for adjective processing. These individual differences are an interesting avenue to explore in future research. Other possibly interesting individual differences pertain to selective attention and vocabulary size (cf. Yoshida et al., 2011).

The findings of the current study are in line with the results of Huang and Snedeker (2013) demonstrating that adults display a stronger tendency to use contrastive information than children. Yet, in their study five-year-olds were able to identify the referent based on referential contrast, whereas our three-year-olds were not able to predict the target referent even though the task was much easier. Future research could focus on contrastive processing in 4-year-old children in order to further examine the developmental phase in which the use of contrastive information becomes more available to children. Relatedly, future research might look into factors that facilitate the use of contrastive information in the incremental processing of adjective-noun phrases. For instance, it could be the case that highlighting the relevant contrast in preceding discourse (cf. Sekerina & Trueswell, 2012) could have enhanced the performance of the three-year-olds in our experiment.

It would also be theoretically interesting to compare the processing of contrastive and prototypical adjective uses in languages with different adjective-noun orders. Obviously, anticipatory adjective processing is not relevant in languages such as Hebrew where attributive adjectives are usually placed after the noun. Evidence from novel word learning studies seems to indicate that the postnominal position facilitates adjective mapping to relevant properties (Yoshida & Hanania, 2013). However, there is evidence that Hebrew-speaking toddlers also have difficulty integrating the meaning of the adjective with that of the noun, even though attributive adjectives always follow the noun. When asked to find the *big teddy* in a visual scene showing a big teddy (correct attribute; correct noun), a small teddy (wrong attribute; correct noun), a big clock (correct attribute; wrong noun) and a small clock (wrong attribute; wrong noun), Hebrew-speaking toddlers would often make choices based on the noun alone (Ninio, 2004). Hence, a possible advantage of the postnominal position (Yoshida & Hanania, 2013) might be counterbalanced by a reduced salience of the adjective which is “overshadowed” by the NP-initial noun: A child may choose a referent based on the noun alone and then fail to repair her initial interpretation upon hearing the adjective. It would be worthwhile to investigate whether and how the postnominal position might influence adjective processing in contrastive and prototypical contexts. Elliptic constructions and nominalized adjectives (e.g., ‘the tall one’) might be particularly informative in this respect because they do not reveal the referent by using the noun before the adjective.

Another interesting path for future research would involve a paradigm, in which children’s adjective processing would be studied in a more naturalistic setting, with real input provided by the child’s caregiver (as in Arunachalam, 2016). This contextual methodology, in which language processes of children can be related to parental speech, is a valuable addition to adjective research in experimental settings.

Appendix: List of Items

	Adjective	Prototype	Non-prototype/contrast	Unrelated
1	tall (hoog)	tower (toren)	chair (stoel)	butterfly (vlinder)
2	“	house (huis)	glass (glas)	ladybug (lieveheersbeestje)
3	“	mountain (berg)	table (tafel)	dress (jurk)
4	“	tree (boom)	bicycle (fiets)	watering can (gieter)
5	“	apartment building (flatgebouw)	fence (hek)	ice cream (ijsje)
6	big (groot)	elephant (olifant)	dog (hond)	pen (pen)
7	“	hippo (nijlpaard)	gift (cadeau)	sand (zand)
8	“	whale (walvis)	monkey (aap)	modder (mud)
9	“	bus	teddy bear (knuffelbeer)	flower (bloem)
10	“	giant (reus)	cloud (wolk)	chocolate sprinkles (hagelslag)
11	small (klein)	gnome (kabouter)	window (raam)	policeman (politieagent)
12	“	chick (kuiken)	bath (bad)	hair (haar)
13	“	mouse (muis)	ball (bal)	doctor (dokter)
14	long (lang)	snake (slang)	candy stick (zuurstok)	computer
15	“	train (trein)	ladder	princess (prinses)
16	“	garden hose (tuinslang)	twig (tak)	pan
17	“	rope (touw)	pencil (potlood)	t-shirt
18	“	garland (slinger)	necklace (ketting)	alarm (wekker)
19	“	giraffe	road (weg)	frog (kikker)
20	thick/fat (dik)	elephant (olifant)	candle (kaars)	drawer (kast)
21	thin (dun)	pencil (potlood)	ice cream (ijsje)	book (boek)

Note. The words in parentheses are the Dutch translations

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Later Syntactic Development: The Past Tense Counterfactual Sentence

Marilyn A. Nippold and Valencia C. Perry

Abstract In the context of addressing later syntactic development, this chapter examines one type of complex sentence, the past tense counterfactual (PTCF). An example of such a sentence is, "If the lunar module Eagle had crashed during its descent on July 20, 1969, astronaut Neil Armstrong might not have become the first person to walk on the moon." Because PTCF sentences are used to express the relative timing of past events with clarity and precision, they are an important component of academic language and therefore deserve the attention of researchers who seek to learn more about literate language development. Hence, we review and discuss studies that have examined the ability of children, adolescents, and adults to comprehend or produce PTCF sentences, focusing on speakers of English living in the United Kingdom or the United States. Collectively, the studies indicate that PTCF sentences continue to develop into adulthood and that certain elements are more challenging than others, particularly the correct form of the past participle verbs. Because many adolescents and young adults who are well-educated, competent speakers of English do not show mastery of PTCF sentences, we suggest that explicit instruction in the grammar of these sentences in academic contexts may be useful.

Keywords Later syntactic development · Past tense counterfactual sentences · Academic language · Literate language development · Past perfect verb form · Present perfect verb form · Usage-based perspective · Cultural and linguistic diversity · Predictability value · Verb learnability

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1 Introduction

This chapter focuses on the development of complex syntax beyond the preschool years. Specifically, we discuss a series of studies that examined one type of complex sentence, the past tense counterfactual (PTCF). This is a conditional “if-then” sentence such as, “If voters had studied the ballot measures carefully, they would have understood the costs and benefits of the new proposals.” In formal English grammar, a correctly formulated PTCF sentence includes a subordinate clause that contains the past perfect verb form (i.e., *had studied*) and a main clause that contains the present perfect verb form (i.e., *would have understood*). In addition, although both clauses refer to events that happened in the past, one (expressed by the past perfect) preceded the other (expressed by the present perfect) (Crystal, 1996; Quirk & Greenbaum, 1973). Another distinguishing feature of PTCF sentences is their hypothetical or *irrealis* quality (D. Ravid, personal communication, February 1, 2019) such that neither event *actually* happened! This can be seen in the example sentence above which implies that voters did *not* study the measures carefully and therefore did *not* understand the costs and benefits of the proposals.

Characteristic of formal, academic language, PTCF sentences have a low frequency of occurrence in adults’ conversational speech (Crutchley, 2013) and are more likely to occur in contexts where the relative timing of past events must be expressed with accuracy, clarity, and efficiency. For example, students in a high school United States history class may be asked to read the following passage (https://www.history.com/topics/womens-history/19th-amendment; History.com Editors) and then to summarize the key points during an essay exam:

> The 19th Amendment to the U.S. Constitution granted American women the right to vote, a right known as women’s suffrage, and was ratified on August 18, 1920, ending almost a century of protest. In 1848, the movement for women’s rights launched on a national level with the Seneca Falls Convention, organized by Elizabeth Cady Stanton and Lucretia Mott. Following the convention, the demand for the vote became a centerpiece of the women’s rights movement. Stanton and Mott, along with Susan B. Anthony and other activists, raised public awareness and lobbied the government to grant voting rights to women. After a lengthy battle, these groups finally emerged victorious with the passage of the 19th Amendment. Despite the passage of the amendment and the decades-long contributions of Black women to achieve suffrage, poll taxes, local laws and other restrictions continued to block women of color from voting. Black men and women also faced intimidation and often violent opposition at the polls or when attempting to register to vote. It would take more than 40 years for all women to achieve voting equality.

A student in the class might demonstrate her newly-acquired insight into the topic by producing the following PTCF sentences (where the past perfect and present perfect are highlighted):

> If women such as Stanton, Mott, and Anthony *had surrendered* their battle over voting rights, the 19th Amendment to the US Constitution *would not have been passed*. Nevertheless, women of color were forced to continue that battle for another 40 years. If they *had* not *done* so, their legal right to vote *would* not *have been achieved.*

Consistent with the complex, irrealis quality of PTCF sentences, these sentences reflect the writer's understanding that the suffragists did *not* surrender, that the 19th Amendment *was* passed, but that women of color had to *continue* fighting and were eventually victorious.

In contrast, a classmate with weaker academic language skills might attempt to summarize the passage as follows:

> If women such as Stanton, Mott, and Anthony *surrendered* their battle over voting rights, the 19th Amendment to the US Constitution *would not pass*. If women of color *did not fight* for their rights, they *could not vote*.

In these two sentences, the writer used the simple past tense (*surrendered, did not fight)* instead of the past perfect (*had surrendered, had not fought)* in the subordinate clause and the conditional future tense (*would not pass, could not vote)* instead of the present perfect (*would not have passed, could not have voted)* in the main clause. This summary is problematic, particularly in an academic context where articulate communication is expected, because the student was unable to coordinate the two halves of each sentence to express the relative timing of past historical events with clarity and precision, leaving the reader to fill in the missing information.

Note also that the ability to read and comprehend the passage above places many demands on a student's linguistic and cognitive resources. For example, the passage contains numerous abstract words (e.g., *equality*, *intimidation*, *movement*, *opposition*, *passage*) that must be understood. It also contains many long and complex sentences that equate to an average of 21.50 words and 2.63 clauses per communication unit (C-unit), which is an utterance that contains a main clause and optionally may contain one or more subordinate clauses. The passage also has a Flesch-Kincaid reading equivalent of grade 13.7 (Microsoft Word, 2016), which translates to college level performance. Cognitively, a student would need to attend to and remember the information in the passage, draw inferences, and integrate what has been learned into an existing knowledge base before being able to summarize the main points in writing.

Yet these are precisely the literate language skills that high school students in the United States are expected to possess. For example, according to the Common Core State Standards (CCSS.ELA-Literacy.R1.9-10.1, R1.9-10.2, R1.9-10.3, R1.9-10.4; National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010), when reading expository passages, 9th and 10th grade students (ages 14–16 years old) should be able to analyze information, draw inferences, identify main ideas, and determine the meanings of unfamiliar words in context. Then, when expressing themselves in spoken and written language, they should be able to demonstrate command and use of standard English grammar, including different types of phrases (e.g., noun, verb, adverbial, adjectival) and clauses (e.g., main, relative, adverbial, nominal) along with general academic and domain-specific terminology (CCSS.ELA-Literacy.L.9-10.1, L.9-10.6). Given the conditional and hypothetical nature of PTCF sentences –with their temporal, grammatical, and experiential demands – it is not surprising that they are a late linguistic attainment. Before discussing the evidence that supports that view, it is necessary first to establish the place of PTCF sentences in the larger context of syntactic development.

2 Development of Complex Syntax

When children are between two and three years old, their productive language expands beyond the use of simple one- and two-word utterances to include longer and more complex utterances (Owens, 2012). For example, at age two, a child might say, “Want cookie” but by age three, that same child might say, “I wanna have a big cookie!” The use of complex syntax develops quickly during the preschool years and upon reaching five years of age, most children with typical language development can spontaneously generate sentences containing any type of subordinate clause (Barako Arndt & Schuele, 2013; Diessel, 2004; Frizelle et al., 2018; Paul, 1981; Tyack & Gottsleben, 1986). Thus, as children grow older and gain proficiency in using subordinate clauses within complex sentences to express themselves, their mean length of utterance (MLU) gradually increases, ranging from around 3.20 morphemes at three years of age to around 6.0 morphemes at five years of age (Miller, 1981).

Because most five-year-old children are active communicators, conversing easily with familiar adults and making few grammatical errors in their speech (Owens, 2012), they may appear to have mastered the syntax of their native language. This, however, would be a superficial and inaccurate account of syntactic development. Despite the remarkable linguistic attainments of a typical five-year-old child, it is important to note that syntax continues to develop throughout the school-age years, adolescence, and into adulthood as speakers and writers gradually learn to produce longer and more complex utterances that contain a greater number and variety of subordinate clause types (Berman & Nir-Sagiv, 2007; Berman & Verhoeven, 2002; Nippold et al., 2005, 2007, 2017; Ravid & Berman, 2006; Verhoeven et al., 2002). This growth in subordination causes their mean length of C-unit (MLCU) to undergo gradual age-related increases. For example, Nippold et al. (2005) reported that during an expository speaking task, on average, 11-year-old children had an MLCU of 9.29 words; 17-year-old adolescents had an MLCU of 10.59 words; and 25-year-old adults had an MLCU of 11.04 words. Moreover, in addition to using a greater number and variety of subordinate clauses within sentences, school-age children, adolescents, and adults – compared to preschool children – tend to use a larger and more diverse set of words and phrases (e.g., adjectives, prepositional phrases, appositive constructions) within clauses (Ravid, 2005). For example, Perera (1986) reported that during the school-age years, children gain the ability to produce elaborated noun phrases as subjects (e.g., “*A little old man selling lanterns of brass* walked down the street” p. 509) in their formal academic writing assignments. Notably, intra-clausal expansions, which occur in the production of PTCF sentences, add meaning to the message and contribute to increases in the length and complexity of utterances (Scott, 1988). At the same time, they allow speakers and writers to convey large amounts of information more efficiently than if they were limited to producing strings of simple sentences. For example, consider the following PTCF sentence that a high school student in a United States history class might produce:

> If the American pilot, cognizant of the dangers, had landed the plane in Wales rather than in Ireland, the soldiers on board might have encountered the Cardiff Blitz.

With 28 words and two clauses, this sentence is dense with information that would be difficult to express– and tedious to follow – if it were stated via a string of simple sentences such as the following: The pilot was American. He did not land the plane in Wales. Instead, he landed it in Ireland. It was extremely dangerous in Wales. Cardiff is a city in Wales. The Cardiff Blitz was happening. German planes were dropping bombs over Cardiff. The American pilot knew this. He avoided the danger. He kept the soldiers safe. The soldiers were not caught in the Blitz.

This example illustrates how the ability to produce complex sentences, including the PTCF, can empower an individual to explain complicated phenomena in a way that is clear, precise, and efficient. It is therefore important to investigate the development of PTCF sentences as an aspect of later syntactic development that is especially valuable in academic contexts.

3 Development of PTCF Sentences

Crutchley (2004) published the first developmental study of PTCF sentences. In her investigation, British school children living in the UK, ages 6;0 to 11;11 years old (n = 799), were prompted to produce PTCF sentences in response to pictures that illustrated contrastive situations, one negative and one positive. To begin, a practice activity was presented where the child was shown a picture of a girl being scolded by her teacher for not turning in her homework (negative situation) and a picture of that same girl at her desk at home doing her homework (positive situation). The examiner then said, "If she had done *this* (while pointing to the positive situation), then *this* (while pointing to the negative situation) would not have happened." The examiner then modelled a fully correct PTCF sentence that described the two pictures, i.e., "If she had done her homework, she wouldn't have been told off by the teacher" (p. 215), which the child was asked to repeat. Following the practice activity, two test items were presented in the same manner but without modeling a correct PTCF sentence. In one item, a picture was shown of a girl shutting the door to a rabbit's cage (positive situation) contrasted with another picture that showed the girl chasing the rabbit after it had escaped the open cage (negative situation). The examiner then asked the child to tell about each picture to elicit a PTCF sentence such as "If the girl had shut the cage door, the rabbit would not have escaped." The second test item, presented in the same manner but with different pictures depicting contrastive situations, was designed to elicit a PTCF sentence such as "If the boy had run faster, he would have caught the school bus."

Crutchley (2004) reported that children's performance on the task improved in relation to increasing age but that full mastery of PTCF sentences was not observed even in the oldest group. She also found that only 40.7% of all responses constituted a fully correct PTCF sentence in that the subordinate clause contained the elements "if + had + past participle" and the main clause contained the elements "would + have + past participle" (e.g., "If the boy had run, he would've caught the bus," p. 235). All other responses lacked one or more elements of a fully correct PTCF sentence. Frequently, the structure "if + past simple" was used in the subordinate clause replacing the had + past participle (e.g., "If he wasn't late for the bus, he wouldn't have missed it," p. 235) and sometimes the main clause lacked the auxiliary verb *have* and the correct form of the past participle ("If he walked faster, he wouldn't miss the bus," p. 235). In interpreting her results, Crutchley hypothesized that PTCF sentences are difficult for children to learn because they express subtle meanings and have a low frequency of occurrence in the spoken language of adults. Thus, from a usage-based perspective of language acquisition (Diessel, 2004), children may not receive enough exposure to PTCF sentences for their unique grammatical patterns to become firmly entrenched in memory and therefore accessible for spontaneous production.

To investigate these hypotheses, Crutchley (2013) examined a large database of conversational language samples that had been produced by British adults ($n = 124$) who represented a variety of ages, social classes, and geographic locations throughout the UK. Drawn from the British National Corpus (BNC, 2007), each sample was searched electronically for the presence of sentences that contained elements of the PTCF in the subordinate clause (if + had + lexical verb) and/or the main clause (would + have + lexical verb). Each returned sentence was examined further to verify that it was indeed a PTCF sentence or an approximation of one.

Crutchley (2013) reported that out of 610,563 sentences, only 389 (.06%) were PTCFs and that many of them were syntactic variations of a fully correct PTCF sentence. She also noted that these variations were similar to the types of PTCF sentences that had been produced by the school-age children in her developmental study (Crutchley, 2004). For example, often the adults used a simple past tense verb (e.g., if I *came* back later…) to express the past perfect in the subordinate clause (e.g., if I *had come* back later…) and a modal and infinitive verb (e.g., he *would* still *be* there) to express the present perfect in the main clause (e.g., *would have* still *been* there). Based on those results, she determined that PTCF sentences occur infrequently in the spoken language of adults and that when the adults in a child's environment do use them, they produce many variations. She therefore stated that "Low token frequency and high type frequency are hypothesized to account partly for children's late acquisition of the PTCF construction" (p. 438).

Given that the oldest participants in Crutchley's (2004) developmental study were 11-year-old preadolescents, Nippold et al. (2020b) wished to determine if growth in the production of PTCF sentences continued during the adolescent years and into early adulthood. In their investigation, two groups of adolescents (younger and older) and one group of young adults ($n = 40$ per group) participated. The mean ages of the groups, respectively, were 13, 16, and 22 years. All participants spoke American English and were living in the western United States. The adolescents were attending a public middle school (8th grade) or high school (11th grade) in western Oregon and the adults were attending a nearby public university. A written language task was administered in group fashion in classrooms at the middle school, high school, or university. The task consisted of four short fables and a sentence completion activity. To introduce the task, a practice item was presented using the fable, *The House Mouse and the Field Mouse* and its moral message ("The grass is not always greener on the other side of the fence"). The fable was followed by a summary statement ("The field mouse was afraid of the cat and the people who lived in the house") and an incomplete PTCF sentence ("If the field mouse had not gone home to live in peace…"). The participants were asked to read the fable, its moral message, and the summary statement, and then to complete the PTCF sentence in a way that made sense with the story. After they had done so, the examiner modelled a fully correct PTCF sentence based on the story ("If the field mouse had not gone home to live in peace, he would have been very unhappy"). After the practice item was presented, four test items, using different fables, were presented in the same way but without modelling a correct PTCF sentence. Those fables were *The Fox and the Grapes*, *The Crow and the Pitcher*, *The Ant and the Grasshopper,* and *The Rooster and the Fox*. Table 1 contains an example of a test item used in the study.

As shown in Fig. 1, Nippold et al. (2020b) found that accuracy on the PTCF sentence completion task improved in relation to increasing age and that the 22-year-olds performed significantly better than the 13-year-olds. However, all three groups showed wide variability in their performance, evidenced by the error bars in Fig. 1. It was also found that mastery (accuracy = 90% or better) occurred in only 48%, 60% and 73% of the 13-, 16-, and 22-year-olds, respectively. In addition to overall performance, the investigators examined performance on the essential elements of the main clause of a PTCF sentence, the modal verb *would*, the auxiliary verb *have*, and the past participle. As shown in Fig. 2, results indicated that, for all groups, using the correct form of the past participle was the most difficult element, followed by the auxiliary verb *have*, but that using the modal verb *would* was not difficult for any group.

Table 1 Example of a fable and prompt used to elicit the completion of a past tense counterfactual sentence in the Nippold et al. (2020b) study

The Crow and the Pitcher (Adapted from Aesop's Fables, http://www.aesopfables.com/aesopsel.html)
A crow who was perishing with thirst saw a pitcher on a porch. Hoping to find water, he flew to it with delight. However, when he reached the pitcher, he discovered, to his great dismay, that it was only half-full of water and he was unable to reach it with his beak.
The crow tried everything he could think of to reach the water. He even collected some sticks to use as straws to draw up the water. But this did not work and all of his other efforts were also in vain. At last he decided to collect as many stones as he could find. He carefully dropped them one by one into the pitcher, until he brought the level of water up to his reach. In this way, he was able to drink the water to save his own life.
The **moral** of the story is, "Necessity is the mother of invention."
The thirsty crow was dismayed that he could not reach the water in the pitcher.
If the crow **had not thought** of a clever solution to his problem,
____
(Please complete the sentence in a way that makes sense with the story)

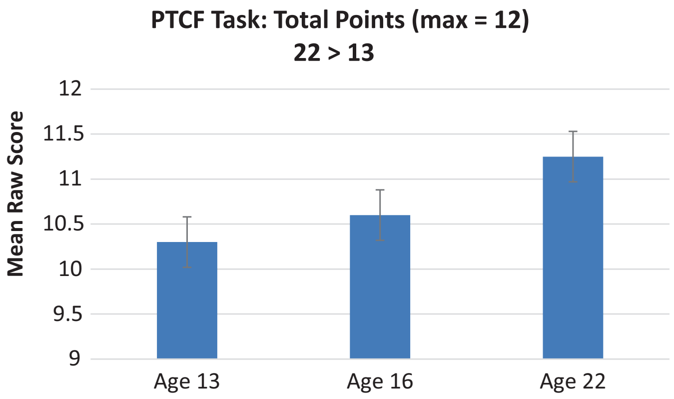

Fig. 1 Overall performance of the three groups of participants on the PTCF Sentences Task (Nippold et al., 2020b). The error bars represent +/−1 standard error of the mean

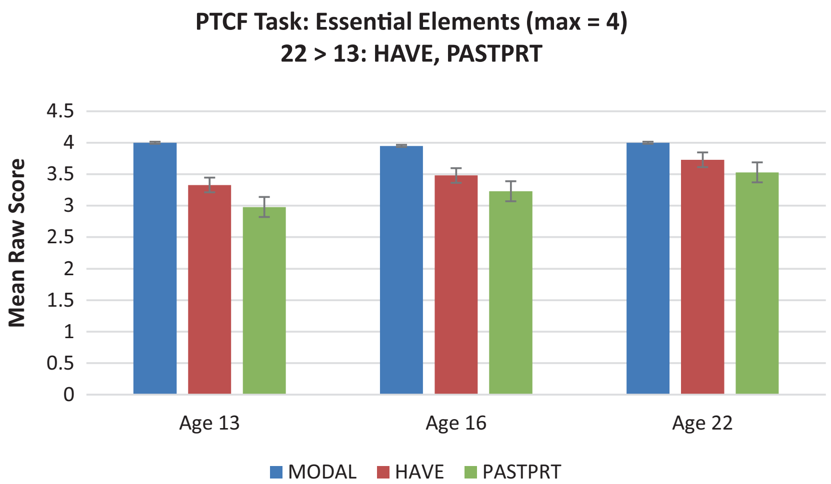

Fig. 2 Performance of the three groups on the essential elements of the PTCF Sentences Task (Nippold et al., 2020b). The error bars represent +/−1 standard error of the mean

Examples of correct and incorrect responses on the task are shown in Table 2. Of particular interest was a pattern in which participants of all ages used the modal verb *would* with an infinitive verb (e.g., *would die*, *would continue, would be*) in place of the present perfect (e.g., *would have died*, *would have continued, would have been*). Another pattern often occurred in which they used a simple past tense verb in place of the past participle (e.g., *flew* for *flown*). It is noteworthy that these specific patterns had also occurred in Crutchley's (2004, 2013) samples of British English-speaking school-age children and adults living in diverse regions of the UK.

In other research conducted with the same participants, Nippold et al. (2020b) elicited written language samples from each adolescent and adult, and calculated

Table 2 Examples from Nippold et al. (2020b) of responses to the *Crow and Pitcher* prompt: If the crow **had not thought** of a clever solution to his problem

Correct:	
1.	he wouldn't have had the energy to fly anymore (age 13)
2.	he would have stayed dehydrated (age 16)
3.	he would have died from dehydration (age 22)
Incorrect:	
4.	the crow would most likely die of thirst (age 13)
5.	he would continue to be thirsty (age 16)
6.	he wouldn't get any water (age 17)
7.	he would become ill from dehydration (age 21)
8.	he would've flew away with thirst (age 16)

MLCU as an index of general language competence. On this measure, mean raw scores for the groups of 13-, 16-, and 22-year olds, respectively, were 13.65, 15.08, and 16.78 words, confirming normal language competence in each group. Then, to determine if language competence was associated with performance on the PTCF sentences task, correlation coefficients were calculated between MLCU and PTCF, using each participant's raw scores on those two measures. However, no correlation coefficients were statistically significant. Thus, performance on the PTCF sentences task was not associated with language competence and it should not be assumed that any difficulties with PTCF sentences necessarily reflect language deficits. However, the fact that many students with normal language competence struggled with the task suggests that they may require explicit instruction in order to learn the correct grammatical patterns of PTCF sentences.

Nippold et al. (2020b) acknowledged that their study of adolescents and young adults examined only the main clause of a PTCF sentence (present perfect verb form) and that it used only a production task. Thus, it was unknown how adolescents and adults would perform on a task that involved both the subordinate and main clauses of a PTCF sentence, and hence the past perfect and present perfect verb forms, respectively. It was also unknown how comprehension of PTCF sentences might differ from production of those sentences.

To address these limitations, Nippold et al. (2020a) conducted a larger and more detailed study of PTCF sentences with young adolescents and young adults ($n = 80$ per group) whose mean ages were 12 and 21 years old, respectively. All participants were monolingual speakers of Standard American English (SAE) and were attending a middle school or university in western Oregon (United States). The task required the completion of 32 PTCF sentences. For half the sentences, the past perfect verb form was targeted in the subordinate clause, and for the other half, the present perfect verb form was targeted in the main clause. Half the participants in each group used a fill-in response format (to examine production) and half used a multiple-choice response format (to examine comprehension). For the fill-in format, an unmarked clue word (always an infinitive verb) followed the sentence, as in these examples:

Tom would have enjoyed his dinner more if he __________ the baked chicken.
Clue word: **choose**
If Mary had seen the fire at school, she would ___________ the fire alarm.
Clue word: **ring**

Using the clue word, the participant was expected to complete each sentence to express the past perfect (i.e., had chosen) or the present perfect (i.e., have rung) verb form. For the multiple-choice format, instead of a clue word, five answer choices followed each sentence, and the participant was expected to select the best one to complete the sentence, as in these examples:

Tom would have enjoyed his dinner more if he __________ the baked chicken.

A. had chosen*
B. chose
C. had choosed
D. choosed
E. choose

If Mary had seen the fire at school, she would ___________ the fire alarm.

A. ring
B. have rung*
C. ringed
D. rang
E. have rang

Before completing the 32 test items, each participant completed two practice items that were similar to the test items, presented in the same format, and received corrective feedback.

Nippold et al. (2020a) reported that the adults outperformed the adolescents on both the production and comprehension of PTCF sentences, and that production was more difficult than comprehension for both groups. These results are illustrated in Fig. 3. However, there was a great deal of variability within groups on both response formats, evidenced by the error bars shown in Fig. 3. It was also found that mastery (accuracy = 90% or higher) of PTCF sentences occurred in only 2% and 25% of the adolescents and adults, respectively, for production, and in only 10% and 50% of the groups, respectively, for comprehension. This confirmed the view that PTCF sentences are a late linguistic attainment, with acquisition extending into early adulthood. It was also found that the past perfect was more difficult than the present perfect in both response formats, for both groups. This suggests that some adolescents and even some adults may require explicit instruction in the production and comprehension of PTCF sentences if they are to master this type of complex sentence that they may be expected to produce and comprehend in academic contexts such as a high school or college history class.

It is perhaps surprising to learn that many young adults who are university students and monolingual speakers of SAE have not yet mastered PTCF sentences. This leads to intriguing questions concerning the performance of young adults from

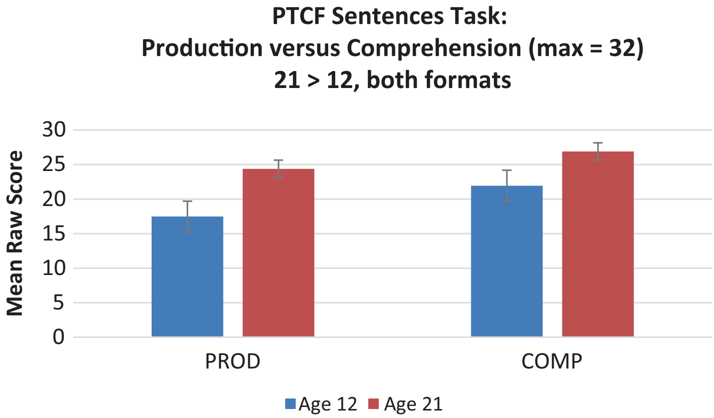

Fig. 3 Performance of the adolescents and adults (*n* = 40 per group) on the production and comprehension of past tense counterfactual sentences (adapted from Nippold et al., 2020a, p. 768). The error bars represent +/−1 standard error of the mean

more diverse backgrounds. To begin to address this topic, Perry et al. (2021) conducted a small pilot study of young adults (*n* = 25) who were attending a university in Washington, DC, located in the mid-Atlantic region of the United States. The participants in their study had a mean age of 24 years and most were graduate students. Each participant completed a written background questionnaire. When asked to indicate their native (or first) language, 23 participants (92%) reported English and 2 (8%) – both of whom had spoken English since early childhood – reported another language (Spanish or Arabic). When asked to rate their own ability to communicate in English, 20 participants (80%) rated themselves as excellent and 5 (20%) rated themselves as good/fair. Regarding their racial backgrounds, 21 (84%) circled Black/African-American/Afro-Caribbean, 2 (8%) circled Mexican/South American/Latino, and 2 (8%) circled "Other." Participants reportedly spent their formative years (ages 1–12) living in the United States (mostly in eastern or southern states) or in other countries (Bahamas, Jamaica, Saudi Arabia, Trinidad and Tobago). Thus, the participants in this study were a diverse and well-educated group of English-speaking adults.

In the Perry et al. (2021) study, each participant completed the more challenging fill-in version of the written PTCF sentences task (production measure) used in Nippold et al. (2020a), described above. The task consisted of 32 incomplete sentences. For half of the sentences, the missing elements were in the subordinate clause (e.g., The old house would have looked nicer if the owner ___________ the front porch), requiring the participant to generate the past perfect verb form (*had swept*) in response to a clue word (*sweep*); for the other half, the missing elements were in the main clause (e.g., If John had slipped off that ladder, he would _________ his arm), requiring the participant to generate the present perfect verb form (*have broken*) in response to a clue word (*break*). To ensure the participants understood the task, they completed two practice items, one for the past perfect and one for the present perfect, and received corrective feedback before being instructed to complete the 32 test sentences.

In the Perry et al. (2021) study, each participant earned a raw score for the present perfect, past perfect, and both verb forms combined. The results are reported in Table 3. A dependent *t*-test indicated that performance was significantly higher on the present perfect than on the past perfect ($t = 5.43$, $p < .0001$, $d = 1.30$), as illustrated by Fig. 4, and that the effect size was very large (Cohen, 1988). However, it was also found that there was a great deal of variability in the performance of the adults, evidenced by the error bars in Fig. 4, and that only 20% of them showed mastery of the task, earning a total raw score of at least 29 (90% or higher).

To gain additional insight into the participants' performance on the PTCF task, Perry et al. (2021) generated a list of all test items for the present perfect and past perfect verb forms and recorded the number and percentage of participants that employed each targeted structure. As reported in Table 4, the data indicate that for the present perfect, performance ranged from a low of 12% (*have swum*) to a high of 96% (*have stood, have done, have thrown, have caught, have built, have given*), and that some of the more challenging items included *have fallen* (72%), *have bitten* (64%), *have woken* (60%), and *have swum* (12%), often produced as *have fell, have bit*, *have woke,* and *have swam,* respectively. Table 4 also shows that for the past perfect, performance ranged from a low of 8% (*had drunk*) to a high of only 64% (*had felt, had slept, had bought, had taught, had taken*), and that some of the more challenging items included *had driven* (40%), *had ridden* (32%), *and had drunk* (8%). Often these items were produced as *drove* or *had drove*, *rode* or *had rode*, and *drank* or *had drank*, respectively, with the auxiliary verb *had* used inconsistently.

As reported in Table 5 and illustrated in Fig. 5, the auxiliary verb *have* (for the present perfect) was used more often than the auxiliary verb *had* (for the past perfect) ($t = 5.61$, $p < .0001$, $d = 1.87$), a statistically significant difference with a very

Table 3 Performance of the adults ($n = 25$) on the present perfect and past perfect verb forms and on both forms combined (Perry et al., 2021)

Variable	
Present perfect (max = 16)	
M	12.84
SD	2.13
Range	7–16
Past perfect (max = 16)	
M	8.04
SD	5.27
Range	0–15
Combined (max = 32)	
M	20.88
SD	6.71
Range	7–30

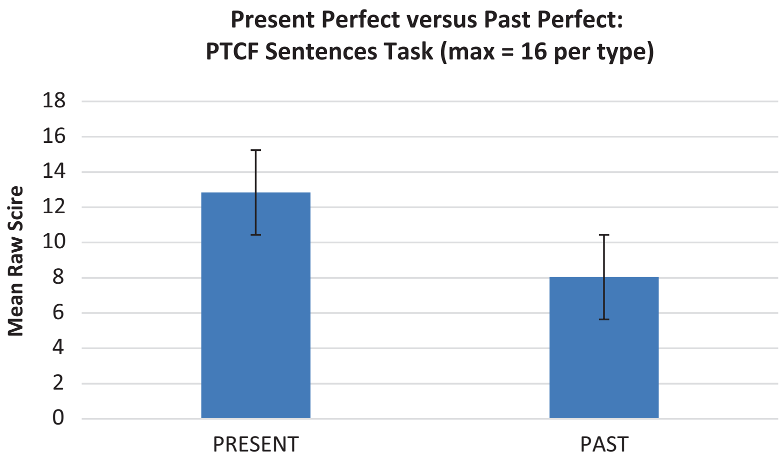

Fig. 4 Performance of the adults (n = 25) on the production of PTCF sentences (Perry et al., 2021). The error bars represent +/−1 standard error of the mean

large effect size (Cohen, 1988). Another pattern observed was that, regardless of the use or nonuse of the auxiliary verb *have* or *had*, participants often used an irregular past tense verb in place of the past participle, with common instances of this listed in Table 6 (e.g., *drank* for *drunk*).

The results of Perry et al. (2021) were similar to those of Nippold et al. (2020a), who used the same task to examine the production of PTCF sentences in young adults living in the western United States. In both studies, it was more difficult to use the standard form of the past perfect than the present perfect. In addition, individual performance was variable and a fairly low percentage of adults in those two studies (20% and 25%, respectively) showed mastery of the task. The findings of Perry et al. were also similar to those of Nippold et al. (2020b), who found that young adults often had difficulty using the correct form of the past participle verb, sometimes substituting a simple past tense verb in its place (e.g., *ate* for *eaten*), a pattern also seen in Crutchley's (2013) study of the language spoken by British adults.

The occurrence of these patterns in different groups of adults raises questions concerning the possibility of dialectal issues influencing the results. Currently, very little beyond a surface level of analysis is known about how speakers who use different varieties of English, such as African American English (AAE), British English, Southern English, or SAE may differ in their performance on formal tasks of the production or comprehension of PTCF sentences. It is interesting to note, for example, that some speakers of AAE reportedly use the preterite verb *had* before a past tense verb (verb + ed) – *not* to express the past perfect (e.g., "If I *had jumped* higher, I might have won the meet") – but to express the simple past tense (e.g., "My sister *had* jumped out of the way"). Rickford and Théberge Rafal (1996) reported numerous instances of this phenomenon (e.g., *had bit, had came, had threw, had went*, pp. 232–233) in the spoken narratives of African American pre-adolescents,

Table 4 Number (and percentage) of participants ($n = 25$) who employed each targeted structure on the present perfect and past perfect verb forms on the PTCF production task (Perry et al., 2021)

Present Perfect	
Have fallen	18 (72%)
Have broken	19 (76%)
Have hung	22 (88%)
Have stood	24 (96%)
Have grown	22 (88%)
Have bitten	16 (64%)
Have swum	03 (12%)
Have done	24 (96%)
Have thrown	24 (96%)
Have caught	24 (96%)
Have spoken	19 (76%)
Have built	24 (96%)
Have rung	18 (72%)
Have sold	24 (96%)
Have given	24 (96%)
Have woken	15 (60%)
Past Perfect	
Had drunk	02 (8%)
Had felt	16 (64%)
Had slept	16 (64%)
Had ridden	08 (32%)
Had told	12 (48%)
Had swept	15 (60%)
Had bought	16 (64%)
Had eaten	15 (60%)
Had written	12 (48%)
Had driven	10 (40%)
Had taught	16 (64%)
Had held	11 (44%)
Had sung	11 (44%)
Had chosen	14 (56%)
Had taken	16 (64%)
Had blown	11 (44%)

and suggested that speakers may use it as a way of orienting the listener to an important event in the story. They noted also that the standard form of the past participle (i.e., *had bitten, had come, had thrown, had gone*, p. 233) never occurred in those contexts. For more details, the reader is referred to Green (2002), who provided a robust discussion of the preterite *had* and its position in the six-way system of past tense marking in AAE. In view of this information, it would be interesting to know

Table 5 Performance of the adults (n = 25) on the auxiliary verbs *have* and *had* and on the past participle verb (Perry et al., 2021)

Variable	
Auxiliary verb *have* (max = 16)	
M	15.52
SD	0.77
Range	13–16
Auxiliary verb *had* (max = 16)	
M	9.44
SD	5.74
Range	0–16
Past participle verb (max = 32)	
M	24.40
SD	4.09
Range	17–31

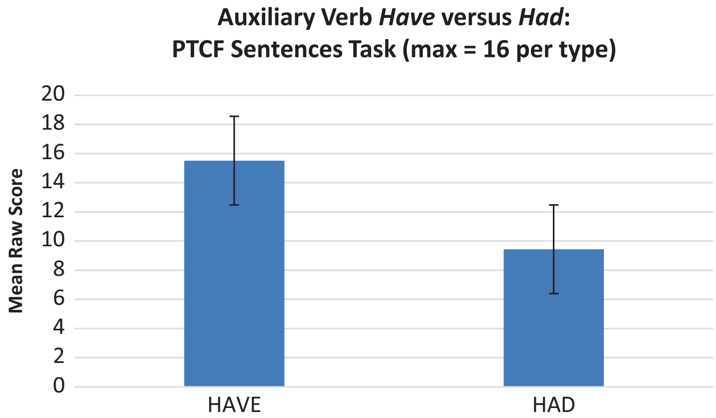

Fig. 5 Performance of the adults (n = 25) on the auxiliary verb *have* versus *had* in the production of PTCF sentences (Perry et al., 2021). The error bars represent +/−1 standard error of the mean

if any participants in the Perry et al. (2021) study were influenced by the preterite *had* feature of AAE, given that 84% reported themselves to be Black/African-American/Afro-Caribbean. Dialectal influences on the production and comprehension of PTCF sentences should be addressed in future research.

Regarding AAE, another intriguing feature of this dialect is that in general, the morphology used in simple past tense and past participle environments is identical in shape (e.g., *bit* and *bit*), and there is often no separate participle verb form (*bitten*) as there is in SAE (Green, 2002). Although past participles occur in AAE, the manner in which these forms are used is variable and it is not consistent with SAE patterns. For example, consider the AAE marker BIN. With this marker, the word *been*

Table 6 Examples of past irregular verbs frequently used in place of the expected past participle verb in the study of young adults by Perry et al. (2021)

Past irregular verb	Past participle verb
Drank	Drunk
Rode	Ridden
Ate	Eaten
Wrote	Written
Drove	Driven
Sang	Sung
Chose	Chosen
Took	Taken
Blew	Blown
Broke	Broken
Grew	Grown
Bit	Bitten
Swam	Swum
Threw	Thrown
Spoke	Spoken
Woke	Woken

is spoken with prosodic stress to indicate that an activity began in the distant past, as in "He BIN playing ball" (Beyer et al., 2015, p. 61). In SAE, the same meaning would be conveyed in a wordier fashion by adding the auxiliary verb *has* and an adverbial phrase, i.e., "He *has* been playing ball *for a very long time*." However, there are instances in AAE where verbs such as *gone* and *done* are expressed in their participle form when they follow BIN as in "He BIN gone to the store" or "He BIN done washed the clothes." In SAE, these sentences might be stated as "He left for the store a long time ago" or "He finished washing the clothes ages ago." Moreover, in AAE the participle *done* may also be used to indicate a completed action as in "She done took the keys" which in SAE might be stated as "She has already taken the keys" or "She already took the keys." Thus, the use of participles in AAE is variable and complex. More research is necessary to clarify the rules that underlie those patterns.

4 General Discussion

A common pattern that we have seen with the studies just reviewed is that identifying and using the correct form of the past participle verb was often the most challenging aspect of PTCF sentences tasks for English speakers of all ages, including children, adolescents, and adults. It is noteworthy also that the participants in those studies were drawn from a variety of locations throughout the UK and the

US. Although the reasons for this pattern are not well-understood, one possibility is that it is difficult, if not impossible, for learners to extract a single rule that can be followed consistently because multiple rules for marking this verb form seem to exist in formal English. As illustrated by the examples in the Appendix, there are many regular verbs (Set A) where the past participle takes the same form as the simple past tense verb and where both end with the suffix–*ed* (e.g., *called, called; jumped, jumped*; *landed, landed*). Theoretically, this condition should make it easy to learn how to mark the past participle verb. At the same time, however, there are many irregular verbs (Set B) where the correct form is identical for the infinitive, simple past, and past participle (e.g., *cut, cut, cut,* respectively). Although this type of consistency could potentially minimize confusion, it represents still another rule to learn, and one that differs from the previous rule (Set A). Moreover, there are many other irregular verbs (Set C) where the infinitive takes a different form, but the simple past and past participle take the same form (e.g., *catch, caught, caught*, respectively), a condition that may be less predictable than the previous condition (Set B) but more predictable than another condition (Set D) where all three verbs – the infinitive, simple past, and past participle – are unique (e.g., *draw, drew, drawn*, respectively). Finally, we see that for past participles that end in the suffix –e*n* (Set D), sometimes the suffix is attached to the simple past tense verb (e.g., forgot-forgotten) and other times it is attached to the infinitive verb (e.g., give-given). Moreover, there are instances where the form of the past participle is even less obvious because the vowel changes across the three verb forms (e.g., *write, wrote, written*). Thus, it is possible that the existence of multiple rules and inconsistencies reduces the predictability of past participle verbs, and hence the ease in which children, adolescents, and adults can learn the correct forms. Clearly, future research is needed to examine these and other possible explanations but it may be especially fruitful to measure the extent to which the *predictability value* of various past participle verb forms influences their degree of learnability.

5 Educational Implications

Given the documented difficulty for speakers of American and British English to master the grammar of PTCF sentences, particularly the appropriate past participle verbs, it may be necessary to provide explicit instruction in this type of complex sentence. As part of language arts classes, for example, high school English teachers could teach the grammar of PTCF sentences using evidence-based strategies such as sentence modeling and sentence completion that reportedly can improve the ability of children and adolescents to produce different types of complex sentences, based on research in education and speech-language pathology (e.g., Balthazar & Scott, 2015; Eisenberg, 2006; Graham & Perin, 2007; Saddler & Graham, 2005).

In using these strategies, it is especially important to focus on contexts where there is an obvious need for precision. Starting with a more familiar situation, this instruction could occur, for example, during a cooking lesson where measuring the ingredients for a recipe is essential for success. To begin, the teacher could model PTCF sentences such as, "If James (a student in the class) *had added* two cups of sugar to the mix, rather than one, the cake *would have tasted* too sweet," stressing the past perfect (*had added*) and the present perfect (*would have tasted)* verb forms. For some students, it may be necessary to explain that while both events happened in the past, one preceded the other, stressing the relative timing of past events. In addition, given that AAE expresses some time concepts differently from SAE (such as the use of the preterite *had* applied in a markedly different way from the past perfect), explicit instruction may be needed to teach the relationship between time and language forms used to indicate the occurrence of past events. It also may be helpful to actually carry out both sets of conditions (i.e., adding too much sugar and bearing the consequences; adding the correct amount of sugar and enjoying the results) so students can experience for themselves the importance of timing issues and the descriptive language used to accurately convey the subtle differences between those contrasting conditions.

Following these modeling and experiential activities, the teacher could offer sentence completion prompts by providing just the subordinate clause of a PTCF sentence ("If James *had forgotten* to add eggs to the mix, ____________________"), and asking the students to complete it using a grammatically correct main clause (e.g., the cake *would have been* too dry). Eventually, students would be expected to generate their own complete PTCF sentences to discuss similar situations where there is an obvious need for exactitude (e.g., "If Harry *had studied* for the chemistry exam the night before, he *would have earned* a higher score").

Following success with these types of familiar situations, the teacher could move on to more challenging contexts such as those that occur in a high school history class. Working collaboratively with the history teacher, for example, the English teacher could encourage the students to produce PTCF sentences during classroom assignments such as oral reports or essays where the relative timing of past events must be expressed with accuracy and precision (e.g., "If the Seneca Falls Convention *had not occurred* in 1848, the demand for women's voting rights *might have lost* momentum"). In carrying out this instruction in grammar, it is essential that it be part of the larger goal of building knowledge of important events in history, which requires students to possess sophisticated academic language skills. For example, before students can independently produce PTCF sentences in academic contexts they must be able to read and comprehend difficult text, interpret novel and abstract words, process long and complex sentences, draw inferences, and integrate the information into an existing knowledge base. To be effective, instruction must therefore consider students' individual strengths and weaknesses in key aspects of literate language development. Future research is necessary to explore the effectiveness of this instruction in situations where the use and understanding of PTCF sentences can enhance the accuracy, clarity, and efficiency of spoken and written communication.

Acknowledgement In 1997, I (Marilyn) had the pleasure of meeting Professor Dorit Ravid at the Child Language Seminar (now known as the Child Language Symposium) in Garderen, The Netherlands. At the time, Dorit and I were among only a handful of researchers around the world who were actively studying later language development. During the past 25 years, interest in later language development has expanded greatly, and Dorit and I have continued our discussions, meeting up in wonderful cities such as Boston, Edinburgh, London, Madison, Newcastle, Paris, Reading, Sheffield, Tel Aviv, and Vancouver. Given our shared interests in many areas of later language development – including morphology, syntax, word learning, and figurative expressions – there is always much to talk about, and Dorit has become a trusted friend and an inspiring colleague.

Indeed, the inspiration for this chapter began to brew in February 2019 when Dorit and I met up in San Francisco, where we shared a pot of tea while our husbands, Gary and Arik, roamed the city in search of coffee houses and book stores. While drinking our tea, Dorit and I had a stimulating conversation about the nature and development of past tense counterfactual sentences, and rather than the caffeine, it was Dorit's curiosity, insights, and vast knowledge of linguistics and later language development that fueled our discussion that afternoon. I will always remember that day with fondness and with the knowledge that if a mysterious fire drill had not driven us out of the Ferry Building and into the peace and quiet of a nearby hotel lobby, this chapter might never have been written. Thank you, Dorit!

Appendix

Examples of infinitive, simple past, and past participle regular and irregular verbs in English, grouped into four different sets (A, B, C, D); adapted from englisch-hilfen.de – Learning English online; irregular verbs; https://www.englisch-hilfen.de/en/grammar/unreg_verben1.htm

	Infinitive	Simple past	Past participle
Set A. Regular verbs: the simple past and past participle forms are identical and end in -ed			
1.	bake	baked	baked
2.	call	called	called
3.	climb	climbed	climbed
4.	dance	danced	danced
5.	jump	jumped	jumped
6.	land	landed	landed
7.	skip	skipped	skipped
8.	talk	talked	talked
Set B. Irregular verbs: the infinitive, simple past, and past participle forms are identical			
9.	burst	burst	burst
10.	cut	cut	cut
11.	hit	hit	hit
12.	hurt	hurt	hurt
13.	let	let	let
14.	put	put	put
15.	rid	rid	rid
16.	set	set	set

	Infinitive	Simple past	Past participle
Set C. Irregular verbs: the simple past and past participle forms are identical			
17.	buy	bought	bought
18.	catch	caught	caught
19.	deal	dealt	dealt
20.	dig	dug	dug
21.	fight	fought	fought
22.	grind	ground	ground
23.	hold	held	held
24.	keep	kept	kept
Set D. Irregular verbs: the infinitive, simple past, and past participle forms are all different			
25.	choose	chose	chosen
26.	do	did	done
27.	draw	drew	drawn
28.	freeze	froze	frozen
29.	give	gave	given
30.	shake	shook	shaken
31.	take	took	taken
32.	write	wrote	written

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Part II
Language and Cognition

Moveable Figures and Grounds: Making the Case for the Dual Nature of Motion Events as Events of Motion and Change of State

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Abstract This study examines how we encode in language an aspect of motion that has gained little attention – the differentiation of Figure and Ground in a motion event. We examine how twenty-eight Dutch and English speakers describe and recall events that involve moveable Figures and Grounds, where the roles of the objects in the event are reversible. The results indicate, first, that whether speakers clearly identify the moving object in their description of an event depends on the category type of the event and the naturalness or canonicalness of one direction of motion over the other. In

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addition, their memories of which object was moving in a recall task were influenced by the linguistic descriptions that were used and the canonical direction of motion.

Keywords Motion events · Figure-Ground · Dutch · English · Satellite-framed languages · Cognitive effects of language · Memory for events · Recall task · Canonical motion · Endpoints

1 Introduction

During the 1980s and beyond, work by Talmy (1985, 2000a, 2009) revolutionized the manner in which we view and think about motion events. His seminal work breaking down the components of motion events and the manner in which languages differentially encoded those components linguistically inspired a wealth of research – concerning the expression of motion events across languages, concerning children's acquisition of the linguistic means for expressing motion events, concerning bilinguals' management of differing systems in their two languages, and concerning potential cognitive ramifications of the ways in which languages encode such events, particularly for memory and attention. Much of that work has focused on two aspects of events – the Path of motion and the Manner of motion – but work has extended beyond these as researchers discover striking differences across languages in other aspects of motion events as well. In this study, we focus on an aspect of motion events that has not yet gained much attention. Our focus concerns the extent to which a language encodes the identification and differentiation of two major items in an event, the Figure and the Ground. We are concerned, in particular, with cases when two elements of an event might participate in these roles interchangeably, with either of them acting as Figure and either as Ground (e.g., putting a ring on a finger or putting a finger through a ring). Heretofore, research has largely concerned itself with static Grounds relative to which a Figure moves (e.g., a stationary background or container, the Ground, relative to which an object, the Figure, moves or is placed). But an examination of cases in which either object in an event can act as Figure or Ground (e.g., a ring vs a finger when one is being placed on/in the other) can help illuminate some essential aspects of the nature of how we verbalize and process information about motion events.

Our first major goal for this study concerns a linguistic aspect of motion event descriptions: We examine the extent to which languages obligatorily differentiate Figures from Grounds. Several sub-goals arise as offshoots of this first goal. The first offshoot is the exploration of a new parameter for motion events: the extent to which a language focuses on the ongoing event versus the endstate/result of that event, related to the patterns in the language for differentiating Figures from Grounds. A second offshoot is an examination of the extent to which the particular category of motion (e.g., insertion of X into Y, placement of X onto Y, and so forth) can influence whether Figures and Grounds are clearly distinguished in a language. Our second major goal concerns cognitive aspects of such motion events: We aim to explore the extent to which the linguistic differentiation of Figures and Grounds in an event may have an impact on the conceptualization and processing of the event.

We focus in particular on the storage of that event in memory. We examine these questions in relation to two languages, Dutch and English.[1]

1.1 *Background*

1.1.1 Linguistic Structure

Talmy (1985) revolutionized the study of motion events and our understanding of the manner in which languages encode such events crosslinguistically. He broke down motion events into several essential component parts: a Figure (a thing or person that is moving[2]); the Ground (the static object or structure relative to which the Figure is moving[3]); the Motion itself; and the Path (the course taken by the Figure when moving).

(1)	Figure	Motion	Path	Ground
	ball	move	into	hole

Such an event may be expressed by, e.g., (2):

(2) "The ball went into the hole."

In addition to these essential components, languages also often express co-event relations, such as the Manner of motion, or the Manner in which the Figure moves along the Path. Thus, for example, if a ball rolls into a hole, the component parts are as follows:

(3)	Figure	Motion	Path	Ground	Manner
	ball	move	into	hole	rolling

This might be expressed in a language like English as in (4):

(4) "The ball rolled into the hole."

In some cases, the linguistic encoding may also include the fact that an agent causes the motion, adding two components, as in the following:

(5)	Agent	Cause	Figure	Motion	Path	Ground	Manner
	boy	caused	ball	move	into	hole	rolling

[1] This is the first in a series of reports connected with a larger study examining the differentiation of Figures and Grounds across distinct types of languages and comparing monolinguals' and bilinguals' linguistic performance and memory of events.

[2] Talmy, 2000a: Figure = "a moving or conceptually movable entity whose path, site, or orientation is conceived as a variable, the particular value of which is the relevant issue".

[3] Talmy (2000a): Ground = "a reference entity, one that has a stationary setting relative to a reference frame, with respect to which the Figure's path, site, or orientation is characterized".

Such an event might be expressed as in (6) or (7):

(6) “The boy rolled the ball into the hole”
(7) “The boy made the ball roll into the hole.”

One key insight of Talmy’s was that languages differ in the extent to which distinct elements are “conflated” linguistically into a single lexical item. According to his typology focused on lexicalization patterns, some languages favor the conflation of Path with Motion, yielding the use of verbs like *enter,* resulting in constructions like that in (8) for an event like that in (1) above.

(8) “The ball entered the hole.”

Some languages, in contrast, favor the conflation of Manner with Motion, yielding constructions like that in (4) above. Some (more rare languages) show patterns in which the Figure is conflated with Motion, as in Atsugewi (see Talmy, 1985).

According to a later typology of “event integration” focused on the “core schema” of motion (“the association function that sets the figural entity into a particular relationship with the ground entity”, Talmy, 2000b: 218), in which the Path is key, languages can be classified into two major types. This depends on whether Path is expressed in the verb, dubbed “Verb-framed” (or “V- framed”) languages, or, conversely, external to the verb (or a grammatical category that is in a sister relation to the verb root, including different grammatical items, such as verb particles, verb prefixes, verb complements, incorporated nouns or affixes, and the like), dubbed “Satellite-framed” (or “S-framed”) languages. (For clear expositions, see Matsumoto & Kawachi, 2020; Zlatev & Yangklang, 2004.)

Some languages, like Spanish and other Romance languages, are typically Verb-framed, so the above event in (1) or (3) might be expressed as in (9), and (5) as in (10).

(9)	La	pelota	entró	en	el	hueco	(rodando)
	the	ball	entered	in	the	hole	(rolling)

(10)	El	niño	metió	la	pelota	en	el	hueco		
	the	boy	inserted	the	ball	in	the	hole		
	or									
	El	niño	hizo	que	la	pelota	entrara	en	el	hueco
	the	boy	made	that	the	ball	entered	in	the	hole

Other languages, like English, and many Germanic languages, like Dutch, are typically Satellite-framed languages, so events like those above in (1), (3), and (5) could be expressed as in (2), (4), (6) and (7) above. The Dutch expression of these is as in (11) through (13).

(11)	De	bal	ging	het	gat	in
	the	ball	went	the	hole	in

(12)	De	bal	rolde	het	gat	in
	the	ball	rolled	the	hole	in

(13)	De	jongen	rolde	de	bal	het	gat	in
	the	boy	rolled	the	ball	the	hole	in

Since Talmy's original work, a wealth of research has explored this distinction across many languages, which has led to modifications and expansions of the theory. In general terms, there has been a great deal of data supporting broad differences across languages, with speakers of Verb-framed languages tending to express Path in verbs (and providing less detail about Manner of motion than speakers of Satellite-framed languages), and speakers of Satellite-framed languages tending to incorporate Manner into the verb and expressing Path with one or more satellites (Choi & Bowerman, 1991; Hickmann et al., 2009, 2012; Slobin, 1991, 1996a, b, 2004, 2006). Such patterns are entrenched, so much so that one's language even appears to set up expectations about the meanings of new words: For example, Naigles and Terrazas (1998) found that English, Spanish, and Japanese speakers differed in whether they expected a novel verb to encode a path of motion (Spanish and Japanese speakers) or manner of motion (English speakers).

However, there have been many proposals for modifying the model and revising it to accommodate growing crosslinguistic research.[4] First, many have emphasized that additional categories of language types are needed. Because of patterns found in languages that have serial verbs, such as Mandarin Chinese and Thai, some have proposed a third type of language, beyond just Verb-framed and Satellite-framed, to include "equipollently framed" languages (e.g., Naidu et al., 2018; Slobin, 2004, 2006) or "serializing languages" (Ameka & Essegbey, 2013; Fagard et al., 2013; Zlatev & Yangklang, 2004). Additional types have been proposed, such as "case-framed" languages (Naidu et al., 2018), needed to accommodate languages like Telugu, which expresses Path via case marking; "parallel" languages, to accommodate languages that allow both V-framed and S-framed constructions equally (Talmy, 2000a); "doubly framed" languages, which allow Path conflation in the verb and

[4] In addition to the proposed modifications mentioned here, there are questions that go beyond the scope of this chapter. For example, there are fundamental questions about the basic elements that form part of the essential structure of motion events. Zlatev et al. (2021) conclude that "the key conceptual/semantic categories … such as Path, Manner and Motion itself, lack clear definitions" (p. 3) (Blomberg, 2014; Imbert, 2012; Soroli et al., 2019; Zlatev et al., 2010). Even the issue of what counts as a "verb" in the Talmyan approach has been raised, with some suggesting that "verb" means only the main verb of a structure, leading some to modify the terminology. Talmy's strict definition of a "satellite" is also problematic for some languages, such as Nahuatl (Sasaki, 2011). Thus, Matsumoto (2018) favors instead the use of "head path coding" vs "head-external path coding"; Slobin (2017) has recently used the terms PIV (Path-in-Verb) and PIN (Path-in-NonVerb) languages.

Some researchers have responded to the widening range of crosslinguistic variation by suggesting modifications to the model (see, e.g., Zlatev & Yangklang, 2004; Zlatev et al., 2021). Zlatev et al. (2021) have proposed that there are 7 essential elements for motion events (Figure, Landmark, Region, Motion, Frame of Reference, Direction, and Path), and 3 secondary elements (Manner, Shape, Agent+Cause). Others argue that we need a systematic way of coding that will allow us to capture variation from a multi-level perspective (Soroli & Verkerk, 2017: 38), including morphosyntactic and pragmatic features. See Beavers et al. (2010) for discussion.

Path expressions in satellites about equally (Soroli et al., 2019); and "radical V-framed" languages (Bohnemeyer & Stolz, 2006; Perez Baez & Bohnemeyer, 2008) and "distributively framed" languages (Sasaki, 2011), to accommodate interesting linguistic patterns in Yucatec Maya and Nahuatl.

Others have noted that elements beyond Path and Manner, such as Ground, can be conflated into the verb as well (Cifuentes-Férez, 2010). Further, some researchers have emphasized that the classifications should be understood less as dichotomous categorizations and more as "clusters with distinct prototypes" (Naidu et al., 2018, p. 20), wherein even those languages that might have been expected to follow the V-framed and S-framed patterns do not always categorically follow the expected patterns. Instead, languages fall on a cline between V-framed patterns at one end and S-framed at the other (Berman & Slobin, 1994; Hickmann et al., 2012; Slobin, 2004).

Based on the density of elements expressed across languages (Hendriks et al., 2008; Hickmann et al., 2012; Hickmann & Hendriks, 2010; Soroli & Verkerk, 2017), researchers have proposed a cline of Manner salience (Slobin, 1996a, 2000, 2004, 2006) and a cline of Path salience (Ibarretxe-Antuñano, 2009) (see also Fortis & Vittrant, 2016). A given language may even demonstrate several patterns, depending on what aspect of the language is being considered (Beavers et al., 2010; Kopecka, 2006; Soroli & Verkerk, 2017), and the preponderance of V-framed versus S-framed properties may vary from one dialect to another within the same language (Batoréo & Ferrari, 2016, for Portuguese).

Beyond the consideration of the patterns relevant to the basic components, it appears important to consider multiple other parameters when considering the typological class of a given language (Zlatev & Yangklang, 2004). Those additional features include, e.g., the number of Ground elements expressible in a single clause (Bohnemeyer et al., 2007); variations in the frequency with which Manner is expressed in the main verb (Hickmann et al., 2012) and the proportion of Manner verbs available in the given language; how telic and atelic Path, or boundary-crossing or non-boundary crossing Paths are encoded (Aske, 1989; Slobin, 1996b; Slobin & Hoiting, 1994; Vuillermet & Kopecka, 2019); how motion along or toward a coast influences the linguistic expression (Batoréo & Ferrari, 2016); and the influence that any of these may have on the expression of other elements (Aske, 1989; Slobin & Hoiting, 1994). Furthermore, one parameter may lead to classifying a given language in one direction, but another may lead in a different direction (Soroli & Verkerk, 2017).

More subtle distinctions have been proposed as well: these include the identification of components of Path, the possible differentiation of Path and Direction, the addition of Co-Motion (several Figures moving together) as a co-event relation (Cifuentes-Férez, 2010), the extent to which Deixis and Posture are incorporated into the expression of motion (Fagard et al., 2013; Morita, 2011; Vuillermet & Kopecka, 2019), the expression of voluntary motion as differentiated from the expression of caused motion (Hickmann et al., 2012), and distinctions in types of path orientations, into "path focused" and "ground-focused"/"boundary focused" (Slobin & Hoiting, 1994). (See Matsumoto & Kawachi, 2020, Naidu et al., 2018, Soroli et al., 2019, for insightful discussions). (See further proposals in Vuillermet & Kopecka, 2019, Fagard et al., 2013, Thiering, 2015.)

One striking area of research has noted differences across languages in the extent to which endpoints are expressed and encoded in expressions of motion. For example, Donoso and Bylund (2015) asked native speakers of Spanish and of Swedish to describe events they watched on videos, some involving explicit endpoints, some showing endpoints of low salience, and some with endpoints of intermediate salience. Swedish speakers were more likely to include information on the endpoints in their encoding of the events than the Spanish speakers. Bylund and Athanasopoulos (2015) describe results similar to those of Swedish in languages like Afrikaans, Dutch, and German. These authors argue that speakers of such languages construe goal-oriented motion with "maximal viewing frames (i.e., endpoints included)", while speakers of languages like Spanish, English, Modern Standard Arabic, and Russian, adopt "immediate viewing frames (endpoints excluded…)" (p. 591). They argue that the linguistic structure of the language influences which group it falls into, in that languages that highlight endpoints tend to lack imperfective aspect, whereas languages that de-emphasize or omit endpoints tend to have this grammatical feature.

All of the above research has served to bring out the complexities of motion events and their linguistic encoding as well as highlight the many subtle variations both across and within languages that affect the expression of motion events. Through all of these studies, two elements of the motion event that have not undergone much scrutiny are the Figure and Ground themselves. Even though some subgroupings have been proposed, e.g., for types of Grounds, these two components of a motion event are largely taken as "givens" (but see, e.g., Sasaki, 2011; von Stutterheim et al., 2020). The research we report in this chapter attempts to provide some data that lead to a reexamination of the status of these two elements. Our results suggest that, in some cases, languages are more "particular" about differentiating Figures from Grounds, while in other cases, languages seem to focus less on what is actually moving than on the endstate or result achieved. As we explore how speakers encode events involving moveable Figures and Grounds, we expand on our proposal that motion events are more properly viewed as encapsulating a dual nature – not only are they motion events, but they are events of changes of state. The data below suggest that, in fact, what are largely accepted as all falling into the realm of "motion events" might more properly be divided into two types: on the one hand, there are events that encourage a focus on the event as ongoing motion, while on the other hand, some events encourage a focus on these events as changes of state. This dual nature can help illuminate the tension in speakers' focus on ongoing movement vs endpoints. As languages differ in the available means for encoding events, those available means can tip the balance towards one focus or the other.

1.1.2 Cognitive Effects of Linguistic Descriptions

There is evidence that the way the language packages the expression of a motion event (and beyond, e.g., Fausey & Boroditsky, 2011) can have an effect on speakers' attention to or perception of an event. Early on, Slobin (1996b) proposed a "thinking for speaking" hypothesis, according to which speakers, when expressing motion events, attend to particular components of those events, according to the patterns used in their language. Thus, speakers of V-framed languages could be expected to attend to paths more than manners, speakers of S-framed languages might attend more to manners than to paths. Researchers have attempted to explore whether monolingual speakers of distinct languages show evidence for such differences in thinking by using memory studies, similarity matching studies, eye tracking studies, and ERP studies.

Some studies have approached these issues using similarity judgment tasks involving the presentation of 3 videos (or pictures), one of which involves two of the components of motion of interest (e.g., a particular path and a particular manner of motion) whereas the other two videos involve only one of these components (either a path similar to that in the initial video or a manner similar to that in the initial video). The participant is asked to judge which of the latter two videos or pictures is more like the first. The reasoning is that if language affects the perception or conceptualization of motion events, speakers of one type of language will favor the choice of one of the alternates, and speakers of another type will favor the choice of the other alternate. Thus, for example, speakers of a language that highlights the path of motion (V-framed languages) should favor the same-path alternate, while speakers of a language that highlights the manner of motion (S-framed languages) should favor the same-manner alternate (or, given the importance of path universally, the two alternates about equally).

Some research following this reasoning indeed found initial support for language-specific effects on speakers' choices (Athanasopoulos et al., 2015; Athanasopoulos & Bylund, 2013; Bylund et al., 2013; Bylund & Athanasopoulos, 2014, 2015; Hohenstein, 2005; Naigles & Terrazas, 1998). Bylund and colleagues have argued, for example, that differences in a focus on ongoing motion vs endpoints is connected with whether a language encodes aspect or not (Bylund & Jarvis, 2011; Donoso & Bylund, 2015). But speakers' performance yielding such results may not reflect overall differences in perception induced by linguistic structural differences so much as online mediation by language as the participant is carrying out the task at hand. Finkbeiner et al. (2002) note that similarity judgment studies entail a degree of memory, since participants need to remember the first video(s) shown in order to compare subsequent videos to them. They argued that the tasks may reflect online covert use of language to accomplish the task more than reflecting a general conceptual framework for motion that is set by the language and used even when language is not involved. Indeed, in cases in which participants' use of language is blocked, e.g., through a verbal interference component, differences across language groups appear to disappear (Athanasopoulos et al., 2015; Athanasopoulos & Bylund, 2013; Bylund & Athanasopoulos, 2015; Finkbeiner et al., 2002; Gennari et al., 2002; Papafragou et al., 2008; Papafragou & Selimis, 2010).

An alternative approach for exploring the question of cognitive effects of linguistic structure has been to examine participants' memory for events. If language encourages one to pay attention to particular aspects of events, greater attention could lead to better memory of the events. For example, Filipovic (2011) showed monolingual and bilingual English and Spanish speakers a series of videos involving complex paths and manners of motion (see also Aveledo & Athanasopoulos, 2016). Afterwards, and after a brief intervening task, participants were shown a new set of videos with the same or different manner of motion and were asked simply to judge whether they had seen each one previously. English monolinguals had fewer errors recognizing whether they had seen a video with that particular manner of motion in the memory task (34% to 36% errors) than any other group (68% to 82% errors). Spanish monolinguals and bilinguals judged that they had seen a high proportion of the videos, even though the new videos differed from the first in terms of the manner of motion. The inference is that Spanish structure does not highlight manner, so speakers are less likely to pay attention to manner and remember it.[5]

Attentional differences linked to language structure have also been observed in studies using eye tracking (e.g., Papafragou et al., 2008; Soroli & Hickmann, 2010). In such studies, participants appear to focus on distinct aspects of videos according to their language. Thus, for example, Flecken, Carroll, et al. (2015a, b) found that French speakers showed greater fixation on a Figure than German speakers, and they also showed an earlier fixation on the endpoints. Flecken, Carroll, et al. interpret their data as revealing language planning: "language-specific structures affect attentional processes (information selection and structuring) in language production" (p. 119).

The role that language plays is not entirely clear, however: Flecken, Carroll, et al. (2015a, b) point out that differences may be associated with what the speaker needs to know about the scene in order to express the event within the linguistic patterns available in the language they are speaking. However, Flecken et al. (2014) found that in a non-verbal task designed to impede participants' use of language in the processing of videos, speakers of German, which does not have grammaticalized aspect, still looked more frequently at endpoints in critical videos than speakers of Arabic, which has grammaticalized verbal aspect. And in a study using ERPs, Flecken, Athanasopoulos et al. (2015) found differences in German and English speakers' attention to endpoints, in accordance with differences in the use of aspect in German and English. They showed participants an initial video and then pictures that were either endpoint-matches with the video or trajectory-matches. Flecken, Athanasopoulos et al. (2015) examined P3 waves, an ERP component that reflects "attentional processing, stimulus evaluation, and target detection" (p. 43). The German speakers (but not the English speakers) showed larger P3 waves when shown endpoint-matches than when shown trajectory-matches. The authors argue, thus, that even in a non-verbal ERP task evidence for the influence of the language on motion event perception is detected.

A question that arises in relation to the influence of language on memory or processing of events is whether language overrides all else. In the above studies, the language produced by speakers, overtly or covertly, has been consonant with the motion event being observed. The perception of the event and the linguistic

[5] The fact that bilinguals' performance was like that of the Spanish monolinguals leads Filipovic to conclude that the results strongly suggest that bilinguals "tend to adhere to a single lexicalization pattern that is acceptable in both languages, which is the Spanish one in this case" (p. 466) and to argue for "a single storage system in bilingual processing and memory" (p. 480).

description of that event can, thus, act to mutually support each other. What happens when there is conflict between the two? Does whether a speaker describes an event correctly or incorrectly matter? In what follows, we will see that language can indeed influence a speaker's memory for an event, but that there are limitations on that influence.

2 Current Study

2.1 Goals

The current study focuses on cases in which two elements of a scene are movable, so that either one might act as the Figure or the Ground (e.g., a finger moving into a ring, or a ring moving around a finger). Figures and Grounds have received little attention in previous work (but see recent interesting work by von Stutterheim et al., 2020). Our first goal is to explore linguistic patterns in such cases in the encoding of which element of a scene acts as the Figure and which as the Ground. Languages appear to differ in the extent to which the Figure and Ground are differentiated (Choi et al., 2018). Our ultimate goal is to investigate the types of structures examined here across a wide variety of language types, both V-framed and S-framed languages. The current study, however, is an initial investigation examining these structures in two similar languages, English and Dutch. The aim was to gain insights into how speakers of two similar languages are alike or distinct in their processing of such structures. (Subsequent studies will compare the findings for these two S-framed languages with V-framed languages.) This initial examination reveals striking phenomena in what affects the extent to which Figure and Ground are differentiated even within languages; the patterns to be reported here are dependent on the type of category and hinge in part on whether one direction of movement is more natural or unmarked than the other.

A second goal is to explore the extent to which linguistic practices affect speakers' memory of events. We explore whether general patterns of linguistic description in the language affect memory and whether individual speakers' descriptions (accurate or inaccurate) of such events impinge on their memory of those events.

Our hypothesis is that, in some contexts, speakers "care" about which object is moving and specify that linguistically. But in other cases, they may be less attentive to which object is moving. We hypothesize, further, that the language used to describe events may directly affect memory of the events. The results here will serve to provide insights into, first, alternative ways of viewing "motion" events – one of which is viewing them not as motion but as changes of state. Secondly, the results will help to delineate possible limitations on the role of language in its influence on cognition and perception, especially in relation to the naturalness of the events in question.

2.2 *Figures and Grounds*

In much of the research to date, both Figures and Grounds have played essential roles – they are the elements that figure prominently with regard to the Path of motion. Examples of linguistic expressions involving motion events have generally involved stable Grounds relative to which movable Figures are located or change location. Not all motion events involve stable Grounds, however. Some involve two elements, one of which acts on the given occasion as a (temporary) Ground, and another element, acting as the Figure, moves or is located relative to that Ground. But those roles could be reversed. For example, I can hold out my hand and move a ring to be located around one of my fingers (i.e., place a ring on my finger) or I could equally hold the ring in one place and insert my finger through the ring (i.e., stick my finger through the ring).

Observations of linguistic expressions in some languages and in some contexts suggest that not all languages or events show similar patterns in such cases. Languages vary in the degree to which they specify which object is moving in the Figure-Ground relationship. In English, for example, to express the event in which John is making a napkin fit into a napkin ring, which item is seen to be moving determines the structure used, as in (14) versus (15).

(14)	Napkin moving:	John put/stuck the napkin IN the napkin ring.
(15)	Napkin ring moving:	John put/stuck the napkin ring ON the napkin.

Dutch has similar constructions:

(16)	Napkin moving:	Jan	deed	het	servet	IN	de	servetring.
		Jan	did	the	napkin	INTO	the	napkin ring.
(17)	Napkin ring moving:	Jan	deed	de	servetring	OM	het	servet
		Jan	did	the	napkin ring	ONTO	the	napkin

Sometimes languages are less attentive to which object is moving and focus more on the change of state and end result. In Spanish, for example, the focus is on the resulting state of encirclement, that of one thing being located around another. Thus, regardless of whether the napkin or the napkin ring is moving, one tends to use the same verb *meter* 'insert' in Spanish, as in (18). In general, Spanish uses *meter* for movement leading to a resulting state involving enclosure.

(18)	Napkin or napkin ring moving:	Juan	metió	la	servilleta
		John	inserted	the	napkin

But even in languages like English and Dutch, there are occasions in which the end result also seems to be the major focus, not which object is moving. One can express an event in terms of A moving relative to B even if the actual event involved

B moving relative to A. E.g., in preparing for a party, I might stick the napkins through napkin rings. But when, for example, I wish to list preparations that have already been completed, I might say, "I've already put the napkin rings on [the napkins]." Or if a person is moving house, she might hang all her dresses up by inserting a hanger into each dress to hang it up. But she might report this by saying "I've put all my dresses on their hangers now."

The extent to which we differentiate Figures and Grounds in such cases may be dependent on a number of factors, such as the type of motion involved, and the extent to which one direction of motion is more canonical than the other. The size, the movement, and the position of the Figure relative to the Ground may also be relevant (Thiering, 2015). For some cases, both actions may be equally "natural," as in (19) and (20). In (a), the cookies and the foot act as the Figures; in (b) the wrapper and the slipper act as the Figures.

(19) a. I put the cookies in plastic wrap.

b. I wrapped the cookies with plastic wrap.

(20) a. He stuck his foot in his slipper.

b. He stuck the slipper on his foot.

In other cases, one direction of movement appears more "natural" than the other, as in (21) and (22). The (a) cases appear more natural or canonical than the (b) cases.[6]

(21) a. She put a scoop of ice cream on the cone.

b. She lifted the cone up under the scoop of ice cream.

(22) a. I stuck the cap onto the pencil.

b. I stuck the pencil into the cap.

In the current study, we present data from 9 distinct category types of motion events, to be described below. Participants are shown a video in which either A moves relative to B or B moves relative to A. Data from English and Dutch speakers are examined, first, for their descriptions of such cases, and then, subsequently, participants' memory of the videos they had observed was tested.

Our hypothesis is that the more speakers show linguistic differentiation between Figures and Grounds, the more they will show sensitivity to Figures vs Grounds at the cognitive level. Thus, we expect that speakers will differ by category type in the degree to which they pay attention to which object is moving in their descriptions, and this will affect their memories of which object was moving.

[6] As one reviewer noted, the canonicity of one direction over another could be confirmed through a corpus search of the description of such events.

Our predictions are the following:

1. Some categories of motion will be more likely to elicit differentiation of Figures and Grounds than others, according to the relative "naturalness" of the two directions of motion.
2. Speakers will be more likely to remember which object moved in relation to the category types for which speakers of their language are generally more likely to differentiate Figures and Grounds linguistically.
3. If, for a particular video, a given individual participant does not accurately express which object moved (e.g., mis-describing a video in which a pencil is moved into a cap as "the cap was put onto the pencil"), that participant will be more likely to show errors in memory for that video than participants who, for that same video, accurately depicted which object acted as the Figure ("the pencil was put up into the cap").

3 Method

Participants carried out a linguistic description task and a recall task. In the linguistic description task, the participants had to describe videos, while in the recall task, participants were asked to judge whether a video presented during recall was identical to one they had seen previously or not. (The recall task pitted motions they had seen against videos in which the roles of Figure and Ground were reversed). In addition to the main tasks, participants also filled out a language background questionnaire. (The English translation of the Dutch questionnaire is shown in Appendix A.)

3.1 *Stimuli*

3.1.1 Linguistic Description Task

"Target" videos were prepared to depict 9 categories of actions. These category types were selected based on discussions and analyses conducted with native speakers from different languages, and they attempt to capture those movements that appeared to be encoded differently across languages. Potential differences across a variety of languages, such as Spanish and Korean, are being explored in other and future studies (see Choi et al., 2018). The categories of actions were the following ("F" refers to the Figure, "G" to the Ground):

1. Placement of an object (F) UNDER A COVER (G), loose fit
2. Placement of an object (F) INTO A COVER/ENCLOSURE (G), tight fit
3. Placement of an object (F) ON A HORIZONTAL SURFACE (G), loose fit
4. Placement of an object (F) INTO A CONTAINER (G), loose fit
5. Placement of an object (F) INTO A CONTAINER (G), tight fit

6. Placement of an object (F) ONTO A BASE (G), tight attachment
7. Placement of an object (F) AROUND A BASE (G), tight attachment
8. Placement of an object (F) AROUND A BASE (G), loose attachment
9. Placement of an object (F) HOOKED ONTO a base (G)

We will refer, for the sake of clarity, to these videos as involving the "canonical" or "forward" direction, with our prediction that for a given action the forward direction of movement is likely to be the pragmatically canonical direction.

In addition, for each of the videos, a "reverse" video was prepared. What was the Figure in the "canonical"/"forward" direction became the Ground, and what was the Ground became the Figure.

For each of the category types, there were 6 video events (for a total of 54 videos in each direction), described in Table 1. In each video, two hands are seen moving a Figure (F) into the relevant position relative to a Ground (G). Hands and objects moved in front of a black background.

In addition to these target videos, 16 filler videos (plus their reverses) that did not involve a Figure and Ground were prepared. These involved the hands opening (closing) an object, moving two objects in parallel to the left (right), moving two objects in parallel upwards (downwards), laying an object down from a standing position (standing the object up), pushing an object (pulling), attaching object A to object B (B to A).

Six presentation sets of the above videos were prepared for the Linguistic Description task. In each set, a participant was exposed to half of the videos in each of the 9 category types in the "canonical/forward" direction and half in the "reverse" direction. The 6 sets were balanced so that, in the linguistic description task, half of the participants were exposed to a given item in the canonical/forward and half in the reverse direction.

3.1.2 Recall Task

For this task, participants were shown a series of videos like those of the Linguistic Description task. Participants were asked to judge for each video whether or not they had seen it before.

Some of the videos were "matches", or exact replicas of what the participant had seen before, and some were "deviant", or videos in which the movement was reversed between A and B (e.g., if they had seen the hands move a cap onto a pencil, they now saw the same pencil move up into the cap).

For each category type, each participant saw two "match" videos (one canonical and one reverse direction), and 4 "deviant" videos. The match videos were counterbalanced so that each video was seen as an exact replica by one sixth of the participants. They also saw 8 match filler videos, 8 deviant filler videos, and 13 new videos that they had not seen at all in the linguistic description task.

In the Recall task, as in the Linguistic Description task, the videos were seen in random order.

Table 1 "Forward" and "Reverse" events depicted in videos

	Category types	Events	
	(Forward/reverse)	Forward motion	Reverse motion
1	Put A UNDER B to cover loose/ put B over A, cover loose	Paper under small bed	Small bed over paper
		Screwdriver under cloth	Cloth over screwdriver
		Chain piece toy under hat	Hat over chain piece toy
		Chicken under toy bench	Toy bench over chicken
		Doll under blanket	Blanket over doll
		Dog under tunnel	Tunnel over dog
2	Put A IN B tight cover/ put B on A, cover tight	Toothbrush bristle into cap	Cap over toothbrush bristle
		Document into sleeve	Sleeve over document
		Egg into cover	Cover over egg
		Mobile into cover	Cover over mobile
		Eyeglasses into case	Case over eyeglasses
		Pen into cap	Cap over pen
3	Put A ON B loose support/ put B up under A	Scissors on file folder	File folder under scissors
		Cake on small table	Small table under cake
		Nesting cup on top of other cup	Nesting cup under other cup
		Triangular block on flat block	Flat block under triangular block
		Cup on tray	Tray under cup
		Thick candle on red plate	Red plate under thick candle
4	Put A IN B loose containment/ put B up around A	Banana in pot	Pot around banana
		Green shoe in box	Box around green shoe
		Corn in net	Net around corn
		Blue duck in round pot	Round pot around blue duck
		Red duck in glass square box	Glass square box around red duck
		Ball into basket	Basket around ball
5	Put A IN B tight fit/ put B up under A tight	Egg in egg tray	Egg tray put up under egg
		Treasure chest in bigger chest	Bigger chest put up under treasure chest
		Small candle into little candle holder	Little candle holder put up under small candle
		Cork in bottle	Bottle put up under cork
		Nesting cup put into larger cup	Putting larger cup up under smaller one
		Shape into playschool box	Playschool box put up under shape

(continued)

Table 1 (continued)

	Category types	Events	
	(Forward/reverse)	Forward motion	Reverse motion
6	Put A ON B tight attachment/ put B up under A tight	Russian doll head on base	Base up onto Russian doll head
		Bristle block head on bristle block	Bristle block up onto bristle block head
		Lego on lego	Lego up under lego
		Eraser on pencil	Pencil up onto eraser
		Clamps on bar	Bar up onto clamps
		Paper clip on paper	Paper up onto paper clip
7	Put A AROUND B tight/ put B through A tight	Montessori bead on metal play form	Metal play form through Montessori bead
		Napkin ring on napkin	Napkin through napkin ring
		Cover onto soap box	Soap box through cover
		Pencil holder onto pencil	Pencil through pencil holder
		Ring on peacock pole	Peacock pole through ring
		Sleeve on coffee cup	Coffee cup through sleeve
8	Put A AROUND B loose/ put B through A loose	Hoop around tomato	Tomato through hoop
		Hoop around sharpie	Sharpie through hoop
		Box frame around teapot	Teapot through box frame
		Donut around spoon	Spoon around donut
		Big cookie cutter around paper towel holder	Paper towel holder through big cookie cutter
		Wire spiral around drumstick	Drumstick through wire spiral
9	HOOK A on B/ HOOK B on A	Green hanger on pink hanger	Pink hanger on green hanger
		Ornament on hook	Hook on ornament
		Starfish on comb hook	Comb hook on starfish
		Tool on eye	Eye on tool
		Cup on hook	Hook on cup
		Sewing hook on sewing eye	Sewing eye on sewing hook

3.2 Procedure

Each participant took part in both the Linguistic Description task and the Recall task. Participants were asked to fill in the background questionnaire between the two tasks.

3.2.1 Linguistic Description Task

In the Linguistic Description task, participants were asked to describe the action they saw in the video (the full set of instructions is provided in Appendix B). Participant responses were digitally recorded and later transcribed.

Following the Linguistic Description task, participants were asked to fill out the background questionnaire, after which they completed the Recall task. (Participants were not told in advance that they would be asked to recall the videos from the description task.)

3.2.2 Recall Task

For the Recall task, participants were asked to judge whether each video presented to them was one they had seen earlier in the experiment. They were told that some would be ones they had seen, and some not, and that the video had to be an exact replica of what they had seen for them to say "yes".

3.3 Participants

Participants consisted of 18 Dutch native speakers (10 male/8 female; mean age 29.5 years, range 21–56) and 10 native English speakers (2 male/8 female; mean age 25.9 years, range 20–35). All participants were university students or were adults with at least a university degree.

All English speakers were monolingual. All Dutch participants were L1 speakers of Dutch. It is virtually impossible to find fully monolingual speakers in The Netherlands. All but three of the Dutch speakers were born in The Netherlands; one of the remaining was born in Surinam, where Dutch is also spoken, and moved to The Netherlands at age 10. Another moved to The Netherlands at age 2;2, and another at age 5. All but one of them reported learning Dutch from birth; the remaining person began learning Dutch as a toddler. All but two reported having 100% input from both parents in Dutch; one heard 100% Dutch from her mother and 80% Dutch/20% Czech from her father; another heard 100% Dutch from his mother, and 100% Bulgarian from his father. Speakers were asked to estimate their command of Dutch on a scale of 1 to 4 for speaking, comprehension, reading, and writing, for a maximum total of 16. The mean self-evaluation score was 15.2 [range 14–16]. Sixteen of the Dutch speakers also reported that they spoke English. Thirteen of these started learning English in primary school, two at age 12, and one began English at age 2. Participants' self-evaluations, on the same scale of proficiency, in English was 13.4 [range 4–16], which indicates a high level of proficiency. Four also spoke another language: one knew "passive French," one also spoke Bulgarian, another Japanese, and one Limburgish.

The Dutch speakers were located and tested in The Netherlands, the English speakers were located and tested in the USA.

4 Results

4.1 Linguistic Descriptions

This analysis was performed on transcriptions of the digital recordings for each answer provided by participants. The linguistic descriptions were coded for whether a speaker explicitly encoded which object was moving (A or B). The explicit identifications of which object was moving, according to category type and direction (forward/reverse), are shown in Fig. 1 for English and Fig. 2 for Dutch. Cases that were indeterminate or neutral, in which A and B were not clearly distinguished for roles as Figure and Ground (e.g., "He connected the pink clothes hanger and the green one" or "A lego toy being pushed together, one's a duck and one a flat surface") are also shown in the Figures. Figures 1 and 2 show, for example, that for some cases (e.g., category 1: object under a cover, loose fit) participants seemed to clearly identify A as moving in the forward cases and B as moving in the reverse cases, while in others, such as category types 4 (object into a container, loose fit) and 5 (object into a container, tight fit), they seemed to describe the events in terms of A moving, even in Reverse contexts, when object B was moving; and, in still others, such as in 9 (hooking) there were a number of neutral descriptions.

Analyses focused on those cases in which participants identified A or B as moving. The proportion of times they correctly identified A or B as moving (in forward and in reverse motion, respectively) was calculated for each condition. Arcsine transformations were applied to the proportions, and an ANOVA in which category type and direction (Forward (A moving)/Reverse (B moving) motion) were treated as within-subject variables, and language group as between-subjects.

Results revealed, first, significant main effects of category type, $F(8, 208) = 10.26$, $p < .001$, and of direction, $F(1, 26) = 60.95$, $p < .001$. There was no main effect of language group. Accuracies for each category type overall, as well as for each direction within a category, are shown in Table 2.

Pairwise comparisons (all such comparisons here and below were conducted with Bonferroni correction) revealed that the significant main effect of category type was due to better performance on category types 1 and 9 than many of the others. When participants identified the A and B objects as moving, they were significantly more accurate in the first category (Put A UNDER B to cover loose/put B over A, cover) than in almost all the other category types, all ps$\leq .008$, except for HOOKing ($p = .666$) (but only near-significantly more than for type 6, putting A ON BE tight attachment/ put B up under A tight, $p = .053$). In addition, participants were more accurate in category 9 (HOOKing) than in categories 4, 5, and 8, all ps $\leq .05$. Participants were also significantly more accurate in category 3 than in 4, $p = .002$.

The main effect of direction was due to the fact that they were generally more accurate in identifying A as moving in the forward direction (mean = .883) than in identifying B as moving in the reverse direction (mean = .634).

These results were modified by the significant interaction of Category Type X Direction, $F(8, 208) = 37.89$, $p < .001$. Follow-up t-tests, shown also in Table 2,

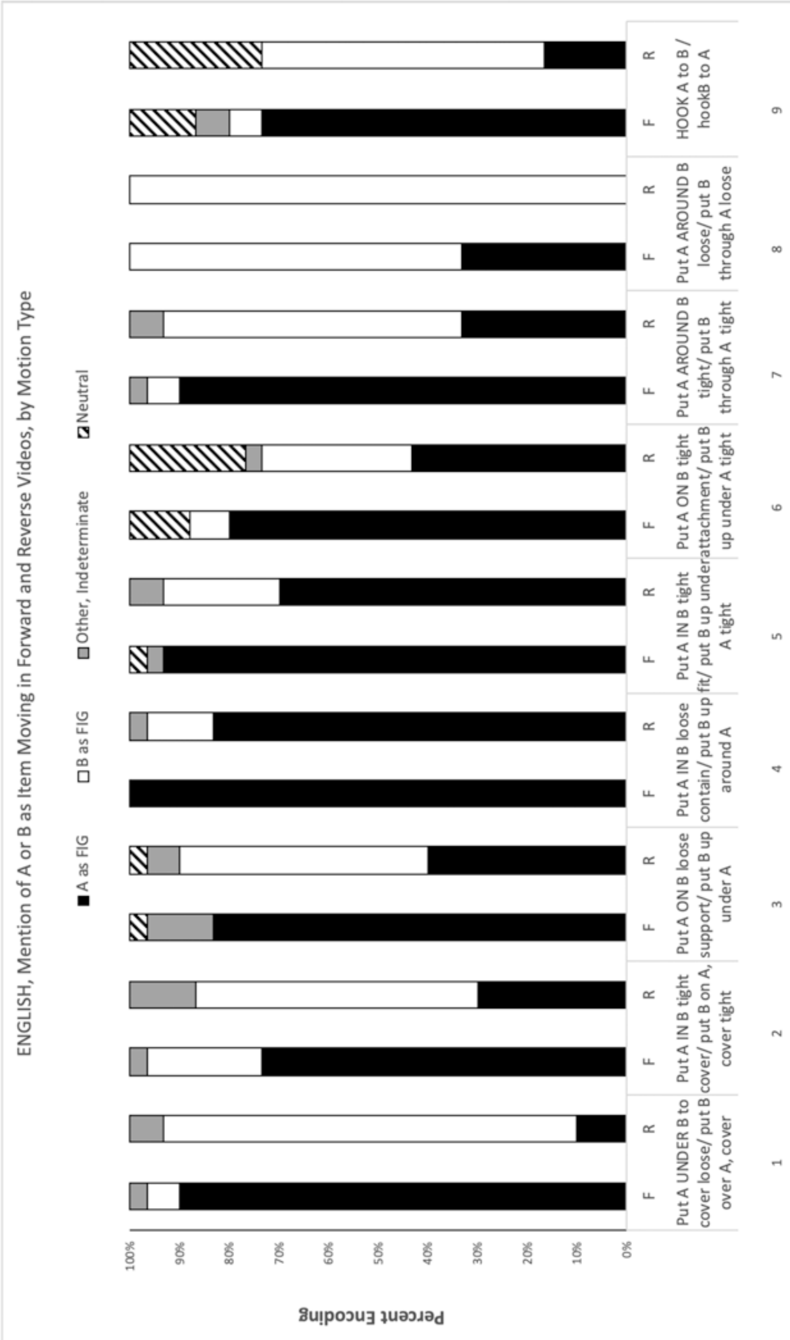

Fig. 1 ENGLISH descriptions, MON ENG

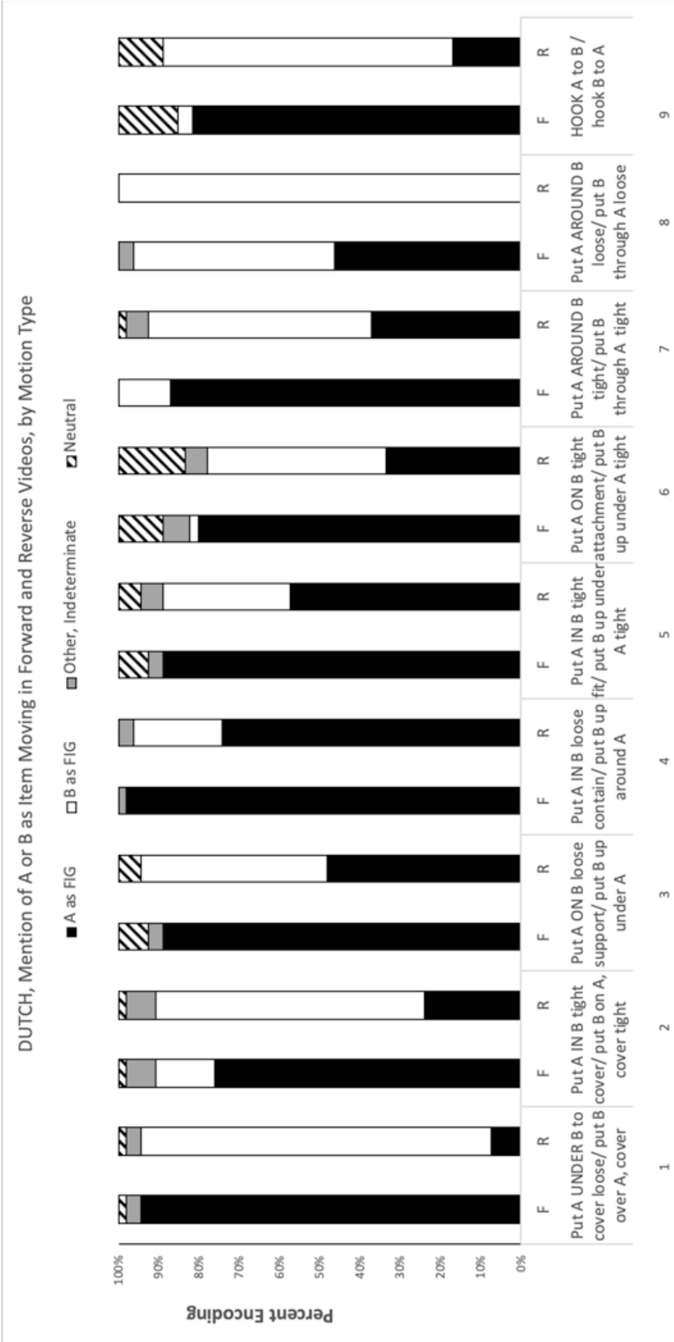

Fig. 2 DUTCH descriptions, MON DUTCH

Table 2 Comparison of means for correct encoding of A or B as moving, by category type

		ACCURACY in identifying A, B as moving			Comparison of forward and reverse movement		
		Overall	Forward (A moving)	Reverse (B moving)	*t*	*df*	*p*
1	Put A UNDER B to cover loose/ put B over A, cover loose	.931	.967	.896	1.52	27	.14
2	Put A IN B tight cover/ put B on A, cover tight	.738	.792	.684	2.0	27	.056
3	Put A ON B loose support/ put B up under A	.772	1.00	.544	5.78	27	.000 ***
4	Put A IN B loose contain/ put B up around A	.598	1.00	.196	13.288	27	.000 ***
5	Put A IN B tight fit/ put B up under A tight	.661	1.00	.321	10.20	27	.000 ***
6	Put A ON B tight attachment/ put B up under A tight	.786	.935	.637	4.83	27	.000 ***
7	Put A AROUND B tight/ put B through A tight	.770	.902	.639	4.68	27	.000 ***
8	Put A AROUND B loose/ put B through A loose	.708	.416	1.00	−12.58	27	.000 ***
9	HOOK A to B/ HOOK B to A	.863	.938	.788	1.90	27	.068

*** $p < .001$

comparing the two directions for each category type showed no difference in accuracy for the first category type, but for every other type, a significant or near-significant difference between the two directions. In all cases except one, accuracy was higher in the forward direction than the reverse direction. That is, in the reverse direction, they were often describing the events as if they had occurred in the forward direction (encoding it as if A was moving). This suggests that, as we had predicted, the forward direction is the more natural or canonical direction of these events. The one exception to this was category 8, for which descriptions of the reverse direction were more accurate than for the forward direction. This suggests that the canonical movement for category type 8 is one of putting objects through objects that loosely envelop them, rather than the enveloping objects moving around the contained object.

To sum up, these results for the linguistic descriptions reveal that speakers of these two languages show some striking aspects in their description of these events: First, when either object in the event could potentially act as the Figure and either could act as the Ground, only in some cases did the speakers clearly encode which object is moving. The two categories for which they did differentiate linguistically which object was moving are the first one – put A UNDER B to cover loosely/put B over A to cover it – and the last one, HOOKing. In all other cases, there appears to be a natural canonical direction for movement and speakers often described the non-canonical direction as if they had seen the canonical one.

4.2 Recall

Speakers' judgments of whether they had seen a given video were scored according to whether they agreed that "Yes," they had seen the given video before. In the "Match" condition, speakers saw a video identical to one they had seen before. "Yes" responses in such a condition were correct hits. In the "Deviant" condition, speakers saw a video that differed from the one they had originally seen by having the roles of A and B reversed in the memory task. "Yes" responses in such a condition were false positives.

An ANOVA was conducted in which category type, direction, and fidelity (match vs deviant) were treated as within-subject variables and language group as between-subjects.

Results reveal a main effect of fidelity, $F(1, 25) = 115.07$, $p < .001$, with more "Yes" responses in the Match condition (.811) than in the Deviant condition (.427). There were also significant interactions of Direction X Fidelity, $F(1, 25) = 44.10$, $p < .001$, Category Type X Fidelity, $F(8, 200) = 9.98$, $p < .001$, and Category Type X Direction X Fidelity, $F(8, 200) = 11.03$, $p < .001$. There were no other main or interaction effects.

The proportions of "Yes" judgments by Direction and Fidelity are shown in Fig. 3. Simple effects analysis revealed that in the Match condition, participants gave more "Yes" responses in the forward direction (.910) than in the reverse direction (.712), $F(1, 25) = 25.36$, $p < .001$, whereas in the Deviant condition, they gave more "Yes" responses in the reverse direction condition (.530) than in the forward direction condition (.324), $F(1, 25) = 35.85$, $p < .001$. That is, participants were more likely to agree that they saw a video when they had seen a forward video than when they had seen a reverse video; and, conversely, they were more likely to judge that they had seen a deviant video if they had originally seen a reverse video and now saw a forward video than if they had originally seen a forward video and now saw the reverse. The results in the Match condition mean that almost 30% of the time participants did not think they had seen the reverse video even when in fact they had seen it. And, strikingly, the results in the Deviant condition show that they believed that they had seen the forward video almost 50% of the time when in fact they had seen the reverse video. These findings suggest that participants may have been "normalizing" reverse events that they had seen, to a default, canonical, forward version of the event.

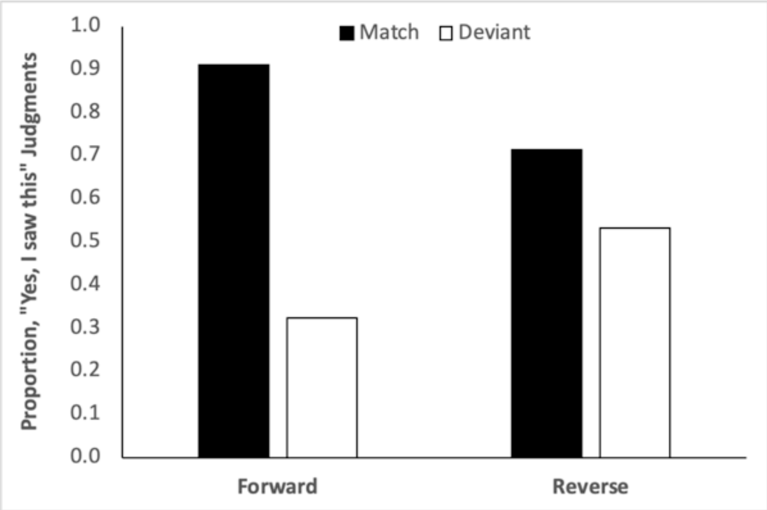

Fig. 3 Recall by direction and fidelity
Forward = Original video seen in "Forward" direction (A moving); Reverse = Original video seen in "Reverse" direction (B moving) Match = Same video seen as in Description Task;
Deviant = A and B had reversed Figure/Ground roles in Recall task video relative to their roles in Description Task video

However, the interactions involving category type in interaction with direction and fidelity mean that this effect was specific to particular category types. Performance by category type, direction, and fidelity is shown in Fig. 4. (For informational purposes, this is broken down by language group in Appendix C.) In order to explore the interactions involving category type, *t*-tests were conducted comparing, for each category type, the responses in the Match conditions for forward vs reverse motion and the responses in the Deviant conditions for forward vs reverse motion. The results are shown in Table 3.

As can be seen in Table 3 and Fig. 4, there were significant differences in participants' recall of forward and reverse videos in both the Match and Deviant conditions for categories 4 and 5: in the Match condition, speakers were more likely to agree that they had seen the video when they had seen the forward direction than when they had seen the reverse direction; in the Deviant condition, they were more likely to falsely judge that they had seen the (forward) video when they had in fact originally seen the reverse video than they were to judge that they had seen the (reverse) video when they had in fact originally seen the forward video. Similarly, for categories 1, 6, 7, and 8, in the Deviant condition, speakers were again more likely to falsely judge that they had seen the (forward) video when in fact they had originally seen the reverse video.

In sum, these results again indicate that speakers "normalized" the stored memory of such events to the more canonical direction of events, leading them to judge that that is in fact what they had seen. This was true for all category types except types 2 (Put A IN B tight cover/ put B on A, cover tight), 3 (Put A ON B loose support/ put B up under A), and 9 (HOOK A to B/ HOOK B to A).

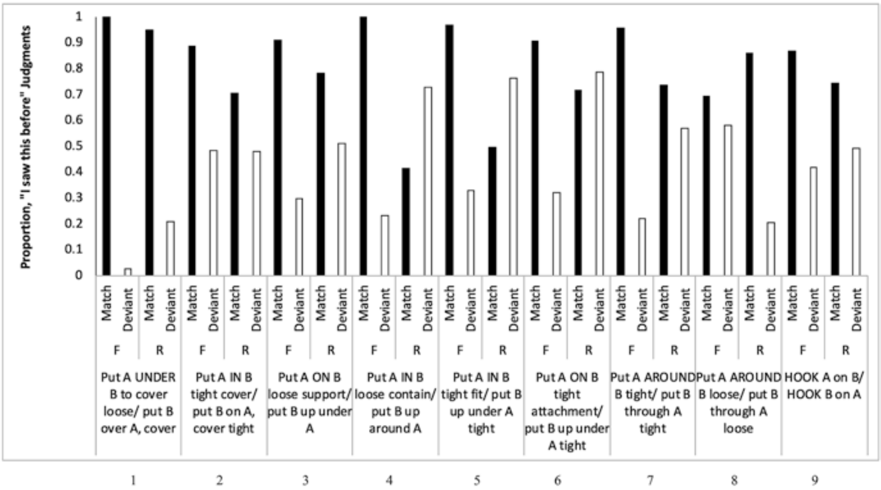

Fig. 4 All speakers' recall by condition
F = Original video seen in "Forward" direction (A moving); R = Original video seen in "Reverse" direction (B moving); Match = Same video seen as in Description Task;
Deviant = A and B had reversed Figure/Ground roles in Recall task video relative to their roles in Description Task video

4.3 *Descriptions vs Judgments*

The above recall analyses look at all speakers' performance as a group. It is possible that the data could be skewed by some speakers who mis-described the videos in the Linguistic Description task and then thought they had in fact seen the videos as they had mis-described them. That is, perhaps those who mis-described given videos in the initial task were those who showed false positives in the recall task. In order to examine this possibility, each response set by each participant was scored for whether s/he described it appropriately in relation to A vs B moving, and how that person then responded in the recall task on that same item. (Because speakers' descriptions for category type 1 were rarely incorrect in their identification of A and B as moving – at least 90% correct in both directions, this category type was left out of these analyses.)

Table 4 shows a breakdown, for each language, for the linguistic descriptions in relation to recall. Table 4 shows those cases in which individual participants described videos correctly vs cases in which individuals described given videos incorrectly, and then shows the breakdown within that of their recall responses, according to whether the relevant initial video showed a forward or reverse motion and according to whether the recall video was a match with that initial video or deviated from it.

Table 3 Comparison of judgments of "Yes, I have seen this video before"

"Yes" judgments					Comparison of forward and reverse movement		
			Forward (A moving in original video)	Reverse (B moving in original video)	*t*	*df*	*p*
1	Put A UNDER B to cover loose/ put B over A, cover loose	MATCH	1.00	.96	1.00	26	.327
		DEVIANT	.02	.19	−3.12	26	.004 **
2	Put A IN B tight cover/ put B on A, cover tight	MATCH	.88	.69	1.93	26	.065
		DEVIANT	.46	.45	−.148	26	.883
3	Put A ON B loose support/ put B up under A	MATCH	.89	.78	1.14	26	.265
		DEVIANT	.30	.50	−1.79	26	.086
4	Put A IN B loose contain/ put B up around A	MATCH	1.00	.45	5.70	26	.000 ***
		DEVIANT	.24	.74	−4.42	26	.000 ***
5	Put A IN B tight fit/ put B up under A tight	MATCH	.96	.52	4.00	26	.000 ***
		DEVIANT	.30	.74	−6.15	26	.000 ***
6	Put A ON B tight attachment/ put B up under A tight	MATCH	.91	.72	1.98	26	.058
		DEVIANT	.32	.76	−4.95	26	.000 ***
7	Put A AROUND B tight/ put B through A tight	MATCH	.94	.72	2.28	26	.031 *
		DEVIANT	.24	.57	−4.72	26	.000 ***
8	Put A AROUND B loose/ put B through A loose	MATCH	.67	.85	−1.41	26	.170
		DEVIANT	.54	.20	3.77	26	.001 **
9	HOOK A to B/ HOOK B to A	MATCH	.83	.71	1.06	26	.301
		DEVIANT	.41	.49	−.79	26	.439

* $p < .05$, ** $p < .01$, *** $p < .001$

It can be seen from these data that the patterns of responding when individual participants' descriptions are compared with their recall are consistent with the results reported above. To be specific, we see the following in the various conditions:

4.3.1 Correct Descriptions

Match Condition: Even when participants described a video correctly, they were more likely to accept a Match video in the recall task if they had seen the forward video (96.6% "Yes") than if they had seen the reverse video (86.4% "Yes").

Deviant Condition: In the Deviant condition, even when a participant described the initial video correctly, they were more likely to accept the deviant/non-matching video in the recall task if that recall video showed the event in the forward direction (A moving; 28.9% "Yes") than in the reverse direction (B moving; 24.5% "Yes").

Table 4 Percentage "Yes, I have seen that video," in cases in which the participant mentioned A or B as moving, by condition

		Participant's description CORRECT				Participant's description INCORRECT			
Linguistic description task	Original video Viewed:	Forward video (A moving)		Reverse video (B moving)		Forward video (A moving)		Reverse video (B moving)	
	Participant's C/INC description:	A moving		B moving		B moving		A moving	
Recall task	Recall video:	Match (A moving)	Deviant (B moving)	Match (B moving)	Deviant (A moving)	Match (A moving)	Deviant (B moving)	Match (B moving)	Deviant (A moving)
	Participant's "yes" response =	HIT	FALSE POS	HIT	FALSE POS	HIT	FALSE POS	HIT	FALSE POS
Identification of video as one previously seen	Dutch	94.3	24.6	83.8	30.2	60.0	74.1	56.3	86.0
	English	100	24.3	90.9	27.1	55.6	70.4	38.2	90.9
	Together	**96.6**	**24.5**	**86.4**	**28.9**	**58.3**	**72.2**	**48.8**	**87.9**
	N[a]	170/176	90/368	102/118	68/235	14/24	39/154	40/82	152/173

[a]Note: N = Number of "yes" responses / Number of cases in which participants mentioned A (or B) as moving

4.3.2 Incorrect Descriptions

If the participant initially provided an incorrect description of a video in the linguistic description task, they still showed evidence of favoring the forward direction in the recall task:

Match Condition: If speakers described a forward video in the linguistic description task (incorrectly) as if B was moving, and they were also then shown that forward video in the recall task, they were more likely to accept the recall video (58.3% "Yes") than if they had initially described a reverse video as if A was moving and again saw that reverse video in the recall task (48.8% "Yes"). This again shows participants' favoring of the forward direction, even when they had mis-described it initially as if B was moving. Note, critically, that this also means that they were not swayed by their own linguistic descriptions 58.3% of the time in that condition.

Deviant Condition: If a speaker initially mis-described a forward video as if it were the reverse (as if B was moving) and then saw a reverse video (B moving) in the recall task, they accepted that mis-matching video 72% of the time. This judgment shows that the linguistic description swayed their responses in this condition. They were even more likely to accept a video in the similar condition when the initial video showed B moving (a reverse video) but they had described it as if A was moving and then saw in the recall task a video with A moving. In this condition, they indicated (mistakenly) that they had seen that forward (A moving) video 88% of the time.

To summarize, these data on individuals' patterns of responses show the following:

1. First, influence of the naturalness or canonicalness of the direction of an event. Speakers appear to at least sometimes store their memory of videos in terms of the canonical event direction. This is shown through the favored status of the forward movement over the reverse movement. Thus,

   – When participants described the initial videos correctly,

     in the Match condition they recognized the recall video more with the forward direction (A moving) than with the reverse direction (B moving);
     in the Deviant condition, they were more likely to (mistakenly) think they had seen the forward video (A moving) than that they had seen the reverse video (B moving)

   – When they gave incorrect descriptions of the initial videos,

     in the Match condition, they were more likely to (correctly) accept that they had seen a forward video (A moving) than a reverse video (B moving);
     in the Deviant condition, they were more likely to (incorrectly) judge that they had seen a forward video than a reverse video.

2. Second, influence of language. When speakers mis-described an initial video, and then were shown a video they had not seen in the Deviant condition, they

showed high levels of judging that they had indeed seen the video *as they had mis-described it*. In the case of forward videos (originally saw A moving, but described it as if B was moving), they accepted that they had seen B moving 72% of the time; in the case of reverse videos (originally saw B moving, but described it as if A was moving), they accepted that they had seen A moving 88% of the time.

3. However, language competes with memory of the actual event, only winning out about 50% of the time. When speakers mis-described an initial video, and then were shown that same video in the Match condition, they recognized the video that they had seen 58% of the time in the forward condition and 49% of the time in the reverse condition.

5 Discussion

The above results on Dutch and English speakers' descriptions of and memory for events in which two objects could potentially act interchangeably as Figure or Ground help illuminate both linguistic and cognitive aspects of the encoding, processing, and recalling of motion events. In particular, they suggest the following:

– First, speakers are not attentive in all situations to which of two Figures might be moving. Some types of events, such as our first category, Put A UNDER B to cover loose/ put B over A, cover loose, do indeed lead speakers to clearly identify which object is acting as Figure and which as Ground. In contrast, for almost all of the other category types we tested, speakers tended to describe the event in terms of the canonical direction of motion. E.g., in our fourth category, Put A IN B loose containment/ put B up around A, speakers encoded the event in terms of what is assumed to be the more natural, canonical direction in which such an event would normally take place (we put lamps on tables, we do not slide a table under a lamp; we put items in a container, rather than raise a container up around items to encompass them): even when B was moving, they described the event as if A was moving 80% of the time.

This finding alone suggests that speakers may be viewing these events not so much as a motion event as, more holistically, an event involving a change of state or location.

– Second, speakers' recall of the events they observed and the identification of matches and mis-matches also favored the canonical direction of movement.

In cases involving Matches with the original videos they had seen, whether they had described that original video correctly or incorrectly, speakers (correctly) agreed they had seen the video shown in the recall task more often when it involved forward motion than when it involved reverse motion. This suggests that speakers were sometimes storing the videos in memory in terms of the canonical direction of motion, even if they had seen the reverse.

(Interestingly, one might have expected the opposite might have occurred, given that the reverse videos were more marked, and, hence, presumably more "memorable".)

In cases involving Deviant videos in the recall task, regardless of how they had described the original video, speakers were still more likely to judge that they had seen a recall video if it showed forward motion than if it showed reverse motion. This again suggests that storage of the events in memory was at least sometimes in the shape of the canonical event.

– Third, at the same time, the results provide some support for the position that the linguistic encoding of the event they had described influenced memory for the videos as well.

  If a speaker saw A (or B) moving in both the initial task and the recall task, they showed better "memory" of the video if they had described it (correctly) as A (or B) moving (86–97% correct) than if they had mis-described it as B (or A) moving (49–58% correct).

  If a speaker mis-described an initial video (as if B was moving when in fact A was, or as if A was moving when in fact B was), they were much more likely to judge that they had in fact seen the video they *described* (72% if they had described it as if B was moving, 88% if they had described it as if A was moving) than when they described the initial video correctly and saw the deviant video (25% "yes" judgments in the cases in which the initial video had A moving and the deviant recall video showed B moving and 29% "yes" responses in the cases in which the initial video had B moving and the deviant recall video showed A moving).

– Fourth, the data reveal that language alone did not always sway judgments. When participants mis-described an initial video and then saw a Match in the recall task, their judgments that they had seen the original video (not one that matched their description) were correct 49% to 58% of the time.
– Finally, the data here show the Dutch and English speakers performing in the same fashion, both in terms of the contexts in which they do and do not discriminate A and B acting as Figures and in terms of their memory for events. Both Dutch and English are S-framed languages, and also most of the Dutch speakers were fluent in English. So without further research, we cannot be sure what the ultimate reasons are for their similarity in performance. However, our speculation is that it has more to do with the pragmatics surrounding the events tested – what is natural or canonical in real-world contexts. (See below.)

These findings lead to our proposition that motion events such as those shown here are complex in that they involve both MOTION and a CHANGE OF STATE or LOCATION at the same time. As such, on a given occasion, in a given context, a speaker may view and encode and process such an event in either way. The factors that affect which way a speaker processes and remembers a given event include the naturalness or canonical direction of similar events and the speaker's own linguistic encoding of the event.

The results appear consistent with and might shed some light on previous research that has identified crosslinguistic differences in speakers' focusing on endpoints vs the trajectory of motion. Even though both English and Dutch express aspect, which Bylund and colleagues predict will lead to a focus on the trajectory of motion, our participants showed in some cases, by not differentiating which object was moving, a focus on the end results of the motion, i.e., the resulting change of state or location. Our results, then, might suggest that motion events that involve endpoints naturally have a dichotomous nature in that they involve both ongoing motion and arrival at some change of state. As others have noted (Bylund & Athanasopoulos, 2015; Slobin & Hoiting, 1994), the linguistic means a given language has available for encoding and describing a given event are limited. The means available in some languages (i.e., in those languages that encode aspect, like English and Dutch) may highlight the ongoing nature of the event, and the means available in others (those that do not encode aspect) may highlight holistically the nature of the event as a change of state. But the characteristic of the event not usually highlighted by the language at hand does not disappear and can influence performance in some contexts, such as those provided here. Even though speakers of English and Dutch may generally pay attention to the ongoing trajectory of motion, they showed here that the endstate achieved was influential in their descriptions and memory in many cases.

We set out with two main goals:

Our first major goal was linguistic: to examine the extent to which languages obligatorily differentiate Figures from Grounds. These data reveal that a distinction is not always made.

Two sub-goals of this were, first, the exploration of a new parameter for motion events: the extent to which a language focuses on the ongoing event versus the end-state/result of that event, related to the patterns in the language for differentiating Figures from Grounds, and, second, an examination of the extent to which the particular category of motion (e.g., insertion of X into Y, placement of X onto Y, and so forth) can influence whether Figures and Grounds are clearly distinguished in a language. These data indicate that these are related. Some types of motion events, like our first one, lead speakers to make clear linguistically which object is moving, A or B. Others, like most of the other types, seem to be processed as if they are what may be the canonical event. They are often described as such, even if the reverse took place, which suggests that the change of state, rather than the trajectory of motion per se, is the focus. Why is there a difference across types? In many of our categories, the reverse motions were more marked, less natural, than the forward motions. The contexts in which these motions take place are likely to favor forward motion over the reverse.

Our second major goal was cognitive: to explore the extent to which the linguistic differentiation of Figures and Grounds in an event may have an impact on the conceptualization and processing of the event. There clearly is some impact of language on the storage of the events in memory. However, the impact of language interacts with the impacts that the category type and canonical direction of motion have on memory for events. Linguistic encoding does not always override those latter two.

We asked at the outset whether language overrides all else in the processing of events, here, specifically, in the memory of events. In previous studies, the language produced by speakers, overtly or covertly, has been consonant with the motion event being observed. In our study, there was often conflict between the description of an event and the actual event that occurred. Our results shed some light on the larger question of the role of language in relation to cognitive processing. Our data reveal that the two can compete to determine how a given event is remembered or stored. In the cases here, there were actually three elements competing: the actual event observed, the pragmatically canonical or natural configuration of that event, and the speaker's linguistic description of that event. When these three coincided, they appeared to serve to support and reinforce one another. Such is the case when a speaker saw A moving, and A moving was the more natural direction of movement, and the speaker described the event as showing A moving. When the three elements are at odds with one another – when the actual event showed a less natural direction of motion or when the speaker mis-described the event – then the "memory" of the event was affected. Thus, if the initial event showed B moving, but the recall event showed A moving, the greater naturalness of A moving could sway the speaker's "recall" of the event; or if the speaker mis-described the initial event (saying that A (or B) moved when the opposite had actually occurred), this could also sway the speaker's "recall," leading him or her to accept a video in the recall task that matched the event as the speaker had described it. However, our data showed that the linguistic description did not override everything else. That is, it is not the case that language acted in any simple way to shape how an event is stored in memory or to mediate its recall. Language appears to compete with the stored memory as well as some perception of the natural or canonical direction of events. Thus, the perception of an event and the linguistic description of that event can at times act to mutually support each other (when these are consonant with one another) or to compete with each other in determining the accuracy of recall of events.

It remains to be seen to what extent the findings here are upheld with evidence from other languages. Further research exploring these issues crosslinguistically will help to illuminate the possibilities and limitations of viewing motion events as having this dual nature. At the very least, our findings suggest another aspect of motion events – the extent to which Figures and Grounds are differentiated – that is worthy of closer scrutiny.

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Appendices

Appendix A: Questionnaire

Questionnaire, Bilingual Dutch Speaker

We would be grateful if you could give us the following background information to help us with our studies. Please feel free to leave any item blank if you feel you would prefer not to answer.

Name: ____

Contact details (email and/or telephone):
____

<table>
<tr><td>Are you: Male ☐ Female ☐ ?</td><td rowspan="3">Please indicate the areas where you have lived for significant periods (more than a year) of your life:

e.g.:
Place: The Netherlands dates: 1990-1993
Place: England dates: 1993-1999
Place: Spain dates: 1999-2005

Place: _____ Dates: _____
Place: _____ Dates: _____
Place: _____ Dates: _____
Place: _____ Dates: _____</td></tr>
<tr><td>Were you born in the The Netherlands?
Yes ☐ No ☐</td></tr>
<tr><td>If you were not born in The Netherlands:

At what age did you move to The Netherlands? _____
How long have you lived in The Netherlands? _____yrs.</td></tr>
</table>

Language Upbringing:

Which of the following languages do you speak? (Select all that apply and fill in the blanks)

☐ Dutch
I began speaking Dutch: (a) ☐ as a baby, (b) ☐ by age 2 (c) ☐ between 3 & 5 years of age, (d) ☐ in grade school, (e) ☐ later, around age ____.

☐ English
I began speaking English: (a) ☐ as a baby, (b) ☐ by age 2 (c) ☐ between 3 & 5 years of age, (d) ☐ in grade school, (e) ☐ later, around age ____.

☐ Spanish
I began speaking Spanish: (a) ☐ as a baby, (b) ☐ by age 2 (c) ☐ between 3 & 5 years of age, (d) ☐ in grade school, (e) ☐ later, around age ____.

☐ Other
language(s):____
I began speaking this language at around age: ______________________________________

What language(s) did your mother and/or father (if applicable) speak to you when you were a child? [Please insert any other language(s) they may have spoken to you in the blank spaces.]

MOTHER	FATHER
☐ Virtually 100% Dutch	☐ Virtually 100% Dutch
☐ About 80% Dutch, 20% _________	☐ About 80% Dutch, 20% _________
☐ About 60% Dutch, 40% _________	☐ About 60% Dutch, 40% _________
☐ About 50% Dutch, 50% _________	☐ About 50% Dutch, 50% _________
☐ About 40% Dutch, 60% _________	☐ About 40% Dutch, 60% _________
☐ About 20% Dutch, 20% _________	☐ About 20% Dutch, 20% _________
☐ Virtually 100% ______	☐ Virtually 100% ______
☐ Other combination. Please specify:________________	☐ Other combination. Please specify:________________
☐ N/A	☐ N/A

What language(s) did your younger/older siblings speak to you when you were a child (if applicable)?

YOUNGER	OLDER
☐ Virtually 100% Dutch	☐ Virtually 100% Dutch
☐ About 80% Dutch, 20% _________	☐ About 80% Dutch, 20% _________
☐ About 60% Dutch, 40% _________	☐ About 60% Dutch, 40% _________
☐ About 50% Dutch, 50% _________	☐ About 50% Dutch, 50% _________
☐ About 40% Dutch, 60% _________	☐ About 40% Dutch, 60% _________
☐ About 20% Dutch, 20% _________	☐ About 20% Dutch, 20% _________
☐ Virtually 100% ______	☐ Virtually 100% ______
☐ Other combination. Please specify:________________	☐ Other combination. Please specify:________________
☐ N/A	☐ N/A

What was the normal language of instruction in the primary and secondary schools you attended?

PRIMARY SCHOOL	SECONDARY SCHOOL
☐ Virtually 100% Dutch	☐ Virtually 100% Dutch
☐ About 80% Dutch, 20% _________	☐ About 80% Dutch, 20% _________
☐ About 60% Dutch, 40% _________	☐ About 60% Dutch, 40% _________
☐ About 50% Dutch, 50% _________	☐ About 50% Dutch, 50% _________
☐ About 40% Dutch, 60% _________	☐ About 40% Dutch, 60% _________
☐ About 20% Dutch, 20% _________	☐ About 20% Dutch, 20% _________
☐ Virtually 100% ______	☐ Virtually 100% ______
☐ Other combination. Please specify:________________	☐ Other combination. Please specify:________________
☐ N/A	☐ N/A

What is/was the language of instruction in the university/college you attend(ed) (if applicable)?

☐ Virtually 100% Dutch
☐ About 80% Dutch, 20% ______
☐ About 60% Dutch, 40% ______
☐ About 50% Dutch, 50% ______
☐ About 40% Dutch, 60% ______
☐ About 20% Dutch, 80% ______
☐ Virtually 100% ______
☐ Other combination. Please specify:_________________
☐ N/A

What language(s) did you speak at primary school with your classmates when outside of the classroom?	Overall, what language(s) did you speak with most of your friends when you were a child?
☐ Virtually 100% Dutch ☐ About 80% Dutch, 20% _________ ☐ About 60% Dutch, 40% _________ ☐ About 50% Dutch, 50% _________ ☐ About 40% Dutch, 60% _________ ☐ About 20% Dutch, 20% _________ ☐ Virtually 100% ______ ☐ Other combination. Please specify:________________ ☐ N/A	☐ Virtually 100% Dutch ☐ About 80% Dutch, 20% _________ ☐ About 60% Dutch, 40% _________ ☐ About 50% Dutch, 50% _________ ☐ About 40% Dutch, 60% _________ ☐ About 20% Dutch, 20% _________ ☐ Virtually 100% ______ ☐ Other combination. Please specify:________________ ☐ N/A

Language Use Now [Please fill in the blank space with any relevant language.]

At present, at home, I speak

☐ A	☐ B	☐ C	☐ D	☐ E	☐ F
Only Dutch	More Dutch than ______	Dutch and ______ about equally	More _____ than Dutch	Only ______	Other/N.A.

At present, at work, I speak:

☐ A	☐ B	☐ C	☐ D	☐ E	☐ F
Only Dutch	More Dutch than ______	Dutch and ______ about equally	More _____ than Dutch	Only ______	Other/N.A.

At present, to my friends, I speak

☐ A	☐ B	☐ C	☐ D	☐ E	☐ F
Only Dutch	More Dutch than ______	Dutch and ______ about equally	More _____ than Dutch	Only ______	Other/N.A.

At present, my mother speaks to me in:

☐ A	☐ B	☐ C	☐ D	☐ E	☐ F
Only Dutch	More Dutch than ______	Dutch and ______ about equally	More _____ than Dutch	Only ______	Other/N.A.

At present, my father speaks to me in:

☐ A	☐ B	☐ C	☐ D	☐ E	☐ F
Only Dutch	More Dutch than ______	Dutch and ______ about equally	More _____ than Dutch	Only ______	Other/N.A.

At present, my siblings and I speak to each other in:

☐ A	☐ B	☐ C	☐ D	☐ E	☐ F
Only Dutch	More Dutch than _______	Dutch and _______ about equally	More ______ than Dutch	Only _______	Other/N.A.

At present, my friends speak to me in:

☐ A	☐ B	☐ C	☐ D	☐ E	☐ F
Only Dutch	More Dutch than _______	Dutch and _______ about equally	More ______ than Dutch	Only _______	Other/N.A.

On a scale of 1 to 4, how well do you feel you can …?

Understand Dutch now:

☐ A	☐ B	☐ C	☐ D
I can understand basic words and expressions	I can understand simple conversations	I can understand extended conversations	I can understand virtually any kind of conversation

Speak Dutch now:

☐ A	☐ B	☐ C	☐ D
I only know basic words and expressions	I can carry out simple conversations	I can carry out extended conversations	I can carry out virtually any kind of conversation

Read Dutch now:

☐ A	☐ B	☐ C	☐ D
I can read basic words and expressions	I can read simple texts	I can read extended texts	I can read virtually any kind of text

Write Dutch now:

☐ A	☐ B	☐ C	☐ D
I can write basic words and expressions	I can write simple texts	I can write extended texts	I can write virtually any kind of text

On a scale of 1 to 4, how well do you feel you can …?

Understand English now:

☐ A	☐ B	☐ C	☐ D
I can understand basic words and expressions	I can understand simple conversations	I can understand extended conversations	I can understand virtually any kind of conversation

Speak English now:

☐ A	☐ B	☐ C	☐ D
I only know basic words and expressions	I can carry out simple conversations	I can carry out extended conversations	I can carry out virtually any kind of conversation

Read English now:

☐ A	☐ B	☐ C	☐ D
I can read basic words and expressions	I can read simple texts	I can read extended texts	I can read virtually any kind of text

Write English now:

☐ A	☐ B	☐ C	☐ D
I can write basic words and expressions	I can write simple texts	I can write extended texts	I can write virtually any kind of text

On a scale of 1 to 4, how well do you feel you can …?

Understand Spanish now:

☐ A	☐ B	☐ C	☐ D
I can understand basic words and expressions	I can understand simple conversations	I can understand extended conversations	I can understand virtually any kind of conversation

Speak Spanish now:

☐ A	☐ B	☐ C	☐ D
I only know basic words and expressions	I can carry out simple conversations	I can carry out extended conversations	I can carry out virtually any kind of conversation

Read Spanish now:

☐ A	☐ B	☐ C	☐ D
I can read basic words and expressions	I can read simple texts	I can read extended texts	I can read virtually any kind of text

Write Spanish now:

☐ A	☐ B	☐ C	☐ D
I can write basic words and expressions	I can write simple texts	I can write extended texts	I can write virtually any kind of text

General information

Please indicate your level of education:

☐ Primary education (Grade School)
☐ Secondary education (High School)
☐ University or college education up to year _____ or degree:_____
Major:____
☐ Post-graduate education up to year _____ or degree: _________________
☐ None of the above

Please indicate the level of education completed by your mother:

☐ Primary education (Grade School)
☐ Secondary education (High School)
☐ University or college education up to year _____ or degree:_____
Major:____
☐ Post-graduate education up to year _____ or degree: _________________
☐ None of the above

Please indicate the level of education completed by your father:

☐ Primary education (Grade School)
☐ Secondary education (High School)
☐ University or college education up to year _____ or degree:_____
Major:____
☐ Post-graduate education up to year _____ or degree: ______________
☐ None of the above

What is your present occupation (or if retired or unemployed, what was your last occupation before retiring or becoming unemployed)?

____

What is your partner's present occupation (if applicable)?

____

MOTHER	FATHER
What was your mother's occupation when you were a child? _________________________________ ___	What was your father's occupation when you were a child? _________________________________ ___
Please indicate where your mother has lived _________________________________ _______	Please indicate where your father has lived and when _________________________________ _______

Have you ever undergone speech or language therapy?

☐ Yes
☐ No

Have you ever been treated for a hearing problem?

☐ Yes
☐ No

Have you ever been treated for a vision problem?

☐ Yes
☐ No

Appendix B: Instructions to Participants

Linguistic Description Task

This experiment consists of two parts. In this first part, you will see a series of videos. You will see each video once.

We are simply asking that you describe (in Dutch/English) the action you see in each video, in a complete sentence. Some of the actions may be actions you have not seen before; just make your best attempt at describing each action.

For each item, you will see the video, and then you will see a microphone. When you see the microphone, describe the action you have seen. Press the letter "Q" when you have finished speaking. You will then see an arrow, which you should press when you are ready to move on to the next item.

You will see three practice videos, during which you can ask any questions, which we will answer, and then we will show you some videos for which you will not receive any feedback.

Any questions?

Recall Task

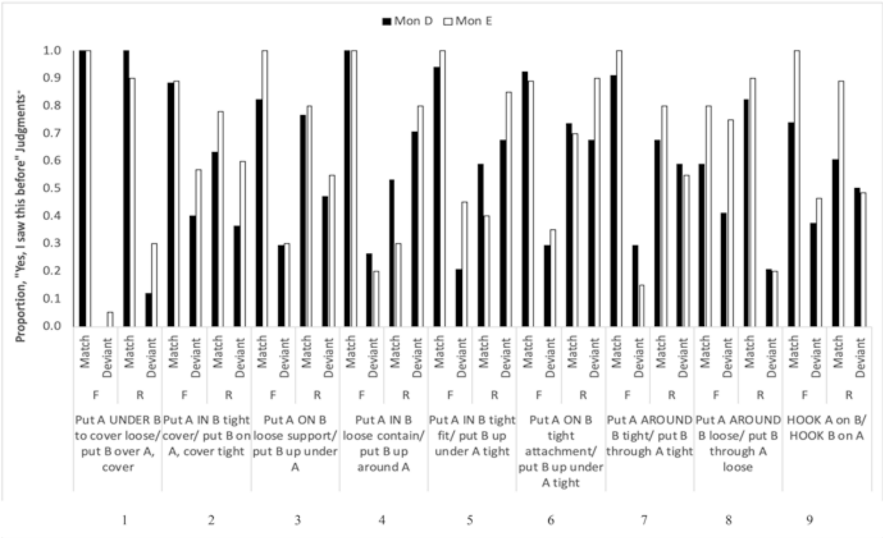
You will now see some more videos. Some of them you have seen before, some of them you have not.

We ask that you simply make a judgment on whether you have seen the video in the first part of the study.

You will see the video first, then a screen with a question mark. When you see the question mark, answer "yes" or "no" on whether you have seen the video before.

Note: The video must be EXACTLY THE SAME as the one you saw before for you to say "yes"; otherwise, you should answer "no."

Appendix C: Dutch and English Speakers' Recall by Condition



F = Original video seen in "Forward" direction (A moving); R = Original video seen in "Reverse" direction (B moving)
Match = Same video seen as in Description Task;
Deviant = A and B had reversed Figure/Ground roles in Recall task video relative to their roles in Description Task video

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On the Nature of Language Production – Towards a General Model

Sven Strömqvist

Abstract This chapter is a sketch towards a general model of the language production process in different modalities, with special reference to the dynamic interaction between language and thought. The model, it is argued, must take the temporal, social and cognitive organization of the language production process into account.

Special attention is given the external representation and its affordances, that is, what the spoken or written representation offers the speaker or writer to do. For the purpose of demonstration, three different situations of language production are subjected to contrastive analysis: a predominantly monological discourse in a spoken and a written condition derived from a narrative task; a genuinely dialogical spontaneous spoken discourse; and the writing of a poem.

Further, the paper proposes a partly new conceptual approach: that of seeing language production basically as a process of drafting – in writing as well as in speech. In effect, text-writing can be said typically to be a solitary drafting process where revisiting and reinterpreting one's own previous discourse is essential to developing the text, whereas spoken conversation is typically a joint drafting process where attention to one's co-speaker's reactions is essential to developing the discourse.

Keywords Language production · Speaking · Writing · Drafting · Affordances · Language and thought

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1 On the Linguistic Production Process in Speech and Writing

Models of speaking and models of writing tend to be crafted in theoretically and methodologically diverse traditions. Models of the speaking process are typically associated with psycholinguistics (e.g., Fromkin, 1973; Levelt, 1989), whereas models of the writing process often stem from cognitive psychology (e.g., Bereiter & Scardamalia, 1987; Flower & Hayes, 1981; Kellogg, 2008). Some models represent a multidisciplinary approach (e.g., Ravid & Tolchinsky, 2002) and many scholars model the writing process with a developmental perspective (e.g., Ravid & Tolchinsky, 2002; Kellogg, 2008; Myhill, 2008). A Whorfian perspective (see, e.g., Whorf, 1956; Gumperz & Levinson, 1996; Levinson, 1997) on the dynamic interaction between language and thought in the production process is, however, rare in these contexts as are efforts to handle speaking and writing within one and the same model.

Here we will explore the feasibility and meaningfulness of a general model of language production, common to both speech and writing (and, indeed, language in any other modality). In that model, differences between speech and writing are not manifest as categorial differences, that is, as differences in parameters or components, but as differences in the relative importance of the components in different production situations, and as differences in terms of the pathways the information travels to furnish the speaker or writer with a basis for developing or rethinking her/his discourse. Further, the model is adapted to a modestly neo-whorfian perspective on the language production process. It takes as theoretical points of departure Slobin's notion of *thinking for speaking* (Slobin, 1996) and the corresponding notion of *thinking for writing* (Strömqvist et al., 2004). A central thesis for the model proposed is that "When you construct an utterance or a text you construct a model of your thoughts on the conditions of the language and medium (speech, sign, writing) employed" (Strömqvist, 2009, p. 223). Choice of language and medium is seen as having cognitive consequences (Slobin, 2002) – in terms of which information the speaker/writer encodes into a linguistic form, how the speaker/writer organizes her/his attention and what she/he remembers.

Strömqvist et al. (2004) present a bird's eye perspective on facts and factors typically determining the linguistic production process in spoken, signed and written communication. In Table 1 (from Strömqvist et al., 2004, p. 361) these facts and factors are organized in terms of causes, consequences and constraints. Starting from the top row, the table describes four possible spatio-temporal configurations between sender and addressee and then proceeds to describe various "communication technologies" (spoken or signed face-to-face interaction, written off-line communication etc) representing adaptations to the different configurations. Moving down, the left-most column then lists different parameters/dimensions along which speech and writing vary, variations which are conducive to characteristic constraints and affordances. These dimensions include Duration of the signal, Modalities,

Table 1 A bird's eye perspective on differences between spoken and written language communication and processing

Spatio-temporal configuration of communication setting:	same time, same place	same time, different places	different times, same place	different times, different places
Communication technology:	e.g., spoken or signed face-to-face interaction	e.g., telephone; written on-line communication: text telephone, computer talk systems	e.g., written notes, inscriptions, dictaphone	e.g., written off-line communication: books, forms, e-mail
Duration of signal:	very short: very high speed of processing; short-distance editing	⟷		very long: speed of processing may be relaxed; long-distance editing
Modalities:	predominantly multi-modal	⟷		predominantly mono-modal
Distribution of expressive features:	both simultaneous and linear	⟷		predominantly linear
Relation between perception and production:	discourse perceived on-line, just as it is produced on-line	⟷		discourse perceived by receiver only after final editing
Interactivity:	on-line feedback and mutual adaptation possible	⟷		on-line feedback and mutual adaptation not possible
Normative ideals:	In a given linguistic community, speech, sign, and writing tend to be associated with partly different normative ideals, towards which the speakers, signers, and writers are orienting in the production process.			

From Strömqvist et al. (2004, p. 361)

Distribution of expressive features, Relation between perception and production, and Interactivity. We will return to these dimensions in Sect. 2, providing illustrations of how they apply in the analysis of speaking and writing. First, however, we shall briefly review how the various constraints and affordances in Table 1 fare when it comes to modelling the production process in speech and writing. For this purpose, Table 1 can be seen as a specification of requirements for a model of the language production process.

Now consider the model sketched in Fig. 1. It is intentionally kept rather abstract to allow for it to be discussed in relation to both speaking and writing. Admittedly, it underspecifies several subprocesses but it is intended to serve as a point of departure for discussion and further refinement. The model in Fig. 1 schematically depicts a variant of the so-called finalistic chain of speech (see, e.g., Lindblom and Öhman, 1979): you speak in order to be heard in order to be understood. Similarly, and modified for writing: you write in order to be read in order to be understood. Further, the model schematically depicts a small number of sub-processes – from thought to external representation (signal) on the part of the speaker/writer (A) and from external representation (signal) to thought on the part of the listener/reader (B). As the listener/reader has (re)constructed the message content and the initiative to respond is with B, it is B's turn to construct a message, whereas A shifts to the listener/reader role.

The model in Fig. 1 consists of boxes and arrows. The first box, "Content Constructor, A", represents the sub-processes by which the speaker/writer A) constructs a message content. In the famous speech production model by Levelt (1989, p. 9ff) the corresponding module is called "Conceptualizer". The content is then encoded into a linguistic form (the second box, "Encoder, A"), including, ultimately,

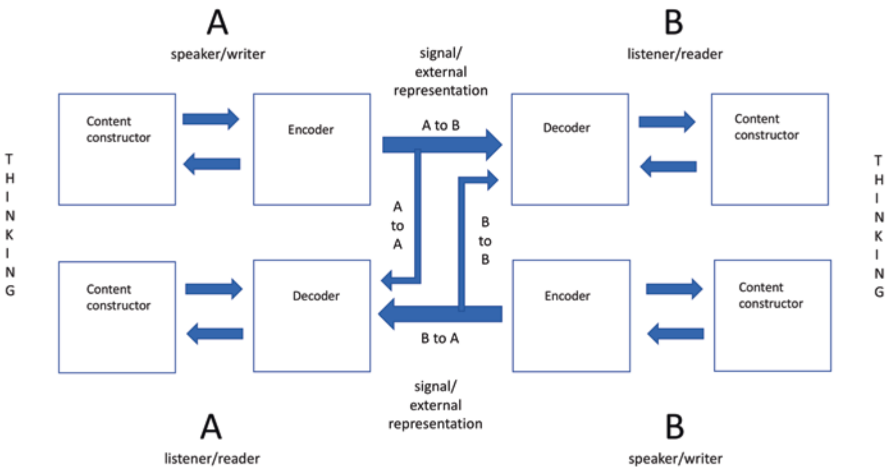


Fig. 1 A sketch towards a model of linguistic communication and processing

the compilation of motor plans which are finally executed to produce a signal or, if you like, an external representation. In general, we know a lot about the structure and sub-processes in the Encoder – in relation to speech they are assumed to involve things like morpho-syntactic and prosodic framing, lexical choices, phonological encoding and phonetic specifications. But what do the processes in the Content Constructor look like? And what is the nature of the internal representation of the content that is being shaped there? Is there a language of thought, possibly similar to spoken languages, a "mentalese" as suggested by Fodor (1975)? The more similar that hypothetical language might be to the language targeted by the Encoder, the more translation-like the step from Content Constructor to Encoder. This situation is represented by the simple feed forward arrow between the first two (upper left) boxes in Fig. 1. In contrast, if the internal representation of the content rests on some sort of image semantics (Langacker, 1987; Gärdenfors, 2000), then the encoding process involves mapping from ideas to language of a kind that goes beyond trivial translation from one language to another. Still the feed forward arrow might be valid as a representation of the information flow between the Content Constructor and the Encoder. Further, in the Wundtian tradition as is manifest in Levelt's model, the content is exhaustively specified already by the Content Constructor, and so the information exchange between Constructor and Encoder is unidirectional.

However, not all theories of the production process can do with merely a unidirectional feed forward relationship between content construction and encoding. Notably, Slobin's theory of Thinking for Speaking (Slobin, 1996) assumes that our thinking takes on a special quality in relation to language use; we are influenced by grammatical demands and rhetorical habits when we decide on which aspects of content to select for encoding into a linguistic form. And since language communities around the globe vary considerably with respect to grammars, semantic fields and rhetorical habits, this means that linguistic diversity has cognitive consequences. Along similar lines, Strömqvist et al. (2004) argue that Thinking for Speaking and Thinking for Writing differ. "When you construct a linguistic utterance, you construct a model of your thoughts on the conditions of the language and medium (speech, sign, writing) employed" (Strömqvist, 2009, p. 223).

Slobin's work provides a new angle to the Whorfian tradition, which leverages, essentially, the interference between the shaping of the content and the resources available for encoding. This interference or interaction is further intimately related to the notion of cognitive control. The basic idea here is that our cognitive system needs selective principles and guidelines in order to work efficiently. In that context, language provides rich and powerful guidelines (see, e.g., Posner & Snyder, 1975; van den Noort et al., 2019) for what information to select, how to structure it and what to focus on in an information array of a potentially very big number of options. In effect, the given linguistic encoding resources at hand come to influence what is being attended to and encoded. The backward arrow between the first two boxes in Fig. 1 represents this influence and, together with the forward arrow, guarantees that the information flow between Content Constructor and Encoder is bidirectional.

Before turning to a few examples of authentic discourse, let us briefly consider the phase in the production process when the internal representation is made external. What is the difference between the internal and the external representations? Perhaps the most obvious difference is that they have different affordances (Gibson, 1969): A:s internal representation cannot be shared with B, but his external representation can. This triggers the communication chain: B perceives, decodes and interprets A:s external representation and typically proceeds to produce a response, which B, now in the listener/reader role, perceives, decodes and interprets. But B is not the only perceiver of A:s external representation. A her/himself is a listener or reader of the external representation she/he just produced. This allows A to monitor her/his external representation and evaluate whether it came out as planned or not. Monitoring is a fundamental asset and allows the speaker to perform a self-repair in case the external representation does not match the internal one (Levelt, 1983). In Fig. 1 this is indicated by the two arrows "A to B", representing the transmission of the signal from A to B, and "A to A", representing the internal feedback loop allowing A to monitor his own output. In Levelt's model of the speech production process (1989) the latter type of feedback loop is present exclusively for the purpose of allowing monitoring.

Now, if we consider writing rather than speaking, the same feedback loop is typically loaded with a much heavier duty. In the type of writing activities described in the right-most column of Table 1 the message is not propagated to an addressee until it has been read and re-read and, typically, modified several times by the writer – not just in terms of repairs of, for example, misspellings, but, importantly, in terms of changes of the content. How does the writer interact with his/her external representation during this phase of production? Does she/he rely on the long-lasting representation as an "external memory" (see, e.g., Mueller & Oppenheimer, 2014) with the cognitive consequence of freeing resources for focusing on hitherto ignored aspects of the content construction? Or does the long-lasting external representation hamper her/his further content planning, is she/he getting trapped, as it were, by the external representation?

If we want to make room for this type of production cycle in our model, we might want to think of the message content not as a highly specified structure already before it enters the encoding phase. Rather, we might think of it as intentionally vague and underspecified and, importantly, open to modification and revision. If you pursue this line of thought, it becomes somewhat problematic to determine when the message is fully accomplished. By which criteria do you decide when it is completed? Should it have a sentence form? In case of a narrative, should it be an episode? Should it be the whole narrative? Or is it only complete when, in a dialogue, the conversationalists have reached what Clark (2006) terms "common ground", a process which cannot be reduced to one speaker but essentially relies on social interaction? The answer to these questions tend to be different depending on whether you consider speaking or writing.

2 Temporal, Social and Cognitive Organization of the Linguistic Production Process: Three Examples

In the 1950s and 60s, shortly after the breakthrough of modern (acoustic) phonetics and at the brink of modern psycholinguistics, Goldman-Eisler conducted a series of experiments on the temporal patterning of connected speech (elicited in interviews or structured tasks such as narrations in relation to cartoons). The studies were later integrated into a comprehensive volume (Goldman-Eisler, 1968) where a foreword provides the credo or rationale for the entire research endeavor: that the crucial dimension of time had so far tended to be missing in studies of language and language behaviour. Central findings from the studies presented include the following generalizations. Speakers were found to vary a lot with respect to speed or, more precisely, ”production rate”, defined as speech plus pauses (where a pause is an instance of silence longer than 250 milliseconds). When all pauses were removed, the speed of the remaining continuous stretch of speech, termed “articulation rate”, was found to be very similar across speakers (in terms of, e.g., number of syllables per minute). In conclusion, perceived speech rate was mainly due to the amount of pausing.

Goldman-Eisler tentatively hypothesized that pauses were mainly caused by cognitive factors. To further validate this hypothesis, Goldman-Eisler calculated the predictability of the word coming up after a pause, using a procedure proposed by Shannon (1951), which, basically, amounts to asking a panel to guess which word comes next. Goldman-Eisler found that words preceded by a pause tended to be harder to predict. This finding strengthened the hypothesis that pauses were indeed caused by planning needs. Words with a lower predictability need to be more carefully planned or searched for. More specifically, Goldman-Eisler found that pauses within sentences are for lexical choices and that most pauses are followed by a decline in predictability. From the point of view of the listener, Goldman-Eisler further remarked, a pause can be effectively used to anticipate a sudden increase in information. This remark rests on the assumption that there is indeed a listener co-present, as is typically the case in spoken language communication.

In what follows, we will explore four examples in terms of their temporal, social and cognitive organization. The first two are fragments – one spoken and one written – from a personal narrative by a ten-year-old (Example 1a and 1b; from Strömqvist, 2009); the third one is a fragment from a spoken discussion between two university students (Example 2); and the fourth one derives from the writing of a poem by an amateur poet (Example 3).

2.1 A personal narrative

Example 1a is the beginning of a spoken personal narrative by a Swedish ten-year-old. The discourse is monological rather than dialogical in so far that the narrator produces all propositional content while the listener’s speech production is reduced to feedback items. The propositional content as encoded in the Swedish original, all in all four phrases, is rendered below together with a literal translation in English.

Example 1a: Propositional content, spoken version

de va så här en gång efter skolan	it was like this once after school
så ja å min bästis Ane	so me and my buddy Ane
hon kommer från Norge då	she is from Norway
vi va på en klätterställning	we were at a climbing frame

Figure 2 renders a graph describing the fundamental frequency (F0) contour of the four verbal phrases in Example 1a. The phrases are aligned with the temporal extension of the F0 plot.

Red fat dots represent the presence of F0 tone and green lines represent silence. The distribution of silence by and large corresponds to Goldman-Eisler's analysis of pausing behaviour. Shorter pauses occur within phrases and contribute to the perception of the speech rate as faster or slower. Longer pauses occur between phrases. There is one exception to this rule: there is a long phrase-internal pause after "hon" (she) where, in addition, the final sonorant segment is prolonged ("hon::"), a special case of a so-called filled pause. This is a way for the speaker to communicate to the listener that she intends to complete the proposition just initiated. There are thus two simultaneous layers of communication accomplished by the speaker: the propositional layer and at the same time a so-called collateral layer where the speaker refers to the production process itself – to timing, delays, rephrasings, mistakes, repairs, intentions to speak, and the like (Clark, 1996; Clark et al., 2002).

Tempo also adds meaning to the propositional content. We may validate the interpretation of some phrases as slower and some as faster by checking how (im) perfectly the verbal content is aligned with the F0 plot. The first, second and fourth phrases are all reasonably aligned with the plot. In contrast, the verbal content of the completion of the third phrase ("kommer från norge då") falls to a large extent outside the F0 plot, indicating that this part of the phrase is spoken with a higher speech rate than the surrounding phrases. From a content point of view, the increased speech rate in the third phrase contributes to setting it off as background information (see further below).

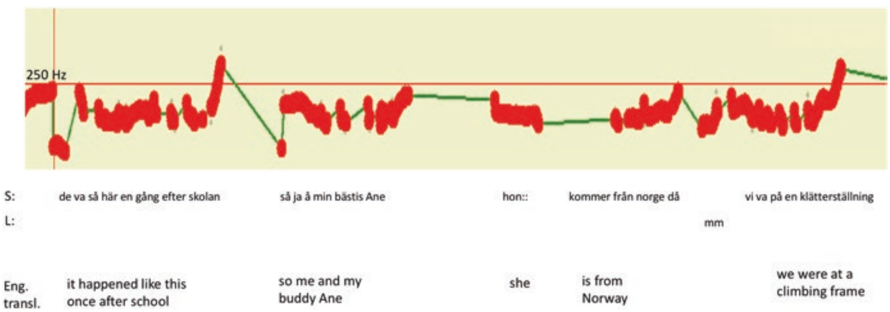


Fig. 2 Temporal and tonal characteristics of Example 1a. (From Strömqvist, 2009, p. 71)

With respect to the F0 contour, we observe a rising contour at the end of each phrase, something typical of the regional variant of Swedish spoken by the narrator. These rises – in combination with the silences that follow – signal that the phrase and associated information chunk is terminated and that speaker turn may be shifted (Sacks et al., 1972). Note that the listener takes the opportunity to produce a feedback item ("mm") exactly in the turn relevance place thus created between the third and fourth phrase.

The F0 contour further allows us to measure the distance between the lowest and the highest frequency points in the phrase, the so-called voice range. In general, increased voice range is closely associated with greater emotional investment in the propositional content on the part of the speaker (Williams & Stevens, 1972). In this context, we observe that the voice range is significantly decreased in the third phrase, which, content-wise, is dedicated to background information about the narrator's friend. The combination of the increased speech rate and decreased voice range serves to set off this phrase as parenthetical, to use a metaphor from written language.

In general the temporal patterning and the pause distribution in Fig. 2 not only reflect planning needs on the part of the speaker. These needs by and large coincide with the processing needs in the listener, who profits from the inter-phrasal pauses to digest the information chunks just delivered and to prepare for the chunk(s) to come. This balance between production processing needs and perception processing needs is crucial, since spoken language communication operates under strict online-constraints: the spoken utterances must be perceived online just as they are produced online. The distribution pattern is thus both cognitively and socially determined.

Example 1b shows the finally edited version of the corresponding written narrative (Swedish original and literal English translation), produced a few minutes later by the same ten-year-old.

Example 1b: Propositional content, written version

Detta hände för ungefär 3 månader sen.	This happened around 3 months ago.
jag och min bästis Ane	i and my best friend Ane
(hon kommer från norge)	(she is from norway)
var på en klätterstälning	we were at a climbing frame
det var efter skolan	it was after school
så det var bara vi där.	so only we were there.

Writing the narrative was a solitary activity with no reader co-present and, therefore, online constraints lifted. It is reasonable to assume that memory traces from the previous spoken condition lingered on. Yet, the content was constructed in a somewhat different fashion. Compare, for example, the first phrase "de va så här en gång efter skolan" (it was like this once after school) in speech versus "Detta hände för ungefär 3 månader sen." (This happened around 3 months ago.) in writing. Note further, that in writing, the 10-year-old did indeed put parentheses around precisely the background information we metaphorically described as parenthetical in the spoken discourse. So whereas she accomplished this in speech with simultaneously distributed expressive means – linguistically encoded propositional content simultaneously with a combination of increased speech rate and decreased voice range – she now expresses herself under the conditions of written language: successive, linearly distributed information in the form of first an opening parenthesis, then a series of words and then a closing parenthesis. (c.f. Table 1)

Whereas Example 1b rendered the propositional content of the written version as manifest in the final edited text, Fig. 3 (from Strömqvist, 2009, p. 72) describes the pausing and editing behaviour during the writing activity. Editings and pauses were derived by means of ScriptLog (Strömqvist et al., 2006). A pause was here operationally defined as keyboard inactivity >2 seconds.

After activating the writing window (“START”) the writer is inactive for 105.48 seconds, then writes “det”, followed by a 3.06 secs pause, then writes “var en” followed by a 3.95 secs pause, then writes “dag”, thus having composed an external representation, “det var en dag” (it was a day) which content-wise is similar to the first few words of the recent spoken discourse. She then deletes what she has written and starts anew constructing the following first sentence: “Detta hände för ungefär 3 månader sen.” (This happened around 3 months ago.). In other words, the writer has interacted with her own external representation to construct a partly new content – a kind of interaction which was absent in the recent spoken discourse activity. One component of this interaction is necessarily reading her own text so far produced (Torrance et al., 2016).

Moreover, the pausing pattern plotted in Fig. 3 is very different from the corresponding pattern in the spoken discourse (Fig. 2). Figures in blue mark pauses which occur at major information boundaries, similar to the distribution of longer pauses in the spoken discourse. Figures in red mark phrase-internal or word-internal pauses. The majority of these pauses would constitute a major threat to the listener’s processing of the input, had they occurred in spoken discourse under strict online constraints. But in writing these constraints can be lifted – there is no reader co-present who has to process what is being written as it is being written millisecond by millisecond and so these potentially disruptive pauses can be afforded at no cost at all in terms of communicative inefficiency. But why are they there?

It is well-known that low-level processes, such as spelling, tend to compete for cognitive resources, if they are not automatized. This is not only true for writers in a relatively early phase of development (such as the 10-year-old in Example 1b) but also for adult writers. Thus Alves et al. (2007) found that a group of adult writers

<START><105.48>det <3.06>var en <3.95>dag<DELETE14> Detta hände <9.36>för
unge fär 3 måm<DELETE>nader sen<3.66>.<CR> <4.48>jag och min bästis
an<DELETE2><2.15>Ane <4.81>(<3.38> hon komer <2.45>från norge<2.90>)
<5.60>var<12.16>på en <3.63>klät<2.30>ter stälning <12.06><LEFT22>
<RIGHT22><2.83> det var efter <2.01>skolan så det var <2.78>bara<2.33>
<CR><2.65>vi där<4.35>.

Fig. 3 Pausing and editing during the writing activity in Example 1b. (From Strömqvist, 2009, p. 72)

who were less versatile in terms of key board skills had fewer fluent phases or "bursts" during text writing, as compared to a control group of more skilled typists.

Several of the red-marked pauses in Fig. 3 may reflect that the ten-year-old struggles with aspects of low-level processing. At the same time she has carved her way into a deeper sense of written language. She encodes her content under the conditions of written language in that she moves from a more simultaneous distribution of expressive features in speaking to a more linear distribution in writing. But her adaptation to the written medium is not just a matter of encoding practices. She has discovered some of the unique affordances of writing in that she interacts with her external representation not only for monitoring misspellings but also for rethinking content and making content revisions in a way that would not be possible, or at least very difficult, with a spoken language representation.

Further, in both the spoken discourse activity and in the written one there are passages where the narrator begins executing an external representation before all details of the content construction seem to be in place. It is as if she is constructing an external representation to have something to interact with in order to support the further development of her discourse.

2.2 A Discussion

The following example is a fragment from a vivid discussion about film between two Swedish university students, A and B. Here, we shall not be concerned with the temporal and pausing characteristics of the discourse, but instead we will focus on instances of joint content construction by the two participants. The left column shows a transcription of the original Swedish wordings and a literal English translation is given in the right column.

Example 2: A discussion

A: Ja, nej, men den hade nog slutat gå då, eh.	A: Yeah, no, but it wasn't on any longer, ehm.
B: Men det är väl med eh, vad heter han?	B: But that's, you know, with what's his name?
A: eehm. Ja, Farrell.	A: Eehm. Yes, Farrell.
B: Colin, Farrell. Colin Farrell.	B: Colin, Farrell. Colin Farrell.
A: Precis.	A: Precisely.
B: Och sen ett par andra duktiga skådespelare.	B: And then a few other superb actors.
A: Ja, ja precis.	A: Yes, yeah precisely.
B: John C Reilly och alla andra som är med.	B: John C Reilly and all the other participants.
A: Precis.	A: Precisely.
B: Och det är väl det absurda med att man måste ha	B: And, you know, that's the absurd thing, you have to have
A: Ja	A: Yeah
B: en partner	B: a partner
A: annars transformeras man till ett djur som släpps ut i det vilda.	A: otherwise you're transformed to an animal that is unleashed into the wild.
B: Just det. Och så fick man välja djur.	B: Right. And then you got to choose animals.
A: Ja, precis.	A: Yes, precisely.

In contrast to the basically monological narrative in example 1a, we are here dealing with a dynamic dialogical discussion. The discourse unfolds as the content threads from A and B are intertwined to a coherent whole. Ample positive feedback giving reflects a high degree of common ground and new turns with propositional content are often initiated with a connector ("but", "and") to further reinforce the cohesion of the discourse. And, perhaps most noteworthy, A and B take turns completing or expanding each other's initiated propositional content, sometimes resulting in the completion of a hitherto incomplete grammatical structure. Thus, in subfragment (i) – below for ease of reference – speaker A fails to access the name of the actor designated for the grammatical role of prepositional object, and asks speaker B for help ("what's his name?"). B fills in "Colin Farrell", thereby helping A out with the proper name and, at the same time, completing the prepositional phrase initiated by A. And in subfragment (ii) below, a complex sentence construction is distributed across three turns (two by B and one by A).

Example 2, subfragment (i):

B: But that's, you know, with what's his name?
A: Eehm. Yes, Farrell
B: Colin, Farrell. Colin Farrell.
A: Precisely.

Example 2, subfragment (ii):

B: you have to have
A: yeah
B: a partner
A: otherwise you're transformed to an animal that is unleashed into the wild

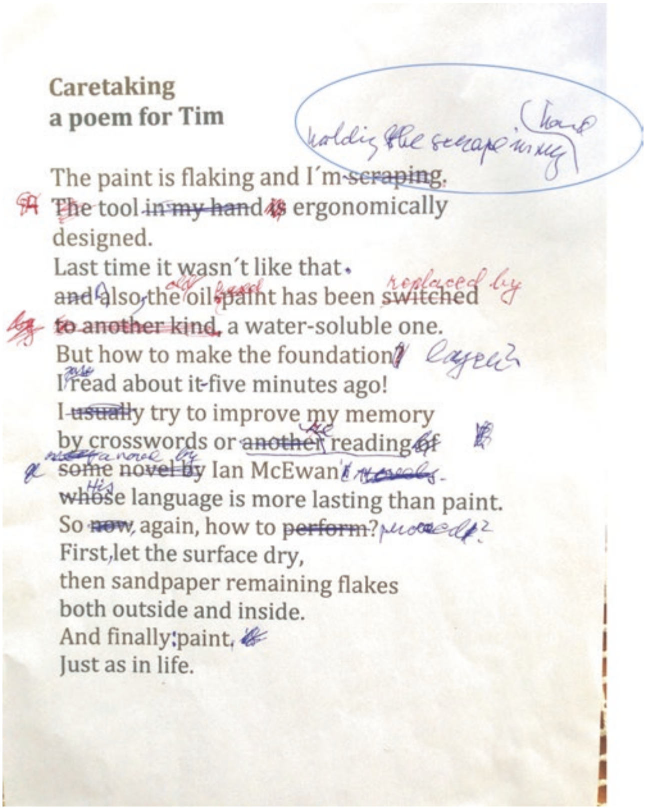
The sequence in subfragment (i) furthermore illustrates what ethnomethodologists would typically categorize as a "repair" or "error correction" (Jefferson, 1974; Jefferson et al., 1977). In this kind of analysis B's presumed failure to access the proper name Farrell is conceptualized as an error, which is corrected or repaired by A in that he supplies the name searched for. In contrast to the writing activity in Example 1b, where the writer has to monitor and repair his output on his own – necessarily a so-called "self-repair" – speaker B in 2 (i) has shared his external representation with his co-conversationalist A, who, by processing B's representation, is in a position to perform an "other-repair". Indeed, Jefferson (1974) describes error correction as an interactional resource. The other-repair is a special case of cooperation and it strengthens the nature of the emerging discourse as a joint accomplishment for which A and B are co-responsible.

The above analysis highlights the social organization of the dialogical speech production process. But is the subfragment (i) we just reviewed really best described as a repair or correction? There is nothing previously intact that has been broken. Rather, we are simply dealing with a situation where the discourse content is being further modified, completed or extended – as a result of a production process which is distributed over two speakers.

2.3 A poem

The last example is a piece of poetry by a Swedish amateur poet. It was written in honour of an English-speaking friend. The manuscript displayed in Example 3 is the penultimate version of the poem, revised after breakfast on the second day of writing. I was generously invited to follow the writing process closely for two full days, being able to interview the poet about his successive modifications and revisions of the manuscript as they took place in real time. This methodology offers valuable insights into the ramifications and reasoning behind the writer's different choices as the poem emerges. See Martin (2015) for a groundbreaking example of how this method can be practiced.

The poet first drafted a version on his computer and printed it. He then proceeded to work with the print, using first a red and then a blue ballpoint pen to delete and add words and phrases during some first epochs of revision. He told me that this practice – first typing and then handwriting – was a habit he had developed and grown comfortable with. In the evening he let go of the manuscript and did not touch it until the next morning.



Caretaking
a poem for Tim

holding the scraping

The paint is flaking and I´m ~~scraping~~.
~~The~~ tool ~~in my hand~~ ~~is~~ ergonomically
designed.
Last time it wasn´t like that.
~~and~~ also the oil ~~paint~~ has been ~~switched~~ replaced by
~~to another kind~~, a water-soluble one.
But how to make the foundation? layer?
I read about it five minutes ago!
I ~~usually~~ try to improve my memory
by crosswords or ~~another~~ reading ~~of~~
a novel by ~~some novel by~~ Ian McEwan's ~~novels~~.
His ~~whose~~ language is more lasting than paint.
So ~~now~~, again, how to ~~perform~~?
First, let the surface dry,
then sandpaper remaining flakes
both outside and inside.
And finally: paint,
Just as in life.

Example 3 A poem: paenultimate version

When he resumed his work after breakfast, he read through his text and made the change which is marked with a circle in Example 3: substituting “I’m scraping” with “I’m holding the scrape in my hand”. He explained to me that the poem is superficially about scraping and repainting a house, but the deeper layer is about existential choices. “I’m holding the scrape in my hand” (instead of “I’m scraping”) therefore makes a deeper impact. The subject is empowered: he is holding his destiny (the scrape) in his own hands. Also, the last line (“Just as in life”) grows even more powerful as the first and last line are brought into a tighter interdependence, they reinforce each other, which strengthens the whole poem.

In conclusion, the history behind the manuscript in Example 3 testifies to a far more elaborate interaction between the writer and his external representation than we observed in any of the previous examples. The careful switching from typing to handwriting is one aspect of this process but perhaps the most important aspect is time. When revisiting his manuscript on the next day the writer came to think of a new and more succinct formulation. The quality of the new formulation derives to a large extent from how it relates to the poem as a whole and to the last line in particular – relations that were not present in the writer’s mind when the first – and later erased – formulation was born on the previous day.

It is hard to reconstruct in detail how all this happened. The creation of an external representation can have many different consequences. Writing down an idea can be seen as creating an “external memory” (c.f., e.g., Mueller & Oppenheimer, 2014). By virtue of this external memory, the writer can free working-memory resources and focus on other aspects of the content construction than those immediately encoded in the written external representation; he can always return to his written representation and pick up the thread again. This mechanism was probably at play during the writing of the poem, as well as during the writing of the fragment in Example 1b. Similarly, Suwa and Tversky (1997), studying architecture students making design sketches, found their subjects to refocus on and rethink spatial relations when interacting with their sketches. Once the concrete sketch – the external representation – was there, the students attended to certain spatial relations in the design to a greater extent than before the sketches were actually made. Thus, in both the process of text writing and in the process of drawing design sketches, the creator’s interaction with her/his own external representation had cognitive consequences.

Another mechanism is related to the constructive nature of long-term memory. As time goes by, the inner representation is getting increasingly divorced from the external one. When revisiting and interacting with her/his original external representation, the writer, now finding the external representation not matching her/his idea of what she/he wants to express, may therefore rethink and revise the external representation. Conversely, the writer might find her/himself trapped by the external representation and sometimes do better in deleting the external representation so that it doesn’t get in the way of new ideas.

3 Conclusions and Suggestions for Further Research

The four discourse fragments (1a, 1b, 2 and 3) analyzed in the previous section differed substantially in terms of their temporal, social and cognitive organization – differences that are intimately associated with differences in processing during language production. These differences have cognitive consequences and affect content construction on the part of the speaker/writer. We propose that a key element is the external representation and its *affordances* (Gibson, 1969), that is, what the external representation offers the speaker or writer to do.

Speech and writing offer the author different time frames for interacting with her/his external representation. Further, in monological writing and dialogical speech the information externalized by the author travels different pathways to furnish the author with a basis for modifying, re-working or extending his discourse. Producing written discourse is often a long-term process involving revisiting and re-working one's previous discourse material. With time, the author's internal representation tends to get increasingly divorced from his/her external one. Revisiting the earlier draft might then engage the author to resolve the emergent discrepancy by rethinking and revising her/his draft. A different outcome is that the "external memory" in the form of the earlier draft will keep the author trapped, making it difficult to advance the discourse. In contrast, spoken discourse production is typically an extremely fast process where the external representation has a very short duration, making it excessively hard to attend to or reflect on one's own external representation. However, in this case the external representation is not so much the acoustic signal as the way the author's utterance is interpreted and acted upon by her/his co-conversationalist. The co-conversationalist's reactions will be conducive to the author's own furthering of the discourse.

In line with these observations we propose that an appropriate generic term for the production process would be *drafting*. When a speaker produces an utterance or a writer a piece of text, she/he initiates or furthers a draft which typically awaits completion further on in the discourse process. In effect, text-writing can be said typically to be a solitary drafting process where revisiting and reinterpreting one's own previous discourse is essential to developing the text, whereas spoken conversation is typically a joint drafting process where attention to one's co-speaker's reactions is essential to developing the discourse.

In conclusion, a comprehensive model of language production must put the affordances of the external representation in a key position in order better to understand the temporal, social and cognitive organization of language production in speech and writing. The sketch towards a model we put forth in Fig. 1 handles differences between speech and writing not as categorial differences, that is, as differences in parameters or components, but as differences in the relative importance of the components in different production situations, and as differences in terms of the pathways the information travels to furnish the author with a basis for developing or rethinking her/his discourse.

Further, focusing on *drafting* and *affordances of the external representation* can offer systematic comparisons between not only speaking and writing but a much broader range of expressive systems, modalities and media, such as the construction of mathematical proofs, architectural drawings, cardboard modelling, painting, sculpture, composing music and many others. Also, some activities might offer particularly privileged windows on certain aspects of the drafting process, for example, the situation where you get trapped by your external representation. This situation is often instantiated in cross-word puzzle solving. You are convinced that you've found the right word, but it turns out to be wrong. As long as it is still there it hinders the puzzle solver from completing the puzzle. Pilot studies we have conducted indicate that as the erroneous/hindering word is substituted for the right one, the temporal characteristics change dramatically and there is something akin to a burst in puzzle-solving activity.

The broadening of the range of expressive systems for the comparative study of drafting is conducive to several questions for further research. How do the creating agents (authors) interact with their external representations? Is there a critical trade-off point beyond which it is too costly to make major revisions of the external representation? Where in the process is that point located, depending on type of representation? According to which criteria do the agents determine that the drafting process should terminate? For example, a candidate criterion in spoken communication is when common ground (Clark, 2006) is reached. In the construction of mathematical proofs, by contrast, the process typically terminates when analytical truth is established. When it comes to art and literary texts, criteria are, perhaps, more complicated and less clear cut. Writing a poem or creating a painting is more of an open-ended problem-solving process. More research is needed to answer these and related questions.

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Too Little Morphology Can Kill You: The Interplay Between Low-Frequency Morpho-Orthographic Rules and High-Frequency Verb Homophones in Spelling Errors

Dominiek Sandra

Abstract Many orthographies represent the morphological structure of words, i.e., keep the spelling of a morpheme constant despite variability in pronunciation (e.g., *cats, dogs*). Experimental work strongly suggests that this structure plays a beneficial role in both visual word recognition and spelling. Readers apparently decompose words into their constituent morphemes for the sake of lexical access. Moreover, early on, spellers rely on a word's morphological structure to derive its spelling (e.g., *picked, called*). However, morphologically complex words can also be a spelling hurdle, more particularly, when different morphological structures yield different spellings (i.e., morpho-orthographic representations) with the same pronunciation, i.e., grammatical homophones. The error risk on these homophones is codetermined by the token frequencies of the homophones, the rule's type frequency, and properties of working-memory. The focus in this chapter is on a salient error type in the spelling of Dutch verb homophones but is extended to other languages as well.

Keywords Homophones · Homophone intrusions · Morphological decomposition · Morphological awareness · Spelling errors · Rule frequency · Homophone dominance · Working memory

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1 The Key Role of the Phonological and Morphological Principles in Alphabetic Orthographies

Since the birth of psycholinguistics, the major focus has been on the recognition of written words and the recognition and production of speech. This is not surprising. Spoken language research involves the primary function of language. In contrast to written language, speech is a naturally evolved human skill. Hence, the study as to which mental processes and structures enable our ability to produce and understand spoken language sheds light on the nature of the mental infrastructure that has evolved to make language possible.

When turning to the written modality, the focus was and still is on written word recognition. This is not surprising either. Although psycholinguistics before the Chomskyan era targeted totally different issues than those during and after that period, their major focus was on recognition processes and their underlying memory structures. Understanding highly automatic mental processes is a scientific challenge for cognitive psychology, and word recognition is such a process.

Because word spelling neither involves the primary function of language (speech) nor is a fully automatic processes, it has escaped the attention of many researchers of language. Another reason may be the difficulties that are involved in studying production processes. Measuring word recognition processes, like the accuracy in the recognition of briefly flashed words on a tachistoscope or reaction speed in a lexical-decision task, is easier than the study of spelling processes.

The present paper sets out from the conviction that some issues in writing do provide insight into the interface between language and cognition, in this case, word spelling (e.g., Sandra & Fayol, 2011). As Bar-On and Kuperman (2019) write: “the ‘weak spots’ of a language where spelling errors are abundant can expose specific mechanisms of word learning and processing” (p. 1121, see also Protopapas et al., 2013). The focus will be on one of those weak spots in the spelling of a particular language: homophonous verb forms in Dutch that are formed by regular inflectional rules of the concatenative type. However, it will become clear that the same problems emerge in several alphabetic orthographies. Hence, these spelling problems point to language-independent cognitive components in spelling.

The Dutch orthography is an alphabetic system. Its basic principle is “spell what you hear”, i.e., the basis of all alphabetic orthographies. However, this phonological principle is not applied across the board. The second foundation of this spelling system is a morphological principle, which means that the spelling of a morpheme remains constant across all words or word forms in which it occurs. There would be no need for the latter principle if it did not clash from time to time with the phonological principle. In such cases, it overrides this basic principle. For instance, even though a [t] is heard in the Dutch word for dog, i.e., *hond,* [hɔnt], it is spelled with <d> because the [d]-sound that can be heard in the plural [hɔndən] is devoiced in word-final position. This dual encoding of linguistic structure in the orthography is not restricted to Dutch. It occurs in many languages, English and French only being two other examples. For instance, the past tense suffix in *picked, called, ended* is pronounced differently but is consistently spelled as <ed>. An example from French is the case of silent letters. For instance, the final letter of *galop* ('gallop') is <p>, although it is not pronounced – [galo] – because a [p] is heard in *galoper* [galope] ('to gallop').

Both the phonological and the morphological principles confront young children with cognitive hurdles when learning to read and spell. Phonemes are the most abstract building blocks of spoken words. This explains why alphabetic writing systems were the last to emerge in the history of writing (Britannica, 2021). It also makes them the least accessible phonological units, which is why phoneme awareness develops later than all other phonological awareness skills (Anthony & Francis, 2005). Children find it hard to identify the sounds in, for instance, *cat.* This is counterintuitive for fluent readers, but we can re-experience the difficulty of this deceptively simple segmentation task when attempting to segment a word in a typologically different language: in our perception, the word's sounds blend into a seamless sound stream. Learning to read and write changes the children's perception of spoken words (Morais & Kolinsky, 2002), as they no longer hear an impenetrable sound stream but the individual sounds. The consensus in the literature is that phoneme awareness is a two-way street: a precursor of this skill that exists before literacy acquisition facilitates the phonological recoding of written words, which in turn enhances phoneme awareness. This results in a self-reinforcing, interactive process of word decoding (Share's self-teaching hypothesis Share, 1995), which eventually yields fluent technical readers and spellers.

When the orthography of a language is also governed by a morphological principle, children face another challenge. They must learn when this principle overrides the basic phonological principle of their orthography. As the review below will show, this requires a form of metalinguistic awareness that takes time to develop. Moreover, it may result in written word forms where the conflict between the two principles leads to persistent spelling problems. This will be the central theme of this text. However, let's first have a look at the good news.

The morphological principle recurs in the orthography of ~~so~~ many languages. This makes it likely that there is a reason why preserving morphemes' spellings takes precedence over representing a word's sounds. The most plausible explanation that comes to mind is that a constant spelling of the basic meaning-carrying units[1] of words facilitates word recognition and makes it easier to spell morphologically related words. It seems easier to recognize a word like *musician* (derived from *music*) than, for instance, *musishian,* the French word *galop* ('gallop', derived from *galoper*) than *galo* or *galeau,* or the Dutch word *hond* ('dog', singular of *honden*) than *hont.* Similarly, the use of a morphological relationship may facilitate the spelling of a word. For different languages, the people who were involved in designing spelling rules must have followed the same rationale: the principle "spell the same what means the same" is beneficial for readers and/or spellers. This makes sense as

[1] Note that I also refer to inflectional affixes, which have a very abstract meaning (e.g., 3r person singular past tense), i.e. their grammatical function.

the purpose of language is to communicate meaning. It is almost self-evident to express basic meaning units by giving them the same orthographic representation. However, if the orthographic representation of morphological structure indeed facilitates written word recognition and word spelling, how could it ever be harmful? This question seems to undermine the goal of my paper from the start. Why put something in the spotlight that seems impossible when following the above line of reasoning?

Before embarking on my endeavor, I must first present evidence from the literature that what seems logical is indeed true, i.e., that the morphological structure of written words is useful for visual word recognition and word spelling. Before doing so, a short note on the scope of this paper is in order. The literature on the role of morphemes in reading and, to a lesser extent, in spelling, is massive. It is an impossible task to write a solid review in a single chapter. In view of my goal to discuss the harm that morphological spelling rules may cause, i.e., regular Dutch verb homophones, I will restrict myself to inflected word forms and only refer to derived words when it is unavoidable.

Note that inflection is the territory where one would expect the largest benefits of morphological spelling rules. Inflectional affixes are a means for generating grammatical variants of a single word – plurals (*cats*), verb forms (*works, worked, working*), different grammatical cases (nominative, accusative, etc.). Being grammatical variants of a word, these forms result from mechanistic affixing operations (e.g. add *-s, -ed, -ing*). This is the case in Germanic and Romanic languages but also in a typologically different language like Hebrew (e.g., Ravid, 2001). This makes these word forms fully predictable (ignoring irregulars), both at the level of form and meaning. In contrast, derivational affixes are used to create new words. Neither their existence (e.g., *deep-depth* but not *steep-stepth*) nor their meaning (*revolve-revolution*) is predictable.

In Sect. 2, I will address some major findings on the role of morphology in visual word recognition. This is where I will also discuss experiments with derived words, as these have been the popular word type in this line of research. However, as will become clear, it is plausible that the insights into the processing of derived words, almost by implication, generalize to regularly inflected word forms. In Sect. 3, I will discuss the evidence bearing on the role of morphemes in spelling. Taken together, Sects. 2 and 3 will reveal the beneficial nature of morphological structure in written words. Finally, in Sect. 4, I will present evidence, essentially from spelling errors on Dutch verb forms but also from identical phenomena in other languages, that morphological structure can be harmful too. In Dutch, the facts show that even analytically transparent morphological spelling rules remain a difficult hurdle when it comes to their application, even for the best spellers. They are harmful because they do not fit the basic cognitive principles of the language user. That is why the study of word spelling can shed light on the interface between language and cognition.

2 The Role of Morphological Structure in Visual Word Recognition

The interest in morphology in psycholinguistics emerged in the mid-seventies of the last century. Murrell and Morton (1974) demonstrated that a short period of word memorization improved participants' recognition of a briefly flashed word when it was morphologically related to one of the words on the study list (e.g., *cars-car*). No facilitation was found when the word shared the same letter sequence but was morphologically unrelated (*card-car*). Their conclusion that the lexical representation of a morpheme is accessed in word recognition was supported by the results in Taft and Forster's (1975) seminal paper on the visual recognition of derived words. In their model, the morphemic representation of the stem provides access to the central lexicon, where the lexical representation of the derived word is stored. Hence, both the stem and the whole word are accessed.

Note that, from a linguistic perspective, it would have been strange if derived words did not have their own representation in the mental lexicon, as it is often impossible to infer a derived word's meaning from the meanings of the stem and the affix(es) (e.g., *revolution, revolver,* which are both etymologically related to *revolve*). Linguists would be more surprised to learn that the stem, which often cannot be used to compute the meaning of the derived word, is nonetheless automatically accessed. However, upon closer inspection, such a semantic perspective cannot support hypotheses on orthographic processing, as the early stages of lexical processing are unlikely to be affected by higher-level information about word meaning.

Stem access also occurs for regularly inflected word forms (e.g., *finds*). Later experiments by Taft (1979) demonstrated an effect of stem frequency for regularly inflected word forms matched on the frequency of the whole form (e.g., *sized* vs. *raked*). However, for my later arguments, Taft's most important finding was that high-frequency inflected word forms were recognized faster than low-frequency ones matched on stem frequency (e.g., *things* vs. *worlds*). This indicates that even regularly inflected forms are stored in the mental lexicon. As will become clear, this finding will support my claims in Sect. 4, as it will help explain why a particular type of morphologically complex words can be harmful in spelling. Again, linguists would not be surprised by Taft's finding that regularly inflected word forms are morphologically decomposed, as these forms result from the mechanistic application of affixation rules. However, they would be surprised to learn that the full forms are stored as well, as the meaning of these forms can be computed on the fly.

Using the technique of frequency manipulation, Baayen et al. (1997) reported similar findings for the singular form of Dutch nouns. Lexical decision times to the singular were determined by the summed frequency of both the singular and the plural, which consisted of the stem and the plural suffix *-en.* This finding, too, indicates that a regularly inflected form is decomposed into its stem and suffix, which increases the frequency of the stem representation. The frequency of the plural itself also determined response speed, which supports the existence of separate lexical representations for these fully regular inflected forms as well.[2]

Using a different technique, i.e., morphological priming, Stanners et al. (1979), also concluded that inflected forms are morphologically decomposed in the process of lexical access. When priming the stem with an inflected form (*pours-pour, burned-burn, lifting-lift*), using an average of 10 intervening items between prime and target, they obtained equally strong priming effects as for identity priming (e.g., *pour-pour*). Several subsequent experiments confirmed full priming of regularly inflected forms on their stem (Fowler et al., 1985; Napps, 1989; Sonnenstuhl et al., 1999). These findings support the idea of prelexical morphological decomposition, which results in access to the stem representation. This type of experimental design makes it impossible to decide whether these items also have full-form representations. To do that, the inflected form should have been the target. Smaller priming of, for instance, *pour-pours* compared to *pours-pours* would suggest the existence of a full-form representation.

Despite the popularity of the priming paradigm, researchers started to question its validity for the study of lexical processing and representation. A clever experiment by Oliphant (1983) highlighted this. In a classical priming experiment, he found the typical facilitation effect for identical word repetition. However, when the repeated words appeared as primes in the instructions for the experiment, which had to be read aloud, he found no repetition effect. He concluded that effects in this paradigm depend on participants' conscious access to the primes and, hence, do not shed light on unconscious processes in the automatic process of lexical access. In their seminal paper Forster and Davis (1984) doubted the validity of visible primes as well, even on theoretical grounds. They argued that it is hard to explain why low-frequency words show stronger facilitation from identity priming than high-frequency words. This would mean that the repetition of low-frequency words would soon wipe out the typical frequency effect in word recognition experiments. However, this is at odds with the fact that frequency is a robust predictor of word recognition times. Hence, something had to be wrong with the priming paradigm itself. The authors convincingly demonstrated that the effects from visible primes are plagued by episodic memory effects and hence are problematic for the study of the mental lexicon. Episodic memory contains the memory traces for specific events we have experienced. For instance, our recollection that we saw a word or a related word on a screen a short time ago and that we made a certain response. Forster and Davis argued that the visible prime not only contacted a memory trace in the mental lexicon but also left an episodic memory trace, which was apparently more salient for high-frequency than for low-frequency words. In a series of experiments, they demonstrated that presenting the primes immediately before the target, but so briefly

[2] In contrast to Taft (1979) these authors did not find evidence for full-form representations of regular verb forms ending in *-en.* Baayen et al. do not offer a conclusive explanation and emphasize the homographic nature of the Dutch

suffix *-en,* which is used to mark the plural of verbs and nouns (and considerably more often for verbs).

(i.e., 60 ms)[3] that participants could not identify them, resulted in equally strong priming effects for high-frequency and low-frequency words. They concluded that a masked prime does not leave an episodic memory trace and can only initiate a lexical access process. Whatever the word's frequency, the prime offers the same head-start in lexical processing. They ruled out other explanations for their findings and concluded that the masked priming effect was purely lexical. Their paper demonstrated that masked priming is a powerful technique for the study of the lexical access process.

The masked priming technique revived interest in prelexical morphological decomposition. A crucial paper was published by Longtin et al. (2003), who reported equal facilitation on response times when visual targets were primed by masked transparent derivations (*gaufrette-gauffre,* 'wafer'-'waffle'), opaque derivations (*fauvette-fauve,* 'warbler'-'wildcat'), or pseudo- derivations (*baguette-bague,* 'little stick'-'ring'). They found inhibition when the prime was the concatenation of a stem spelling and a letter sequence that did not match a suffix (*abricot-abri, 'apricot'-'shelter'*). Importantly, pseudo-derivations were not derivations at all but words with a so-called surface morphological structure: a concatenation of the orthographic sequences of a stem and a suffix in a monomorphemic word. The authors interpreted their data as evidence for a prelexical process of blind morphological decomposition, which only operates when the orthographic string is the concatenation of a potential stem and a potential suffix. This process is blind to the true morphological status of the segmented parts, and as a prelexical process, by definition, can have no access to information about form-meaning units. As the ending *cot* in *abricot* does not match the spelling of a French suffix, the process does not segment the letter string into *abri* + *cot,* so that the lexical representation of *abri* is not primed.

The Longtin et al. paper put Taft and Forster's concept of prelexical morphological decomposition in the spotlight again. Longtin and Meunier (2005) found further support for this process, using masked pseudowords that consisted of a non-existing combination of a stem and suffix. These pseudowords were either interpretable (*rapidifier-rapide,* 'quickify'-'quick') or not (*sportation-sport,* 'sport' + verbal suffix). Their control items were the concatenation of a stem and an existing orthographic word ending that could not be a suffix (e.g., *rapiduit-rapide, 'quick'* + non-suffix). They only obtained facilitation on lexical decision times from pseudowords with a morphological surface structure (potential stem + potential suffix), i.e., from *rapidifier* and *sportation* but not from *rapiduit*.

Rastle et al. (2004) reported evidence from English that confirmed Longtin et al.'s notion of blind prelexical morphological decomposition. In a masked priming paradigm with a lexical decision task, they found equally strong facilitation for pseudo-derivations (*corner-corn*) and semantically transparent derivations (*cleaner-clean*). As in the Longtin et al. study, primes with the same orthographic overlap but with no surface morphological structure (*brothel-broth*) produced no facilitation.

[3] Many experiments that were published later used shorter interstimulus intervals, e.g., 50 ms or sometimes smaller.

Some studies also provided evidence for early semantic effects in the processing of morphologically complex words (Diependaele et al., 2005; Feldman et al., 2015). Note that such findings do not contradict the existence of a bottom-up process of blind morphological decomposition. This process may initially be blindly driven by morpho-orthographic information but quickly interact with partially activated lexical representations through a process of top-down activation.

Closer to our focus on inflected word forms, the masked priming technique was also applied to inflected word forms and has been used in combination with ERP, MEG, and fMRI data. Using 50 ms masked primes in combination with ERP measurements, Royle et al. (2012) found that masked regular past tenses in French facilitate lexical decision times on their stem (e.g., *cassait-casse,* 'broke'-'break'). In contrast, they found null effects for prime-target pairs that were semantically related (synonyms) or only orthographically related (e.g., *cassis-casse,* 'blackcurrant'-'break'). The morphological priming condition also left a unique signature on the ERP data for the morphological pairs: an early morpho-orthographic effect at 250 ms post onset (N250) and a strong effect around 400 ms post onset (N400) in the morphological condition only. However, the problem of morphological processing has not yet been fully unraveled. The title of Leminen et al. (2019) paper – "Morphological processing in the brain: The good (inflection), the bad (derivation) and the ugly (compounding)" – emphasizes our incomplete understanding of morphological processing in visual word recognition. Yet, for inflected word forms, they find a lot of converging evidence in the data from neuroimaging techniques. They conclude that most EEG and MEG studies indicate that regular forms are accessed and decomposed earlier than irregular ones and mobilize different memory systems: procedural versus declarative memory. Furthermore, EEG, MEG and fMRI data suggest a different topographical distribution of the activation patterns triggered by these two types of inflected word forms: the processing of the regular forms involves areas that are typically involved with the procedural memory network.[4]

The literature on visual word recognition suggests an important role of morphology in the processing of morphologically complex words, both for inflected word forms and derived words. The evidence favoring a process of blind prelexical decomposition is quite convincing. Even though the concept originated in the domain of derivational morphology (Taft & Forster, 1975), it is supported by several findings for inflected word forms. For instance, the frequency effects of stems and whole word forms (Taft, 1979; Baayen et al., 1997) and the masked priming effects in the neuroimaging data discussed by Leminen et al. (2019) are compatible with the process of blind morphological decomposition proposed by Longtin and

[4] But see Morris and Stockall (2012), who report equal morphological priming from regular and irregular past tense primes (*sold-sell* vs. *walked-walk*) at the N250 component in an ERP experiment with 50 ms masked primes. A striking result, as past tenses that do not share the orthographic form of their stem have the same effect as those that do. The authors conclude: "For this to be possible, the morphological relationship between 'sold' and 'sell' must be accessible to early stages of form based, pre-semantic processing." (p. 91).

colleagues and Rastle and colleagues. This also makes sense from a theoretical perspective. It would be difficult to defend the existence of blind morphological decomposition for derived words while questioning such a process for inflected forms, as the latter can be generated mechanistically. The question is, of course, ultimately an empirical one – and a strong empirical argument favoring this position is provided by the blind morphological decomposition effects, which are insensitive to the semantic transparency of a derived word (*gaufrette* vs. *fauvette*), the distinction between derived and pseudo-derived words (*gaufrette* vs. *baguette*), and the distinction between existing words and non-existing words like *rapidifier* and *sportation.* If the process is operational whenever the written word has a surface morphological structure, it should also decompose regularly inflected forms.[5] At the same time, several findings indicate that there is also a full-form representation of inflected forms, even though their existence and meaning can be predicted, simply as the result of exposure frequency. Apparently, repeating a regular word form sufficiently often yields a full-form orthographic representation, just as is the case with monomorphemic words.

3 The Role of Morphological Structure in Spelling

3.1 Morphological Relations between Words are Beneficial at an Early Age

If morphological structure matters for word reading, what about word spelling? Do spellers also rely on a word's morphological make-up? There is a lot of evidence that they do, in some cases even from a very early age.

Rebecca Treiman and coworkers demonstrated that many young children soon benefit from a word's morphological structure to spell a word. In American English, the phoneme /t/ is pronounced as the flap [t] in intervocalic position, as in words like *duty* and *dirty.* Treiman et al. (1994) found that children between 5 and 8 years old made fewer errors on words like *dirty,* which are derivations in which a stem is followed by a suffix (*dirt* + *y*) than on matched mono-morphemic words like *duty,* which offer no such help. Young children seem to be able to rely on their morphological awareness that *dirty* is derived from *dirt* and, for that reason, is spelled with a *t.*

Treiman and Cassar (1996) contrasted inflected words like *tuned* and *faced* (mostly regular past tenses and a few plurals) with matched monomorphemic ones like *brand* and *feast.* Young children often experience problems with the spelling of consonant clusters, often leaving out the first consonant. Cassar and Treiman wondered whether these omissions were caused only by phonological factors (e.g.,

[5] Note that a blind decomposition process that is tuned to the presence of orthographic sequences matching affixes makes no predictions with respect to compounds.

difficulties in perceiving the vowel and a subsequent liquid or nasal as two distinct speech sounds) or also by children's knowledge of the words' morphological structure. They found fewer omission errors of the first consonant in inflected word forms, across several experimental tasks. This result, too, indicates that morphological structure can help even young children to spell correctly (for similar results, see Bourassa and Treiman, 2008).

However, there is a methodological problem with pairs like *brand* vs. *tuned.* The items are matched on their final consonant cluster, but there is a systematic frequency mismatch: the stem of inflected items occurs in several inflected word forms, making it a higher-frequency sequence than the corresponding letter string in the control words. Deacon and Bryant (2006a) remedied this possible contamination by comparing inflected and derived words to monomorphemic controls matched on the stem's orthographic pattern, like *rocked* vs. *rocket.* The items were pronounced in a sentence context, then repeated in isolation, upon which the children had to write the letter sequence preceding the final consonant cluster (which was provided, e.g., *rock* in ___*ed* vs. ___*et*). The 6- to 8-year-old children performed better on the bimorphemic items than on their controls. Apparently, these children had previously noticed the stem in derived words and now used this knowledge to their advantage when having to spell its letter pattern. They could do so in derived words but not in monomorphemic words. Deacon and Bryant (2006b) reported the same outcome for 7- to 9-year-old children: the same letter sequence (e.g., *turn*) was spelled better when it was the stem in a derived word (*turning*) than when it had no morphemic status (*turnip*).

Comparable findings were reported for French. In this language too, young children have been shown to make use of morphological relations in spelling. In French, the final letter of written words is often not pronounced (e.g., *tabac,* [taba], 'tabacco'). Sénéchal (2000) and Sénéchal et al. (2006) compared two sets of words ending in a silent letter: those whose silent letter could be recovered from the pronunciation of derived words, and those that did not allow this (controls). For instance, the *p* in *galop* ([galo], 'gallop') can be recovered from *galoper* ([galope], 'to gallop'), whereas the *c* in *tabac* can only be spelled from memory. The children, who were between 9 and 10 years old (Grade 4), spelled a silent letter more often in the morphological condition, thus demonstrating their ability to rely on morphological relations between words for spelling purposes at an early age.

Pacton et al. (2012) followed the reverse rationale. They used words whose spelling mismatched the spelling that was predicted by this strategy. For instance, the French word *numéro* ('number') should be misspelled as *numérot* if spellers apply a morphological strategy. Indeed, the derived verb *numéroter* ('to assign numbers to'), in which a [t] sound can be heard, suggests that a *t* must be spelled when the root is not followed by a suffix. As predicted, good spellers made overgeneralization errors reflecting the use of such a morphological strategy. Incidentally, note that this is a case where morphology is harmful (see Sect. 4).

Another rationale was used by Casalis et al. (2011). Morphological relationships should help in the spelling of orthographically ambiguous vowels, i.e., vowels with different orthographic realizations across words. For instance, the vowel sound in *lait,* i.e., [ɛ], can be spelled as *ai* (*lait,* 'milk), *è* (*très,* 'very'), *ê* (*fête,* 'party'), or *ei* (*neige,* 'snow'). The authors dictated derived words like *laitage* ('dairy product') and controls like *failaise* ('cliff') in Grade 3 (age: ± 8 years) and Grade 4. The ambiguous vowel was spelled correctly significantly more often in derivations than in controls. This finding converges with the above findings that young children already rely on morphological relationships during spelling.

Pacton and colleagues reported interesting experiments with pseudowords. A potential problem with Deacon and Bryant's study was the presentation of the test items. Presenting the final letters (e.g., ___ed) may have triggered a morphological strategy. Pacton et al. (2013) also matched the frequency of the critical orthographic sequence in derived and control words by presenting 8-year-olds with pseudowords in an orthographic learning paradigm. This method enabled full control over the exposure frequency to the critical letter sequence. The pseudowords were presented in the context of a series of short stories, which children had to read silently. Control items appeared seven times in a story (e.g., *modoit*), whereas the critical items appeared five times as a monomorphemic item (e.g., *vensoit*) and twice with a real French suffix (e.g., *vensoite, vensoitiste*). Grade 3 children benefited from the morphological relationships. Note that the critical items were seen less often (as isolated letter strings) than the control items. Apparently, the morphological relationships overruled this difference in whole-word frequency.

Pacton et al. (2018) used an extra control condition to rule out another interpretation. The effect might be due to the presence of an extra phonological cue for the spelling of the silent letter in the derived words (e.g., *vensoitiste*) and/or the presentation of each critical item in several words (i.e., three). Using the same technique, they compared how well Grade 3 and Grade 5 children learnt the spelling of items like *coirard* in a so-called opaque condition (seven presentations of *croirard*), a morphological condition (five presentations of *croirard* and two derived words: *coirarde* and *coirardage*), and an orthographic control condition (five presentations of *croirard* and two words in which a non-suffix was appended to the pseudoword: *coirardume* and *coirardore*). Even though the morphological and orthographic conditions were matched on the two potentially confounding factors in Pacton et al. (2013), the children in the morphological condition (in both grades) again performed better in a forced-choice task with three alternative spellings (e.g., *coirard, coirars, coirar*).

Another approach was taken by Bar-On and Kuperman (2019) and Gahl and Plag (2019), who looked for patterns in spelling errors. Their studies bring us closer to home, as they adopted the same rationale as we did in our studies on 'the Dutch spelling problem': a systematic study of error patterns should shed light on the factors that trigger the errors and determine their nature. Gahl and Plag (2019), like Sandra (2010), emphasize that this is the same methodological approach as the one in studies of speech errors, which were also used as a means for discovering the representations, processes, and temporal dynamics of the production process (e.g., Fromkin, 1971; Garrett, 1975). Bar-On and Kuperman studied the erroneous intrusion of a vowel letter in Hebrew words and found that the majority did not disrupt the word's morphological structure. Gahl and Plag studied errors in the spelling of suffixes like *-able/-ible* (e.g., *acceptible, accessable*) and *-ence/-ance* (e.g., *avoidence, occurrance*), and found that the error risk was determined by the strength of the morphological boundary, i.e., the ease with which the stem could be segmented from the suffix (e.g., due to a high ratio of stem frequency to whole word frequency). Importantly, these spelling errors did not reveal a preference for the higher-frequency suffix (which matches our findings in Dutch, cf. Sandra et al., 1999). The major error determinant was the segmentability of the derived words.

3.2 The Importance of Morphological Awareness

Many researchers who have studied the beneficial impact of morphological relationships on young children's spelling have also addressed the question whether this was caused by (or at least correlated with) their level of morphological awareness. The term 'morphological awareness' is rather vague, as is the term 'phonological awareness' (Uppstad & Tønnessen, 2007). Different researchers operationalize it in different ways. Sometimes, it is measured by asking participants to infer a morphological rule from an example and apply it to another word (e.g., *help-helped, live-?* or *run-runner, teach-?*). Other researchers measure it by asking participants to identify morphemes in words (e.g., *teach* is a part of *teacher*). Despite such differences, several researchers have demonstrated that children who obtain good scores in a morphological awareness task more often make use of morphological relationships in spelling, even when the pronunciation of a morpheme varies across words. This has been found for (a) suffixes whose pronunciation varies as the result of a preceding sound, like the English past tense suffix *-ed* (Nunes et al., 1997a, b), (b) silent word-final letters in French (Sénéchal, 2000; Sénéchal et al., 2006), (c) orthographically ambiguous vowels in the stem of morphologically complex words (Casalis et al., 2011), and (d) the stem of derived words (Deacon & Bryant, 2006b). Casalis et al. (2011) demonstrated that morphological awareness cannot be reduced to phonological awareness but adds a significant and independent contribution to the spelling of morphologically complex words. Interestingly, Deacon and colleagues reported results indicating a positive impact of morphological awareness on spelling in general, i.e., not only on words whose spelling depends on morphological relationships (Deacon & Bryant, 2006b). Perhaps being sensitive to words' morphological structure or being consciously aware of their morphemes implies a general interest in words, which includes morphological relations but is not restricted to it.

Several studies have investigated whether literacy skills are better in schools whose curriculum includes an explicit instructional goal to train children's morphological awareness. Carlisle (2010) reviewed the literature on the relationship between the instruction of morphological awareness and the key components of literacy achievement, i.e., phonological awareness, orthographic development (visual word recognition and spelling), and meaning. She found only seven studies that addressed effects on orthographic development. There are indications that working towards this goal in teaching English improves spelling performance. However, the sample is small and factors like the age of the target group make it difficult to arrive at a firm conclusion. Plausibly, an explicit focus on words' morphological structure must come at the right age. Which age is the right age seems to depend on the morphological complexity of the language. Carlisle emphasizes that all four studies on Chineseconsistently showed that morphological awareness instruction improves both character reading and writing, even at a very early age: from kindergarten to Grade 4.

Research by Ravid and coworkers indicates that morphological awareness is also related to the typology of the language (e.g., Ravid, 2001, 2012; Ravid & Bar-On, 2005, Gillis & Ravid, 2006). Hebrew is a morphologically rich language: all verb forms and most nouns and adjectives consist of a root and a morphological pattern of affixes, the former being a discontinuous sequence of three or four consonants, which is interdigitated with vowels, i.e., the pattern (Ravid, 2001). Children who acquire Hebrew as their native language quickly catch on to spoken words' morphological structure and thus develop the skill of attending to it. They bring these morphological skills to their spelling performance. For instance, Ephratt (1997) found that gradeschoolers who were asked to color three letters of their own choice in a word consistently colored root letters, and Ravid and Bar-On (2005) found stronger priming from genuine roots than from identical pseudo-roots. This heightened root sensitivity makes children considerably better in using morphological cues for spelling neutralized phonological segments compared to children with a morphologically poorer native language, like Dutch (Gillis & Ravid, 2006).

4 When Morphology Hurts

Notwithstanding (a) the observation that young children already attempt to apply morphological relationships when spelling and (b) the reports that morphological awareness improves spelling performance on morphologically related words, one should not conclude that spelling errors on these words always betray a weak morphological awareness. Indeed, sometimes morphology hurts spellers with a high level of morphological awareness. There is evidence that some morphologically complex words cause unexpectedly many spelling errors, even among those with a high level of morphological awareness. Sometimes, the nature of some morpho-orthographic spelling rules does not seem to fit general cognitive principles that are used for spelling, and, consequently, is a source of persistent spelling errors.

In the following paragraphs I will summarize the experimental work that several of my collaborators and I have carried out on what is the greatest stumbling block in written Dutch: the spelling of (some types of) regular verb forms. The phenomenon and its causes in our cognitive infrastructure are fascinating, especially because this problem is not restricted to this language. It surfaces in several orthographies, in different disguises, and thus sheds light on general, i.e., not language-specific, cognitive phenomena. Whether these aspects of our cognition cause spelling problems or not depends entirely on the nature of the spelling rules of the language. A considerable spelling hurdle emerges when there is a clash between the two major spelling principles behind the orthography of an alphabetic language: the phonological and morphological principles. It is a hurdle at which even the best spellers fall from time to time, and this is precisely what makes it interesting for researchers interested in language and cognition. How can that be?

4.1 The Morphological Principle in Dutch: Uniform Stem Spelling and Analogical Suffix Spelling

Table 1 exemplifies the spelling rules for regular verb forms in Dutch. The examples in columns 3–6 highlight their transparency, at least from a descriptive point of view. They show what spellers need to know. Present tense: 1st person singular =

Table 1 The spelling of Dutch verb forms, as a function of the phonological properties of the stem

Grammatical function			Stem-final phoneme		
		no *d/no t*	*d*	*t*	no *d*/no *t* weak prefix
Infinitive		werken	leiden	testen	bedoelen
		wɛrkən	lɛidən	tɛstən	bədulən
		(to work)	(to guide)	(to test)	(to mean)
Present	1st singular	werk	leid	test	bedoel
		wɛrk	lɛit	tɛst	bədul
Present	2nd singular	werkt	leidt	test	bedoelt
		wɛrkt	lɛit	tɛst	bədult
Present	3rd singular	werkt	leidt	test	bedoelt
		wɛrkt	lɛit	tɛst	bədult
Present	plural	werken	leiden	testen	bedoelen
		wɛrkən	lɛidən	tɛstən	bədulən
Past	singular	werkte	leidde	testte	bedoelde
		wɛrktə	lɛidə	tɛstə	bəduldə
Past	plural	werkten	leidden	testten	bedoelden
		wɛrktən	lɛidən	tɛstən	bəduldən
Past Participle		gewerkt	geleid	getest	bedoeld
		ɣəwɛrkt	ɣəlɛit	ɣətɛst	bədult
Imperative		werk	leid	test	bedoel
		wɛrk	lɛit	tɛst	bədul

stem, 2nd and 3rd person singular[6] = stem + <t>, all persons in the plural = infinitive. Past tense: stem + <te > when a voiceless consonant is heard in the infinitive (spelled as *p, t, k, f, s, ch*),[7] otherwise stem + <de>. Past participle: stem + <t> or <d>, depending on the consonant in the past tense suffix. Imperative: stem. There is no more to it.

In more than 90% of the cases (type-wise and token-wise, Sandra & Van Abbenyen, 2009) the suffix that must be spelled can be derived from the verb form's pronunciation, as illustrated by the verb *werken* ('to work) in Table 1. For instance, the final sound in *werkt* is pronounced, like the suffix sound in the English verb form *works.* Similarly, the two sounds of the past tense suffix are pronounced: *werkte*, [wɛrktə], 'worked'. The correspondence between pronunciation and spelling also holds in verb forms whose stem-final phoneme triggers the past tense allomorph [də], spelled <de> (e.g., daalde, [da:ldə], 'descended'). This is also the case, for instance, when the 2nd person singular in the present tense is mentioned before its subject: one does not hear a [t], and, hence, one does not spell <t> (e.g., *werk je,* [wɛrk jə], 'work you' vs. *je werkt,* [jə *wɛrkt*], 'you work).

When using a verb like *werken* as an example, readers who are unfamiliar with Dutch might think that Dutch verb forms are always spelled in accordance with the principle "spell what you hear". However, the above morphology-based description, in terms of stem and suffix, and the verbs *leiden* ('guide'), *testen* ('to test'), and *bedoelen* ('to mean') in Table 1 clearly show that this is not the case. At the stem level, this becomes clear in the spelling of inflected verb forms whose stem ends in the phoneme /d/ (e.g., *ik leid,* 'I guide'). Due to final devoicing a [t] is heard, i.e. [lɛit]. Spellers must recover the infinitive to decide whether they must spell a *t* or a *d:* we spell a *d* in *ik leid* because the infinitive *leiden* is pronounced with a [d], i.e., [lɛidən]. The principle that causes orthographic constancy of the stem implicitly adopts the idea of underlying phonemes: the phoneme /d/ underlies the sound [t] in *leid.* Obviously, it does not matter whether underlying phonemes are ghost entities that have originated in linguists' analytical minds rather than objective facts like those on which theories in physics and biology are founded.[8] Whatever one's take on this matter, the Dutch spelling rules require the stem to have a constant spelling across all verb forms in the inflectional paradigm.[9] This is known as the 'principle of uniformity' in Dutch spelling.

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[6] The 2nd person singular is spelled without a <t> if the verb form precedes the subject.

[7] Language users have no problem in choosing between *-te* and *-de,* as the consonant is the result of an automatic phonological process of progressive assimilation, i.e., the first phoneme of the suffix is voiced/voiceless when the last stem phoneme is voiced/voiceless.

[8] I do not reject this kind of linguistic analysis. However, it is important to remain aware that this analysis has shaped our perception of language and can yield the erroneous belief that this perception matches the reality of language. Rather, this 'received' knowledge reflects a linguistic, hence, analytical, perspective on language.

[9] There are systematic exceptions. The voiced consonants /v/ and /z/ in verbs like *blijven* ('to stay') and *reizen* ('to travel') are not written as *v* and *z* in word-final (devoiced) position, as the morphological principle would require, but as their devoiced counterparts *f* and *s* (e.g., *blijf,* 'stay', *reis,* 'travel'). Despite this inconsistency, spellers make no errors on these verb forms.

The morphological principle also holds at the suffix level. For instance, the 3rd person singular of the present tense of *leiden* is *leidt.* It is pronounced as [lɛit], due to final devoicing of the stem-final consonant, but so is the form *leid.* However, *leidt* is spelled with <t> at the end, the orthographic marker of a suffix, because a [t] sound follows the stem in a form like *maakt,* [ma:kt] ('makes'). Hence, the spelling *leidt* reflects the application of the morphological principle at the stem level and at the suffix level. The principle of preserving the spelling of the suffix also determines the spelling of the past tense. For instance, the past tense of *leiden* is *leidde,* pronounced as [lɛidə] – the double *d* is pronounced as [d] (degemination) – because it is the concatenation of the stem *leid* and the suffix allomorph *-de.* The suffix is spelled as *-de* in analogy with a past tense like *belde,* [bɛldə], 'called', where the sound sequence [də] is heard after the stem. Hence, application of the morphological principle yields the doublet <dd> in past tense forms of verbs whose stem spelling ends in <d>. The same analogical reasoning applies to a past tense form like *testte,* pronounced as [tɛstə] ('tested'): the stem spelling *test* is concatenated with the suffix spelling *-te* because the sound sequence [tə] is heard after the stem in a past tense like *maakte,* [ma:ktə] ('made').[10] Not surprisingly, the morphological principle that governs the spelling of suffixes is known as the 'analogical principle'.

To summarize, the spelling of regular Dutch verb forms is driven by a morphological principle, which comprises two subprinciples: one at the stem level and one at the suffix level. The principle of uniformity stipulates that the spelling of the stem remains constant across all regular verb forms in which it occurs. The principle of analogy stipulates that the spelling of the suffix is spelled in analogy with its spelling in inflected forms with the same grammatical function of verbs whose suffix can be heard. From an analytic perspective, this is all very straightforward and transparent.

4.2 When Phonology and Morphology Clash: The Tragedy of Regular Verb Homophones

Despite this descriptive simplicity, many errors on Dutch verb forms are made. The real problem is the persistence of the errors, as not only beginning spellers make them but experienced spellers as well. One encounters them in newspapers, subtitles, headlines in television journals, exams and papers written by students studying (even language students), and occasionally … their professors. Some people make more of these errors than others (see below) but we should learn a humble lesson from the errors' remarkable tenacity: some morpho-orthographic rules can be simple in description but difficult in practice. This is surprising, as the rules are taught

[10] This analogical principle is not applied if it would yield the doublet <tt> in final position. An inflected form like *testt* is orthographically impossible in Dutch: reduplicated consonants never occur in word-final position. Hence, a general orthographic principle overrules this morphological principle for this subset of verbs. Spellers have no problems with this inconsistency.

at a young age (Grade 4, about age 10) and errors in them are laden with stigma from elementary school to university level. Even in society at large, there is virtually zero tolerance for spelling errors on verb forms. The irony: despite this, everybody makes them, at least occasionally.

The spelling of regular verb forms in Dutch presents us with a paradox: errors on them are persistent even though (a) they are descriptively easy, (b) they are taught at an early age, (c) students are reminded of their importance throughout their school career, and (d) there is a stigma on them in society. Even though many people like to link these errors to a general norm relaxation in society and a tendency to lower the bar in education, such an account cannot explain that a doctoral dissertation with the significant title "The tragedy of the verb forms" (van der Velde, 1956) was published more than 60 years ago. Nor can it explain why highly experienced spellers, like journalists and teachers at all educational levels, cannot avoid making these errors from time to time. Clearly, there must be something about these simple rules that nonetheless makes them difficult. This phenomenon, which is obviously a pain in the neck of language purists, makes it even more interesting for psycholinguists, as a systematic investigation of these errors can shed light on our cognitive infrastructure for spelling. This is what the Dutch story has taught us.

4.2.1 Verb Homophones

This error persistence is also remarkable against the background of children's early sensitivity to morphological awareness (see Sect. 3.1.). The Dutch 'verb tragedy' seems to fly in the face of what is known in the international literature. This literature would predict a difficult learning curve (as for the English past tense, e.g., Nunes et al., 1997a, b) but not the fact that these errors are so persistent that they even survive in texts of highly educated spellers. Clearly, the errors' resistance against prolonged efforts in spelling education and a considerable amount of stigmatization highlights an aspect of our cognitive infrastructure that has remained under the research radar for a long time. This is what makes them so intriguing: whereas problems with morpho-orthographic spelling rules in other languages often (largely) disappear when children grow older (provided they follow a typical literacy development), the errors we studied continue to plague even experienced spellers from time to time.

We started our investigation (Sandra et al., 1999) from a simple observation: these errors cluster around certain verb types. More particularly, they typically occur when the application of the morpho-orthographic rules and the phenomenon of word-final devoicing interact to cause verb homophones. Two verb types yield such grammatical homophones. Verbs whose final stem phoneme is /d/, spelled as *d* as the result of the principle of uniformity, yield homophones in the 1st vs. 2nd and 3rd person singular of the present tense (Type 1). See Table 1, where *leid* and *leidt* are spelled in accordance with the morphological principle (stem uniformity and suffix analogy), but are both pronounced as [lɛit], due to devoicing of stem-final /d/. Second, verbs whose stem-final phoneme is not /d/ and with a so-called weak prefix yield homophones in the 3rd person singular present tense and the past participle (Type 2). For instance, application of the morphological spelling rules to the verb *bedoelen* ('to mean') yields the homophone pair *bedoelt-bedoeld* ('means'-'(has) meant', see Table 1). Final devoicing yields the pronunciation [bədult] for the form ending in <d> as well, thus masking the difference caused by the word forms' morpho-orthographic spelling. As a result, typical verb spelling errors in Dutch are homophone substitutions. At the same time, such errors also occur in verb forms with partial homophones in their inflectional paradigm. For instance, past participles ending in <d>, like *gedroomd* ('(has) dreamed') are partially homophonous with the 3rd person singular present tense (*droomt,* 'dreams'). Spelling errors like *gedroomt,* i.e., a non-existing form, are common (cf. Surkyn et al., 2021, for the cognitive factors behind them). Hence, the first take-home message is that the confrontation between transparent morpho-orthographic rules and homophony creates one of the 'weak spots' in (Dutch) spelling that Bar-On and Kuperman (2019) refer to.

4.2.2 Three Cognitive Factors behind the Dutch Verb Tragedy

Working memory

Our research revealed that these errors are driven by the operation of three factors (Frisson & Sandra, 2002; Sandra et al., 2004, 2010; Sandra et al., 1999; Sandra & Van Abbenyen, 2009; Surkyn et al., 2020, 2021; Verhaert et al., 2016; see also Sandra, 2007, 2018, 2020 for a discussion of the data from a theoretical perspective, but with different accents than here). The first factor is working memory. Sandra et al. (1999) found that an increase in the distance between the verb homophone and the word that determines its spelling (the subject for the present tense, the auxiliary verb for the past participle) increases the error rates. This demonstrates that the application of these rules consumes working memory resources. The determinant of the suffix spelling must be kept in working memory until the verb form is spelled. However, it can be lost by then, as this information fades away as time goes by. Another possibility is that retrieval of the memory trace is still possible but cannot be accomplished in time. Schmitz et al. (2018), in a study of spelling errors on Dutch verb homophones on Twitter, reported the same adjacency effect. They also found that more errors were made in the evening and at night than in the morning and that the error risk was larger in longer tweets. The latter effects suggest that whatever causes a reduction of attentional resources in working memory leads to an increase in the errors.

Homophone dominance

The second factor is the homophones' orthographic representations in long-term memory. In several experiments we found that most errors are due to intrusions of the higher-frequency homophone. This suggests that, when the rules cannot be used (in time) to determine the verb form's spelling in working memory, the higher-frequency homophone is automatically retrieved and spelled. To be sure, this will more often result in the correct spelling than an error, as the higher-frequency spelling is most likely to occur. However, even though 'choosing' the higher-frequency form is a good 'strategy' in a probabilistic domain,[11] it is a bad one in a rule-governed domain, as rules are deterministic by nature. Hence, spellers' tendency to spell the higher-frequency form when running into working memory problems often causes a spelling error. The result is that most errors are made on the lower-frequency homophone. For instance, for verbs with homophones like *leid* and *leidt* (Type 1), most errors are made in the 1st person when the 3rd person spelling is more frequent but in the 3rd person when the spelling of the 1st person has a higher frequency. The same effect occurs for the Type 2 verbs mentioned earlier (e.g., Sandra et al., 1999, see also Assink, 1985). We have dubbed this phenomenon the effect of homophone dominance.

This effect was also demonstrated in cases where the spelling rule for an inflected form is poorly known, as in the case of the Dutch informal imperative. If spellers do not know the spelling rule, there is no point in mobilizing working memory resources. This, then, should be an ideal scenario for the retrieval process and the frequency-dependent intrusion errors that it gives rise to. This was confirmed by the results reported by Sandra (2010). The spelling of the informal imperative for Type 1 verbs matches the stem spelling, i.e., ends in <d>. Significantly more intrusion errors occurred when the verb's <dt> homophone was the higher-frequency one (e.g., *wordt,* 'becomes', for *worden,* 'to become').

The studies mentioned above were controlled experiments, requiring participants to write from dictation under time-pressure. Thus, we taxed their working memory to magnify the effect and to thus guarantee sufficient statistical power for detecting error patterns. However, we recently found evidence for the same effect in an anonymized chat corpus, consisting of more than 400,000 posts voluntarily provided to us by teenagers between 14 and 20 years old (> 2.3 million tokens, comprising 5804 and 2441 verb forms of Types 1 and 2, respectively; Surkyn et al., 2020). This finding is important, as it confirms the experimental data in an everyday writing situation. Interestingly, even though chatters are known not to observe the traditional spelling rules (e.g., *kisssssss, yolo, w8*[12]), they displayed the same effect of homophone dominance for Type 1 and Type 2 verbs. Schmitz et al. (2018) reported the same findings for both verb types in an analysis of Twitter data. Our chat corpus contained many more homophone intrusions (about 30% for both verb types) in comparison to Schmitz et al.'s corpus of tweets (about 7%), a difference that is probably related to differences between these two types of social media. More importantly, despite this difference in overall error rates, the error patterns (effect of homophone frequency) were the same. These error patterns were targeted in Surkyn et al.'s study. An important finding was that the error pattern was not

[11] Obviously, the preference for the higher-frequency form is not a conscious choice but is due to the higher accessibility of its orthographic representation in long-term memory.

[12] yolo: you only live once; w8: wait

affected by significant differences in the error rates of socially defined subgroups (Gender: male/female, Age: younger/older, and Educational Track: general, technical, vocational): the effect of homophone dominance did not interact with the effects of these social variables. This is exactly what is predicted by the model that we derived from all our experimental studies. Working memory acts as an error *trigger,* whereas the frequencies of the orthographic representations of the verb homophones in long-term memory determine the error *pattern.* Social variables, which may affect the knowledge of the spelling rules, their speed of application, or the spelling attitude, may have an impact on the attentional process in working memory – and, hence, affect the number of errors (which was indeed the case for all three social variables) – but not on the automatic process of orthographic retrieval. Hence, the error pattern should be the same.

Sandra and Van Abbenyen (2009) found that the frequency of the higher-frequency homophones was not only determined by the frequency of the verb homophones themselves. The frequency of a homographic homophone of one of the verb spellings co-determined the error-risk. For instance, 1st person singular verb forms like *bloed* ('blood') and *dood* ('kill'), whose spelling (and pronunciation) is also used for a (semantically related) noun and/or adjective, contributed to the orthographic frequency of the <d> spelling, as evidenced by the error pattern.

Interestingly, in a recent study (Surkyn et al., 2021), we found that the effect of frequency is not restricted to the level of full inflected forms but extends to the sub-lexical level. In our study of spelling errors of partially homophonous past participles (e.g., *gedroomt* instead of *gedroomd*, 'dreamed', due to the partial homophony with *droomt,* 'dreams') we found significant effects of two additional frequency variables. First, chatters made fewer errors when the correct <d> spelling received more support from other forms in the verb's inflectional paradigm (e.g., *droomde,* 'dreamed). This measure of <d> support was calculated as the (logarithm of the) ratio of the token frequency of the <d> spelling over the token frequency of the <t> spelling. Second, they made fewer errors when the correct <d> spelling received more support from the token frequency of the bigram straddling the morphological boundary, taking all inflected forms of all verbs into account. This measure of bigram support was calculated as (the logarithm of) the ratio of the token frequency of the bigram ending in <d> (e.g., *md* in *gedroomd, 'dreamed'*) over the token frequency of the bigram ending in *t* (e.g., *mt* in *komt, 'comes'*). These two factors accounted for independent variance in the error data. Importantly, both measures pick up aspects of the morpho-orthographic spelling of Dutch verb forms, as they both reflect the analogy principle in the spelling of Dutch verb forms: at the intra-paradigmatic level and at the inter-paradigmatic level. Interestingly, the morpho-orthographic cause of this relationship between the error risk and the effect of bigram support is highlighted by the fact that the effect is only found when the count is made over verbs but disappears when including nouns and adjectives as well. In keeping with these findings, Sandra (2010) and Sandra and Van Abbenyen (2009) also found evidence of sub-lexical homophonous patterns straddling the morpheme boundary, more particularly, in past tense forms.

Low-frequency spelling rules

The third factor that is responsible for intrusions of verb homophones is the frequency with which the morpho-orthographic rules must be applied. Perhaps, the importance of this factor should have been emphasized more strongly in earlier publications (but see Sandra & Van Abbenyen, 2009). Indeed, this factor amounts to another important frequency effect: rules that are not needed often enough in spelling cannot become automatic in their application. At this point, the distinction between the principle of uniformity and the principle of analogy is crucial. The former does not cause spelling problems in young adolescents. Even in our analysis of verb spelling errors in their chats, we (Surkyn et al., 2020) observed almost no phonetic spellings like *vint* for *vind* (1st person singular from *vinden,* 'to find'), pronounced [vInt]. We attested only 14 such errors on a total of 1665 homophone intrusions with a stem-final <d> (0.84%). If even adolescents do not make such errors on a medium where observing spelling rules is not considered important and medium-specific spellings are often used, we can safely conclude that the principle of uniformity does not pose a challenge. The fact that we observed this in a dataset where about 1 verb homophone out of 3 was misspelled reinforces this conclusion. As mentioned earlier, this is likely due to this principle being applied across the board in Dutch spelling. The phoneme /d/, spelled <d>, must often be recovered from a final [t]-sound, by means of a morphological relationship, in order to spell the singular of many nouns (*land-landen,* 'country'-'countries'), the uninflected form of many adjectives (*goed-goede,* 'good'), and all regularly inflected forms of verbs with a stem-final <d> (*leid,* 'lead', *leidt,* 'leads', 'led', *leidde,* '(has) led', *geleid*). The frequent application of this principle causes a form of overtrained behavior, which enables automatic application.

In contrast, the principle of analogy is used very infrequently. Estimates based on CELEX (Baayen et al., 1995)[13] show that verb homophones must be spelled very seldom. For instance, homophones from verbs with a stem-final <d> have an occurrence frequency of less than 10%, both type-wise and token-wise (Sandra & Van Abbenyen, 2009). Especially the low type frequency (5%) means that the paucity of homophones from different verbs in everyday writing situations makes it almost impossible for spellers to form a solid representation of the analogical spelling rules, whether it be in the form of an abstract rule or a population of sufficiently frequent exemplars. Cognitive scientists are not surprised when a principle whose use is so limited does not lead to automatic application. This explains why an attentional process in working memory is required, which fails whenever this memory system runs out of resources. In our speeded dictation tasks, this was due to a combination of the time-pressure and (in one condition in Sandra et al., 1999) the distance between the verb homophone and the word that determines its suffix spelling (the latter always preceded the homophone). However, this finding can probably be

[13] CELEX was used instead of SUBTLEX-NL (Keuleers et al., 2010) because only the former contains information on a verb form's grammatical function (e.g., 1st person singular present tense).

generalized to any factor that depletes working memory resources. In everyday writing situations, this can obviously also be time-pressure and the distance between the two grammatically related words, but it can also be an overload of working memory as the result of the complexity of the writing process itself. Indeed, the latter involves a focus on the meaning of the text, its cohesion and structure, the formulation of the sentence, lexical choices, and the spelling of the selected words.

The interplay of three cognitive factors

The conclusion emanating from this research is that morpho-orthographic rules can cause considerable problems. The frequency with which a morpho-orthographic rule is needed for spelling is a major determinant of spelling success. This fits in with our knowledge about the importance of frequency in cognition, both in language processing and in other domains. This explains why the principle of uniformity, i.e., stem constancy, causes no spelling problems in Dutch. It leaves its stamp on so many word spellings – across word classes, i.e., nouns, adjectives, and verbs – that it can be swiftly applied to the morpho-orthographic spelling of the stem (i.e., <d> in stem-final position, as in *leid* or the inflected form *leidt*). Very strong evidence in favor of this is the finding that even teenagers do not spell such stems phonetically in their chat messages (see above).

In contrast, the principle of analogy, which is almost exclusively applied in the spelling of verb homophones, is needed so infrequently that even experienced spellers do not seem able to automate it. The resulting need to allocate the analogical rules attentional resources creates an error risk, especially when some factor taxes the speller's working memory resources: time-pressure, words separating the subject and the verb homophone, a division of attention over several aspects of writing, etc. When this happens, spellers apparently do what they are used to doing in other domains: they have recourse to the highest-frequency event. This is another frequency effect, but this time at the item-specific level. As mentioned earlier, spellers' preference for the higher-frequency form is not a conscious decision. As in many other domains, their behavior is unconsciously steered by what they have encountered or done most often. In the absence of the ability to apply the rule in time, they unknowingly rely on the distribution of the homophone's orthographic forms they have been exposed to, a result of implicit statistical learning.

In short, two frequency factors dominate the scene: rule frequency and item frequency. In the absence of sufficiently frequent rule application, even experienced spellers fail to apply the rule when their working memory resources are depleted, and then spell the most frequent item. The balance between rule frequency and item frequency determines spelling success.

4.2.3 Converging Evidence from Different Alphabetic Orthographies

The French connection

Very similar findings were reported in French by Largy et al. (1996, see also Fayol et al., 1994). Despite some differences between their study and ours, there is a remarkably strong convergence between the observations in Dutch and French. Largy et al.'s participants had to write down sentences that had just been read and simultaneously recall a list of five words or count the number of clicks they heard during dictation. The use of a concurrent task (dual-task paradigm) was meant to create cognitive overload in working memory. In their critical sentences, like *Les chimistes prennent des liquides. Ils les filtrent* ('The chemiste take liquids. They filter them.'), Largy et al. found homophone intrusions like *filtres,* which is the plural form of the noun *filtre* rather than the plural verb form (*filtrent,* 'filter'). As in our experiments in Dutch, the errors were characterized by a frequency effect: more intrusions were made when the noun homophone was more frequent than the verb homophone. Note that the intruder and the target word belonged to different grammatical classes.[14] Apparently, when working memory is overloaded, the 'pressure' from the higher-frequency homophone can be so strong that the homophonic intruder is not only an error from the perspective of the grammatical context (like the errors we studied) but also from the perspective of the target word's grammatical category.

Although the commonalities are striking, there are a few differences between our studies and Largy et al.'s study. An important difference concerns the occurrence of the errors in everyday writing situations. Whereas the homophone intrusions in Dutch are a persistent and notorious error, Largy et al. remark that their homophone intrusions seldom occur outside the laboratory. They must be experimentally induced by creating a considerable overload in participants' working memory. A second difference concerns the trigger of the errors. Whereas the errors in Dutch and French were both triggered by working memory overload, those in French were likely induced by the presence of another grammatical homophone in the sentence. The French direct object *les* ('them') before the critical verb is homographic and homophonic with the French plural form of the definite article. This may have created a noun bias that facilitated the retrieval of a higher-frequency noun homophone. Finally, Largy et al. studied verb-noun homophones, whereas we studied homophones of the same verb. Differences in the occurrence frequencies of the French and Dutch errors in ordinary writing situations – very rare (Largy et al.) vs. relatively common – are related to all these discrepancies.

The commonalities between the studies are more important. They emphasize that the Dutch findings are not restricted to the specific orthography of one language. Rather, the converging cross-linguistic data show that descriptively simple morpho-orthographic spelling rules can cause spelling errors when working memory is sufficiently overloaded. This opens the door for the intrusion of the wrong grammatical homophone, which is most likely to be the higher-frequency spelling.

Our findings that homophone intrusions in Dutch are not restricted to word forms but extend to the sublexical level (Sandra & Van Abbenyen, 2009; Surkyn et al., 2021) are also supported by research in French. Pacton and Fayol (2003) found that

[14] As mentioned earlier, the effect of homophone dominance in Dutch is co-determined by the frequency of homographic noun and adjective homophones (Sandra & Van Abbenyen, 2009).

children who were tested in Grade 3 (~8 years old) and Grade 5 (~11 years old) are biased to spell the homophonic word-final phoneme /ã/ as *ent,* which is the most frequent spelling pattern for this pronunciation. As this homophone is written as *ent* in adverbs, as part of the adverbial suffix *-ment* (e.g., *calmement*, 'calm') and *ant* in past participles (*regardant,* 'watching'), most homophone intrusions occur in past participles. Importantly, Grade 3 children made these errors on word forms with a high and low frequency, whereas Grade 5 children continued to make them on low-frequency forms. The latter finding is important: if Grade 5 children's spelling were only determined by rule application, form frequency would have no effect.

The findings reported by Pacton et al. (2005) further emphasize the importance of sublexical homophony. The French sound [o] can have different spellings across words (e.g., *piano,* 'piano'; *manteau,* 'coat'; *escargot,* 'snail'), as can the sound [ɛt] (e.g., *planète,* 'planet'; *défaite,* 'defeat'; *assiette,* 'plate'; *conquête,* 'conquest'). Both sound patterns also correspond to the spelling of the masculine and feminine diminutive suffixes, respectively: *-eau* (*éléphanteau,* 'baby elephant') and *-ette* (*fillette,* 'little girl'). The authors found that children in Grades 2, 3, and 5, but also adult spellers, more often chose the latter spelling sequences when the preceding context triggered the diminutive ('a little /vitar/ is a /vitaro/'). However, the probability that they do so was determined by their familiarity with the orthographic pattern straddling the morpheme boundary. For instance, they made more errors when they had to spell pseudowords like [vitafo] and [sorivet] than [vitaro] and [soritet] because the letter patterns *feau* and *vette* occur less often than *reau* and *tette* (see Sandra, 2010; Surkyn et al., 2021, for similar effects of cross-morphemic letter patterns).

Take-home message from the Dutch and French data

The convergence of the Dutch and French data, shows that children, but also adults, do not simply apply even simple morpho-graphic rules but are sensitive to the frequency of all kinds of orthographic patterns in words: at the level of full forms but also at the sublexical level, even when the pattern crosses a morpheme boundary. Clearly, the written input results in the emergence of varying associative strengths between a particular pronunciation and its possible spellings, apparently with complete disregard for grammatical information. These associations and their occurrence frequency are stored, whether it be in the form of multiple mappings between a pronunciation and several spellings or a cluster of exemplars. Obviously, this also occurs when such storage can have counterproductive effects on spelling. Upon reflection, this is what one should expect, as our brain cannot 'know' during learning whether an association between pronunciation and spelling will turn out to be helpful or harmful. Instead, it diligently stores what it is exposed to and excels in keeping track of recurring associations, i.e., patterns in the input. Such statistical learning naturally yields orthographic representations of the inflected forms of regular grammatical homophones, even though these are superfluous from a linguistic perspective, and representations of regularities (in contrast to rules) in the mappings between a single pronunciation and multiple possible spellings. Spellers' frequency-sensitive access to this stored information is the source of many grammatical homophone intrusions.

More cross-linguistic convergence

Not unexpectedly, problems with morpho-orthographic spelling rules also turn up in other languages (see Bryant et al., 1999). In English, it takes children time to learn that the regular past tense ending is always spelled as *ed,* despite variations in its pronunciation (*stopped, killed, started*). However, English regular past tenses do not give rise to grammatical homophones. In contrast, the English genitive does (e.g., *the boys have a book* vs. *the boys' book* vs. *the boy's book,*). Bryant et al. (1997) observed that British children between the ages of 9 and 11 still have problems spelling the silent apostrophe. Interestingly, this spelling problem seems quite persistent as well, as evidenced by the authors' remark that "[t]he apostrophe has become a kind of cultural shibboleth: educated people, it is typically assumed, use it well and uneducated people do not. In some circumstances, such as applying for a job or even writing an examination essay, the misuse of apostrophes can be a serious disadvantage." This could be a description of the stigma that rests on spelling errors on regular Dutch verb homophones.

Similar problems occur in Greek. Chliounaki and Bryant (2003) point out that children encounter the same problems with morpho-orthographic spelling rules in a shallow orthography (Greek) as in a deep one (English). This indicates that learning to apply these rules represents a serious cognitive hurdle in many orthographies (but see below for the impact of typological differences). The title of their paper captures this important message: "Different morphemes, same spelling problems: Cross-linguistic developmental studies." Protopapas et al. (2013) arrive at the same conclusion and observe that "difficulties in spelling [Greek] inflectional suffixes, […] persist *through a long period of morphological development,* whereas lexical idiosyncrasies determining word root spellings seem to be mastered more readily" (p. 640, my emphasis).

In Danish, children wrestle with the same problem (Juul & Elbro, 2004). One such problem is reminiscent of the effect of homophone dominance that is so persistent in Dutch. The infinitive and present tense forms of Danish verbs with a stem-final /r/ are grammatical homophones with differently spelled suffixes (*e* vs. *er,* respectively). As in Dutch, this situation causes considerable spelling problems.

4.3 Spelling Errors Affect the Quality of Correct Orthographic Representations

In our accounts of the persistence of spelling errors on regular Dutch verb homophones, we have focused on the role of working memory, rule frequency and relative homophone frequency. Interestingly, recent research suggests the role of yet another frequency factor: the relative frequencies of correct and incorrect spellings of a word. The findings reported by Rahmanian and Kuperman (2019), in the context of reading experiments, support the idea that being exposed to incorrect homophone spellings (e.g., *inocent, comit, begining*) leads to the storage of these incorrect orthographic representations as well. The authors observed that a larger proportion of incorrect spellings in the input caused longer eye fixation times in sentence reading and longer lexical decision times in isolated word recognition. They interpreted their results in terms of Perfetti's (2007) Lexical Quality Hypothesis: stable lexical representations have consistent associations between their orthographic, phonological, and semantic aspects. Misspellings cause unstable representations because each spelling error reduces the frequency of the correct spelling and because an alternative (homophonic) spelling form is stored. The latter acts as a competitor during word reading (and, quite likely, also word spelling). This view fits in with our above description of the brain as an excellent bookkeeper of the information it is exposed to.

Rahmanian and Kuperman's findings support our studies in Dutch. Before discussing this point, it is important to mention a few differences between their study and ours. As mentioned, these authors did not address spelling performance but the impact of spelling errors on word reading. Moreover, they focused on words whose spelling must be memorized whereas we studied rule-governed (inflected) word forms. Finally, their spelling errors were pseudo-homophones, i.e., spellings that do not exist in English (*inocent*), whereas we focused on spelling errors that were existing homophones. Despite these differences, their findings are directly relevant for an account of our results. Even though the Dutch grammatical homophones for the Type 1 and Type 2 verbs mentioned above are both existing spelling forms, misspellings that are triggered by the higher-frequency homophone disturb the frequency relationship between the two spelling forms and further increase the frequency imbalance.

Interestingly, we found evidence supporting Rahmanian and Kuperman's claim in a recent study on partially homophonic verb forms in chat messages (Surkyn et al., 2021). The verb forms were past participles like *gedroomd* ('dreamed'), which are homophonous with the 3rd person singular of the present tense (*droomt,* 'dreams'). A striking observation was the exceptionally high error rate on the form *gezegd* ('(has) said'), which was misspelled as the non-existing form *gezegt* (containing *zegt,* 'says') in more than 25% of its occurrences (well above the average of 11%). We suggested that the frequent occurrence of this spelling error, for a verb form that itself occurs very frequently in chat messages, causes the development of a competitor orthographic representation. This fits in with Rahmanian and Kuperman's claim that sufficient exposure frequency to an incorrect, non-existent (homophonic) spelling feeds a process of implicit learning of this incorrect spelling, which results in an unstable lexical representation. As Gahl and Plag (2019) remark, my paper on sublexical homophone intrusions also suggested the possibility of incorrect orthographic learning: "It might be argued that the incorrect orthographic representations are also stored in the mental lexicon" (Sandra, 2010, p. 425). Given a chat context, the more a given spelling error is used by other chatters – through a process of accommodation, doubt, or yet another factor – the stronger the competition from this rival spelling will become. It is unclear whether learning incorrect spellings is a medium-specific phenomenon, affects some spellers more than others, and can be avoided (by some types of spellers) in more formal writing contexts. The issue of the medium-specific learning of incorrect spelling forms is a promising avenue for future research.

Here, too, the above remark applies that the brain is indifferent to distinctions like ‘correct’ or ‘incorrect’. It just stores what it is exposed to. This supports an earlier claim I made in several publications: sufficient exposure to regular verb forms leads to an independent full-form representation, like any other word. From an analytical perspective, such a representation is obviously not needed – on the contrary, it is even the source of spelling errors – but there is no reason why the brain would ‘care’ about this. It just keeps track of repeated inputs (Sandra, 1994).

Homophone intrusions at the sublexical level (Sandra, 2010) are also compatible with Rahmanian and Kuperman’s view. Spelling errors in Dutch like *taste* (for *tastte,* ‘touched) or *lachtte* (for *lachte,* ‘laughed) involve a homophonic intruder that is a non-existing spelling. Quite possibly, such errors reflect the speller’s reliance on the higher-frequency spelling of a sound sequence that crosses the morpheme boundary (see also Pacton et al., 2005). It also fits the many demonstrations in the literature that human cognition can better be described as a probabilistic system, which excels in detecting recurrent (but not necessarily constant) patterns, than as a deterministic system, which is superior in rule induction and application (see also Deacon et al., 2008).

Interestingly, further support for the negative impact of misspellings comes from a possibly unexpected source: the impact of digital writing on formal writing situations. Simoës-Perlant et al. (2018a, b) studied the impact of digital writing on writing in a formal context. They studied the rise of two types of intrusion errors since the advent of social media: those that cannot be mistaken as spelling errors (e.g., *svt* for *souvent,* ‘often’) and those that can be mistaken for ordinary spelling errors (e.g., *quil* for *qu’il,* ‘which he’; *c’est à dire* for *c’est-à-dire*, ‘that is to say’). When comparing the errors on the same dictation that secondary education students wrote in 1974 (age ~15 years) and in 2012 (matching the groups on spelling level and taking the test at the same time of the year), they found no impact from social media for the former error type but a considerable impact for the latter error type: 3.42% errors in 1974 vs. 13.75% in 2018. They conclude: “Therefore, if the modifications that can be mistaken for misspellings are frequently used in digital writing, this can damage the content of the orthographic lexicon, at least more than when the user only produces standard writing.” (p. 172) Clearly, their description of the disturbing effect of competitor spelling forms with the same pronunciation is the same as Rahmanian and Kuperman’s. It also converges with our view that the persistence of spelling errors on Dutch verb homophones is due to sufficient exposure to rivaling orthographic representations. Sufficient exposure automatically yields orthographic representations, which affect spellers’ output. Simoës-Perlant et al. (2018a, b) also found that digital writing in instant messaging poses a larger threat for adolescents who are poor spellers and whose orthographic knowledge is still not fully consolidated. Weak orthographic representations are more easily overruled by non-standard spellings that are frequently used in instant messaging. This, too, is compatible with

Perfetti's Lexical Quality theory and the above views on how orthographic representations develop.

4.3.1 Morpho-Orthographic Homophones vs. Lexical Homophones: Shared Error Sources

It is very interesting to see that our findings on Dutch grammatical homophones and the results in other languages that are compatible with it run quite parallel with the findings on spelling errors on lexical homophones. White et al. (2008) reported that English homophones like *beech* and *beach* show an effect of homophone dominance: more errors are made on the lower-frequency spelling (*beech*). Moreover, more errors were made when the preceding sentence contained a prime word that was orthographically related to the incorrect spelling, both for the dominant and subordinate spelling forms. For instance, although more errors were made on *beech* than on *beach,* the errors on both forms increased in sentences like *After presenting her sp<u>ee</u>ch on animal rights, Sue went to the b<u>ea</u>ch to relax* and *The t<u>ea</u>cher was most proud of the b<u>ee</u>ch tree in his garden.* This priming effect did not interact with the frequency of the target homophone. The authors conclude (a) that the effect of frequency dominance reveals the frequency-sensitive storage of lexical homophones, which are accessed by the lexical route, and (b) that the priming effect reveals an interaction between the lexical route and the non-lexical route, in which a spelling pattern is assembled through phoneme-grapheme correspondences (otherwise the higher-frequency homophone would be insensitive to the priming effect).

Our findings that the same effect of homophone dominance occurs for regularly inflected verb forms in Dutch strongly suggests that at least the higher-frequency spelling is stored like a monomorphemic form and thus, from the perspective of lexical access, functions like a lexical homophone. White et al.'s suggestion that multiple access 'routes' are operational at the same time can also explain why errors on Dutch verb homophones include intrusions from the lower-frequency spelling on the higher-frequency one. If frequency dominance were the only error determinant, such intrusions could not be explained, as they are excluded both by the morpho-orthographic rule that is appropriate in the grammatical context and by a frequency account. Possibly, these atypical intrusions are due to preceding words that prime the lower-frequency spelling. Another explanation might be that a frequency-sensitive, probabilistic system is subject to activity in a phoneme-grapheme assembly route, and, hence, does not always 'select' the higher-frequency spelling pattern.

Tsai et al. (2011) found that young Taiwanese children's tendency to make spelling errors on lexical homophones in Chinese correlates with measures of their attentional skills. Their suggestion that the errors are a signature of problems with attention, as evidenced by children with attention deficits, is at least compatible with our claim that errors on grammatical homophones in experienced spellers reflect a depletion of the attentional resources in working memory. It seems that homophones, both lexical and grammatical ones, require specific attention. This attentional component might not be needed for grammatical homophones if the morpho-orthographic rules yielding them could become automatized, due to a sufficiently large number of target types and tokens. This is how we explained the virtually non-existent spelling errors with respect to the principle of uniformity (i.e., spelling invariance of the stem). Research in a morphologically rich language that makes frequent use of morpho-orthographic rules might shed light on this question. There is at least one study that has focused on this issue.

In a cross-linguistic comparison between the spelling abilities of Hebrew and Flemish (i.e., Dutch-speaking) children in Grades 1–6 (~6 to ~12 years old), Gillis and Ravid (2006) found large differences between the two language groups. Whereas the Hebrew children rapidly used morphological cues to spell words correctly, the Flemish group experienced many problems with words whose spelling was only recoverable when using morphological cues (due to stem uniformity and/or analogy at the suffix level). Even in Grade 6, many errors were still made, although the results indicated a growing awareness of the Dutch morphological principle. The authors attribute this discrepancy between the languages to differences between the rich morphological structure of spoken Hebrew words (Ravid, 2012) versus the sparse inflectional morphology in spoken Dutch. Consequently, unlike Dutch-speaking children, young Hebrew children soon learn to attend to a word's morphological structure. Although this explanation pertains to differences between the spoken languages, the authors suggest that this typological difference has implications for spelling as well. Quite likely, a morphologically rich language soon causes a high degree of morphological awareness, which in turn helps children attend to the morpho-orthographic buildup of words. Gillis and Ravid's view is compatible with our claim that Dutch verb homophones yield so many errors because the distribution of verb forms in Dutch hardly requires the application of the analogical principle, as most inflectional suffixes can be spelled 'by ear'. This stands in contrast to the need to frequently appeal to the principle of uniformity, which probably explains why errors are seldom made in the stem part of inflected verb forms, even in adolescent's chat messages. This cross-linguistic comparison supports the third factor that is responsible for the persistence of verb spelling errors in Dutch: morpho-orthographic rule-frequency, or, perhaps more generally, the frequency with which the morphological spelling principle is applied. It also suggests that the importance of morphological structure in the spoken language makes it easier for children to learn and apply morpho-orthographic spelling rules. This underscores the importance of cross-linguistic studies, both in typologically similar languages with similar orthographies (Dutch, English, Danish, French) and in typologically different languages (Hebrew, Greek).

4.3.2 Early Morphological Awareness vs. Errors on Regular Verb Homophones: An Inconsistency?

Our findings that the effect of homophone dominance in Dutch, even in experienced spellers, is notoriously persistent and is apparently immune to all types of instructional methods (rule-based, analogy-based, algorithmic-based) – as even experienced spellers make the errors – seems to fly in the face of the many studies that have demonstrated that (a) there is a positive correlation between morphological awareness and success in the application of morpho-orthographic rules, (b) a beneficial effect of morphological intervention has been shown, and (c) in the domain of inflectional morphology, grammatical awareness affects the error rate on verb homophones. It also seems at odds with demonstrations of an early morphological awareness in children (Treiman et al., 1994; Cassar & Treiman, 1996, Sénéchal, 2000; Sénéchal et al., 2006).

To begin with, there is abundant evidence that morpho-orthographic rules for spelling inflected forms create a considerable hurdle in many languages. Learning these rules is considerably more difficult, and, hence, slower than learning the mappings between phonemes and graphemes. Insight into words' morphological structure seems to be a prerequisite to guarantee effective rule application. First, this is indicated by the frequent finding (in several languages) that children's morphological awareness correlates with their ability to apply morpho-orthographic rules. Children who can detect the morphological relationship between words (for instance, to derive a silent letter) or who perform well on tasks targeting morphological awareness (e.g., analogy task) have been shown to spell morphologically complex words better than children who score worse in this respect (Sénéchal, 2000; Sénéchal et al., 2006). Note that this not only applies to the ability to analyze a word's internal morphological structure (which may help, for instance, for silent letters or diminutives in French, i.e., words whose spelling does not depend on another word in the sentence) but also pertains to the ability to determine which word determines the spelling of an inflectional suffix, i.e., grammatical awareness. Recent work by Chamalaun et al. (2021) has revealed that grammatical awareness in 11- to 18-year-old secondary school students is a reliable predictor of the spelling correctness of Dutch verb homophones, i.e., the same type of homophones that my collaborators and I studied. Adolescents who were able to identify the grammatical function of a verb form (e.g., present tense, past participle) were significantly more successful in correctly spelling this verb form. Second, the observation that children's performance on these word forms improves as they grow older and that the amount of this improvement is predicted by their degree of grammatical awareness indicates that the ability to spell these word forms correctly requires insight into grammatical concepts. This insight underlies the invariant spelling of the stem (e.g., Deacon & Bryant, 2006b) and the analogical spelling of the suffix or another grammatical marker like the apostrophe in the English possessive (for the English past tense *-ed:* Nunes et al., 1997a, b; for the English possessive: Bryant et al., 1997; for Danish; Juul & Elbro, 2004; for Greek: Chliounaki & Bryant, 2003). Third, intervention studies that explicitly attempt to improve children's morphological awareness have reported beneficial effects. Children with spelling problems obtained higher spelling scores when an intervention program targeted their morphological awareness and explicitly focused on the morpho-orthographic rules (Kirk & Gillon, 2009). Good et al. (2015) showed that this was even the case for children with language impairment, who generalized this morphological awareness to novel words.

In sum, there can be no doubt that the application of morpho-orthographic rules depends on a sufficiently developed morphological awareness.

Still our findings for Dutch verb homophones prove that, when certain conditions are met, analytically simple morpho-orthographic spelling rules may cause persistent spelling problems, even for highly educated people who write texts for professional purposes. Hence, they survive, despite a high level of morphological awareness. Even though the cross-linguistic comparison in Sect. 4.2.3 indicates that grammatical homophones are a problem in other languages as well, a particularly strong manifestation of this problem seems to be found in Dutch. Why?

A first observation is that children's early sensitivity to morphological structure concerns a budding awareness of morphological relatedness at the level of the stem, as shown by Treiman and colleagues and Sénéchal and colleagues. As has been reiterated in this contribution, the morpho-orthographic spelling of Dutch stems, which is governed by the principle of uniformity, does not cause any problems in Dutch either, once it has been learnt. In contrast, spelling inflectional suffixes cause many problems. The 'Dutch problem' is a problem with these suffixes. However, even though such suffixes come with a difficult learning curve in several languages (for instance, English *-ed*, see the work by Nunes and colleagues), the initial difficulties progressively disappear and seldom cause the lasting problem that verb homophones cause in Dutch. I could find only one problem in the literature that echoes the spelling problems for Dutch homophones, or at least the attitude of extreme intolerance that is associated with them: the English apostrophe marker for the possessive (see the earlier citation from Bryant et al., 1997).

Putting everything into perspective, the major culprit is rule frequency. Strong support for this analysis comes from the dissociation in Dutch verb homophones between almost error-free performance with respect to the principle of uniformity and the many problems with respect to the principle of analogy. This supports the idea that only morpho-orthographic rules with a high frequency, i.e., which are applied to a wide variety of words with a high token frequency, can eventually be applied automatically. This account can also explain why even young children who learn to read and spell in Hebrew can readily make use of different types of morphological cues (Gillis & Ravid, 2006). They use morphological spelling rules so frequently that they are quickly able to apply them automatically. However, when rule application cannot become automatic, it requires attentional resources in working memory. Any factor that puts a limit on these resources creates a risk that the rule cannot be applied in time. When this happens, another frequency factor enters the scene and ultimately determines the spelling output: item frequency, more particularly, the homophones' frequencies. Not knowing the answer, spellers (unconsciously) have recourse to the higher-frequency spelling. This effect of homophone dominance has been found at the level of the full form and at the sublexical level.

In short, the answer to the question whether the Dutch findings are not at odds with the rest of the literature is negative. Experienced Dutch spellers apply the morphological principle of uniformity automatically. Moreover, as in other languages, their degree of grammatical awareness is a predictor of their spelling errors on verb homophones (Chamalaun et al., 2021). The factor that sets the Dutch verb spelling errors apart is rule frequency. Frequent rules have a steep learning curve but eventually lead to automatic rule application. Highly infrequent rules are also difficult to learn but never lead to automatic rule application. In Dutch spelling, the former is the case for the principle of uniformity, the latter for the principle of analogy. This explains why Dutch verb homophones occupy a special place in the landscape of morpho-orthographic spelling errors.

4.3.3 Persistent Errors Do Not Imply One Type of Speller

The persistence of verb homophone intrusions in Dutch provides a window on the cognitive infrastructure that underpins the spelling of Dutch verb homophones. However, it should not make us blind to differences between spellers. Roughly speaking, one can make a clear distinction between two types of spellers: (a) those who have sufficient morphological and grammatical awareness to be able to apply the morpho-orthographic rules but, due to the three factors mentioned above, from time to time make an error on a grammatical homophone and (b) those who have insufficient morphological and/or grammatical awareness to apply these spelling rules. Obviously, in the absence of rule knowledge, working memory need not be overloaded to make a spelling error, as it cannot even start the computational process that implements the spelling rule. Consequently, for spellers of the latter type, the door will always be open to intrusions of the higher-frequency homophone, which means they will make many intrusion errors on verb homophones. These two types of spellers should indeed leave different fingerprints on the error rates. Whereas the former will make an occasional error, the latter will make many errors (even in a single text). Chamalaun et al.'s (2021) finding that spellers' grammatical awareness predicts their spelling success on Dutch verb homophones supports such a distinction. Homophone frequency will shape different error patterns for these two types of spellers. Whereas low rule frequency is the problem of experienced spellers, lack of rule knowledge is the problem of weak spellers.[15]

For practical purposes (e.g., in a school context), it is important to distinguish between these two types of spellers, as the former are the victim of their cognitive infrastructure, so to speak, whereas the latter do not possess the required rule knowledge. From the perspective of this analysis, there is no reason to point the finger to experienced spellers who occasionally fall into an inevitable trap, whereas such a reaction is more understandable when spellers make many such errors. One might want to distinguish a third group: spellers who know the rules but who are sometimes too indifferent to apply them. The prediction would be that such spellers will

[15] Note that the distinction between two types of spellers is a simplification. It would be better to speak of a continuum between good and poor spellers, as some spellers will have a better mastery of the rules (or apply them more swiftly) than others.

make many errors as well, as the result of a negative spelling attitude. Obviously, spelling, like any other form of cognitive behavior, is not only affected by knowledge but by motivation as well.

5 Conclusions

The study of spelling errors on Dutch verb homophones can teach us a lot about human cognition. It shows that morpho-orthographic rules involving inflectional endings whose spelling (a) is determined by another word in the sentence and (b) causes verb homophones for two verb types are difficult to master, like many morpho-orthographic rules in other languages. However, the errors also show that low rule frequency makes it virtually impossible to automatically apply the rules. Hence, these rules continue to require attentional resources in working memory, and when the latter is overloaded, there is a strong tendency to write the higher-frequency homophone spelling. This explains why spellers with a good knowledge of the spelling rules and a willingness to avoid errors occasionally make errors on the lower-frequency form or, as in the case of partially homophonic past participles, rely on intra-paradigmatic and inter-paradigmatic support. It also explains why spellers with a poor knowledge of the spelling rules make many errors, as they can only cling to the higher-frequency spelling. The story of Dutch verb homophones demonstrates why descriptively simple and analytically clear spelling rules, which only involve the concatenation of a stem and a suffix, remain a spelling hurdle for the best spellers and a huge problem for weak spellers. It can safely be predicted that, given the strong impact of rule frequency and item-frequency, in combination with our working memory limitations, these spelling errors are here to stay.

It is important that this conclusion is based on error data on different verb types, which have been studied in both laboratory experiments (speeded dictation) and in analyses of a large chat corpus. It is also important that this conclusion applies to homophone intrusions at both the lexical and sublexical levels.

Understanding the cognitive origin of persistent spelling errors is not only important for spelling researchers. It also has practical consequences. Certainly, it is relevant for teachers, who are confronted with these (highly stigmatized) errors daily. For instance, the above distinction between several types of spellers is relevant for them. This type of research is also relevant at a larger societal level. Perhaps, insight into the almost unavoidable error trap that is created by the concerted action of three cognitive factors may lead to less stigmatization of the occasional error on Dutch verb homophones and to a distinction between such occasional errors and the frequent errors made by weak spellers. The irony is that many of those who condemn an occasional error on verb homophones sin against their own belief, as no one can claim to be immune to the errors.

Obviously, this does not mean that teachers should not focus on morpho-orthographic spelling rules. On the contrary, children and teenagers will not acquire these rules by means of implicit learning, as errors persist even in the face of considerable teaching efforts. Moreover, implicit learning results in the induction of statistical regularities, which may be helpful on some occasions but act as a jammer on others. High-frequency orthographic patterns are, by definition, probable but nonetheless sometimes grammatically incorrect. Such implicit learning cannot, of course, be 'switched off', as our brain deals in the business of statistical learning all the time. However, as has been shown in many studies, explicit training of morphological and grammatical awareness (see above) is the only way to maximally protect spellers against verb homophone errors that are always lurking around the corner. They will never be able to wipe them out completely, but there is no other way around the problem.

Of course, there is an alternative when a spelling problem is so persistent and is so heavily stigmatized. Spelling rules that are so demonstrably ill fit to the cognitive infrastructure of the user should perhaps be replaced by rules that can be automatically applied. In the case of Dutch, this might amount to the preservation of the principle of uniformity and the rejection of the principle of analogy. Such a change would not lead to a breakdown in adolescents' ability to reflect on language structure. The preservation of the principle of uniformity would help the development of morphological awareness just as much as it does now. Obviously, the quantitative implications of such (or any other) proposal, i.e., the number of affected spelling forms, should be studied first. It remains to be seen whether insights in psycholinguistics carry sufficient weight to have such a far-reaching practical impact. In the case of Dutch verb homophones, installing new rules that can be applied automatically by most users would leave more time for teachers to focus on the essence of writing instruction: the delivery of well-written, coherent, and well-structured texts.

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The Influence of Roots and Stems on the Lexical Processing of Complex Words in German

Eva Smolka and Wolfgang U. Dressler

Abstract Psycholinguistic research continues to be puzzled about the question as to how complex words are processed and stored in lexical memory, especially since different languages and language families provide different results. In our paper, we review behavioral and electrophysiological experiments on the processing of complex words in German, including inflections, derivations, and compounding. Overall, our findings indicate root/stem access at each of the complexity levels (i.e. inflections, derivations, and compounds), irrespective of verb regularity, and irrespective of semantic transparency. Finally, we consider the relevant lexicon-based and learning-based models that may integrate these findings. We argue that cross-language comparisons are vital for the exploration of lexical processing.

Keywords Lexical processing · Morphological processing · Complex words · Roots and stems in German · Verb regularity and verb inflection · Verb derivation · Prefix and particle verbs · Familiar and novel compounds · Semantic transparency · Constituent priming

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1 The Influence of Roots and Stems on the Lexical Processing of Complex Words in German

Humans possess the ability to construct and understand meaning in an almost unlimited number of possible word combinations. This ability to combine words into sentences (Bever & Langendoen, 1972; Ferreira & Henderson, 1991; Osterhout & Holcomb, 1992) has been extensively studied. However, the limits on this combinatorial ability with respect to smaller meaningful units that combine into words or words that combine into sequences (via derivations and compounding) continues to be debated. For example, the meaning of *aufstehen* ('stand up') is relatively semantically transparent with respect to the contribution of its stem *stehen* ('stand'), while the meaning of *verstehen* (and the corresponding English 'understand') is rather obscure and opaque with respect to *stehen* (and corresponding '*stand*').

Linguistic, psycholinguistic, and neurolinguistic researchers who follow the combinatorial tradition are therefore intrigued by a range of questions, as follows: What are the fundamental properties of the lexical processing system? How are the units organized at each level in the hierarchy of the mental lexicon? And what is the interplay of roots and stems and the meaning of whole words in online lexical processing? So, do we access the stem *stehen* and *stand* when processing *verstehen* and *understand*?

Second, is the way in which complex words are stored and processed language-specific? That is, does the size of the basic units depend on the language family or on other language-specific or typological features? This paper investigates these questions about complex words in German and compares them with similar questions in Indo-European and Semitic languages.

1.1 Definition of Roots and Stems and Our Terminology

The "root" in Semitic languages refers to 3–4 consonants that define the semantic content of a word. Typically, it is intertwined in a nonlinear/ nonconcatenative way with the word pattern that defines the phonological and syntactic features of the word. For example, the root *l-m-d*, which encodes the notion of "learning", intertwines with different word patterns to yield the Hebrew words *lamad* ('he learned'), *limed* ('he taught'), *limudim* ('studies'), and *talmid* ('student').

With respect to Indo-European languages, some linguistic theories differentiate between a root, a stem, and a base as the constituents of words (e.g., Bauer, 1983). The "root" is the part that remains when all (inflectional and derivational) affixes have been removed and cannot be parsed any further. Hence, the inflected verb *ich laufe* ('I run'), PPT *ge-lauf-en*, the derived verb *verlaufen* ('get lost'), and the compound *Laufbahn* ('career', lit. 'run-path') all hold the same root, /lauf/, which is at the same time the lexical base (stem). In a narrower sense, originating from diachronic linguistics, the concept "stem" refers to the part that remains when all inflectional affixes have been removed. In the above example *ich lauf-e* the root and the stem /lauf/ coincide, while in the examples *ich verlauf-e (mich*) (‘I get lost’), and *Laufbahnen* (‘careers’) the stems in the broader sense of our contribution are complex themselves: /ver-lauf-en/ and /Lauf-bahn/*,* respectively, the latter comprising two simplex stems.

This paper focuses on three key questions: First, do we access and process the smaller (meaningful or potentially meaningful) constituent units regardless of the combinatorial process that coins a particular word formation, and if we do – under what conditions?[1] One processing strategy may be the parsing of words into constituents and the storage (and retrieval) of exception words as backup. For example, most of the present models on inflections assume that irregular verb inflections like *geworfen* (‘thrown’) must be stored as whole-word units in lexical memory (e.g., Clahsen, 1999; Marslen-Wilson & Tyler, 1998). If this is the case for German, then irregular (or subregular) stems like *worf* will not be accessible. To this end, we study verb inflections in German, specifically the combination of stems like *werf* and *worf* with affixes like *ge-* and *-en*, as in *werfen* (‘throw’) and *geworfen* (‘thrown’), respectively.

Second, do we access and process the smaller units regardless of their contribution to the meaning of the whole complex word? For example, many lexicon-based models on derivations and compounds (e.g., Marslen-Wilson et al., 1994) assume a fundamental difference in the storage and processing of semantically transparent and opaque derived words. In these models, semantically transparent words (whose meaning can be derived from the meaning of the parts, like *success-ful* and *departure*) are stored and accessed via their stem. By contrast, because the meaning of semantically opaque words cannot be derived from the meaning of their parts, words like *successor* or *department* must be stored as whole-word units.

To study this question for German, the second part deals with derivations and compounds, where the meaning of the stem undergoes some shift in meaning. Verb derivations combine a stem like *stehen* (‘stand’) and either an inseparable prefix like *ver-* or a separable particle that possesses a meaning of its own like *auf* (‘up’, ‘on’) to coin prefix and particle verbs like *verstehen* (‘understand’) and *aufstehen* (‘stand up’), respectively. By comparison, compounding is the combination of stems with other stems, as in *Standpunkt* (‘standpoint’) and *Kopfstand* (‘headstand’).

Finally, are the processes responsible for the comprehension of stems like /lauf/ in inflections like *ge-lauf-en* (PPT ‘run’), in derived verbs like *ver-lauf-en* (‘get lost’), and in stem sequences like *Lauf-bahn* (‘carreer’, lit. ‘run path’) comparable—given that most present models on inflections differ dramatically from models on derivations or compounds? To this end, we compare the findings in German from different points along a continuum of complexity—inflections, derivations, and compounds—to provide converging evidence for the formulation of an adequate model on lexical processing in German.

[1] We do not deal with purely phonological processing of syllables, phonemes or prosody.

1.2 Models of Lexical Processing

Psycholinguistic models on lexical processing mostly do not differentiate between the terms root, stem or (lexical) base and use any one of them to refer to constituents in contrast to whole-word units. Given the large number of models, we will provide a short selection of a few exemplary models on morphological processing and refer to a detailed description in Milin et al. (2017), drawing the main distinction between more classical lexicon-based models and learning-based models. The former assume discrete morphological entries, the latter assume morphological effects to denote epiphenomena of functions such as form-meaning-correspondence (e.g., Gonnerman et al., 2007; Joanisse & McClelland, 2015), information uncertainty (see Milin et al., 2009, for an overview), or discriminative learning (e.g., Baayen & Smolka, 2020; Baayen et al., 2011, 2015).

Lexicon-based models differ in the number of postulated systems and processing styles: Parsing or whole-word retrieval, or both, occur in a single system or in two separate systems. For example, the assumption of two innate and inherently independent systems, one for each processing style, is typically based on the seminal linguistic theory provided by Chomsky's (1970) "lexicalist hypothesis", which distinguishes between (universal and language-specific) rules and a lexicon. So-called "dual-mechanism" accounts are the psycho- and neurolinguistic implementations of this hypothesis (e.g., Clahsen, 1999; Pinker, 1991; Pinker & Ullman, 2002). Inflections which follow productive rules (e.g. "affix *ge-* and *-t* to the stem to form the participle" as in *ge-lieb-t*, 'loved') are processed by the procedural system in left-frontal brain structures (including Broca's area and left basal ganglia). By contrast, irregular verbs that do not follow the rule (e.g. inf. *werf-en*, PPT *ge-worf-en*, 'throw-thrown') are stored in the declarative memory system in left temporo-parietal brain structures (including the hippocampus; Newman et al., 2007; Pinker & Ullman, 2002; Ullman et al., 2005).

Different from the above approach, "dual-route" models (Frost et al., 1997; Marslen-Wilson et al., 1994) describe both types of processes as operating within a single system, where parsing and retrieval may interact. They typically differentiate between complex words that are productive and can thus be parsed on a combinatorial basis (e.g. *walk-s*, *walk-ed, walk-ing*, *walk-er*) and complex words that are unproductive and embody some kind of exception that needs to be represented as a whole-word unit—be it an irregular inflection or a semantically opaque/noncompositional meaning (e.g., *throw-n, under-stand*).

For example, in the seminal dual-route model developed by Taft and colleagues (Taft, 1979, 2004; Taft & Forster, 1975; Taft & Kougious, 2004; Taft & Nguyen-Hoan, 2010; Xu & Taft, 2015), parsing occurs before whole-word access. At the early processing stage, there is an attempt to parse all complex words into their constituent units before whole-word representations are accessed. At the lexical (i.e. lemma) level, only productive words (i.e. regular inflection; semantically transparent derivations and compounds) are represented via their base, unproductive words (i.e. irregular inflection; opaque derivations and compounds) via whole-word units (e.g., Taft, 2004).[2]

The dual-stage model suggested by Marslen-Wilson and colleagues (Marslen-Wilson et al., 2008; Rastle et al., 2000) also claims distinct processing stages defined by the time course of early and late word recognition, which are typically examined by means of masked versus overt priming paradigms. At the early prelexical stage, a semantically blind parsing process decomposes all words that possess any affix-like structure (including pseudo-affixes such as *re-* in *reach* and *-er* in *corner*) into constituents. Only at the later lexical stage is semantic meaning integrated, so that semantic compositionality determines word recognition: transparent words (e.g. *teach-er*) are recognized via their stem, (pseudo-)opaque words (e.g. *corner*) are retrieved as whole-word units.

In other iterations of the dual-route model (e.g., Marelli & Baroni, 2015; Schreuder & Baayen, 1995), the parsing and retrieval processes are not independent but rather run in parallel, and recognition of complex words can draw on both processes/ routes, which can co-occur and interact.

The above models are in stark contrast to single-system models that posit one system that processes all complex word formations and does not explicitly represent morphemes. These are learning-based models, where the emphasis is on existing knowledge guiding subsequent learning rather than on different types of representations. The most prominent representatives are "distributed connectionist" approaches, more recently called "convergence-of-codes" models (e.g., Gonnerman et al., 2007; McClelland & Patterson, 2002; Mirković et al., 2011; Westermann & Ruh, 2012; Smith, 1995; for an overview see Joanisse & McClelland, 2015). The requisite knowledge can be construed as an associative memory, which computes meaning based on orthographic or phonological input representations. These form-to-meaning mappings capture the systematic relationships among the form and meaning codes that characterize each word. A hidden layer captures these systematic relations so that combinatorial effects that correspond to morphological effects in lexicon-based models emerge from the combined activation of orthographic, phonological, and semantic codes. In other words, the hidden layer mimics morphological effects by capturing the statistical relations between codes for form and for meaning (e.g. Plaut & Gonnerman, 2000; Raveh, 2002).

Any differences in word recognition performance that arise among words reflect variations in the systematicity of the mapping between an orthographic or phonological form and a meaning, but not qualitative differences in the nature of the underlying representations or access processes. For example, when meaning similarity is held constant, the orthographic and phonological predictability between regular verbs like *love-loved* is stronger than that between irregular verbs like

[2] In a later model (Taft & Nguyen-Hoan, 2010), Marcus Taft assumes whole-word storage for both semantically transparent and opaque words. Initial activation is similar for both, but processing differs in that the lemma of a semantically transparent word like *hunter* gets facilitation from the lemma of its base *hunt* and the lemma of its suffix *-er*. By contrast, the lemma of a semantically opaque (pseudo-derived) word like *corner* receives inhibition from the lemma of *corn*.

fall-fell or *think-thought*. Furthermore, there is a graded overlap of form and meaning similarity between semantically transparent and opaque word pairs, such as *spinach-spin* (form only), *hardly-hard* (low semantic), *lately-late* (moderate semantic), *boldly-bold* (high semantic) (e.g., Gonnerman et al., 2007, Mattiello & Dressler 2019).

The "Naïve Discrimination Learning" (NDL) model proposed by Baayen and Ramscar and colleagues (e.g., Baayen et al., 2011, 2015; Ramscar, 2002; Ramscar & Baayen, 2013; Ramscar et al., 2018) also considers morphological complexity as an epiphenomenal by-product of form-to-meaning mappings, and even does away with the hidden layer. One of the main features is that—through progressive exposure—learning relies not only on similarity but also on progressively better differentiation among units. Based on the principles of error-driven learning (Rescorla & Wagner, 1972), language learning enables a language user to better predict events in the world by weighing and assessing the "informativity" of cues (e.g., orthographic) to predict relevant semantic outcomes (e.g., Ramscar & Baayen, 2013).

In contrast to the above distributed connectionist or NDL accounts that dispute morphological structure, the "stem-based frequency" model proposed by Smolka and colleagues is specifically adapted to the findings presented here for German. It assumes a single system/single parsing process, so that all complex words are accessed via their stem (e.g., Smolka & Libben, 2017; Smolka et al., 2007, 2014). This approach is fully compatible with the usage-based approach, and its analysis of the verb-root-based Hebrew morphology of Dorit Ravid and her team (cf. Ashkenazi et al., 2020; Ravid, 2003).

In what follows we will describe lexical processing and representation for complexity at specific points along a continuum, starting with verb inflections, followed by verb derivations, and compounds. We will describe the psycholinguistic models and theories that are specific for that particular type of word complexity, together with a description of the relevant experiments and findings in German that have been conducted to date. Finally, we will summarize the various findings on complex words and discuss how models may incorporate them.

2 Part A—The Processing of Roots and Stems in German Verb Inflections

2.1 Linguistic Aspects on the Differentiation Between Verbal Roots and Stems

In Semitic languages, each verb typically consists of its root consonants and one of the verbal patterns called *binyanim* (e.g., Bolozky, 1999; Ravid, 2003, 2019). While the root consonants and the verb pattern are nonlinearly (nonconcatenatively) intertwined within each other, the inflection of person and number is affixed in a linear way. For example, the verb *lamadti* ('I learned') consists of the root *l-m-d*, intertwined within the *binyan* pattern *Qal* to provide the past tense verb *lamad*, and the suffix *-ti* (1. Sg. past tense) that signifies the inflection.

In addition to the root-based verbs, Arabic verbs hold also stem-based morphology, which is characterized by different basic thematic vowels. For example, the homophonous root *d-m-n* is differentiated by means of the thematic vowels in the Arabic stems (in the basic preterit) *damana* ('dung', 'fertilize') versus *damina* ('resent'), and the same holds for the homophonous root *ḥ-l-m* that occurs in the different stems *ḥalama* ('dream') versus *ḥaluma* ('be mild').[3]

The Archaic Indo-European languages have fewer roots than Semitic languages. For example, in Ancient Greek only subregular and irregular roots show an ablaut (apophony) in one syllable, and the basic vowel /e/ may be either changed to /o/, /ē/, /ō/ or deleted.

Originating from Indo-European stress patterns (Paul, 1998), the German ablaut system holds even fewer root-based subregular and irregular verbs, such as the verb *werfen* ('to throw') from the root *w-r-f*. Ablaut is restricted to three vowel changes, and the pool of irregular verbs can be classified into subgroups of ablaut clusters, that is, vowel patterns according to which the infinitive stem vowel is transformed into preterit and past participle (PPT) stems (Paul, 1998). For example, the basic /e/ in Inf. *werf-en* ('throw') is changed via ablaut to preterit *warf*, and PPT *ge-worf-en*; and changed via umlaut (metaphony) to 3.Sg.Prs. *wirf-t*.

Another well-known ablaut pattern (class III, Paul, 1998) includes verbs like *singen* ('sing'), *ringen* ('ring'), *sinken* ('sink'), and *trinken* ('drink') and requires that verbs with the short infinitive root vowel /i/ before a nasal and a stop consonant be transformed into preterit /a/ and PPT /u/, as in *singen-sang-gesungen* ('sing-sang-sung').

Ablaut cluster (class II) subsumes verbs such as *schießen* ('shoot') and *schieben* ('shove') with the long infinitive stem vowel /i:/, which is altered either into the preterit and PPT vowel /o/ (class IIb), as in *schoss-geschossen*, or into /o:/ (class IIa), as in *schob-geschoben*. By contrast, the ablaut vowel /i:/ is typically used for verbs subsumed under ablaut cluster I, where the infinitive stem vowel /ai/ is transformed into /i:/ in the preterit and participle stem, such as in *meiden-mied-gemieden* ('avoid-avoided-avoided').

To summarize, irregular verbs in German are considered to have roots that form different stems (according to the ablaut rules), such as the stems /werf/, /warf/, /worf/ from the root *w-r-f*. These stems are not restricted to the verbal system: for example, the inflected verb *ich stehe* ('I stand'), the derived verb *verstehen* ('understand'), and the compound *Stehleiter* ('stepladder') all share the same root /steh/, which is at the same time the lexical base (stem). Curiously, /steh/ is related in an irregular way to the lexical base /stand/ of the irregular preterit *stand*, the PPP

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[3] An important difference between Semitic and Indo-European languages is that Arabic root-homophonous verbs also have the same inflection, in contrast to Indo-European languages, as in Lat. *sed-e-re*, *sed-a-re*, 1. Sg.Perf. *sed-i, sed-a-vi.* (Aro, 1964: 44–93, Cuvalay-Haak, 1997: 95–97, Kilani-Schoch & Dressler, 1985, Larcher, 2003).

ge-stand-en, and the slightly opaque compound *Stand-punkt* ('point of view', lit. 'stand-point').

In contrast to irregular verbs, for regular German verbs, the root and the stem coincide, as in *lieben-liebte-geliebt* ('love-loved-loved'). The same root/stem may also occur in derived adjectives like *lieblich* ('lovely'), derived verbs like *verlieben* ('fall in love'), and nouns like *Liebe* ('love').

2.2 Psycholinguistic Aspects on the Processing of Verbal Roots and Stems

Past-tense and particle formations in various languages have been used to investigate the question whether complex words are lexically represented via their root, stem or as whole-word units.

Applying long lag repetition priming or masked priming, early studies in English found evidence in favor of a processing difference between regular and irregular verbs based on significantly different magnitudes of facilitation (e.g., Forster et al., 1987; Fowler et al., 1985; Napps, 1989; Napps & Fowler, 1987; Stanners et al., 1979). These findings were well incorporated within "dual-mechanism" accounts, assuming two distinct systems (and brain regions) for the processing of regular and irregular verbs (Newman et al., 2007; Pinker & Ullman, 2002; Ullman et al., 2005).

Marantz and colleagues (Embick & Marantz, 2005; Fruchter et al., 2013; Stockall & Marantz, 2006) formulated their slightly different "distributed morphology" approach by postulating that all English verbs, regular and irregular alike, are parsed on the basis of phonologically driven rules, followed by stem-based lexical access (similar to the "stem-based frequency" account, see below). Like dual-mechanism accounts, though, they assume irregular verbs like *sing* and *sleep* to be stored in lists,[4] and that a blocking principle prevents regular suffixes from being applied to irregular forms (i.e. blocking incorrect **singed* and **sleeped*).

The dual-system/dual-process approach developed by Marslen-Wilson, Tyler, and colleagues (e.g., Klimovich-Gray et al., 2017; Marslen-Wilson & Tyler, 2007; Bozic et al., 2013b) also postulates two distinct brain systems for parsing and storage. A specific left hemispheric neural system is selectively tuned to the processing of combinatorial sequences, such as regularly inflected verbs, while a broader, bi-hemispheric substrate serves whole-form and stem-based access.

However, as soon as experiments altered the binary distinction between 'regular' and 'irregular' into a differentiation between verb types that vary by degree of form overlap, abundant behavioral (Basnight-Brown et al., 2007; Kielar et al., 2008; Pastizzo & Feldman, 2002) and electrophysiological (Justus et al., 2008; Kielar &

[4] The lists organize the irregular verbs according to their phonological similarities (describing both the phonological realization of the stem and the choice of an irregular suffix, such as a zero suffix in *sung* or a *-t* suffix in *slept*.

Joanisse, 2010) studies in English were able to identify priming patterns that differ according to the form-overlap between prime and target, indicating that English past-tense priming is modulated in a graded way: strongest priming by regular verbs like *rained-rain*, intermediate effects by semi-regulars that retain the stem and have an affix-like structure like *slept-sleep* and *blown-blow*, and weakest priming or no priming by vowel-change irregulars like *drank-drink* and *taught-teach*. Such graded effects support "connectionist network" or "convergence-of-codes" models (Basnight-Brown et al., 2007; Kielar et al., 2008; Mirković et al., 2011; Westermann & Ruh, 2012; for overview see Joanisse & McClelland, 2015), suggesting that the regular-irregular distinction relies on the variations in phonological predictability between word pairs such as *walk-walked* versus *think-thought*.[5]

The implication of the above findings for the interpretation of regularity is complicated in English due to the confound between regularity and morpho-phonological compositionality, so that regular but not irregular verbs can be parsed (e.g. by searching for *-ed* or its equivalent). Indeed, many studies in languages with a richer inflectional system than English have not yet yielded unequivocal results—revealing no (statistically) significant differences between regular and irregular inflection. These include French (Meunier & Marslen-Wilson, 2004), Italian (Orsolini & Marslen-Wilson, 1997), Spanish (Balaguer et al., 2005), Portuguese (Veríssimo & Clahsen, 2009), Russian (Gor & Jackson, 2013), Polish (Reid & Marslen-Wilson, 2003), and Greek (Tsapkini et al., 2002). An overview of ERP-results is provided in Table 1 in Smolka et al. (2013), an overview of ERP-studies in Leminen et al. (2019).

German participle formation has been of particular interest to the study of verb inflection, because it does not confound regularity and morpho-phonological decomposition. Both regular and irregular verbs attach the prefix *ge-* and one of two suffixes, *-t* or *-en*, to the stem. Dual-mechanism approaches assume the *-t* suffix to be the default suffix, and the *-en* suffix to be irregular (e.g., Clahsen, 1999; Clahsen et al., 2002; Sonnenstuhl et al., 1999; Marcus et al., 1995), which corresponds to the assumption that the default is productive and irregular is unproductive. The participle stem preserves the infinitive stem, as in *kaufen-ge-kauf-t* or in *laufen-ge-lauf-en*, or changes the stressed stem vowel, as in *denken-ge-dach-t* or *werfen-ge-worf-en*. These stem/suffix combinations result in four participle types that are more closely defined in Smolka et al. (2007). In any case, the morphological transparency in the surface form (*ge*-stem-*t/en*) means that a parsing process can apply, at least in principle, equally to all regular and irregular forms.

Since many of the main assumptions of "dual-mechanism" accounts are based on limited findings in German (e.g., Clahsen, 1999; Clahsen et al., 2002; Marcus et al., 1995; Sonnenstuhl et al., 1999), it was particularly valuable to test these claims. The fundamental difference in the processing characteristics of the parsing and storage systems should produce essentially different patterns in word recognition and speech production for regular and irregular words. For example, because the rule

[5] Some connectionist models (e.g., Basnight-Brown et al., 2007; Ramscar, 2002) stress the importance of semantic similarity in addition to frequency and phonological overlap for the coding of past tense.

system includes only stems like /lieb/, and stem activation is the basis of priming, the target *lieben* ('love') should be equally primed by the participle prime *geliebt* ('loved') and by the identical prime *lieben* (hence "full" priming). Furthermore, stem frequency (i.e. lemma frequency) but not whole-word frequency of either prime or target should affect priming. By contrast, if we assume that the memory system holds irregular verbs as whole-word units, whole-word frequency effects are expected; and because irregular verbs are linked as close semantic associates, participle priming *geworfen-werfen* ('thrown-throw') should be weaker than identity priming *werfen-werfen* (hence "partial" priming) and rather resemble the priming by a semantic associate like *schmeißen-werfen* ('chuck-throw').

The first two studies reviewed here (e.g., Smolka et al., 2013, 2021b) had a similar structure as the only previous behavioral study on participle priming in German (e.g., Sonnenstuhl et al., 1999), but with significantly improved designs. Inflected verb targets belonged to the regular (*kaufe*, 'I buy') and two irregular types—semi-irregular (*laufe*, 'I run'), and irregular (*saufe*, 'I booze'). They were preceded by an identical prime (*kaufe*, *laufe*, and *saufe*, respectively), their past participle (*gekauft*, *gelaufen*, and *gesoffen*, respectively), or an inflected regular control (*höre*, 'I listen'). In addition, while lemma frequencies were matched across all conditions, participle frequencies were manipulated between low and high.

When we applied cross-modal priming to the same regular and (semi-)irregular verbs of the Sonnenstuhl et al. (1999) study, we replicated their findings of a critical interaction between regular and irregular verbs: 'regular' participles induced *full* priming (i.e., participle priming as strong as identity priming), while semi-irregular participles induced *partial* priming (i.e., participle priming less than identity priming). We observed that this interaction relies on differences in identity priming between 'regular' and 'irregular' verbs rather than on differences in participle priming—as was the case in the original Sonnenstuhl et al. study. Interestingly, with the larger set of materials and two types of irregularity, no critical interaction emerged, and regular, semi-irregular, and irregular participles all produced *partial* (i.e. less than identity) priming. Next, we demonstrated that *full* priming for regular verbs crucially depended on the frequency of the participles. By using subsets with relatively high- or low-frequency participles, the effect of participle priming was almost absent in the former and *full* in the latter.

The second experiment examined the effects of high- and low-frequency participles as primes on inflected verb targets in the visual domain. Again, we observed that *full* or *partial* priming effects depended on participle frequency rather than verb type, given that low-frequency participles of irregular verbs induced *full* priming (i.e. participle priming as strong as identity priming).

It is possible that word frequency determines whether the two morphemes will 'fall apart' during processing or whether the associative strength between them is so high that the processing of the whole word does not allow access to morphemic representations fast enough. On the other hand, it is also possible to think of the word frequency effect as a ceiling effect of the response latencies, where fast responses to high frequency targets cannot be speeded up any further by a high frequency prime.

Moreover, our ERP study (Smolka et al., 2013) replicated the *partial* priming effects across all verb types, but indicated gradual differences between them. Regular participles (*gekauft-kaufe*) yielded the strongest priming effects on verb targets, semi-irregular participles (*gelaufen-laufe*) produced intermediate effects, and completely irregular participles (*geworfen-werfe*) showed the weakest effects, both in N400 amplitude and topography (see Fig. 2 in Smolka et al., 2013).[6] These graded priming effects confirm the assumptions of a single-system, which accounts for priming effects that are modulated by the amount of form overlap between prime and target and argue against a categorical distinction between regular and irregular verbs.

Another priming study examined whether not only regular but also irregular verbal roots/stems are accessed and represented in lexical memory (Smolka et al., 2007). As in the previous studies, we compared the effects of regular (e.g. *gekauft,* 'bought') and irregular (e.g. *geworfen*, 'thrown') participle primes on verb targets (*kaufen*, 'buy' and *werfen*, 'throw', respectively). New to this study was the inclusion of nonword participles and their effects on verb targets (e.g. **gekäuft-kaufen* and **gewurft-werfen*). Nonword participles held either irregular stems in combination with an incorrect suffix (e.g., **geworft*), or morphologically related stems from outside the verbal paradigm (e.g., **gekäuft* and **gewurft*). The logic behind the inclusion of nonword participles was as follows: since items like **geworft* and **gewurft* are nonwords, they are not stored in lexical memory. Priming by nonwords thus cannot be attributed to the lexical retrieval of any whole-word unit. Rather, priming by a nonword can occur only if the nonword stem, which carries the relevant meaning information for the target, was accessed. Thus, the priming of the target verb *werfen* ('throw') by a nonword participle like **geworft* indicates that the stem *worf* was accessed, suggesting that */worf/* is treated as a lexical unit.

Results showed equivalent priming by regular and irregular participles (*gekauft-kaufen* vs. *geworfen-werfen*). Most importantly, the priming by nonword participles (**gekäuft-kaufen*, **gewurft-werfen* or **geworft-werfen*) was equivalent to the priming by correct participles (see Fig. 1 in Smolka et al., 2007). As Fig. 1 indicates, further ERP data (Smolka et al., 2021a) replicated these findings: Both correct (regular and irregular) participles and nonword participles induced strong left anterior negativities (LAN) as well as reduced centro-parietal negativities (N400 modulations) relative to unrelated participles. Moreover, nonword participles were as effective as correct participles in facilitating the base verbs, indicating that the stems in nonword participles were accessed, regardless of whether they originated from regular or irregular verbs. These findings were taken to indicate that the stems of both regular and irregular participles were accessed and their meaning was activated.

However, stem access holds only for existing stems, not for nonexistent stems that are created by analogy to phonological ablaut rules. For example, a regular stem

[6] Furthermore, the priming by both regular and irregular participles was always stronger than that by semantic associates.

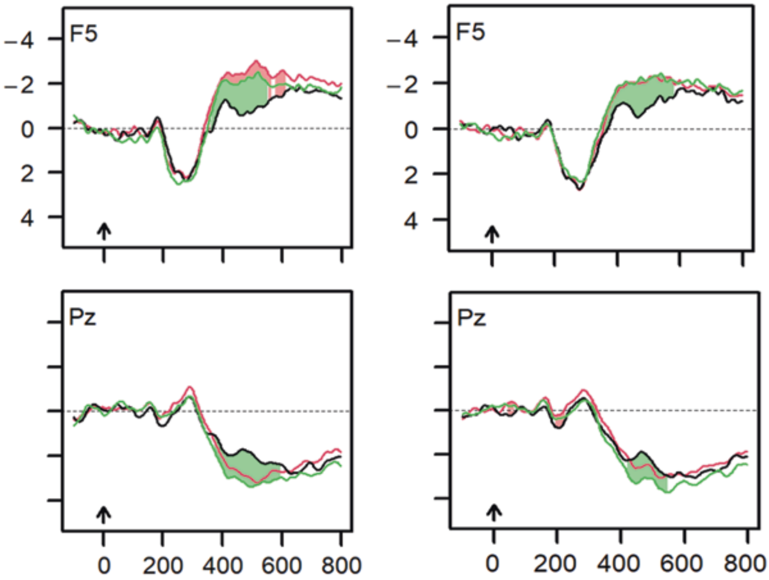

Fig. 1 The left panels present the brain potentials to regular verb targets (e.g. *kaufen,* 'buy') preceded by their correct participle (e.g. *gekauft*, 'bought', in red), a nonword participle (e.g. **gekäuft*, in green), and an unrelated participle (in black). The right panels present the brain potentials to irregular verb targets (e.g. *werfen,* 'throw') preceded by their correct participle (e.g. *geworfen*, 'thrown', in red), a nonword participle (e.g. **geworft*, in green), and an unrelated participle (in black). The upper panels show the left anterior negativity (LAN) at the left frontal electrode F5; the lower panels show the N400-effect at the centro-parietal electrode Pz. The arrow on the X-axis indicates the target onset at 0 ms; the Y-axis provides the micro-Volt, negativity is plotted upwards

like *hinken* ('limp') may be ablauted to **gehunken*, following the ablaut pattern of irregular verbs like *sinken-gesunken* ('sink-sunk') and *trinken-getrunken* ('drink-drunk').[7] In a lexical decision task, only the existing stems in nonword participles like **geworft* and **gewurft* were accessed, but not the nonexistent stems of **gehunken* and **geblunken* (from *hinken,* 'limp', and *blinken*, 'blink', respectively) (Experiment 4 in Smolka, 2005). These findings are inconsistent with the online processing of stems according to (phonological) analogy. Rather, they are in line with access to existing stems—regular and irregular alike. These findings gave rise to the postulation that during the lexical processing of inflected verbs in German, stems are accessed—irrespective of verb type, and within the same processing system.

[7] In Middle High German, *hinken* ('limp') still was an irregular verb and followed the ablaut pattern (IIIa) of verbs like *trinken* ('drink') (Paul, 1998).

3 Part B—The Processing of Roots and Stems in German Verb Derivations

The word forms in Part A belonged to verb inflections, where the combination of a stem and affixes defines features such as person, number, tense, aspect, and mood but keeps the basic meaning of the stem.

The following sections deal with word formations where the combination of stems and other constituents (e.g., prefixes, particles, and other stems) results in a shift in meaning. For example, the combination of the stem *stehen* ('stand') with either prefixes like *be*-, *ge*-, *ver*-, or particles like *an*, *auf*, *zu*, produces complex verbs with entirely different meanings than that of the stem. Even complex verbs that appear to be fully semantically transparent such as *anstehen* ('stand in line') and *aufstehen* ('stand up') do not have whole-word meanings that are easily predictable from constituent meanings in the absence of situational experience or lexical conventions. More difficult, of course, are prefixed verbs like *bestehen* ('exist', 'insist'), *gestehen* ('confess'), *verstehen* ('understand'), and particle verbs like *zustehen* ('legally due'), which contain only remote resemblance to the meaning of *stehen*. As noted above, one of the major questions in psycholinguistic research concerns the nature of processing units, and whether morphological processing is independent of semantic and form processing (e.g. Feldman, 2000).

A traditional way to dissociate morphological and semantic processing has been the manipulation of semantic transparency between morphologically related words. The priming of a word like *think* by a morphologically related and semantically transparent word like *rethink* can be attributed to both morphological and semantic processing, since the meaning of its morphemic constituents *re-* and *think* derive the meaning of the whole word. By contrast, the facilitation of a target like *treat* by a semantically opaque prime like *retreat,* whose meaning cannot be derived from the meaning of its parts, can disentangle morphological and semantic processing. Such priming would represent morphological processing that is independent of semantic processing, and would thus provide evidence that the words *treat* and *retreat* share some lexical representation (be it localized or distributed) in spite of their opaque meaning relation.

A seminal study of Bentin and Feldman (1990) demonstrated the dissociation between semantic and morphological processing in Hebrew. Purely semantically related primes facilitated targets only when they immediately succeeded the prime, whereas morphological priming effects lasted over long word lags as well. Moreover, the recognition of a target like *migdal* ('tower') was primed by morphologically related words sharing the same root *g-d-l* (referring to the notion of "rising"), regardless of whether they were semantically related like *gadol* ('big') or semantically unrelated like *gidul* ('tumor').

Further studies in Hebrew and Arabic replicated robust priming by both semantically transparent and opaque derivations. Morphological priming by means of the root was stable across different stimulus onset asynchronies (SOA) in the masked priming paradigm (Boudelaa & Marslen-Wilson, 2005, 2011; Deutsch et al., 1998;

Frost et al., 1997; Velan et al., 2005), and by using cross-modal priming (Boudelaa & Marslen-Wilson, 2004a, b, 2011; Frost et al., 2000). These findings were taken as evidence that in Semitic languages the morphemic constituents of a word—the root in particular—represent essential processing units regardless of meaning. The non-linearity/ nonconcatenativity of the root and the word pattern were assumed to stress the abstraction of the root in order to derive the meaning of the word.

By contrast, morphological priming in Indo-European languages was found to depend on semantic compositionality/transparency (e.g., Diependaele et al., 2005; Longtin et al., 2003; Marslen-Wilson et al., 1994, 2008; Rastle et al., 2000; Taft & Nguyen-Hoan, 2010). Under overt priming conditions (i.e. when primes are fully processed), semantically transparent words whose meaning can be derived from the meaning of the constituents, such as *confessor-confess,* induced priming, while semantically opaque words whose meaning cannot be derived from the meaning of their parts, such as *successor-success,* did not. Lexicon-based accounts interpreted these findings to indicate that semantic transparency determines lexical representation. A transparent word like *confessor* possesses a lexical entry that corresponds to its base and is represented as the stem /confess/ and suffix /-or/, while an opaque word like *successor* is represented in its full form /successor/ (e.g., Diependaele et al., 2005; Marslen-Wilson et al., 2008; Meunier & Longtin, 2007; Rastle et al., 2000; Taft & Nguyen-Hoan, 2010).

Several other studies replicated the findings that only semantically transparent but not semantically opaque complex words prime their bases. This so called "semantic transparency effect" was established in English (Feldman & Soltano, 1999; Feldman et al., 2004; Lavric et al., 2011; Rastle et al., 2000), French (Longtin et al., 2003; Meunier & Segui, 2002), Serbian (Feldman et al., 2002), Dutch (Zwitserlood et al., 2005; Zwitserlood et al., 1996), Polish (Reid & Marslen-Wilson, 2003), and Russian (Heyer & Kornishova, 2018) for derivational morphology. Although on different theoretical grounds, "convergence-of-codes" models (Gonnerman et al., 2007) also stress the importance of semantic relatedness between words, since word pairs with high semantic similarity (e.g. *payment-pay*) induced strong facilitation, words of moderate similarity (e.g. *shipment-ship*) intermediate facilitation, and unrelated words (e.g. *message-mess*) induced no facilitation at all.

However, comparable studies in German that applied similar priming conditions found no influence of semantic transparency on the way complex words are processed and represented (Baayen & Smolka, 2020; Smolka, 2019; Smolka & Eulitz, 2018; Smolka et al., 2009, 2014, 2015). These studies investigated complex (prefix or particle) verbs, that is, verb stems like *werfen* ('throw') combined with inseparable prefixes like *be-*, *ent-*, *ver-* or with separable particles like *an*, *auf*, *zu* that possess meanings of their own, arriving at different grades of semantic transparency with respect to the same stem. For example, the prefix and particle verbs *bewerfen* ('throw sth. at so.'), *zuwerfen* ('throw sth. to so.', 'slam'), *aufwerfen* ('pose a question'), *unterwerfen* ('subjugate'), *vorwerfen* ('accuse'), and *entwerfen* ('design') all vary from relatively transparent to relatively opaque with respect to their stem.

The results of several cross-modal and visual-visual priming experiments showed that the recognition of verb stems like *brechen* ('break') were facilitated by both

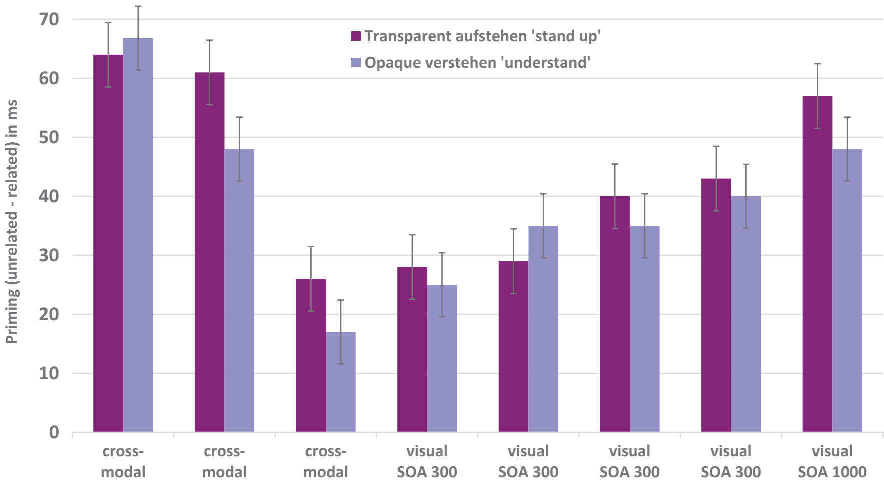

Fig. 2 The Y-Axis presents the priming effects of semantically transparent (e.g. *aufstehen*, 'stand up') and opaque (*verstehen*, 'understand') complex verbs as primes to their base targets (e.g. *stehen*, 'stand'). Priming is calculated relative to an unrelated prime. The X-Axis presents eight different experiments applying either cross-modal (auditory primes—visual targets) or within-modal (visual primes presented for 300 ms or 1000 ms—visual targets) priming. Y- bars present the standard error of the mean

semantically transparent prefixed verbs like *zerbrechen* ('break into pieces') and semantically opaque verbs like *verbrechen* ('commit a crime'), without modulation by degree of semantic transparency (see Fig. 2 for a summary of eight priming experiments). These morphological effects further strongly differed from both the facilitation by purely semantically related verb pairs (e.g., *zerbersten-brechen*, 'burst-break'), and the inhibition induced by purely form-related verbs pairs with similar stems (e.g., *verbrennen-brechen*, 'burn up-break') or embedded stems (e.g., *bekleiden-leiden*, 'dress-suffer'), confirming that the priming of morphologically related words was not due to meaning or form overlap between verb pairs holding the same stem. Most importantly, the rigorous design proved that these morphological effects were modality-independent and occurred under conditions that were sensitive to detecting semantic and form similarity (Smolka et al., 2014).

Subsequent studies further assured that strong priming without semantic transparency effects was not due to the syntactic or phonological properties of prefix and particle verbs (Smolka et al., 2019). A linguistically motivated concern was that the above experiments lumped prefix and particle verbs together, in spite of their different syntactic and prosodic characteristics, which may affect lexical processing. For example, as native speakers are used to encountering the separate stem in verbs with separable particles ('*Sie WIRFT ihm etwas VOR*', 'she accuses him of sth.', lit: 'she throws sth. before him'), they may access the stem regardless of whether the meaning of the whole word is semantically transparent or opaque. This should not be the case with verbs holding inseparable prefixes ('*Sie ENTWIRFT das Muster*', 'she designs the pattern'), where the stem never occurs by itself. To meet this concern, the two cross-modal experiments applied prefix and particle verbs in separate sets of semantically transparent and opaque verb conditions. The results replicated our previous findings of stem access—independent of semantic transparency and syntactic membership to inseparable prefix or separable particle verbs. It seems that form properties (and, to a lesser extent, the degree of semantic and form overlap between words) dominate lexical processing in German.

These results were further replicated by means of event-related potentials (ERPs; Smolka et al., 2015), which revealed widespread N400 modulations (i.e. negativities between 300 ms and 600 ms peaking at about 400 ms, hence called "N400") in response to morphologically related words—brain potentials that are generally taken to indicate expectancy and (semantic) meaning integration. Most importantly, the activation by semantically opaque verbs was equivalent to that by transparent verbs (see Fig. 3 in Smolka et al., 2015), and stronger than the activation by purely semantically related verbs or form-related verbs (see Figure 7 in Smolka et al., 2015).

Altogether, these findings provide strong evidence that German lexical processing and representation is driven by the verbal roots, regardless of their contribution to the whole-word meaning.

Most recently, these findings from German were also replicated with Dutch prefixed verbs (Creemers et al., 2020; Creemers & Embick, 2021; de Grauwe et al., 2019) with the results showing facilitation for both transparent and opaque forms, and suggesting that complex verbs are parsed regardless of their semantic transparency.

In summary, the above findings indicate that complex verbs in German and Dutch are lexically represented and processed via their stem, independent of their degree of semantic transparency. These findings strongly differ from those in other Indo-European languages like English and French, where semantic transparency determines the lexical accessing and processing of complex words. Hopefully, comparable experiments on Hebrew or Arabic verbs holding the same root but varying the verbal (*binyan*) patterns to derive semantically transparent and opaque derivations will be conducted in the near future.

4 Part C—The Processing of Roots and Stems in German Compounds

A newly-coined compound in German that gained notoriety during the Covid pandemic, *Teststrasse* ('test street'), demonstrates a class of words that are extremely common in German and many other (especially Germanic) languages.

Compounding is very productive and typically involves the combination of lexical stems,[8] so that the above compound can be easily expanded by adding the stem

[8] For an exception see *mein Ich-bewusstsein* ('my self-awareness, lit. I-awareness).

schnell ('rapid'), as in *Schnellteststrasse* ('rapid test street'). Different from English though, German bi- and multi-constituent compounds are typically written as single words (i.e. without spaces). The above examples further demonstrate that in German, as in other Germanic languages like Dutch and English, the right constituent of a compound is normally the so-called "head" that provides the basic meaning and specifies the grammatical category of the whole compound. Hence, *Schnellteststrasse* describes a type of a street in the form of a noun with feminine gender. Even though the left constituent or "modifier" of a compound is considered to define the head in more detail, it may nevertheless perform a significant semantic grouping function (e.g., Gagné & Shoben, 1997; Gagné & Spalding, 2009), as the following examples referring to *schnell* demonstrate, such as *Schnelltest* ('rapid test'), *Schnellbahn* ('rapid train'), *Schnellschrift* ('speed-writing'), *schnellwüchsig* ('fast-growing'), *Schnellkochtopf* ('pressure cooker'), *Schnellverbindung* ('quick connection').

4.1 Psycholinguistic Aspects of the Processing of Compounds

As in other complex word formations like prefix or particle verbs, the meaning of a compound may range from relatively semantically transparent as in *Apfelkuchen* ('apple cake') to semantically opaque, as in *Baumkuchen* ('a cake that resembles the annual rings of a tree', lit: 'tree-cake') or even more opaque *Mutterkuchen* ('afterbirth', lit: 'mother cake'), which contain a modifier or a head that renders the compound semantically more opaque. As with derivations, a long-standing research question concerns to what degree the meaning of the free-standing stems contributes to the meaning of the whole-word compound. To what degree does the semantic transparency of the constituents affect the recognition of a compound's meaning?

Numerous studies have shown that native speakers of a language access the constituents when perceiving a stimulus to be a compound (e.g., Kuperman et al., 2009; Libben, 1994; Zwitserlood, 1994). Semantically opaque compounds are generally processed more slowly than semantically transparent ones, and semantically opaque compounds are less likely to show constituent activation because the semantic opacity of the whole compound makes its constituents less salient and less useful to lexical comprehension (Libben et al., 2003; Sandra, 1994; Zwitserlood, 1994). Furthermore, the headedness of the compound and the transparency of its constituents play an important role in compound processing, and both factors seem to interact with each other. For example, compound processing is faster if the modifier is opaque, as in *shortcake* or *pothole*, than if the head is opaque, as in *jailbird* or *sourpuss* (e.g., Gagné & Spalding, 2009, 2014; Isel et al., 2003; Libben, 2014; Libben et al., 2003; Marelli & Luzzatti, 2012; Sandra, 1990; Zwitserlood, 1994). This has been interpreted to indicate a competition between the compound's constituents that correspond to independent words and their whole-word counterparts. For example, upon seeing the compound *shortcake*, the constituent /short/ may compete with the whole-word adjective *short* (e.g., Fiorentino & Fund-Reznicek, 2009; Frisson et al., 2008; Gagné & Spalding, 2009; Libben, 2006; Monahan et al., 2008). In contrast to constituent priming, lexical decisions—which are assumed to indicate processing at the lexical level—were shown to induce decomposition of both transparent and opaque compounds (Experiment 3 in Ji et al., 2011). Altogether, the above findings suggest that the mechanisms responsible for the processing of compounds are not yet fully understood.

To examine whether the lexical processing of German compounds is driven by semantic transparency, Smolka and Libben (2017) conducted an overt visual constituent priming experiment. They manipulated the semantic transparency of either the modifier, as in transparent *Hundeauge* ('dog's eye') versus opaque *Hühnerauge* ('corn'/ 'clavus', lit. 'hen's eye'), or the head, as in transparent *Lastesel* ('pack donkey') versus *Drahtesel* ('bicycle', lit. 'wire donkey'), where the reference to an actual 'donkey' is metaphorical.

For constituent priming of the modifier, participants saw modifiers like *Hund* ('dog') and *Huhn* ('hen') as primes and made lexical decisions to compound targets like *Hundeauge* and *Hühnerauge*, respectively. For the constituent priming of the head, participants saw a head like *Esel* ('donkey') and made lexical decisions to compound targets like *Lastesel* and *Drahtesel*; constituent priming was measured relative to matched unrelated nouns. Results showed a complex interplay between the frequency of the constituents and the frequency of the whole-word compound. For example, the whole-word frequency of a compound was facilitating (i.e., faster responses to high-frequency compounds), while head frequency was inhibiting (i.e., slower responses to compounds holding high-frequency heads), and modifier frequency was partly facilitating (i.e. only when the compound was preceded by low-frequency modifiers). These findings indicate that the frequencies of the constituents and whole-word compound affect compound processing as they do in other languages. Compound constituents and their corresponding independent words may in fact compete for activation in compound processing (e.g., Goral et al., 2008; Libben, 2014; Libben et al., 2021; Marelli et al., 2009).

In contrast to other languages, however, we found strong constituent priming, as responses to compounds were faster when the compound was preceded by a word that corresponds to one of its constituents as compared to an unrelated prime word (e.g., *Hund-Hundeauge* vs. *Rest-Hundeauge*). Most importantly, and similar to the previous findings on complex verbs, constituent priming was not affected by the semantic transparency of a compound. Rather, both modifiers and heads facilitated compound recognition regardless of their meaning relatedness to the whole-word compound. That is, semantically transparent and opaque modifiers like *Hund* and *Huhn* primed their compounds *Hundeauge* and *Hühnerauge* to the same extent, and semantically transparent and opaque *Esel* in compounds *Lastesel* and *Drahtesel* exerted the same amount of facilitation (Smolka & Libben, 2017).

We expanded this line of inquiry in a most recent ERP-study (Eulitz & Smolka, 2021) by examining whether compound processing in German is affected not only by semantic transparency but also by the familiarity of the constituent combination. To this end, we compared the brain potentials observed when participants read compound triplets that held the same head like *auge* ('eye') and were semantically transparent like *Hundeauge* ('dog's eye'), semantically opaque like *Hühnerauge* ('corn';

lit. ‘hen’s eye’), or novel (i.e. possible but nonexistent) like *Hosenauge* (‘trouser’s eye’). These findings are in line with those by Libben (2020) on novel compounds, showing that all lexical substrings that may be activated will be activated.

As expected from our behavioral results, and as depicted in Fig. 3, there were no reliable ERP effects that differentiated between semantically transparent and opaque compounds, regardless of whether the semantic transparency manipulation concerned the modifier or the head. However, novel compounds showed a more negative amplitude than either semantically transparent or opaque compounds. This N400 effect indicates that the brain differentiates between familiar (semantically transparent and opaque compounds) and novel (neologism) word combinations—an indication that novelty affects lexical processing, unlike semantic transparency. This finding is supported by the finding that familiarity may be more important than frequency (Sommer-Lolei et al. 2021).

Altogether, these findings indicate that the lexical processing of German compounds is independent of the semantic transparency of single constituents, and that constituent structure represents an important aspect of language processing in German. It is possible that the productivity of compounding in German generates a lexical processing ‘style’ in which native speakers abstract a constituent structure

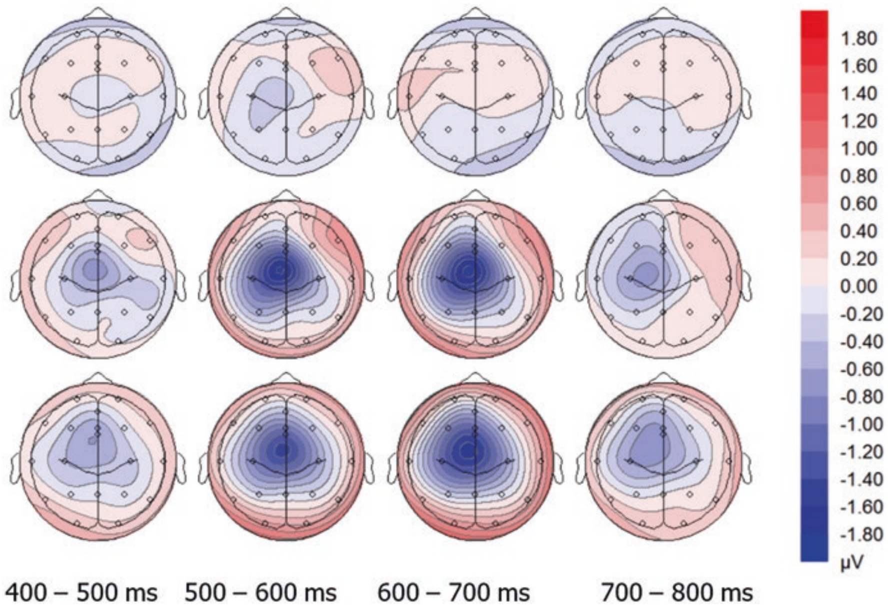

Fig. 3 Difference maps for the mean amplitudes in 100 ms latency windows from 400–800 ms: the upper row shows no reliable effect between semantically transparent (e.g. *Hundeauge*, ‘dog’s eye’) and opaque (e.g. *Hühnerauge*, ‘corn’, lit. ‘hen’s eye’) compounds. By contrast, novel compounds (e.g. *Hosenauge*, ‘trouser’s eye’) induce centro-parietal negativities (N400-effects) relative to familiar transparent and familiar opaque compounds in the middle and lower row, respectivley

regardless of the meaning of a particular whole-word compound: Lexical processing of an opaque compound like *Drahtesel* refers to its stems /draht/ and /esel/.

5 General Discussion

The current chapter investigated the key drivers of morphological processing in German. Motivated by the conflicting evidence on the role of constituent units in lexical processing and representation across languages (e.g., Bozic et al., 2013a, b; Carota et al., 2016; Günther et al., 2019; Smolka et al., 2014, 2019), we focused on the extent to which roots and stems might affect the processing of complex words in German. To this end, we have reviewed our plentiful findings in German along a continuum of complexity, including verb inflections, verb derivations, and compounding. The experiments varied in presentation modality (including cross-modal auditory-visual priming and within-modal visual-visual priming at long SOAs to tap into lexical processing), and measured response latencies as well as brain potentials.

With respect to verb inflections, we summarize the main findings as follows (Smolka et al., 2007, 2013, 2021a, b): First, behavioral responses indicate that *full* and *partial* priming effects (as indicative of stem access and whole-word retrieval, respectively) depend on word frequency rather than verb type/regularity. Response latencies further reveal equivalent participle priming by regular and irregular verbs, as soon as controls are rigorously matched. Second, brain potentials indicate that participles effectively prime their base verbs, with the priming effects gradually decreasing from regular verbs to semi-irregular verbs to the least priming of irregular verbs. Third, behavioral and ERP responses show that nonword participles (holding existing stems) prime their base verbs just as correct participles do (e.g., **geworft-werfen* versus *geworfen-werfen*), and regardless of whether they hold regular or irregular roots/stems.

Our main finding with respect to complex verbs (Baayen & Smolka, 2020; Smolka, 2019; Smolka et al., 2009, 2014, 2015, 2019) and compounds (Eulitz & Smolka, 2021; Smolka & Libben, 2017) is that neither behavioral nor ERP data reveal effects modulated by semantic transparency. That is, we observe equivalent priming by semantically transparent and opaque complex verbs to their base (*bewerfen-werfen*, 'throw at-throw' versus *entwerfen-werfen*, 'design-throw'), equivalent priming by semantically transparent and opaque modifiers to their corresponding compound (*Hund-Hundeauge* vs. *Huhn-Hühnerauge*), as well as equivalent priming by semantically transparent and opaque heads to their corresponding compound (*Esel-Lastesel* vs. *Esel-Drahtesel*). Brain potential results further reveal that familiarity outweighs semantic compositionality.

It is important to keep in mind that our repeated findings of "lack of verb regularity" or "lack of semantic transparency" effects do not represent "null effects" but rather result from priming effects of similar strength—between regular and irregular words on the one hand, and between semantically transparent and opaque words on the other hand. Rather, we take these findings to indicate a similar processing style for the different types of complex words.

Jointly, this set of findings points to a setup where the internal structure of complex words clearly plays an important role in determining how they are processed and represented in German. Because stems are accessed under cross-modal priming conditions (see Smolka, 2019; Smolka et al., 2019; Exp. 2 in Smolka et al., 2014), these findings further indicate that the lexical level includes modality-free representations of the stems. We now consider the overall implications of our results for lexicon-based or learning-based models.

5.1 Implications for Models of Complex Word Processing

Overall, our overview reveals a straightforward set of findings. It shows that roots and stems clearly play a prominent role in the processing of complex words in German, with root/stem effects observed across all types of complex words, and no modulations of either verb regularity (in inflections) or semantic transparency (in derivations and compounds). Rather, grouping across verb types occurred for frequency rather than regularity, and grouping across compound conditions occurred for familiar versus novel compounds rather than for transparent versus opaque compounds. Hence, nonlinguistic factors like frequency and familiarity seem to be more influential in the processing of complex words in German than linguistic ones.

We draw multiple inferences from the above findings. Firstly, we see this as strong evidence that the internal structure of words is one of the key processing cues for the listeners and readers of German, which is also reflected in the way complex words are processed and stored in their lexical memory.

This point is especially clear from the findings where all complex words—regardless of their semantic transparency—significantly facilitated the recognition of their constituent stems. This likely arises from the strongly combinatorial nature of the German language, where the frequent use of prefixed verbs, productive compounding, and morphology to express syntax (Smolka et al., 2014, 2019) might necessitate a processing and representational strategy where the internal structure of words is prominently marked for all complex words.

In considering how these findings fit into the existing lexicon-based or learning-based models, it is clear that they can only be accounted for by a model that assumes the same processing style for productive (regular, transparent) and unproductive (irregular, opaque) words. This would capture the continuous nature of both verb regularity and semantic transparency on the one hand, and the equivalent effects found for the different verb types and semantically transparent and opaque words in the reviewed data, on the other.

Within the framework of lexicon-based accounts, “dual-mechanism”, “dual-stage” or “dual processing” models, which require different types of processing for regular and irregular verbs or semantically transparent and opaque complex words, cannot readily account for the results in German. A possible model should rather assume a similar processing style for all types of complex words irrespective of their verb regularity or semantic transparency—be it whole-word or compositional processing. One of the possible options is a model proposed by Libben (2014, 2020), where whole-word activation and constituent activation both emerge from a single integrated processing activity.

Within the framework of learning-based accounts, distributed connectionist network models (e.g., Kielar & Joanisse, 2010; Kielar et al., 2008; Mirković et al., 2011) can readily explain the findings of modulated participle priming because graded priming patterns emerge from differences in the strength of form-to-meaning mappings across words. However, the lack of semantic transparency effects under overt priming does not support the assumptions of "convergence-of-codes" models, where the magnitude of priming effects reflects the degree of semantic and phonological overlap between words (e.g. *preheat-heat* vs. *midstream-stream* vs. *rehearse-hearse*). Importantly, these experiments (e.g. Marslen-Wilson et al., 1994; Gonnerman et al., 2007) applied cross-modal priming in English and tested both suffixed-stem pairs and prefixed-stem pairs (as in the examples), the latter types resembling the critical items used in our experiments in German.

Alternatively, the framework of the "stem-based frequency" account (Smolka & Libben, 2017; Smolka et al., 2007, 2014) takes care of the findings in German showing that root or stem access occurs in all complex words, including regular and irregular verbs as well as semantically transparent and opaque derivations and compounds. In this approach, representations of all constituents (roots, stems and affixes) co-exist, with connections between them capturing the most frequent co-activations of the constituents and the whole-word concept. Here, lexical entries of the base stems and the affixes are accessed first, followed by the activation of the whole-word concept due to the co-activation of the constituents.

While some models assume different stem representations for the syntactic categories of nouns and verbs, such as $time_N$ and $time_V$ respectively (e.g., Taft, 2004), in the stem-based frequency account, semantic similarity guides the organization of allomorphic stems, irrespective of word category and lexicality (i.e. free and bound stems). Hence, the stems /kauf/ and /käuf/ will cluster and refer to the same semantic concept of "buying"; /lauf/, /lief/, /läuf/ will cluster referring to the concept of "running"; and /werf/, /warf/, /worf/, /wirf/, /wurf/, /würf/ will cluster referring to the concept of "throwing".

Processing differences between regular and irregular verbs emerge due to two factors. First, the differences in stem frequencies, which are higher for stems of regular verbs like /kauf/ (all verb forms share the same stem) than for semi-irregular verbs like /lauf/ or /lief/ (with the same stem in fewer verb inflections), and lowest for irregular verbs (with many different stems, each used only once or twice). Second, differences in the frequency of the stem-affix combination, which represent whole-word frequency, will also play a role. The participle priming effects that we have observed in the form of graded N400 amplitudes and graded scalp distributions may reflect the differences in stem frequencies across the verb regularities: from strongest and most widely distributed effects in both amplitude and topography for regular verbs, to intermediate effects for semi-irregular, and weakest effects for irregular verbs.

The assumption of semantic clustering despite form variation (i.e. the same root in different stems) allows us to explain the data on nonword priming. Indeed, the findings that nonword participles like **gekäuft* and **gewurft* or **geworft* were as effective as correct participles in facilitating the base verbs strongly downplays the role of lexical storage. Note that the assumption of semantic clustering despite form variation fits well with the assumption of the "naïve discriminative learning" account (Baayen et al., 2011, 2015; Baayen et al., 2019; Baayen & Smolka, 2020), claiming that different forms become more similar because they correspond to the same semantic unit ("lexome"). Alternatively, the above findings in German may as well be captured within the naïve discriminative learner. Instead of interpreting the current results as stem-driven lexical access, this model would argue that they emerge due to prime-to-target pre-activation in a discriminative lexicon. Starting from letter trigrams, this approach was capable of modelling German priming data for semantically transparent and opaque prefixed verbs—including the lack of a semantic transparency effect (Baayen & Smolka, 2020). That is, the model mimicked "stem access" without an assumption of stems altogether. What remains to be shown is whether the naïve discriminative learner will be capable of capturing the nonword priming effects that we have shown for regular and irregular verb inflections.

5.2 Why Should German Differ?

Why should the results in German diverge from those observed in other Indo-European languages (Feldman et al., 2002; Feldman et al., 2004; Heyer & Kornishova, 2018; Longtin et al., 2003; Reid & Marslen-Wilson, 2003) and rather resemble those in Semitic languages (Boudelaa & Marslen-Wilson, 2004b, 2005; Frost et al., 2000)? This question is being asked regardless of the type of word form. Answers to this question can, of course, only be speculative regarding the structure of languages. It is possible that different languages vary in the extent to which they drive the development of such a representational level that encompasses constituent structure. Germanic languages like German and Semitic languages like Hebrew and Arabic share some typological characteristics that are characterize morphologically rich languages—they are synthetic (i.e. using many morphemes to express meaning), nonconcatenative (i.e. nonlinear), and they encompass morpho-phonological root/stem alternations (Smolka & Ravid, 2019). It is possible that these typological features drive similar psycholinguistic processes. Indeed, the simulation by Günther et al. (2019) shows that it is the language input that triggers differential processing styles across English and German.

In terms of the "ecological view" (e.g., Bick et al., 2011; Frost, 2009, 2012), the specific linguistic properties of a given language modulate the way it is processed, even though some language characteristics are universal. This view may well describe the situation with the German data: Even though German shares many features with other Indo-European, and in particular, Germanic languages, specific properties drive the development of a representational level that encompasses constituent structure. This paper thus stresses the importance of cross-language comparisons. For example, Dorit Ravid and her team (Levie et al., 2020) have pioneered the systematic investigation of verb-derived word families in Hebrew. A contrastive investigation to fill this gap for German and other languages waits to be conducted in the future.

5.3 Conclusion

This paper provides ample behavioral and electrophysiological evidence that native German speakers access and process the roots/stems in word formations of varying complexity, such as regular and irregular verb inflections, semantically transparent and opaque verb derivations and compounds. In sum, the current study shows that morphological structure is one of the key drivers of processing and representation of complex words in German, possibly more so than in the other Indo-European languages due to the morphological richness of the German language. A comprehensive model thus needs to adapt to these special characteristics of the German language and the mental lexicon of native German speakers.

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On the Subitizing Effect in Language Contact

Francesco Gardani and Chiara Zanini

Abstract Numerical cognition is an essential component of our daily life. It is the ability to process numerical quantities. In language, symbolic representations of numerical quantities are encoded by numerals. In situations of language contact, numerals are often borrowed from one language into another (Haspelmath & Tadmor, *Loanwords in the world's languages: A comparative handbook*. De Gruyter Mouton, Berlin, 2009), and it has been observed that high and more abstract numerals are more prone to borrowing than lower numerals (Matras, Yaron, *Language contact* (Cambridge Textbooks in Linguistics). Cambridge University Press, Cambridge, 2009: 202). Linguists mainly explain the higher borrowability of high numerals in sociocultural terms, for example, because of "their association with formal contexts of use" and "through intensification of economic activity" (Matras, Yaron, *Language contact* (Cambridge Textbooks in Linguistics). Cambridge University Press, Cambridge, 2009: 200). We propose an alternative explanation, informed by cognitive science, showing that low numerals are more resistant to borrowing than high numerals because they are more deeply anchored in cognition.

Keywords Borrowing · Language contact · Lexical borrowing · Linguistic typology · Numerals · Numerical cognition · Subitizing

1 Introduction

Numerical cognition is an essential component of our daily life. It is the ability to process numerical quantities. In language, symbolic representations of numerical quantities are encoded by numerals. Numerals are a near-universal category in

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language. Almost all languages of the world have number words, but they vary considerably with respect to how they encode numerosity[1] and which quantities they encode: some languages have an unlimited number of terms for quantities; others, such as some Australian (Zhou & Bowern, 2015) and Amazonian languages (Epps, 2013), have restricted numeral systems that extend only as far as 3 (e.g., Mangarrayi) or 5 (e.g., Yidiny) (Comrie, 2013); to date, researchers have identified only one language apparently missing numerals, namely Pirahã (Gordon, 2004; Everett, 2017).

In situations of language contact, numerals are often borrowed from one language into another (Haspelmath & Tadmor, 2009). However, not all numerals are borrowed equally, as low numerals are borrowed less frequently than high numerals (Greenberg, 1978; Thomason & Kaufman, 1988: 74; Matras, 2009: 202). Well-known cases include Japanese where "[w]ith a few lexical exceptions, the native system is now used only up to '10'; above '10', even those counters which prefer the native numerals must use the Chinese set" (Martin, 2004: 767). Often, however, only the lowest numeral range is resistant to borrowing: for example, in Yakkha, a Sino-Tibetan language spoken in parts of Nepal, Darjeeling district, and Sikkim, all numerals above 'three' are borrowed from Nepali (Schackow, 2015: 106). To explain this dissimilar borrowing behavior, linguists have resorted to sociolinguistic factors, such as the dominance of a language community over another, in terms of trade and education (Matras, 2007: 50–51). While this claim is virtually correct, it fails to capture some facts, for example, why it is precisely the group of the lowest numerals (one to three/four) that is more resistant to the pressure exerted by language contact. In this paper, therefore, we propose an alternative explanation, informed by cognitive science, which—we argue—will not only complement but also surpass the sociolinguistic explanation: we explore the hypothesis, informed by cognitive science, that lower numerals are more resistant to borrowing than higher numerals because the mental representation of the former is much more precise, more deeply anchored in cognition, and therefore less susceptible to change.

The article is structured, as follows. Section 2 details the two parallel and dissociated core systems responsible for non-symbolic and non-verbal numerical cognition, viz. the Parallel Individuation System and the Approximate Number System, and the two ensuing processes of enumeration, viz. subitizing and counting. Section 3 provides evidence for the interaction between numerical cognition and language in both monolingual and bilingual contexts, showing that the encoding of numbers and numerosities in language echoes the type of information processed by the non-verbal numerical systems. In Sect. 4, we explore the possibility that numerical cognition also plays a role in language contact and make the hypothesis of a subitizing effect on the borrowability of numerals. Section 5 illustrates the language sample, the dataset we built to test the subitizing effect hypothesis, and the statistical tests we performed on the data. The results are discussed in Sect. 5.3. Section 6 concludes the article.

[1] The term 'numerosity' was introduced by Nelson & Bartley (1961: 179). According to Ramirez-Cardenas & Nieder (2019: 102), it can be defined as "[t]he number of items in a set".

2 Numerical Cognition

Numerical cognition is the ability to process numerical quantities represented either symbolically (e.g., by the word *two* or the Latin digit *II* for the numerical quantity 2) or non-symbolically (e.g., by a set of two visual objects) (Piazza et al., 2007: 165). Symbolic numerical representation has been shown to be a cultural invention and language-specific, whereas the non-symbolic representation system does not depend on language competence, but rather relies on the core knowledge systems. The core knowledge systems are a set of non-verbal cognitive skills that allow humans to represent the most salient aspects of the environment, such as inanimate and animate physical objects, places in the spatial layout with their geometric relationships, time and numbers (Vallortigara et al., 2010), and to behave accordingly (Carey, 2009; Dehaene, 2011; Spelke, 2000). These skills seem to have played a crucial role in evolutionary success: they are present from birth in humans and are phylogenetically ancient, as they are mostly shared with non-human animal species (Cantlon & Brannon, 2007; Rugani et al., 2015; Spelke, 2000; Starr et al., 2013).

In every-day life, people resort to language while performing calculations and for this reason, mathematical reasoning would appear to be impossible to perform without the support of words and symbols. Recent studies, however, have shown that language is not a necessary condition for mastering basic numerical abilities (for a review cf. Gelman & Butterworth, 2005). This view is backed by the fact that numerical tasks can be solved also by non-human animals (Agrillo et al., 2007, 2014; Cantlon & Brannon, 2006; Rugani et al., 2013; Vallortigara, 2012), pre-verbal infants (de Hevia, 2011; de Hevia et al., 2014; McCrink & Wynn, 2007), adults who speak languages that (appear to) have no number words (Butterworth et al., 2008; Pica et al., 2004) and even educated adult humans under specific experimental conditions that prevent the use of language (Cordes et al., 2001).

Non-verbal numerical cognition is, in fact, thought to be based on two parallel, and dissociated, core systems: one system—labeled Parallel Individuation System (PIS, also known as ‘object tracking system’ in Shettleworth, 2010 or ‘object file system’ in Rugani, 2017)—is responsible for representing small sets of items (from 1 to 3–4). The other system—the Approximate Number System (ANS, also known as ‘analogue magnitude system’)—is responsible for approximate quantity estimation (Carey, 2009; Feigenson et al., 2004; Hyde, 2011; Hyde & Mou, 2016; Tzelgov et al., 2015).

The PIS allows human and non-human animals to identify a new object when this enters a real scene and to dedicate to it a corresponding file that is held in the working memory. The number of the files that can be simultaneously tracked and stored is usually limited to three or four (Trick & Pylyshyn, 1994; for differences across species as concerns the upper limit, cf. Carey, 2009). Thus, the effectiveness of this system—that allows enumeration without counting—relies on perceived spatio-temporal information and property changes. In other words, the PIS is based on the visual system used to localize and track objects in space (Dehaene, 2011: 57). It follows that PIS is not specific to number representation and, hence, number is just implicitly represented as the result of a series of visual operations. By contrast, the ANS is assumed to handle larger numerosities: it "allows individuals to perceive and approximately estimate numerosity without counting and using symbols" (Tikhomirova et al., 2019). This ability is generally measured by non-symbolic comparison tests in which individuals are asked to compare two arrays of objects (mostly dots) and to determine which array is larger or smaller (e.g., Smets et al., 2016). The ANS is ratio-dependent in compliance with Weber's law: as the ratio between the numbers to be discriminated increases, response times decrease and response accuracy increases (Gallistel & Gelman, 1992). Numerical discrimination becomes more precise with age (Halberda & Feigenson, 2008; Feigenson et al., 2004; Izard et al., 2009). For example, newborns can successfully discriminate arrays with a minimum ratio of 1:3 (e.g., 8 vs 24), while infants can estimate arrays with a 1:2 ratio at 6 months (e.g., 8 vs 16) and arrays with a 2:3 ratio at 9 months (e.g., 8 vs 12). The minimum discernible ratio increases for preschool children (3:4), and adults can discriminate ratios as small as 7:8.

The hypothesis of the independence of the mechanisms underlying the perception and representation of small vs large numerosities, viz. Parallel Individuation System vs Approximate Number System, is supported by several studies. For example, Hyde and Spelke (2011) measured event-related potentials (ERPs) activity in 6–7.5 months old infants while they were looking at either small (1–3) or large (8–32) sets of objects. The authors reported that small numbers were associated to an early occipital-temporal response peaking at about 400 ms, regardless of their ratio. By contrast, larger numbers were associated to a mid-latency parietal response, peaking at 500 ms, that was dependent on the ratio between successive large numbers. Evidence also comes from recent studies on children with developmental dyscalculia, showing that subitizing was intact, whereas large numerosity comparison was impaired (Decarli et al., 2020). Consequently, two processes of enumeration can be identified: 'subitizing'—the ability to enumerate small quantities (1–4 objects) in a rapid (40–100 ms/item), effortless, and accurate way (Kaufman et al., 1949); and 'counting'—the ability to process more than 4 items, which is slow (250–350 ms/item), effortful, and error-prone (Trick & Pylyshyn, 1994). Numerals from 1 to 4 belong to subitizing, obey a pre-attentional mechanism, they are so to speak primitive, more natural, more immediate (Green, 2017), whereas higher numerals belong to counting and are a result of enculturation. (But note that Frank et al., 2008: 819 consider "language for exact number [...] a cultural invention rather than a linguistic universal".)

Although the dissociation between the two core systems responsible for nonverbal numerical cognition has been observed across human and non-human animals (Hubbard et al., 2008; Hurford, 1987; Kawai & Matsuzawa, 2000; Posid & Cordes, 2015),[2] the core system underlying subitizing has been claimed to be "both ontogenetically and phylogenetically primitive" (Hauser & Spelke, 2004: 861), and

[2] In non-human animals, the ANS has been found consistently in trained animals, from apes to bees, but also in numerous vertebrate species (cf. Nieder, 2020 and references therein).

subitizing has been claimed to reflect fundamental perceptual, attentional, and cognitive capacity limitations such as working memory storage capacity (Cowan, 2001, 2010); according to Dehaene (2011: 80), "[w]hen our species first began to speak, it may have been able to name only the numbers 1, 2, and perhaps 3". Crucially, subitizing is ontogenetically primary as it develops before counting, as studies on infants have demonstrated (Starkey & Cooper, 1995).

3 The Signature of Numerical Cognition in Language

As we have seen, both core systems responsible for non-verbal numerical cognition, viz. PIS and ANS, are shared by human and non-human animals. By contrast, the symbolic representation of numerosity is argued to be "unique to humans and requires the ability to precisely represent numerosity verbally as number words or visually as Arabic number symbols" (Tikhomirova et al., 2019). According to Hurford (1987: 1), "the structure of natural numeral systems turns out to yield a rich vein of evidence that can be brought to bear on central questions of the nature of language, the relation of language to mind and society, and the nature of number." However, reactions to Hurford's input have mostly followed a language-relativistic Whorfian perspective so as to ask whether and, if so, to what extent calculation can be performed without using number words (cf. Pica et al., 2004 on the Munduruku community in the Tapajós River basin and Spaepen et al., 2011 on the Nicaraguan homesigners). The reverse prospective, which pursues questions such as whether cognitive abilities common to humans have contributed to constrain the range of grammatical possibilities and whether such constraints have resulted in crosslinguistic trends (Christiansen & Chater, 2008), has received much less attention. Here, we take this perspective, as we are interested in the question whether numerical cognition shapes the resources that language users resort to, to express numbers and quantities.

As we said in Sect. 2, the non-symbolic representation system—responsible for both subitizing and counting—relies on the core knowledge systems and does not depend on language faculties. However, the symbolic and the non-symbolic systems are not totally independent from each other, rather they interact. Neuropsychological studies have provided robust evidence that the non-symbolic system is fundamental in the construction of the symbolic system and constantly interacts with it (Cantlon, 2018; Furman & Rubinsten, 2012; Notebaert et al., 2011; Piazza et al., 2007; Wynn et al., 2013). This suggests that access to the symbolic system such as the verbal representation of numerosity in language can imply access to the non-symbolic system. Clear evidence for the interaction of the two systems comes from the so-called SNARC (Spatial-Numerical Association of Response Codes) effect (Dehaene, 2011; Dehaene et al., 1993; Fischer & Shaki, 2014; Göbel et al., 2011; Winter et al., 2015). The SNARC effect relates to the mental number line in long-term memory, a spatial representation of numbers along a left-right-oriented continuum, such that small numbers would be located on the left side and large ones on the right side

(Galton, 1880). This spatial-numerical association constrains the performance in numerical tasks: as a matter of fact, adults (but also pre-verbal human infants and animals, cf. de Hevia & Spelke, 2009; Rugani & de Hevia, 2017) have been shown to process small numbers faster when their responses are executed with the left hand (e.g., with left side buttons) and to process large numbers faster when their responses are executed on the right hand (e.g., with right side buttons). The SNARC effect has been demonstrated for both Indo-Arabic numeral digits and number words (Landy et al., 2008; Nuerk et al., 2004; Nuerk et al., 2005) and notably, only when the tasks required the semantic processing of numerical magnitude (Fias, 2001). For example, a SNARC effect is reported robustly in parity judgement tasks (in which participants are asked to judge whether number words are smaller or larger than a reference number), whereas it has not been observed in asemantic phoneme monitoring tasks (in which subjects are asked to decide whether or not a certain phoneme is contained in the number word displayed). Roettger and Domahs (2015) found a SNARC-like effect in a series of speeded behavioral response tasks using German words that varied in grammatical number. The authors found that words inflected in the singular had a relative left-hand advantage and words in the plural a relative right-hand advantage, suggesting that grammatical number is also affected by numerical processing. The deep connection between physical size and numerosity (numerical quantity) is also supported by studies concerned with gestures performed while producing linguistic expressions of size, such as the metaphors 'tiny number', 'small number', 'large number', and 'huge number' (Woodin et al., 2020).[3]

Psycholinguistic studies that aim to test models of lexical organization in bilinguals and models of word translation provide evidence that numerical information is accessed during language processing even in multilingual contexts. In three pivotal studies, De Brauwer et al. (2008) and Duyck and Brysbaert (2004, 2008) have shown that semantic processing is almost always activated in translation tasks, especially with words that share similar meanings in both languages and are not cognates (i.e., their forms are not similar). This is precisely the case of number words. The authors conducted several tasks involving bi−/trilingual participants and found a robust SNARC-like effect in parity judgement tasks (in which participants were asked to judge the parity of written L2 number words by pressing a key with the left or right hand) as well as in simple translation judgement tasks (in which participants were asked to specify whether two number words were each other's translation).

[3] It is worth noticing that there is no consensus on the phylogenic origins of the mental number line. Some scholars have argued that the left-right-oriented continuum is innate, as its signature has been found in several studies of pre-verbal infants and non-human animals (e.g., Rugani et al., 2015; Rugani & Regolin, 2020). Other authors have challenged this view, claiming that the direction of this mental mapping is modulated by one's cultural experience (e.g., Pitt et al., 2021). This debate, however, is beyond the scope of the present article. What is important to stress here is that, even if the direction of the association between numbers and space may vary as a function of exposure to culture and could depend on the direction of writing (so that the SNARC effect can be weakened or reversed in right-to-left writing systems; e.g., Dehaene et al., 1993), the SNARC effect "reflects the automatic activation of quantity information in the subject's brain" (Dehaene, 2011:81).

Notably, this SNARC-like effect—which was unrelated to the participants' L2 proficiency—was interpreted as the signature of conceptual mediation during number word translation (especially when translating from L2 to one's L1). Duyck and Brysbaert (2004, 2008) also reported a magnitude effect as L2 number words denoting small quantities (e.g., *two*) were faster to translate than L2 number words denoting large quantities (e.g., *eight*) (for further discussion cf. also Brysbaert & Duyck, 2010).

All the evidence thus far reported suggests that the structure of languages echoes the information processed by the non-verbal numerical systems. This is, in fact, not surprising. As stated in Sect. 2, non-verbal numerical cognition—as part of the core knowledge systems—is fundamental for biologically successful behavior (Spelke, 2000). If core knowledge information is biologically fundamental to the extent that it constrains numerical cognition even when numerical magnitude is represented and processed symbolically (Cantlon, 2018), delivering this kind of information in a prompt and efficient way, such as by means of language, is expected to be advantageous. A growing body of literature has shown that this type of information can contribute to shaping languages from the lexicon to syntax. For example, using data-driven computational models and performing an analysis on nine different languages, Rinaldi and Marelli (2020) showed that the use of number words in spontaneous language production depends on numerical ratio—a clear signature of Weber's law and of the Approximate Number System (Sect. 2). This system is indeed ratio-dependent: as the ratio between the numbers to be discriminated increases, response times decrease, and accuracy increases. Rinaldi and Marelli (2020) also reported that number words referring to lower numerosities are used more precisely and in more specific contexts than those referring to higher numerosities. In previous work, Dehaene and Mehler (1992) had arrived at analogous results. The authors measured the frequency with which number words are used (both in speech and in writing) in different languages and found that the frequency of numerals decreases systematically with number size, regardless of cultural, geographic, and linguistic differences. Moreover, in languages such as English, words expressing twoness or threeness (e.g., bicycle and triangle, respectively) are by far more type-frequent than those expressing fiveness or large numerosities (e.g., quinquennial). The use of number words resembles those of digits. In this respect, it has been calculated that 1, 2, or 3 are twice as likely to occur as all other digits (Dehaene, 2011). According to Dehaene (2011), the observed distribution of number words in the lexicon of diverse languages is not due to environmental or cultural biases. Rather, the fact that there are more words to denote small numbers and progressively fewer words to denote increasingly larger numerosities, resonates with "the decreasing precision with which numbers are mentally represented" (Dehaene, 2011: 110) so that "numerical regularities in the world seem to be lexicalized only if they concern a small enough numerosity" (Dehaene, 2011: 113).

Evidence for the idiosyncratic character of the lowest numerals (1 to 3 and 4) comes also from within grammar. Because of their indicative-deictic character (Seiler, 1990: 190), very low numerals are often associated with referential functions (determination): for example, the numeral for 1 also serves as an indefinite determiner in many languages (e.g., *un* 'one / a(n)' in French; cf. Givón, 1981 for a diachronic account on this development drawing on Hebrew examples). The use of the numeral for 1 as an indefinite determiner is attested in a high number of unrelated languages from Mandarin to Native American languages, such as to make it a good candidate for a linguistic universal. An inspection of the WALS Online corpus (Dryer & Haspelmath, 2013) reveals that the numeral 'one' is used as indefinite article in 112 out of 534 reported languages (198 of these have neither an indefinite article nor a definite article; cf. Map 38A by Dryer, 2013b). For similar reasons (e.g., indicative-deictic character), in inflecting languages only the lowest numerals (notoriously those for 1, 2, 3) are sensitive to gender and case distinction (Blažek, 1999; Gvozdanović, 1992; Hurford, 1987: 192). This is the case, for example, in Ancient Greek (*heîs*, *mía*, *he* 'one.M, one.F, one.N'; *treîs*, *treîs*, *tría* 'three.M, three.F, three.N'; *téttares*, *téttares*, *téttara* 'four.M, four.F, four.N'), Latin (*ūnus*, *ūna*; *ūnum* 'one.M, one.F, one.N'; *duo*, *duae*, *duo* 'two.M, two.F, two.N'; *trēs*, *trēs*, *tria* 'three.M, three.F, three.N'), Romanian *unu*, *una* 'one.M, one.F'; *doi*, *două* 'two.M, two.F') and Croatian (*jedan*, *jedna*, *jedn* 'one.M, one.F, one.N'; *dva*, *dvije*, *dva* 'two.M, two.F, two.N').

Importantly, Franzon et al. (2019, 2020) argued that nonverbal numerical cognition also shapes grammatical number. The authors provided typological and neuropsychological evidence in favor of the hypothesis that the possible range of inflectional number values (as reflected, for example, in the inflection of nouns such as *apple* vs *apples*) parallels the numerosities processed by the non-verbal numerical core knowledge systems. Indeed, grammatical number is a widespread typological feature (according to map 33A by Dryer, 2013a in WALS Online, 90.8% of the considered languages have a grammatical device to convey nominal plurality; cf. Corbett, 2012: 122) and presents a variety of values across languages, including, at least, singular and plural (i.e., the necessary condition for other values to surface), but also dual, trial, (debatably quadral), paucal, greater paucal, and greater plural for two, three, (four), a few, a few more, and excessive number, respectively. However, grammatical number values never denote any exact numerosity beyond the range of 1 to 3 (and 4) and no morphologically encoded number value for, say, 21 has ever been observed in natural languages.

4 The Hypothesis: The Subitizing Effect in Language Contact

When communities speaking different languages come in contact with each other (societal multilingualism), or when different language systems coexist in one and the same speaker (individual multilingualism), several parts of a language—a source language (SL)—can be transferred into a recipient language (RL). Which parts of an SL come to be transferred into an RL, and with which frequency this occurs, depends on several factors. There seems to be general agreement on the fact that not all parts of a language's grammar are subject to transfer to equal extents. This idea is often conceptualized and conveyed in terms of borrowability scales, that is, hierarchies that detail, and in some cases aim at predicting, the likelihood with which some items or components of grammar are borrowed (see useful overviews in Bakker & Matras, 2013: 165–174; Curnow, 2001; Wohlgemuth, 2009: 11–17). As concerns numerals, it has been observed that high and more abstract numerals are more prone to borrowing than lower numerals (Matras, 2009: 202). However, not all numerals are borrowed at the same rate. Crosslinguistic investigations have shown that low numerals are borrowed less frequently than high numerals (Greenberg, 1978; Matras, 2009: 202; Thomason & Kaufman, 1988: 74). This generalization is roughly mirrored in Greenberg's "near-universal" 54: "If an atomic numeral expression is borrowed from one language into another, all higher atomic expressions are borrowed" (Greenberg, 1978). Based on a sample of 27 languages, Matras (2007: 50–51) reported that lower numerals are less likely to be borrowed than higher ones (e.g., *twenty, one-hundred, a billion*) and proposed the following implicational borrowability scale for cardinal numerals:

higher numerals 1000, 100 > above 20 > above 10 > above 5 > below 5.

According to Matras, the split observed between lower and higher numerals would follow from the dominance of a language community over another in formal contexts such as trade, education, and institutional discourse. Clearly, formal contexts more often involve reference to higher numerals and thus foster their borrowing. Conversely, lower numerals, especially the ones expressing quantities smaller than five, are frequently used in casual contexts, a self-explanatory fact for the retention of their native forms.

While this claim seems reasonable, it fails to clarify some points. First, if it is evident that formal contexts almost always require reference to large quantities, it is not as clear why informal contexts would mostly imply reference to smaller quantities. After all, it has been amply shown that our environment is not more frequently composed of small sets of objects than of large ones (Dehaene (2011: 80). Second, from a mere culture-centered perspective, it is far from straightforward to outline the criteria by which a quantity should be defined as small or large. For example, 2 is smaller than 7, and 7 is far smaller than 100. In fact, Matras claims that "conceptual complexity and inaccessibility" play a role, as is evident from that fact that the borrowing ranking for numerals for "0" is closer to that of numerals for "100" and "1000", which he explains with "the ability to easily identify and appreciate a quantity" (Matras, 2007: 52), which does not apply to "zero". And yet, how do we explain the fact that for numerals, such as one, two, three and four, the borrowing chances decrease dramatically? And why is the borrowing threshold almost always set at three/four?

In a paper focusing on Berber varieties, Souag (2007) proposes multiple answers to these questions. As for the numeral for 1, he proposes a frequency-based motivation: the fact that across most Berber languages, the numeral for 1 also serves as a determiner considerably increases its frequency and so discourages its replacement. As for the numerals for "two" and "three", Souag (2007) says that their retention "is paralleled by several other typological facts", such as the existence of dual and trial—but no higher—number values in a number of languages (cf. Sect. 3). Eventually, Souag (2007: 242) weighs also "cognitive factors, such as the possibility of subitisation and the processes involved".

Putting aside language contact for a moment, we can observe that crosslinguistically, the number of numerals progressively decreases as they encode increasingly larger numerosities. The distribution of numerals in the lexicon as well as their frequency of use across typologically diverse and geographically distant languages appears not to be random or solely attributable to sociocultural factors. Rather, it seems to follow precise patterns that can be captured in terms of cognitive pressures. Specifically, the progressive decrease of number words to designate increasingly larger numerosities seems to reflect the way numerical information is mentally represented and processed. Low numerals encode quantities which are processed via subitizing (Sect. 2); subitizing is a mechanism more deeply anchored in cognition than counting, and this makes low numerals more salient for the speakers. Hence, the fact that, overall, languages have more words to express low numerosities is not because the referential world comprises mostly sets of few items, but because the mental representation of low numerosities is more precise. Further evidence for this is that virtually all languages have at least words to designate low numerosities, and even the very few languages apparently missing numerals show a lexical opposition to distinguish small quantities from relatively larger ones.

In this paper, we propose that the different behavior of low vs high cardinal numerals in language contact is also explainable in cognitive terms, as it reflects the way numerical information is represented and processed in the brain. Specifically, we argue that lower numerals undergo borrowing less frequently than higher numerals as an effect of subitizing: the mental representation associated to the lowest numerals (*one, two, three*, and possibly *four*) is much more precise, more salient, more deeply anchored in cognition, and therefore more stable and less susceptible to change. In other words, while sociocultural pressures can certainly play a role in the borrowing of high numerals (Matras, 2007: 50–51), their impact on low numerals is countered by phylogenetically ancient and evolutionarily successful cognitive abilities which have also been shown to affect language processing. In the next section, we detail the language sample we have built to test our hypothesis and present the results of our investigation.

5 Data and Analysis

5.1 Dataset and Methods

In order to test the hypothesis of a subitizing effect on the borrowability of numerals (Sect. 4), we created a language sample that includes:

– 25 typologically diverse recipient languages, comprising one creole, one isolate language, and 23 belonging to 15 language families (Afro-Asiatic, Austroasiatic, Austronesian, Hmong-Mien, Indo-European, Japonic, Khoisan, Matacoan, Nadahup, Niger-Congo, Nilo-Saharan, Sino-Tibetan, Tai-Kadai, Tupian, Uto-Aztecan), spoken in four geographical macro-areas (Africa, Europe and Asia, North and Central America, South America, and the Pacific);
– only languages in which at least one numeral from "one" to "ten" has been borrowed;
– creole languages, only as they secondarily borrow from other languages, that is, the use of numerals already existing in a creole's lexifiers is excluded, as it is not considered as borrowing (cf. Gardani, 2008, 2012, 2018, 2020b);
– only cases of borrowed numerals in the sense of matter borrowing, that is, the takeover of concrete (phonological and morphological) material (cf. Gardani, 2020a).

We focused not on whether numeral borrowing is possible at all, but on which numerals are borrowed, when numerical borrowing occurs. For this reason, among others, our sample is smaller than samples used for lexical borrowing in typological research such as Haspelmath and Tadmor (2009), which counts 41 recipient languages.

We analyzed our data by means of the R software (R Core Team, 2020). First, we calculated the proportion of borrowed and inherited forms per each numeral and, controlling for lexical variants, counted the ratio of borrowed numerals for which there exist no further inherited variants to borrowed numerals for which there also exist non-borrowed variants. Then, following Baayen (2008) and Tagliamonte & Baayen (Tagliamonte & Harald Baayen, 2012), we investigated the differences in the proportion of borrowed and inherited forms per each numeral by means of conditional inference trees and random forest, making use of the party package in R (Strobl et al., 2007; Strobl et al., 2008; Hothorn et al., 2006). These non-parametric models[4] are particularly suitable when the sample size is small while the number of predictors is high, and are robust in case of outliers; moreover, "random forests allow the researcher to explore more aspects of the data and by consequence more insights into the explanation for variable processes" (Tagliamonte & Baayen Tagliamonte & Harald Baayen, 2012: 163). We fitted a random forest model to inspect the importance of the variables that possibly come into play in the borrowing of numerals, considering the type of etymon (inherited vs borrowed) as the dependent variable and the type of numeral (from 1 to 10), the language family, the geographical area, and the presence of non-borrowed lexical variants (yes/no) as

[4] The algorithm tests the association of each independent variable with the dependent variable and chooses the independent variable with the strongest association. On this basis, it parts the dataset in two subsets. The algorithm recursively repeats this sequence (i.e. choosing the best association and further splitting the dataset) until no variables can be associated with the outcome. The results are plotted as a tree structure. A random forest can be grown from many conditional trees and returns the importance measure of each independent variable averaged over many conditional trees.

predictors. We also fitted a conditional inference trees model using the same predictors to check how these variables operate together.

5.2 Results

The results of the data analysis are summarized in Table 1. For the actual data see *Appendix 1*. We found that the ratio of borrowed forms increases as the numerosity denoted by the numerals increases and noticed that a threshold obtains between the group of numerals ranging from 1 to 3 (borrowed forms: 18.18% to 26.66%) and the group of the numerals ranging from 5 to 10 (borrowed forms: 48.48% to 70%). The numerals encoding 4 display a behavior in-between, while being slightly more inclined towards the group of the lowest numerals than that of the higher numerals in the data set.

Figure 1 illustrates the proportion of *all* borrowed and *all* inherited forms per each numeral. Here, borrowed and inherited forms show an opposite trend. While the borrowed forms increase progressively in correspondence with higher numerals, the inherited forms decrease. Here too, a clear threshold can be observed between the group of numerals ranging from 1 to 3 and that of the numerals ranging from 5 to 10.

Further, we counted the ratio of borrowed numerals to borrowed numerals for which there also exist non-borrowed variants. We found that, when numerals belonging to the range from 1 to 4 have been borrowed, there mostly also exist inherited correspondents or a non-borrowed series. As shown in Table 2, the ratio of borrowed numerals to numerals for which there are non-borrowed variants decreases progressively, with only numerals for 10 displaying a deviant behavior.

In the random forest model, the variable importance scores revealed that the type of numeral (0.148) is by far the most important predictor when analyzing the probability for a borrowed numeral form to occur. Some predictivity can be spotted also for the language family (0.071) and the presence of non-borrowed lexical variants (0.030), whereas the geographical area does not seem to contribute statistically significant effects. The index of concordance for the model with this set of predictors is equal to C = 0.94.[5] The impact of variables is plotted in Fig. 2.

Table 1 Ratio of borrowed to total numerals in a 25-language sample

	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten
∑ forms	33	31	30	32	33	28	31	29	30	32
∑ borrowed	6	8	8	12	16	18	19	19	21	21
Borrowed:Total %	**18.18**	**25.80**	**26.66**	**37.50**	**48.48**	**64.28**	**61.29**	**65.51**	**70.00**	**65.62**
Borrowed:Total ratio	**0.18**	**0.25**	**0.26**	**0.37**	**0.48**	**0.64**	**0.61**	**0.65**	**0.70**	**0.65**

[5] C is an index of the goodness of fit of the model. A C greater than 0.8 indicates that the model discriminates well.

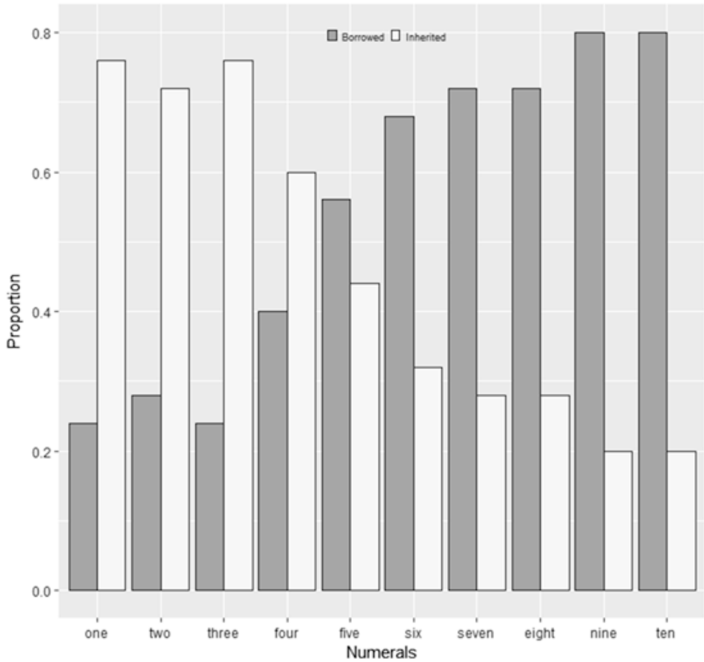

Fig. 1 Proportion of all borrowed (in dark gray) and all inherited (in light gray) forms across numerals

Table 2 Ratio of borrowed numerals to borrowed numerals for which there are non-borrowed variants in a 25-language sample

	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten
∑ borrowed	6	8	8	12	16	18	19	19	21	21
∑ borrowed of which variants	5	6	4	6	8	4	4	4	4	6
Ratio	**0.83**	**0.75**	**0.5**	**0.5**	**0.5**	**0.22**	**0.21**	**0.21**	**0.19**	**0.28**

Consequently, we grew a conditional inference tree (C = 0.85) to check how the predictors evaluated by the random forest interact with each other. All significant predictors in the random forest model were included. The tree and its possible splits are plotted in Fig. 3. The first and most important split (Node 1) separates numerals encoding 1, 2, 3, and 4 from numerals encoding higher numbers. The next split is located in the left branch and divides forms for which a non-borrowed variant is attested from those for which no lexical variant exists. Regarding the latter, a further node (Node 4) parts the data on the basis of the language family. Moving rightwards, Node 7 separates numerals higher than 4 on the basis of the language family and no further split is observed. The bar plots at the bottom show that numerals equal to and lower than 4 are unlikely to be borrowed (cf. Node 6 vs Node 5) and,

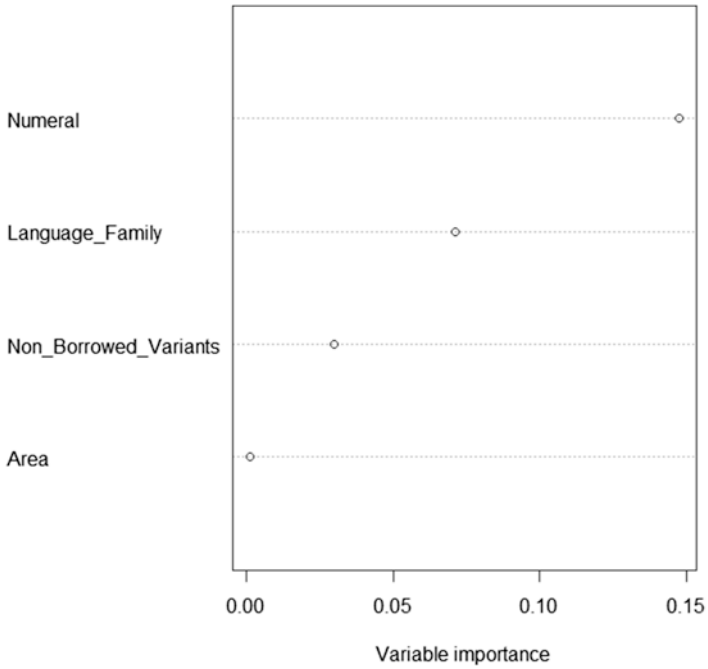

Fig. 2 Conditional permutation importance of variables in the occurrence of borrowed vs inherited numerals

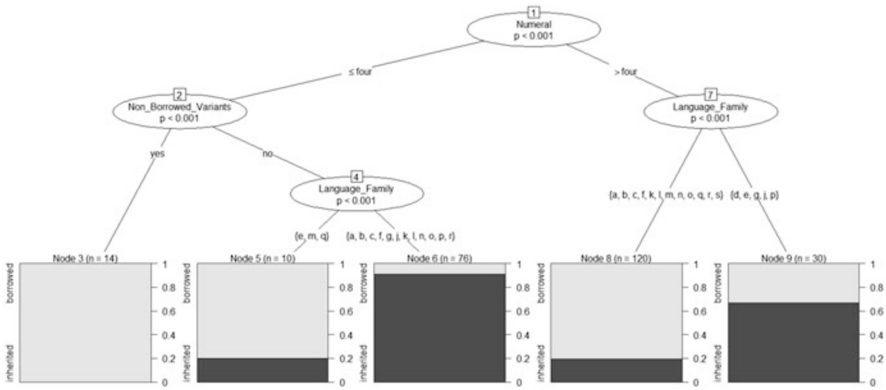

Fig. 3 Conditional inference tree of the occurrence of borrowed vs inherited numerals. The variables selected for the best split and the corresponding p-values are circled; the branches specify the levels of the variables; the bar plots at the bottom illustrate the proportion of inherited forms (in dark gray) vs borrowed forms (in light gray) in each end node that contains all observations for that combination of features. Language families are indicated by lowercase letters in the plot (a = Austroasiatic, b = Afro-Asiatic, c = Nadahup, d = Japonic, e = Khoisan, f = Indo-European, g = creole, j = Niger-Congo, k = Austronesian, l = Nilo-Saharan, m = Tai-Kadai, n = Sino-Tibetan, o = isolate, p = Hmong-Mien, q = Matacoan, r = Tupian, s = Uto-Aztecan)

if borrowed, non-borrowed lexical variants are also likely to be present (cf. Node 3). Conversely, numerals higher than 4 are more likely to be borrowed than lower numerals (cf. Node 6 vs Node 8) and in this case, borrowability appears to be modulated only by genealogical factors.

5.3 Discussion

We provide an analysis of the data along the following lines: First, the results unambiguously confirm the generalization, known from the extant literature, that lower numerals are less prone to borrowing than higher numerals. Second, the data show that in terms of borrowing frequency, there exists a clear threshold between the group of numerals ranging from 1 to 3–4 and that of the numerals ranging from 5 to 10. This perfectly matches with the divide between subitizing and counting theorized in cognitive science. The range from 1 to 3–4 corresponds to the symbolic representation of numerosities that are subject to subitizing. The range from 5 to 10 corresponds to the symbolic representation of numerosities that are processed by counting. We interpret these data as a sign of the signature of cognition in language. Third, the fact that, if the lowest range of numerals are borrowed at all, then still non-borrowed variants exist, further backs our hypothesis of a subitizing effect in language contact.

While the figures we presented in Tables 1 and 2 can be explained in terms of the hypothesis we made in Sects. 3 and 4, they can be just as well accounted for by the sociocultural explanation predominant in the literature (cf. Sect. 1). However, a clear clue that our cognition-based threshold hypothesis is superior comes from the statistical analysis we performed. The trees method makes it possible to measure the importance of the variables at play and, on that basis, to operate the best splits of a dataset. Crucially, our models chose the predictor 'type of numeral' as the most important independent variable in explaining the distribution of borrowed numerals (random forest) and set the first split at 4 (conditional inference tree). In other words, the borrowing dynamics underpinning lower numerals ranging from 1 to 4 appear to be different from those underpinning numerals higher than 4. It is somewhat hard to explain the partitioning of the data by the models from a perspective grounded only on sociocultural factors. Why 4 and not, for example, 5? Ultimately, both 4 and 5 denote low numerosities. In our view, a hypothesis also informed by cognitive science offers a more precise and a falsifiable explanation. While sociocultural variables cannot be completely excluded, especially as concerns higher numerals, our results clearly point to a priority of cognitive pressures in preserving the inherited forms of lower numerals, precisely up to 3–4. Hence, the distribution of borrowed number words across typologically diverse and geographically distant languages, like those included in our dataset, appears not to be random or solely attributable to sociocultural factors. Rather, it seems to follow a precise pattern that can be captured—we claim—in terms of subitizing effects, as proposed in Sect. 4.

6 Conclusion

In this paper, we explored the hypothesis that non-symbolic numerical cognition plays a role in language contact, as it influences the borrowing chance of number words in a decisive way. We set out from known facts as to the extent to which numerals are subject to borrowing (their borrowability) in situations of language contact. According to the received knowledge, lower numerals are more stable than higher numerals in that they are observed to resist borrowing more frequently. To date, linguists have explained this pattern mainly resorting to sociocultural motivations, claiming that higher numerals are more prone to borrowing as a consequence of intensification of economic activity and of education. While sociocultural pressures can certainly play a role in the borrowing of higher numerals, in our study we took the perspective of cognitive science and proposed an alternative and—we think—superior explanation.

We argued that lower numerals are more resistant to borrowing than higher numerals as an effect of the way numerical information is mentally represented and processed: very small quantities (up to 3, possibly 4) are processed via subitizing, a mechanism more deeply anchored in cognition than counting that makes the mental representation of low numerosities more precise and, thus, low numerals more salient for the speakers. Accordingly, we hypothesized a subitizing effect on the borrowability of numerals. We tested this hypothesis against empirical evidence drawn from a sample of 25 typologically diverse recipient languages. We performed statistical analysis to investigate the differences in the proportion of borrowed and inherited forms per each numeral by means of conditional inference tree and random forest models. The results unambiguously confirm the prediction, known from the extant borrowability scales, that lower numerals are less prone to borrowing than higher numerals. Crucially, our results show the signature of cognition in language, which is due to the interaction of the non-symbolic and the symbolic systems: in terms of borrowing frequency, there exists a clear threshold between the group of numerals ranging from 1 to 3–4 and that of the numerals ranging from 5 to 10. This threshold—we argue—results from the impact that phylogenetically ancient and evolutionarily successful cognitive abilities have on language processing and thus on borrowing behavior.

Appendix 1

Numerals: One–Four (Part A)

Languages			Numerals							
Areas	L family	RL name	One	*B vs I*	Two	*B vs I*	Three	*B vs I*	Four	*B vs I*
Europe and Asia	Austroasiatic	Ceq Wong	nãy		ber		pɛt		pɑn	
Europe and Asia	Austroasiatic, Munda	Bondo	mujũ		mbaru		iʔŋge		uʔu	
Africa	Afro-Asiatic, West Chadic	Hausa	ɗáyá		bíyú	B, SL Benue-Congo languages	úkù		húɗú	
South America	Nadahup	Hup	ʔayǔp		koʔăp		mɔtaʔăp		hibab’ní	
		Hup variants								
Europe and Asia	Japonic	Japanese	hitotsu		futatsu		mittsu		yottsu	
		Japanese variants	ichi (2)	B, SL Chinese	ni (1)	B, SL Chinese	san	B, SL Chinese	yon	
		Japanese variants							shi	B, SL Chinese
Africa	Khoisan	Kwadi	ǁwí		ǀám		dátùa	B, SL Bantu	né	B, SL Bantu
Europe and Asia	Indo-European	Molise Croatian	jena		dva, dvi		tri		četar	
		Molise Croatian variants								
Europe and Asia	Indo-European	Istro-Romanian (Northern)	ur/ura		doi/do		trei		pɒtru	
Europe and Asia	Indo-European	Selice Romani	jékh		dúj		trín		štár	

Numerals: One–Four (Part B)

Languages			Numerals							
Areas	L family	RL name	One	*B vs I*	Two	*B vs I*	Three	*B vs I*	Four	*B vs I*
South America	Creole	Saramaccan	wán		tú		dií		fő́	
		Saramaccan variants								
Europe and Asia	Indo-European	Domari	ikak		diyyes		taranes		štares	
		Domari variants								
Africa	Niger-Congo, Bantoid	Swahili	-moja		-wili		-tatu		-ne	
Pacific	Austronesian	Takia	ksaek		raru, uraru		utol		iwaiwo	
		Takia variants								
Africa	Afro-Asiatic, Berber	Tarifiyt Berber	ižžən		ŧnayən	B, SL Classical Arabic	ŧřaŧa	B, SL Arabic (Moroccan, Classical)	ābʕa	B, SL Arabic (Moroccan, Classical)
		Tarifiyt Berber variants	ištən							
Africa	Afro-Asiatic, Berber	Ayt Ndhir	yun/yuṯ		sin/snaṯ		šraḏ̣ šraṭ		rbɛa	B, SL Arabic
Africa	Nilo-Saharan	Tasawak	fó		hínká		hínzà		táásì	
		Tasawak variants	a-fːó		à-hínká		à-hínzà		à-tːáásì	
South America	isolate	Urarina	lejhia		kuruata(ha)a		nitɛatahaa		heena	

Numerals: One–Four (Part C)

Languages			Numerals							
Areas	L family	RL name	One	*B vs I*	Two	*B vs I*	Three	*B vs I*	Four	*B vs I*
Europe and Asia	Tai-Kadai	Thai	nɯ̀ŋ		sɔ̌ɔŋ		sǎam	B, SL Middle Chinese	sìi	B, SL Middle Chinese
		Thai variants	ʔèek	B, SL Sanskrit	yîi	B, SL Middle Chinese	trii	B, SL Sanskrit	càtù	B, SL Pali/ Sanskrit
		Thai variants	ʔèt (2)		thoo	B, SL Sanskrit	tray	B, SL Sanskrit	càtùrá	B, SL Sanskrit
Europe and Asia	Sino-Tibetan	Yakkha	i		hiC		sum		cār	B, SL Nepali
		Yakkha variants	eko	B, SL Nepali						
Europe and Asia	Sino-Tibetan	Rabha	gósa		aniŋ		antham		cari	B, SL Assamese
Europe and Asia	Hmong-Mien	White Hmong	ib		ob		peb (2)		plaub (2)	B, SL Tibeto-Burman
South America	Matacoan	Wichí	unu	B, SL Spanish	lus	B, SL Spanish	tales	B, SL Spanish	kwatlu	B, SL Spanish
South America	Tupian	Paraguayan Guaraní	peteĩ		mokõi		mbohapy		irundy	
		P. Guaraní variants								
North and Central America	Uto-Aztecan	Yaqui	wepulai		woi		baji		naiki	
		Yaqui variants	uno	B, SL Spanish	los ~ dos	B, SL Spanish	tres	B, SL Spanish	kuatro	B, SL Spanish
Pacific	Austronesian	Rapa Nui	tahi		rua		toru		hā	
		Rapa Nui variants	ho'e	B, SL Tahitian	piti	B, SL Tahitian			maha	B, SL Tahitian

Numerals: Five–Eight (Part A)

Languages			Numerals							
Areas	L family	RL name	Five	*B vs I*	Six	*B vs I*	Seven	*B vs I*	Eight	*B vs I*
Europe and Asia	Austroasiatic	Ceq Wong	limãʔ	B, SL Malay	nãm	B, SL Malay	tujoh	B, SL Malay	lapan	B, SL Malay
Europe and Asia	Austroasiatic, Munda	Bondo	moloi		ʈḭʔiri		giʔ		ʈomam	
Africa	Afro-Asiatic, West Chadic	Hausa	bìyẫr		ono		bákwài		tákwàs	
South America	Nadahup	Hup	ʔayup d’apṹh		céc	B, SL Portuguese	céci	B, SL Portuguese	ʔóytu	B, SL Portuguese
		Hup variants								
Europe and Asia	Japonic	Japanese	itsutsu		roku		nanatsu		yattsu	
		Japanese variants	go (1)				nana		hachi (3)	
		Japanese variants					shichi			
Africa	Khoisan	Kwadi	tánù	B, SL Bantu	ǀíˤɲàu		ǀáˤɲàu		sébéþótlı̀textɔpenɔ	
Europe and Asia	Indo-European	Molise Croatian	pet		sèj	B, SL Italo-Romance	sèt	B, SL Italo-Romance	òt	B, SL Italo-Romance
		Molise Croatian variants	čing	B, SL Italo-Romance						
Europe and Asia	Indo-European	Istro-Romanian (Northern)	činč		šɒse		šɒpte		opt	
Europe and Asia	Indo-European	Selice Romani	pándž		šó		efta	B, SL Greek	ofto	B, SL Greek

Numerals: Five–Eight (Part B)

Languages			Numerals							
Areas	L family	RL name	Five	*B vs I*	Six	*B vs I*	Seven	*B vs I*	Eight	*B vs I*
South America	Creole	Saramaccan	féífi (2)		síkísi		sḗbën		áíti	
		Saramaccan variants					séíbi	B, SL Sranan/ Dutch		
Europe and Asia	Indo-European	Domari	pʌndžes		sitt-ēk-i	B, SL Arabic	sabʕ-ak-i	B, SL Arabic	tamāniy-ak-i	B, SL Arabic
		Domari variants								
Africa	Niger-Congo, Bantoid	Swahili	-tano		sita	B, SL Arabic	saba	B, SL Arabic	-nane	
Pacific	Austronesian	Takia	kafe-n da		siks	B, SL Tok Pisin/ English	sabaen	B, SL Tok Pisin/ English	eit	B, SL Tok Pisin/English
		Takia variants	faif	B, SL Tok Pisin/ English						
Africa	Afro-Asiatic, Berber	Tarifiyt Berber	xəmsa	B, SL Arabic (Moroccan, Classical)	sətta	B, SL Arabic (Moroccan, Classical)	səƀʕa	B, SL Arabic (Moroccan, Classical)	ƫmənya	B, SL Arabic (Moroccan, Classical)
		Tarifiyt Berber variants								
Africa	Afro-Asiatic, Berber	Ayt Ndhir	xəmsa	B, SL Arabic	sətta	B, SL Arabic	səbɛa	B, SL Arabic	ṯmanya	B, SL Arabic
Africa	Nilo-Saharan	Tasawak	xámsà	B, SL Arabic	sít:à	B, SL Arabic	sábàɣà	B, SL Arabic	tàmáníyà	B, SL Arabic
		Tasawak variants								
South America	isolate	Urarina	saukia		sauta	B, SL Quechua	kãsi/kãasi	B, SL Quechua	hoosa/fwoosa	B, SL Quechua

Numerals: Five–Eight (Part C)

Languages			Numerals							
Areas	L family	RL name	Five	*B vs I*	Six	*B vs I*	Seven	*B vs I*	Eight	*B vs I*
Europe and Asia	Tai-Kadai	Thai	hâa	B, SL Old Chinese	hòk	B, SL Middle Chinese	cèt	B, SL Middle Chinese	pàeaet	B, SL Middle Chinese
		Thai variants	bencà	B, SL Pali/ Sanskrit	chɔ̆ɔ	B, SL Pali	sàttà	B, SL Pali/ Sanskrit	ʔàtsatà	B, SL Sanskrit
		Thai variants	pancà	B, SL Pali/ Sanskrit						
Europe and Asia	Sino-Tibetan	Yakkha	pā̃c	B, SL Nepali	cʰʌ	B, SL Nepali	sāt	B, SL Nepali	āṭh	B, SL Nepali
		Yakkha variants								
Europe and Asia	Sino-Tibetan	Rabha	pas	B, SL Assamese	soi	B, SL Assamese	sat	B, SL Assamese	at	B, SL Assamese
Europe and Asia	Hmong-Mien	White Hmong	tsib		rau (3)	B, SL Tibeto-Burman	xya		yim	B, SL Tibeto-Burman
South America	Matacoan	Wichí	sinku	B, SL Spanish	seis	B, SL Spanish	siete	B, SL Spanish	ocho	B, SL Spanish
South America	Tupian	Paraguayan Guaraní	po		poteĩ		pokõi		poapy	
		P. Guaraní variants	cinco	B, SL Spanish	seis	B, SL Spanish	siete	B, SL Spanish	ocho	B, SL Spanish
North and Central America	Uto-Aztecan	Yaqui	mamni		busani		wobusani		wojnaiki	
		Yaqui variants	sinko	B, SL Spanish	seis	B, SL Spanish	siete	B, SL Spanish	ocho	B, SL Spanish
Pacific	Austronesian	Rapa Nui	rima		ono		hitu		va'u	B, SL Tahitian
		Rapa Nui variants	pae	B, SL Tahitian						

Numerals: Nine–Ten (Part A)

Languages			Numerals				
Areas	L family	RL name	Nine	*B vs I*	Ten	*B vs I*	References
Europe and Asia	Austroasiatic	Ceq Wong	smilan	B, SL Malay	spuloh	B, SL Malay/ Chinese	Kruspe (2009)
Europe and Asia	Austroasiatic, Munda	Bondo	no	B, SL Oriya	ḍos	B, SL Oriya	Chan; Swain (1998: 393)
Africa	Afro-Asiatic, West Chadic	Hausa	tā̃rà		góomà		Awagana et al. (2009)
South America	Nadahup	Hup	nówi	B, SL Portuguese	déc	B, SL Portuguese	Epps (2009)
		Hup variants			d’apũh nihũ´ʔ		Epps (2009)
Europe and Asia	Japonic	Japanese	kokonotsu		tō (1)		Schmidt (2009)
		Japanese variants	kyū (2)		jū (2)		Schmidt (2009)
		Japanese variants					Schmidt (2009)
Africa	Khoisan	Kwadi	móyò	B, SL Bantu	mólà	B, SL Bantu	Chan
Europe and Asia	Indo-European	Molise Croatian	nòv	B, SL Italo-Romance	dijač	B, SL Italo-Romance	Breu (2013)
		Molise Croatian variants					Breu (2013)
Europe and Asia	Indo-European	Istro-Romanian (Northern)	dɛvet	B, SL Croatian	dɛset	B, SL Croatian	Loporcaro et al. (2021)
Europe and Asia	Indo-European	Selice Romani	eňňa	B, SL Greek	deš		Elšík (2009)

Numerals: Nine–Ten (Part B)

Languages			Numerals				
Areas	L family	RL name	Nine	*B vs I*	Ten	*B vs I*	References
South America	Creole	Saramaccan	nɛ̃́ígi		téni		Good (2009)
		Saramaccan variants	nɛ̃́ni				Good (2009)
Europe and Asia	Indo-European	Domari	tisʕ-ak-i	B, SL Arabic	das		Matras (2012)
		Domari variants			ʕašr-ak-i	B, SL Arabic	Matras (2012)
Africa	Niger-Congo, Bantoid	Swahili	tisa	B, SL Arabic	kumi		Schadeberg (2009) and Versteegh (2010: 648)
Pacific	Austronesian	Takia	naen	B, SL Tok Pisin/ English	ten	B, SL Tok Pisin/English	Ross (2009)
		Takia variants					Ross (2009)
Africa	Afro-Asiatic, Berber	Tarifiyt Berber	tsʕa	B, SL Arabic (Moroccan, Classical)	ʕəšr'a	B, SL Arabic (Moroccan, Classical)	Kossmann (2009)
		Tarifiyt Berber variants					Kossmann (2009)
Africa	Afro-Asiatic, Berber	Ayt Ndhir	tsaɛa	B, SL Arabic	ɛəšra	B, SL Arabic	Kossmann (2013: 308–309) and Souag (2007)
Africa	Nilo-Saharan	Tasawak	tísàɣà	B, SL Arabic	ɣàsárà	B, SL Arabic	Kossmann (2007: 84, 2009) and Chan
		Tasawak variants					Kossmann (2007: 84, 2009) and Chan
South America	isolate	Urarina	iskõo	B, SL Quechua	(le=) tɛuŋka	B, SL Quechua	Olawsky (2006)

Numerals: Nine–Ten (Part C)

Languages			Numerals				
Areas	L family	RL name	Nine	*B vs I*	Ten	*B vs I*	References
Europe and Asia	Tai-Kadai	Thai	kâaw	B, SL Middle Chinese	sìp	B, SL Middle Chinese	Suthiwan (2009)
		Thai variants	nóp	B, SL Pali/ Sanskrit	thót	B, SL Pali/Sanskrit	Suthiwan (2009)
		Thai variants					Suthiwan (2009)
Europe and Asia	Sino-Tibetan	Yakkha	nau	B, SL Nepali	das	B, SL Nepali	Schackow (2015)
		Yakkha variants					Schackow (2015)
Europe and Asia	Sino-Tibetan	Rabha	noi	B, SL Assamese	dos	B, SL Assamese	Chan; Her et al. (2019), Joseph (2007: 397), passim
Europe and Asia	Hmong-Mien	White Hmong	cuaj		kaum (2)	B, SL Tibeto-Burman	Ratliff (2009)
South America	Matacoan	Wichí	nwewe	B, SL Spanish	lyes	B, SL Spanish	Vidal and Nercesian (2009)
South America	Tupian	Paraguayan Guaraní	porundy		pa		Estigarribia (2017: 62, 2020: 99–101)
		P. Guaraní variants	nueve	B, SL Spanish	diez	B, SL Spanish	Estigarribia (2017: 62, 2020: 99–101)
North and Central America	Uto-Aztecan	Yaqui	batani		wojmamni		Estrada Fernández (2009)
		Yaqui variants	nueve	B, SL Spanish	dies	B, SL Spanish	Estrada Fernández (2009)
Pacific	Austronesian	Rapa Nui	iva		ho'e 'ahuru; 'aŋahuru	B, SL Tahitian	Kieviet (2017: 147, 150)
		Rapa Nui variants			ho 'e 'ahuru	B, SL Tahitian	Kieviet (2017: 147, 150)

Abbreviations: *B* borrowed, *I* inherited, *L* language, *RL* recipient language, *SL* source language. *NB* numbers in parentheses indicate tones

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Human Teaching's Prosocial Roots

Sidney Strauss

Abstract An argument is made that our conception of Western human teaching ought to be expanded beyond viewing it mostly through the prism of information transfer. Three ways to expand are suggested. One is that in addition to information (I) that gets transferred, we can add knowledge (K), understanding (U), skills (S) and attitudes (A): IKUSA. A second expansion is to add to teaching what happens prior to IKUSA transfer, i.e., stage-setting that enables transfer. It includes teachers' and learners' mutual emotions-motivation- and mind-reading. Part of mind-reading is to detect if there is an IKUSA gap between the teacher and learner. If such a gap exists, the teacher acts to close it by using many strategies which include explanation, demonstration and pointing. These strategies have been thought to be teaching. Nevertheless, it is argued that stage-setting is no less a part of teaching than IKUSA transfer. A third expansion is to show that knowledge gap detection and closure are fundamentally prosocial in nature. The prosocial aspects of teaching are examined in light of evolutionary theory.

Keywords Teaching · Cognition · Information transfer · Prosociality · Compassion · Altruism · Empathy

Before beginning my chapter, I would like to write a few words about my dear friend Dorit Ravid. We have had countless interesting discussions over the years about our work, family, the state of the State of Israel, and much more.

Anybody who has met Dorit cannot but help being immediately struck by her strong and effervescent personality. No wall flower is she. Time hasn't changed that but it has a way of catching up on us where the far future turns into today in what appears to be record time.

Dorit will soon be retiring. That seems as incomprehensible as the past meeting the future in the present. How can it be that this life-force of energy and curiosity about matters of all sorts will be retiring?

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Dorit has extensive knowledge in numerous areas along with an extraordinarily sharp and penetrating mind. This became apparent in meetings she and I had about scientific matters and in her comments in discussions during weekly meetings of the Tel Aviv University Unit of Human Development and Education for over a full quarter century. One passion of her wide-ranging mind is evolutionary theory, which I examine in these pages.

In addition, we had a joint research project where we were thesis guides for an excellent, then MA student, and now a no less excellent faculty member, Dr. Orly Haim (Haim et al., 2004). Our work with Orly was on teaching and its relations to subject matter knowledge. The teaching part of our joint work presages some of the themes that percolate in the present chapter.

Besides being an especially high level academic, Dorit was also a good friend. Those of us in academia know that finding both traits in one person is not the norm. I appreciate both, especially the latter, and feel grateful for having come to know Dorit.

And now on to what I present here.

"All for one, one for all". Dumas (1844). *The Three Musketeers*.

On occasion we are moved by acts of bravery that fire our imagination (What courage they had to do what they did.) and our self-reflection (Would I do such a thing?); and engender a sense of inspiration (I stand in awe of people who endangered themselves for the sake of others.). Here are two among countless examples of extraordinary courage.

The first began on March 11, 2011, when there was the real possibility that there would be a meltdown of Japan's Fukushima Dai-ichi nuclear plant. The plant's manager, Mr. Masao Yoshida, and his team valiantly fought to bring the impending disaster under control.

After 3 days of fighting the possible meltdown, the already-dire situation worsened. A total of 12 of the 13 emergency generators stopped functioning. Three of the six reactors were out of control, leading to the frightening prospect of a nuclear fission chain reaction and contamination that would be worse than a reactor meltdown.

For many Japanese citizens, the results of such a chain reaction would have been catastrophic. Given the palpable unfolding danger in these events, Mr. Yoshida knew that he and his team's chances of survival were slim. And yet, he remained at the helm and managed to bring the nuclear plant under control. While potentially sacrificing his life, his valor saved an extraordinarily large number of Japanese citizens' lives.

The second example comes from those who helped save Jews escape the deadly clutches of the Nazis during WWII by allowing them to hide in their homes. Often, those caught hiding Jews were killed. Entire families, including children, were murdered so that others would know the consequences if they were to be found giving refuge to Jews. There were also other dreadful consequences, such as being sent to concentration camps, for those who knew that their neighbors were hiding Jews but did not inform on them to the Nazi authorities.

Despite these frightening costs, there were people who risked their lives and those of their family members to hide Jews. One such person was Ludviga Pukas from Ukraine. She worked as a domestic with the Sterniks, a Jewish family with two children, in the town of Proskurov. The Sternik's home burned down and all their possessions were lost. That gave Ludviga the opportunity to register the two Jewish children as her own along with her legitimate daughter. She moved to a new home but had to leave it to go to the Jewish ghetto with all three children because she aroused her neighbors' suspicions. After the ghetto was destroyed by the Nazis, Ludviga managed to escape with the children, and they returned to their home where she also hid a Jewish woman until May of 1944 when they were liberated by the Red Army.

Anyone interested in reading about women who helped save Jews during WWII can find some of their stories in https://www.yadvashem.org/yv/en/exhibitions/righteous-women/index.asp

In these two remarkable stories, people risked their lives to help strangers whose lives were threatened. These, and many similar acts, are extreme forms of helping behavior. We find them extraordinary because of the human drama involved where lives were on the line.

The undeniable courage of these individuals goes beyond their individual valor. It touches on a debate that, in the West, has been raging from ancient Greek times. Its more recent version began when Darwin posed his revolutionary theory about evolution where he viewed altruistic acts as problematic for his ideas.

In these pages I attempt to show that teaching is a ubiquitous form of helping prosocial behavior, albeit not as dramatic as the two cases I briefly described. I attempt to make a case for expanding our understanding of Western teaching in two ways, by including (1) some aspects of the cognition of teaching that go beyond information transfer and (2) prosociality. To do that, I begin by discussing the cognition of teaching, expanding on the notion of teaching as information transfer. That leads to a section that suggests that teaching has helping at its core and shows that at the heart of teaching is its prosociality.

1 The Cognition of Teaching

Teaching is not a one-way direct transmission from a source, a teacher (T), to a recipient, a learner (L). Teaching is bidirectional and interactive (Strauss et al., 2014). Teaching is also not solely the transfer of information, knowledge, understanding, skills and attitudes (IKUSA). Normative Western adult teaching involves much more than that. It includes (1) stage-setting, (2) interventions intended to transfer IKUSA, (3) the organization of teaching, and (4) scaffolding it.

I briefly write about all four and refer the reader to Strauss (2018) for a fuller exposition of these ideas.

1.1 Stage-Setting

Before transferring information, knowledge, understanding, skills and attitudes (IKUSA), Ts dynamically evaluate several parameters that they assume are prerequisites for learning (Strauss & Shilony, 1994). These assumptions are generally based on their experiences, and not necessarily on textbook knowledge. For example, Ts make an assumption that if a L is high on a parameter, say, motivation, learning is more likely than if the same L is low on that same parameter. Before IKUSA transfer, Ts determine the level of these parameters and may intervene if they are low. This is no less part of teaching than IKUSA transfer. I address three states regarding Ls, i.e., their (1) emotional, (2) motivational and (3) IKUSA states.

1.1.1 Emotional State

The adult T attempts to assess the L's emotional state: is he positively emotionally engaged? Is he anxious about learning what is being taught? Does he show signs of anxiety when being taught, say how to dig a trench on the edge of a village in Kerala, India to keep elephants out of the fields that have been planted? Does a hunter-gatherer child show signs of anxiety when being taught to crack nuts on a forest floor in the Congo Basin? Is he possibly thinking: "Oh no. Nut-cracking again. I'm really not very good at this". Replace math anxiety with nut-cracking anxiety, and you'll know what I mean.

If Ts believe a L has anxiety, they attempt to influence his emotional state so as to enable him to become emotionally engaged more positively in learning. This belies an assumption teachers have about the relations between motivation and learning.

1.1.2 Motivational State

Related is the L's *motivational state*. Is he motivated to engage in learning? The T wants him to persist in the task at hand and, as a result, the L's motivational state should ideally be at no less than some minimal level so that the L will be engaged in the T-L interactions.

Notice that, for both emotional and motivational states, there are implicit assumptions here for teaching. One is that a L who is emotionally anxious and/or unmotivated will not easily learn the material being passed on by the T. Adult professional Ts (and non-professional Ts, such as parents and children) believe that these are prerequisites for learning, and it is incumbent on them to assess the L's emotional and motivational states and intervene, if necessary, so as to enable the L to be receptive to her IKUSA transfer interventions.

Ts have been found to believe that fostering positive emotions and motivation is essential to teaching and, as a result, learning. Strauss (2001) and Strauss and

Shilony (1994) described adult professional teachers' mental model of children's minds, how learning occurs there and the roles of teaching in fostering that learning. Ts' mental models includes emotional and motivational components.

1.1.3 IKUSA State

A third part of stage-setting concerns Ts' assessment of a L's current *IKUSA state* (information, knowledge, understanding, skills and attitudes). This mind-reading is done so that the T knows what to address in her teaching. She needs to know what the L knows and how much is needed to understand the issues at hand. If a T doesn't have a sense of that, she may aim the IKUSA too high or too low, given the L's current IKUSA state.

I dwell a bit on the T's mind-reading assessment of the L's IKUSA state. From a cognitive perspective, implicit in this mind-reading may be the adult T representing (1) a solution to the task at hand, (2) the L's current representation of the task's solution, and, if it exists, (3) a gap between the IKUSA state required to solve the task and the L's IKUSA state for task solution. If there is an IKUSA gap, Ts act to close it. If there is no IKUSA gap, there is no need for transfer.

Notice that, implicit in detecting IKUSA in a L, a T probably knows that both she and others have competency in IKUSA, can possess partial IKUSA or can be ignorant. Without this there would be no meaning to detecting, say, a knowledge gap between yourself and others. Detecting a knowledge gap is not IKUSA transfer. It is, however, a condition for it to occur.

I elaborate here on IKUSA gap detection and closing and show that even infants have this ability. One reason I present this is to use it later to illustrate the place of prosocial behaviors in IKUSA gap detection and reduction.

Research suggests that infants have gap detectors and act to close that gap. Children age 1 year can be preverbal (i.e., they do not yet speak, but they understand language) yet they can communicate socially and, of relevance here, they may do so by pointing. Research conducted by O'Neill (1996) and Ulf Liszkowski and his colleagues (Behne et al., 2012; Knudsen & Liszkowski, 2012a, b; Liszkowski et al., 2006, 2008) indicates that preverbal 1- and 1½-year-old infants appear to recognize an information gap (the I of IKUSA) and act to close it.

Briefly, evidence for this is provided by Liszkowski et al. (2008) who did the following. An experimenter showed an array of objects on a table to preverbal 12–18-month-old infants and talked about each of them. He then inadvertently (but really on purpose) knocked one off the table, say a key. The infants saw it fall to the floor. After a short time, the experimenter looked around, pretended he couldn't find the key and asked where it was. Infants often pointed to its location on the floor.

You might think that nothing extraordinary happened. After all, the experimenter didn't know where the key was, and when he asked the knowledgeable infant where it was, the infant pointed to its location. But notice that there is an information gap here. The infant knew something that the experimenter (presumably) didn't, and the infant acted to reduce the information gap and did so by pointing to the key's location. As suggested above, this recognition and closure of a gap is at the heart of transferring IKUSA, and we see that preverbal infants are capable of both.

So as to test this idea further, Liszkowski et al. (2008) used the same experimental setup but this time, when the experimenter dropped the key, both he and the infant saw where it fell. As in the first experiment, the experimenter looked around searching for it and, not having found it, asked the infants where it was. But this time, many fewer infants pointed to its location.

That may be the case because there is no knowledge gap here. Both the infant and the experimenter knew where the object was and, importantly, the infant may have known that the experimenter knew where it was. At least the infant acted as if it knew that the adult knew where it was. Of course, more research is needed to understand the developmental trajectory of teaching's knowledge gap detection and reduction from infancy to age 3½, but this kind of research is a very encouraging beginning to find the origins of IKUSA detection and reduction and its developmental course.

As an interim summary, teaching includes stage-setting which involves reading at least three states: emotional, motivational and IKUSA. The cognition of reading a L's IKUSA may include Ts' representations of possible gaps between the cognitive states necessary for task solution and the L's IKUSA states. The components of the cognition of teaching includes all of this and more within stage-setting.

This is an admittedly minimalist account of stage-setting. Nevertheless, it presents a view, albeit a very general one, of the place of stage-setting in the cognition of human teaching. I believe that these are at the heart of Western human teaching no less than the transfer of IKUSA. Having hopefully made this point, we can now turn to interventions for IKUSA transfer.

1.2 Interventions for IKUSA Transfer

As mentioned above, assessing a L's IKUSA states includes detecting if there is a knowledge gap between the T and the L. If a L knows the material at the T's level, there is no need to transfer IKUSA to the L. But if there is an IKUSA gap between the two, transfer is called for. The result of IKUSA transmission may be closing an IKUSA gap. This is the intention of IKUSA transmission although it is not guaranteed, of course. We attempt to close the gap, but sometimes it doesn't close, i.e., learning doesn't necessarily occur.

Two major ways for this transfer to happen are to explain what is at hand and demonstrate solutions to a problem. I now slightly unpack them.

1.2.1 Explanations

Regarding explanations, Ts attend to many aspects of the L. For instance, in explaining, Ts pace the speed of presenting IKUSA, use vocabulary that is appropriate for a L's level and seek to connect the new IKUSA to already-learned IKUSA that is in the L's long term memory. It may be the case that underlying our choices of pace and vocabulary are an implicit understanding of the L's information processing constraints. When passing on IKUSA, Ts try not to exceed these constraints.

1.2.2 Demonstrations

With respect to demonstrations of complex skills that cannot be learned by one exposure to the task at hand, such as demonstrating to a 10-year-old how to juggle three balls, it can be done by (1) breaking the task into component parts where the T demonstrates each part separately (e.g., beginning with two balls, how to thrown them at the same height, how to move the balls from one hand to the other, etc.), eventually putting them together at their seams; (2) performing the task in slow motion (e.g., a T moves her hands slowly without and then with the balls); and (3) exaggerating parts so as to focus the L's attention to salient parts of task solution. Exaggeration supports attention allocation to the fundamental properties of the task at hand and de-emphasizes its less important parts (Gardenfors, 2017).

Notice that these aspects of demonstration bear a family resemblance to ways adults intuitively speak to infants in what is termed "motherese". Three main factors distinguish motherese from ways adults speak to older children and other adults: the pace of talking is slower; the melody (called prosody) is at a higher pitch and sing-songy; and the vocabulary is much simpler. It is possible that those who talk motherese may have an intuition about cognitive processing constraints on the part of the infants who are being spoken to.

To return to demonstrations in passing along IKUSA, and possibly similar to motherese, underlying each of these three ways to demonstrate may be Ts' implicit assumptions about Ls' information processing constraints and Ts' attempts to reduce the task's cognitive load so as not to exceed those constraints. If the T doesn't have some sort of belief about Ls' information processing constraints, she could simply demonstrate the full and continuous procedure at a standard pace without exaggerations as if performing it alone without a L present. But she usually doesn't, suggesting that a belief system about cognitive constraints regarding learning may be part of her mental model of IKUSA transfer and, therefore, of learning (Strauss & Shilony, 1994).

These ways of taking into account Ls' cognitive constraints when explaining and demonstrating are the tip of the cognitive iceberg of how we close an IKUSA gap. Clearly, much work has to be done here.

1.3 Organization of Teaching

Ts do not pass on IKUSA in a helter-skelter manner. The ways Ts transfer IKUSA are organized and embedded in an architecture of organized sequences in which IKUSA is transmitted. Something is presented first, and that is not by chance. The same is the case for what follows that and what follows that and so on and so forth.

For example, when teaching the rules of a board game, we may begin with demonstrating and explaining that each player has a piece that can move along a track that has squares. The T may then tell a L that to win the game, you must move your piece to the last square. To demonstrate how much to move, the T demonstrates throwing a die. After that, the L is asked to read the number on the face that is up. Then the L is shown how to move his piece that number of squares on the board.

This is an example of how IKUSA transmission can be organized. There is a loose organization of the sequence of transmitting IKUSA when a T teaches a L how to play a board game. But notice that although this teaching is loosely organized, not everything goes. For instance, it is unlikely a T begins by throwing a die without telling the L how that is connected to the moves a piece makes.

So what we see here is that not only are explanations and demonstrations used to transfer IKUSA, but both are embedded in an organization that arranges them in a sequence. Some sequences may be more effective in bringing about learning than others and may have developmental implications.

To complicate the picture even more, but bringing it closer to the complexity of human teaching, as the teacher is demonstrating and explaining in an organized sequence, she is also monitoring the L's emotional, motivational and IKUSA states and is making on-the-spot decisions about how next to proceed. All of this is generally happening without reflection. What teachers have to know and know how to do when transferring IKUSA and how they pull off this extraordinarily complex feat is the stuff of what I am pursuing on these pages.

When the T determines that the L has grasped the rules, she is likely to move to a second phase of IKUSA transfer where both she and the L play the game. But this is not true playing because the T monitors the L's playing, makes corrections with further explanations, and demonstrates when necessary. This phase is still part of IKUSA transfer. When the L knows how to play the game successfully, by the T's and L's definition of success, the T stops teaching and the two can then play the game as equals. When Ts stop teaching whatever is being taught is an important topic that needs considerable theoretical and empirical scrutiny.

1.4 Scaffolding

While the adult T is doing all of the above, it is often the case that the L has only a partial grasp of the task. When that happens, Ts adjust their teaching to their representation of the L's changing knowledge state. These scaffolding adjustments (Wood et al., 1976) are sometimes termed contingent teaching because the forms of teaching are contingent on the T's representation of the L's changing representation of the task at hand as inferred from his moves. As the L becomes more competent in the eyes of a T, she hands over increasing responsibility to the L, termed fading. If the L is not progressing or solves the problem at a lower level than before, Ts often intervene more tightly, sometimes teaching lower level rules so as to strengthen them (Ziv et al., 2016).

A way to describe this, for the purposes of understanding what teaching is, is to suggest that adult Ts have an on-line Theory of Mind that allows them to make IKUSA transmission adjustments via their IKUSA-reading, as well as their stage-setting with attention paid to the L's emotional, motivational, etc. states.

1.4.1 An Interim Summary

This has been a very lean description of some aspects of the cognition of human teaching. IKUSA transfer is crucial to teaching, of course. But teaching also includes Western stage-setting with all its complexity. Along with this, though, the heart of adult human teaching is not restricted to IKUSA transfer and its attendant stage-setting. It has many hearts. One is teaching's prosociality, and it is to this that I now turn.

2 Prosociality

Prosociality is an umbrella term that includes, among others, sympathy, caring, altruism, empathy, helping behavior and compassion. These constructs are related to each other and all are surrounded by debate regarding their definitions. I enter some of this minefield with the knowledge that there is no unanimity about what these constructs are.

I begin this section with a very brief exposition of the place of altruism in evolutionary theory, then turn to various aspects of prosociality and, finally, to its relations to teaching.

2.1 Evolutionary Theory and Altruism

Altruism was a bane for Darwin (1859) in his theory of evolution. He understood that it ran counter to a "red tooth and claw" understanding of natural selection. How could it be, he asked, that some insects are born neuter, unable to have offspring, without the possibility of passing on their traits to the next generation? No less problematic for Darwin were insects that sacrifice their lives for the benefit of others. If an invader enters an ant or bee's colony's nest, some attack to kill the invader and are killed in the process. And, being killed, they cannot pass on their genes to offspring (even though Darwin didn't know about the existence of genes) which are at the heart of evolution. This, in Darwin's view, is the ultimate act of altruism.

As he fully acknowledged, his theory could not explain neuters and soldiers who are born to kill and be killed. The "unit" of interest for evolution was supposed to be the individual. And the struggle was for those individuals to survive and pass on their genes to their offspring. In recognizing these conundrums, and anticipating future speculation, Darwin suggested that there might be another "unit" in evolution: the group to which the individual belongs. That could be the hive of bees, a colony of ants, the families of primates and perhaps many other animals.

A bit after Darwin's theory appeared, Peter Kropotkin, a Russian anarchist prince, began a crusade against Darwin's theory, claiming that animal cooperation is rampant. By and large, this view ran counter to Darwin's theory that had competition as its core. Kropotkin maintained that non-human animals work in concert in ways that benefit individuals and the collective they are part of. And, more than that, this cooperation was not restricted to family members.

So, in Darwin's day, there were two competing views of the evolution of living beings. One was that at the heart of evolution is competition for limited resources and those that are most fit have more access to these resources, survive longer, can have more offspring and can pass their traits on to them. The opposing outlook was that animals cooperate, and it is that cooperation that enables the survival of individuals and the group.

Advocates of both views more or less agreed that, among many animals, there is something special about family members being more likely to come to the aid of each other than they are to others who are not family members. But Kropotkin argued that such mutual aid was not restricted to family members.

As we know, the Darwinian view held sway and Mendel's discovery of the mechanisms of what gets transferred and the lawfulness of the results of that transfer to offspring increased the appeal of Darwin's theory and created what is termed neo-Darwinian theory.

That having been said, though, the notion of evolution selecting for cooperation never died in scientific circles. For example, Nowak (2011) shows how evolution leads to cooperation, and is not restricted to competition.

Helping others is essential to prosociality. Some of what we need to know about it is who is it that we help and what should be in place for someone to help others. Let us begin with who we help. As mentioned, there are two major categories of who we help: those who are our relatives and those who are not.

2.1.1 Helping Relatives

From the time Darwin wrote *Origins*, until fairly recently, there has been intense debate about Darwin's theory among theologians, evolutionary biologists, psychologists, philosophers and mathematicians. One area of debate revolved around the special status of family members regarding helping behaviors. Everyday observations show us that, among some groups in the animal kingdom, parents expend more time and energy to protect and nurture their offspring than with those who are not their kin. Debate about what leads that to be the case raged for quite a while.

A little over a century after Darwin's epic theory appeared, William Hamilton (1963) published a mathematical treatise that, in effect, solved what people noticed but could not explain. Animals invested more resources (time, care, food, protection, etc.) in their offspring than in others more distantly related, and the former received more resources than those who were unrelated. The model he built served as a way to understand the evolution of what he thought was altruism.

Although Hamilton did not coin the term, his mathematical model came to be called kinship selection. Hamilton's deceptively simple equation, termed the Hamilton rule, was $r\ X\ b > c$, where r is a coefficient of relatedness, b is the benefit and c is the cost. For example, when a cheetah mother brings prey she killed to her pups, the relatedness (r) is that her pups have .5 of her genes; the benefit (b) to the pups is that they are more likely to survive; and the cost (c) to the mother is that she has increased the likelihood that she will not survive because she gave the prey to her cubs and did not eat it herself.

To greatly simplify matters, we now know that the more genes that are in common between individuals, the more likely it is that an animal will help another, with the converse being that the fewer genes in common, the less likely it is that one gives resources to another and aids it.

2.1.2 Helping Strangers

An open question after the problem of kin selection was resolved has been to understand people helping perfect strangers, those who have very little or virtually no common genes with those who helped them. Recall the people who saved strangers mentioned at the beginning of this chapter.

A solution to this problem was proposed again by Hamilton, this time with a colleague, Robert Axelrod (Axelrod & Hamilton, 1981). At the time they began working together, Axelrod was studying game theory with computer simulations as a way to model cooperation. Here is the point of their collaborative work: the game, the prisoner's dilemma, was to be able to considerably extend Hamilton's work from situations of relatedness between individuals (the r of Hamilton's rule) to situations where individuals are not related, which is almost everyone.

Notice that this work shows us that two partners, who are strangers, can cooperate, and that that cooperation can lead to positive results for each. In other words, genetically unrelated players cooperate in a way that is beneficial to both. This is an advance over Hamilton's work, which gave an explanation for individuals expending more resources with genetically-related individuals as opposed to those who are genetically-unrelated.

Their research, and the flood of studies that followed in its wake, shows that there is cooperation among human beings when playing this game and, most important, that cooperation can be carried out among perfect strangers. The collaborative work between the Axelrod and Hamilton spurred further work on cooperation and altruism for the almost four decades since their joint article appeared.

This section covered much ground too quickly, avoiding important details and exciting implications of the work begun by Darwin and those who followed in his footsteps.

You, the reader, may be asking what this has to do with teaching. The short answer is that in many cases, Ts teach people who are unrelated to them. Now it is incumbent on me to show that teaching is a form of cooperation that involves helping unrelated others and that it can be described as prosociality.

2.2 Prosociality and Teaching

In this section, I begin by appealing to the readers' experiences and ask you to think of the times you taught and have been taught. If what I am about to write has a ring of familiarity, it may serve as a guide for where we can expand the richness and complexity of human teaching to go beyond stage-setting and IKUSA transfer, to now include prosociality.

When one teaches and, it must be added, when it goes well (and it does not always go well), something special happens. A closeness akin to, and possibly beyond, friendship is formed between the T and L. And folded into aspects of teaching (stage-setting and IKUSA transfer) are emotional connections the L and T feel for each other.

Involved in this bidirectional and mutual giving to and receiving from are relations that move from unequal to equal relations regarding both IKUSA and the power of the one who is often the initial giver, the T. And as the balance of IKUSA and the power relations shifts, the T does not abuse her power. Furthermore, teaching, which is fundamentally giving, also involves a willingness to share with another person and that other person's willingness to take, to accept, what is being shared. No less than that, a T has responsibility for another person, a L. This involves a commitment to achieve both the mutual goal of the L's learning and the well-being of the L as teaching and learning transpire. Moreover, teaching involves acts of mutual respect for what each is doing in stage-setting, organizing the teaching, scaffolding and passing on IKUSA. All of this, and more, in concert, makes teaching feel like it possesses a spark of spiritual communion with another.

To place this on another, more general plane, teaching involves what has been termed prosociality. Among its many aspects, prosociality entails empathy, compassion and altruism. I now explore these three.

2.2.1 Empathy

Empathy is not a unitary construct, having both cognitive and emotional components. And its definitions abound. Among them, I choose a particularly useful definition, offered by Baron-Cohen (2011): "Empathy is our ability to identify what someone else is thinking or feeling and to respond to their thoughts and feelings with an appropriate emotion" (p. 18).

Notice that this definition includes a response to others' thoughts and emotions with an appropriate *emotion*. However, it does not include an act or acts based on that appropriate emotion.

Here's an example. Earlier this morning I was sitting in my favorite café in my neighborhood in Jaffa. A young woman tried to enter the café, pushing a stroller with her infant in it. The door to the entrance opened out towards the sidewalk and not into the café. She was having trouble managing opening the door while trying to hold the stroller in place so that when she managed to open the door, she could push the stroller past it. She was struggling doing all of this, and her frustration was mounting with the passing of time. When watching this, I shared that emotion; I felt frustrated, which was an appropriate emotional response to her emotions. According to Baron-Cohen's definition, I was being empathetic.

But notice that another response I had, walking over and opening the door for her, is not part of his definition. Acting to help is not necessary for an empathic response to others' thoughts and emotions. The link between empathy and acting (possibly on behalf of others) is unclear. Sometimes we feel empathy and do not act to help. Sometimes we do.

In the case I just noted, I could have observed the scene and, while having empathic feelings, I could have stayed in my chair, not helping her enter the café. The reasons for not opening the door for her could be many: I did not want to leave my table because it was a crowded time at the café and someone might have taken my seat; or I thought that, with perseverance, she could eventually handle it on her own; or I had had previous encounters with her and enough were less than pleasant that I did not feel particularly generous towards her; or I saw someone behind her who wanted to enter the café and believed he would most likely open the door for the woman with the stroller to be helpful and so that he could get into the café, making my efforts unnecessary, etc.

The point here is that the connections between empathy and helping behavior are unclear. One can be empathetic towards someone in distress and can either help or not help that person while remaining empathetic.

Moreover, Bloom (2016) suggests that sometimes empathy has its drawbacks. Medical practice is one of them. If a surgeon is empathetic to a patient's high anxiety about an upcoming operation, that surgeon could empathically have high anxiety, as well. That might make it less likely that she could perform the surgery well.

In line with Bloom's interesting idea, I suggest that a T's empathy around a L's negative feelings (sadness, frustration, anger) can be detrimental to their teaching. Being empathetic towards those feelings held by a L may sometimes make for poor teaching. It is important for teachers to recognize pupils' frustrations, anger, etc.

But empathizing could be a distraction. Once a T recognizes the L's negative feelings she can try to defuse them, as I had mentioned in the section on stage-setting. But defusing them is not a prerequisite for a definition of empathy.

2.2.2 Compassion

Similar to empathy, compassion is not a single entity. Strauss et al. (Strauss et al., 2016) provide a helpful and comprehensive definition of compassion that has three main components: cognitive, affective and (very important for the point I will be making) behavioral components that give rise to five elements: (1) recognizing suffering, (2) understanding the universality of suffering, (3) feeling empathy for the person undergoing suffering and connecting with the distress, (4) tolerating uncomfortable feelings aroused in response to others' suffering, and (5) motivation to act and to actually act to relieve suffering.

There are two important points here for the purposes of the present chapter. One is that in this definition, compassion includes empathy. When compassionate, we see another in distress and resonate with that feeling. But it does not end there. We act, which is the essence of the second point. We are motivated to alleviate another's suffering and act to relieve it. This component of acting is missing in most definitions of empathy.

Along with this important addition of acting to alleviate others' suffering, another addition for teaching regards the emotions surrounding compassion. They are negative emotions of suffering (anger, frustration, etc.). Hence our wish to act so as to relieve them in others. It has to do with what was presented about stage-setting. In life we act to relieve these emotions in others so as to help them feel more positively and achieve harmony within themselves and with others. In teaching we act to alleviate anxiety, boredom, etc. for those reasons but also so as to be able to transfer IKUSA more effectively.

According to Bloom (2016), empathy and compassion can exist independently of each other. I gave an example of empathy I had for the woman attempting to enter a coffee shop with her baby in a stroller. But that empathy did not necessarily lead me to act on her behalf. If I had acted to open the door for that woman, it would have been an act of compassion.

Here is another story from 2 days ago, a story of compassion and acting to improve one of my grandsons' wellbeing. As he and four other of my grandchildren were walking around Jaffa, he stepped into a small sewage hole that was large enough for his foot to slip in. His leg was hurt, and he was crying at the pain. I embraced him, kissed him, rubbed his back, asked where it hurt and told him that the pain would subside soon.

While I was doing this, I did not feel his pain empathically. My leg did not hurt, and I did not feel his pain. I simply *acted* to comfort him. I was acting in what could be called a caring and compassionate way. The story ended well. It did not take long before he and his cousins were laughing about the terrible stench from his shoe, sock and pant leg. He told them that if someone tried to pick a fight with him, all he had to do was raise his leg in their direction to drive them off.

How can this Western understanding of compassion be related to teaching? If, as Bloom (2016) claims, compassion leads to prosocial behavior and if teaching is prosocial (as I attempt to show below), then it is possible that teaching involves compassion.

A T can see a L's frustration in not understanding how to solve a problem and, as a consequence, and possibly understand his lack of motivation, perhaps due to anxiety over not being a "good" learner of the subject matter being taught. Signs of the frustration and low motivation could be that the L gives up quickly and/or changes the topic over and over again.

The T is not necessarily empathetic about the L's feelings. But the teacher acts compassionately by trying to defuse the frustration and low motivation. Experienced Ts have an arsenal of teaching strategies to do both. If successful, these strategies lead to the L's wellbeing regarding successfully understanding the material at hand, giving him confidence in his abilities to solve a problem that, in the past, had seemed formidable and possibly even insurmountable; and perhaps helping him to be motivated to solve such problems and be persistent in the face of obstacles in the future. Notice that the wellbeing mentioned here is very much in the emotional and motivational realms of stage-setting and less in the cognitive realm of understanding subject matter.

2.2.3 Altruism

Here, too, definitions flourish. At their core is giving up something of value to you both knowingly and voluntarily for the benefit of another. The two stories I related at the beginning of this chapter, saving strangers' lives in Japan and Europe, fit this definition of altruism.

Where could altruism enter the picture in teaching? Our IKUSA is the result of millennia of cultural innovations, and it is of immeasurable value to us all. Passing it on both knowingly and voluntarily for the benefit of another person could seem to fulfill the definition of altruism. However, there are two places where the definition does not fit teaching: (1) there are places where it is not given voluntarily, and (2) when teaching, you do not necessarily lose something of value.

Regarding the voluntary part of altruism, teaching is voluntary in the overwhelming majority of the times where it occurs on our planet every nanosecond: among farmers in lettuce fields in Botswana, tribal villages in India, the south Pacific seas where fishing is the main source of livelihood, playgrounds in Prague, at home when parents teach their children, when children teach each other and much more. All of this takes place voluntarily in virtually every place and moment on our planet.

One notable exception to this is schools. Schools are culturally designated locations where teaching and learning occur, and where material (often state-approved curricula) is taught by culturally designated purveyors of teaching, those people with qualifications (licensed professional teachers). Their employment and salaries are subjected to rules and regulations within a framework of labor laws and unions. In this sense, school teachers do not teach voluntarily. They are paid wages for it. And this means that their teaching is not altruistic. For some school teachers, teaching is a calling. It is a noble profession that can be inspiring. But, for all school teachers, it is not altruistic.

To reiterate this point, non-professional teaching may meet the condition of altruism being done knowingly and voluntarily. But those conditions are not met by professional teachers who teach in schools, in companies that have professional development and more.

The second condition in the definition of altruism is that one loses something of value for the benefit of another. Our IKUSA is cultural and has accumulated over the millennia and, as a result, it is of great value for each and every one of us. Given this, one could think that passing it on for the benefit of others may fulfill the part of the definition of altruism that includes losing something of value.

I now show which people think teachers lose something when teaching. And I then show places where we do not lose something of value.

Regarding losing something of value when teaching, evolutionary biologists and those dealing with cultural evolution could argue that the T loses something: the time and energy spent to teach someone. Both are investments that could have been spent otherwise and by choosing to teach, the T loses both. This fits with the definition of altruism.

However, the T does not lose her transferring information, knowledge, understanding, skills and attitudes (IKUSA) when transferring it to a L. When I pass on IKUSA to another person, I do not lose my IKUSA. I pass it on, but it remains with me. In this sense, teaching does not fit the definition of altruism.

This is in line with the distinction between what in economics is termed non-rival goods. My having something does not prevent others from having it (as in the case of breathing air) and rival goods where an object in my possession cannot be consumed by someone else (as in my owning a car). In economic terms, then, teaching is non-rival.

The understanding of this distinction is found early on in life. Even 3-year-old toddlers know that when they teach someone, what they taught remains with them. In a pilot study I conducted, I told toddlers that I did not know their father's name and asked them if they could tell me what it is. They told me, and I repeated his name. I asked them if they thought I knew his name and because I had just said it, they all acknowledged that I did. I then asked them if they still knew their father's name. They all said that they still did, and many gave me looks bordering on the incredulous. How could I be asking such a silly question is what their facial expressions revealed.

I put these same children in another situation, one with passing on an object. There was an array of objects on a table between us. One was a spoon, and I gave it them. I asked them if they have the spoon, and they all said that they did. Then I asked them if I have the spoon. They said that I do not have it now and, for some of them, their previous look of incredulousness was transformed into a slight form of wry amusement and, sometimes, mild disgust.

What we learn from this is that toddlers distinguish between passing on objects (in a rival good scenario) where either the object is in my possession or not versus passing on IKUSA (which are non-rival goods) where transferring IKUSA to another doesn't lead one to lose what was just transferred.

To briefly summarize the points I made here about teaching being altruistic, IKUSA transfer is not altruistic among professionally-trained Ts because it is not voluntary; nor is it altruistic for everyone because we don't lose the IKUSA we pass on to others, which is a condition for altruism.

Hopefully, so far, so good. Having presented ideas about teaching in relation to empathy, compassion and altruism, I now turn to the following section on teaching's prosociality as it relates to helping behavior. The main idea in the upcoming section is that in addition to teaching being involved in stage-setting and IKUSA transfer, it is also fundamentally prosocial of the helping behavior kind.

2.2.4 Prosocial Helping Behavior

Of the different kinds of prosocial behaviors, I now concentrate on helping behaviors of which there are at least three kinds: instrumental, empathic and altruistic. Svetlova et al. (2010) studied each one's origins and developmental course.

Instrumental helping, which was studied extensively by Warneken and Tomasello (2006, 2007, 2009) is somewhat self-centered and revolves around self-interest, objects that are of interest to you and actions, such as helping your father clean the kitchen table of crumbs from a recent meal. Instrumental helping has been found among toddlers when, for instance, they help others retrieve an object that is out of their reach. I pick up on this later. This kind of helping behavior appears at approximately 18 months.

In contrast to instrumental helping, it is thought that empathic helping is based on more social understanding regarding concern for others. Here toddlers are more other-oriented than when they display instrumental helping, understanding that others have different thoughts, understandings, feelings than the ones they have. Svetlova et al. (2010) found that toddlers around 30 months of age showed empathic helping.

Finally, the third, altruistic, helping behavior involves people relinquishing something, say a valuable object, both knowingly and of their own volition. It also includes the knowledge that they will be losing that valuable object to someone else. Although there are differing definitions of altruism, as mentioned above, at their core is giving up something of value to you both knowingly and voluntarily for the benefit of another.

2.2.5 Origins and Development of Aspects of Prosocial Behavior

For a comprehensive analysis of instrumental helping behavior and a review of studies that test it and its development, see Bridges and Gweon (2018).

Tomasello and his collaborators (Tomasello, 2009; Tomasello & Carpenter, 2007; Warneken & Tomasello, 2006, 2007, 2009) have done considerable theory development and research around cooperation. In general, their findings indicate that from the second year of infants' lives, they seem to be guided by a cooperative impulse.

In Tomasello's view, toddlers are naturally altruistic. For reasons mentioned above, I quibble with Tomasello's use of the term "altruism" but, for the moment, I put it aside. Part of Tomasello's conclusion is based on work with colleagues, termed instrumental helping with very young children. In various situations, one person (A) helps another (B) achieve a goal that B cannot achieve and where A gets no clear reward for that help.

Here is a situation studied in an experiment conducted by Warneken and Tomasello (2006) that tested instrumental helping. A toddler is in a room standing next to his mother. An adult enters the room holding many books in his hands. He walks to a cabinet whose doors are closed and bangs his book-laden hands into the cabinet doors. This is what the toddler sees.

Typically, 18-month-olds walk over to the cabinet and open the door in an unsolicited manner. The mother does not tell the toddler to do anything, and the adult experimenter does not speak to the child, nor does he gesture as if asking for help. This kind of behavior among toddlers is termed instrumental helping.

I dwell on this study with a bit of detail because it is a prototype of instrumental helping, and I will use this study as a template to show how teaching shares important features with instrumental helping. If I succeed in this task, it means that prosociality enters the picture of teaching.

But first things first. Let us see what the structure of instrumental helping is comprised of. Table 1 presents some of what may be needed for the 18-month-old's helping behavior.

In the books scenario just presented, a number of inferences are needed to understand the experimenter's behaviors. One is that he has a goal, which is to put the books in the cupboard. Another is that the means to achieving that goal is to open the cupboard doors. And if that is the case, then an impediment to achieving that goal is that he has many books in his hands which prevent him from opening the cupboard doors.

As reasonable as this is, it must be emphasized that these are inferences from the situation. The goal to put books in a cupboard is not seen in the experimenter's behaviors. Neither is the impediment. The way to understand the goal, impediment, etc. is to infer them from others' behaviors.

If the toddler is to help the experimenter, it might be that he recognizes aspects of the experimenter's behaviors, has knowledge about them, decides to act and then acts. In Table 1 we see that it is possible that the *toddlers inferred the experimenter's goal* and the *means* to achieving it. They may have also recognized that there was an *impediment* to the other person achieving that goal. They might also have *world knowledge* of two kinds. One is knowledge about the external world. In this case it is knowledge that doors can be opened. They also might have agency in the form of

Table 1 Partial relations between agent and helper leading to instrumental helping

Experimenter	Helper
	Possible Recognition Of
Goal	Agent's goal
Place books in cupboard	
Means to achieve the goal	Means to achieve the goal
Open cupboard doors	
Impediment	Impediment
Door is closed Books in hands prevent opening doors	
	Knowledge
	World knowledge
	Doors can be opened
	Self-knowledge
	I can open the doors
	Decision
	Open the doors
	Action
	Open the doors

self-knowledge, which is to say that they may know that they, themselves, can open the cabinet door.

If this is the case, we see that there is quite a bit happening here. The situation is much more complex than what I have been describing, but you may now have an inkling as to its complexity.

But making these inferences about the situation, and having these two kinds of knowledge and having decided to open the cupboard doors does not necessarily lead to the act of opening the doors.

This issue has been addressed in a particularly interesting article mentioned above by Bridgers and Gweon (2018) where they suggest, among other things, that an important aspect of helping behavior is what they term means-inference. It involves identifying the cause of the problem (the doors are closed and the adult's hands are full with books) and the appropriate means to resolve the issue (open the doors). The helper needs to know whether this appropriate intervention is doable and reasonable to carry out. In other words, what the costs and benefits of the helping behavior are.

Despite Bridgers and Gweon's (2018) excellent treatment of helping behaviors and conditions that enable them, we are still left with a problem. Let us say that all the conditions are met for instrumental helping behavior to occur. And there is a decision to act in a manner we interpret as helpful, taking into account all the variables Bridges and Gweon mentioned. We still do not know why the helper acts. To decide to help does not necessarily lead to acts of helping.

In another context about decisions to act and actually acting, today I decided not to eat chocolate and then proceeded to buy chocolate, telling myself I won't eat it. And, on occasion, I do not consciously decide not to eat chocolate, yet when I am offered chocolate, I do not take it. Relations between decision-making and acting based on a decision have been a topic of debate among philosophers and psychologists for eons. What I am pointing out, though, is that helping behaviors do not escape this conundrum.

I just analyzed the complexity in some of what may be involved in instrumental helping behavior with the books example. Having done that, we are now in a position to examine my claim that an aspect of human teaching (detecting and closing a knowledge gap) involves such prosocial behaviors.

To support this claim, let us return to research reviewed above (Knudsen & Liszkowski, 2012a, b; Liszkowski et al., 2008) where infants detected and closed a knowledge gap when they pointed to the location of a key that fell off a table. An analysis of what is involved in that experiment is found in Table 2.

To remind the reader of the experiment, after the experimenter noted and talked about the objects on a table between him and the toddler, the key fell to the floor in full view of the toddler and purportedly unbeknownst to the experimenter. After some seconds, the experimenter asked where the key was located. And preverbal infants pointed to its location.

Table 2 Partial relations between agent and helper leading to instrumental helping in a teaching situation with knowledge gap reduction

Experimenter	Helper
	Possible Recognition Of
Goal	Agent's goal
Retrieve the key	
Means to achieve the goal	Means to achieve the goal
Search for the key	
Impediment	Impediment
Ignorance of key's location after search	
	Knowledge
	World knowledge
	Key is on the floor
	Self-knowledge
	I can pass on knowledge to the agent about the key's location
	Decision
	Point to the key
	Action
	Point to the key

Let us analyze this situation in ways similar to our analysis of the books scenario. In the key study, the experimenter's goal was to know the key's location so as to retrieve it. The means to achieve that goal was to search for the key. Because he could not find it, the impediment to achieving that goal was ignorance. Reasons for that ignorance could be that it was occluded by a leg of the table, it was difficult to see because it was dark under the table, etc. The bottom line was that the experimenter could not locate the key so as to retrieve it.

From the point of view of the helper, the infant in our case, she may recognize the experimenter's goal. She may also recognize the means to achieve it, i.e., to look for it, and she should also recognize the impediment to retrieving the key, i.e., after searching for the key, the experimenter's continued ignorance about its location. The infants have world knowledge which is that the key is on the floor, and it is possible that they have self-knowledge which is that they can pass on their world knowledge to the experimenter. There also may be a decision to point to the key's location. And here, too, the decision to act must be carried out, i.e., the infant points to the key.

Now that we presented the books and key scenarios, we can see if helping behavior is inherent to an important part of teaching: IKUSA gap detection and closure. We can do this by comparing instrumental helping and IKUSA gap detection and closure. This gets at the claim that at the heart of teaching is prosociality. If we see that there are similarities between the books and key scenarios, we could be in a position to claim that IKUSA gap detection and closure are an instance of instrumental helping. It is to this comparison that we now turn.

2.3 Comparing Instrumental Helping and Knowledge Gap Detection and Closure

In both the books and key scenarios, the experimenter had a goal: to put the books in the cabinet and to obtain the key. In both scenarios there is an impediment to achieving the goal: hands full of books and closed cupboard doors, and ignorance as to the key's location. In the two scenarios, the child has world knowledge: cupboard doors can be opened and the location of the key. There is also an overlap in the children's self-knowledge: I can open the doors, and I can point to the key's location. And in both scenarios, there may be a decision to act and to actually act. Finally, the children act prosocially by removing the impediment that allowed the experimenter to achieve his goal: opening the cabinet doors and pointing to the key's location.

Pointing to the key's location so that the other person can obtain the key is a specific instance of how prosociality is embedded in the gap detection and closure part of teaching. The generic case is that Ls have a goal to gain IKUSA and ignorance is an impediment to that goal. The T helps the L achieve that goal by transmitting IKUSA and, as I showed, that can be done by, among other strategies, explanation and demonstration and, in the case of preverbal infants (and older children and adults for that matter), by pointing.

When we compared the books and keys scenarios, it appears that they have similarities. I am making the claim that these similarities may indicate that the key scenario that involves teaching (closing a knowledge gap and closing it) is an instance of prosocial behavior.

But, given these parallels, perhaps an opposite claim can be made. Maybe the prosocial behavior in the books scenario is a case of teaching. Maybe when toddlers opened the cabinet doors, they intended to teach the experimenter how to do that. This would imply that the toddlers thought that the experimenter did not know how to open the doors, rather than believing that the experimenter knew how to open the doors but could not because of the impediment. Given the context of the scenario, although my alternative caveat explanation is possible, it seems implausible. This requires further analysis and experimentation.

If what I am suggesting seems reasonable, that inherent in the gap detection and closure of teaching is prosocial helping, we should attempt to go beyond the key scenario and analyze other knowledge gap detection and closure situations so as to test the generality and limits of their connection to prosociality.

And, finally, look where this reasoning has led us. If my ideas are accepted, this suggests that teaching is not only cognitive in nature. It is also fundamentally prosocial. This expansion of teaching to include prosociality joins the other expansion I presented, that it involves IKUSA and stage-setting.

3 Summary and Last Comments

The main purpose of this chapter was to argue that our conception of Western human teaching ought to be expanded in three ways.

First, we can move beyond viewing teaching mostly, if not exclusively, through the prism of information transfer. It was suggested that prior to IKUSA transfer, stage-setting takes place which includes mutual emotions-motivation- and mind-reading on the part of Ts and Ls. Part of mind-reading is to detect if there is an information, knowledge, understanding skill and attitude (IKUSA) gap between the T and L. If there is such a gap, Ts act to close it via strategies such as explanation, demonstration, pointing as well as many other strategies. It was argued that stage-setting is no less a part of teaching than IKUSA transfer.

A second expansion was to show that knowledge gap detection and closure are fundamentally prosocial in nature. Two disparate studies were analyzed. One explicitly tested toddlers' instrumental helping behavior when a toddler opened a cupboard door to help an adult place books in it. There is consensus that this kind of study taps prosocial instrumental helping behavior. The second study involved infants detecting a knowledge gap and acting to close it. This has been seen as an instance of knowledge transmission. An attempt was made to show a parallel between the two studies, suggesting that the knowledge gap detection and closure study involved prosocial helping.

At a higher level of generality, it was suggested that teaching surely has its cognitive elements, but it is possible that it is also inherently prosocial.

It is my hope that the ideas behind these expansions helped you, the reader, see some of the complexity inherent in teaching, understand that teaching is prosocial in its essence and possibly feel awe at how we teach naturally without having been taught how to teach.

And to end where I began, some of the ideas percolating in these pages were the result of conversations with Dorit. But more important, in my eyes, is that Dorit has been an empathetic, compassionate and altruistic friend. As an example, she invited me to have dinner with her family at a time in my life when that was much needed. I will never forget her kindness and am deeply grateful for that. That is Dorit, a remarkable scientist and an extraordinary friend.

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Part III
Linguistic Literacy

Linguistic Literacy: Twenty Years Later

Liliana Tolchinsky

Abstract The chapter provides an updated reappraisal of Ravid & Tolchinsky's (2002) framework modeling linguistic literacy. The chapter suggests a re-elaboration of the model's main constructs – rhetorical flexibility as an outcome of developing literacy, literacy as a domain of knowledge, and the developmental and representational status of literacy knowledge – in the light of the concerns that have impacted the domain of literacy during the last 20 years. The chapter concludes that from varied perspectives – theoretical, research-based, pedagogical, and sociopolitical – developing literacy en route to critical rhetorical flexibility is as timely as it was 20 years ago.

Keywords Developing literacy · Rhetorical flexibility · Linguistic variation · Printed and digital medium · Enabling factors

What do tourist trips and yoga classes have in common when practiced by Israelis? Israelis manage to triple the achievements of non-Israelis in the same amount of time. They manage to visit triple the number of cities, monuments, and museums in a weekend in comparison to most other tourists, and they will perform a triple number of asanas in a 45-min yoga class. These associations came to my mind when recalling my writing experience of *Developing linguistic literacy: a comprehensive model* more than twenty years ago at Dorit's home in Yahud. She produced triple the

The title refers to a position article co-authored with Dorit Ravid and published twenty years ago (Ravid, D. & Tolchinsky, L. 2002. Developing linguistic literacy: A comprehensive model. *Journal of Child Language, 29*, 419–448), which introduced the notion of "linguistic literacy".

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number of ideas and put them into words three times faster than I did; she also recalled and consulted dozens of references in the blink of an eye, prepared two full meals, and ran off to join her class in Israeli folk-dancing that same evening. Dorit's energy and erudition have paid off in many areas. She developed an impressive career and has published a huge number of high-quality papers – name a topic in psycholinguistics, you will find a paper by Dorit and her associates. She continues to provide delightful dishes, now including international delivery service to her grandchildren and still enjoys folk-dancing as well as gymnastics and swimming.

In *Linguistic literacy* (thereafter LL), we argued for considering literacy as an integral part of language development. It was a rather unusual approach at a time when literacy was considered a school subject of study rather than a developmental domain of knowledge. Twenty years later, literacy has become a domain of concern to linguists, psycholinguists, and neuroscientists, in addition to educational psychologists. There is growing awareness on the part of linguists of the impact of writing on the definition and conceptualization of basic units of linguistic analysis such as words and sentences (e.g., Harris, 2009; Olson & Oakley, 2014). And because of the role these units play in common classificatory criteria of languages (like word structure and word order), linguists have begun to question the extent to which language typologies might be based on the written variety, in cases where there is one (Moreno Cabrera, 2018). But studying language processing "wearing literate glasses" (Kolinsky & Morais, 2018) has often led psycholinguists to disregard or underestimate the contribution of literacy to perceiving, understanding, and producing language. Neuroscientists and developmental neurobiologists have shown that the acquisition and practice of literacy evoke important functional reorganization of the human brain. The development of neural networks that are largely specific for reading and writing and the resultant increase of functional connectivity with other brain areas supporting language activities are currently under constant scientific examination (e.g., Carreiras et al., 2009; Dehaene et al., 2015). Computer science and mathematical modeling are increasingly applied to archeological and historical research to access the discourse features and structural complexity of preliterate verbal reports (Mota et al., 2016), opening for investigation what until very recently was considered impossible: recovering preliterate language and thinking. These advances might enable us to ascertain whether Harris (2009) was right when he affirmed that "once literacy becomes established, it begins to invent its own myths about pre-literacy" (p. 21).

In parallel, educational psychologists are developing increasingly complex models of reading and writing processes and the interrelations between them. These take into account the increasing difficulty of text comprehension and production in response to higher standards of literacy achievement. And they recognize the power of writing as a social activity that is shaped by writing communities and by the writer's cognitive characteristics, capacities, and physical actions (Graham, 2018).

How does LL stand in the light of these issues? Are the views we advanced 20 years ago still applicable, or have they become obsolete? In what follows, I address these questions with the aim of providing an updated reappraisal of the LL framework in the light of concerns that have impacted the domain of literacy during the last 20 years.

To start, I review how we defined the major outcome of developing literacy in terms of the notion of *rhetorical flexibility* – elaborated here to involve the kind of rhetorical flexibility uniquely attained by literacy. I then revisit the perspectives from which we approached literacy in LL, how we defined the domain, and our view of development, and the representational status of literacy knowledge. Here, I expand these concerns to include the *medium*, whether written/printed or digital, with digital communication providing an additional source of linguistic variation under the umbrella of literacy, in addition to genre and modality. I also discuss current shifts in developmental inquiries into the domain, and how research has moved from focusing on what learners bring to the task to looking at what they need to learn. Next I consider different levels at which literacy knowledge is accessed, underscoring the inadequacy of the implicit/ explicit dichotomy, and the need to include sociocultural, emotional, attitudinal, and other factors as explaining development, so opening up new domains of awareness over and above the metalinguistic and metacognitive. Findings of current research on reading comprehension and text writing then lead me to the interactive triangle – *experience with written language, development,* and *literacy activities* – proposed as enabling conditions for command of rhetorical flexibility.

I next unpack the idea of *experience with written language* underlying the developmental changes attributed to literacy, considering emotional and sensorimotor factors which, while not considered in our earlier LL model, prove to play a role in promoting or hindering literacy achievements in childhood and adolescence. In referring to *the role of the developing child*, I consider the neurobiological basis of later developments that enable learners to benefit from experience with written language. Finally, by considering different types of *literacy activities,* I argue that to understand what writing does to people, we need to consider what people do with writing.

1 An Initial Proposal for Elaborating a Major Outcome of Literacy

The LL model proposed that *rhetorical flexibility* is attained through experience with written language, development, and literacy activities. That is, a person learns how to adjust his or her linguistic repertoire in response to different communicative circumstances. We were not implying, however, that rhetorical flexibility is triggered by literacy alone. There is rich evidence showing that children's adjustment to different communicative circumstances begins very early on. Small children can handle a large repertoire of speech acts. We assumed that flexibility is enhanced and expanded by literacy and shaped by increasing command of the socially determined features of genre and register. These two constructs, genre and register, were assumed to subsume the inherent variability of language use, so that the defining feature of literacy is “control over linguistic variation from both a user dependent (`lectal ‘) and a context-dependent (modality, genre, and register) perspective”.

Today, however, the expansion of digital means of communication and research from the perspective of situated cognition call for considering additional sources of variation. Beyond genre and modality, digital media introduce a new linguistic space that literate people need to control. To illustrate, notational combinations of letters and ciphers (U2) or use of capital letters to mean shouting, both legitimate for texting, are (so far) unacceptable in academic essays.

Current approaches to academic literacy in the framework of sociocultural pragmatics call for including what Uccelli and Phillips Galloway (2020) term control over “situated discourse practices” to supplement linguistic skills and advanced literacy-related activities, as part and parcel of literary attainments. Over the years from childhood to adolescence, heterogeneity of discourse practices increases, with the shift from a caregiver-dependent child to a fully autonomous adult, marking a peak from this point of view. Peer-interaction regulates most decision-making processes during this transition, motivated by adolescents’ readiness to achieve independence from adults while, at the same time, requiring them to respond to the cultural expectations of school learning. Each context tends to trigger distinct and possibly contrasting identities. At the highest point of idiolectal development, young people in the industrialized world are required to gain command of “academic language” – also called “the language of education”, “the language of science”, and “the language of schooling” – in the sense of the repertoire of language features used in educational and scientific contexts (Halliday, 1994). Uccelli and Phillips Galloway suggest that awareness of these practices, and of the metalanguage used for realizing them in different contexts, involves extending the notion of rhetorical flexibility to *critical rhetorical flexibility*, entailing “an increasing reflective attention to how language choices convey particular meanings to either embrace—or depart from—conventional academic language resources” (p. 171). In what follows, I embrace their proposal as a means of elaborating on the major outcomes of linguistic literacy.

2 A Further Proposal for Elaborating on Literacy Perspectives

In our earlier work, we defined as our domain of concern those aspects of literacy competence that find expression in language, together with aspects of linguistic knowledge that are affected by this competence. We thus deliberately excluded such areas as computer literacy, visual literacy, and so on. But today, digital means of communication early on expand children’s repertoire of interactive settings. Estimates from industrialized countries indicate that by the second decade of the century, even preschoolers are being introduced to mobile technology, with many using touchscreens daily (Kabali et al., 2005). The phenomenon of "textism" is so widespread that teenagers and undergraduates have been estimated to write 5–20% of words in their text-messages in what is variously termed "texting register", *net-speak, cyberspeak, fingered speech*, or *a chat alphabet*).

With digitalization, the *computer screen* has emerged as a distinctive textual unit. This development has brought about crucial changes in the way people read and conceptualize knowledge, and has multiplied the types of texts people need to control. These diverse "fluid" texts challenge two distinguishing features of written texts: demarcated boundaries and permanence. Being "text-literate", as of 2021, means being able to understand both transitory and permanent written texts and being able to cope with fluid intertextuality.

Scripts and orthographies have also been subjected to marked transformations in digital communication. Once installed in our computers, "fingered speech", like any form of language use, develops its own rules and its own vocabulary. Take, for example, the changing nature of how "lol" is used. It once meant "laughing out loud," but has become a marker of empathy of accommodation, a pragmatic particle (McWhorter, 2013). Texting is also developing a multimodal *notational* system meant to be interpreted rather than read aloud. It uses a different way of separating words (by punctuation); its spelling is largely sound-based (*ull* rather than *you will*), to reduce the time and cost of messaging. Common abbreviations, or "textisms", include letter homophones (such as *c* for *see*), number homophones (*2 day* for *today*), and phonological contractions (txt for text) (Plester et al., 2009).

It is still an open question whether *electronic texts* afford a platform for "deep reading" (Wolf, 2019). Studies examining the process by which units are extracted from a text, and how these units are synthesized in processing multiple texts, found individual differences in how well students deal with macro-construction and organization of digital materials. Understanding "hypertext" containing links to other texts is often assumed to involve higher levels of cognitive processing in the face of multiple facets of text information. But studies on the issue yield contradictory findings. Some show textese to have a positive effect on children's grammar performance, hence on their literacy abilities; others point to a negative effect of all "electronic multi-tasking" on how well students recall lecture material. Baron (2015) concluded from her investigation of hundreds of university students in countries with different languages and writing systems that digital reading constitutes "hyper reading", where readers aim to rapidly identify information that they consider relevant to their concerns; that even academics appear to scan scholarly materials, particularly online articles, more rapidly than before; and that people read less than a third of the words they encounter on web sites.

The proliferation of digital means, which contravene such time-honored conventions of writing as notational boundaries, spelling rules, as well as lexical and syntactic usage, with crucial effects on how people read and write, means we have no choice but to expand our *domain of concern* to add digital media. In an era of mass-writing, use of the Internet has created new literacy spaces. More than ever, writing has become a multifaceted activity that combines other means of expression such as sounds and images. Children need to develop their writing in relation not only to genre and reader, but also to the medium of presentation. This means adding to the sources of variation in becoming literate: Learners need to be able to both process technically and evaluate *critically* the textual presentations they encounter, from text messages to what's app via email and on to computerized databases (Van Waes et al., 2016).

2.1 The Developmental Approach

The second perspective from which we examined literacy was *developmental* in nature. We were interested not only in describing what children have to learn in order to become linguistically literate, but also in their current state of knowledge and their ideas about written language in the process of becoming literate. This point of departure echoes basic tenets of ideas of emergent literacy, invented spelling, and constructivist approaches to literacy that flourished during the later decades of the twentieth century. Although each domain had a specific focus, they all alike emphasized what children *bring to* the learning process. They took into account the ideas that children themselves construct about writing and written language, even if they do so informally, as playing a role (in Piagetian terms) as assimilatory schemas of what they are taught or exposed to and hence as serving as the basis for establishing new schemas. In so doing, they put into practice Carol Chomsky's (1976) proposal that pedagogues and researchers alike recognize the creative and innovative abilities that children demonstrate in acquiring literacy, by "encouraging children to use their creative tendencies when they come to the second large linguistic task of their young lives, learning to read" (and to spell).

As against these views, so-called "componential" models of reading and writing (or of other complex domains) in cognitive psychology have gained ground today. I return to these models in greater detail later. Basically, they attempt to identify functionally defined information-processing components which accomplish more complex levels of performance (such as reading comprehension, text writing).[1] Their goal is to detect which of the purported components better explain performance. Literacy is viewed as the product of an array of component skills, all of which are necessary to high-level performance. For example, phonological awareness, letter knowledge, automaticity in reading letter sequences, and lexical access all constitute key components of early reading skills (Snow, 2018). Componential models focus on the obstacles children must solve to become literate; and development is viewed in terms of the skills and knowledge children needed for becoming literate, rather than attempting to tap the insights learners gain through experience with written language across childhood and adolescence.

[1] The reasons for the current predominance of these approaches are beyond the scope of the present chapter.

2.2 The Representational Status

In LL we made it clear that "Ours is not a dichotomous model of accessibility of knowledge in terms of implicit/unconscious versus explicit/conscious knowledge." Rather, we assume that there are multiple levels between the two extremes – as suggested by Culioli's (1990) definition of the "epilinguistic" level, and as most clearly expressed in the multileveled model of Karmiloff-Smith (1992). For sure, newcomers to the field access the information embedded in literacy-related artifacts, tools, and symbols at multiple levels of input and intake. When babies bang on a cellphone screen to obtain a desired outcome, they apply a basic *action schema* that demonstrates what Bruner (1973) described as an "attainment of competence" in infants. Babies are intentionally mobilizing a sequence of actions afforded by a given object (in this case, a literacy-related object), which succeeds in attaining a goal. A child who applies the same sequence of actions to a book as to a cellphone or television screen is less literate than one who adjusts his/her actions to the requirement of different literacy-related artifacts. There is a *continuum* of degrees of awareness and metacognitive/metalinguistic knowledge from this implicit procedural level of access to the most sophisticated explanations that involve copious use of metalanguage (say, of a narratologist about the features that distinguish narrative from poetry).

The different levels of access are task – and context-dependent. Take, for example, the case of meta-phonological awareness at a phonemic level, which many scholars consider to be a requisite for learning to read. It turns out that the same five-year old who, in a typical metalinguistic task, is unable to pronounce the sub-syllabic segments that compose a word can in fact pronounce them when searching for letter-to-sound correspondences in trying to spell a word. The graphic support provided by the letter s/he is tracing helps to raise awareness of the implicit phonological structure of the word the child is trying to spell (Tolchinsky, 2019).

Experience with written language in all its variety enables us to think about language – about the different units of language, the distinction between form and content, what has been said and what is meant, to revise, paraphrase and reinterpret – so inducing higher levels of awareness. But, as we argue below, more than metalinguistic awareness is involved. Awareness of motivational, attitudinal, and affective factors, as well as of discourse-based practices, are both a requirement and a product of literacy.

Thus, awareness of personal efficacy for self-regulation (e.g., avoiding distractions, dealing with frustration, persisting in the face of difficult writing tasks) makes a significant contribution to narrative text quality across levels of schooling (Camacho et al., 2021). And teaching metalanguage that supports students' awareness of the situational expectations and functions of academic discourse practices facilitates text comprehension (e.g., Schleppegrell, 2013).

2.3 Linguistic Developments Attributed to Literacy

In LL we argued that acquiring literacy is part of what is termed "later language development'", linguistic acquisition beyond the preschool years. Historically, and paradoxically, it was Carol Chomsky who put this domain on the map. In her 1969 publication, *The Acquisition of Syntax in Children from 5–10*, she showed that there are relevant changes in understanding and production of grammatical structures even after children have attained "the border of adult language competence." Her recognition that children continue to develop the skills needed to understand complex constructions beyond the age of five, despite established beliefs that children complete their acquisition of syntax by then, went hand in hand with her view of literacy as "the second main challenge children need to overcome". Nowadays, the domain covers every aspect of linguistic development after the borderline age of 5 (Karmiloff Smith, 1986), roughly the age that coincides in most cultures with the onset of formal literacy instruction. Berman (2004) pointed out the meaning of this *boundary* by making a distinction between a native language user and a proficient language user. This distinction captures how language development is impacted by becoming a literate language user (e.g., Berman & Ravid, 2017; Jisa, 2004). Literacy has become the main explanatory factor of the changes observed in every aspect of linguistic knowledge beyond age five, from word-level lexical and morphological processes to higher levels of syntactic construction and semantic rigor during discourse processing.

Studies in English show that children progress from adding an average of 860 root word meanings (word forms with different meanings), per year before Grade III to adding about 1000 root word meanings per year between Grades III to VI. Thus, excluding derived forms, children understand on average about 10,000 root words by the end of 6th grade (Biemiller, 2012). In Hebrew, vocabulary growth across the school years has been shown to yield greater lexical diversity and semantically more specific encoding of concepts (Ravid, 2004, 2006). Seroussi (2004) had grade-school, middle – and high-school students compared with adults complete Hebrew sentences with two competing abstract nouns constructed from the same consonantal root (e.g., *šetef* 'fluency' / *šitafon* 'flood'). Older students and adults knew the meanings of less familiar nouns, while adults made wider use of extended meanings and metaphorical senses of the same terms (for example, they applied the Hebrew term *chisun* 'vaccination' to the "disease" of racism).

Studies in different languages show that across childhood and adolescence, students use longer, morphologically complex words more often (e.g., *unforgettable)* and make use of lexical categories such as adjectives and adverbs that are infrequent before age six. Ravid and Levie (2010) found that the adjective class grows larger, richer, and more diverse with age and schooling – in lexicon, morpho-semantics, and syntax. And Nippold (2016) pointed to a growing use of adverbs that introduce subtle differences in meaning, such as how likely something is to happen (for example: *possibly*) and to what extent something is (for example: *extremely, very*).

Studies applying scales of semantic-pragmatic abstractness to nouns used in extended texts (Ravid, 2006; Berman & Nir-Sagiv, 2007; Nir-Sagiv et al., 2008) found that abstractness increases as a function of age, while at the same time, children increasingly accept and understand polysemy, synonyms, homonyms, and homographs (Bar-On, 2001). Knowledge of multiple word meanings increases with age both in first and additional language learning and relates significantly to reading comprehension (Booton et al., 2021). Derivational morphology plays an increasingly important role at the interface between vocabulary and syntax (Ravid, 2004), and morphological mechanisms are marshalled to cover lexical gaps (Llaurado & Tolchinsky, 2014).

There is also an upsurge in syntactic complexity, using more marked constructions such as passive voice, center-embedded clauses, and nonfinite subordination, with longer, more tightly packaged syntactically and thematically linked chunks (Berman & Nir-Sagiv, 2007). Across different languages there is a general spurt in text-embedded linguistic complexity from adolescence up. However, once embedded in discourse, structural elements show notable differences in distribution as a function of genre, modality, and register. To illustrate, texts produced by older participants typically contain a higher proportion of content words than those of younger children (Berman & Ravid, 2017), while expository essays have higher lexical density than written narratives, which in turn are denser than their spoken counterparts. Similarly, taking the structure and content of *noun phrases* as a qualitative means of evaluating syntactic complexity, the proportion of complex noun phrases increases primarily in the written language and in expository texts, as a function of age, most markedly from high school up.

Three dimensions of language use – conditional constructions, epistemic modality, and figurative language – point to a blossoming with age of added expressive options, linguistically, conceptually, and discursively. These emerge as hallmarks of advanced, literacy-related language use, where linguistic knowledge is marshalled to express more complex conceptual domains.[2]

Conditionals serve diverse functions, from a parent's promise to give a child ice-cream to the formulation of experts' predictions in academic writing, which depend on knowledge of the scientific domain for which the hypothesis is formulated. Hypothetical conditionals describe events or circumstances that have not taken place, but that might or could occur under certain conditions. In contrast, counterfactuals no longer lie in the realm of possibility, they can no longer occur under any circumstances. Nippold et al. (2020) reported that even adolescents (aged 11–14 years) are less proficient in completing counterfactual sentences than are adults asked to perform the same sentence-completion tasks. Hypothetical and counterfactual conditionals are less common in everyday conversation, yet they figure widely in school language. Comprehending them is important for academic study, particularly in subjects like science and history, where hypotheses and alternative

[2] These three topics are analyzed in detailed in our forthcoming book, Tolchinsky, L. & Berman, R.A. *Language Use and Development beyond Age Five.* OUP.

explanations are important. Badger and Mellanby (2018) noted that when British children aged 5–8 years of age were asked to repeat sentences including counterfactuals like "If Peter had bought some ice cream, he would have shared it with his friends", only older children were successful, and only partially so, and comprehending these constructions correlated positively with other school-related skills. Markovits et al.'s (2016) study of 9- and 12-year-old French-speaking students showed how difficult it is to grasp conditionals involving arbitrary relations (e.g., *If a circle is red, then the star is black*): It took until almost adolescence before children could entertain a full set of possible alternatives, showing that they were able to apply formal reasoning that is independent of content.

A second development involving the opening up of alternatives is the shift from reliance on deontic to epistemic modality. Up until middle childhood, around age 9–10 years, children speaking different languages use mainly "deontic" modal expressions. They talk and write about how they view non-actual events judgmentally, as being good or bad, in terms of socially imprinted conventions, or else they express ability or necessity by terms such as *can, must, should,* or negative *not right, mustn't.* The move to epistemic modality is reflected in diverse and protracted developments, including choice of abstract or generic Subject noun phrases referring to entities and situations which could give rise to alternative contingencies (e.g., some solutions on how to avoid these conflicts; an open mind and a desire to think the situation through rationally; an unwillingness to listen). Such heavy, erudite nominal subjects are rare in the language of children before adolescence. They are also commoner in the written language usage of adults than of high school students, as a sign of highly literate, well-educated language users.

A third development concerns access to figurative uses embracing heterogeneous phenomena that include idioms and proverbs, metaphors, irony, jokes, and lies. It takes until well after the early school years – in some domains such as irony, even beyond adolescence – for children to assign appropriate interpretations to different types of figurative usage, including idioms (Nippold & Taylor, 2002), metaphors (Gentner, 1988; Vosniadou, 1987), and various kinds of linguistic humor, from obvious to subtle (Ashkenazi & Ravid, 1998). And the ability to comprehend and interpret poetry, the highest level of non-literal language, continues into adulthood and may even require special training (Peskin, 1998). Here, too, development is modulated by factors such as how *culture-bound* a given usage is, differing levels of conventionality, how relatively concrete or abstract are the concepts involved, the role of supporting context, and the degree of metalinguistic awareness necessary to distinguish what is said from what is meant.

As one example of progression in use of figurative language, *similes* are understood before metaphors since they contain clear language cues that signal the relation between two entities or domains – *Peter* ***is as*** *brave* ***as*** *a lion* – and the precise feature – braveness – that is attributed to the target. In a metaphor like *Peter is a lion*, the feature that underlies the comparison must be inferred, and so it takes longer to understand than a metaphor. Metapohorical idioms *a*re usually understood and produced earlier than proverb-type idioms, because *proverbs* are rooted deeply in the beliefs of a given culture and require a longer period of acculturation to enter the repertoire of speakers (Berman & Ravid, 2017). Ironical uses are grasped even later since they involve the highest level of mentalizing, the speaker must have read the hearer's thoughts on the situation before stating his or her own opinion on that same situation. Yet, importantly, for each type of figurative usage, different factors (in addition to mentalizing) modulate understanding: familiarity, salience, context, speaker expectations, the kind of scenario invoked by the statement, intonation, vocabulary, syntactic construction, and so forth. Familiarity with discourse practices also plays a role in irony development: Learners need to have some experience with the social norms to which irony may allude, especially with the lexical or syntactic choices that are associated with irony in a given language and culture (Kim et al., 2014; Shively & Cohen, 2008).

There is no way to become a competent speaker-writer and a true member of one's community without understanding and producing idioms, recognizing proverbs, sharing metaphors, and/or reacting to irony and sarcasm (Huang et al., 2015). Telling jokes may also be a useful tool for social adaptation, although it, too, requires familiarity with the discourse and communal constraints that decide when, how, and with whom this can be practiced (Bitterly et al., 2016).

All these areas have a long developmental trajectory, and each involves not only lexical and grammatical knowledge but advanced language-dependent social and pragmatic skills. Use of linguistic means must also be adjusted to the constraints of genre and modality in the path to literate language use. Increasing adequacy in these areas yields increasing differentiation of the linguistic means used in specific communicative settings, while at the same time, there is a growing individuality in use of language beyond conventionalized means of expression (Berman & Slobin, 1994).

Berman and Nir-Sagiv (2007) characterize this tendency as a move "from dichotomy to divergence", as the ability to move beyond rigidly genre-typical forms of expression in constructing monologic texts. For example, from high school on, but not before, writers will introduce timeless, "story-external" generalizations into their narratives, and they may refer to specific, past-tense events in their expository texts. Having a more diverse vocabulary, an ample repertoire of syntactic constructions, and means for inter-clausal connectivity reinforces *both* greater adequacy and stronger individualization of expression. There is a growing heterogeneity as a function of age necessarily associated with divergent social and academic experiences as well as construction of distinct identities.

Most studies that have documented these changes attribute them to literacy, typically measured in terms of schooling. Olson and Oakley (2014) justify this apparent limitation by characterizing informal education as little more than immersion in a world of literacy, learning the conventions of comprehending and producing written texts in a variety of domains. And formal instruction is indeed an essential ingredient of written culture. Yet schooling needs to be viewed as interacting with individual development, on the one hand, and with specific literacy activities, on the other, as enabling factors of developing literacy.

3 The Enabling Factors: An Interactive Triangle

In LL we suggested that "Although, these changes are linguistic in nature, they depend on a rich interaction between written language, the developing child, and literacy activities". To support this claim, we assigned the weight of observed later language development to the availability of multiple linguistic resources and diverse text types embodied in written products (by means of what we termed "writing as a style of discourse"), We assumed that experience with written language combined with direct instruction would yield as a *concomitant process* the ability to think about and analyze language. This was taken to explain children's increasing command of linguistic features – lexicon, syntactic constructions, discourse structure – required by different types of text. The mobilization of resources through increasing access to the *products* of writing – essays, sets of instructions, reports, novels, encyclopedic entries – should explain the crucial changes that occur in language development and attainment of the two main activities in developing literacy: reading comprehension and text writing.

3.1 Experience with Written Language

Research in the last two decades has helped operationalize the two constructs we assumed as enabling factors of developing literacy – *experience with written texts* and *metacognition* – by studying the relations between cognitive processes and linguistic representations that support reading and writing. On the one hand, developmental models of reading and writing have evolved that multiply the number of component skills and types of knowledge found to explain reading comprehension and text writing. On the other, there is growing work on exploring the connections between reading and writing. "These Siamese twins … share common foundations (viz., written language and cognitive skills), but do develop distinct personalities (particularly through its uses and consequences), and do definitely keep a relationship with each other" (Alves et al., 2020, p. 3).

To illustrate, while Gough and Tunmer's (1986) *Simple View* (SV) model held that reading comprehension can be predicted by the two components of decoding and listening understanding, subsequent modifications (e.g., Scarborough, 2001) extended the domain to include factors of: background knowledge, vocabulary, language structures, verbal reasoning, and literacy knowledge. More recent models have extended these factors to include: working memory, grammatical knowledge, inference making and socio-emotion towards reading. Moreover, *background knowledge* has been split into topic / content knowledge and discourse knowledge (Kim, 2020a, b).

It further emerged that the contribution of these components differs by language and orthography. Decoding was shown to be more influential than linguistic comprehension in younger English-speaking students, whereas in more transparent orthographies, linguistic comprehension was a stronger predictor of reading comprehension (Florit & Cain, 2011 in Ahmed & Wagner, 2020). And, in languages with a transparent orthography, cognitive factors such as executive functions do not have a direct effect on the development of reading comprehension among novices beyond decoding and oral language skills: Once children learn to decode efficiently, it is their language skills (and not their executive functions) that have a strong effect on the development of reading comprehension (Dolean et al., 2021).

A similar trend towards multiplying components and specifying aspects of skills is detected in developmental models of writing. In Juel et al, 's (1986) *Not So Simple View of Writing* (NSVW), text composing was explained in terms of two skills: ideation and spelling. This view was subsequently expanded to include *handwriting* fluency as part of transcription skills, in addition to working memory, long-term memory, and executive functioning such as attention, self-monitoring, and regulation strategies (Berninger & Winn, 2006). Kim and Schatschneider (2017) later added even more factors explaining writing quality: Their model accounted for two-thirds (67%) of writing quality in 1st grade – including direct and indirect effects of discourse-level oral language, working memory, and spelling as well as vocabulary, theory of mind, inference – making, and grammatical knowledge. Several studies even specified the abilities that account for writing quality in *different genres*. These found, for example, that vocabulary depth contributes significantly to the quality of *descriptive* texts (Castillo & Tolchinsky, 2018; Tolchinsky, 2019); knowledge of advanced vocabulary is essential for *analytical essays* (Uccelli et al., 2014); while inference analysis and syllogistic reasoning significantly contributes to the quality of argumentative texts in higher education (Preiss et al., 2013). A study of reading comprehension among Hebrew-speaking 4th grade to high-school students presented with six narrative and non-narrative texts ranged in level of difficulty, followed by types of questions requiring from factual knowledge to inferential reasoning (Kaplan, 2013) revealed a complex interaction between age-schooling level, on the one hand, and level of difficulty, text type, and kind of questions, on the other, yielding a far from "simple" account of what is involved in comprehension. Overall, such research shows that the required skills and knowledge differ involved in reading comprehension vary according to communicative goals and related structural constraints of different genres of discourse.

Reading and writing co-evolve in literacy learning. Reading what one has written so far is important for constructing a text. Authors can in no way revise or edit their texts without (re-) reading them (on- or off-line). That is, internal monitoring of text writing requires external monitoring through reading. Besides, use of writing for communication has increased rapidly over the past few years, while much of the reading undertaken on digital media serves to support writing (Van Waes et al., 2016). It is thus not surprising that researchers address the relations between these two activities, on the assumption that such studies may disentangle the factors conditioning literacy attainments. Experience with written texts encompasses *both reading and writing*, leading to the question of how the two interact. Does writing enhance reading comprehension or does reading comprehension enhance text writing?

A recent meta-analysis of published studies in English (Ahmed & Wagner, 2020) addressed this question by examining the interrelation between the different components included in 76 studies for K-3 to 12. Focusing on correlations between reading – and writing-related variables addressed in these studies, they examined direct and indirect effects of components skills of reading and writing based on the predictions of the models of SVR and the NSVW. Results showed that, in line with previous studies (e.g., Limpo & Alves, 2013), the transcription component (handwriting and spelling) made a unique contribution to quality of writing and productivity. Surprisingly, however, key features of spoken language – including listening comprehension, vocabulary/morphology, and oral expression – failed to reveal a significant effect on writing. On the contrary, *text reading* – including reading comprehension and passage-level reading fluency – emerged as directly related to quality of writing, in contrast to linguistic – and domain-general cognitive processes, which did not show such an effect. In line with the LL model that point at experience with written texts as a literacy enabling factor, Ahmed and Wagner (2020) conclude that "…factors that are specific to a reader's interaction with written text might be implicated in text generation" (p. 69).

Given the abilities and knowledge that are shared by reading and writing, it is tempting to assume a bidirectional-interactive connection between the two. But a review of studies in different languages and age-schooling levels show a more complex pattern of interrelations. Overall, the directionality of the connection (from reading to writing, from writing to reading or interactive) is a function of grain size – yielding different results for lexical-level versus discourse-level skills (Kim et al., 2018; Jimenez et al., 2020) – while in extended texts, these relations turn out to be a function of level of processing level: local cohesion, microstructure, or macrostructure (Parodi, 2006).

Kim et al., (2018) followed children's writing of narrative and opinion texts from Grades 3 to 6. Researchers found a strong correlation between word-reading and spelling across grades, explained by the limited number of similar skills involved in the two processes (e.g., phonological awareness, letter knowledge, letter patterns, and morphological awareness). However, when reading – writing relations were examined at the discourse level, the relation was weak. The authors suggest that knowledge of and experiences with reading comprehension are likely to contribute to written composition, but not the other way around, at least during Grades 3–6. They add that for writing to transfer to reading at the discourse level, explicit and targeted instruction might be necessary. Writing acquisition and experiences may promote awareness of text structure and text meaning, and, consequently, reading comprehension. Yet for this transfer to occur, children may require instruction that explicitly identifies relevant aspects of text.

3.2 The Role of the Developing Individual

As noted, in LL we considered that changes in later language development "are linguistic in nature, yet they depend on a rich interaction between written language, the developing child, and literacy activities". The previous sections of this paper pointed to the diverse skills and knowledge implied in the construct *written language* as emerging from modeling reading comprehension and text production, the main activities in developing literacy. I now move to discuss the role of the other term in the interactive triangle assumed to feature in the path to literacy attainments: the developing child.

Advances in developmental neurobiology have led me to modify this term, from developing child to "developing individual". Contemporary research provides compelling evidence of the brain's long-lasting learning capabilities (Stiles et al., 2012). It shows that *Synaptogenesis* – formation of new synapses – is a powerful means for long-lasting learning and that the prefrontal cortex, the site of *executive functions*, remains plastic at least through late adolescence (Koechlin, 2016), possibly throughout the life span. Together, these neurological underpinnings provide constantly increasing opportunities for changes in the internal and external environment to shape development. As a result, the linguistically relevant developments evident well after age 5 years might be due to fresh peaks in flexibility and adaptability of the brain. These peaks of flexibility are fed by a combination of increasing cognitive control and growing command of literacy. For example, the progressive mastering of connective devices for constructing a narrative – largely commanded by high school adolescence – is not simply due to improved linguistic skills or more complex syntactic structures. Rather, the denser and more skilled packaging of narrative information depends on increased *executive abilities*, including longer memory spans and the ability to hold different pieces of information in mind simultaneously while dealing with an online task such as producing a monologic narrative.

The brain's long-standing flexibility enables children, adolescents, and adults to take advantage of experience with written language throughout the life span, so making developing literacy an *open-ended* process. And school instruction takes advantage of processes of maturation, while enhancing the development of the brain network supporting cognitive control cognitive control (Brod et al., 2017).

Current neuroemergent approaches have shifted away from explaining brain-behavior relationships in terms of specific brain regions to point to the involvement of networks (groups of brain regions) that do not maintain a one-to-one correspondence with behavioral profiles. At the same time, findings from developmental neurobiology contribute additional interpretative dimensions to most developmental trajectories identified in the different realms of language use. For example, some researchers suggested that the protracted development in producing and understanding irrealis conditions is due to their grammatically complexity, like subjunctive mood or past perfect aspect in different languages. But this was ruled out by Bowerman's (1986) pioneer study showing that young preschoolers' use of conditionals in different languages reveal similar conceptual distinctions irrespective of grammatical marking of, say, the difference between hypothetical and counterfactual conditionals. Besides, from our perspective, this structural complexity reflects conceptually abstract notions, such as considering alternative explanations for as yet unrealized states of affairs projected into future time. These abilities involve executive functioning of divergent thought and formal reasoning, known to flourish only around adolescence, a key period of transition in social-cognitive development that is supported by structural changes in the brain.

3.3 Literacy Activities

The third term in the interactive triangle proposed in LL refers to the role of literacy-related activities for developing literacy. As explained by Olson and Oakley (2014), "While writing makes some properties and uses of language more available, whether or not writers and readers take these up varies from person to person and culture to culture. Ways of writing and reading, then, are not dictated by the written form, although the form may invite, sustain, and justify certain uses of writing and modes of interpretation" (p. 6); as some insist, *use* matters (Bloom, 2006). The purpose, quality, and frequency of the literacy activities in which people are involved have groundbreaking implications. Historically, the limited use that the Vai people of Liberia made of their writing system was taken to account for the lack of general social or cognitive effects that writing had on its users (Scribner & Cole, 1981), limited to some awareness of the syllabic constituents of their speech, which the researchers attributed to their syllabic writing system. Studies on illiterate adults, too, show a similar circumscribed effect of "literacy" once they have been taught to read (Castro-Caldas & Reis, 2000).

Differential use of writing underlies the well-known distinction between illiterates and functionally illiterate people. Illiterates have never known how to decode or encode written words; functional illiterates, in contrast, have learned to encode and decode written words, but they are incapable of *making use of* written language in their daily lives. There are, unfortunately, very few studies addressing the psycholinguistic features of functional illiterates. They constitute a heterogeneous group, and show linguistic deficits in several domains, including phonological, orthographic, and lexical processing, oral and reading comprehension, and verbal fluency (Eme, 2011; Vágvölgyi et al., 2016).

Differences in use may also explain why, although today more people are writing than ever before – when they text or scribble on Facebook, they're writing – and although these same people have attended school, they are not active participants in the literate culture of the" textual community" (Olson & Oakley, 2014). True, most children, in the western world at all events, are introduced to basic skills of reading and writing around age 6 or 7 years if not before. On the other hand, many of these children grow up to have "poor literacy skills", or to being "functionally illiterate—even though they might be skilled in using what's app, talkbacks, blogs, Facebook, and other digital media in their everyday interactions. The notion of *rhetorical* *flexibility* implies an entire process of acculturation beyond mastering the technology of writing, a process that turns writing and reading into *instruments of thought*. Wolf (2019) compares the activities involved in what she defines as *deep reading* to those involved in scientific discoveries: observing, formulating hypotheses, and contrasting predictions, gaining insights, reacting critically, approaching the text topic from different perspectives. And Graham's, (2018) *writer(s)-within-community* model (WWC) combines physical behaviors (how often students carry out literary and digital writing activities) with a large set of cognitive mechanisms, motivational beliefs, knowledge, control mechanisms production processes, the capabilities, and perceptions of writers and collaborators, and the interaction between the two, the role of context and modulators that simultaneously shaped and constrained writing (p. 258). Such contemporary takes on the complex nature of reading and writing and the interaction between them presents researchers on literacy with formidable but exciting challenges.

3.4 Unmentioned Factors: Emotional and Psychomotor Factors

We have seen that the idea of *experience with written text* points to a multilayered complexity of linguistic, literacy-related, and cognitive functioning variables involved in reading comprehension and text production. This kaleidoscope encompasses factors from grapho-motor skills at one end to strategic planning and self-regulation processes at the other. The combined impact of linguistic, cognitive, and socio-emotional effects is supported by developmental evidence from neurobiology. Different approaches under the umbrella term *neuroemergentism* have synthesized developmental concerns with diverse imaging technologies to investigate the bases of language and cognition in the brain (see, for example, Hernandez et al., 2019). Neuroemergent approaches have shifted away from explaining brain-behavior relationships in terms of specific brain regions to underline, as noted earlier, the involvement of groups of brain regions rather than locations that maintain a one-to-one correspondence with behavioral profiles. Research shows that these networks are influenced by emotional (Pessoa et al., 2002) and motivational processing (Padmala & Pessoa, 2011) which alter functional connectivity and global efficiency (Kinnison et al., 2012). Such findings show that other partners beyond language and metacognition – the main factors of concern in LL – are called on to enable developing literacy.

The number of networks involved increases as reading comprehension progresses, marshaling sensory information, imagery, emotional empathy, executive monitoring, and attentional control. Fed by visual information (of letters, spacing between words, punctuation, paragraphing), multiple networks are activated in parallel with input from one another supporting text comprehension. This occurs particularly at points when readers obtain new insights or change perspective on the topic they are reading about. Imagery and emotional empathy play a crucial role in reading comprehension, by giving shape to the events and situations depicted in the text (Bernhardt & Singer, 2012). As Wolf (2019) suggests, it pays to "combine inferential capacities with empathy and perspective-taking to ferret out the mysteries in what we read" (p. 60).

Similar involvement of different networks is found in text production. With certain limitations, neuroimaging techniques have explored neural functioning while people are in the course of writing (e.g., Richards et al., 2019) Although many correlates of cognitive processes during text writing are still relatively unexplored, studies show that the multiple and recursive processes involved in text writing – of idea generation, planning, setting goals, access to genre-specific knowledge and writing-schemas stored in long-term memory, translation into linguistic forms – depend on neural networks that span extensive regions of the brain marshaling motor and visual brain areas in addition to cognitive and linguistic areas.

Neural underpinnings substantiate the behavioral characterization of text-writing processes as multi-faceted, as are their written outcomes. Scanning of narrative-text writing in expert and non-expert writers showed increased prefrontal brain activation in experts, suggesting that proficient text writing is subject to a higher cognitive control, and at the same time is more flexible, emotional, and effortless than that of their non-expert peers. Non-expert writers produce texts in a kind of free-associative process of writing, guided by imagined scenes of the story they are attempting to complete. This finding is consistent with the "free-association" style observed for poor writers by means of think aloud protocols (Flower & Hayes, 1981) and provides neurobiological support to Bereiter and Scardamalia's (1987) knowledge-telling model for immature writers.

A recent study with Portuguese students from grades 5 to 8 underlines the fundamental contribution of motivational and behavioral variables to students' writing performance (Camacho et al., 2021). Both the affective disposition involving how the act of writing makes the author feel, ranging from happy to unhappy and different levels of self-confidence using self-regulatory behaviors (e.g., 'I can avoid distractions while I write'), made a direct contribution to narrative text quality across educational levels. The study also showed that writers' attitudes affect the frequency at which they perform writing activities. A similarly positive relation between motivation and frequency was also found for reading (e.g., De Naeghel et al., 2012). These results converge with Graham's (2018) writer(s)-within-community model (WWC), which posits that a person's beliefs about the writing task affect how, and how often, one engages in writing activities,

Neurobiological studies also provide alternative explanations for well-known phenomena in developing literacy. Take, for example, the case of narrative, which research has recurrently shown to be more precocious and less difficult than expository or descriptive prose. Various developmental and psycholinguists explanations have been proposed to explain such differences: that chronological sequences are less demanding than logical relations; that retrieving events from memory is enough for building a narrative; that children are more familiar and from an earlier age with narrative than with expository schemas. Over and above these factors, the neuroeconomist Paul Zak discovered that compelling narratives cause release of the hormone oxytocin and have the power to affect our attitudes, beliefs, and behaviors (Zak, 2015). In a series of experiments, Zak and his colleagues showed how our brain releases this molecule when listening to interesting stories. The narrative context creates a feeling of trust and pleasure. This finding adds a dimension in understanding children's relative ease in mastering narratives prior to other discourse genres.

Another example of alternative explanations provided by a neurobiological perspective concerns the contribution of handwriting to text writing. In addition to genre-specific contributions to writing quality made by linguistic, socio-pragmatic, and motivational factors, such studies yielded two general, recurrent, and related findings. Over the years, in different languages and contexts, studies have pointed to handwriting and working memory as highly involved in writing quality (Connelly et al., 2012; Wagner et al., 2011). Measuring this contribution is controversial: Some studies found that handwriting accounts for more than 50% of the variance while others (Christensen & Jones, 1999) found it to explain as high as two-thirds the variance. Although earlier studies suggested that this influence declines with age (Berninger et al., 1994), later studies found that handwriting continues to exert an influence on the task across grade school (Alves & Limpo, 2015; Camacho et al., 2021; Kent & Wanzek, 2016), among high school students (e.g., Christensen & Jones, 1999) and even in adults (Bourdin & Fayol, 2002).

The contribution of handwriting to writing quality occurs in tandem with that of working memory, as a theoretical construct for describing the processes and systems related to recalling, holding in mind, and processing of mental information when performing a task. For example, Gathercole et al., 2004 showed that *working memory* (WM) is particularly associated with the literacy scores of younger children: Children with better scores on WM spans tend to produce more coherent texts, and longer, more complex sentences (Alloway et al., 2005); but see Kim et al., 2015) for conflicting results.

The point is that WM can hold only a few items for a short time – it is a limited resource. If writers must devote large amounts of working memory to the control of lower-level processes such as handwriting, they may have little WM capacity left for higher-level processes such as idea generation, vocabulary selection, monitoring the progress of mental plans, and revising text to meet these plans. Note that in this commonly accepted explanation for the observed relation between handwriting, working memory, and text quality, researchers focus on the burden placed on WM by lack of fluency and insufficient automatization of handwriting (e.g., Connelly et al., 2012; Wagner et al., 2011). In this view, writers need to devote time and conscious attention to the grapho-motor facets of writing in such a way as to *exhaust* the limited capacity associated with WM. Current neuroscientific frameworks suggest a complementary explanation, which highlights the role of handwriting in activating memory networks. In this view, fluent handwriting promotes activation of WM, and thereby impacts writing quality.

Askvik et al. (2020) found that the neural activity activated when writing by hand using a digital pen on a touchscreen is important for memory and for the encoding of new information.[3] Writing by hand provides the brain with optimal conditions for learning. Even though participants did not take personal notes from a lecture as in a natural classroom environment, it seems that this type of activity in the brain is still present when writing letters by hand as opposed to when simply pressing a key on the keyboard. This specific type of experience may cause the neural changes associated with learning.

Whenever self-generated movements are included as a learning strategy, more of the brain gets stimulated (Van der Meer & Van der Weel, 2017). The simultaneous spatiotemporal pattern from vision, motor commands, and kinesthetic feedback provided through fine hand movements, is not apparent in typewriting, where only a single button press is required to produce the complete desired form (Vinci-Booher et al., 2016). This would explain several studies supporting the benefits for learning when taking notes by hand compared to laptop note-taking (e.g., Mueller & Oppenheimer, 2014).

4 Final Remarks

I began the chapter by wondering about the impact of the expanding concerns on literacy we have witnessed during the last couple of decades on the framework proposed together with Dorit Ravid 20 years ago. After revisiting some of these ideas, I would say that the main impact is of a broadening rather than replacement of the ideas we expressed in LL. What we proposed as the central feature of literacy – rhetorical flexibility –is enhanced by including the idea of critical reflection. Following the conceptualization of (Uccelli et al., 2020), I embrace the idea that "the contribution of literacy is not only to make us rhetorically more powerful, convincing, and precise, but also more flexible and critical".

The sources of variability that a literate person needs to command have expanded to include the medium (printed or digital) in addition to genre and modality. The explosion of fluid as well as more permanent texts relying on multimodal notational systems, alternating scripts, and idiolects is a challenge to traditional practices of reading and writing. Control over such diversity may lead to new forms of "bi-literacy" (Wolf, 2019).

The construct *experience with written language* as an enabling factor for developing literacy has been broken down into the multiple factors found to explain successful reading comprehension and text production and the complex interactions among them. These factors have also been shown to differ as a function of age, language, and genre. Recent studies also highlight the role played by awareness of discourse practices, attitudinal, emotional, and motivational factors that seem to be crucial for taking advantage of experience with written language. This means that to

[3] The activated brain areas in the parietal and central regions showed event-related synchronized activity in the theta range. Existing literature suggests that such oscillatory neuronal activity in these particular brain areas is important for memory and for the encoding of new information.

control over lectal, contextual, and medium-related variations, we need to add control over our own attitudes and self-efficacy – a challenging task, indeed.

Beyond skills and knowledge, I propose a revised view of the role of literacy-related activities whose frequency and quality seem to condition both reading comprehension and text production. And, finally, I underscore the contribution of recent neurobiological perspectives to support behavioral explanations of reading and writing as well as to provide alternative explanations for many if not all developmental trends.

In LL we pointed to the need that research scope of language acquisition should be extended along several lines: In the age range addressed, from early childhood to language development across adolescence and into young adulthood; in domains of inquiry, from focus on acquisition of basic morpho-syntactic categories to include later derivational morphology, the literate lexicon and complex `written' syntax; in modality, from focus on spoken language to the inclusion of written language knowledge; and in scope of inquiry, from focus on the acquisition of isolated constructions to a motivated integration of bottom-up and top-down linguistic properties of discourse. Taking the above as a checklist, we can say that every item it includes can and should be taken into account. The study of later language development has flourished in the last few decades, with linguists and psycholinguists agreeing that "language acquisition beyond age five" is a lifespan process in which literacy plays a crucial role. There is also growing awareness on the ways in which the language of literate people differs from that of illiterates or even of less literate people, and that linguists like "normal" people think about language through the lenses of literacy (Kolinsky & Morais, 2018). The notion that language development must be studied at the crossroads of genre and modality (and, increasingly, also medium) is by now well established in the field. The work of Berman (2004) and her associates, including both Dorit Ravid and the present author, on later language development has enabled us to approach literacy through the lenses of different genres and modalities. And investigation of the reading-writing connection has been illuminated by neural registers of their interaction in different orthographies (Cao & Perfetti, 2016).

To conclude on a more global note, going beyond the contribution of literacy to individual development, I choose to cite Morais (2017), maintaining that literacy impacts not only individual minds but also society and humanity at large. The conceptual framework he developed to account for the complex interactions between literacy and democracy suggests that literacy can be negative if it is focused merely on skills and oriented towards serving purely capitalist market needs or totalitarian and pseudo-democratic systems. Morais claims that literacy must be free to serve the flow of ideas and critical thinking, open to analysis of complex issues, and enable well-informed public debate and collective decision-making. And he argues that the more literate individuals are, the better they will participate in exercising control over the affairs of their community and the more they can contribute to truly democratic governing. This idea is particularly challenging in the light of the fact that, as Morais reminds us, illiteracy rates remain quite high worldwide. In sum, from varied perspectives – theoretical, research-based, pedagogical, and sociopolitical, developing literacy en route to critical rhetorical flexibility is as timely as it was 20 years ago.

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On the Role of Understanding in Reading and Reasoning

David R. Olson

> *"Then you should say what you mean," the March Hare went on.*
> *"I do," Alice hastily replied; "at least—at least I mean what I say—that's the same thing, you know."*
>
> *"Not the same thing a bit!" said the Hatter. (Alice in wonderland).*

Abstract What role does understanding play in reading and reasoning? Does the concept of understanding play any role in understanding? Does reading precede understanding as Augustine argued? I examine children's understanding of language in relation to their later acquisition of the verbal concept of understanding. I then apply this framework to the gap between how students "make sense" of what they read and the adult standard for reading comprehension. I do so by reference to the views of Bruner, Smith and especially Seidenberg's (Reading at the speed of sight. Basic Books, New York, 2017) recent analysis of learning to read.

Keywords Understanding · Making sense · Word meanings · Literacy · Reading

For a psychologist to find common ground with the distinguished linguist Dorit Ravid, on a topic important to Education, is one of the pleasures of international scholarship. Dorit Ravid is one of the few distinguished linguists who have examined the importance of writing, not only as record, but also as a structured "discourse style" with linguistic, psycholinguistic and educational implications (Ravid & Tolchinsky, 2002). "Written language takes over as a model for thinking about language in general…[and] learning to write imposes cognitive demands on

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memory, executive functions, and top-down processing" that are not readily met before adolescence (Berman & Ravid, 2009, p. 92). These authors noted, for example, that only high school students discussed conflict in terms of "misunderstandings" rather than as disagreements. To illustrate, an editor interviewing a prospective writer said "Now don't misunderstand me. I said "pretty good" not "very good" (John McPhee, New Yorker, April 19, 2021). Such observations suggest that although understanding is a fundamental human competence, the concept of understanding comes to play an important role in acquiring a higher level of literacy, and, I argue, in the very process of understanding itself. Ravid has also insisted on the importance of linguistic and metalinguistic concepts not only in speaking and writing but also in thinking and reasoning.

We adults commonly say that young children understand language with their first word. For example: When our daughter Joan was little more than a year old, on a whim I said to her "Joanie, go get your shoes". Up to that point she had never spoken a word or given any indication of understanding language, so my request was clearly unrealistic. Yet she looked at me briefly, then wheeled around and disappeared down the hallway. Moments later she returned, shoes in hand, and a smile on her face that expressed a pride matched only by that felt by her astonished father. She had understood what I said! As I shall say, I ascribed understanding to her, and I am quite sure I am right in making such an ascription.

Although we ascribe understanding at an early age, it will be a half-dozen years before children acquire a working concept of understanding expressed by the word "understand" such that they can ascribe understanding to anyone else. We commonly explain this gap by claiming that the concept of understanding is a metalinguistic concept, a part of children's "theory of mind", the ability to talk and think about what others say, think, believe, know and understand (Gopnik & Astington, 1988; Robinson et al., 1983). Understanding is one of the concepts that bridges oral and written language—although, as mentioned, attributing understanding or misunderstanding appears to be one of those skills that continues to develop well into adolescence, which is to say, the later school years. In my recent research I have attempted to sort out, as the title of my redcent book says "*What it means to understand*" (Olson, 2022). Answering that question offers a new way of thinking about what, in psychology, is studied either as metacognition or as a set of complex computational processes under the label of Comprehension and Comprehension Monitoring.

When children learn to talk, they learn to understand what was said; language without understanding is babbling. Similarly, to be a reader is to understand what one is reading; to read without understanding has many possible sources. Yet, children appear to understand many expressions long before they acquire the concept of understanding. Adults, on the other hand, have a relatively clear notion of what it means to understand, and they willingly ascribe understanding to young children. As I prefer to say, young children understand, but they are unable to ascribe understanding to themselves or others. My book is an extended examination of the implications of learning to ascribe understanding. To ascribe or attribute understanding one must have the concept of understanding expressed by the word "understand" or one of its synonyms. The basic hypothesis of my book is that we may learn something important about understanding by examining how we adults go about ascribing understanding to children, other adults and even to computers. That is, instead of examining understanding as a skill or process or state, I examine, rather, how we adults talk about understanding—a shift of focus from process to concepts—from cognitive psychology to psycholinguistics.

The first task is to set out what we mean by "understanding", that is, the conditions under which we correctly and appropriately ascribe or attribute understanding to ourselves and to others. These conditions serve as the meaning or semantic features of the word "understand". The primary criterion for understanding is "correctness"—one may think one understands when, in fact, one misunderstands. "Thinking that one understands" I refer to as the feeling of understanding, the feeling that something "makes sense" to the listener or reader. The concept of understanding, in contrast, is defined in terms of correctness. To understand is to understand correctly. Thus, the claim that "I understand…" is true or false. The feeling of understanding is largely private and subjective, the concept of understanding assumes truth or correctness.

A second criterion for understanding, I argued, is intersubjectivity. The concept of understanding is applicable to self and other, what something means is not private but shared with others and in this way is both a psychological and a social achievement. Intersubjectivity follows from the fact that a language is a public, socially shared practice. The Mad Hatter was wrong when he claimed that he could use a word to mean anything; it is not just a matter of power. Intersubjectivity or self-other equivalence was first made clear by Wittgenstein (1958) in his argument against a private language of thought. There can be no private language, he claimed, because there is no criterion for judging correctness of a norm, rule, or concept other than agreeing or disagreeing with others about uses of words. Private thoughts or impressions lack such public criteria. In my view, what makes sense to a listener or reader may fail to meet this social criterion.

Equipped with a concept of understanding defined in terms of correctness and intersubjectivity, a person is in a position to judge whether or not someone or something understands. Understanding is simply meeting the criteria mentioned above. Thus, children learning a language meet the criterion of correctness and they share that understanding with the adult. Computer programs that pass the Turing Test may also meet those criteria. Thus, we as adult speakers may ascribe understanding to both young children and computers, even if they meet our two criteria in dramatically different ways.

However, in my book, I examine the fact that understanding is also the competence to ascribe or judge that one has met the criteria for correct understanding. Understanding in this sense is knowing the conditions under which understanding can be correctly ascribed. The view I attempt to defend is that one understands in a special way (to be spelled out) when one can correctly ascribe understanding to oneself, that is, when one knows that the criteria for understanding, namely, correctness and intersubjectivity, have been met. This is a level of understanding that exceeds young children and computers and that continues to develop through the school years and into adolescence. Thus, the ability to ascribe understanding to oneself and others is, in my view, the paradigm for self-consciousness, an awareness of mind.

Having defined the concept of understanding in terms of correctness, we may return to the question as to the relation between the concept of understanding and the feeling of understanding. The theories of most analytical philosophers, beginning with Locke, and as well as modern psychological theories of comprehension and comprehension monitoring, dismiss feelings as subjective and misleading and exclude them from their account of understanding. That is, there is no place in such a theory for the feeling of understanding, the feeling that something makes sense. However, Joelle Proust (2014) argued that the philosophical picture of mind should be broadened beyond a concern with knowing to include the feeling of knowing. I draw the same distinction between understanding and the feeling of understanding and argue that both have a place in the account of understanding. Proust distinguishes the feeling from the concept in terms of a set of distinguishing features. Concepts, such as the concepts of knowing and understanding, are categorical and allow judgments of true or false. Feelings, on the other hand, are quantitative, evaluable, attuned to action and carry a phenomenal tone or tingle; they are cognitive emotions (Oatley & Jenkins, 1996). Cognitive emotions are affects that are adaptive and attuned to situations but are not categorically true or false. In the normal case of understanding language, one both correctly understands and feels that one understands. However, understanding may be correct even in the absence of the feeling, as is the case with computers. The feeling of understanding is the certainty that what one hears or reads makes sense. Misunderstanding, on the other hand, is not correct, but may still "make sense" to the holder. Hence, I distinguish what most writers take as synonymous, making sense to the listener and understanding correctly. Understanding correctly and justifiably, I argue, is available only to older children and adults who, in possession of the concept, are able to correctly ascribe understanding and misunderstanding to themselves and others. In the book I defend the claim that the possession of the concept is identical to knowledge of the *sense* of the word "understand"; for the moment it is sufficient to point out that the ability to ascribe depends upon knowing the word—ascription is a verbal practice. It is saying something, for which we are accountable to others, about meeting the criteria for the use of the word "understand".

One understands an expression when the conditions for the ascription of understanding—correctness and intersubjectivity—are met. Correctness is met when the expectations—roughly speaking, the beliefs and desires of the subject—are brought into congruence with the linguistic properties of the expression. Sometimes only a word or two are required; in other cases, subtle linguistic properties such as the tense of a verb or the technical meaning of a term are critical. Analysis proceeds until intersubjective agreement has been achieved. The correctness of an interpretation, ultimately, is resolved as any legal or scientific dispute would be resolved, namely, by reason and evidence. In ordinary spoken discourse little analysis is required, as ordinary discourse is attuned to the needs and interests of the listener and the linguistic resources demanded are minimal.[1]

A half-century of psychological and linguistic research has examined the features that make the understanding of an expression easy or difficult. These features include properties of the expression or text, the context in which it occurs, and the role of prior commitments, beliefs and expectations of the listener–all of which have a bearing on understanding. But in each case, understanding is achieved when the two critical features of understanding—correctness and intersubjectivity—have been met, although these criteria are not explicitly stated in this research. This general claim, however, ignores the fact that young children and computers may be said to understand even if they lack the concept of understanding. A second step must be taken.

The second step in my account of understanding is to focus, not on the achievement of understanding but on who is ascribing understanding. The focus on the ascriber allows me to distinguish the theorist from the subject and hence to explain how we as theorists go about ascribing understanding to young children and computers. Computer programs that pass the Turing Test and those that translate between languages are widely claimed to understand language. It is the theorist who ascribes understanding to young children and computers on the basis of the fact that their response to an expression is both correct and shared with others.

What young children and computer programs cannot yet do is ascribe understanding or misunderstanding to themselves and others. Because theorists have neglected the issue of who is doing the ascribing, the ability to ascribe understanding has also been neglected. Hence, it is widely assumed that the process of understanding is far more important than the ability to ascribe understanding—the latter seen as a metalinguistic, reflective process carried out primarily by the theorist in the attempt to explain understanding.

Psychologists examine the processes of comprehension quite independently of the subject's knowledge of the concept of understanding that would allow those subjects to make the ascription. Of course, it is possible to argue that the ability to ascribe does not matter or at least does not matter as long as one understands. One may understand perfectly well, it may be argued, without the concept. In school, it is the teacher who judges that the student understands; whether the student can make the judgment does not matter, so long as his or her answer is correct in the eyes of the teacher.

However, the ability to ascribe understanding may bring important social as well as cognitive advantages. As mentioned, if disputes can be resolved by saying "you misunderstand" rather than "you are wrong", a discussion of meaning rather than of truth becomes possible, thereby elevating the level of discourse. Interestingly, Plato's account of Socrates' dialogues often began with the question "What do you mean?"

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[1] This is especially true for rhetorical speech which is designed exclusively for believers (Olson, forthcoming).

The more important consequence of the possession of the concept of understanding is on the process of understanding itself. Possession of the concept of understanding permits one to claim that oneself (or another person) understands. Thus, understanding and claiming to understand are importantly different. Claims can be made only with words. Obviously, one can claim to understand only if one knows the word expressing that concept. But in addition to claiming that one understands, one is giving one's word that understanding has occurred, a claim that is either true or false. Claiming that one understands is a judgment that is public and objective, that may be contested, and that may be defended by evidence and reason. Therefore, ascribing understanding is a rational activity that goes beyond simply meeting the two conditions for understanding. Stated another way, understanding is reflective; it is knowing that you understand or that another understands. One not only understands but knows that the criteria of correctness and intersubjectivity have been met, as well as the kinds of evidence that warrant that judgment. Furthermore, it is the possession of the concept that permits self-ascription; it makes understanding an introspectable mental state. Only now does one know what it feels like to understand!

The focus on the concept of understanding allows us to raise the question: Does a person with knowledge of the concept of understanding read and listen more critically than one lacking the concept? I will suggest one way this may be possible. If one knows that the conditions for the correct ascription of understanding including both correctness and intersubjectivity, one may "monitor" their comprehension to see that these conditions are met. Monitoring is a rational process that involves providing linguistic evidence for the correctness or incorrectness of the understanding, a process that requires a degree of linguistic awareness.

Judging the correctness of an interpretation is not always easy. This is especially true with written texts that are designed for and may be read by both believers and skeptics. Some texts, such as those found in academic books, are "unsponsored" in that no clear author is identified. Furthermore, written texts, unlike spoken utterances, make little accommodation to the prior beliefs and desires of any particular reader. Following James and Dewey, I would argue that understanding is the fixation of the beliefs of the reader in response to a text. Accommodating these beliefs to the properties of a text is not a simple matter; it may not be believed, for example. Finally, in reading, unlike oral discourse, there is no immediate way of determining that "agreement" has been achieved. In schools, it is the teacher who, adopting the status of the correct understander, determines whether or not understanding has been achieved. This, of course, is the goal of reading comprehension exercises and reading comprehension tests. In my book I review some of the evidence, admittedly limited, that indicates a change in behavior when children acquire mental concepts such as understanding.

1 Making Sense

The school's single-minded focus on correctness of interpretation of what one is reading runs afoul of the post-modern critique that objects to the notion that texts have a correct interpretation: interpretation depends not only on context and prior knowledge but on the interpretive standards of one's "textual community" (Stock, 1983). The exclusive focus on correctness tends to sideline the reader's partial and sometimes incorrect "feeling of understanding"—the feeling that what one is reading or hearing makes sense to the reader. The feeling of understanding, as mentioned earlier, is no guarantee that one actually and correctly understands. For that reason, the school is not wrong in overriding students' feelings and opinions and in insisting on evidence for correctness and validity of interpretation. However, all that a reader has to go on in the quest for understanding is the feeling that what they are reading makes sense. It is this feeling that allows the reader to go on, to persist in reading even if correct understanding has not been achieved.

The feeling of understanding, like the feeling of knowing, has come in for some attention. Bruner (1990) argued that the cognitive sciences had lost contact with the more basic goal of psychology, namely, the problem of meaning. By meaning, Bruner was referring not to the meanings in the language, that is, the semantic structure of the language, but rather to what language means to the listener or reader, what he called "making sense". What makes sense to a listener or reader, as mentioned, may not meet the standard or criterion for understanding as set by the teacher. Understanding is identified objectively; it is correct or incorrect quite independently of the feeling that what is read or heard makes sense. Clearly, computer programs that pass the Turing Test for understanding do not have the feeling of understanding or the notion that something makes sense. The feeling of understanding is somewhat independent of correctly understanding. It is subjective, quantitative, and evaluative, rather than true or false. Important future research could be done to determine how the feeling that something makes sense relates to correctly understanding. Jan Derry (2013, p. 56) pointed out that followers of Vygotsky and Bruner give priority to "pupils' own conceptions… over any concern to ensure that the pupils are able to distinguish clearly between correct and incorrect [justifiable] knowledge". She suggests that the trend to accept "multiple voices" tends to blur the distinction between subjective and normative understanding. Understanding implies correctness that is to be distinguished from subjective meaning-making.

Bruner's concept of meaning, I suggest, is problematic in that he fails to sufficiently distinguish between meaning as a property of language (what a word means, for example), and what the expression means in the minds of the speakers. Frege (Dummett, 1993), more than a century ago, dissolved the meaning of an expression into two parts: what he called its *sense,* essentially a word definition, and its *reference*, what the word or sentence refers to in a particular context for a speaker or listener. Frege's well-known example is that "Morning Star" and "Evening Star" have distinctive *senses,* but both refer to the same thing, the planet Venus. The *sense* of a word or expression is a uniquely linguistic property defined in relation to other words. Words and their meanings make up the semantic structure of the language. In contrast, the *reference* of a term is the object or state in one's model of the world, in a word—one's subjective commitments and beliefs. Disagreement is an error of reference. An example of this is when I once called Pluto the Morning Star. Misunderstanding may occur for many reasons, including when one violates the conventional meaning, that is, the *sense* of the term as when one thinks that Venus is a star rather than a planet. Contrary to the Mad Hatter, one cannot mean whatever one wants by a term. Hence, it is the *sense* of the expression that is often critical in distinguishing understanding from misunderstanding. Distinguishing *sense* from *reference* is itself a form of linguistic awareness; hence attributing misunderstanding requires a level of linguistic awareness; it is a quibble about words rather than an argument about things. When a person has access to the concept of understanding, they can ascribe understanding and misunderstanding to themselves or others. They can justify their attribution on the basis of a property of the language, a particular word or grammatical feature. This high standard for the concept of understanding is the difference between having the concept applied to one, as we do to an infant or a computer program, and the child actually doing the ascribing him/herself. I return to the relation between sense-making and understanding in my discussion of Seidenberg's treatment of reading and reading comprehension.

Treating understanding as a linguistic concept provides a new way of thinking about what we are conscious of. We are conscious of understanding only when we possess a concept of understanding. This claim is parasitic on Donald Davidson's (2001) claim that one cannot have a belief without a concept of belief. That is to say, the experience of understanding is available only to one with the concept of understanding. It is the concept that permits self-ascription of understanding. Self-ascription is all that we mean by an awareness of understanding.

One of the goals of my account of understanding is to turn mental processes into linguistic ones, that is, to see understanding as little more than the knowledge and ability to use the word "understanding" correctly. The mental state of understanding is not a mysterious mental or brain state but rather the subjective side of the application of the concept. Again, understanding is to be identified with knowing that one has met the conditions for correct ascription of understanding. Rather than assuming that a mental state of understanding already exists and that one learns a word for it, the reverse may be true. That is, the mental state is the consciousness of the fact that one has met the conditions for correctly ascribing understanding to oneself. One can be in this state only if one has possession of the concept. If so, one cannot experience understanding without the concept of understanding, just as Davidson claimed for belief. Without the concept, it is just a feeling. So too for understanding, one understands only when one has a concept of understanding and the ability to ascribe understanding to self and other.

Familiarity with our own experience of understanding, enhanced by our easy recognition of understanding in young children and other adults, may lead us to assume that young children already know what understanding is. Both psychologists and educators assume that everyone knows what understanding is and that efforts should be directed to improving understanding by focusing on vocabulary and grammar. On the contrary, it may be argued that children understand expressions but lack knowledge of the concept of understanding; and along with it the ability to correctly ascribe understanding to themselves and others. To possess the concept of understanding is to know the conditions for correct ascription and the evidence that would justify that ascription. Applying the concept to oneself is introspection. Introspection is not a survey of one's interior mental life (as Descartes may have thought), but simply applying to oneself the very concept learned for sharing understanding with others.

Equipped with the concept of understanding, one can introspect one's understanding of any expression by examining whether or not the conditions for correct ascription have been met. This, of course, is what writers do when they revise their writing to ensure, so far as possible, that a reader has the evidence they require to reach agreement with the writer.

To review: To ascribe understanding one must know the meaning and use of the word "understand". Like any new concept, the word calls attention to the salient facts relevant to its application. The primary use of "understanding" is to ascribe understanding or misunderstanding. In particular, one is justified in ascribing misunderstanding only if one has a reason or evidence. Although one may understand an expression without a concept of understanding, so long as it results in agreement, one cannot ascribe understanding without the concept of understanding. Attributing misunderstanding, on the other hand, calls on and brings awareness to the property of language that provides evidence for the judgment. This is what makes the ascription of understanding rational, as it is subject to reason and evidence.

2 Reading Comprehension

Tests of reading comprehension reveal that children often assume that they understand when, by adult standards, they are actually failing to understand. They are poor judges of their own understanding (Prinz et al., 2020). They willingly accept contradictory statements, fail to draw obvious inferences, draw inferences when they are not warranted, and so on. Even well into the school years, a majority of students have difficulty in evaluating arguments presented in a text and in evaluating evidence for their interpretations (National Center for Educational Statistics, 2010). Roughly speaking, it is a difference between reading and reading critically. Can the acquisition of the concept of understanding, implying as it does an awareness of the conditions to be met for correct understanding, help to explain this later achievement?

Empirical studies of comprehension (Kintsch, 1998) and comprehension monitoring (Markman, 1981), like all tests of reading comprehension, assume (more or less implicitly) that understanding can be defined in terms of correctness and intersubjectivity. Tests have an objective standard of correctness, namely, that of the educated community of which the test maker is a member. It is further assumed that with further analysis, intersubjective agreement may be achieved even if, as in the case of a test, no such opportunity is provided during the test. Teaching students to "monitor" their comprehension by more careful reading is an attempt to gain intersubjectivity, to bring the reader into a "textual community" shared by teacher and student. However, as noted, a strict focus on correctness may overlook the subjective experience of the reader in his or her attempt to make sense of what they read. The feeling of understanding may add confidence to what is understood. Moreover, making sense provides the motivation for action, allowing one to simply "go on". The feeling may assure one that one is on the right track and allow one to continue, in the hope of reaching understanding eventually. Thus, we need both the feeling of making sense and the achievement of understanding in any account of learning and comprehension.

The upshot is that we have two quite different concepts at play. *Understanding* requires truth or correctness; *making sense* requires only the subjective feeling of certainty that one's understanding is appropriate to one's own goals.

3 Understanding in Reading and Learning to Read

One of the unchallenged assumptions in the psychological study of reading is a firm distinction between reading and understanding. The idea is an old one. Augustine (1958), writing in the fifth century, insisted that reading preceded understanding. He did so to discourage readers from jumping to conclusions as to the meaning of sacred texts. Without this, he claimed, religious interpretations were no better than the "ravings of the astrologers". But one may ask, were readers not understanding what they read all along, at a level of understanding sufficient to allow them to go on? What Augustine was concerned with was correct understanding, not the feeling of understanding involved in reading itself. To do so, he argued one must command the important linguistic concept that distinguishes words from things and literal from metaphorical meaning, the concepts that make up linguistic awareness. The process of understanding, however, may involve the continuous monitoring of understanding as making sense, the plausibility that allows one to go on.

Making sense is the process of assigning meaning to a text by revising and updating one's beliefs on the basis of the available textual and contextual evidence. The process is one of constraint satisfaction, making the best of what is at hand. The goal and the outcome of reading is not only to make sense of what is read, but also to decide that one has met the conditions for correct understanding. This is achieved when the evidence bearing on truth and the intersubjective standards for use are assumed to have been met. Only then can one claim one knows what an expression or text means. This is not to discount personal subjective understanding, but only to distinguish it from socially agreed upon, justifiably correct understanding.

Minimally, this suggests that reading and making sense of what is read are interactive processes rather than sequential ones. In understanding ordinary speech, the listener can count on the speaker attuning the utterance to fit into the listener's framework of beliefs and expectations. This is less the case for written texts, even those designed to teach children, yet the principles are the same, namely, that reading is not distinct from understanding but rather the attempt to achieve understanding of what one is reading. Making sense is quantitative, subjective, and a pleasant emotion, but, as I argued, is not to be mistaken for valid "understanding". Understanding is the product or outcome of the processes of sense-making.

In the psychological study of reading, understanding is commonly referred to as "comprehension". Comprehension is defined as the achievement of correct understanding, meeting an objective standard set by experts and measured by a test. The subjective experience of "making sense" plays no role in that theory. In advancing what he called the Simple View of Reading (SVO), Gough et al (1996) argued that reading could be considered in two parts, decoding and understanding. He pointed out that even before they learn to read, children know how to understand language; all that remained to be learned was the skill of decoding from print to speech. Decoding was essentially phonics. The distinction between reading and understanding is pervasive in the scientific study of reading. In his recent book *Reading at the speed of sight,* Seidenberg (2017) adopts the notion that phonics precedes understanding, claiming "A child who has gained a basic understanding of the relation between print and sound (i.e. phonics) can get on with the task of learning to read words" (p. 123). He denies that understanding of print could precede learning to decode even if he grants that "The insight that writing could represent speech was an epochal event in human history". Yet he goes on to assert that "we aren't obligated to use that information when we read" (p. 124). I would say that that is the pivotal insight that children must acquire in learning to read. They have to realize that the stream of speech can be analyzed into components that can be represented by written marks (Morais et al., 1987; Homer & Olson, 1999). Consequently, literate people tend to reflect on their language in terms of the properties of the script (Olson, 1994; Davidson, 2001). Once they have learned to recognize a few known words, they are in a position to learn how phonological components are represented by individual letters.

Seidenberg adopts the "dual route" model of reading, namely that in an alphabetic orthography, written signs provide both phonological and morphological information, that is, clues to both sound and meaning. Individual letters represent phonemes, but letter strings represent recognizable morphemes and words. But he then goes on to dismiss the relevance of morphological cues (essential to word recognition) while claiming that phonetic clues are primary. He reviews abundant evidence showing that decoding, learning the relation between graphemes and phonemes, is the knowledge most lacking in beginning and poor readers; and that teachers fail in not teaching those relations. But he pays insufficient attention to how morphological information may inform phonological decoding.

One of the problems is that 'whole-word', that is, morphological reading, is not well understood. Children have no difficulty in learning to read written numerals such as 1, 2, 3, in which each sign represents a morpheme rather than a phoneme. Moreover, Cattell, in the nineteenth century, showed that words are recognized as quickly as individual letters. The victim of a stroke, Howard Engle, lost the ability to recognize words even if he continued to be able to write while unable to read. He could recognize letters but not words! The importance of the distinctive role of morphological as opposed to phonological features of written words became obvious when reading theory attempted to account for learning to read scripts other than alphabets that have signs that are uniquely morphological, as in written Chinese. Share (2014, p. 3), who has studied a range of writing systems, points out that morpheme distinctiveness and morpheme consistency "are crucial for rapid silent reading". He further points out that teachers do not teach children how to read. Rather, they teach children how to teach themselves by providing information about the systematics of the writing system.

Although Seidenberg acknowledges that there are two routes to word identification, he insists that "the initial hurdle is grasping the alphabetic principle", that is, grapheme-phoneme relations. I would say, it is the second, admittedly the most challenging hurdle, made more difficult by ignoring the prior and simpler way of recognizing a word as an orthographic unit. While he acknowledges that learning letters and their associated sounds is interactive, namely, that learning letters is a route to phonological awareness, he denies that the two routes to word recognition are also interactive. Recognizing that a letter string may represent a word is the first and most important step. The second is recognizing that the letter string indicates the phonemes of the word (Ehri & Wilce, 1980).

I think that Seidenberg's emphasis on decoding follows from Gough's sharp and misleading distinction between decoding and comprehension. The relation is not an if-then temporal or causal relation, but rather a class inclusive relation: Decoding is in the service of word recognition and comprehension. In scanning letter strings, one is looking for recognizable units, known words. Recognizing words is the key to skilled reading, but that in no way discounts the importance of the ability to decode print into sound and to use sound to work out words one does not recognize, as Seidenberg points out. The ability to go from letters to sounds is essential for many words and for all new words, as well as for learning to write and spell. Once one decodes an unfamiliar letter string into a known word, the letter string on a subsequent occasion may be recognized orthographically as a whole word. Morpheme recognition permits rapid reading as Share claimed.

Seidenberg's commitment to phonics leads him to disparage English spellings in which the relation between graphemes and phonemes is one to many rather than one to one. Rather than consider the possibility that many of the most familiar words such as *have* and *some* may have irregular spellings for good reasons (such as encouraging whole word recognition of "closed class" words), Seidenberg sees such irregular spellings as undesirable and confusing to children and. In my view, only children schooled on phonetics independently of its connection to known words find such word spelling confusing. Indeed, people of my generation who were taught by the look-say method have difficulty in seeing such words as irregular! What is missing is a clearer analysis of how making sense interacts with learning to decode.

A cognitive view that takes seriously the premise that experience is processed in terms of the already known would reverse the decoding plus understanding formula. It would insist that children expect that what they encounter in print makes sense and, hence, that attempts at making sense precede and are critical to decoding. In fact, the general impression of the book is that Seidenberg never grasped the basic principle of the “cognitive revolution”, namely, that prior beliefs affect perception, the basic assumption of views Seidenberg rejects.

The primary subject of Seidenberg’s critique of theories of reading and learning to read is Frank Smith (1971), the foremost critic of the decoding plus understanding model. Smiths’ view, now seen as part of the Whole Language Model, is based on the claim that reading is essentially prediction combined with constraint satisfaction to achieve understanding. The account argues that a reader already possesses a great deal of knowledge about the world, about stories, about language, as well as some knowledge about words and letters. Such prior knowledge functions as a set of expectancies that allow for predictions as to what is likely to come next in the attempt to determine what is meant by an expression or a text. These predictions provide the meanings that are at play in understanding a text. Reading is seen as bringing prior knowledge and expectancies to a text, rather than as decoding words and only then assigning meaning to them. In my view, prediction was sometimes misleadingly described as guessing and reading as a “psycholinguistic guessing game”. Guessing implies explicit invention. Rather, in my view, prediction is a set of expectancies in terms of which we interpret what we see or read rather than explicit guesses. One could reasonably ask “Do you know what it says or are you guessing?”. These are quite different things.

Smith’s view that reading depends on prediction gets a great boost from recent advances in the field of Machine Learning (ML). ML of language is based entirely on the prediction of what is likely to come next, based on what has occurred in the past. Any stimulus is seen in a context provided by prior experience. In ML the prediction principle applies at all levels of linguistic structure including letters, words, sentences, and extended text. Indeed, ML predictions are so powerful that ML not only can “understand” texts to a level that permits translation to another language, it can write texts as well. The predictive principle, as mentioned, is a rather general premise of the cognitive revolution, the claim that any stimulus is perceived in the light of prior knowledge rather than as a “thing in itself”. ML would seem to endorse Smith’s claims that fluent reading makes little or no appeal to the phonological value of individual letters. As Share pointed out, rapid reading is morpheme recognition.

Seidenberg (2017) claims to have provided important evidence from current research on reading that demonstrates the inadequacy of Smith’s theory. In fact, the interesting research he summarizes offers little of relevance to the nature of reading or the nature of understanding beyond showing that knowledge of grapheme-phoneme relations is important and lacking especially in poor readers. But poor readers are not only poor at decoding. They are also poor at prediction, inference, and comprehension in general. Correlations amongst such variables imply that reading ability is a general ability, a fact well captured by the Whole Language movement.

For Smith, reading is making sense, bringing meaning, in the form of expectancies, to a text. Seidenberg quotes Smith as saying that “It has become crystal clear to me– and it has taken about ten years to come to this understanding—that children learn phonics best after they can already read". I would amend Smith's claim only by adding "at least a few words". That is, letters have meaning only as representations of phonemes, units of spoken words. Yet Smith's claim that they can actually read without any knowledge of grapheme-phoneme relations—as if they were written numerals—although not impossible to imagine, seems to me to be implausible. More defensible, in my view, is the idea that knowing how to recognize a few words provides a good basis for working out how letters serve to represent the sound of a word.

The Cognitive Revolution was the attempt to shift the study of cognition from what was given in a stimulus or text to what the reader brings to a text in the form of expectancies and prior knowledge. Prior knowledge was acknowledged as "top down" in contrast to stimulus driven "bottom up" processes. The prediction theory annuls the distinction; it is prediction all the way down, prior experience determining what can be seen in a word or letter.

Seidenberg correctly insists that letter sound relations, phonetics, is fundamental to reading and he provides ample evidence to show that decoding problems are an important source of reading difficulty for young children. Although he acknowledges that in learning the alphabet one is becoming more aware of the phonological properties of spoken words, he more often treats decoding as simply learning the sounds associated with letters, as if they were the sounds produced by the keys of a piano. In my view, phonics should be seen as learning the relation between the letters and the sounds that are to be found in actual spoken words and sentences. Phonics, that is, should be seen as learning phonological awareness. Learning to read is learning something important about one's own speech. Seidenberg is appropriately alarmed that Ken Goodman (1994), a reading as prediction theorist *par excellence,* actually denies the relevance of sound values of letters altogether calling phonological awareness "narrow and sterile". I agree with Seidenberg that sound-letter relations are fundamental, while at the same time I assert that sounds are heard in relation to meaningful words. The invention of an alphabet, a system of writing that creates signs carrying both semantic and phonological information, was a major invention. To deny children access to the principles of this invention and the ways to make use of the information provided by an alphabet is as misguided as teaching phonics independently of their relation to known words.

Where the prediction theory of reading is somewhat misleading, in my view, is in its somewhat narrow view of the expectancies that even beginning readers bring to their encounters with print. By focusing on the larger structures of the text such as making sense of the story, Smith's prediction theory minimizes and Goodman entirely dismisses the other kinds of expectancies a reader either brings or has to learn, primarily how the letters represent sounds and how letter strings represent known words. As ML systems show, prediction applies to all regular patterns in the linguistic form, prediction as to the next sentence, the next word as well as to the next letter. Knowing the sound associated with a letter allows prediction of the next letter, the next word just as much as does an expectation of what is likely to happen in the story being read.

A more serious criticism of the prediction theory of reading is its alliance with theorists of sense-making. Specifically, the outcome of reading in the Whole Language movement is identified with what makes sense to the reader, a subjective criterion. Understanding, as I argued earlier, also meets an objective criterion, truth or correctness. These standards of correctness are sometimes to be met only by the reader paying "scrupulous" attention to the very words of a text. Success is monitored by the teacher and may be assessed by an objective test. Only through such objective monitoring can subjective meanings be shown to be limited.

My amendment of Smith's suggestion that learning phonics is easy when one already recognizes "a few words" gains some support from one traditional way of teaching reading. Phonological awareness was once taught by showing learners how letters work in identifying known meaningful words. The "Horn book" used in teaching reading before printed books became widely available provided a text, one per classroom, protected by a layer of animal horn, of a familiar text such as the Lord's Prayer that children knew by heart. Teaching reading was then a matter of showing the children how the printed words represented the memorized verbal form: "Lord" says "lord"; "L" says /l/ and so on. For the learner, learning this mapping is a discovery; some children had and continue to have particular difficulty in grasping the letter-sound relationship. The primary difficulty here is in phonological awareness not in letter-sound matching. Much easier is learning the relation between the printed word and a spoken word, although this is not to be taken for granted either (Homer & Olson, 1999).

Phoneme-grapheme relations are essential but only in relation to word recognition. Seidenberg provides some evidence showing that even in reading known words, knowledge of the phonetic values of letters comes into play. I consider such evidence equivocal in that the letter "b" in a word is a clue to the orthographic identity of a word just as much as it is a clue to its phonological identity—just as the dual-route theory of word identification implies. What such studies suggest to me is that even pseudo-homophones evoke an attempt to find a meaningful word. This would imply that knowledge of a word as a unit of meaning is fundamental and inescapable. Seidenberg claims the opposite, namely, that decoding proceeds semantics. Researchers could test this hypothesis: Do children who can sound out a letter string also know if what they have produced is a real word or not a real word? That is, is decoding a non-word simply a matter of forming sounds or is it testing to see if one can arrive at a known word? It is known that good readers can sound out non-words. Do they do this without any appeal to their knowledge of real words? I suspect their primary concern is in determining if they are known words, that is, words with a meaning. If so, phonics is in the service of word recognition. Of course, my conjecture may be false. But if it is true, teaching phonics as simply associating signs with sounds, rather than as visual signs of known words, is misplaced. Can children learn to read by reading Jabberwocky "mome raths outgrabe"? To me, this is not only false, it is foolish. Only after one can read a few words and recognize the possibility of non-words may the experience of encountering Jabberwocky be interesting and educational.

Seidenberg reviews considerable evidence that shows that good readers, as Smith argued, are better predictors. If prediction theory is broadened to include phonological regularities as well as expectancies of meaning, there would be very little difference between the views of Smith and Seidenberg. Both embrace to some degree the principle of prediction based on prior experience. Smith acknowledged that sounding out was an important skill to be used in conjunction with other forms of knowledge such as making sense. But in so doing he may have inadvertently encouraged readers to ignore the value of phonological information.

Regardless of how the relations between decoding and understanding are resolved, Seidenberg raises two further criticisms of Smith and the Whole Language approach. The first is his call to reject the so-called reading wars. He finds it unconscionable that reading theorists would pit structure against meaning as if these excluded each other. I agree. Yet he rejects so-called "balanced" reading programs for claiming that sounds and meaning "aren't independent, they bootstrap each other. [And that] reading is a system of interacting components (p. 267). In fact, Marie Clay's "three cueing systems" approach—semantics, syntactics, grapheme-phoneme relations— to word identification is a plausible alternative to the decoding plus comprehension model endorsed by Seidenberg, who sees these systems as independent and insists that if one, decoding, was mastered first, comprehension and reading difficulties would be averted. It does seem inescapable that an alphabetic writing system provides both morphological and phonological information and to ignore one or to fail to acknowledge their interdependence is inexcusable.

I am far more sympathetic to Seidenberg's criticism of what he sees as a general bias in educational as opposed to psychological research of the sort he defends. Educational theories, he claims are often based on subjective judgments, personal experience, and anecdotal evidence. Science demands a degree of objectivity. He writes: "The educational worldview takes subjectivity as an existential condition" (p. 261). He traces the emphasis on subjectivity to theorists such as Vygotsky and Bruner and to "a constructivist philosophy… It is discovery learning and social construction of knowledge par excellence" (p. 299). When applied to reading and learning to read, that "subjectivist" and "relativist" view would seem to delegitimize both systematic instruction and with it—objective methods of assessment.

I take Seidenberg to have raised an important point. Educators are indeed concerned with the subjective experiences of the learner in a way that experimental psychology and objective testing does not. One of the guiding principles of teaching is that the situation or the text should make sense to the child. Yet, as I have argued, making sense, although important, is an inadequate criterion. Understanding must also meet an objective standard of correctness. If so, how are the subjective and the objective to be reconciled?

In my view, understanding, like knowing, must meet a socially shared standard of correctness. For knowing, the standard involved allows the distinction between true and false; for understanding, the standard allows the distinction between understanding and misunderstanding. One understands only when one achieves a level of correctness.[2] In education, adopting notions of sense making, meaning making, or social discourse, while instrumental to learning, may not adequately meet the standard of objective correctness. Educators who fail to set and monitor that standard, or who fail to teach the children what that standard is as well as how to meet that standard, are failing to meet their responsibilities as educators. As mentioned, Derry is eloquent on this point.

On the other hand, educators who merely monitor the standard of correctness and ignore the learner's own subjective feelings of understanding lose access to a major motivation for reading and for learning. Furthermore, when out of range of the teacher, that feeling of understanding is all that a reader has to go on for evaluating whether or not they understand. Empirical psychologists have yet to invent devices for measuring that feeling or determining its relevance to further learning.

There is a long running conflict between imposing objective standards on learners and allowing students to rely on their own intuitions and judgments. The classical view was that experts "knew" and were in a position to judge and reject—when necessary—students' own judgments. The Dewey revolution, greatly elaborated by Piaget, Vygotsky and Bruner, was to recognize that learners were not passive but rather actively involved in learning and thinking. Educators succeeded, it was claimed, only when they learned to take advantage of the interests and thoughts of the learners.

Critics of Dewey, like modern critics such as Seidenberg, point out the limitations of the learner's judgments. There is abundant evidence that children will often think they understand a text, for example, yet be unable to reject false paraphrases or fail to see necessary implications. In my view, understanding has to meet two criteria: one is correctness in terms of available evidence, the second, intersubjectivity, namely that the understanding would be shared by others. An understanding that meets these criteria would go beyond subjective sense making, the feeling of understanding. Educators both model this standard and have responsibility for helping learners recognize when they have met that standard. The pervasive reliance on making sense as well as familiar attacks on objective assessment undermine the goal of teaching children to correctly understand what they read. Sense making is fundamental to both learning to read and to achieving understanding; it is a necessary but not sufficient condition. Conversely, the fact that these are developmental achievements hides the extent to which such developments are the result of explicit teaching.

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[2] Needless to say, correctness is not absolute. Rather it is a standard that readers would agree is justified by the available evidence.

4 Conclusion

Understanding language allows the formation of consciously held knowledge. Acquiring the concept of understanding raises anew the centrality of meaning. One important step is taken when we recognize that understanding is a concept that allows the ascription of understanding to oneself and others. Acquiring the concept is therefore a milestone in human development. Just as "What do you mean?" was an important part of Socrates educational program, so "Do you understand?" is an important part of our own.

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John Effect in Literacy Acquisition: The Role of Morphological Awareness in Literacy Acquisition in Different Orthographies

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Abstract Morphological awareness (MA) is a fundamental metalinguistic awareness that contributes to literacy development across orthographies. Investigating MA may help educators and researchers understand morphological processing in reading and writing, design assessment tools, and implement interventions to striving readers and writers. In this chapter, we focus on reviewing the developmental contribution of MA to reading and writing in different orthographies and discuss unique morphological structures in specific orthographies. Specifically, we examine how MA influences reading and writing in English, German, French, Spanish, Arabic, Hebrew, and Chinese. Also, we review how MA's contribution to literacy differs by the morphological structure of an orthography, such as the linear combination of affixes and roots in Indo-European alphabetic orthographies, some nonlinear affixations in Arabic and Hebrew, and the dimensionality of MA in Chinese. Future MA studies are suggested to empirically test the unique morphological structures in different orthographies.

Keywords Morphological awareness · Orthography · Reading · Writing

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1 Introduction

The role of morphology in language processing is based on its ability to represent meaning across oral and written forms through morphemes, the smallest units of meaning in a given language. A great body of research has linked literacy outcomes in word reading, reading comprehension, and spelling to morphological skills. We offer thanks to Dr. Dorit Ravid, who has made significant contributions regarding the critical role of morphological awareness (MA) in learning to read and spell. Her study of the rich and complex history of Hebrew has provided a unique and valuable perspective for the study of morphology. Specifically, Dr. Ravid contributed to the investigation of linear and nonlinear morphology in Hebrew, noting that nonlinear morphological awareness developed later than linear morphological awareness (Ravid & Malenky, 2001). Dr. Ravid and colleagues also have examined the inflectional and derivational morphological patterns in Hebrew, indicating that derivational skill was more challenging than inflectional skill (Levin et al., 2001). Further, Dr. Ravid has probed the role morphological factors play in Hebrew spelling. She has observed that accuracy in spelling grammatical words develops earlier than in content words, and accuracy for spelling function letters is acquired earlier than for root letters within content words (Ravid, 2001).

Most notably, Ravid published the first book about spelling acquisition in Hebrew, highlighting the significant correlation between morphology and orthography related to consistency between grammatical and lexical representation and spelling components as a focus of further research (Ravid, 2013). Dr. Ravid's research on Hebrew morphology has extended our understanding of morphology and morphological awareness development across orthographies.

As the beneficiaries of such a great body of work, we would like to dedicate this chapter to Dr. Ravid in honor of her contributions to our understanding of morphological principles in different orthographies. Following a review of the research on the role of MA in reading and spelling in various orthographies, we emphasize that while MA plays an important role in various orthographies, its contribution is dependent on the depth and complexity of the orthography.

"In the beginning was the Word…" (John 1:1). Beginning with Pāṇini's advanced treatise on morphological awareness around the fourth century BCE, linguists have investigated written words and their inner meaning structures (Weisler & Milekic, 2000). These early efforts include Xu Shen's *Shuo Wen Jie Zi* [An Explication of Written Chinese Characters], published around 100 ACE, Sibawayh's *Al Ketab* [The book of Arabic Grammar], published around 800 ACE, and German linguist August Schleicher coined the term "morphology" in 1859 to refer to the study of the *morpheme*, which is defined as the smallest unit of meaning in a word (Booji, 2012). Acknowledging this early awareness and these early studies on morphology, we have coined the term "John Effect" to refer to the influence of morphology on reading and writing in different orthographies.

Earlier educational researchers found that the manipulation of morphemes and morphological structures (i.e., MA), is part of new vocabulary learning (e.g., Carlisle, 1995; McBride-Chang et al., 2005; Tyler & Nagy, 1990). For example, knowledge of the morpheme -*struct* meaning *to build* helps a student to learn a series of derived words such as *structure, construct, construction, destruction, instruct*, and *instructor*. Another example is lexical compounding structures in Chinese. With the knowledge of five compounding structures (i.e., subject-predicate, verb-object, subordinate, coordinate, and verb/adjective-complement), children can generate new words for novel concepts (e.g., Cheng et al., 2015; Liu & McBride-Chang, 2010). More recently, across orthographies, researchers have found that MA plays an essential role in reading and writing (see Ruan et al., 2018, for a meta-analysis). Further, MA interventions have been found to be effective in literacy acquisition in addition to phonological awareness and phonics training (see Galuschka et al., 2020; Goodwin & Ahn, 2013, for meta-analyses).

Meanwhile, MA's contribution to reading and writing varies by the linguistic properties of different orthographies (Ruan et al., 2018). In this chapter, we begin by reviewing the developmental contributions of MA to reading and writing and then examine how the nature and contribution of MA vary in different orthographies. Finally, we aim to provide future directions to researchers about the role of morphology in different orthographies.

2 Developmental Contributions of MA to Reading and Writing: An Overview

The role of MA has been explicitly addressed in the Lexical Quality Hypothesis (LQH) model (Perfetti, 2007). In the LQH model, morpho-syntax is one of the four constituents of word identity. Furthermore, MA has been specified in the second phase of the Triplex Model of learning to read Hebrew (Share & Bar-On, 2018). In the Triplex Model, the second phase is called lexico-morpho-orthographic processing, during which children rely heavily on lexical and morpho-orthographic knowledge for word reading. In addition, MA is easily integrated into the cognitive components of reading addressed in prevalent reading theories such as the Simple View of Reading (SVR), which suggests that reading is the product of decoding and language comprehension (Gough & Tunmer, 1986). Among metalinguistic skills (e.g., phonological, orthographic, and morphological awareness), phonological and orthographic awareness build foundations for word decoding and decoding fluency (Song et al., 2016; Swanson et al., 2003; Wu et al., 2012). On the other hand, MA contributes to successful decoding and comprehension (Kearns et al., 2016; Kim, 2017; Perfetti, 2007, Perfetti & Hart, 2002). When students decode polymorphemic words, they need MA in addition to phonological awareness, phonics, and orthographic knowledge. For example, when reading *chirping* in the sentence *the bird is chirping on the tree*, students decode *ch* with /tʃ/, *ir* with /ɜːr/, and *p* with /p/; then the recognition of the inflectional ending *ing* facilitates the efficiency of the word decoding. For comprehension, once the word is successfully decoded, the suffix *-ing* and its preceding referential verb (*is*) help typical readers to comprehend that the event (*birds chirping*) is happening right now rather than in the past. In older students, more advanced MA contributes to successful syllable division, word comprehension, and text reading comprehension. Examples of these skills include the awareness of derivational suffixes in English and differentiating semantic radicals in complex Chinese words (Foorman et al., 2012; Kieffer & Lesaux, 2007; Levesque et al., 2017; Tong et al., 2011).

The role of MA is clearly addressed across word writing stage theories but is less attended to in the early writing stages. For example. Ganske (1999, 2014) suggested five stages of word writing (*Emergent, Letter Name, Within Word, Syllable Juncture, and Derivational Constancy*) and designed word writing assessment lists for each stage. Among those lists, polymorphemic words were not covered until the Syllable Juncture and Derivational Constancy stages (see Ganske, 1999, 2014). In standardized spelling assessments such as Wechsler Individual Achievement Test-IV (WIAT-4, 2020), the first appearance of a polymorphemic word for dictation was in the Grades 4–8 list (*camped*). The reason is that researchers tend to focus on phoneme-to-grapheme correspondence during initial spelling development (Bayersmann et al., 2019). However, Treiman and Kessler (2014) proposed the Integration of Multiple Patterns (IMP) theory and suggest that MA develops early via implicit statistical learning from accumulated reading and writing experiences. Thereafter, individual differences in MA were observed in young children and were predictive of future polymorphemic word writing accuracy (Egan & Tainturier, 2011; Hauerwas & Walker, 2003; Kemp et al., 2017).

Previous research studies have found that MA contributes to reading and writing, whether in shallow and transparent orthographies like Spanish or deep and opaque orthographies like English and Chinese. However, current MA literature has predominantly focused on English. There is much less research targeting MA in other orthographies, including a lack of studies on the less opaque orthographies, alphabetic orthographies embedded in Semitic languages (e.g., Arabic and Hebrew), and non-alphabetic orthographies (e.g., Chinese). In the following sections, we first review the roles of MA in reading and writing of Indo-European alphabetic orthographies and then discuss MA in other orthographies of various morphological structures.

3 MA in Indo-European Alphabetic Orthographies

MA varies in the extent of its influence on word reading and writing in different Indo-European alphabetic orthographies (or *spelling*; Seymour, 2013). The relationship between MA and learning to read and write in these orthographies is based on the idea that morphemes have semantic, phonological, and syntactic properties (Mahony et al., 2000). Additionally, studies have shown that adults rely on morphological information to process more complex words, suggesting a higher degree of organization within their storage system for vocabulary (Nagy et al., 1989).

Polymorphemic words are common in many Indo-European alphabetic orthographies. For example, approximately 60–80% of the new words that school-aged children will encounter in English (Nagy & Anderson, 1984) and around 75% of French words are polymorphemic (Rey-Debove, 1984). Elbro and Arnback (1996). Nagy et al. (2014) highlighted several reasons why MA may be critical to proficient reading and writing in alphabetic orthographies, including contributions at both the sound level for decoding and encoding and the comprehension level for vocabulary reading comprehension. For example, studies show that MA promotes decoding after children have moved beyond the beginning stages of learning to read (e.g., Angelelli et al., 2017; Bayersmann et al., 2019; Hasenacker & Schroeder, 2017; Quémart et al., 2012). This finding may be attributed to students using two different methods to access morphologically complex words, with whole word representations used for familiar words and component morphemes used for unfamiliar words (Caramazza et al., 1988). Moreover, regardless of the transparency of the orthography, the significance of MA to reading achievement increases as students grow older (e.g., Carlisle & Stone, 2005; Fleischhauer et al., 2021). However, MA's contributions to reading and writing may vary based on the language's orthography; thus, theoretical conceptualizations of reading and writing development should consider cross-linguistic differences.

Much research has been done on the connection between MA and reading in English (Carlisle, 1995, 2000; Carlisle & Fleming, 2003; Deacon & Kirby, 2004; Kemp, 2006; Nagy et al., 2006), due to the complexity and depth of its orthography often leading to slower reading development when compared to that of more transparent orthographies. Nagy et al. (1994) observed that Grade 5 students encounter approximately 10,000 unfamiliar words in English reading over a school year. About 4000 of those words can be considered derivatives of more frequent words. Anglin (1993) estimated students' vocabulary growth in derived words between Grade 1 and Grade 5 to be more than three times greater than the increase in the number of root words for the same students (e.g., 14,000 derivatives: 4000 root words; Ku & Anderson, 2003). Thus, MA plays a significant role in more advanced reading development when working in a deep orthography such as English.

MA "brings an important degree of regularity" to the mapping of grapheme-phoneme correspondences in deep orthographies such as English, despite it being less morphologically complex (Rastle, 2019, p. 46). Unlike most transparent orthographies, MA and other sublexical units (e.g., syllables, rimes) may be equally relied upon when reading in a deep orthography (Mousikou et al., 2001), with proficient readers being more aware of morphological structure than poor readers. Moreover, Goodwin and Ahn (2013) noted that both lexical (i.e., definitional) and syntactic (i.e., grammatical) roles of morphemes could support students' reading and word writing in English. Nagy et al. (2006) found that the variance in word writing could be predicted by a students' MA, even after taking the effect of phonological awareness into account. The fact that English word writing prioritizes morpheme consistency over the consistency of phonemes may explain this finding (Bowers & Bowers, 2018).

In shallow orthographies, such as Spanish, Finnish, or Italian, most words can be decoded and spelled correctly using phoneme-grapheme correspondence rules (Defior et al., 2000). However, MA still plays an essential role in reading and word writing, as languages with a shallow orthography tend to be morphologically complex (Perfetti & Harris, 2013; Ramirez et al., 2011; Seidenberg, 2011). For example, there can be up to 47 different inflections for Spanish verbs and more than 40 inflected forms for Italian verbs (Job et al., 2013). Thus, morphological information may be used in shallow orthographies when processing long, unfamiliar words that are morphologically complex (Angelelli et al., 2017; Defior et al., 2008). Studies of shallow orthographies have demonstrated that MA, especially awareness of derivational morphology, promotes reading and writing accuracy as well as reading fluency (Angelelli et al., 2017; Burani et al., 1999; Müller & Brady, 2001; Ramirez et al., 2011). For example, Ramirez et al. (2011) found that, in a group of upper elementary and middle school Spanish-speaking children, MA contributed more to reading in Spanish than phonological awareness. Angelelli et al. (2014, 2017) found that Italian grade 3 students with and without dyslexia wrote morphemic pseudowords more accurately than non-morphemic pseudowords, thereby highlighting the fact that intermediate grain-size units (i.e., units larger than the single phoneme, but smaller than the word) are used in spelling regardless of the consistency of phoneme-to-grapheme correspondences.

Similar to shallow orthographies, languages with an intermediate orthography such as German and French have fairly consistent phoneme-grapheme correspondences but rather inconsistent grapheme-phoneme correspondences, leading to difficulties in writing. Therefore, morphological awareness is needed in writing tasks (Sénéchal et al., 2006). For example, in German, graphemes almost always have one consistent phoneme, yet, due to morpheme consistency, there may be several acceptable translations of a phoneme into a grapheme (e.g., *hast- hasst* ['have-hate'], ist- isst [is-eats], Meer-mehr [sea- more]; Kargl & Landerl, 2018). Consequently, reading and spelling improve in languages with an intermediate orthography when MA is employed (Quémart & Casalis, 2017). However, this may vary depending on the unique characteristics of a language's orthography. Hasenäcker and Schroeder (2017) and Fleischhauer et al. (2021) found that German-speaking fourth-graders break down morphologically complex words into their component morphemes when reading, while younger students tend to rely on grapheme-phoneme correspondences and syllables. Conversely, in French, Cole et al. (2011) found that second- and third-grade children used morphemes and syllables equally as they read multimorphemic words.

Portuguese can also be considered an intermediate orthography. The language has a simple syllabic structure; however, it is less transparent in its phonology. Portuguese is similar to English, where morphologically-based regularities with different meanings for different word forms guide the writing and reading of many words (De Freitas et al., 2018; Oliveira et al., 2020). De Frietas et al. (2018) conducted a study of Portuguese Grade 4 students to examine the role of MA in word reading and reading comprehension. Findings indicated that MA contributed to reading comprehension and supported reading accuracy and speed through improved decoding skills (De Freitas et al., 2018).

Currently, MA intervention studies in Indo-European languages predominantly focus on English and older students (Grade 4 and up), with few focusing on shallow and intermediate orthographies. Bowers et al. (2010) conducted one of the few meta-analyses that focused on MA intervention across orthographies (Danish, Dutch, English, and Norwegian) and found that MA interventions, when integrated with other literacy instruction, effectively improved word reading, writing, and vocabulary skills irrespective of orthographic depth or student age. As young students show individual differences in MA that are predictive of future literacy achievements (Treiman & Kessler, 2014), Bowers et al.'s findings may suggest the necessity of integrating MA beyond phonics instruction in early grades. However, more studies are needed to investigate the necessity of teaching and assessing MA in the early stages of reading and writing.

4 Nonlinear Affixation: The Case of Arabic and Hebrew

Modern Arabic and Hebrew each possess two versions of the same orthography. While one is considered shallow and transparent, the other is deep and opaque (Abu-Rabia, 2007; Ravid, 2013). The transparent and shallow version is vocalized and represents both consonants and vowels (Abu-Rabia, 2007; Ravid, 2013). Arabic and Hebrew are also considered morphologically dense due to the use of long clusters of bound morphemes (inflectional and derivational affixes). The richness of morphology in Semitic languages includes (1) the many semantic notions that are expressed within a word, (2) large structural systems that organize the lexicon by morphological means, and (3) many systematic and semi-systematic morpho-phonological alternations. For example, in Hebrew, inflectional suffixes such as *-o* (*sus* [horse]-*suso* [his horse]) do not change the lexical category of the word and have transparent meanings. Derivational suffixes in Hebrew, however, can change a word into various meaning categories. For example, a derivational suffix can change a verb to a noun (*xofshi* [free] derived from *xofesh* [freedom]), a noun to another meaning-related noun (*mitriya*, 'umbrella' derived from *matar* [rain]), or a word from one category to another (*iriya* 'municipality', from *ir* [city]). Due to the richness of morphology, the spelling rules of these morphemes are generally unpredictable (Levin et al., 2001).

Polymorphemic words in Indo-European languages (e.g., English, Spanish) are usually a linear combination of prefixes, roots, and suffixes (prefixes are attached to the beginning and suffixes to the end of a root). However, the cases in Semitic languages are different. Despite following patterns of alphabetic orthographies, Semitic languages such as Arabic and Hebrew share few similarities of morphological structure with other alphabetic orthographies. In many Arabic and Hebrew polymorphemic words, the root and other morpheme letters (or *word patterns*) are interwoven (Abu-Rabia, 2007; Deutsch et al., 2003). A root is usually a consonant letter cluster (e.g., *zmr* means the concepts related to *singing* in Hebrew), and word patterns (vowel or vowel-consonant letter strings) are inserted in between these consonant letters to form derivatives (Frost et al., 1997). For example, the Hebrew root *zmr* (sing) can be derived into *zemer* (song) and *zamir* (mockingbird/singing bird). An example in Arabic is that the root *ktb* refers to *concepts of writing,* and the derivative *kateb* was combining *ktb* with _a_e_ word pattern.

Due to these linguistic properties of written Arabic and Hebrew words, virtually every content word in Arabic and Hebrew is polymorphemic (Deutsch et al., 2003; Taha & Saiegh-Haddad, 2016). Therefore, unlike alphabetic orthographies, MA plays an especially important role in reading polymorphemic words in Arabic and Hebrew. Young children (as early as second grade) use morphological pattern cues to fill in missing phonological information when reading unfamiliar words. They also start to differentiate homographs using morphosyntactic cues over time (Bar-On & Ravid, 2011). Therefore, given the high morphological density, word recognition in Arabic and Hebrew can be challenging and slower to develop with poor MA (Shimron, 2006), reinforcing the need for intervention research on this topic.

Arabic and Hebrew researchers have attempted to investigate the role of MA in typical and striving students in primary grades (Kindergarten to Grade 3) and higher grades. Levin et al. (2001) monitored the inflectional and derivational MA in Hebrew and correlated these scores with writing accuracy scores one year later (i.e., when students became first graders). They found that derivational MA posed more difficulties than inflectional MA, and the composite MA scores were strongly associated with vowel writing accuracies in Grade 1. Vaknin-Nusbaum et al. (2016b) found that Grade 2 and Grade 5 Hebrew-speaking students with poor MA tend to struggle with reading comprehension (see similar findings in Vaknin-Nusbaum, 2018 and Vaknin-Nusbaum et al., 2016a). Saiegh-Haddad and Taha (2017) found that Arabic-speaking students with dyslexia showed MA deficits as early as Grade 1, and these deficits were associated with word reading and writing difficulties beyond phonological factors (see similar findings in Schiff & Saiegh-Haddad, 2018). Mahfoudhi et al.'s (2010) study compared the predictors of reading comprehension of Arabic-speaking typical and striving readers from Grades 3–8 and found that MA was only predictive of typical readers' comprehension abilities. On the other hand, striving students in these older grades could perform as well as typical students on MA tasks, but MA did not predict their reading comprehension. The authors concluded that although Arabic striving readers were exposed to polymorphemic words early on, they could not utilize MA to facilitate comprehension tasks.

MA intervention was found to be effective in enhancing reading comprehension and writing accuracy in both Arabic and Hebrew. Also, MA intervention seems to benefit older striving students more than phonological awareness intervention. Taha and Saiegh-Haddad (2016) compared how in Grades 2, 4, and 6 Arabic-speaking students with typical and struggling reading profiles responded to phonological and morphological word writing interventions and found that both interventions significantly improved striving and typical students' word writing accuracy. However, MA intervention showed more benefits to Grade 6 striving students than did phonological awareness intervention. Specifically, the reading and writing growth scores of striving Grade 6 students surpassed those of typical students in the MA intervention group, whereas phonological intervention did not suggest differential benefits to different types of students. A randomized controlled trial MA intervention study conducted by Vaknin-Nusbaum and Raveh (2019) focused on Grade 5 Hebrew striving students. Their intervention package included segmentation and identification of morphemes from polymorphic words and constructing derivatives from roots. Their intervention showed clear advantages of the intervention group on reading accuracy and comprehension compared to the striving students without explicit MA instruction. These studies made strong cases of MA intervention's effectiveness on striving students' reading and writing skills in dense morphological orthographies like Arabic and Hebrew.

5 Dimensionality of MA: The Case of Chinese

Unlike the orthographies discussed above, Chinese is a morpho-syllabic orthography that cannot be further decomposed to the phoneme-grapheme level. Chinese characters are both a morpheme and a syllable and have complex visual structures (variant configurations and stroke patterns). Therefore, MA in Chinese is confounded with phonological and visual-orthographic processing but emerges as soon as students start to recognize characters (e.g., Kim et al., 2020; Ku & Anderson, 2003; Liu et al., 2013; Shu et al., 2006; Tong et al., 2017). Therefore, it is unsurprising that the fact that Chinese MA predicts reading and writing is well established (e.g., Cho et al., 2011; Han et al., 2022; McBride-Chang et al., 2003; Ramirez et al., 2011; Rispens et al., 2008; Tong et al., 2009).

However, in research studies, the dimensionality of Chinese MA as a theoretical construct is still under debate. For example, Tong et al. (2017) suggested that MA occurs at the semantic radical level (a stroke pattern within a morpheme that cannot stand alone as a character) in addition to MA at character- and compound-level (real words with two or more morphemes). By contrast, Liu and McBride-Chang (2010) suggest that MA only occurs at the character and compound levels. More recently, Han et al. (2022) examined MA at the radical, character, and word level. This chapter adopted Han et al.'s version by suggesting a 3-dimension model of Chinese MA. That is, we suggest Chinese MA occurs at the semantic radical level (within-morpheme), the character level, and the compound level (also see Li et al., 2002; Liu et al., 2013; McBride-Chang et al., 2003; Tong et al., 2017).

The first dimension of MA is at the semantic radical level. Most Chinese characters in the elementary lexicon are composed of semantic radicals and phonetic radicals (Shu et al., 2006). A semantic radical sends the meaning clue to the character, and a phonetic radical indicates the character's sound (Ho et al., 2003). For example, in the semantic-phonetic character 油 (/you2/, oil), 氵 is the semantic radical suggesting the meaning of the character 油 is relating to *water and liquid*. Meanwhile, the phonetic radical 由 (/you2/) gives the pronunciation hint to the character 油(/you2/, oil).

There are 7000 commonly used characters (morphemes) in the Chinese lexicon but only 1300 syllables (Chao, 1976). One of the reasons is related to the large number of characters sharing the same phonetic radicals. Also, phonetic radicals occupy more character space than semantic radicals, which leads to many words looking similar to each other. For example, the characters 躁 (mad, */zao4/*) and 燥 (dry, */zao4/*) have the same syllable and are visually similar but vary in meaning as they share the identical phonetic radical while the semantic radicals are different (the left part of the characters). Therefore, differentiating semantic radicals are critical in Chinese reading and writing and are predictive of concurrent and longitudinal reading and writing (Feldman & Siok, 1999; Ho et al., 2003; Zhang et al., 2012; Zhang et al., 2021). In a longitudinal intervention study by Wu et al. (2012), guided semantic radical instruction as part of MA instruction showed significant positive impacts on Grade 2 students' word reading and writing skills. Packard et al. (2006) found that explicit semantic radical intervention, as part of the MA intervention package, significantly improved the word writing skills of Grade 1 students as compared to the control group students.

The second dimension of MA is the meaning processing of individual morphemes. Since the number of morphemes is much greater than that of syllables (Chao, 1976), a large number of homophone characters exist in the Chinese lexicon. Some of these homophone characters have to be differentiated at the morpheme level. For example, homophones 撼 (to shake, /han4/), 旱 (dry, /han4/), 汉 (a Chinese ethnic group, /han4/), and 汗 (sweat, /han4/) all share the single syllable /han4/ but have drastically different meanings. A student with good homophone awareness differentiates the meanings based on visual-orthographic differences among these words, and then knows how to apply these words in different word contexts (旱 /han4/ in the bimorphemic word 干旱 [/gan1 han4/, drought] and 汗 /[han4/, sweat] in the bimorphemic word 出汗 [/chu1 han4/, to sweat]). Lack of character-level MA, especially homophone awareness, has been associated with poor vocabulary knowledge, reading comprehension, and word writing (Liu et al., 2013; Kim et al., 2020; Shen & Bear, 2000; Tong et al., 2017). Meanwhile, character-level MA also involves homograph awareness, defined as two morphemes written with the same character but having different meanings. For example, the character 木 (/mu4/, wood) in the word 树木 (/shu4 mu4/, trees) has a distinct meaning from the 木 (/mu4/, numb) in the word 麻木 (/ma2 mu4/, numbness). Previous studies have found that homograph awareness also contributes significantly to Chinese vocabulary and reading comprehension (Han et al., 2022; Liu et al., 2013; Xie et al., 2019).

The third dimension of Chinese MA is at the compounding word level. Most compounds in Chinese have two morphemes (e.g., 树木 /shu4 mu4/, trees). These Chinese bimorphemic compounds can be categorized into words of five compounding structures: subject-predicate, verb-object, subordinate, coordinate, and verb/adjective-complement (Liu & McBride-Chang, 2010; Zhang, 2004). Compound awareness facilitates understanding the inner relations between the two morphemes in each compound word and thus aids word comprehension and text reading comprehension (Liu & McBride-Chang, 2010). For example, in the compound word 牛奶 (/niu2 nai3/, milk), 牛 (/niu2/, cattle) is used to define 奶 (/nai3/, milk), and thus

牛奶 means *cow's milk*. However, when switching the order of the two morphemes, namely 奶 (/nai3/, milk) defining 牛(/niu2/, cattle), the compound word 奶牛 [/nai3 niu2/, (cow)] refers to *milk-producing livestock*. Therefore, at the compounding word level, proficient MA involves differentiating compound meanings based on morpheme sequences and grammatical demands.

Currently, there are very few studies conducting MA intervention. Zhou et al., (2012) was one of the few that compared homophone intervention to compound awareness intervention. They found that compound awareness training demonstrated better word reading accuracy improvements than homophone intervention. Future Chinese researchers should attempt to replicate this finding. Also, further researchers should investigate whether the intervention should target compound awareness or combine the three dimensions of MA to maximize the benefits.

6 Conclusion and Future Directions

In this chapter, we have reviewed past endeavors on MA across orthographies. In Indo-European alphabetic orthographies, most early-grade words have a monomorphemic structure. Therefore, most studies in these orthographies have concentrated on MA among older students. By contrast, Arabic, Hebrew, and Chinese words are characterized by complex morphological structures with specific phonological and orthographic properties. Irrespective of orthography, MA intervention has been shown to be effective in improving typical and striving students' literacy skills. Nevertheless, several research areas need future endeavors. In this section, we discuss the future research foci on MA.

In Indo-European alphabetic orthographies, researchers have found that implicit statistical learning and individual differences of MA emerge early on (e.g., Kidd, 2012; Treiman & Kessler, 2014). These learning experiences and individual differences in early MA knowledge are predictive of future reading and writing achievements (Deacon et al., 2014; Manolitsis et al., 2017; Pittas & Nunes, 2014). Future researchers should investigate whether assessing and instructing MA are necessary for the early grades. For Arabic and Hebrew orthographies, due to having unique morphological features (nonlinear affixations; Levin et al., 2001; Taha & Saiegh-Haddad, 2016), future studies should adjust the reading and writing development theories for these orthographies. Also, the dimensionality of Chinese MA needs to be tested with empirical data to validate the 3-dimension model.

In conclusion, much is still unknown about the nature of MA in orthographies in the early stages of reading and writing. All in all, "in the beginning was the Word," and at the beginning of classroom instruction, morphemes of words already influence reading acquisition and written communications. Therefore, literacy researchers should further investigate the nature of MA in different orthographies and at various developmental stages to provide assessment and instructional suggestions to classroom teachers.

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The Distibution of Arabic Verbal Patterns in Text Production: Between Varieties and Modalities

Lior Laks, Ibrahim Hamad, and Elinor Saiegh-Haddad

Abstract Arabic is a typical case of diglossia, in which different varieties of the same language are used within the same speech community for different communicative functions, and often in different contexts: Spoken Arabic for everyday speech and Modern Standard Arabic (MSA) for formal speech and for conventional reading/writing. While Spoken Arabic is typically used only in the spoken modality, MSA may be used in both modalities: speaking and writing. The verbal system of both Spoken Arabic and MSA consists of roots and patterns, which differ mainly in transitivity and semantic class, e.g. causative, incohative. This study examines the distribution of verbal patterns in (spoken) Palestinian Arabic (PA) and in Modern Standard Arabic (MSA), in the spoken modality (MSA-S) and in the written modality (MSA-W), as they are actually used in narrative text production. Verbs were coded accordng to roots, patterns, transitivity and semantic class.

The results reveal that the distribution of verbal patterns and their semantic functions may be clearly differentiated according to variety (PA vs. MSA) and according to modality (spoken PA/MSA vs. written MSA), as some patterns are more typical of one variety/modality than others. In addition, the results demonstrate the special status of spoken MSA as an intermediary variety sharing some features with spoken PA and others with written MSA.

Keywords Arabic · Diglossia · Modality · Narrative texts · Variety · Verb · Verbal pattern · Form-function relations

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1 Introduction

Arabic is a typical case of diglossia (Ferguson, 1959), where two varieties of the language co-exist and are used for two different sets of communicative fucntions (Albirini, 2016; Eid, 1990; Ibrahim, 1983; Maamouri, 1998; among others). In the Israeli context, these are MSA (Modern Standard Arabic) and PA (Palestinian Arabic). PA is the language of daily communication among Arabic native speakers, whereas MSA is the language of formal speech and of reading/writing (Saiegh-Haddad & Henkin-Roitfarb, 2014).[1] While PA is mainly used in the spoken modality, it has been used in recent years in the written modality in the social media and in other electronic means of informal communication like whatsapp. In contrast, MSA is used both for formal speech (religious sermons, lectures, TV broadcasts etc.) and for conventional writing. Lexical and grammatical differences between the two varieties have been shown to exist in all domains of language (Eid, 1990; Ibrahim, 1983; Maamouri, 1998; Saiegh-Haddad & Henkin-Roitfarb, 2014; Saiegh-Haddad & Spolsky, 2014).

Mastering the verbal system of Arabic requires mastery of these systems as they are used in the colloquial varieties and MSA and this includes mastery of different types of morpho-phonological and semantic-syntactic knowlege: (i) the inflectional paradigm of each pattern; (ii) the semantic-syntactic features of each pattern; and (iii) the derivational relations (if any) between the different patterns. Thus, examining how verbs are deployed in actual text production in this morphologically rich context can shed light on various aspects of speakers'linguistic knowledge, as well as the structure and content of the Arabic mental lexicon.

While most studies of the Arabic verbal system have focused on MSA, the current study examines the deployment of verbal patterns in narrative text production among adult native speakers in Palestinian Arabic (hereafter PA) and in Modern Standard Arabic (hereasfter MSA). The verbal system of Arabic, both Spoken Arabic varieties and MSA, consists of patterns which differ mainly in semantic class (e.g., causative and inchoative) and transitivity. Various studies have examined the morpho-phonological and semantic-syntactic properties of the Arabic verbal system (e.g. Benmamoun, 2003; Henkin, 2009; Holes, 1995; Younes, 2000), but few studies have examined their actual usage in text production, and even fewer, if any, have compared the actual use of verbal patterns in the two Arabic varieties: PA versus MSA, or in the two modalities of MSA: spoken versus written. The current study is one step in this direction.

The study addresses the following questions:

(i) What is the distribution of verbal patterns and their semantic features in narrative text production?
(ii) Does the deployment of verbal patterns show sensitivity to variety-related differences (PA vs. Spoken/written MSA)?

[1] While we agree that diglossia consists of a continuum, for the sake of convenience, we will continue to refer to it in a dichotomous way, acknowledging that this is just an abstraction (Basiouny, 2009).

(iii) Does the deployment of verbal patterns show sensitivity to modality-related differences (spoken PA and MSA vs. written MSA)?

We will show that the distribution of the verbal patterns and their semamtic functions reflect a remarkable disparity in langage deployment between the two varieties of Arabic, more so than between modalities within the same variety.

2 Arabic Diglossia

In all literate societies, spoken and written languages are used in different sociocultural contexts, and the two forms of linguistic expression tend to be associated with different communicative conditions and distinct processing constraints, involving such factors as clarity, speed, and effort in online versus offline output (Chafe, 1994; Olson, 1994; Slobin, 1977; Strömqvist et al., 2004). Yet, what appears unique to Arabic diglossia, although possibly applying to some extent in other sociolinguistically analogous situations (Saiegh-Haddad et al., 2021), is that the spoken and written language varieties are so distinct in lexicon, phonology, morphology, and syntax that preliterate children find it very difficult to understand a textwhen it is presented to them in the standard language.

Diglossia is “a relatively stable language situation in which, in addition to the primary dialects of the language there is a very divergent, highly codified (often grammatically more complex) superposed variety, which is largely learned by formal education and is used for most written and formal spoken purposes but is not used by any sector of the community for ordinary conversation” (Ferguson, 1959: 345). Though Ferguson proposes a dichotomy between a spoken and a written variety, the linguistic situation in Arabic diglossia has been described in terms of levels, or a continuum, with speakers shifting between as many as four (Meiseles, 1980) or five (Badawi, 1973) varieties, ranging between colloquial/vernacular and literary/standard forms, resulting in levels that are neither fully standard nor fully colloquial. As such, there are “gradual transitions” (Blanc, 1960) between the various varieties, and “theoretically an infinite number of levels” (Basiouny, 2009: 15). See Albirini (2016) for an extensive discussion of diglossia in relation to language attitudes, social identities, variation and codeswitching and their individual and combined impact on the linguistic behavior of Arabic speakers.

In diglossic Arabic, children start out speaking a local variety of *Spoken Arabic* (hereafter SpA), the one used in their immediate environment: at home and in the neighborhood; once they enter school, at the age of 5–6, they are formally exposed to Modern Standard Arabic as the language of reading and writing, while *Spoken Arabic* remains the language of informal speech.[2] Academic school-related speech

[2] Implicit learning of some of the linguistic strcutures of MSA (e.g., sounds, words) can happen before school from exposure to the language via TV and book reading. Yet this question has not so far been tested.

is conducted in SpA or in a semi standard variety, Educated *Spoken Arabic* (Badawi, 1973), except in Arabic lessons, where MSA is more dominant, at least in aspiration (Amara, 1995). Outside the school milieu, there is a similarly stable co-existence of the two major varieties, each functioning for distinct spheres of social communication: Spoken Arabic is used by all native speakers: young and old, educated and uneducated, for informal and intimate verbal interaction in the home, at work, in the community, and so forth. On the other hand, MSA, alternating with Educated SpA, is expected to be used for formal oral interactions, such as giving a speech or a lecture, and for writing (however, see, Abu Elhija, 2012; Al-Khatib & Sabbah, 2008; Haggan, 2007; Khatteb Abu-Liel et al., 2021, Mostari, 2009; Palfreyman & Al Khalil, 2007; Warschauer et al., 2002 for use of *Spoken Arabic* in electronic writing in Arabic). Thus, while *Spoken Arabic* is undoubtedly the primary language of spoken usage, native speakers of Arabic, including young children, are actively and constantly engaged with MSA as well. They complete their school assignments and take their exams in MSA, and they also pray, watch some TV programs and read storybooks in MSA. Thus, besides proficiency in using *Spoken Arabic*, linguistic proficiency in Arabic involves concurrent proficiency in using MSA, from an early age, for both reading and writing, and also for formal speech.

2.1 Linguistic Distance in Arabic Diglossia

Arabic diglossia was established, at the latest, with the standardization of Arabic in the eighth and ninth centuries A.D., with the early grammarians producing a set of norms for the written form of the language that they called *Alfusha* 'the most eloquent language', the modern descendent of which is called *Alfasiha*, 'the eloquent langauge' often referred to as (Modern) Standard Arabic (MSA, StA). Over the course of many years, the continued use of this favored set of written linguistic norms has led to substantial differences between the dynamic spoken varieties and the fixed written form, making the two linguistically distant, and has engendered the notion that the written standard was the 'real language', while the other varieties were 'degenerate' and 'corrupt' versions (Maamouri, 1998). The linguistic distance between the spoken and the written varieties of Arabic is evident in all areas of structure and usage, including not only lexicon and phonology, but also syntax and morphology, as documented in a range of studies in the past several decades (see for example, Eid, 1990; Geva-Kleinberger, 2000; Hary, 1996; Henkin, 2010; Ibrahim, 1983; Ibrahim & Aharon-Peretz, 2005; Kay, 1994; Levin, 1995; Khamis-Dakwar et al., 2012; Meiseles, 1980; Rosenhouse, 2007, 2014; Myhill, 2014; Saiegh-Haddad & Henkin-Roitfarb, 2014; Saiegh-Haddad & Armon-Lotem, in press; Versteegh, 2001; Wright, 1889).

Phonological differences between the two varieties are apparent in their phonemic and syllabic structure, phonotactic constraints, syllable weight and stress patterns (Aquil, 2011; Broselow, 1979; Jastrow, 2004; Watson, 1999, 2002). Morphologically, MSA and the dialects of SpA differ markedly in inflectional categories, such as the absence in SpA of final short vowel inlfections indicating case and mood, and of the preponderance of the genitive-accusative forms of duals and so-called "sound masculine plurals" (Holes, 1995, 2004). MSA has a rich morphological system of grammatical agreement, contrasting with a far less varied and less complex system of agreement marking in SpA (Aoun et al., 1994, 2010; Benmamoun, 2000; Brustad, 2000). Derivational morphology also reveals differences between the two varieties, primarily in the distribution and frequency of verbal patterns, with some patterns being less frequent and productive in MSA than in SpA (Benmamoun, 1991; Blanc, 1970; Bolozky & Saad, 1983; Fassi Fehri, 1994; Rosenhouse, 2002; Shawarbah, 2007; Younes, 2000). For example, the verb pattern *ʔaCCaC* (e.g. *ʔarsal* 'send') is hardly productive in Palestinian Arabic (PA), with a dictionary search revealing only 75 *ʔaCCaC* verbs in PA, only 3.5% of all PA verbs (Laks, 2018). Syntactically, SpA and MSA vary in clausal word order; with VSO as the typical word order of MSA as against SVO in SpA (Bolotin, 1995; Fassi Fehri, 1993; Mohammad, 1989, 2000; Shlonsky, 1997). The two varieties also differ in use of nominal constructions, with nominalizations being far more common in MSA than SpA (Laks & Berman, 2014; Rosenhouse, 1990, 2008). Moreover, at the intersection of morphology and syntax, the two varieties differ in processes of passivization, with use of passive verbs being far more common in MSA than in SpA (Hallman**,** 2002; Holes, 1998; Laks, 2013). *Lexically*, SpA and MSA feature overlapping and unique lexicons, with approxmately 40% of the words in the spoken lexicon of young speakers of a dialect of PA depicting a unique SpA lexical form (Saiegh-Haddad & Spolsky, 2014).

Given the linguistic distance between SpA and MSA and the complementary distribution of the way words and structures pattern in the two varieties, a given linguistic form can generally easily be identified as belonging to either SpA or MSA, with certain forms common to both varieties. For example, inflectional endings marking case and mood are used only in MSA, never in SpA, and negation relies on different sets of negation particles in SpA and MSA (Benmamoun & Albirini, 2016). On the other hand, processes of noun pluralization are similar in SpA and MSA, although in a few cases the same word may be pluralized differently in the two varieties (Saiegh-Haddad et al., 2012; Albirini, 2016).

These linguistic differences have clear implications for language development in general and for the acquisition of linguistic literacy in particular. Yet, the literature to date is almost lacking in psycholinguistic developmental research that measures (not only outlines) linguistic differences between the two varieties of Arabic in acutal use, and investigates the consequences of such differences for language acquisition and usage. One exception is a recent study measuring the lexical distance between SpA and MSA in a dialect of Palestinian Arabic used in Central Israel: about 40% of the words in the spoken lexicon of kindergarten children had completely different lexical forms in MSA; another 40% consisted of partial cognates that had overlapping yet different forms in the two varieties (with differences ranging between one-to-seven phonological parameters, including phoneme substitution, addition, and deletion); and only about 20% had the same lexico-phonological form in both SpA and MSA (Saiegh-Haddad & Spolsky, 2014). The fact that only

20% of the words used by children aged 4–6 years maintain an identical surface lexical-phonological form in MSA is a compelling result – particularly in light of the finding that children found it difficult to recognize the lexical relatedness between SpA/MSA cognates, even when the gap between the two forms consisted of a single consonant, and of further research showing an impact of distance on phonological represntations in the long-term memory(Saiegh-Haddad, 2011; Saiegh-Haddad & Haj, 2018) and phonological processing in short-term memory (Saiegh-Haddad & Ghawi-Dakwar, 2017). These findings support the results of earlier studies demonstrating the difficulty encountered by precshool children as well as by adolescnets speaking the same variety of Palestinian Arabic in reading and in operating on the phonological structure of MSA words – such as recognizing, isolating, or encoding a phoneme – when the same word had a different phonological form from that used in their SpA vernacular (Saiegh-Haddad, 2003, 2004, 2005, 2012; Saiegh-Haddad et al., 2011, 2020; Saiegh-Haddad & Schiff, 2016; Schiff & Saiegh-Haddad, 2017, 2018). These results have been shown to be related to quality of phonological representations in the lexicon (Saiegh-Haddad & Haj, 2018), and were shown to have cross-dialectal external validity (Saiegh-Haddad, 2007). Further evidence from the scant research available in this domain demonstrating the difficulty schoolchildren have with linguistic structures that do not exist in their spoken vernacular is provided by the forced-choice grammaticality judgment study of Khamis-Dakwar et al. (2012) among schoolchildren, native speakers of Palestinian SpA, when presented with MSA linguistic structures. Laks and Berman (2014) investigated morpho-syntactic differences between SpA and MSA as reflected in the speech and writing of adult native speakers of Jordanian Arabic; they found clear inter-modality linguistic differences on a range of linguistic structures, including case marking, adverbials, dual forms, copula construction, nominalizations, aspect, and modalized prepositions.

3 The Verbal System of Arabic

Verbs constitute a central lexical category as they express relations between entities and events or states. They encode semantic, morphological and syntactic information, and they determine the argument structure of sentences (Berman, 1980, 1987, 1990, 1993; Hirsh-Pasek & Golinkoff, 2006; Pine et al., 1998; Ravid, 1995, 2008; Schachter, 1985; among others).

Semitic morphology relies heavily on non-concatenative morphology, and all Semitic verbs have a consonantal root and must conform to one of the verbal patterns (templates) available in the language (Aronoff, 1994; Bat-El, 1989, 2011; Benmamoun, 2003; Berman, 1978, 1993; Bolozky, 1978; Ravid, 1990, 2008, 2011; Schwarzwald, 1981, 2002; among others). The pattern determines the phonological shape of the verb, i.e. its vowels, prosodic structure and consonantal affixes (if any). The phonological shape of the verb is essential for determining the shape of the other forms in the inflectional paradigm.

Table 1 Arabic verbal patterns

Pattern	Example	
CaCaC	ʔakal	'Eat'
CaCCaC	Farraq	'Scatter'
Ca:CaC	Sa:ʕad	'Help'
ʔaCCaC	ʔarsal	'Send'
tCaCCaC	Tfarraj	'Watch'
tCa:CaC	Tna:qaš	'Discuss with'
inCaCaC	Inkatab	'Be written'
iCtaCaC	ijtamaʕ	'Meet'
iCCaCC	Izraqq	'Become blue'
istaCCaC	istaʕmal	'Use'

There are different methods of transcribing the verbal patterns (see for example, Holes, 1995). We do not include the glottal stop consonants, except for the *ʔaCCaC* pattern, as we assume it is epenthetic. However, selecting one mode of presentation or another has no implications for the results of the study, and we adhere to one mode for the sake of uniformity

Table 1 lists the verbal patterns of PA.[3]

When examining the Arabic verbal system, including the PA verbal system discussed here, it is important to note that two paradigmatic relations are relevant: inflectional and derivational. Each one of the derivational patterns listed above has its own set of inflectional paradigms for tense/aspect, and each paradigm consists of conjugated forms according to gender, number and person (see Aronoff, 1994).[4] Such paradigms share some properties, but they are also distinct from one another. For example, while the formation of imperfective forms in all patterns is based on affixation, the vowels of the prefixes and the stems for each pattern are different.

The relations between verbs in the different patterns are derivational and are manifested mainly in transitivity alternations and other types of semantic relations (e.g., Bolozky & Saad, 1983; Fassi Fehri, 1994; Glanville, 2011; Goldenberg, 1998; Guerssel & Lowenstamm, 1996; Hallman, 2006; Henkin, 2009, 2010; Holes, 1995; Izre'el, 2010; Jastrow, 2004; Levin, 1995; Ouhalla, 2014; Ryding, 2005; Shawarbah, 2012; Younes, 2000; Watson, 2002; Wittig, 1990). The use of the same stem consonants in different patterns results in different verbs, and the semantic relations between them can be of different degrees of transparency. At the same time, verbs that are formed in certain patterns share some typical semantic and syntactic

[3] MSA consists of the same number of patterns with some morpho-phonological differences, for example *tCaCCaC* (PA) vs. *taCaCCaCa* (MSA). For purposes of uniformity, we will use the PA patterns with respect to both PA and MSA. The examples in this study are in their 3rd person masc. Past form, the citation form, which is conventionally assumed to be the base of formation throughout the inflectional paradigm as it is free of inflectional suffixes (see Bat-El, 2002; Ravid, 1995; Ussishkin, 1999; among others). However, the direction of derivation is irrelevant for the purpose of this study.

[4] The participle forms do not mark differences in person, but have only four forms that differ in gender and number.

features. For example, *CaCCaC* verbs are usually active transitive (e.g. *ʔaθθ*ar 'affect'), and their intransitive alternates are formed in *tCaCCaC* (e.g. the inchoative verb- *tʔaθθ*ar 'get affected'). The two verbs are formed in two different patterns, yet both use the same root consonants *ʔ-θ-r*.

The patterns differ in their distribution and frequency. *CiCeC/ CaCaC* is considered the most basic verbal pattern, hosting a large number of verbs that constitute the basic vocabulary items of MSA, as well as of many other dialects (See for example, Holes, 2004).[5] This verbal pattern does not have specific semantic-syntactic features, and it hosts active transitive verbs like *katab* 'write', *rikeb* 'ride' and *šireb* 'drink', active intransitive verbs like *miše* 'walk' and *rakadˤ* 'run', and intransitive inchoative verbs that denote a change of state, e.g. *jimed* 'freeze' and *kiber* 'grow', as well as other types of verbs. Some patterns tend to have a 'usual mate', namely another pattern, or several patterns, with which they have typical derivational relations (see Table 2). *CiCeC/ CaCaC* is related to *CaCCaC* in two ways. In (a) the *CaCCaC* verb is the transitive causative counterpart of the *CiCeC* intransitive inchoative verb, while in (b) the *CaCaC* verb is transitive and the *CaCCaC* verb is also transitive and denotes an intensification of the action of the verb. In (c) the same *CaCaC* verb as in (b) is in relation with an *inCaCaC*, which is inchoative. In (d) the transitive-intransitive alternation is between *CaCCaC* (transitive) and *tCaCCaC* (intransitive).

The examples in Table 2 demonstrate that *CaCCaC* is typically active and transitive, *inCaCaC* and *tCaCCaC* are typically intransitive and *CiCeC/CaCaC* is neutral with respect to transitivity. In addition, *CiCeC* can be derivationally related to *CaCCaC* and *tCaCCaC* we need to add another example in the table for this one, *inCaCaC* like jimed-tjammad but not *inCaCaC*, whereas *CaCCaC* is derivationally related to *CiCeC/CaCaC* and *tCaCCaC* but not to *inCaCaC*.[6] The picture that emerges is that the verbal patterns are organized in terms of families, where some patterns are more related to others (see Berman, 1978, 2003; Bolozky, 1978, 1999; Doron, 2003; Ravid, 1990, 2008; Ravid et al., 2016; Ravid et al., 2016; Schwarzwald, 1981, 2002, for Hebrew). It is crucial to note that such distinctions reflect strong tendencies rather than a clear-cut distribution. The derivational relations between verbs in different patterns depict many irregularities. For example, the verb *tfarraj*

Table 2 Relations between verbal patterns

Patterns	Verb1		Verb2	
a. CiCeC – CaCCaC	wiqeʕ	'fall'	waqqaʕ	'make X fall'
b. CaCaC – CaCCaC	mazaʔ	'Tear X'	mazzaʔ	'Tear X into small pieces'
c. CaCaC – inCaCaC	Kasar	'Break X'	Inkasar	'Become broken'
d. CaCCaC – tCaCCaC	ɣayyar	'Change X'	tɣayyar	'Become changed'

[5] *CiCeC* and *CaCaC* are considered the same pattern as they differ only in their vowels and they share similar inflectional paradigms.

[6] This has some exceptions, e.g. *ʕiref* 'know' and *tʕarraf* 'get to know'.

‘watch’ is formed in *tCaCCaC* but is active and transitive, and it does not fall into one of the typical semantic classes of this pattern (e.g. inchoative and reflexive). Derivation in patterns in Semitic languages makes a critical contribution to the structure and organization of the lexicon and provides its infrastructure (Boudelaa, 2014; Benmamoun, 2000; Ravid et al., 2016).

3.1 Traditional Classification of Arabic Verbal Patterns

Several studies offer a traditional semantic-syntactic classification of the verb patterns of MSA (see Holes, 1995; Ryding, 2005; and references therein). According to these accounts, *CaCaC* is the most basic pattern and it has three templates that vary in the vowel patterns: *a-a, a-i*, and *a-u*. The *a-a* pattern *CaCaC* refers to an action performed by an agent, and it can be either transitive (e.g. *fataħ* ‘open’) or intransitive (e.g. *rakadˤ* ‘run’). The *a-i* pattern *CaCiC*, e.g. *xasir* ‘lose’ has an inchoative function. The *a-u* pattern *CaCuC* is an intransitive form that refers to the process of acquiring a particular new quality, e.g. *sˤaɣur* ‘become small’, related to the adjective *sˤaɣi:r* ‘small’. In PA, there are just two vocalic patterns: *a-a* (e.g. *qaʕad* ‘sit’) and *i-e* (e.g. *fihem* ‘understand’). We will relate to these two vocalic patterns as one verbal pattern throughout the paper.

CaCCaC, in which the second consonant is geminated, is active and is mostly transitive. This pattern can have an intensive/iterative and causative meaning in relation to *CaCaC* verbs. For example, the root *ħfr* ‘dig’ can have an active meaning in *CaCaC ħafar ‘dig’*, compared to the iterative meaning of *CaCCaC ħaffar* ‘dig up continuously’. Similarly, the root *rqsˤ* has a causative meaning, e.g. *raqqasˤ* ‘make X dance’, compared to the *CaCaC* verb *raqasˤ* ‘dance’.

Ca:CaC is also mostly transitive. This pattern implies the involvement of a particular patient or another participant other than the agent, e.g. *ja:dal* ‘argue with’ requires the cooperation on part of a patient as a second argument.

ʔaCCaC is mostly transitive, but in some cases it can also be intransitive. As transitive, it can have a causative meaning, e.g. *ʔadxal* ‘make X enter’ (cf. *daxal* ‘enter’). If it is intransitive, it can/may be inchoative, e.g. *ʔaðˤlam* ‘become dark’.

taCaCCaC actualizes the effect of its action on its agent, so it is generally a reflexive verb, e.g. *taqarrab* ‘make oneself close to’. It could be either transitive, e.g. *taʕallam* ‘study’, or intransitive e.g. *tasˤarraf* ‘behave’.

taCa:CaC is mostly intransitive. It implies a reciprocal relationship between the participants, e.g. *tafa:ham* ‘understand each other’. Many of *taCa:CaC* are derivationally related to *Ca:CaC* transitive verbs, e.g. *ka:tab* ‘write to X’ and *taka:tab* ‘correspond’.

inCaCaC signifies the effect of the action without the presence of an agent; it is mostly an inchoative-passive verb, e.g. *inkasar* ‘become broken’.

iCtaCaC is either transitive (e.g. iktašaf ‘discover’) or intransitive. When it is intransitive, it can be either reflexive e.g. *iɣtasal* ‘wash oneself’ or inchoative, e.g. *iħtaraq* ‘become burned’.

iCCaCC is intransitive and is used to denote becoming colored or having physical defects, and it is considered as the rarest of patterns, e.g. *ixdˤarr* 'become green' and *iʕwarr* 'become blind in one eye'.

istaCCaC is either transitive or intransitive. It can be mostly reflexive, e.g. *istaʕadd* 'make oneself ready' or active, e.g. *istafsar* 'inquire'.

3.2 Semantic-Syntactic Relations Between Verb Patterns: A Psycholinguistic Perspective

While the literature provides a classification of the functions of Arabic verbal patterns (see Ryding, 2005), there has been relatively little research on their function as realized in actual text production. Saed (2006) examined the acquisition of the verbal system in PA in preschool children, aged 2–3, 3–4, 4–5 and 5–6 years. Based on spontaneous conversations, the study showed that in all age groups, *CaCaC* was the most prevalent pattern, followed by *CaCCaC* and then *tCaCCaC*, with a slight rise in the frequency of the remaining patterns with age. She argues that the semantic functions of causativity (*šarrab* 'make drink'), then reflexivity (*tħarrak* 'move') and inchoativity (*tkassar* 'get broken') are acquired early, between the ages of 3–4. Reciprocal verbs (*tqa:tal* 'fight each other') are acquired as late as ages 5–6 and intensive verbs (e.g., *kassar* 'break X intensively') are the second most frequently used verbs between the ages of 3–4, but become less frequent after the age of 4. Tarabani (2006) examined the distribution of PA verbal patterns in five Palestinian groups from the ages of 2–6, and then in 4th grade for comparison. The study showed that the most common pattern for all age groups was *CaCaC*, follwed by *CaCCaC*. A recent study Laks et al. (2019) examined the distribution of verbal patterns in Palestinian Arabic. The study showed that only some of the patterns are used in nnartive text production. *CaCaC* was shown to be the most productive pattern, followed by *CaCCaC* and *tCaCCaC*. The other patterns were relatively rare (see Sect. 4). Most studies that were conducted in Arabic (see Bolozky & Saad, 1983; Hallman, 2006; Holes, 1998; Saad, 1982) mainly focused on MSA. These studies revealed the semantic-syntactic features that underlie some of the systematic alternations between patterns. For example, *CaCCaC* transitive verbs alternate with *tCaCCaC* in passive, inchoative and reflexive formation (Rosenhouse, 1991–1992; Tucker, 2011; Younes, 2000). Similarly, causative verbs are mostly derived in *CaCCaC/ʔaCCaC* from *CaCaC* verbs (Dank, 2011; DeMiller, 1988; Ford, 2009; Ouhalla, 2014).

Research shows that the acquisition of the verbal system in Semitic lanuages is a critical milestone in the acquisition of language, because it incorporates the acquisition of derivational morphology as an organizing principle in the lexicon. Many studies have examined the acqusition of the verbal patterns in Hebrew, including use of patterns in different types of elicited texts (Armon-Lotem & Berman, 2003; Ashkenazi et al., 2016; Berman, 1980, 1993; Berman & Slobin, 1994; Berman & Ravid, 2009; Berman et al., 2011; Ravid, 1995, 2003, Ravid & Berman, 2009; Ravid et al., 2016). Hebrew has a system of five verbal patterns in addition to two patterns that host passive verbs. It has been shown that with age, speakers-writers use a wider variety of patterns for a wider range of semantic-syntactic functions (Berman, 1993). Some studies also pinpoint age-related differences in the acquisition of the verbal patterns in Hebrew. For instance, Berman (1980, 1982, 1993) observes two stages in the acquisition of verbal patterns before children master the system and the relations between patterns (ages 5–6). The first stage is up to around the age 3, in which a single non-alternating form is used for a given concept, and with all thematic realizations of it conflated into a single pattern. For example, *ʔaxal* (*CaCaC*) ‘eat‘can be used to convey both ‘eat’ and the causative verb ‘make eat’, instead of *heʔexil* (*hiCCiC*), e.g., *ʔima ʔaxla oti* ‘Mom ate me‘ instead of *ʔima heʔexila oti* ‘Mom made me eat’. Later, around the fourth year, children alternate between patterns of the same root, manifesting two main types of switching – between the transitive patterns *hiCCiC* and *CiCeC* (e.g., *heʔelim* – *ʔilem* ‘make vanish’) and between the intransitive patterns *niCCaC* and *hitCaCeC* (e.g., *nirdam* – *hitradem* ‘fall asleep’).[7] This shows that children’s errors during the course of acqusition do not cross transitivity boundaries, a finding that Berman interprets as indicating that children demarcate predicates according to the value of transitivity.

Research on Hebrew also shows that, at any age, *CaCaC* is the most frequent pattern for both transitive and intransitive verbs (Ashkenazi et al., 2016; Berman, 1993; Berman & Ravid, 2009), but the frequency rates of *CaCaC* verbs vary with development. *CaCaC* verbs constitute about 70% of all verb tokens in the speech of children up to 3rd grade, yet they decrease with age, whereas *hiCCiC* and *CiCeC* increase. A drastic drop in *CaCaC* was noticed between the age of 5–6 (Stansaz, 2016). The second most frequent patterns in speech and writing in Hebrew appear to be the transitive patterns *hiCCiC* and *CiCeC*, followed by the intransitive patterns *niCCaC* and *hitCaCeC*. The rarest verbs are the passive patterns *CuCaC* and *huCCaC* (Berman, 1993; Ravid et al., 2016; Ravid & Vered, 2017), which are virtually absent before the age of 3 (Ashkenazi et al., 2016).

A recent study by Ravid et al. (2016) examined the linkage between roots and derivational families in Hebrew, based on the input to toddlers. This study showed that children are exposed to far fewer verb derivational families, with most input consisting of singleton verbs, namely verbs with no root-related verb siblings in the database, and a small number of two-pattern families. Levie et al. (2020) examined the emergence and development of Hebrew verb families from infancy to adulthood. The study consisted of of spoken and written productions of Hebrew-speaking toddlers, children, adolescents and adults. It shows that roots, patterns and derivational verb families are emergent properties of the Hebrew verbal system, as it develops in communicative contexts. It is only by late adolescence and adulthood that Hebrew speakers are endowed with the morphologically diverse and rich Semitic lexicon that enables new-verb creativity. This mature lexicon has multiple

[7] Children did not use *CaCaC* instead of other patterns. Berman (1980) regards this pattern as “basic” since it is neutral with respect to transitivity.

and larger derivational verb families; and much of it is based on regular, transparent roots that are often derived from words in other lexical categories.

Given the rich verbal system of Arabic and the interesting semantic relations between the verbal patterns in this system, the current study investigates the distribution of verbal patterns, their syntactic-semantic features and relations and the occurence of morphological families in actual spoken text production by adult native speakers of Palestinian Arabic.

4 Distribution of Verbal Patterns in Narrative Texts

The current study examines the deployment of verbal patterns in narrative text production among adult native speakers in spoken PA and spoken and written MSA. We examine the semantic propreties of the verbal patterns and whether their deployment differs with respect to variety (PA vs. spoken and written MSA) and modality (spoken PA and MSA vs. written MSA).

4.1 Methodology

The study is based on data elicited in spoken and wrriten narrative text production. It is methodologically grounded in the framework of an international cross-linguistic research project on text construction, entitled "Developing Literacy in Different Contexts and Different Languages", that investigated the text construction abilities of schoolchildren and university graduate students in seven different countries (as described in Berman, 1997, 2007, 2008; Berman & Verhoeven, 2002).

4.1.1 Participants

The sample of the study consisted of 30 adult (aged 25–35) native speakers of Palestinian Arabic (17 women and 13 men), who reside in Kufur Qareʕ in central Israel, an Arabic-speaking non-mixed town. All participants were students at Hebrew-speaking universities or colleges (Arab and Jewish) in Israel.[8] None of the participants was studying the Arabic language or Linguistics.

[8] The participants in our study were monolinguals and code switching to Hebrew was minimal. As the Table below shows, Hebrew words were at most 3.83% with repect to content word types in PA and the ratio of Hebrew words was even lower in MSA, as well as with repect to word types in PA.

	PA	MSA-S	MSA-W			
	Type	Token	Type	Token	Type	Token
Content words	3.83%	1.55%	1.79%	3.11%	0.37%	0.41
Function words	1.89%	0.25%	0.48%	0.16%	0%	0%

4.1.2 Procedure

Participants were shown a silent 5-min movie depicting different scenes of unresolved interpersonal conflicts before each of two elicitation sessions, for example, a fight in school. In the first session, participants were asked to tell a story about interpersonal conflicts in PA (spoken) and in MSA (spoken and written), yielding three narratives. In the second session, they were asked to produce an expository text on conflicts between people, also in PA (spoken) and in MSA (spoken and written), yielding three expository texts. The order of text elicitation was counterbalanced to ensure data is elicited under carefully controlled conditions (Berman & Ravid, 2009) and to allow an examination of similarities and differences between modalities, MSA-S and MSA-W, and varieties, PA and MSA-S.

4.1.3 Coding

Texts were transcribed in broad phonemic transcription using CHILDES (MacWhinney, 2000).[9] All verbs were coded manually according to their pattern, root and semantic class (e.g. inchoative, causative, reciprocal) and transitivity. Coding was perfomed by one of the authors and was examined by another. The analysis excluded auxiliary verbs, which denote aspectual and modality properties and the majority of them are in the *CaCaC* pattern. For the purposes of the current study, verb types constitute verb lemmas, namely unique combinations of root and pattern yielding verbs (see Ravid et al., 2016 for detailed coding of Hebrew verbs). For example, the combination of the root *k-t-b* with the *CaCaC* pattern constitutes one verb type (*katab* 'write'), while the combination of the same root with the *tCa:CaC* pattern constitutes another type (*tka:tab* 'correspond'). Verb tokens were counted as all occurrences of inflected verb forms. Root types constitute different structural skeletons, so that all verbs sharing the same consonantal root are considered one root type.

This coding methodology provides information on (i) the frequency of each pattern by type and token; (ii) the semantic and syntactic features of each pattern and (iii) the pattern(s) typical (and atypical) of each semantic and syntactic function. Semantic classification is modelled after the categories that were used in earlier research on Hebrew, e.g. active, mental, inchoative and reciprocal verbs (see Berman, 1978, 2003; Ravid et al., 2016, and references therein). This classification is based on semantic criteria rather than morphological criteria. Transitive verbs that denote causation of change to somebody or something were classified as causatives, regardless of whether they were derived from a more 'basic' entry. Verbs were classified as inchoative if they denoted a non-volitional event that an argument underwent. Here, we did not consider whether an inchoative verb is derived from a

[9] We would like to express our deep gratitude to Bracha Nir for her assistance in coding the verbs.

transitive verb or is used as the base for the derivation of a causative verb.[10] In a few cases where verbs did not fall into one of the semantic categories, they were coded as 'other'.

4.2 Results

4.2.1 Distrinution of Verbal Patterns

Tables 3 and 4 summarize the distribution of patterns by type and token frequency and percentage out of the total number of patterns in the corpus. The PA results were reported in Laks et al. (2019), and part of the MSA results were reported in Laks and Saiegh-Haddad (2022). Here we present an integration of the results presented in previous studies together with a new set of data in MSA.

As can be seen from Tables 3 and 4 above, *CaCaC* is the most productive pattern in text production in both modalities and varieties, both in type and token. In PA, it constitutes 41% of verb types and 59% of tokens. In spoken MSA, it constitutes 34% of verb types and 50% of tokens, and in written MSA it constitutes 38% of verb types and 51% of tokens. The *CaCaC* pattern is followed in frequency by *CaCCaC* and *tCaCCaC,* which constitute between 12% and 19% of the verb types, respectively, and 7% and 12% of tokens, depending on modality and variety. The remaining patterns are less frequent, and each constitutes less than 10% of the verb types and tokens. In addition, the data in Tables 3 and 4 also shows that *iCCaCC* is not used at all, and *inCaCaC* and *istaCCaC* are very rarely used.

Table 3 Distribution of Arabic verbal patterns by variety and modality in types

Pattern	PA		MSA-S		MSA-W	
	No	%	No	%	No	%
CaCaC	102	41%	84	34%	77	38%
CaCCaC	48	19%	34	14%	24	12%
Ca:CaC	13	5%	21	8%	17	8%
ʔaCCaC	10	4%	12	5%	15	7%
tCaCCaC	29	12%	35	14%	25	12%
tCa:CaC	19	8%	21	8%	15	7%
inCaCaC	5	2%	2	1%	1	0%
iCtaCaC	19	8%	29	12%	28	14%
iCCaCC	0	0%	0	0%	0	0%
istaCCaC	6	2%	10	4%	3	1%
Total	251	100%	248	100%	205	100%

[10] We are aware of the ongoing debate on the classification of verbs as causative and of the different approaches to this question. Since the classification of other types of verbs is based only on their meaning, we thought it would be most consistent to adhere to that classification with respect to causative and inchoative verbs as well.

Table 4 Distribution of Arabic verbal patterns by variety and modality in tokens

Pattern	PA		MSA-S		MSA-W	
	No	%	No	%	No	%
CaCaC	456	59%	327	50%	196	51%
CaCCaC	86	11%	59	9%	29	7%
Ca:CaC	42	5%	56	9%	33	9%
ʔaCCaC	26	3%	24	4%	20	5%
tCaCCaC	71	9%	75	12%	42	11%
tCa:CaC	30	4%	37	6%	19	5%
inCaCaC	7	1%	3	0%	1	0%
iCtaCaC	45	6%	59	9%	42	11%
iCCaCC	0	0%	0	0%	0	0%
istaCCaC	7	1%	12	2%	5	1%
Total	758	100	652	100%	387	100%

Thus, our data shows that *CaCaC* is the most frequent pattern and hosts most basic verbs, both in PA and in MSA, spoken and written (Holes, 1995). This finding from the actual deployment of verbs in Arabic stands in contrast to studies investigating verb innovation (Laks, 2018), which demonstrate that *CaCaC* is hardly ever used in the coinage of new verbs, and that *CaCCaC* and *tCaCCaC* are used almost exclusively for this purpose.

The current data also reveals interesting variety-related differences, wherby some patterns are more typical of one variety than the other. As shown in Table 3, *CaCaC* and *CaCCaC* are more dominanat in PA than in MSA, both spoken and written. MSA texts, in contrast, demonstrate greater variation in the distribution of verbal patterns elaborated here. Finally, The *iCtaCaC* pattern is more frequent in MSA in both modalities than in PA; it constitutes 12% of verbs types in spoken MSA and 14% in written MSA, in comparison to only 8% in PA. Similarly, the *Ca:CaC* pattern constitutes 8% of the verb types in spoken and written MSA, as against 5% in PA. Similar tendencies emerge when verb tokens are considered, as shown in Table 4. As shown in Tables 3 and Table 4, no major differences between MSA-S and MSA-W were found with respect to the distribution of patterns. This shows that variety distinctions are more prominent than modality distinctions.

4.2.2 Semantic Functions Across Patterns

We examined the main semantic functions of the verbs in our corpus and their distribution across the verbal patterns: basic active verbs (*do*, *go*),[11] mental verbs (*remember*, *feel*), causative verbs (*break, destroy*) inchoative verbs (*fall*, *become dirty*), verba dicendi (verbs of utterance) (*say*, *shout*), and reciprocal verbs (*hug*, *fight*).

[11] Motion verbs are classified as active verbs in case they are agentive, e.g., *ra:ħ* ‘go’, or as inchoative verbs in case they denote an event that does not entail volition, e.g. *wiqeʕ* ‘fall’.

Active Verbs

Tables 5 and 6 summarize the distribution of active verbs across patterns by type and token.

In PA, the most typical active verb pattern was *CaCaC*, which made up 56% of the types and 66% of tokens. Active verbs were also common in *CaCCaC*, constituting 17.5% and only 10% of types and tokens, respectively. In contrast, MSA texts displayed greater variation with respect to the distribution of active verbs in other patterns. The *tCaCCaC* pattern made up 10% of the active verb types in both written and spoken MSA. In addition, *iCtaCaC* hosted 10% and 8% of the active verbs types in spoken and written MSA, respectively. In spoken MSA, 13% and 14% of the active verb types and tokens were found in *Ca:CaC*, respectively. Other active verbs were distributed among the other patterns, with a level that ranged between 2% and 7%. Similar tendencies are also found in the distribution of verb tokens. These results mainly reveal variety-related differences. *CaCaC* and *CaCCaC* are typical of active verbs in PA, whereas other patterns, like *tCaCCaC* and *iCtaCaC*, are more typical of active verbs in MSA. In addition, *Ca:CaC* tends more typically to host active verbs in spoken MSA, especially in token count.

Table 5 Distribution of active verbal patterns by variety and modality in types

	PA		MSA-S		MSA-W	
Pattern	No %		No %		No %	
CaCaC	55	56%	30	42%	30	49%
CaCCaC	17	17.5%	6	8%	8	13%
Ca:CaC	6	6%	9	13%	4	7%
ʔaCCaC	3	3%	5	7%	4	7%
tCaCCaC	8	8.5%	7	10%	6	10%
tCa:CaC	3	3%	3	4%	3	5%
iCtaCaC	3	3%	7	10%	5	8%
istaCCaC	3	3%	4	6%	1	2%
Total	98	100	71	100%	61	100%

Table 6 Distribution of active verbal patterns by variety and modality in tokens

	PA		MSA-S		MSA-W	
Pattern	No %		No %		No %	
CaCaC	222	66%	113	59%	73	60%
CaCCaC	35	10%	11	6%	10	8%
Ca:CaC	17	5%	26	14%	10	8%
ʔaCCaC	20	6%	11	6%	5	4%
tCaCCaC	17	5%	10	5%	10	8%
tCa:CaC	3	1%	4	2%	3	2%
iCtaCaC	18	5.5%	11	6%	10	8%
istaCCaC	5	1.5%	5	3%	1	1%
Total	337	100%	191	100%	122	100%

Causative Verbs

Tables 7 and 8 below summarize the distribution of causative verbs across patterns, by type and token.

In PA, the most typical pattern of causative verbs was *CaCCaC*, whose verbs made up 63% of types and 58% of tokens. Causative verbs were also common in *CaCaC*, making up 17% and 23.5% of types and tokens, respectively. 17% of the causative verb types were also found in *ʔaCCaC*, but they made up only 13% of tokens. In contrast, MSA texts, and especially written MSA, demonstrated greater variation with respect to the distribution of causative verbs in other patterns. *CaCCaC* hosted 48% of the causative verb types in spoken MSA and only 29% in written MSA. In spoken MSA, 30% of the causative verb types were in *CaCaC*, while in written MSA there was even greater variation between *ʔaCCaC* (38%) and *CaCaC* (24%). Similar tendencies were also found with respect to tokens, as shown in Table 8. We demonsrate such variety-related differences below with respect to the expression of causativity. As shown in (1), the same participant used the root *f-h-m* 'understand' in two different patterns to denote the causative verb 'make understand', using *CaCCaC* in PA but *aCCaC* in MSA.

(1) a. **PA**: u-**fahhamtoh** inno: ha:ðˤa il-iʃi ɣalatˤ
'I made him understand that thing is wrong'
b. **MSA-S**: fa-**ʔafhamtuhu** wijhat naðˤari:
'I made him understand my point of view'
c. **MSA-W**: wa-**ʔafhamtuhu** wijhat naðˤari:
'I made him understand my point of view'

Table 7 Distribution of causative verbal patterns by variety and modality in types

Pattern	PA		MSA-S		MSA-W	
	No	%	No	%	No	%
CaCaC	5	17%	8	30%	5	24%
CaCCaC	19	63%	13	48%	6	29%
Ca:CaC	1	3%	1	4%	1	5%
ʔaCCaC	5	17%	5	19%	8	38%
tCaCCaC	0	0%	0	0%	1	5%
Total	30	100%	27	100%	21	100%

Table 8 Distribution of causative verbal patterns by variety and modality in tokens

Pattern	PA		MSA-S		MSA-W	
	No	%	No	%	No	%
CaCaC	13	23.5%	12	29%	6	21%
CaCCaC	32	58%	16	38%	8	29%
Ca:CaC	3	5.5%	4	10%	3	11%
ʔaCCaC	7	13%	10	24%	10	36%
tCaCCaC	0	0%	0	0%	1	4%
Total	55	100%	42	100%	28	100%

Mental Verbs

Mental verbs refer to a group of verbs that express the cognitive, affective and perceptive processes. Mental verbs can be found in various verbal patterns. Tables 9 and 10 summarize the distribution of mental verbs across the different patterns.

Table 9 shows that most mental verbs surfaced in *CaCaC* in both modalities and varities. This basic pattern hosted 43% of the verb types in PA, 39% in spoken MSA and 46% in written MSA. The second most typical pattern of mental verbs used in PA was *tCaCCaC*, whose verbs made up 22% of types and 20% of tokens. In contrast, this pattern was less frequent in MSA, where mental verbs in this pattern constitued 8% and 13% of verb types in spoken and written texts, respectively. Similarly, *tCaCCaC* mental verbs constitued 9% and 10% of verb tokens in spoken and in written MSA, respectively. Some *Ca:CaC* mental verbs surfaced in MSA, 11% of the verb types in spoken MSA texts and 15% in written MSA texts, in contrast with no such occurrences in PA. A few mental verbs also surfaced in *istaCCaC* in MSA, constituting 8% of the verb types in spoken MSA texts and 5% in written MSA texts, in contrast to no such occurrences in PA. Mental verbs were common in *CaCCaC* in the spoken modality. *CaCCaC* mental verbs acoounted for 16% and 17% of the verb types is PA and spoken MSA, respectively, in contrast to only 5% in written MSA. Similar tendencies were also found with regard to tokens as shown in Table 10.

Table 9 Distribution of mental verbal patterns by variety and modality in types

Pattern	PA No %		MSA-S No %		MSA-W No %	
CaCaC	16	43%	14	39%	18	46%
CaCCaC	6	16%	6	17%	2	5%
Ca:CaC	0	0%	4	11%	6	15%
tCaCCaC	8	22%	3	8%	5	13%
tCa:CaC	0	0%	1	3%	0	0
iCtaCaC	7	19%	5	14%	6	15%
istaCCaC	0	0%	3	8%	2	5%
Total	37	100%	36	100%	39	100%

Table 10 Distribution of mental verbal patterns by variety and modality in tokens

	PA		MSA-S		MSA-W	
Pattern	No %		No %		No %	
CaCaC	68	57%	60	58%	45	58%
CaCCaC	13	11%	15	15%	3	4%
Ca:CaC	0	0%	7	7%	11	14%
tCaCCaC	24	20%	9	9%	8	10%
tCa:CaC	0	0	1	1%	0	0
iCtaCaC	14	12%	8	8%	7	9%
istaCCaC	0	0%	3	3%	4	5%
Total	119	100	103	100%	42	100%

Verba Dicendi

Verba dicendi refers to all words that express speech or introduce particular quotations, e.g. to tell, and so they convey verbal content to an addressee.

Tables 11 and 12 below summarize the distribution of verba dicendi across patterns with respect to verb types and tokens.

In PA, the typical pattern of verba dicendi was *CaCaC,* making up 55% of types, compared to just 36% and 46% in spoken and in written MSA, respectively. In contrast, MSA texts showed greater variation with respect to the distribution of verba dicendi across the other patterns. In spoken MSA, the *CaCCaC* pattern demonstrated a higher occurence of 21% of the all verb types, in comparison with just 5% and 14% in PA and in written MSA, respectively. In written MSA, the *istaCCaC* pattern was more frequent, with 17% of verb types, compared to 5% in PA and no single occurrence in spoken MSA. Variety-related differences were more dominant with respect to tokens, as shown in Table 12. Ninety-two percent of the verb tokens were in *CaCaC* is PA, in contrast to only 59% and 56% is spoken and written MSA, respectively.

Table 11 Distribution of verba dicendi verbal patterns by variety and modality in types

	PA		MSA-S		MSA-W	
Pattern	No %		No %		No %	
CaCaC	11	55%	12	36%	15	43%
CaCCaC	1	5%	7	21%	5	14%
ʔaCCaC	2	10%	2	6%	1	3%
tCaCCaC	1	5%	7	21%	3	9%
iCtaCaC	4	20%	5	15%	5	14%
istaCCaC	1	5%	0	0%	6	17%
Total	20	100%	33	100%	35	100%

Table 12 Distribution of verba dicendi verbal patterns by variety and modality in tokens

	PA		MSA-S		MSA-W	
Pattern	No %		No %		No %	
CaCaC	118	92%	84	59%	40	56%
CaCCaC	1	1%	13	9%	5	7%
ʔaCCaC	2	1%	3	2%	1	1%
tCaCCaC	1	1%	29	9%	5	7%
iCtaCaC	5	4%	13	9%	13	18%
istaCCaC	1	1%	0	0%	8	11%
Total	128	100%	142	100%	72	100%

Inchoative Verbs

Tables 13 and 14 below summarize the distribution of inchoative verbs across patterns according to type and token.

Table 13 shows that *CaCaC* is the most productive inchoative verb pattern, followed by *tCaCCaC*, whereas the other patterns are relatively rarely used for this semantic function. The distribution of inchoative verbs demonstrates both variety and modality-related differences. *CaCaC* is far less productive in hosting inchoative verbs in PA, whereby only 28% of inchoative verb types surface in this pattern in PA, in comparison with 44% in spoken MSA and 58% in written MSA. This difference is even greater when tokens are considered, where *CaCaC* inchoative verbs constitute 33% in PA, 56% in spoken MSA and 70% in written MSA. *CaCaC* is a far more productive form of inchoative verbs in written MSA than in PA, with spoken MSA falling in between. The distribution of inchoative verbs in *tCaCCaC* demonstrates modality-related differences. *tCaCCaC* inchoative verbs make up 21% of all verb types in PA, 26% in spoken MSA and only 11% in written MSA. The low productivity of *tCaCCaC* inchoative verbs in written MSA is even more prominent in terms of tokens, where only 5% of the verb tokens surface in *tCaCCaC*, in

Table 13 Distribution of inchoative verb patterns by variety and modality in types

	PA		MSA-S		MSA-W	
Pattern	No %		No %		No %	
CaCaC	8	28%	15	44%	11	58%
CaCCaC	3	10.33%	0	0%	0	0%
tCaCCaC	6	21%	9	26%	2	11%
tCa:CaC	3	10.33%	3	9%	1	5%
inCaCaC	5	17%	2	6%	1	5%
iCtaCaC	3	10.33%	3	9%	4	21%
istaCCaC	1	3%	2	6%	0	0%
Total	29	100%	34	100%	19	100%

Table 14 Distribution of inchoative verb patterns by variety and modality in tokens

	PA		MSA-S		MSA-W	
Patterns	No %		No %		No %	
CaCaC	15	33%	43	56%	28	70%
CaCCaC	3	6.5%	0	0%	0	0%
tCaCCaC	12	26%	11	14%	2	5%
tCa:CaC	3	6.5%	9	12%	3	8%
inCaCaC	7	15%	3	4%	1	3%
iCtaCaC	5	11%	8	10%	6	15%
istaCCaC	1	2%	3	4%	0	0%
Total	46	100%	77	100%	40	100%

contrast with 14% in spoken MSA and 26% in PA. The distribution of inchoative verbs in *inCaCaC* demonstrates variety-related differences. As we showed, *inCaCaC* is generally more common in PA than in MSA, and here this is manifested with respect to the expression of inchoativity. 17% of inchoative verb types and 15% of tokens surface in *inCaCaC* in PA, in comparison to 6% and 4% in spoken MSA, and 5% and 3% in written MSA. PA demonstrates greater variation with respect to the distribution of inchoative verbs within patterns. 10.33% of inchoative verb types surface in *CaCCaC* in PA, while this pattern does not host such verbs in either spoken or written MSA. A few inchoative verbs surface in *istaCCaC* in PA or spoken MSA (3% and 6% of verb types, respectively), in contrast with no such occurrences in written MSA.

Reciprocal Verbs

Tables 15 and 16 below summarize the distribution of reciprocal verbs across patterns, according to type and token.

Table 15 shows that most reciprocal verbs surface in the *tCa:CaC* pattern, regardless of variety or modality distinctions. *tCa:CaC* verbs constitute 83% of reciprocal verb types in PA, 68% in spoken MSA and 90% in written MSA. Only 1–4 reciprocal verb types surface in *iCtaCaC*, or 10–27% of all reciprocal verb types. A similar tendncy is observed in tokens, though to a lesser extent, where reciprocal verbs in *iCtaCaC* constitute between 27% and 32% of verb tokens. Spoken MSA demonstrates greater variation with more verb types and tokens in *iCtaCaC* in comparison with PA or with written MSA.

Table 15 Distribution of reciprocal verb patterns by variety and modality in types

	PA		MSA-S		MSA-W	
Pattern	No %		No %		No %	
tCa:CaC	10	83%	11	73%	9	90%
iCtaCaC	2	17%	4	27%	1	10%
Total	12	100%	15	%	10	100%

Table 16 Distribution of reciprocal verb patterns by variety and modality in tokens

	PA		MSA-S		MSA-W	
Pattern	No %		No %		No %	
tCa:CaC	13	72%	15	68%	11	73%
iCtaCaC	5	28%	7	32%	4	27%
Total	18	100%	22	100%	15	100%

Table 17 Distribution of root related verbs by variety and modality in types

Pattern	PA		MSA-S		MSA-W	
	No	%	No	%	No	%
One pattern	169	83%	144	76%	143	83%
Two patterns	28	13.5%	37	19%	26	15%
Three paterns	6	3%	6	3%	2	1%
Four patterns	1	0.5%	2	1%	1	1%
Total	204	100%	189	100%	172	100%

4.2.3 Root-Related Verbs

We now turn to examining relations between verbs that share the same consonantal root. Table 17 presents the distribution of roots with respect to the number of patterns in which they surface in our data.

As can be seen in Table 17, the instances in which two or more verbs shared the same consonantal root and were formed in different patterns were relatively rare in all varieties and modalities. The great majority of all verb types (83%) surfaced in just one pattern both in PA and in written MSA, in comparison with 76% in spoken MSA; Spoken MSA demonstrated greater variation in this respect. Out of the roots that surfaced in more than one pattern, the majority surfaced in 2 patterns, 13.5% in PA, 19% in spoken MSA and 15% in written MSA. Roots that surfaced in more than two patterns were exteremely rare in all text types as well, constituiting between 0.5% and 3% of all roots types.

Of the verb roots with more than one pattern, 80% (28/35) were semantically related in PA, 82% (37/45) in spoken MSA, and 93% (27/29) in written MSA. These semantic relations were manifested mostly in transitivity alternations like causative/inchoative, e.g. *ʔaθθ*ar 'affect' – *tʔaθθ*ar 'get affected' and *ʔanha 'end X' – intaha 'end'*, and transitive-active/reciprocal, e.g. *dˤarab* 'hit' – *tadˤa:rab* 'hit each other'. Cases of verb roots hosted in more than one pattern, yet with no semantic relation, were relatively rare in all varieties and modalities, especially in written MSA. For example, in PA the root *s-b-b* was used in *CaCaC*, denoting 'curse', and in *CaCCaC*, denoting 'cause', and in written MSA the root *ħ-d-θ* was used in *CaCaC*, denoting 'happen', and in *tCaCCaC*, denoting 'speak with'.

5 Discussion

While most studies of the Arabic verbal sysem and their morpho-phonological and semantic-syntactic properties have focused on MSA (e.g., Benmamoun, 2003; Henkin, 2009; Holes, 1995; Younes, 2000), this study examined the deployment of verbal patterns as they are used in narrative text production among adult native speakers. The study compares the use of verbal patterns in light of Arabic diglossia by comparingthe two Arabic varieties: Spoken or Colloquial Arabic versus MSA, as well as in the two modalities of MSA: spoken MSA versus written MSA.

Linguistic proficiency in Arabic diglossia entails proficiency in the use of Spoken Arabic for everyday speech and MSA for formal speech and writing. Hence, mastery of the verbal system of Arabic means mastery of these systems as they are used in the two varieties and this includes mastery of a wide range of morpho-phonological and semantic-syntactic knowlege: (i) the inflectional paradigm of each pattern; (ii) the semantic-syntactic features of each pattern; and (iii) the derivational relations (if any) between the different patterns. Thus, examining how verbs are deployed in actual text production in this morphologically rich context can shed light on various aspects of speakers'linguistic knowledge as well as on the structure and content of the Arabic mental lexicon. Variety-related and modality-related differences in the deployment of verbal patterns and their semantic and syntactic features can serve as a window on variety- and modality-based distinctions in actual language use in general.

The study examined the distribution of verbal patterns and their semantic properties as they are realized in narrative text production, and the extent to which pattern deployment is sensitive to variety (PA versus MSA: written and spoken) and to modality (PA and spoken MSA versus written MSA). The results from our corpusof 90 texts produced by 30 adult Arabic speakersin three conditions: PA, MSA-spoken and MSA-written (30 texts per condition), reveal some interesting differences in the distribution of some patterns by variety and modality. Before we discuss these results, one finding is noteworthy and this consititutes in the observation that in the Arabic verbal system consisting nine potentially active patterns, only three, *CaCaC*, *CaCCaC* and *tCaCCaC*, are relied upon in actual text production, and *CaCaC* is the most dominant among them.

The results showed that the most frequent pattern in use in the data is *CaCaC*. This pattern is considered in the literature as the most basic pattern of verbs hosting the basic Arabic vocabulary items in the language (e.g., Holes, 1995; Watson, 2002). This pattern is also described in the literature as not carrying specific semantic functions and as neutral with respect to transitivity, as it hosts both transitive and intransitive verbs of all types. In accordance with this finding, the results from our corpus show that *CaCaC* hosts a variety of verb types. As such, except for reciprocal and reflexive functions, there was no semantic function that could not be represented in *CaCaC*. Hence, the picture that emerges from the behavior of this pattern in actual text production is that *CaCaC* functions as the most basic linguistic device in narrative text production by adult native speakers.

The frequent usage of *CaCaC* verbs in text production in PA stands in sharp contradiction with the productivity of this pattern in the formation of new verbs in this same variety. For instance, Laks (2018) showed that out of the ten PA verbal patterns, only two were highly active in the formation of new verbs: *CaCCaC* and *tCaCCaC,* but not *CaCaC*. In this study, 163 examples of new verbs were collected that are based mostly on loanwords and on existing PA nouns and adjectives.[12] For

[12] The main collection method relied on volunteer native speakers who documented the use of new verbs in their environments. Other data was based on online searches. Some of the new verbs collected in one of these ways came into regular use, while others are examples of a single occurrence. Importantly, both types show the same criteria in pattern selection, namely verbs were formed in *CaCCaC* and *tCaCCaC*.

example, the verb *massaj* ‘sent a text message’ is formed in *CaCCaC* based on the English word *message*, and the reflexive verb *tmakyaj* ‘put makeup on’ is formed in *tCaCCaC* based on the French word *maquillage*. The study showed that **116** verbs (71%) were formed in *CaCCaC* and 39 (24%) in *tCaCCaC*. Only 7 verbs (4%) were formed in *CaCaC* and one verb (<1%) in *inCaCaC*. New verb formation in *CaCaC* happened only in rare cases of phonological similarity between the base and the derived verb. The low productivity of *CaCaC* in verb innovation, as against *CaCCaC* and *tCaCCaC,* is explained by a morpho-phonological constraint (Laks, 2018). *CaCaC* verbs demonstrate prosodic alternations throughout their inflectional paradigms, as in syllabic structure alternations in different tense forms (e.g. *ka.tab* ‘he wrote’ – *yuk.tu*b ‘he will write/ he writes (imperfective form)’). In contrast, the syllabic structure of other patterns remains intact throughout the inflectional paradigm (e.g. *naf.faz* ‘he committed’ – *ye.naf.fez* ‘he will commit/he commits’). This is a constraint on derivation reducing the degree of productivity in novel word formation from *CaCaC* as against *CaCCaC* or *tCaCCaC*. In addition, *CaCCaC* and *tCaCCaC* are the only patterns that can host verbs with more than three stem consonants (e.g. *kahrab* ‘electrify’, *tkahrab* ‘get electrified’, both derived from the noun *kahraba* ‘electricity’) as they entail a geminate consonant. Altogether, these properties might explain why *CaCCaC* and *tCaCCaC* take over as the patterns that are used for the formation of new verbs, while *CaCaC* verbs remain a closed set of basic vocabulary items that surface heavily in actual language production. Interestingly, similar results were reported for Hebrew. In Hebrew, only 2 patterns (*CiCeC* and *hitCaCeC*)[13] were found to be highly active in the formation of news verbs (see Bat-El, 1994, 2017, 2019; Berman, 1978, 1993; Bolozky, 1978, 1999, 2005; Ravid, 1990, 2003, 2004; Schwarzwald, 1981, 1996, 2008; Ussishkin, 1999; among others)[14]; whereas *CaCaC* is the pattern that is predominant in actual language production.

The current study also showed that *tCaCCaC* and *CaCCaC* were the second most frequent patterns in actual use. These two patterns are also far more frequent than the remaining patterns observed in our corpus in both varieties and modalities, and this aligns with their status as the most productive patterns in the formation of new verbs.

To sum up, the picture that emerges from the examination of verb distribution in PA and MSA narrative texts, is that one verbal pattern (*CaCaC*) hosts the majority of basic and common verbs in the language and is used for most semantic functions. This predominant pattern is followed in frequency of use by two additional patterns: *CaCCaC* and *tCaCCaC,* which have also been shown to be productive in verb

[13] Note that Modern Hebrew *CiCeC* is a descendant of earlier Biblical Hebrew *CiCCeC*, the equivalent of Arabic *CaCCaC*, with a geminate consonant which disappeared from Modern Hebrew verbs. Similarly, Hebrew *hitCaCeC* is the equivalent of Arabic *tCaCCaC* with rather similar syntactic and semantic properties.

[14] Hebrew *hiCCiC* pattern is also used for the formation of verbs in cases where the base begins with a consonant cluster. The formation of *hiCCiC* is more faithful to the base (Bolozky, 1978, 1999, 2005).

innovation (Laks, 2018). The remaining patterns are far less frequent, and some are hardly used at all. As observed in Laks et al. (2019), this reveals a sharp contrast between (i) the existing morphologically rich system that theoretically allows the realization of any consonantal root in any pattern, yielding a variety of verb types; and (ii) a much smaller system of verb types that is actually realized in a restricted number of patterns. This contrast between the potential of the verbal pattern system in generating verbs, and its actual realization both in spoken and written text production and in the formation of new verbs, has important implications for the psycholinguistics of verbal patterns in acquisition and processing (Tallas et al., submitted).

With resect to semantic functions, our study shows that most of the semantic functions of verbs are realized in 1–3 patterns in both modalities and varieties, especially in *CaCaC*, with the exception of reciprocal verbs. The lack of transparent form-function relations between patterns within the verbal systems of both PA and MSA is also manifested in the fact that in the majority of cases, verbs consisted mostly of single roots hosted in single patterns. Less than a quarter of the roots surfaced in more than one pattern, and mostly in just two patterns in both varities and modalities (see Laks et al., 2019 for a detailed discussion of PA roots). Similar results were reported in Ravid et al. (2016) for Hebrew in a corpus of parental input. This stands in contrast to the way the verbal patterns are described in the literature (see for example, Holes, 1995; Ryding, 2005), where the root is perceived as an essential element that relates verbs and where the formation of the same root in different patterns represents predictable semantic relations.

In addition to investigating the general distribution of patterns and their semantic fucntions, the study also addressed variety-related differences in actual use of the different patterns. The results revealed that the distribution of verbal patterns can serve as a diagnostic tool differentiating between the two major varieties of Arabic: PA and MSA. In general, MSA texts: both spoken and written demonstrated greater variation in the distribution of verbal patterns than PA. Also, *CaCaC* was generally more frequent in PA than in MSA, while *Ca:CaC* and *iCtaCaC* were more frequent in MSA than in PA.

Variety-related differences in the distribution of verbal patterns were also reflected in the distribution of semantic functions across patterns. One of the most dominant variety-related difference was in the distribution of verba discendi. In PA, 70% of the verba discendi types surfaced in *CaCaC*, in comparison to just 36% and 43% in spoken and written MSA, respectively. This finding was even more prominent with respect to tokens, where 96% of verba discendi surfaced in *CaCaC,* in comparison with 59% and 56% in spoken and written MSA, respectively. Verba discendi in MSA surfaced in a greater variety of patterns, and primarily in *CaCCaC*, *tCaCCaC* and *iCtaCaC*.

With respect to mental verbs, *CaCaC* was found to host most of them across all text types, but PA demonstrated a greater use of mental verbs in *tCaCCaC* in contrast with a greater use of *iCtaCaC* and *istaCCaC* mental verbs in MSA.

The distribution of causative verbs revealed greater variation in MSA. In PA, *CaCCaC* causative verbs were more common than in MSA, both in types and tokens. MSA demonstrated greater deployment of *CaCaC* and *aCCaC* verbs.

Inchoative verbs also demonstrated variety related differences. PA inchoative verbs demonstrated greater variation, with a distribution of 26% of verb types in CaCaC, 21% in *taCaCCaC*, 18% in *inCaCaC* and the rest with lower percentages among other patterns. In MSA, in contrast, the majority of inchoative verb types surfaced in *CaCaC*, 44% in spoken texts and 58% in written texts. The function of inchoativeness showed a stronger relation to one pattern in MSA, namely *CaCaC*.

To conclude, most semantic functions were found to be primarily represented in *CaCaC* verbs, but the extent to which they were represented in this pattern in comparison to other patterns differed between PA and MSA. Except for inchoative verbs, MSA generally demonstrated greater variation in the distribution of semantic functions across patterns, as most semantic functions could be expressed in a greater variety of patterns.

With respect to modality-related differences, the results reveal less variation than variety-related differences. In most cases, the distribution of verbal patterns across semantic functions in spoken MSA was more similar to written MSA than to PA. However, there were cases where spoken MSA showed greater resemblace to PA as spoken modalities. Mental verbs were more frequent in *CaCaC* in the written modality; they constituted 46% of verb types in written MSA, in comparison to 39% in spoken MSA and 37% in PA. *CaCCaC* mental verbs, in contrast, were more common in the spoken modality, especially in spoken MSA (17%) and in PA (14%), in comparison to only 5% of the verb types in written MSA.

The results above imply a possibly special status of spoken MSA, as an intermediary category between PA and written MSA, sharing modality features of distribution with the former and variety features with the latter. This, for instance, was demonstrated in the distribution of mental verbs which were more frequent in *CaCCaC* in both PA and spoken MSA than in written MSA. The distribution of inchoative verbs also demonstrated some modality realted differences, whereby *tCaCCaC* verbs were more frequent in PA and spoken MSA than in written MSA. Finally, 42% of all active verb types surfaced in *CaCaC* in spoken MSA in contrast to 54% in PA and 49% in written MSA. In the same way, *Ca:CaC* active verbs were more frequent in spoken MSA, constituting 13% of the verb types, in contrast to 8% in PA and 7% in written MSA. Similar tendencies were observed in token counts.

To sum up, the results reported in this chapter shed light on variety and modality differences in the distribution of verbal patterns in text production in PA and in MSA. These differences can be used as diagnostic measures of the differences between Arabic modalities and varieties. Further studies should examine other grammatical aspects, e.g. the distribution of nominal and adjectival patterns, in order to see if they also reflect such variey and/or modality-related differences. The most noticable morphological differences were found between varieties rather than between modalities, reflecting the remarkable disparity in language deployment between the two varieties of Arabic. In other words, based on the deployment of verbal patterns and on their semantic properties, the results indicate that spoken MSA and written MSA pattern more closely together as one variety, different from PA. At the same time, morphological differences are more prominent when PA is compared with written MSA, yet spoken MSA appears, at least on some of the features, to pattern in between the other two.

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Promoting Mother-Child Shared Book-Reading Interactions: The Direct and Delayed Effects of Different Dyadic Interventions

Dorit Aram and Iris Levin

Abstract This study analyzes how training in dyadic activities affected the quality of Shared Book Reading (SBR) amongst mothers of preschool children from low socioeconomic status (SES). Each mother experienced one of three interventions. All interventions guided mothers in principles of mediating children's learning in one dyadic activity: SBR, word writing, or visuo-motor skills. The mother-child activities took place 3 times a week for 7 weeks. A group with no intervention served as a control. The quality of interactive reading improved substantially from pretest to immediate and to delayed posttest, 2.5 months later, in the SBR group. Improvement was exhibited in the number of mother- and child-initiated dialogues, number of dialogues with scaffolds, elaborations, praise, and criticism, and in all types of prompts. No effect of the intervention on interactive reading emerged in any other groups, revealing no transfer of training mothers in general principles of mediated learning to SBR with their child.

Keywords Low socioeconomic status · Preschool children · Parent-child interaction · Interactive shared book reading · Early literacy · Literacy intervention · Home literacy activities · Home literacy

In this study, as in many other ones, we examine literacy interactions in Hebrew. One of the leading researchers in the world in researching Hebrew and Hebrew language development is Prof. Dorit Ravid. The way that she looks at the richness of the Hebrew language and how she describes its components serves as an impetus for us in our research of parent-child interactions that relate to language, such as Shared Book Reading (SBR).

Research provides ample evidence that home literacy activities are related to children's early literacy and predicts later reading and writing acquisition in school (Aram & Levin, 2004; Burgess et al., 2002; Mol & Bus, 2011; Sénéchal, 2006).

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Amongst the different home literacy activities, reading storybooks to children emerges as the prominent and most thoroughly studied activity that characterizes a literate home (Bus, 2002).

1 Style of Storybook Reading

Children exposed to frequent storybook reading consistently surpass their counterparts on vocabulary, and in some reports on alphabetic skills as well (e.g., Aram & Levin, 2002; Mol et al., 2009; National Early Literacy Panel, 2008; Noble et al., 2019). However, the contribution of storybook reading to children's vocabulary depends on reading style. In a meta-analysis, based on 16 selected studies that included 626 children, interactive reading (engaging children in discourse surrounding the text) was found to enhance children's progress more than regular reading (Mol et al., 2008).

Many parents simply read the text, rarely attempting to involve the children in discourse. Various causes may underlie the prevalence of this ineffective practice. Parents may be unaware of their children's limited vocabulary and partial understanding of story grammar. Therefore, they may not realize that children need their parents to facilitate understanding through interactive reading. Parents may also have limited skills for involving children in discourse: they do not allow their children enough time to process the questions and form their replies, may not be inclined to scaffold children's insufficient responses and would rather provide the required response, or tend not to elaborate on children's responses. Finally, many parents commonly read at bedtime when they or the children are too tired, consequently adopting a non-interactive style.

2 Home Based Shared Book Reading Interventions

Studies that have demonstrated that children's vocabulary was enhanced because parents were trained in interactive reading relied on the assumptions that (1) mothers learned to read interactively due to the training, (2) thereafter, mothers applied interactive reading consistently in reading to their children, and (3) that their children became more verbally active during the reading session. However, few studies have analyzed the changes that occurred in mother-child verbal exchanges during reading following such training. In the few studies that have addressed this issue, trained mothers were asked to read storybooks interactively several times a week for four to 12 weeks (across studies). Reading sessions at pretest and posttest(s) were videotaped or audiotaped, and the frequencies of maternal use of strategies supporting or reducing dialogue were assessed. Results showed that, in general, strategies supporting dialogue increased (e.g., Aram et al., 2013; Blom-Hoffman et al., 2006; Briesch, et al., 2008; Huebner, 2000; Huebner & Meltzoff, 2005; Whitehurst et al., 1988), whereas strategies reducing dialogue decreased (Huebner, 2000; Huebner & Meltzoff, 2005) from pretest to immediate posttest. In delayed posttest, about 2.5 to 6 months later, the frequency of dialogic strategies slightly decreased but often did not differ from its heightened level at the immediate posttest (Blom-Hoffman et al., 2006; Briesch et al., 2008; Huebner & Meltzoff, 2005).

These promising results should be taken with some reservation, as a closer examination of the *specific strategies* used by mothers showed that the impact of training did not increase all dialogic strategies, and that increasing strategies varied across studies. In particular, *open-ended questions, evaluations, expansions,* and *praise* increased, whereas *repetition* and *recall* (e.g., "do you remember that ….") did not change. Other strategies, such as *distancing* (e.g., connecting events in the story to the child's life) increased, decreased, or remained unchanged across studies (Blom-Hoffman et al., 2007; Briesch et al., 2008; Crain-Thoreson & Dale, 1999; Whitehurst et al., 1988).

The aforementioned studies of interactive reading training included 2–4-year-old children, recruited from middle or mixed/undefined socioeconomic status (SES). In their meta-analysis, Mol et al. (2008) found that the contribution of interactive reading to children's vocabulary was strong for children recruited from middle to high SES but not from low SES. Moreover, the contribution of interactive vs. regular reading decreased with the child's age. Mol and her colleagues suggest that mothers with low education may not be able to carry out interactive reading at the required level, or that their children may find it difficult to respond to open-ended questions or to questions that require inferencing.

Interestingly, in a more recent meta-analysis, Dowdall et al. (2020) found that SBR interventions had a large effect on caregiver book-sharing competence. Child's age and caregiver's education level were unrelated to child outcome. Yet, the impact of the intervention on child language was moderated by intervention dosage, with lower dosage associated with a minimal impact.

Our current study focused on dyads recruited from low SES families, with 5–6-year-old children. In comparative international studies on reading comprehension among primary and secondary students from 35 to 41 countries, the achievement gap between different social strata in Israel was wide relative to other countries (Chiu & McBride-Chang, 2006; Olstein & Zuzovsky, 2004). Consequently, promoting literacy activities in socially disadvantaged Israeli families is a prominent educational goal. Children aged 5–6 are about to start their studies within a year. We assumed that their parents would be interested in advancing their children's early literacy skills and thus our shared book reading intervention included prompts that focus on school literacy skills.

2.1 Prompts Used in SBR Interventions

Studies examining the effects of SBR interventions on mother-child verbal exchange during reading have focused on strategies promoting dialogue that primarily refers to the story and illustrations, facilitating story comprehension. In the current study, in addition to these prompts, we added two new types of prompts to the dialogues: alphabetic skills and story grammar. These components were chosen because they support the two elements of reading – decoding and comprehension. Reference to print was aimed at promoting the alphabetic skills that provide the infrastructure for decoding (Ehri et al., 2001), whereas analyzing stories in terms of their story grammar was believed to enhance the inferencing required for reading comprehension (van Kleeck, 2008).

We assumed that prompts alerting the children to the print, that is, evoking discussion of letters, sounds, and printed words, would be useful for our cohort of children, who would soon start formally attending school. The prompts on story grammar involved identifying the protagonist, the problem(s) s/he copes with, the solution(s) attempted and reached, and the lesson to be drawn from the story (Trabasso & Wiley, 2005). We assumed that in addition to the regular prompts that relate to particular parts of the story, evocation of the story grammar upon completion of story reading might deepen the child's understanding of the story as a cohesive, large unit of text.

3 Transfer in Learning

We examined whether interactive reading can be promoted only by a specific SBR intervention or whether mothers exposed to the general principles of beneficial mediated learning and who have been trained in other domains (e.g., joint-writing) can transfer these skills to interactive reading.

Mediated learning in this context includes encouragement of active participation on the part of the child, scaffolding at a challenging but not frustrating level, sensitivity to his/her competence and perspective, and assistance in alerting the child to his/her metacognitive processes (see Kozulin, 2002).

This kind of transfer (i.e., learning principles in one domain and applying them to another) requires learning abstract principles and applying them mindfully to a new context (Haskell, 2000). The present study might reveal that mothers who were exposed to principles of high-level mediation, and who practiced them in mediating writing or visuo-motor skills, could apply these principles to storybook reading. If such transfer occurred, it would indicate a high-level learning of mediation principles (Kozulin, 2002).

In the current study, participating mothers were divided into four groups: SBR intervention, writing intervention, visuo-motor intervention, and a control group. The three Intervention groups were instructed on the same beneficial mediated learning principles (Kozulin, 2002), which were applied thereafter to a different dyadic parent-child activity (SBR, joint writing and visuo-motor activities). We chose these activities because promoting children's skills in these areas has been found to contribute to early schooling (Aram & Levin, 2004; Ratzon, et al., 2007). By using two groups of mothers guided in mediated learning in two different domains – writing and visuo-motor skills, the former more related to literacy than the latter – we could derive a stronger conclusion concerning transfer to interactive reading from such guidance. In the third control group, mothers were not involved in any intervention.

Questions of the Current Study

1. To what extent does training mothers to read interactively increase their interactive reading, as measured at immediate and delayed posttest?
2. To what extent does training mothers to read interactively increase their children's initiation of participation during reading, as measured at immediate and delayed posttest?
3. To what extent does training in mediated learning practices applied to writing or visuo-motor skills transfer to interactive storybook reading?
4. To what extent do maternal pretest reading behaviors, intervention group, child's age, and SES predict maternal interactive reading behaviors following the training?

4 Method

4.1 *Participants*

Participants were 127 mother-child dyads recruited from low SES neighborhoods in the Tel Aviv metropolitan area. Both mothers and fathers were invited to participate, but 122 mothers and only five fathers participated in the study. Therefore, we refer to the caregivers as mothers.

Children's mean age at the pretest was 5;50 (years and months) ($SD = 0.35$ months). Their mothers' and fathers' mean ages were 33;60 (SD = 5;60) and 36;60 years (SD = 5;60), respectively. Parental education, measured on a 5-point scale: 1 – Less than 12 years; 2 – Professional high school education; 3 – Academic high-school education; 4 – Post high school academic education; 5 – Bachelor's degree. The parents' education ranged from not finishing high school (9% of mothers and 26% of fathers) to graduating from college/university (10% of mothers and 6% of fathers). This education level is low by Israeli standards, where 43% of the population graduates from college or university (OECD, 2013). The families in the study lived in high-density apartments ($M = 1.3$ number of persons per room) relative to the Israeli standard ($M = 0.84$) (Israel Bureau of Statistics, 2021). The four groups (reading, writing, visuo-motor, and control) were statistically indistinguishable on all demographic parameters.

The assignment of mothers to the three intervention groups was done in the following way. First, mothers were invited to participate in an 8-week intervention aiming to promote school readiness. The mothers were notified that the intervention would begin with a 3-h workshop that would take place on one evening. Six workshops were randomly assigned to the three intervention groups – SBR, joint- writing, or visuo-motor activities. The mothers chose one of six proposed dates to participate in the workshop without being informed that the workshops differed by content. They were videotaped before the workshop and the intervention, immediately after the intervention and 3 months later. As to the control group, mothers were similarly invited to participate in an intervention aiming to promote school readiness. The control group was videotaped three times in parallel with the intervention groups. After the third time the mothers attended the workshop on school readiness.

4.2 The Intervention Programs

Each intervention started with its own 3-h workshop held one evening in a local recreational club, attended by 15–20 mothers each. There were several workshops for each intervention. The three workshops shared the same structure and referred to the following topics in a fixed order, including eight steps: (1) We first discussed the role of school readiness and maternal contribution in this arena. (2) Next, we presented the principles underlying high quality mediation. These principles included the importance of mother-child dialogue and of maternal sensitivity to the child's perspective, attention span, and Zone of Proximal Development. We clarified the importance of helping the child become aware of the meta-cognitive processes that s/he was undergoing and of indicating to the child the progress that s/he has been making in solving the problem. We stressed that guidance should be given when the child needed it and was ready to accept it, and that scaffolding should be at a challenging but not frustrating level. Up to this point, the three workshops were practically the same. (3) We discussed the development and significance of success in schooling for the specific target domain (storybook reading, alphabetic skills, and fine visuo-motor skills). (4) The mothers were divided into small groups to discuss their children's performance, home practice, and maternal mediation in the target domain. (5) A 10-min film screening then introduced mothers to short mediation scenes illustrating principles of high-quality mediation specific to the target domain. (6) We next specified mothers' role in the program: to engage their child three times per week, for 7 weeks, in educational and entertaining activities designed by the researchers. We informed them that a tutor would meet them weekly in their home; discuss the progress made, and the difficulties encountered, and provide the tasks for the coming week. (7) We then displayed the materials for use during the 7 weeks of intervention. We explained that mothers would gradually receive these materials during home visits, which would then remain their own property. (8) Finally, mothers received materials and tasks for the first week, along with guidance in how to apply them in interacting with their child.

4.2.1 Joint Home Activities

The mother-child joint activities took place three times per week (approximately 20–30 min per session) in a fixed structure. In the reading group, the mother read a new storybook to the child each week, asking parallel sets of questions across books. The selected books were age appropriate, challenging but not frustrating, entertaining, and educationally valuable. For example, *Something Else* (by C. Cave) conveys the value of becoming a friend with someone who is different from oneself or others, and *Good Fresh Salad* (by M. Snir) delivers the idea that "the whole is more than the sum of its parts." These books were chosen in collaboration with two experts in children's literature and two preschool teachers.

Printed stickers placed on different pages proposed questions to ask the child before, during, or after the book reading (around six questions per reading). Mothers were guided to use the proposed questions sensitively, by adjusting the questions to the child's needs. The proposed questions were open-ended, focusing on text comprehension (e.g., "what did grandma think about the problem?") or questions on word meaning (e.g., "what is a cockroach?"). Also, few questions referred to distancing, that is, connecting the story to the child's experiences (e.g., "what present do you like"?). There were questions that referred to the print (e.g., "what letter do you know in the title?", "how many words do you see in this title") and to the story grammar (e.g., "who are the story's characters?"). Print-related questions usually appeared before reading the book, so as not to disturb the child's processing of the story line. Story grammar prompts appeared at the end of the book, after the entire story had been read.

In the writing intervention group, materials included tasks pertaining to spelling words (e.g., write words that begin with a specific sound; write a list of peers) as well as the kit produced by Rosenberg (2004). The kit included two boards and small boxes with magnetic cards for games promoting letter knowledge, phonological awareness, word spelling, and word recognition. For example, one game focused on rhyming and consisted of pairing pictures whose referents rhyme; another centered on pairing words that start or end with the same phoneme or the same letter. In the visuo-motor skills intervention group, materials included seven booklets or boxes with educational games relevant to fine motor skills, such as mazes, coloring shapes, and cutting and gluing models.

4.2.2 Home Visits

The same tutor (female graduate students in educational counseling) visited the mother at home each week over the 7 weeks, for a visit lasting about half an hour. The goals of the home visits were to summarize the training experiences of the last week, collect the last week's products (children's drawing, writings, etc.), introduce the tasks for the coming week, discuss the mother's teaching experience, solve emerging problems, and sustain maternal motivation to proceed with the program. Extent of implementation – whether all tasks were completed at the three weekly sessions – was confirmed and documented by the tutors. The tutors checked maternal reports by discussing the tasks or observing children's products (e.g., completed mazes). Almost all mothers reported that all sessions were completed, that collaboration was smooth, and that the tasks were engaging and productive.

4.3 Assessment: Mother-Child Reading Interaction

Mother-child interactive readings were videotaped three times in the family's home. The pretest took place up to 2 weeks prior to the workshop. The immediate posttest was carried out after the intervention program terminated. The delayed posttest took place two and a half months after the immediate posttest.

Three books were used, one per session, drawn from an award-winning, popular Dutch series, translated into Hebrew (*Frog and A Very Special Day*, *Frog Is Frog*, and *Frog Is Frightened*, Velthuijs, 2000a, b, c). These books were chosen because of their suitability for kindergartners, the similarity among them (22 pages each, sharing author, illustrator, protagonists, etc.), and their educational and artistic value. The dyads (mothers and children) were unfamiliar with the books.

The interactions were videotaped, transcribed, and coded with a key developed for this study. Only dialogues (i.e., words exchange between the child and mother) were coded, because the study's focus was on dyadic interaction. A dialogue referred to any question or comment made by one party that was replied to, either verbally or physically (e.g., nodding the head, pointing with a finger). Dialogue was classified according to the initiator – mother or child, the initiated topic, and the inclusion of scaffolding, elaboration, praise and criticism.

The dialogues were classified into three topics: (1) story or illustration, (2) print or alphabetic skills, and (3) story grammar (see Table 1 for examples). Six prompts were concerned with the *story or illustration*: completion, recall, illustration, wh-questions, word meaning, and distancing. Four prompts were concerned with *print or alphabetic skill*: counting words/letters, naming or sounding letters, isolating sounds or rhyming, and print recognition or decoding. Six prompts were concerned with *story grammar*: summary, characters, protagonist, problem, solution, and lesson. Explanations of prompts and examples taken from mother-child dialogue appear in Table 1.

After the classification of the topics, each dialogue was scored according to its inclusion of maternal scaffolding, maternal elaboration, maternal praise, or maternal criticism. Scaffoldings took the form of follow-up questions, comments, or hints. They were recorded when the child failed to respond in a way that the mother regarded as satisfactory, with the mother attempting to lead the child to the correct response. For example, when the frog failed to fly because it had no wings: M (mother): "Does the frog have wings?" C (child): – nods. M: "How come the frog has wings?" (scaffold). C: "Its hands". M: "Do you think that hands are wings?" (scaffold). C: "No" (the two are laughing). Elaborations were recorded when the mother accepted the child's response as correct but required elaboration of the

Table 1 Prompt codes appearing in mother-child dialogues

Prompt code	Explanation	Example
Prompts on story and illustration		
Completion	M starts a word/phrase from the text to encourage C to complete it verbatim	M reads: "Frog in a very special …" (intonation that requires completion). C: day.
Recall	M asks a question that requires recalling a piece of information that has been just mentioned (in the last 1–3 sentences).	M reads: "Help! It's a ghost! Screamed all three friends. And then they saw that it was a rabbit." Whom did they see? C: points at the rabbit.
Illustration	M or C refers to the illustration, asking who and what questions.	C: Mommy, that's the sea (points at the illustration). M: That's the sky. It looks like a sea. C: That's the sea. M: You know what? Maybe it's the sea, because frogs are going into the water. Maybe it is the sky.
Wh- question	M or C asks a 'who', 'what', 'which', 'where', 'when', 'why', or 'how' question.	M reads: "… And he landed on the river … At least he had a soft landing." Why did he have a soft landing? C: Because he landed on water.
Word/phrase meaning	M or C asks about the meaning of a word or an idiomatic phrase.	M reads: "Rabbit, may I borrow a book from you?" What is 'borrowing a book'? C: Taking a book from you. M: Right. And then what do you do? C: (a perplexed expression). M: Return the book. C: nods.
Distancing	M or C asks a question or produces a comment that connects the text to the child's own experiences or to his/her general knowledge.	M reads: "And they cuddled in bed. The frog warmed up beside the duck, and was no longer afraid." Do you do that sometimes? When you are scared, do you come to sleep with mommy and daddy sometimes? C: nods.
Prompts on print or alphabetic skills		
Counting words/letters	M asks the C to count words uttered in a phrase and map each onto a printed word, or to count letters in printed words.	M: How many words are in the book's title – (A) frog is (a) frog? C: Three (correct). C: How do know that there are three words? C: Because I see the space.
Naming or sounding letters	M asks C to name letters or, rarely, to produce their sounds.	M points to the printed word: Do you know any letters in the word 'frog'? Which letters do you know? C names all letters correctly.
Isolating sounds or rhyming	M asks C to isolate the initial or final sound of an uttered word or to trace/produce a rhyme.	M asks: What is the first sound in "frog" [tsfarde'a]? C: tsfa. M: Listen carefully, ts. farde'a. C: ts.
Print recognition or decoding	M asks the child to recognize (or, rarely, to attack) a printed word/phrase.	M reads: "He went to visit the rabbit." Where do you see the word 'rabbit' again? Show me another one. C: Points and says: This one.

(continued)

Table 1 (continued)

Prompt code	Explanation	Example
Story grammar		
Summary	M asks C to succinctly reproduce the story line from memory.	M: Tell me what you remember from the book. C: I remember that the frog … that he is the best. But then the duck flew and he also wanted to fly, but and then the pig also wanted to make cakes, and then he [the frog] did not, he wanted to make a cake too and he didn't succeed because the cake burned.
Characters	M asks who the characters were.	Now, Tom, which characters are in the book besides the frog? C: A rabbit. M: Who else? C: A duck.
Protagonist	The mother asks who the protagonist was and how the child made that decision.	M: Shirley, Who is the main character? C: The frog. M: True. The frog with the pants. And why is he the main character? C: Because he was at the beginning, in the sides, and at the end. M: Right. Instead of saying at the beginning, in the sides, and at the end, what do we say? C: In every place. M: Throughout the … C: Story.
Problem	M asks what the protagonist's major problem was.	M: What was his problem? C: And then he solved it. M: Right. But what was the problem? C: That he couldn't fly and couldn't read and couldn't swim.
Solution	M asks how the problem was solved.	M: How did he solve the problem that he didn't know this and that and that? C: The rabbit helped him.
Lesson	M asks C what s/he has learned from the story.	M: What did you learn from the story? … C: That each one has something else. M: Something else that he is good at. And he must be happy with what he has… Do you understand that Shirley? We shouldn't look at others…

Note. *M* mother, *C* child

response. For instance, M: "… and she went home happily. What's 'happily?'" C: "Like this!" (he puts on a smiling face). M: "Cheerful, right!" (elaboration). Praise included mothers' responses to the child's answers like "that's right" or "correct" as well as to the child him/herself, like "you are sweet!". Criticism targeted either the child's response, such as "that's wrong," or to the child him/herself, such as "you're just guessing."

Two graduate students coded the interactions. They were blind to the group type (intervention groups and control). Following a few training sessions of learning to use the key, 36 protocols were chosen to measure coding reliability. These protocols were randomly selected equally from the four groups (reading, writing, visuo-motor skills, and control) and the three data collections (pretest, immediate posttest, and delayed posttest). Reliabilities were measured by correlations between the scores given independently by the two coders and by t-tests between their mean scores. All correlations between coders' scores were highly significant, with a mean correlation of $M = .96$, and a range of .90–1.00. All t-tests between coders' scores on individual protocols were insignificant.

5 Results

5.1 Shared Book Reading Prior to the Intervention

The characteristics of dyadic reading at pretest are presented in Table 2. Dyadic reading in the pretest lasted on average about 9 min ($M = 9.09$ min, $SD = 4.16$). The number of turns included in mother-child dialogues per reading was on average around 21 ($M = 21.4$, $SD = 33.30$). Each dialogue included at least two turns, one by the mother and the other by the child. The mean number of dialogues initiated by the mother was rather low ($M = 4.30$), considering that the book included 22 pages. Almost all those (98%) referred to a topic of *story and illustrations*. The child initiated fewer dialogues than did the mother ($M = 1.61$), and again practically all of them related to *story and illustrations*. About 12.7% of dialogues initiated by the mother or the child included maternal scaffolds and about 22.2% included maternal elaborations. These figures suggest that mothers sometimes did not stop with the child's immediate response (or failure to respond) and sustained the dialogue to enhance the child's comprehension, involvement, or linguistic communication.

Table 2 Description of mother-child storybook reading of the entire sample at pretest (N = 127)

	Mean	SD	Minimum	Maximum
Characteristics of maternal-initiated dialogues				
Total no. of maternal-initiated dialogues (MID)	4.30	5.42	0.00	28.00
No. of MID on story and illustration	4.20	5.32	0.00	27.00
No. of MID on alphabetic skills	0.02	0.15	0.00	1.00
No. of MID on story grammar	0.07	0.26	0.00	1.00
Characteristics of child-initiated dialogues				
Total no. child-initiated dialogues (CID)	1.61	2.72	0.00	13.00
No. of CID on story and illustration	1.60	2.71	0.00	13.00
No. of CID on alphabetic skills	0.02	0.12	0.00	1.00
No. of CID on story grammar	0.00	0.00	0.00	0.00
Characteristics of maternal- or child-initiated dialogues				
Total no. of dialogues with scaffolds	0.75	1.66	0.00	11.00
Total no. of dialogues with elaborations	1.54	2.55	0.00	14.00
Total no. of dialogues with praise	3.46	6.17	0.00	38.00
Total no. of dialogues with criticism	0.50	1.27	0.00	9.00

5.2 The Effects of the Interventions

Table 3 presents the characteristics of dyadic reading by group and wave. The results of two-way ANOVAs, with repeated measures are presented in Table 4.

Table 3 Description of mother-child joint storybook reading as a function of intervention group and wave (N = 127)

	Wave		
	Pretest	Posttest	Delayed posttest
	M (SD)	M (SD)	M (SD)
Total no. of maternal-initiated dialogues			
SBR intervention	4.71 (6.49)	15.14 (13.16)	9.94 (8.48)
Writing intervention	3.82 (3.56)	5.06 (5.39)	3.44 (4.53)
VM intervention	4.71 (6.49)	7.77 (7.89)	4.68 (4.85)
No intervention	2.74 (5.65)	3.33 (4.03)	1.56 (2.06)
Total no. of child-initiated dialogues			
SBR intervention	1.66 (2.61)	4.14 (6.18)	1.00 (1.55)
Writing intervention	1.62 (3.46)	1.79 (1.98)	1.12 (1.70)
VM intervention	2.10 (2.29)	1.84 (2.79)	1.00 (1.55)
No intervention	1.00 (2.24)	1.26 (2.64)	0.85 (1.97)
Total no. of dialogues with maternal scaffolds			
SBR intervention	0.94 (2.57)	4.83 (5.11)	2.14 (2.44)
Writing intervention	0.41 (0.78)	0.71 (1.53)	0.32 (0.64)
VM intervention	1.31 (1.48)	1.35 (2.01)	0.48 (1.15)
No intervention	0.48 (1.01)	0.63 (1.15)	0.19 (0.48)
Total no. of dialogues with maternal elaborations			
SBR intervention	1.91 (3.40)	7.03 (6.57)	3.66 (3.70)
Writing intervention	1.15 (1.71)	1.41 (2.22)	0.74 (1.46)
VM intervention	2.03 (2.32)	2.77 (3.46)	1.61 (2.11)
No intervention	1.00 (2.34)	1.22 (1.99)	0.52 (0.89)
Total no. of dialogues with maternal praise			
SBR intervention	4.43 (8.83)	16.71 (18.11)	7.06 (7.06)
Writing intervention	2.71 (4.39)	2.62 (3.27)	2.12 (2.56)
VM intervention	4.52 (5.99)	5.06 (5.78)	2.71 (3.12)
No intervention	1.93 (3.33)	2.63 (4.21)	1.19 (2.08)
Total no. of dialogues with maternal criticism			
SBR intervention	0.46 (1.60)	3.54 (4.53)	1.06 (1.35)
Writing intervention	0.15 (0.44)	0.44 (1.48)	0.18 (0.46)
VM intervention	1.13 (1.61)	0.90 (1.85)	0.32 (0.75)
No intervention	0.26 (0.71)	0.78 (1.99)	0.26 (1.02)
No. of maternal dialogues on story and illustration (specific category of prompts)			
SBR intervention	4.66 (6.34)	11.71 (10.64)	8.17 (7.12)
Writing intervention	3.74 (3.56)	4.50 (5.25)	3.00 (4.19)
VM intervention	5.52 (5.40)	7.29 (7.61)	4.45 (4.72)
No intervention	2.70 (5.48)	2.89 (3.71)	1.48 (2.01)

(continued)

Table 3 (continued)

	Wave		
	Pretest	Posttest	Delayed posttest
	M (SD)	M (SD)	M (SD)
No. of maternal dialogues on print and alphabetic skills (specific category of prompts)			
SBR intervention	0.03 (0.17)	2.14 (2.09)	0.89 (1.16)
Writing intervention	0.03 (0.17)	0.41 (0.74)	0.41 (0.74)
VM intervention	0.03 (0.18)	0.16 (0.37)	0.03 (0.18)
No intervention	0.00 (0.00)	0.30 (1.35)	0.40 (0.19)
No. of maternal dialogues on story grammar (specific category of prompts)			
SBR intervention	0.03 (0.17)	1.29 (1.60)	0.89 (1.25)
Writing intervention	0.06 (0.24)	0.15 (0.36)	0.03 (0.17)
VM intervention	0.16 (0.37)	0.32 (0.60)	0.19 (0.40)
No intervention	0.04 (0.19)	0.15 (0.36)	0.04 (0.19)

Note. *SBR* shared book reading, *VM visuo-motor*

Table 4 2-Way ANOVAs of wave × group, and Bonferroni Post-hoc Comparisons of the Dyadic Reading (N = 127)

	F-wave	F-group	F-interact.	Comparison of groups		
Characteristics	df = 2246	df = 3123	df = 3246	Pretest	Immediate posttest	Delayed posttest
No. of MID	17.61***	11.80***	7.18***	n.s.	R > W, V, C	R > W, M, C
No. of CID	8.86***	1.71	3.24**	n.s.	R > W, V, C	n.s.
Scaffoldings	17.74***	13.28***	9.84***	n.s.	R > W, V, C	R > W, M, C
Elaborations	14.62***	14.53***	7.01***	n.s.	R > W, V, C	R > W, M, C
Praise	14.33***	12.44***	9.33***	n.s.	R > W, V, C	R > W, M, C
Criticism	14.43***	7.94***	7.82***	n.s.	R > W, V, C	n.s.
Story/illustrations	12.31***	8.73***	4.62***	M > C	R > W, V, C	R > W, M, C
Print/alphabetic skills	19.28***	15.50***	8.67***	n.s.	R > W, V, C	R > W, M, C
Story grammar	11.85***	17.95***	6.85***	n.s.	R > W, V, C	R > W, M, C

Note. *D* dialogues, *MID* maternal-initiated dialogues, *CID* child-initiated dialogues, *R* reading group, *W* writing group, *V* visuo-motor group, *C* control group
$^{**}p < 0.01$; $^{***}p < 0.001$

Comparing the groups in each wave showed that at pretest, the groups did not differ on any of the measures. In the immediate posttest, the SBR intervention group significantly surpassed all other groups on all characteristics. The other three groups – writing, visuo-motor skills, and control – were statistically indistinguishable from each other. At the delayed posttest, the SBR group outperformed all other groups on all characteristics except two (number of dialogues with criticism and number of child-initiated dialogues), and the three groups were again statistically indistinguishable.

Analyses of the six characteristics revealed a consistent picture. The effects of wave, group, and the Wave × Group interaction were all significant. In the SBR group, dyadic reading increased substantially and significantly on all measures from pretest to the immediate posttest and somewhat declined, on all measures, from the immediate to the delayed posttest. This decline reached significance on two measures out of six (number of mother-initiated dialogues and number of dialogues with scaffolds). Nevertheless, dyadic reading remained significantly higher at the delayed posttest than at pretest on all six measures. In contrast, in the three other groups (writing, visuo-motor, and control) the six characteristics of dyadic reading remained statistically indistinguishable on all three waves.

Analyses of intervention group by topic are presented in the lower parts of Tables 3 and 4. Almost all the dialogues initiated by mothers at the pretest were on *story and illustrations.* We examined whether guiding mothers in SBR increased their prompts on this topic as well as on topics that they regularly neglected – *print* and *story grammar*.

Although most dialogues were on *story and illustrations*, all three topics revealed a consistent picture. The effects of wave, group, and the interaction between them were all significant. Bonferroni comparisons showed that in the SBR group, dialogues related to all three topics increased significantly from pretest to the immediate posttest and declined significantly but to a lesser extent from the immediate to the delayed posttest. Consequently, in this group, dialogues related to all three topics remained significantly higher on the delayed posttest compared to the pretest. In contrast, in the three other groups (writing, visuo-motor, and control) dialogues relating to all three topics remained statistically indistinguishable across waves.

Comparing the groups in each wave showed that at the two posttests, the SBR group significantly surpassed all other groups on all three topics. At pretest, no group differed from another on any topic, except in one case (on Story/illustrations the visuo-motor group scored higher than the control group, Table 4).

5.3 Child's Age and Maternal Education: Regression Analyses

To predict each characteristic of interactive reading during the immediate and the delayed posttests, we ran regression analyses with four predictors: child's age, maternal education, performance on the predicted characteristics at pretest, and group. The previous analyses indicated that the interactivity during storybook reading increased due to the intervention only in the SBR group. Therefore, to assess group effect, we compared the SBR group to the three other groups combined (writing, visuo-motor, and control).

The regression analyses included two models of predictors. Model 1 included child's age, maternal education, pretest scores, and group; Model 2 added three-way interaction – Group × Child's age × Maternal education.

Pretest scores and group had effects on all scores at the immediate posttest. These two unique factors combined explained 42% of the variance on the number of mother-initiated dialogues and 17% of child-initiated dialogues. The variances predicted on number of dialogues with scaffolds, elaborations, praise, and criticism, were 54%, 36%, 46%, and 28%, respectively.

Age had a significant effect on immediate posttest scores only in number of mother-initiated dialogues; specifically, younger children were more involved in maternal-initiated dialogues than were older children. This finding was not moderated by the three-way interactions.

At the immediate posttest, the three-way interaction of Group × Child's age × Maternal education added to the prediction of five out of six immediate posttest scores, significantly or closely so. This interaction appeared on the number of child-initiated dialogues, maternal scaffolds, maternal elaborations, maternal reinforcements, and maternal criticisms. These interactions reflected a consistent picture: In the SBR group, among dyads including mothers with lower education levels, interactive reading decreased with the child's age. These mothers used more scaffolds, elaborations, reinforcements, and criticisms for younger than for older children. At the same time, younger children of mothers with lower education initiated more dialogues with their mothers than older children. No such effects were found for mothers with higher education in the SBR group or for mothers with higher or lower education in the other groups combined.

In sum, the regressions explained 44% of the variance in the number of mother-initiated dialogues and 22% of the variance in the number of child-initiated dialogues. Regarding the number of dialogues including maternal scaffolds, elaborations, reinforcements, and criticisms, the models explained an impressive 57%, 40%, 52%, and 33% of the variances, respectively.

At the delayed posttest, pretest characteristics and group had considerable effects on all delayed posttest scores. These factors combined uniquely explained the number of mother-initiated dialogues (33%) and the number of child-initiated dialogues (23%). These factors also explained maternal scaffolds (27%), elaborations (27%), praise (32%), and criticisms (20%).

The regressions explained 34% of the variance in the number of maternal-initiated dialogues and 23% of the variance in number of child-initiated dialogues. For the number of dialogues including maternal scaffolds, elaborations, reinforcements, and criticisms, the models explained 29%, 32%, 33%, and 27% of the variances, respectively.

6 Discussion

6.1 Interactive Reading: Enhanced Specifically by Training in Reading

The goal of this chapter was to describe a study that explored how guiding mothers from low SES backgrounds in how to mediate learning applied to different joint activities would affect storybook reading. We expected that directing mothers in reading storybooks interactively would improve their reading quality more than guiding the mothers in other joint activities, that is, writing or visuo-motor skills.

Moreover, we investigated transfer effects, whether guiding mothers in the latter joint activities would contribute to interactive storybook reading more than would no intervention. Results partly accorded with expectations. While directing mothers in mediated learning applied to storybook reading had impressive effects on all measured aspects of interactive reading, directing mothers in the other joint activities had no effect on these measures.

The effects of the Shared Book Reading (SBR) intervention on interactive reading were remarkable in the context of the characteristics of habitual reading of storybooks of these mothers before the intervention. Reading characteristics at pretest were similar to those that have appeared in the literature dealing mainly with younger and higher-SES populations. First, the literature indicates that in habitual storybook reading mothers rarely engage the child (Huebner & Meltzoff, 2005). Similarly, in the current study, we found that the number of dialogues initiated by mothers was relatively low. Second, mothers usually contribute more to the discourse during reading than do their children (Curenton et al., 2008). Here, mothers contributed 2.7 times more to dialogues than did their children. Finally, mothers initiated dialogues during reading that focused almost entirely on the story (i.e., the plot, the behavior of the story's characters) and illustrations, often ignoring print characteristics and story grammar (e.g., reference to the protagonist or the story's solution). Disregarding print, even when the children are kindergartners about to start school the next year, may stem from the possible distractive effect it may have on the on-going processing of the story. Ignoring story grammar may reflect limited maternal comprehension that books portray the general scheme of narrative that can help their children in text comprehension. Perhaps mothers do not recognize the potential that meta-cognitive conversations regarding the hero, the plot, etc. can have on their children's comprehension of stories.

Guiding mothers in interactive reading during the seven-week intervention enhanced their reading quality across the board in the immediate posttest. Mothers tripled the number of times they initiated dialogues with their children, thereby greatly increasing their children's discourse during reading. They used dialogues with scaffolds and elaborations, five and four times more, respectively, than at pretest. Mothers also initiated more dialogues including praise and criticisms, showing that the dialogues were more evaluative and instructive. Notably, the children initiated dialogues – asking questions, demanding clarifications – 2.5 times more after the intervention. Our results are in line with a recent meta-analysis that showed that book reading interventions have a large effect on caregiver book-sharing competence (Dowdall et al., 2020).

Maternal interactive reading slightly decreased but sustained its heightened level relative to the pretest at the delayed posttest, measured 2.5 months following termination of the intervention. Maintenance emerged on all measured aspects of maternal reading. This result corroborates previous findings on delayed posttests on trained interactive reading, mainly based on small samples (Abarca, 2018; Blom-Hoffman et al., 2007; Briesch et al., 2008; Huebner & Meltzoff, 2005).

6.1.1 New Prompts: Print and Story Grammar

Discourse on print and on story grammar has hardly been mentioned in the literature on storybook reading. The inclusion of dialogues on print was motivated by the rich evidence indicating the significance of alphabetic skills and print concepts acquired in preschool for reading and writing acquisition in first grade (Foulin, 2005; Goswami, 2003; Lyytinen et al., 2006; National Reading Panel, 2000; Shatil et al., 2000). Research has shown that interactive reading enhances print concepts (Mol et al., 2008, 2009). It has also been shown that children can be alerted to print during interactive reading (Justice & Ezell, 2002; Justice, et al., 2002), and that such a practice enhances children's print and word knowledge (Justice, et al., 2006). The motivation to encourage mothers to initiate dialogues on story grammar was based on the conclusion drawn from a review, stating that story comprehension is supported by analyzing stories within the framework of story grammar (Gersten et al., 2001). The intervention raised the number of these two types of prompts, but these prompts remained minor.

6.2 Why Transfer Failed to Occur, and What Could Facilitate Transfer

The expectation that guiding mothers in other joint activities, that is to say, writing and visuo-motor skills, would improve the nature of their storybook reading quality relative to the control group of no intervention was refuted. In general terms, the rich literature shows that transfer of training is a highly regarded but not very common outcome of training, the reasons not being entirely clear (Haskell, 2000).

Many of the mothers who were not trained in reading interactively were in the habit of reading storybooks to their children (as indicated in maternal reports), and this may account for the resistance of storybook reading interactivity to change. Further, parents have been found to view storybook reading as a context for bonding with the child and a time of enjoyment, more than as a context for learning (Audet et al., 2008). This view has been supported by the mass media where parents are told that storybook reading contributes to the child's security by creating an atmosphere of warmth, tranquility, and caring (Ben-Gur, 2009). Therefore, unless parents endorse the view that storybook reading is a teaching-learning opportunity and are encouraged to read interactively and guided in how to do so, they may be unaware of other ways that reading might be productive. Interventions that include some direct parental guidance to use the knowledge that they gained in one domain to promote their children in other domains may help parents to make a transfer. For example, if parents receiving guidance in the writing program were taught to ask their children questions in different activities, perhaps they might also have progressed in interactive book reading.

6.3 Child's Age and Maternal Education

In a meta-analysis, the effect of interactive reading on children's vocabulary was found to decrease with children's age, from 2–3 to 4–6-years-old (Mol et al., 2008). The authors suggest that older children may need less interactive reading with parents, becoming better able to monitor story comprehension and ask questions on their own. We found that with children's age, particularly mothers with lower education (within our low SES sample) changed their level of interactivity. Specifically, mothers trained to read interactively increased their interactive reading from pretest to posttests, but those with lower education were less interactive with the child's increasing age. These mothers used more scaffolds, elaborations, reinforcements, and criticisms for younger than for older children. Concurrently, younger children of mothers with lower education in the SBR group initiated more dialogues with their mothers than did older children. This finding suggests that maternal interactive reading tends to decline when children get older, as mothers believe their children to need less assistance (De Temple & Snow, 2001), and this belief is held more by mothers with a lower education. In addition, within a sample of mothers from low SES backgrounds, mothers with a lower education may have greater difficulty in crafting challenging questions for older children, which would lead to high-quality discourse. These explanations corroborate the finding that dialogic reading has been found to be more productive for children whose mothers were more highly educated (Mol et al., 2008).

6.4 Limitations and Suggestions for Future Research

The slight decrease from immediate to delayed posttest, apparent in this and in previous studies, may suggest that maintenance of interactivity requires some boosting (e.g., phone calls) following the intervention. However, it may alternatively be proposed that the degree of interactivity in the immediate posttest was perhaps to some extent overdone, due to the intensive intervention. The decrease in the delayed posttest may have moved the interactivity to a more convenient level. Currently, we have no evidence regarding the optimal level of interactivity in storybook reading (appropriate per age or literacy level), or to the amount of support parents need to maintain interactivity in the long run. These important issues deserve investigation.

No transfer of mediating learning in other joint activities to interactive reading occurred. If we had suggested to mothers trained in mediating learning of other activities that they consider applying these principles to storybook reading, it is possible that they could have done it. Such an additional investment could have been productive. No such suggestion was offered in the current study. Future studies should try elaborating procedures to enhance mother-child verbal interactions across a wide variety of contexts, including storybook reading.

In sum, the substantial improvement in interactive reading that emerged in this study raises the hope that such rich reading interactions may continue in the SBR group. Professionals should directly guide parents in how to read to their children. Parents as well as educators should be encouraged to acknowledge this potential and use the context of shared book reading for rich conversations with children.

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Finger Movements and Eye Movements During Adults' Silent and Oral Reading

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Abstract Using a common tablet and a web application, we can record the finger movements of a reader that is concurrently reading and finger-pointing a text displayed on the tablet touchscreen. In a preliminary analysis of "finger-tracking" data of early-graders we showed that finger movements can replicate established reading effects observed in more controlled settings. Here, we analyse and discuss reading evidence collected by (i) tracking the finger movements of adults reading a short essay displayed on a tablet touchscreen, and (ii) tracking the eye movements of adults reading a comparable text displayed on the screen of a computer. Texts in the two conditions were controlled for linguistic complexity and page layout. In addition, we tested adults' comprehension in both silent and oral reading, by asking them multiple-choice questions after reading each text. We show and discuss the reading evidence that the two (optical and tactile) protocols provide, and to what extent they show comparable effects. We conclude with some remarks on the importance of ecology and portability of protocols for large-scale collection of naturalistic reading data.

Keywords Reading · Eye-tracking · Finger-tracking · Data collection · Task ecology · Oculomotor coordination · Natural reading behaviour · Chunking

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1 Introduction

Reading evidence can be collected and analysed in a number of ways, depending on the specific interests of the investigators and the range of theoretical and practical issues they intend to address. The technological advances of the last three decades have provided better and more sophisticated methods of reading research, which have greatly improved data collection and analysis, while contributing to broader and more detailed experimental and educational models of reading.

In the cognitive literature, a wide variety of experimental tasks that involve reading assessment have been proposed and tested in research labs. Among these tasks, eye-tracking and self-paced reading have probably established themselves as the most widely-accepted methods. In turn, experimental methods have been assessed for their ability to give detailed indications about the main perceptual, attentional, oculomotor, cognitive and linguistic processes that make reading possible, and their incremental integration in online text processing.

In education, protocols for reading assessment have focused on the basic outcomes of reading, and what is required for them to optimally interact in real practice, i.e. given specific instructional tasks and objectives. This perspective is more functional than explanatory, geared towards understanding how knowledge of basic reading skills can be used to help students learn more effectively through instructional readings. For example, based on the "Simple View of Reading" (Hoover & Gough, 1990), the two tasks of text decoding and comprehension are assessed to understand how they can be scored either independently or jointly, to evaluate a reader's proficiency and recommend dedicated training for reading improvement.

Cognitive and educational approaches to reading assessment strike us as highly complementary. It is only to be expected that a better understanding of the cognitive processes underlying reading would lead to more effective research-based intervention approaches to maximize reading performance. Conversely, a large screening of the school population for reading assessment at scale would deliver massive naturalistic data to reading researchers for quantitative analysis and modelling. Larger-scale studies could thus be conducted, paving the way to more generalizable results than in the past.

In spite of their huge potential for synergy, however, much remains to be done for the two perspectives to be integrated into a common observational framework. One of the main reasons why we are still far from achieving such a level of interdisciplinary continuity is the lack of an appropriate technological infrastructure for data collection and harvesting (Jamshidifarsani et al., 2019). Eye-tracking technology is constantly improving in sophistication and adaptivity (Jarodzka et al., 2021). Yet, measuring eye movements during natural reading in fairly unconstrained settings like schooling activities in the classroom remains a challenging task. Experimental research requires careful selection of input stimuli, which need be classified along a number of linguistic dimensions (involving orthographic, phonological, morphological, lexical, syntactic and pragmatic knowledge) and cognitive parameters (including working memory and executive functions) to investigate readers' language skills either in isolation or in interaction.[1] However, controlling for all these parameters in protocols for language education and intervention can be very hard, especially when students' reading performance is assessed on real instructional texts, as opposed to words or sentences presented in isolation. In sum, boosting synergy between experimental and educational reading research requires timely delivery of behavioural data that are fine-grained, robust and scalable: a long-awaited desideratum (Chzhen et al., 2018). In this paper, we describe a new method for collecting reading data with a common tablet connected to a server equipped with Artificial Intelligence and Natural Language Processing technology. The method is based on *ReadLet* (Ferro et al., 2018b), a web application that uses a tablet touchscreen to capture the reading behaviour of a subject by recording the speed of her finger pointing to a text as she reads it. We report the results of an experiment where "finger-tracking" data are analysed against eye-tracking data in adults' reading trials. Our method proves to be able to offer reading data that are robust, scalable and remarkably congruent with more established evidence. Structural and dynamic aspects that are specific of the finger-tracking evidence are also discussed.

2 Oculomotor Coordination in Visual Decoding

Recent experimental evidence in visual perception analysis shows that eye movements and finger movements are strongly congruent when a subject is asked to visually explore an image. Lio et al. (2019) recorded the eye movements of subjects while they are viewing an image displayed on a computer screen. In a separate experiment, the authors then invited the same subjects to explore a (different) blurred image, displayed on a touchscreen, by moving their fingers on the display. Blurred picture areas were intended to simulate parafoveal vision. However, the same areas were automatically shown in high resolution (corresponding to the subject's foveal vision), as soon as the subject touched a point on the screen located immediately below the blurred area. No single subject explored the same image in the two modes, but the same images were explored by different subjects either optically or haptically. The experiment proved that the subjects' image-exploring patterns in the two modalities strongly correlate at both individual and group levels. Synchronized recordings of eye movements and hand motor activities are reported from other domains such as piano playing (Furneaux & Land, 1999; Truitt

[1] Laubrock and Kliegl (2015) estimate that there are more than 50 word properties that could account for variance in fixation duration during reading (ranging from lexical neighbourhood frequency, bigram and trigram frequency and orthographic-phonological consistency to lexical frequency, length, subjective familiarity, concreteness and age of acquisition). Similarly, there are a number of sentence level variables that relate to eye movement control, going from subject-initial and object-initial constructions, to main or subordinate clauses, passive or active clauses etc. (see also Balota et al. (2004)).

et al., 1997), handwriting (Alamargot et al., 2007) and typewriting (Butsch, 1932; Inhoff et al., 1986; Inhoff & Wang, 1992; Inhoff & Gordon, 1997). Although these data are fairly heterogeneous and only indirectly related to reading, they converge into highlighting the basic need to coordinate fast eye movements and the much slower motor system of the hands. In particular, the average time the hand lags behind the eyes, or Eye-Hand Span, is fairly constant at around one second, if measured in units of time, but increases with expertise if measured in information units (e.g. letters or musical notes). This is in line with models of working memory that measure the working memory capacity in terms of the execution time of effector-driven processes (i.e. the individual articulatory rate of a speaker in Baddeley's phonological loop (Baddeley, 2007)) rather than processing units.

This evidence is in line with Laubrock & Kliegl's (2015) dynamic investigation of reading dual response costs, when the reader is engaged in simultaneously executing oculomotor and articulatory movements, either overt (in oral reading) or covert ones (in silent reading). During reading, eye movements provide sequential information to the short-term orthographic input buffer, where this information decays very quickly. Buffering is necessary because articulation (either covert or overt) is just too slow to keep the pace of both visual decoding and grapheme-to-phoneme conversion. However, due to short-term memory decay and the buffer's limited capacity, orthographic information cannot be retained indefinitely. Since the voice proceeds at a fairly linear pace, most of the adjustment has to be performed by the oculomotor system, which can either reduce its pace to stop the span between visual decoding and articulation (or Eye-Voice-Span) from growing out of control, or can retrace its steps backwards with a regressive saccade, to refresh items in the orthographic short-term buffer. Incidentally, similar buffering mechanisms (involving morphological processing at the word level) have been shown to be operational also in other types of dual task, such as handwriting (Kandel et al., 2008) and typing (Ferro et al., 2016; Gagné & Spalding, 2016).

Another familiar context which exploits the synergistic behaviour of the ocular system and another slower motor system, is when children learn to read using the finger of their dominant hand to point the letters of written words as they read a connected text. Despite the undoubtedly different dynamics of the two types of text exploration, finger-pointing a word during reading helps children learn to look at print, and supports critical early reading behaviours: directional movement, attention focus, and voice-print match (Mesmer & Lake, 2010; Uhry, 2002). In previous work (Marzi et al., 2020; Taxitari et al., 2021), we presented a preliminary analysis of finger-tracking data of early-graders that were engaged in concurrently reading and finger-pointing a short text displayed on a tablet touchscreen. The evidence showed that finger-tracking can replicate established eye-tracking benchmark effects, such as stable correlation values between tracking time and word frequency (negative correlation), and tracking time and word length (positive correlation). Besides, a comparative analysis of typically and atypically developing children (Marzi et al., 2020) shows different development patterns, with typical readers developmentally becoming less sensitive to word frequency effects, unlike atypical readers, who appear to remain sensitive to lexical frequency for much longer. The effect, also observed by Zoccolotti et al. (2009), is interpreted as showing that the orthographic lexicon of typically developing readers makes room for increasingly rarer and longer words with age. Conversely, atypical readers do not seem to be able to update their orthographic lexicon with rarer and longer words at the same pace as typically developing readers do.

In the present contribution, we examine the correlation of finger-tracking and eye-tracking times during adults' silent and oral reading. Our objective is to show to what extent reading movement patterns and their speed are congruent across the optical and tactile protocols in the two (silent and oral) modalities. In what follows, we will first recall some known features of different reading protocols to discuss their connection with natural reading and finger-tracking. After that, the methodology of a comparative finger-tracking and eye-tracking experiment with adult readers is described in some detail. Results are illustrated and discussed in the ensuing section and, finally, some methodological remarks are reported in the conclusions. Overall, the evidence shows that finger-tracking offers a novel, minimally invasive, inexpensive and nonetheless highly informative way to assess and understand natural reading across different proficiency and age levels. In the end, the protocol's portability and robustness have the potential to bridge the current gap between cognitive and educational research on reading.

3 Natural Reading and Reading Tasks

In a typical eye-tracking experiment, entire sentences are presented one at a time, and participants are asked to read each sentence, either silently or aloud, at their normal reading speed. During the task, the location and duration of their eye fixations are recorded, which makes it possible to assess participants' reading patterns as they evolve during the process of sentence reading. As participants are given very few or no restrictions on how reading should take place, the task allows for a number of reading strategies to be observed. Reading can take place very carefully, with readers making their way through the sentences at a regular pace, virtually word by word. Alternatively, they can decide to skim through the sentences to get the gist of their content, which may be enough for them to correctly answer a few simple multiple-choice comprehension questions.

At the beginning of a typical self-paced reading session, a sentence is displayed on a computer screen as a series of dashes or hash marks, each covering a single character in the sentence. Upon a button press by the experiment participant, the first word of the sentence is shown on the screen. When the participant is ready to view the next word, (s)he presses the button again, thus reverting the current word to dummy marks, and unmasking the immediately ensuing word in the sentence. The participant proceeds in this way until the last word of the sentence is shown. In this case, the only dependent variable is the time the reader takes to push the button in recognition of the word currently displayed. The reading task is certainly less natural than in the eye-tracking protocol. In particular, it reduces the number of possible reading strategies. As only one word at a time is displayed, self-paced reading forces explicit fixation of those (mainly functional) words that are often skipped in natural reading, and it does not permit regressive eye movements. If, on the one hand, this protocol allows for a much narrower interindividual variability in terms of processing strategies, a variety of reading strategies are nonetheless available (Witzel et al., 2012), as the reader may decide to integrate each unmasked word online, or rather buffer it in working memory and postpone sentence integration to a later stage.

More recently, new word-by-word reading techniques (like the maze task) have been proposed as a way to tap into the reader's processing strategies by placing even stricter limits on their freedom. For example, at each button press, two words rather than a single one are displayed, which provide two alternative continuations of the sentence. The reader has to decide on the most sensible alternative (see Gallant and Libben (2020) for a recent adaptation of the task).

As nicely put in a recent contribution by Libben et al. (2021) "[...] a key challenge in the design of psycholinguistic research on lexical processing is to create experiments that have ecological validity and at the same time are sufficiently controlled so that specific variables and hypotheses regarding their effects can be examined." Accordingly, classical reading tasks can mostly be evaluated according to two dominant parameters: (i) whether the task allows investigators to collect evidence of online processing ease/difficulty for the reader, and (ii) whether the reading task is modelled in a "natural" way.

The first parameter is of paramount importance, as reading patterns are a primary source of information of text processing and comprehension operations. Ideally, a reading protocol should provide detailed information of this kind through indication of reading time differences across texts and readers. From this perspective, it is important that the protocol can precisely show where the processing difficulty arises in the text. This explains why self-paced reading and its variants still enjoy considerable popularity among investigators. Due to its preeminent focus on one single parameter at a time, self-paced reading places tight constraints on subjective reading strategies, to provide fairly local, consistent and comparable data points.

However, on our second parameter, self-paced reading fares much worse. There is little that is natural in placing rigid restrictions on the subject's ability to "look ahead" in the reading direction, while processing a word in context. Although context manipulation can reveal a lot of the reader's processing strategies, at least some self-paced data can reflect strategic choices that respond to specific aspects of the task (e.g. pending phrase structures can be "closed" prematurely, to provide fast integration of the current word in the preceding context), rather than reflecting natural reading behaviour.

Eye-tracking seems to suffer something of a mirror-image problem. On the one hand, it places very few if any restrictions on the subject's reading strategy, thereby capturing a natural reading behaviour. On the other hand, it provides a wealth of behavioural patterns and measures (forward saccades, regressions, fixations, refixations and word skippings) that portray the reader's ability to process several words in parallel in its full complexity and interindividual variability. In some cases, however, this makes it difficult to control for specific context-sensitive behavioural patterns, as with the controversial case of parafoveal-on-foveal effects (Brothers et al., 2017), whose investigation may require considerable online manipulation of the textual context (for example, Rayner's (1975) boundary technique: Angele et al. (2013), Dare and Shillcock (2013)).

A finger-tracking experiment consists in recording the movements of the dominant hand's index finger of a subject reading a text displayed on a tablet touchscreen (Ferro et al., 2018a). In the task, the reader is instructed to point each word in the text as she reads it, as is common practice of beginning readers. During reading, the tablet can record the sliding movements of the finger captured by the tablet touchscreen, as well as the voice of the reader (when reading aloud is requested) captured by a built-in microphone. Both acoustic and haptic recordings are continuous in time, while recorded finger movements are also continuous in space: i.e. they tend to cover text letters, punctuation marks and even blanks evenly, with a limited number of orthographic units being skipped. This dynamic is in sharp contrast with the succession of discontinuous individual movements that typically characterize the eyes during reading, which is better described as a series of more or less long fixations that are traversed "in jumps", i.e. by alternating fixated with nonfixated words. Notwithstanding these dynamic differences, both eye and finger movements can be aligned with the time of a reading session and the line(s) and words of the text being read. In particular, the touch screen technology of a current good-quality commercial tablet is able to capture finger movements with a sampling rate in the 60–120 Hz range, approximately corresponding to 12–24 touch events per syllable when reading at a speed of 5 syllables per second. The tablet can thus map a continuous sliding movement on the touchscreen into a discrete series of densely distributed "touch events", each located in the screen area. At any given point in time, an algorithm can thus precisely reconstruct where on the screen the reader's finger is pointing to. This series of discretized events are ultimately mapped onto the text lines, in much the same way a sequence of fixations is projected onto a sequence of words. This allows researchers to observe which letter is pointed to by the reader's finger at any moment during reading.

To illustrate, Fig. 1 (top) shows the visual rendering of a typical eye-tracking record of a short text paragraph after alignment. It is useful to compare the figure with the corresponding record of finger-tracking data for the same text (Fig. 1, bottom). In both renderings, the tracking time is represented through a horizontal bar below each paragraph line. The bar's false-colours code time in milliseconds, with the coding scale being depicted along the vertical bar on the right-hand side of the text. Note that finger-tracking covers text lines in a spatially denser and more continuous way than eye-tracking does. The finger tends to slow down at the end of each line, and moves to the beginning of an ensuing line in one jump, to resume tracking the new line. Note that words, and even single letters within words, are tracked at different speeds. In contrast, the eye typically jumps from one word to another, fixating single words between successive jumps. A word can be fixated more or less quickly, and more than once, whereas some words are completely skipped.

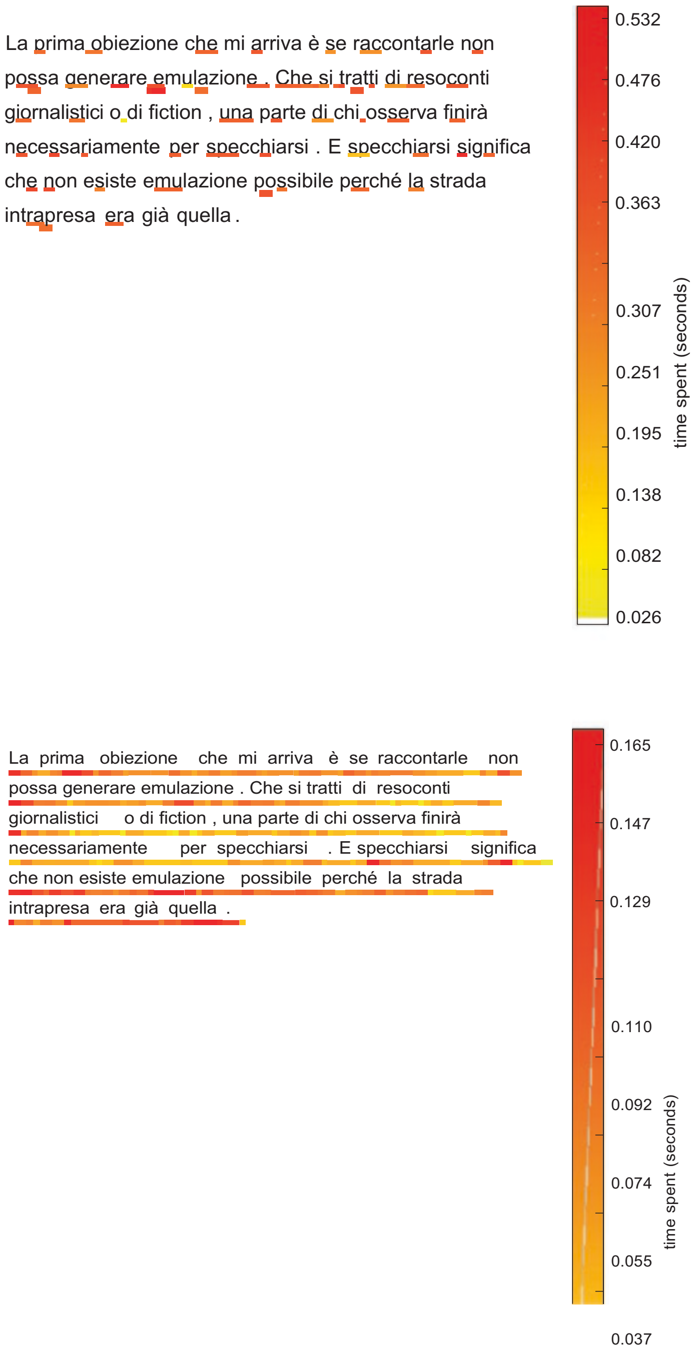


Fig. 1 Visual rendering of an eye-tracking record (top) and a finger-tracking record (bottom) of the first page of one of the Roberto Saviano's journal articles used for the adults' reading trials

Although the two tracking records are differently scaled and differently distributed across the text, it makes sense to align them at the word level for comparison. As a first approximation, the time taken to read the word w_i in the text can be calculated as its total fixation time in the eye-tracking record and its total tracking time in the finger-tracking record. This inevitably neglects important pieces of information that are provided by the two signals (for example, both of them keep track of regressions). Likewise, we are levelling out significant differences between the two protocols: for example, finger-tracking, unlike eye-tracking, allows researchers to examine differences in reading pace at various points within the word. Nonetheless, a word-level comparison provides a useful starting point to understand more about how the two time series of signals correlate in the natural reading of a connected text.

In what follows, we will thus focus on some descriptive statistics of the reading time data offered by the two protocols, and will compare these data across different hierarchical levels of linguistic units: starting from words, to include non-recursive phrase constituents (or "chunks") and full sentences. Ultimately, this preliminary investigation will also allow us to validate finger-tracking against a challenging, well-established benchmark technology in reading research such as eye-tracking, and better understand the similarities and differences between the two experimental protocols in adults' reading.

4 The Experiment

The study was approved by the CNR Research Ethics and Integrity Committee and funded by the Ministry of University and Research through the PRIN grant 2017W8HFRX.

4.1 Participants

Fifty-Six young adults (27 female, 29 male, mean age = 27, age range = 18–39) were recruited for the experiment. All participants were Italian native speakers, with normal or corrected-to-normal vision, and without any known learning or reading difficulties. Two participants were left-handed. Participants gave written informed consent for their involvement. 22 experimental sessions were conducted at the CNR Research Area in Pisa, and 34 experimental sessions in SISSA, Trieste.

4.2 Design

The current study adopted a 2 (tracking protocol: eye-tracking vs. finger-tracking) by 2 (reading condition: silent vs. aloud) Latin square, fully counterbalanced design. Accordingly, each participant was asked to read in four experimental conditions, combining reading mode and tracking protocol. This resulted in a total of four reading sessions per participant, all conducted the same day. Order of presentation of the tracking protocol, i.e. tablet vs. eye-tracker, was counterbalanced across participants. Reading conditions, i.e. silent reading vs. reading aloud, alternated for each participant to avoid fatigue effects, and the order was counterbalanced across participants. The presentation of the different reading texts for each experimental condition was also counterbalanced across participants, so that text passages were equally distributed across experimental conditions.

4.3 Materials

Test reading materials consisted of 8 short Italian texts, each taking up two tablet screen pages. They were extracted from either Roberto Saviano's tabloid news articles, or Lamberto Maffei's popular neuroscience book *Elogio della parola* ('In praise of words') (2018). All texts were automatically PoS-tagged and shallow-parsed in word chunks. For PoS-tagging, we used the coarse-grained level of the ISST-TANL morpho-syntactic tagset (Dell'Orletta et al., 2007), output in CoNLL format. Chunking (Abney, 1991; Federici et al., 1996) defines a non-recursive level of phrasal text segmentation, where lexical heads are always the rightmost word token in the chunk, as illustrated in Example (1). With a few exceptions, functional words are mostly incorporated as pre-head word units within a lexical chunk, and this provides linguistically principled ways to explore the correlation between acoustic, prosodic and syntactic cues in reading a connected text (Pate & Goldwater, 2011).

Example 1
[...] [with his legendary **sword**]$_{P\_C}$ [the **king**]$_{N\_C}$ [has been **ousting**] $_{FV\_C}$ [his **enemies**]$_{N\_C}$ [from the **realm**]$_{P\_C}$

At each reading session (i.e. for each combination of reading mode and tracking type), the subject was required to read two texts: one by Saviano, and the other by Maffei. A single multiple-choice question was asked soon after the reading of each text. On average, the total amount of text being read at each session comprises 557.5 words (range: 524–586) and 24.5 sentences (range: 23–30). Sentences are, on average, 22.75 word tokens long (range: 1–90). A summary of the lexical and linguistic features of our reading texts is presented in Table 1.

4.4 Procedure

Overall, the entire experiment, consisting of four reading sessions, lasted around 30 min per participant. At each reading session, participants were asked to read two texts of two screen pages each, either silently or aloud, and their session was either

Table 1 Distributional features of lexical and phrasal stimuli

	Type	#	Mean	Range
POS types		12		
Word tokens		2230		
Word types		1024		
Word token length (by letters)			5.14	1–16
Chunk types		14		
Sentence length (by tokens)			22.75	1–90
Session text length (by tokens)			557.50	524–586

eye-tracked or finger-tracked. During the reading session, participants were instructed to put on a pair of wireless noise-cancelling headphones with a retractable microphone (BlueParrott S450-XT for the tablet sessions, Razer Nari Essentials Gaming Headset for the eye-tracking ones).

4.4.1 Eye-Tracking Protocol

Participants sat in front of a desk at about 60 cm from a 24″ DELL computer screen. An eye-tracker was placed below the screen, on the same desk. Participants used a five-button response box to proceed from one page to the next one, pressing a central green button. The same toolbox was used to answer the questions, by pressing one of the remaining buttons, numbered from 1 to 4. Eye movements were recorded via an Eyelink Portable Duo eyetracker (SR Research, Canada), which supports head-free eye-tracking with a reported accuracy of 0.25° to 0.50°. Only the right eye of each participant was tracked at a 500 Hz sampling rate. Texts were visualized in Arial (25pt), in black against a white background. Stimulus presentation and eye movements recording were handled with Matlab Psychtoolbox (Brainard, 1997; Kleiner et al., 2007). Compared to the tablet protocol, here the font size was increased to adjust for the larger participant-screen distance than the participant-tablet distance.

Participants were firstly instructed to read two passages on the computer screen while trying to keep as still as possible, without moving their head. Before the actual experiment started, a nine-point-calibration procedure was conducted until the average error was below 0.5° of visual angle. No chin-rest was used during the experiment in either reading modes. A practice reading excerpt from the Italian translation of a Harry Potter's novel was presented as training. After training and calibration, the actual texts were shown, with each passage followed by two multiple choice questions. Upon page changing, a drift correction was carried out to correct for small movements, and a stable fixation on a centrally located target was required before proceeding further.

4.4.2 Finger-Tracking Protocol

Participants sat in front of a desk on which there was a tablet placed on a tablet stand, resting on an anti-slip place mat to prevent accidental tablet displacement during finger-tracking. The tablets used for the study were 10.1 inches Samsung TAB A SM-T510N (1.8 GHz Octa-Core, 3 GB RAM, 64 GB eMMC, Android 10). The screen of the tablet was 14.9cm × 24.5cm with a resolution 1920 × 1200 pixels. The text was presented in Arial (21.25pt). For each text, the same word bounding box coordinates used by the tablet touchscreen were then used to define the text layout on the computer screen used in the eye-tracking sessions.

Before starting a real experimental session, participants were instructed to use the tip of the index finger of their dominant hand to point the text words displayed on the tablet while reading them. An excerpt from the Italian *Pinocchio* novel by Carlo Collodi was used for a brief practice session. Each participant read two passages, of two pages each, one silently and one aloud, one after the other. Each passage was followed by a single 4-choice question.

4.5 Data Processing and Measures

4.5.1 Eye-Tracking

Out of all 112 eye-tracked reading sessions, 24 were excluded from the analyses due to technical malfunctions during data acquisition or excessive noise artifacts in the fixation patterns (e.g., horizontal transposition; 19 sessions). This left us with an effective sample of 88 reading sessions (44 aloud, 44 silent) to be included in the analysis dataset.

A first automatic data trimming was conducted using an R script. Any individual fixation falling more than 60 pixels out of each text bounding box was excluded from the dataset (1.65% data loss). In addition, as the drift correction before each recording was done on a fixation point located in the center of the screen, early fixations falling below the Y-coordinate of the first line of the text were further excluded. Secondly, for each participant, a double visual inspection of fixation patterns was performed. Due to the fact that readers, prior to reading a text and after its completion, normally look at the text in an unpredictable manner, such fixations were manually excluded.

All these steps were taken to ensure optimal performance of the post-hoc drift correction algorithm, which was not designed to spot and exclude the aforementioned fixations. In particular, we used the "warp" algorithm developed by Carr et al. (2021), which was shown to achieve a very good performance. After the vertical drift correction, each fixation was assigned to the corresponding word if falling within its corresponding bounding box.

As a measure of word reading performance, Total Fixation Time (hereafter TFT) was used. It consists of the total time spent fixating a word, including regressions to the word, i.e. second-time fixations. For higher-order linguistic units such as chunks or sentences, the corresponding TFT was calculated as a summation of the TFTs of all words the higher-order unit spans over.

4.5.2 Finger-Tracking

For the tablet sessions, automatic text-to-finger alignment was enforced using a convolutional algorithm finding the closest match between text lines and touch event sequences. The bounding box of each character in the text was then used to calculate the finger-tracking time of the corresponding letter (or Letter Tracking Time, LTT). For each uninterrupted time series of touch events falling within a letter bounding box, LTT is then equal to the difference between the last time tick and the first time tick in the series of touch events.

As a measure of reading performance for any text unit (e.g. a word or a chunk), its Total Tracking Time (TTT) was then used. TTT consists of the total time needed to finger-track the text unit, including possible regressions to the unit (i.e. second-time tracking), calculated as a summation of the LTTs of all letters the text unit spans over.

5 Data Analysis

This section provides an analysis of reading data in both reading types (silent and oral) and for the two tracking protocols (finger-tracking and eye-tracking). As our main objective is to understand how finger-tracking data relate to eye-tracking data in text reading, the main focus will be on comparing total tracking times and total fixation times across the two reading modalities. Accordingly, we start with comparatively assessing how our eye-tracking data pattern across silent and oral reading; we then focus on finger-tracking data, to see how they differently behave in the two reading modes. Eye-tracking and finger-tracking data in each reading modality will then be meaningfully compared and discussed against this background.

5.1 Eye-Tracking

Eye movement patterns are known to differ between silent and oral reading both spatially (in terms of the number of fixated words and saccade amplitude) and temporally (in terms of fixation durations).

Our data are in line with the observation that parafoveal information significantly benefits silent reading more than oral reading in terms of a reduction in both fixation duration (measured by total word fixation times, see Fig. 2) and number of fixations (see Table 2). All in all, eye movement patterns in oral reading can be described

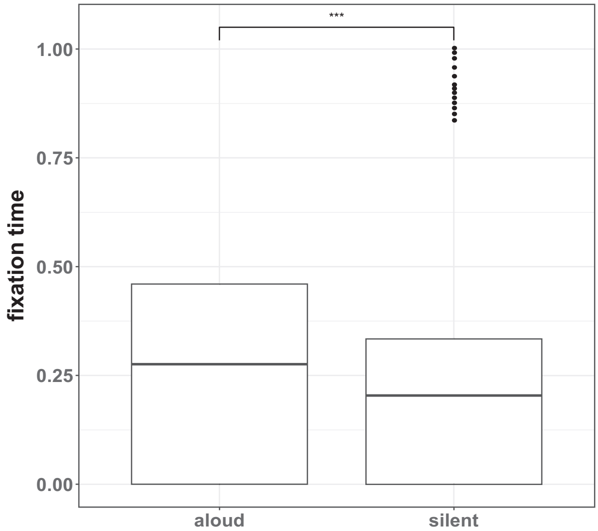


Fig. 2 Box plot distribution of word TFTs (in seconds) in adults' oral and silent reading

Table 2 Distribution of eye movement patterns across adults' oral and silent reading

	Oral		Silent	
	#	%	#	%
Single saccades (same line)	24,612		20,892	
Regressions	6365	26%	4786	23%
Fixations	25,608		22,363	
Backward fixations	9203	36%	6632	30%
Nonfixated words	5479	25%	6990	31%

as more "sequential" than those in silent reading: i.e. the former take smaller steps (i.e. shorter saccades, Fig. 3), make significantly longer fixations ($t(32116) = 31.17$, $p < .001$: Fig. 2), skip fewer words and, finally, make regressions more often (Table 2).

Such a difference is emphasized when we look at the way word TFTs are distributed across chunks of different length. Figure 4 shows a clear gap in the distribution of silent and oral word fixation times, which decreases with longer syntactic chunks: from one word chunks (chunk length = 1) to multiple word chunks (chunk length = 2, 3, 4).

The reason for such a decreasing gap becomes apparent when we look at the number of fixated words in chunks of different size, in oral (Table 3) and silent reading (Table 4). In silent reading, words are skipped more often than in oral reading. In fact, in silent reading, only 15% of 4-word chunks are fully fixated (i.e. no word in the chunk is skipped) against 24% in oral reading, and 6% of 4-word chunks are fixated on a single word only, against 1% of 4-word chunks in oral reading. Besides,

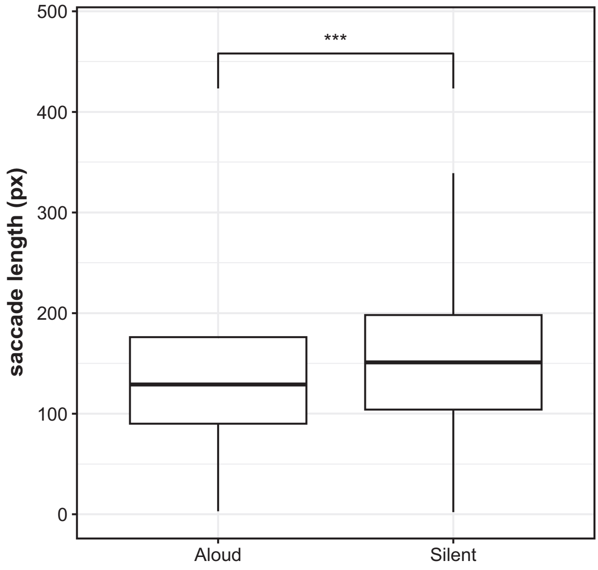
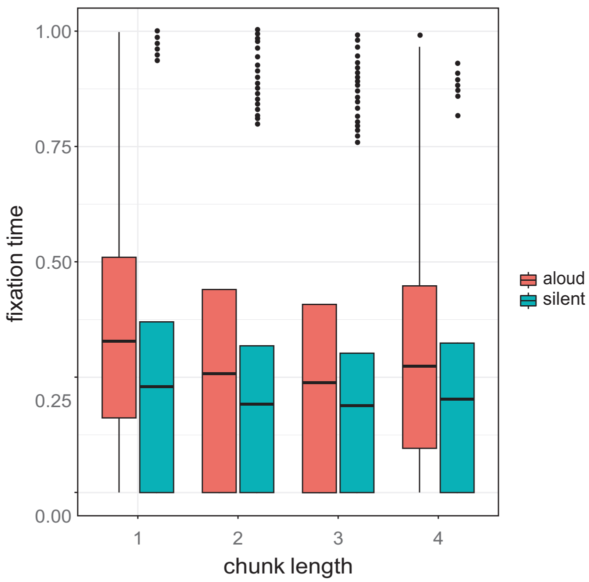


Fig. 3 Box plot distribution of saccade amplitudes (in pixels) for adults' oral and silent reading

Fig. 4 Box plots of word TFTs for chunks of increasing length in adults' oral (red boxes) and silent (cyan boxes) reading



in both oral and silent reading the percentage of fully-fixated chunks decreases with the length of the chunk (see Tables 3 and 4).

A non-linear regression model predicting word fixation time by word position in chunks, for chunks of different token length, sheds light on this pattern of data (Fig. 5). Word fixation time increases as subjects read more of a chunk, and

Table 3 Oral reading: distribution of nonfixated (#0) and fixated words in chunks of increasing length

	Ixated words in oral reading				
Chunk length in words	#0	#1	#2	#3	#4
1	1397 (19%)	5725 (81%)	0	0	0
2	131 (3%)	2584 (51%)	2348 (46%)	0	
3	17 (1%)	163 (12%)	730 (56%)	400 (31%)	
4	0	1 (1%)	33 (17%)	110 (58%)	45 (24%)

Table 4 Silent reading: distribution of nonfixated (#0) and fixated words in chunks of increasing length

	Ixated words in silent reading				
Chunk length in words	#0	#1	#2	#3	#4
1	1801 (25%)	5524 (75%)	0	0	0
2	195 (4%)	3183 (61%)	1883 (36%)	0	0
3	15 (1%)	294 (22%)	734 (54%)	315 (23%)	0
4	0	11 (6%)	57 (28%)	102 (51%)	30 (15%)

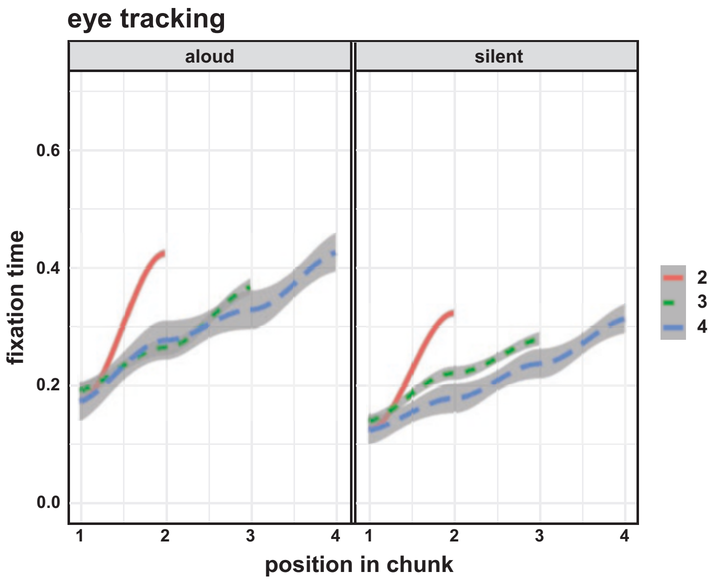


Fig. 5 Regression plots (*ggplot*) of interaction effects between chunk lengths in number of words and word position in the chunk for adults' oral (left) and silent reading (right)

culminates on the chunk's head, as shown by the ascending regression curves by chunk position. This appears to reflect the structure of a chunk. First, the chunk's head is the most prominent syntactic and semantic unit in the chunk, and plays a pivotal role in text processing and comprehension. Secondly, functional units in the chunk tend to take a more peripheral (chunk initial) position than lexical units, and are more likely to be skipped than words that are placed closer to the chunk's head. Incidentally, the processing impact of the chunk structure is similar in both silent and oral reading, as shown by the similar ascending lines in both regression plots.

5.2 Finger-Tracking

Word tokens are systematically and continuously finger-tracked in both silent and oral reading, with no significant difference in the (negligible) number of skipped (i.e. nonfixated) tokens (Table 5). Likewise, tokens are tracked more than once only occasionally in either mode, suggesting that adults' finger movements do not appear to follow eyes' regressive saccades (which are nonetheless frequent in both silent and oral adults' reading, as shown in Table 2), thus exhibiting a mostly one-way, forward-moving trajectory. Like with eye-tracking, silent reading significantly speeds up finger-tracking times ($t(59625) = 30$, $p < .001$: Fig. 6).

Plots of tracking time regressed on chunk length and chunk position (Fig. 7) highlight an interesting interaction between word tracking time and chunk length (measured by the number of word tokens within the chunk). In both oral and silent reading, we observe a clear effect of chunk structure on reading pace. The characteristically step-wise ascending patterns in the plots, with a similar, steepest increase in the tracking time of the head for chunks of different length, highlight, once more, the pivotal role of the head in chunk processing and the different processing loads associated with chunk-initial and intermediate units. This pattern is strongly reminiscent of what we observed for fixation data in the plots of Fig. 4.

We expect such a processing sensitivity to the internal structure of the chunk to have an effect on the average word tracking time for chunks of different length. In longer chunks more functional words are likely to be finger-tracked more quickly than the chunk's head. This expectation is confirmed by the box plots of Fig. 8, whose word tracking times in oral and silent across chunks of different length are strikingly similar to the patterns we observed for word fixation times in Fig. 4.

5.3 Finger-Tracking vs. Eye-Tracking

So far, we have observed patterns of reading behaviour across silent and oral reading, and have shown how they are recorded (fairly consistently) with eye-tracking and finger-tracking. Silent reading takes less time than oral reading, lexical heads increase processing demands and take longer to read, and longer chunks tend to speed up average word reading. In this section, we directly compare evidence in the two tracking protocols.

A cursory look at the density plots of both TTTs (total finger-tracking times) and TFTs (total fixation times) in adults' aloud reading (Fig. 9) shows, unsurprisingly, that most of the nonfixated words fall within the 1–4 letter range (as shown by the steep peak centred on $x = 0$, of the red density curve in the top left panel). Similarly,

Table 5 Distribution of finger movement patterns across adults' oral and silent reading

	Oral		Silent	
	#	%	#	%
Total tokens	31,059		30,037	
Tracked tokens	30,649	98.7%	29,637	98.7%
Nontracked tokens	410	1.3%	400	1.3%
Tracked more than once	529	1.7%	654	2.2%

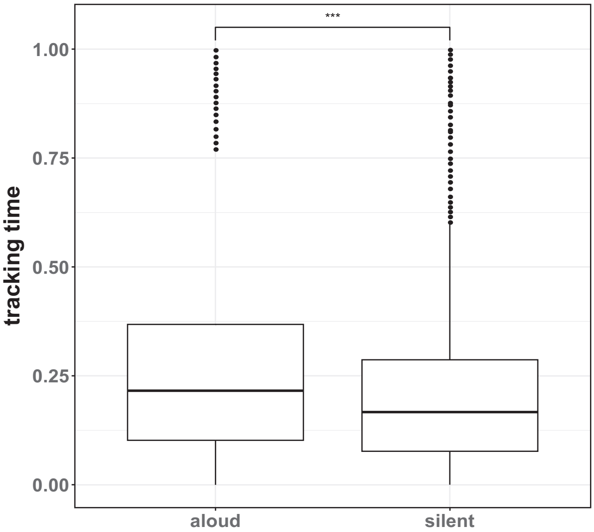


Fig. 6 Box plot distribution of finger-tracking times (in seconds) in adults' oral and silent reading of words

the few non-tracked words fall within the same range (light-blue density line). The effect of nonfixated tokens becomes negligible for longer words, where the two curves appear to exhibit a similar (unimodal) shape.

Table 6 shows correlation scores (Spearman *p*) between TTTs and TFTs in both aloud and silent reading of word tokens. Correlations are given for aggregate data, and by major lexical parts of speech. In each column, scores outside the parentheses are calculated after including all nonfixated tokens, while scores within parentheses are calculated after discarding nonfixated words. It is worth noting that scores between parentheses are comparatively smaller than the scores that are outside the parentheses. Since nonfixated words are mostly short, and finger-tracking times strongly correlate with word length (Spearman *p* .78, against .34 for fixation times), most nonfixated words are finger-tracked quickly, thus raising the correlation across word classes when they are included. As words are skipped more often in silent reading than in oral reading, the gap between correlation scores calculated after including nonfixated words and correlation scores calculated after discarding non-fixated words is larger for silent reading. For the same reason, function words

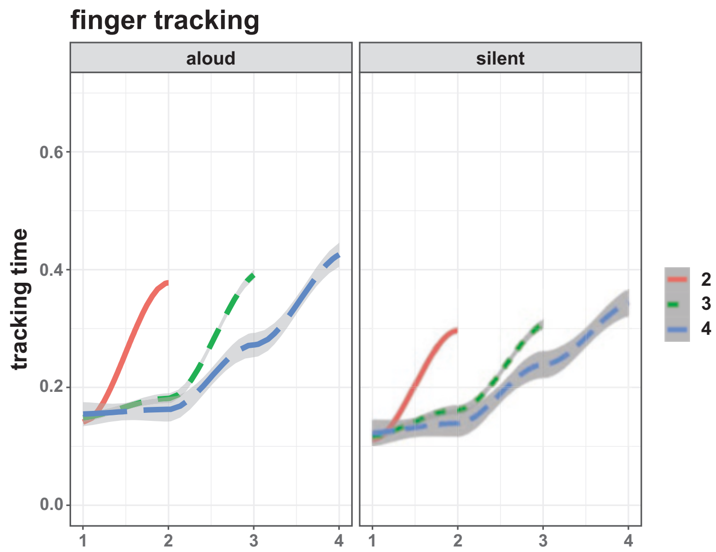


Fig. 7 Regression plots (*ggplot*) of interaction effects between chunk lengths in number of words and word position in the chunk for both adults' oral and silent reading

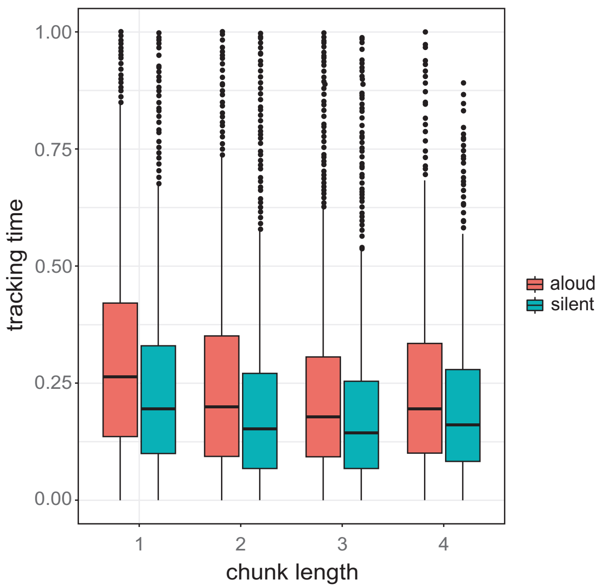


Fig. 8 Box plots of word TTTs for chunks of increasing length in adults' oral (red boxes) and silent (cyan boxes) reading

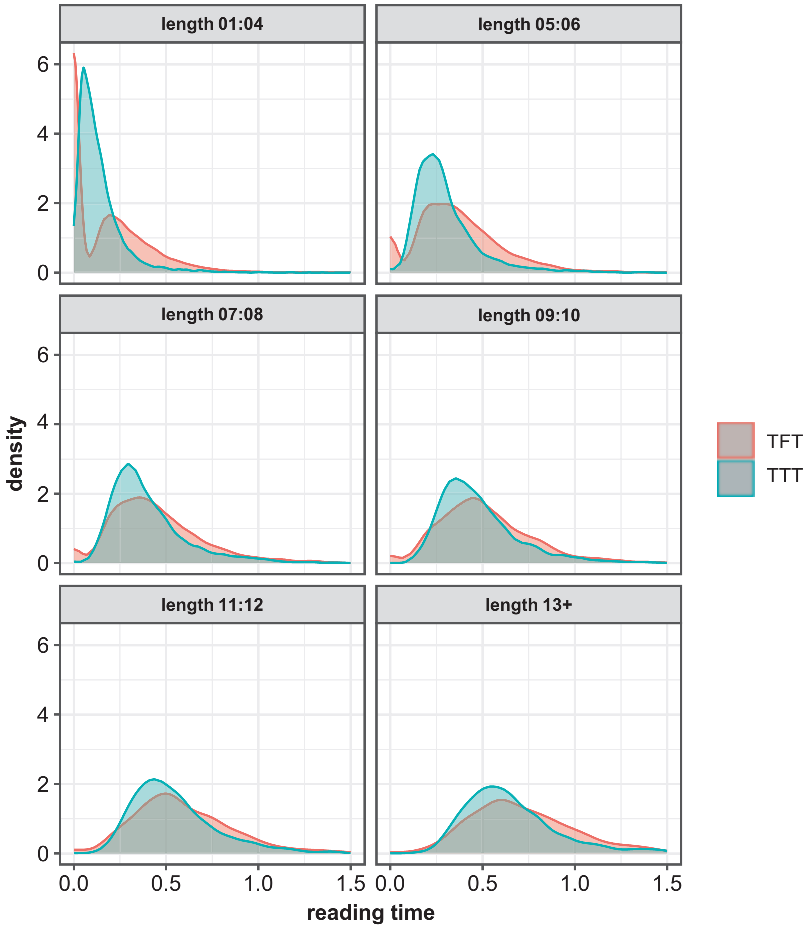


Fig. 9 Density plots of TFTs (red) vs. TTTs (light-blue) for tokens of increasing length in adults' aloud reading

present much larger gaps than lexical words (for silent reading, the *p* value is nearly halved without nonfixated words).

6 Discussion

Finger movements and eye movements reveal surprisingly consistent patterns of reading behaviour, with high correlations between total fixation times and total finger-tracking times at the level of individual words, chunks and sentences. Two major trends are worth reporting in this connection.

Table 6 Spearman *p*'s between TTTs and TFTs in aloud and silent reading of word tokens

Type	Aloud[a]	Silent[a]
ALL	.820 (.670)	.815 (.571)
LEXICAL TOKENS	.684 (.626)	.656 (.502)
FUNCTIONAL TOKENS	.709 (.505)	.716 (.365)
ADJECTIVES	.666 (.626)	.644 (.506)
ADVERBS	.723 (.649)	.701 (.484)
NOUNS	.577 (.550)	.550 (.469)
VERBS	.787 (.687)	.736 (.527)

[a]Scores in parentheses are calculated after discarding nonfixated words

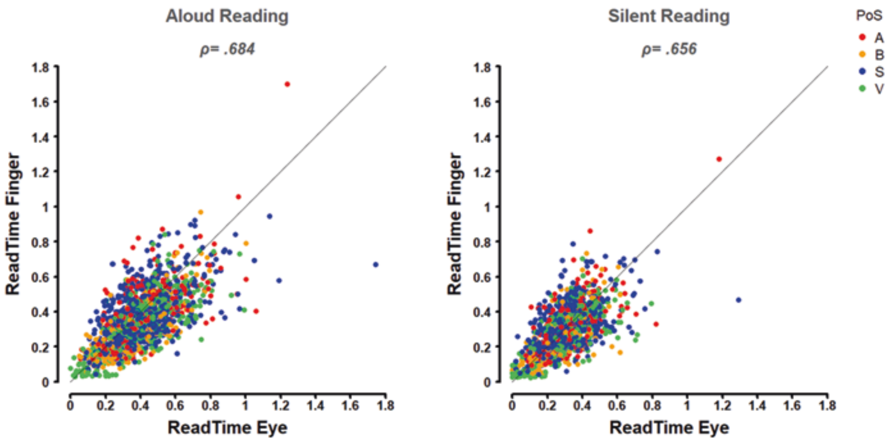


Fig. 10 Scatter plot of TTTs vs. TFTs in adults' aloud/silent reading of adjectives (A), adverbs (B), nouns (S) and verbs (V)

Firstly, Spearman *p* correlation values grow with embedding levels of linguistic units, ranging, in oral reading, from .617 on the word level (Fig. 10), to .787 on the chunk level (Fig. 11) and .99 on the sentential level (Fig. 12). This means that although the two signals are not perfectly synchronised with either letters or words, they nonetheless tend to be in step at the end of major linguistic units (i.e. chunks or sentences). Such an increase in time correlation can be an effect of noise reduction in time aligned data. In fact, the likelihood of finding occasionally misaligned data (e.g. a word that is wrongly assigned the fixation of an immediately preceding or an immediately ensuing word) goes down when text units are chunked together and the alignment window is widened. However, such a significant increase in correlation cannot be the sheer effect of noise reduction. In addition, we conjecture that finger movements, eye movements and sound articulation tend to keep in step at the end of major linguistic units such as chunks or sentences, where reading can naturally pause to give room for text integration and comprehension.Secondly, fixation and tracking times are more highly correlated in oral reading than in silent reading. We

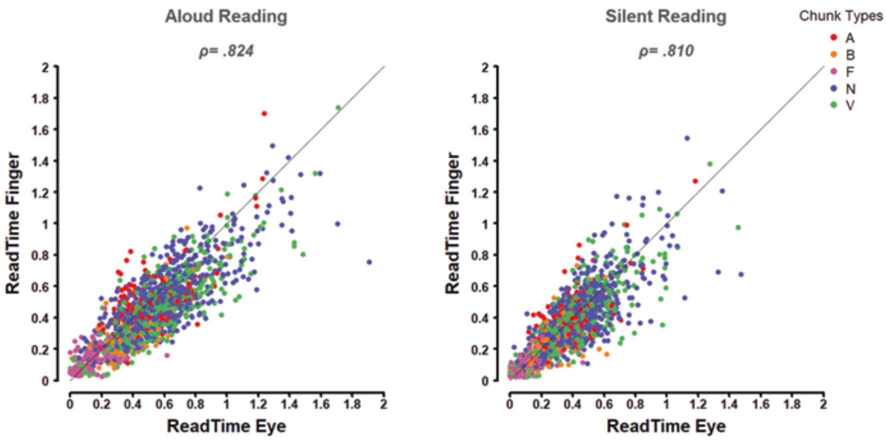


Fig. 11 Scatter plot of TTTs vs. TFTs in adults' aloud/silent reading of adjectival (A), adverbial (B), functional (F), nominal (N) and verbal (V) chunks

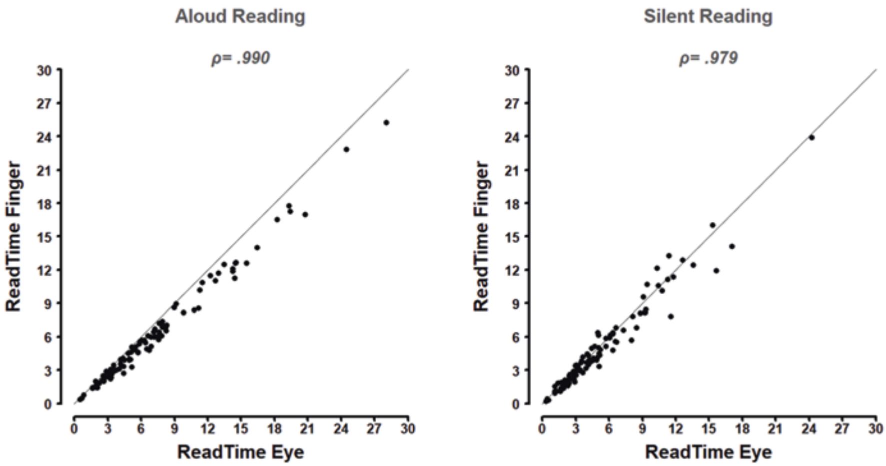


Fig. 12 Scatter plot of TTTs vs. TFTs in adults' aloud/silent reading of sentences

conjecture that this is due to the sequential and continuous dynamic of finger movements, which is more consistent with an oral reading strategy (more and longer fixations, shorter saccades) than a silent reading strategy (fewer and shorter fixations, longer saccades).

Overall, the evidence presented here suggests a nontrivial interaction between eye and finger movements. During reading, eye movements and finger movements are initiated independently and at different speeds, with a likely later start of the finger. The eyes have the main role of processing the text and initiating decoding and articulation (either covert or overt). The finger plays the subsidiary role of pace making and place holding at the end of major syntactic units. This function is more compatible with a more rapid and somewhat inertial series of forward movements.

Both TFTs and TTTs appear to be modulated and constrained by overt articulation (for oral reading) or covert articulation (for silent reading). This is proved by the influence of reading mode on both TFTs and TTTs. In the eye-tracking literature, there is considerable evidence of the influence on the Eye-Voice-Span (EVS) on adult readers' oculomotor planning. Laubrock and Kliegl (2015) offer a compelling working memory interpretation of this influence. To prevent words from exceeding the memory capacity of the orthographic input buffer and thus being skipped in reading, the oculomotor system reduces its pace to stop EVS from exceeding working memory capacity, or refreshes old items in working memory with regressive saccades. Since full articulation is slower than covert articulation, the slowing down effect of keeping EVS to a manageable amplitude is stronger in oral reading. As to the text-pointing finger, a slightly different way to achieve the same goal is pursued. According to our evidence, the finger does not appear to follow regressive eye saccades; it rather slows down its pace at natural linguistic boundaries, such as the end of a chunk or a sentence, where eye and finger movements are eventually kept in sync.

To check the impact of word length on word position in chunk (for chunks of different length) in the two reading modalities – oral and silent – and across the two experimental protocols – finger and eye-tracking – we ran four Generalized Additive Models (or *GAMs*) with word's position in chunk, word length and chunk length as independent variables predicting fixation and tracking times, including subjects as random effects. All models are fairly robust (see parametric coefficients for eye-tracking models in Tables 7 and 8, and for finger-tracking models in Tables 9 and 10).

Table 7 *GAM* fitted to TFT in aloud reading, using word position in chunk, chunk length in number of words, and word length as fixed effects, with subjects as random effects

	Estimate	ST.E	T Value	PR(>|T|)
Intercept	.276	.0083	33.21	<2e-16 ***
Position in chunk	−.029	.0029	−10.01	<2e-16 ***
Chunk length	−.005	.0023	−2.23	.02 *
Word length	.0326	.0005	61.63	<2e-16 ***
Subjects	<2e-16 ***			
Dev. explained	53.2%			

Table 8 *GAM* fitted to TFT in silent reading, using word position in chunk, chunk length in number of words, and word length as fixed effects, with subjects as random effects

	Estimate	ST.E	T Value	PR(>|T|)
Intercept	.249	.0114	21.73	<2e-16 ***
Position in chunk	−.013	.0027	−4.88	<1e-6 ***
Chunk length	−.004	.002	−2.11	.03 *
Word length	.0186	.0005	37.77	<2e-16 ***
Subjects	<2e-16 ***			
Dev.. explained	47.5%			

As expected, word length slows down reading. The effect is more prominent in oral reading than in silent reading (consistent with the higher cost of concurrent overt articulation), and affects finger-tracking more than eye-tracking. In fact, finger movements are continuous through space: they do not skip words and do not benefit from parafoveal vision as much as eye movements do. Chunk length (measured by the number of words making up a chunk) is an accelerating factor. This is also shown by the regression plots of Figs. 5 and 7, where differences in slope across chunks of different lengths are always significant for finger-tracking data only. Note, finally, that the position of a word within a chunk turns out to have opposite effects in eye-tracking (where it speeds up fixation times),[2] and finger-tracking (where it slows down finger movements). We interpret the speeding-up effect of word position on fixation times as the compounded benefit of parafoveal (anticipatory) information and incremental chunk processing. Later words in a chunk are more likely to be predicted and easier to be integrated than earlier words, due to the concurrent availability of reader's topdown (syntactic) expectations and bottom-up (parafoveal) information. That no such effects are observed in finger-tracking seems to suggest that finger movements are less sensitive to complex top-down and bottom-up processing effects, and confirms that finger-tracking is more compatible with a sequential reading strategy.

Table 9 *GAM* fitted to TTT in aloud reading, using word position in chunk, chunk length in number of words, and word length as fixed effects, with subjects as random effects

	Estimate	ST.E	T Value	PR(>|T|)
Intercept	.0575	.0055	10.40	<2e-16 ***
Position in chunk	.0189	.002	9.07	<2e-16 ***
Chunk length	−.0312	.002	−19.29	<2e-16 ***
Word length	.0489	.000	137.65	<2e-16 ***
Subjects	<2e-16 ***			
Dev.. explained	47.7%			

Table 10 *GAM* fitted to TTT in silent reading, using word position in chunk, chunk length in number of words, and word length as fixed effects, with subjects as random effects

	Estimate	ST.E	T Value	PR(>|T|)
Intercept	.0243	0095.	2.56	.01 *
Position in chunk	.0125	.0017	7.144	<9e-13 ***
Chunk length	−.0156	.0014	−11.46	<2e-16 ***
Word length	.0395	.000	131.59	<2e-16 ***
Subjects	<2e-16 ***			
Dev.. explained	50.4%			

[2] The effect is not shown in the regression plot of Fig. 5, whose model does not include word length as an independent variable.

To sum up, in adults' reading the finger appears to play the twofold role of pace maker and place holder. It slides smoothly across the text units until it reaches a suitable syntactic boundary where EVS is checked and kept down to a manageable span with either longer fixations, or regressive saccades. This explains why tracking times are, on average, shorter than the corresponding fixation times. Since finger-tracking is mainly guided by syntactic and prosodic information, while playing little role in actual decoding, its pace is modulated by natural syntactic joints, as well as stress and pauses within prosodic domains. This account explains why the correlation between tracking times and fixation times increases with levels of text analysis: from words to chunks, to sentences. Ultimately, it is at the level of the sentence, arguably the largest EVS-checking domain, that the two measures correlate nearly perfectly, as the end of the sentence is where articulation and eye movements are eventually synchronized. This also provides some reason why the correlation of tracking times and fixation times is higher in oral reading than in silent reading. As observed above, in silent reading eye movements are less sequential, parafoveal vision plays a more extensive and effective role, and saccades are longer. When skipping a long stretch of nonfixated words widens EVS, the ensuing fixation gets longer to compensate for it, and because of heavier processing demands (Kliegl et al. (2006)). The finger, as we saw, typically does not skip words: nonetheless, its pace must be fast enough, on both nonfixated and fixated words, to catch up with the eyes, and this reduces the correlation between tracking times and fixation times at the word level. If our interpretation of the role of text pointing in adults' reading goes in the right direction, then finger-tracking data are not only more compatible with a sequential reading strategy, but they even favour such a strategy, by serially pacing fixations. In the end, although text pointing in adults' reading no longer plays the role of direction/attention controller that is observed in child reading, nonetheless it may force the eyes to behave in a more "oral" reading mode, whether articulation is overt or not. Clearly, to prove this, one needs to eye-track and finger-track a reader at the same time, which is something we intend to do in future trials.

7 Conclusions

Of late, finger and eye movements have been found to provide highly congruent dynamic patterns during exploration of images that are displayed on a computer's touchscreen (Lio et al., 2019). This is not surprising *per se*, and relates to previous work on the synergistic behaviour of fingers and eyes in tasks requiring synchronization of fast eye movements and the slower motor system controlling the fine coordination of finger movements (e.g., Furneaux & Land, 1999; Inhoff & Gordon, 1997). To our knowledge, however, no one has so far investigated the concurrent dynamics of adults' eyes and fingers in a highly demanding cognitive task such as reading. Albeit preliminary, the evidence reported here shows, for the first time, that the two patterns strongly correlate in adults' reading. This is in line with previous evidence (Marzi et al., 2020; Taxitari et al., 2021) reporting a somewhat more expected correlation in child's reading, where text finger-pointing is known to help beginning readers control directional movement, attention focus and voice-print match (Mesmer & Lake, 2010; Uhry, 2002). Here, we focused on the role of text pointing in adults' reading, where it has arguably lost its directional or attentional role.

Adults' finger-tracking times and eye fixation times appear to correlate highly in both oral and silent reading. Their correlation is far from being perfect at the word level, as the two dynamics appear to fulfill different functions and follow a different pace. In adults' reading, the eyes take the leading role. They are responsible for processing the written text, and filling in the orthographic buffer with appropriately encoded time series of letters, ready to be converted into sounds. Although they are autonomous from articulation, fixation times are paced by the need to keep the Eye-Voice-Span to a manageable amplitude. Due to the limited capacity of the orthographic short-term working memory, the eyes' processing speed is bounded by the articulatory rate of the reader. At any given point in time, each word in the orthographic buffer must be read aloud before it is replaced by other upcoming words. In this dynamic, major linguistic units such as syntactic chunks and sentences can play the role of EVS-checking domains. At the end of each chunk, a natural reading pause helps keep articulation and visual processing in step. It looks like finger-tracking in adults' reading plays the role of marking these supralexical domains. Incidentally, this does not mean that the pace of finger-tracking reflects only supralexical levels of processing. Some laboratory evidence not discussed here shows that the finger-tracking speed is also modulated by word stress and word structure patterns, particularly in longer words. Nonetheless, it is at the level of larger linguistic structures that finger-tracking times are more closely related to fixation times, at least in adults' reading.

Our results highlight the usefulness of finger-tracking data as a proxy of more established reading evidence, like eye-fixation data, which nonetheless appears to require more sophisticated and invasive protocols for data collection. We showed that an integration of Artificial Intelligence and Natural Language Processing technologies, exposed as web services on a cloud-based architecture, and a simple web application running on a common tablet, can go a long way toward collecting rich behavioral data that have so far been confined to highly controlled laboratory settings. In addition, reading data collected with finger-tracking are remarkably naturalistic, because they involve full text reading on a very simple and friendly device like a tablet.

We believe that finger-tracking has the potential to offer novel opportunities for reading research, by complementing existing evidence and protocols with new data, which are particularly interesting to investigate from a developmental perspective. For example, we conjecture that a turning point in reading development may involve a radical change in the use of text pointing during reading: for a mature reader, the finger stops playing the role of attention and direction tracker to acquire the subsidiary role of a pace maker and a marker of EVS-checking domains.

The great potential of mobile information technology and cloud computing for huge data collection and analysis makes the finger-tracking methodology especially suitable for extensive reading assessment activities in primary schools. The computing architecture described here supports highly parallel and distributed processes of data acquisition, which can be delivered in real time to research, clinical and education centers as terminals for data modeling and quantitative analysis. Large-scale studies can be conducted, paving the way to more generalizable results than ever in the past. In addition, the possibility to take single-subject measurements on more occasions and in different settings makes finger-tracking evidence suitable not only for group studies, but also for individual diagnostic purposes and large developmental studies.

A recent piece of (neuro)cognitive literature has raised serious concerns regarding the detrimental effects of digital technology on reading and cognitive development (Baron, 2015; Carr, 2020; Greenfield, 2015; Maffei, 2018; Wolf, 2018). However, evidence that digital reading interferes with learning and cognitive development is still inconclusive, and mostly based on internet text materials and digital books which are not optimally enhanced for educational purposes (Kong et al., 2018; Clinton, 2019; Furenes et al., 2021). Although we are ready to acknowledge that educational digital editing is still in its infancy, and much more effort should be put into redesigning present digital formats for child reading, we believe that current advances in information technology (e.g., machine learning, natural language processing and artificial intelligence, but also portable devices and cloud computing) may enable new forms of reader-book interactivity and content adaptivity, based on a detailed assessment of the child's reading profile. In the near future, assistive digital technologies may compare well with current adult reading mediation (at home or in the classroom), boosting emergent readers' motivation and self-confidence, and helping educators assess and address specific reading difficulties. At the same time, this will provide massive, naturalistic data for quantitative analysis and modeling in reading research, thereby advancing our understanding of reading and cognitive development at an unprecedented rate.

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Part IV
Social and Environmental Diversity

Development in Diverse Socioeconomic Environments: How Resilient Are Different Language Domains?

Ayhan Aksu-Koç and Burçak Aktürk Arı

For Dorit, a long time friend from Istanbul to Vienna, for talking morphology, sharing projects, eating good food and more. Cheers to our years together.

Abstract In the present study we explore the linguistic outcomes of monolingual Turkish-learning children from three socioeconomic backgrounds in the domains of vocabulary, inflectional morphology and morphosyntax, on the basis of the cross-sectional maternal report data of a large sample of 16–36 months olds. Results indicated faster rate of growth and higher levels of attainment for children from high socioeconomic backgrounds compared to children from low socioeconomic backgrounds, confirming the findings in the literature. Taking the time of emergence of differences between groups as an index of resilience vs. sensitivity to adverse environmental effects, we show that vocabulary and morphosyntax are more sensitive domains of grammar compared to inflectional morphology, which constitutes the core component of Turkish grammar and is the most resilient to adverse effects.

Keywords Turkish · Language development · Mother report data · Vocabulary · Inflections · Morphosyntax · Resilient vs. fragile

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1 Introduction

The study reported in this chapter examines whether Turkish-speaking children of families from high, middle and low socioeconomic backgrounds differ in rate of development and level of attainment in the domains of vocabulary, morphology and syntax.

Research accumulating since Hart and Risley's (1995) seminal work has shown that family socioeconomic status (SES) has significant effects on the course of children's language development during the early years. Studies have focused on the acquisition of vocabulary and grammar, revealing substantial disparities between children from various socioeconomic backgrounds (see Rowe, 2018; Schwab & Lew-Williams, 2016, for reviews). However, to the best of our knowledge, SES comparisons for the acquisition of morphology are scarce, except for the inspiring work of Dorit Ravid and her colleagues focusing on morpholexical development in the speech of Hebrew-speaking children (Ravid & Schiff, 2006; Ravid et al., 2020; Schiff & Ravid, 2012). In the present chapter, we examine the effects of SES on morphology as well as vocabulary and grammar in the acquisition of Turkish, a typologically different language where morphology and syntax are inherently related. In considering the three domains simultaneously, we focus on the rate of growth in each to understand how they get to be coordinated and integrated.

There are suggestions in the literature that aspects of language may be differentially affected by conditions specific to learners or to learning environments (Goldin-Meadow, 2014; Tsimpli, 2014). We explore our data from this standpoint as well, thinking that comparisons of children's developmental trajectories from the lower and the higher ends of the socioeconomic scale are likely to give us nuanced information about which domains of language are more robust and which are more open to the effects of environmentally adverse conditions. For this purpose, we consider the time of emergence of differences between groups in each domain, taking early separation of trajectories as an indication of sensitivity.

The chapter is structured as follows. After a brief overview of the major findings in the literature on SES differences in early acquisition and the associated input characteristics, we introduce our conceptual framework and our study. Then we present our methodology and our findings in some detail. We conclude with a summary and discussion of our results.

2 Socioeconomic Status, Input, and Early Language Outcomes

Associations between child outcomes and educational and occupational levels of parents, along with the nature of the language input they direct to children, have been shown for both the lower and the higher ends of the socioeconomic scale, with "the magnitude of the SES-related differences depending on the range of SES in the sample studied" (Hoff, 2006: 61). This body of research has manifested SES effects in many aspects of children's language learning, among which vocabulary and syntactic development stand out as key domains.

Regarding vocabulary, Hart and Risley (1995) demonstrated that already by age 3, children of lower-SES families receiving public assistance had smaller expressive and receptive vocabularies and a slower growth rate than children of professional families (an average of 500 words compared to the 1000 words, respectively) and working-class families (an average of 700 words). The striking gaps between these groups were related to differences in language input. High-SES parents directed more talk, more diverse vocabulary, and more complex sentence structures to their children and were more responsive in their interactions as compared to low-SES parents, while working-class parents fell in between these two groups.

Research using different assessment techniques including mother reports, longitudinal investigations of spontaneous speech, standardized tests and off-line and on-line experimental methods have corroborated Hart and Risley's results. Studies have explored maternal education as the key mediator between SES and child outcomes (Arriaga et al., 1998; Dolloghan et al., 1999; Hoff & Tian, 2005), demonstrating robust relations between lexical quantity, lexical diversity and sentence complexity of maternal input, and lexical quantity, lexical diversity and utterance length in children's speech (Fernald et al., 2013; Hoff, 2003, 2006; Hoff & Naigles, 2002; Huttenlocher et al., 1991; Pan et al., 2005; Rowe, 2008, 2012; Rowe et al., 2012; Tamis Le-Monda et al., 2001; Weizman & Snow, 2001; d'Apice et al., 2019, among many others). Compared to low-SES mothers, high-SES mothers use more diverse vocabulary, longer and syntactically more complex utterances, and more repetitions and elaborations, all associated with larger vocabulary size and faster rate of development in children's language.

Variation across SES levels has also been demonstrated for grammatical development. Children from high-SES backgrounds score higher on standardized tests and tests of complex syntax (Dolloghan et al., 1999; Huttenlocher et al., 2002) and produce more complex utterances with more diverse syntactic structures in spontaneous speech than children from low-SES backgrounds (Hoff, 2003, 2006; Huttenlocher et al., 2010; Rowe, 2012; Vasilyeva et al., 2008). The source of these differences is identified as the use of more diversified syntactic constructions, more multi-clause sentences, and higher numbers of noun phrases per utterance by high-SES caregivers with higher levels of education. Use of recasts with partial repetitions and display of fine-grained differences for syntactic structures in 'variation sets' are also observed to be more frequent in the input of middle- and high-SES compared to low-SES caregivers (Alam et al., 2021; Hadley et al., 2017; Hoff, 2006; Tal & Arnon, 2018).

Recent research has focused on the beginning of infancy and traced the precursors of SES differences in input to the social-emotional context of early adult–child interaction (Golinkoff et al., 2015). Caregiver responsiveness to infants indexed by amount of adult–child interaction and child-directed speech (Bergelson et al., 2019; Gilkerson et al., 2017), mother's volubility of talk (more utterances and conversational turns and longer speech durations) (Vanormelingen & Gillis, 2016), and use of nonverbal cues to word meaning (Cartmill et al., 2013) are found to be less frequent in low-SES than high-SES environments. The availability of these input practices impacts positively on the number of child vocalizations and amount of engagement in turn taking (Gilkerson et al., 2017), and predicts vocabulary (Newman et al., 2016) as well as rate of development (Cartmill et al., 2013). It should be noted, however, that despite the observed differences in input quantity, findings also show high within-group variability in input quality due to individual variation across parents (Cartmill et al., 2013; d'Apice et al., 2019; Gilkerson et al., 2017; Vanormelingen & Gillis, 2016; Weisleder & Fernald, 2013). These differences in children's social-interactional environments and practices pertaining to language learning have been observed in many diverse speech communities, such as Dutch (Vanormelingen & Gillis, 2016), Australian (Dwyer et al., 2019), and Israeli (Ravid & Zimmerman, 2017), in addition to American (Golinkoff et al., 2015, among many others).

Studies exploring the impact of SES on the early language development of Turkish-speaking children provide support for the positive contributions of advantageous family ecologies similar to those described above. In a nationwide representative sample Baydar and Akçınar (2015) demonstrated direct relations between maternal education, family economic well-being and receptive word knowledge of 36–47-month-olds. Children of higher-SES households who had more learning materials, more stimulation for learning and more responsive mothers also had richer vocabularies. In the same sample, maternal vocabulary was the most substantial contributor to receptive vocabulary of the children of both high-SES and low-SES families, whereas a warm mother–child relationship and contiguous responses to child utterances were strongly associated with children's lexical knowledge when other family resources were insufficient (Baydar et al. (2014). Exploring factors related to the receptive vocabulary development of four-year-olds, Ekerim and Selcuk (2017) found that the use of inductive reasoning and explanations expressed with more sophisticated and longer verbal input by mothers with higher education and income levels predicted vocabulary knowledge of the children 1 year later. Input-output relations have also been shown in case studies carried out with a few children. Comparing two girls from a high- and a low-SES background, Aksu-Koç (2014) found close associations between maternal input and child output on lexical diversity, tense-aspect morphology and mean length of utterance (MLU). The mother–child dyad of high-SES background displayed notable advances over the low-SES dyad on all three measures after a ten-month interval. Turkish mothers' conversational and bookreading styles similarly show that middle- and high-SES mothers with higher education produce more utterances per event and more elaborative statements with new information in their talk about past events (Küntay & Ahtam, 2004), use explanatory speech with emphasis on reasoning and cause–effect relations in their behavior regulating talk (Sen et al., 2014), and employ a more collaborative style (providing and requesting decriptions, relating events to child's experiences and maintaining a conversation) in their bookreading practices (Ünlütabak et al., 2021) as compared to low-SES mothers.

In summary, children's learning environments that differ in SES also differ in the extent to which they provide stimulating adult–child interactions and enriched language input, which are in turn shaped by the norms of the different cultural contexts they are embedded in (Hoff & Tian, 2005; Rowe & Weisleder, 2020).

3 Conceptual Framework and the Current Study

The above review of the literature shows that children of low-SES families receive relatively impoverished input compared to children of middle- or high-SES families and acquire language at a slower pace of development. In a critical article on bilingualism, Tsimpli (2014: 283) has noted that "even half the input suffices for early language development, at least with respect to the core aspects of language". She defines 'core' by looking at monolingual development for features and structures that are acquired early, late and very late. She argues that what is acquired early and does not depend on input quality represent the 'core' aspects of language, whereas structures that are acquired late and depend on input quality represent those aspects that interface with cognitive, semantic, pragmatic and discourse factors. In a similar vein, Goldin-Meadow (2014: 73) has proposed that properties of language that are robust across a range of learners and learning environments may be identified as developmentally 'resilient'; in contrast, those that are sensitive to changes in the input and learners are developmentally 'fragile'. She notes that "To the extent that variability in either learner or learning environment has no impact on the acquisition of a linguistic property, we have evidence that the development of this property is resilient, at least with respect to this factor" (2014: 68).

As crosslinguistic evidence shows, core (resilient) properties are language specific. In each language, those grammatical properties that are acquired early are the ones that characterize languages into types (e.g., OV vs. VO order, null subject property) (Tsimpli: 288–289). Studying children acquiring typologically different languages from demographically different backgrounds can inform us about which properties are resilient vs. fragile in a specific language. The current study aims to do this by bringing together the two lines of inquiry: one on the effects of SES as a learning environment, and the other, on the resilience of different domains in face of such effects for children acquiring Turkish, a morphologically rich language typologically different from the more often studied Indo-European ones.

3.1 Morphology, a Resilient Component of Turkish Grammar?

Turkish is an agglutinating language with canonical SOV order, free to vary in accordance with pragmatic constraints. In contrast to English, where word order is used to mark grammatical relations, Turkish primarily relies on the suffixation of case inflections on nouns and agreement markers on verbs. Both noun and verb inflection (including tense-aspect-mood) paradigms are regular, the morphemes are syllabic, acoustically salient, semantically transparent with almost a one form: one meaning relationship. Their word-final position reinforced by word-final stress renders inflections perceptually salient.

Noun and verb morphology are accessible early in acquisition and emerge at the same time and with few errors (Aksu-Koç, 2010; Aksu-Koç & Ketrez, 2003; Aksu-Koç & Slobin, 1985; Ekmekçi, 1982; Ketrez & Aksu-Koç, 2009). While SOV is the preferred order by both adults and children (Batman-Ratyosyan & Stromswold, 2001; Slobin & Bever, 1982), position cannot serve as a strong cue for syntactic relations. Children, therefore, learn to attend to inflections in order to assign grammatical roles to sentence constituents early on. Lexical and morphological development are closely related for the same reason, that position is only a weak cue and children rely on the distinct distribution of noun and verb inflections as the source of information for the abstraction of these lexical categories (Göksun et al., 2008; Ketrez & Aksu-Koç, 1999; Küntay & Slobin, 2001; Slobin & Bever, 1982; Ural et al., 2009). Evidence for morphological development and the use of the verb as a syntactic category is found already before the age of 2;0 (Aksu Koç, 2010; Aksu-Koç & Slobin, 1985; Dressler et al., 2007; Ketrez, 1999; Xanthos et al., 2011). Inflectional morphology is thus a crucial component of Turkish grammar and can be expected to be a resilient property.

3.2 Research Questions

The present study examined the effects of SES on child linguistic outputs in data that come from the two poles and the middle of the continuum of parental educational and income levels, and asked the following research questions: (1) Do the children of high, middle and low SES groups differ in terms of rate of development and level of outcome in vocabulary, morphology and syntax? (2) Do the domains of language differ in terms of resilience vs. fragility as indicated by the age at which differences between groups emerge?

As noted above, morphology constitutes the central component of Turkish grammar, obligatory in simple sentence formation, and is, therefore, not likely to be affected by adverse effects of the learning environment. On the other hand, vocabulary, an open word class, and MLU, an indicator of morphosyntactic development conditioned by cognitive and discourse factors, are likely to be responsive to the quality of the learning environment. We therefore do not expect children of different SES backgrounds to differ with respect to the acquisition of basic inflectional morphology but predict differences between groups with respect to lexical and morphosyntactic knowledge. The time of emergence of differences between SES groups compared across domains will further inform us about which domains are resilient because acquisition is early and development proceeds at the same pace across learning environments, and which domains are fragile because acquisition is relatively late and development proceeds at different paces.

4 Method

4.1 Participants

We addressed our questions using the large sample parent report data collected in the norming study of the Turkish Communicative Development Inventory (CDI-TR henceforth) (Aksu-Koç et al., 2019), the Turkish adaptation of MacArthur-Bates CDI (Fenson et al., 2007). The CDI-TR-II sample for toddlers analyzed here comprises a total of 2414 monolingual 16–36 months old children acquiring Turkish. Mothers from low, middle, and high socioeconomic backgrounds from four major cities were interviewed during home visits. In the selection of the sample SES was determined based on family income level and mothers' education. Extensive sociodemographic information including the HOME scale was also obtained during the interviews (Baydar et al., 2008).

For the present analyses, we used a comprehensive SES index estimated as a factor score on the basis of the highest level of education for each parent, monthly per person expenditures of the family, and material possessions in the household. Using this index, our sample was well balanced in its distribution of the different SES groups: 35% of the entire sample was classified as low-SES, 34% as middle-SES, and 31% as high-SES. On average, high-SES mothers had 13 years of education (65% with a college degree or above) and low-SES mothers had 6 years of education (66% with 5 years of primary school). Middle-SES mothers were in between, with 10 years education (58% with 11 years of secondary school).

4.2 Data

The CDI-TR Words and Sentences has subsections designed to tap vocabulary, use of noun and verb inflections, compositional use of verb inflections for complex tense-aspect-mood, use of coordinating and subordinating devices as an index of complex syntax and MLU based on the child's three longest utterances. Parents were asked to indicate whether their child displayed the language behaviors listed under each subsection. Research indicates that parental reports are accurate representations of children's language skills during the first three years and have been used in many studies of language development (Fenson et al., 2007; Anderson et al., 2021: 4). Reliability and validity information for CDI-TR can be found in Aksu-Koç et al. (2019) and Aktürk (2012). In the following sections, we talk about "children's expressive vocabulary" rather than "children's vocabulary as reported by mothers", for the sake of ease of presentation.

4.3 Study Variables

Expressive Vocabulary The expressive vocabulary scale of CDI-TR-II consists of 711 words that belong to 21 semantic categories corresponding to those of the CDI (e.g., sound effects and animal sounds, animals, vehicles, toys, foods, body parts, people, action words, places to go, descriptive words, pronouns, time words and more). Mothers indicated the words that they believed their children used. Since this is a checklist, the words for expressive vocabulary represent lexical quantity and lexical diversity at the same time.

Noun and Verb Inflections CDI-TR-II contains a section asking about the use of 11 inflections, six case inflections[1] (accusative *-(y)I,* dative *-(y)A,* locative *-dA,* ablative *-dAn,* genitive -(*n)In* and the possesive marker *-(I)m* and five verb inflections (past *-DI,* present/ imperfective *-(I)yor,* future *-(y)AcAk,* evidential *-mIş* and aorist *-(A/I)r* that constitute the basic morphology for the construction of simple finite sentences. For each inflection, the mothers were asked whether their child used the specific inflection as illustrated in an example (e.g., "Does your child use the suffix *-A* as in *park-a?"* (park-DATIVE) 'to the park'; "Does your child use the suffix *-DI* as in *git-ti?"* (go-PAST) '(he) went')).

MLU MLU in CDI inventories is calculated as the average of the morphemes or words of the three longest intelligible utterances of the child that the caregiver could remember. In the present study MLU was calculated as the average number of morphemes. As Fenson et al. (2007) note, although MLU based on three longest sentences may have a somewhat augmented value compared to MLU based on 100 utterances produced by the child, it is considered to be a reliable index of productivity and also valuable for comparative purposes. The use of MLU as an index of morphosyntactic development for Turkish-speaking children was established by Ege et al. (1998) who demonstrated a high correlation (r = .83) between age and MLU for children between 17–59 months.

5 Results

To address our question regarding SES differences in the rate of development in the domains of vocabulary, noun and verb inflections and morphosyntax in child output, we conducted three linear multiple regression analyses with age and SES as predictor variables. To answer our question regarding the resilience of domains

[1] Affixes alternate according to the rules of vowel harmony, which operate in terms of the high/low, front/back and rounded/unrounded phonological contrasts. Consonant assimilation and other regular morphophonological processes also apply. Alternating vowels and consonants are represented by uppercase characters.

to adverse environmental effects, we conducted 4 (Age: 16–20, 21–25, 26–30, 31–36 months) x 3 (SES: low-SES, middle-SES, high-SES) ANOVAs to locate the developmental age at which differences between SES groups emerge in each domain. For post-hoc analyses, we adjusted for multiple comparisons using the Bonferroni correction.

We first present the findings related to differences between groups in rate of growth in vocabulary, noun and verb inflections and MLU in child output. Then, we discuss the time of emergence of differences between groups in each domain.

5.1 SES Effects on Rate of Growth of Vocabulary, Inflectional Morphology and Morphosyntax

5.1.1 Vocabulary

The regression analysis revealed that age, SES and their interaction were significant contributors to vocabulary development (all *p's* $< .001$), accounting for 49% of the variance. At the mean age of 26 months, children from low-SES backgrounds produced significantly fewer words ($M = 294$) than their counterparts from middle-SES families who produced on average another 46 words ($M = 340$), while children from high-SES backgrounds produced on average another 76 words ($M = 367$). As expected, children's vocabulary increased across groups of increasing age, yet the rate of this development was dependent on children's learning environments, as indicated by the significant interactions of age with SES. The rate of increase for every additional month was significantly lower for children of low-SES (26 words) than for children of middle-SES (29 words) and high-SES backgrounds (31 words). These differences intensified by 36 months, resulting in increasing gaps between the SES groups.

5.1.2 Noun and Verb Inflections

The results of the regression analysis for noun and verb inflections showed that age, SES, and the interaction of age x high-SES (all *p's* $< .05$) were significant predictors of this outcome variable, accounting for 43% of the variance. The age x middle-SES interaction was not significant. At the mean age of 26 months, the mean number of inflections produced was lower for the children of low-SES families ($M = 6.23$) than for the children of middle-SES ($M = 6.68$) and high-SES families ($M = 6.67$). The number of inflections produced increased across groups of increasing age. The rate of increase for every additional month of age was significantly lower for children of low-SES families (0.44) than the rate of increase for children of high-SES (0.49), but was not significantly different from the rate of increase for the children of middle-SES families (0.45). The results, thus, indicated that even in the case of inflectional morphology, the pace of development for children of low-SES backgrounds was slower relative to the pace of development for children of high-SES backgrounds.

5.1.3 MLU

For morphosyntactic development, the regression results revealed that age, SES and the interaction of age x high-SES were significant predictors (all *p's* < .001), accounting for 34% of the variance. The age x middle-SES interaction was not significant. At the mean age of 26 months, children from low-SES backgrounds produced utterances with fewer number of morphemes ($M = 5.18$) than their counterparts from middle-SES families who produced .27 morphemes more ($M = 5.45$), while children from high-SES backgrounds produced .80 more morphemes, thus longer sentences on average ($M = 5.98$). Children's MLU increased across groups of increasing age. The rate of increase for every additional month was significantly lower for the children of low-SES ($M = .27$ morphemes) than for the children of high-SES families ($M = .36$), while it was not significantly different from the rate of increase observed for the children of middle-SES families ($M = .30$).

A correlation analysis for the association between the outcome values of vocabulary, inflections and MLU within each SES group indicated that development in the three domains progresses in parallel. The partial correlations, with the effects of age controlled, between inflections and vocabulary were $r = .76$ for the high-SES, $r = .62$ for the middle-SES and $r = .66$ for the low-SES groups. The correlations for inflections and MLU were $r = .52$ for the high-SES, $r = .47$ for the middle-SES and $r = .51$ for the low-SES groups, while the values for vocabulary and MLU were $r = .54$ for the high-SES, $r = .46$ for the middle-SES and $r = .53$ for the low-SES groups. These moderate to high correlations, which were all significant at *p's* < .001, point to the almost simultaneous progress and integration of competence in the three domains, particularly between vocabulary and noun and verb inflections.

5.2 SES Effects on Time of Emergence of Differences Between Groups in the Three Domains

5.2.1 Vocabulary

The ANOVA results revealed that age, SES, and their interaction (all *p's* < .001) were a source of difference between groups in lexical development. Significant differences between mean vocabulary scores of children from low-SES ($M = 197$) and high-SES ($M = 284$) backgrounds emerged early, within the 21–25 months age range and persisted throughout 31–36 months. A difference between children from low-SES and middle-SES backgrounds emerged later, between 26–30 months ($M = 348$ and $M = 443$, respectively) but was no longer significant for the

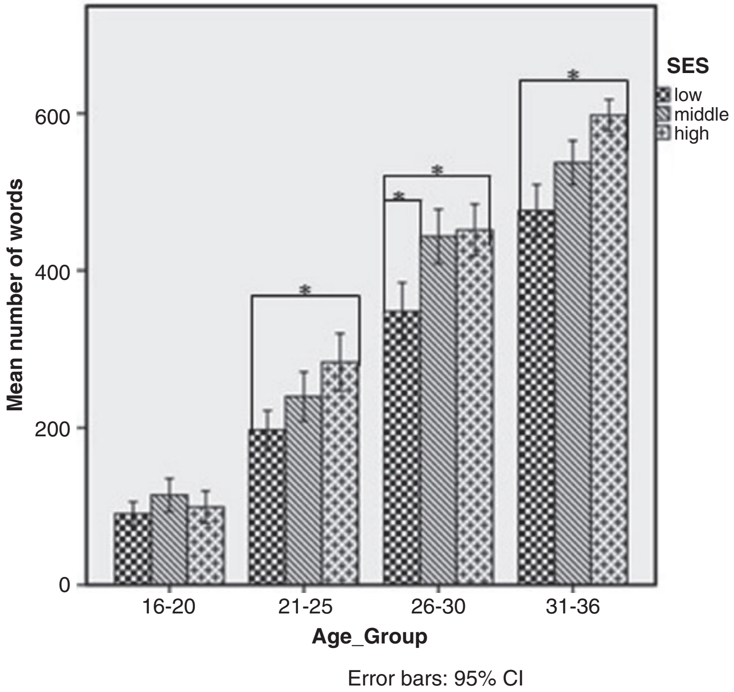

Fig. 1 Vocabulary as a function of age group and SES

31–36 months age range. The difference between high-SES and middle-SES groups was also not significant, but a trend ($p = .092$) towards an emerging gap appeared between 31–36 months, indicating that with age, the children of the high-SES group made a bigger advance in vocabulary than the children of the middle-SES group (see Fig. 1). The mean number of words for the 31–36 months age range was 476 for the children of low-SES, 537 for the children of middle-SES, and 598 for the children of high-SES families. It is observed in Fig. 1 that the vocabulary level of children from the three SES backgrounds was the same in the 16–20 months age range, that differences emerged between the more disparate low-SES and high-SES groups earlier than between groups closer in terms of their learning environments, and that differences between groups increased with increases in age.

5.2.2 Noun and Inflections

The ANOVA results revealed significant effects of age, SES, and their interaction (all p's $< .01$) indicating that the use of inflections by children of low-SES families ($M = 7.07$) was significantly lower than the use of inflections by children of both high-SES ($M = 8.51$) and middle-SES families ($M = 8.49$) in the 26–30 months age range. SES differences were not observed either in the 21–25 months age range

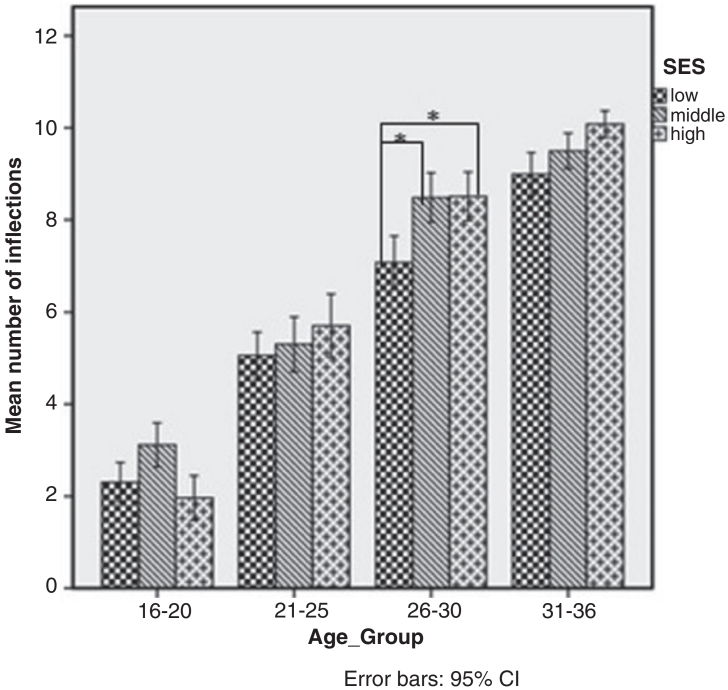

Fig. 2 Noun and verb inflections as a function of age group and SES

when the means were very similar across the three SES groups (M = 5.35), nor in the next age period (31–36 months) when almost all the children were producing the 11 inflections investigated. At 31–36 months, the mean number of inflections used was 8.99 for the children of low-SES, 9.50 for the children of middle-SES, and 10.08 for the children of high-SES families (see Fig. 2). These findings indicate that inflectional morphology was affected by the disadvantageous environmental conditions of the low-SES groups during the age period where a spurt in rate of growth was observed for the children of the high-SES and middle-SES groups, as discussed above. In other words, children of the low-SES group lagged behind their peers in the production of simple sentences for some limited period of time.

5.2.3 MLU

According to the ANOVA results, both age, SES, and their interaction (all p's $< .05$) were a source of difference between groups in MLU in morphemes. Figure 3 shows that the MLU values for the SES groups were almost equal during the 16–20 months (M = 3.11) and the 21–25 months age periods (M = 4.65). A difference between children of low-SES and high-SES groups appeared as a trend ($p < .085$) between 26–30 months. Significant differences emerged between 31–36 months, when the

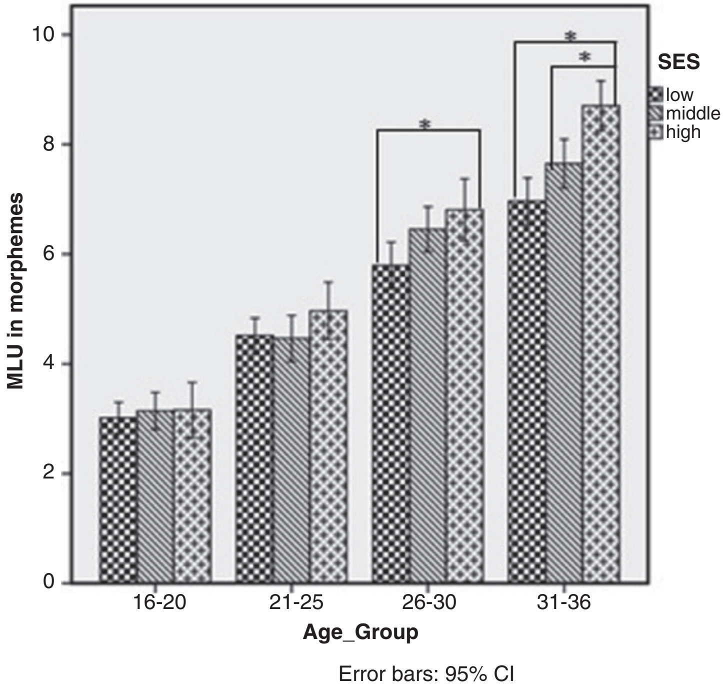

Fig. 3 MLU as a function of age group and SES

MLU values for the children of high-SES families (M = 8.70) were higher than those for the children of low-SES and middle-SES families (M = 6.96 and M = 7.65, respectively). The low-SES and middle-SES groups did not differ in MLU within the period investigated. Figure 3 illustrates the gradual differentiation between the SES groups that becomes apparent for the older age groups. The children from high-SES backgrounds who displayed an advance over the other groups in lexical knowledge also showed an advance in MLU.

In view of the developmental age at which differences between SES groups emerge, we conclude that vocabulary and morphosyntax are fragile domains susceptible to adverse environmental effects while basic inflectional morphology is more resilient.

6 Discussion and Conclusion

In the present study, we asked whether SES differences in learning environments is a source of variation in Turkish children's early outcomes and rate of development in vocabulary, inflectional morphology and morphosyntax. We also wanted to see if the three domains were differentially affected by SES, taking early emergence of differences between groups to indicate lower resilience of that domain to adverse effects. With these questions, we examined a large sample of maternal report data of 16–36 months old monolingual Turkish learning children across four age groups and three SES levels. This preliminary analysis of the data has demonstrated that using an aggregate of three measures provides a valuable means for the exploration of the interrelations of the three domains of vocabulary, inflectional morphology and morphosyntax, and comparisons across three SES levels provides a fruitful terrain for the identification of factors that lead to optimal development.

To summarize the findings, the earliest differences emerged in vocabulary within the younger age range of 21–25 months and later differences were observed in MLU in the older age range of 26–30 months, between children of low-SES and high-SES backgrounds. The pace of development of children from middle-SES backgrounds was faster than that of their peers from low-SES in vocabulary within the 26–30 months period but lagged behind that of their peers from high-SES, in both vocabulary and MLU, in the next age range (31–36 months). As expected, high-SES children had richer vocabulary and higher MLU values by the time they were 36 months old in comparison to their peers from the other two groups. Contrary to our prediction, SES differences were also observed in the domain of noun and verb inflections; children of both high-SES and middle-SES groups had a significant advantage over children of low-SES backgrounds in terms of rate of growth and outcome levels within the 26–30 months period, but the differences evened out by 36 months when all groups had acquired the 11 inflections. Inflectional morphology was the only domain where the middle-SES group did not fall behind the high-SES group.

Among the three domains, the correlation between vocabulary and inflections was found to be higher at each SES level than the correlations between vocabulary and MLU or between inflections and MLU. In view of the inherent connection between lexical and morphological development underscored by Ravid et al. (2020) in their most comprehensive article, this is not surprising. Slower rate of growth in basic inflectional development for the low-SES group may be interpreted as a reflection of their slower rate of growth in the lexical domain. As these authors succinctly note, “in languages with a rich morphology, lexical growth interfaces with morphology earlier on and in more ways …” (2020: 601). However, the developmental lag closes fast, as “… morphology is learned early on in environments where crucial information is expressed through morphology.” (Ravid et al., 2020: 620). Evidence for the way in which lexical growth and morphology interface in Turkish is found in Slobin and Bever (1982) and Göksun et al. (2008), where it is shown that children interpreting Turkish sentences use nominal morphology. Ural et al. (2009), on the other hand, provide evidence from input, demonstrating that the presence of the accusative inflection on nominals and past tense inflection on verbs in child-directed utterances serve as significant cues for classifying transitive and intransitive verbs, and distinguishing between subtypes of intransitive verbs.

Regarding our first research question, the results indicate that learning environments that differ in SES are indeed a source of variation in Turkish children’s rate of growth and outcome levels attained in the three domains. The magnitude of the variation was found to depend on the range of SES sampled; differences emerged earlier, with different rates of growth, in more domains (i.e., vocabulary and morphosyntax), and in greater amounts between environmentally more disparate groups (high-SES and low-SES) than between either of these groups and middle-SES. Although we do not have input data from the mothers, the composite index used in forming our SES groups includes the main indicators associated with input quality. Thus, taking SES as a proxy for input, we explain the findings by referring to the social and material resources characteristic of the three SES groups. Most important among these are the educational level of mothers and the amount and richness of the talk they direct to their children. In the present study, 67% of the high-SES mothers whose children had more advanced skills in all three domains had college level education. As has been shown in comparable large scale studies (Baydar et al., 2014; Baydar & Akçınar, 2015) and smaller sample and case studies (Aksu-Koç, 2014; Ekerim & Selçuk, 2017; Küntay & Ahtam, 2004; Ünlütabak et al., 2021), Turkish mothers with higher education, that is, a college degree or more, and moderate to high levels of economic resources, use more diversified linguistic input with elaborative sentences, provide access to more educational and play materials that stimulate learning, and maintain more sensitivity and emotional responsiveness towards their children compared to mothers with lower levels of education and material resources. Availability of these input properties that characterize the child-directed speech of high-SES caregivers and impact children's vocabulary development as reported in the studies mentioned above, are likely the source of variation in the vocabulary development of the children of the present sample as well.

As noted above, we did not expect knowledge of noun and verb inflections, the use of which represents the ability to construct simple sentences (e.g., *park-a git-ti* (park-DATIVE go-PAST) '(he) went to the park'), to be affected by environmental factors. Previous case studies with children of middle to high SES professional parents have shown that Turkish children acquire this basic morphology around age 2;0 (Aksu-Koç & Ketrez, 2003; Aksu-Koç & Slobin, 1985; Ketrez & Aksu-Koç, 2009; Xanthos et al., 2011). The present findings are striking in showing that disadvantaged learning conditions, where parental education levels and associated input quality are less than optimal, have a bearing even on this most pivotal component of Turkish grammar in terms of pace of acquisition.

SES differences in morphosyntax emerged in the older age range, between 31 and 36 months. Since MLU does not inform about the internal structure and syntactic diversity of utterances, it is difficult to know whether the observed differences represent increased syntactic complexity or just increased utterance length. It can be argued that the MLU values observed for the 31–36 months age range involve increased sentence length as well as some syntactic complexity, as represented by infinitival object complement and converb clauses, which are among the early acquired complex clause types (Aksu-Koç, 2010; Aksu-Koç & Slobin, 1985). Interpreted in that way, these results, which show SES differences in morphosyntactic knowledge, but not in knowledge of noun and verb inflections obligatory in the construction of simple sentences – except for the brief period between

21–26 months – agree with the results reported by Vasilyeva et al. (2008: 93), who found SES differences in the mastery of multi-clause complex sentences but not in the early mastery of simple sentences with basic syntactic rules. These authors argue that "despite variability in the amount of talk of mothers with different levels of education, children from different backgrounds show similar developmental patterns in mastering the use of obligatory elements of simple sentences."

The findings also respond to our second research question by showing that the three domains vary in their sensitivity to effects of disadvantageous environments. Earlier and greater differences between SES groups emerged in vocabulary and morphosyntax, indicating that they are more open to environmental effects. In contrast, differences between SES groups in noun and verb inflections were observed only for a limited period, indicating that this domain is the least affected by disadvantageous environmental conditions. Interpreting these results in Goldin-Meadow's and Tsimpli's terms, we conclude that both lexical and morphosyntactic knowledge, which progressively interface with cognitive, semantic and pragmatic constraints, depend on development with age and rich input (Tsimpli, 2014) and are therefore more fragile domains (Goldin-Meadow, 2014), whereas knowledge of the noun and verb morphology necessary in the construction of simple sentences constitutes the core component of Turkish grammar and is the most resilient to adverse effects.

Finally, the answers to our two research questions provide some directions for when and how to offer intervention for children growing up in disadvantaged learning environments. With respect to timing, the answer is, as early as possible, as indicated by the research of the last three decades concerning SES differences in language development. With respect to how, our findings suggest designing programs to support parents with information about how to provide child-directed speech with high quantity and quality of input starting in infancy, using as much diverse vocabulary and syntactic constructions as possible, with expansions, elaborations, and contingent talk with a lot of turn-taking within affectionate interactive contexts (e.g., Bergelson et al., 2019; Cartmill et al., 2013; Dwyer et al., 2019; Gilkerson et al., 2017; Golinkoff et al., 2015; Hadley et al., 2017; Vanormelingen & Gillis, 2016).

As for the limitations of the present study based on maternal report data, future research should make the cross-domain and cross-SES comparisons using data directly collected from children and caregivers, starting at a much earlier age in infancy using a longitudinal design, explore relations between lexical development and derivational as well as more complex inflectional morphology, and use online as well as offline methods for assessment of pace of development.

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Morphological Verb Families in German-Speaking Children and Parents of Two SES Backgrounds According to a Groundbreaking Model by Dorit Ravid and Colleagues

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Abstract In the last decades Dorit Ravid and her colleagues have developed a groundbreaking model of Hebrew verb morphology from a usage-based acquisitionist perspective focusing on early child speech and child-directed speech of children and parents of different socioeconomic status (SES) backgrounds. They found a denser, more elaborative and more diverse verb morphology in the speech of higher SES parents and children.

We apply essential parts of Ravid et al.'s model to German, a non-cognate and typologically different language that nevertheless shares some important features with Hebrew (e.g., stem vowel change, but much less frequently and regularly, and only in regard to one root vowel), but shows also productive derivational verb prefixation and particle verb formation. Based on spontaneous speech recordings conducted with 29 children (15 higher SES, 14 lower SES, aged 2;11–4;11) acquiring German as their first language, we investigate morphological verb families in German, in both parental input and child output, by using Ravid et al.'s model. Results confirm the expected SES differences and show that the model is appropriate for German (mutatis mutandis due to the differences in productive verb

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derivation) and thus can serve as a basis for subsequent typological comparisons between the two languages and possibly others.

Keywords German morphology · Verb morphology · First language acquisition · Usage-based approaches · Socioeconomic status · Parental input

1 Introduction

Our joint research with Dorit Ravid and her colleagues has always focused on cross-linguistic studies on the acquisition of Hebrew and German, often also in comparison with other languages (e.g., Ravid et al., 2008, 2010; Nir-Sagiv et al., 2008; Basbøll et al., 2008; Dressler et al., 2011; Tribushinina et al., 2014). This chapter is another building block in this very fruitful cooperation and a great opportunity to honor Dorit's impressive work. It is based upon our joint work on the acquisition of causativity in Hebrew and German (Ashkenazi et al., 2018) and it is inspired by Dorit's groundbreaking studies on SES and language acquisition. Even the fact that we applied for the project presented in this chapter was largely influenced by Dorit's stimulating conference presentations as well as by her encouraging advice.

The main aim of our chapter is the investigation of SES and age effects in longitudinal German data of naturalistic parent-child interaction by adapting structurally central parts of Ravid et al.'s model to German verb derivation. We compare child-directed speech (CDS) of parents to child speech (CS) of their children and discuss differences between these two types of speech. Finally, we compare our results to our Israeli colleagues' results on SES effects in Hebrew CDS and CS.

2 Patterns of Verb Derivation in the Acquisition of Hebrew and German

Being a morphologically rich Semitic language, Hebrew is characterized by non-continuous consonantal roots and predominantly vocalic affix patterns (Ashkenazi et al., 2016: 506–507). For verbs, there are seven *binyan* (i.e., 'building') conjugation patterns, of which the following five (non-passive ones) are relevant for early language acquisition (Ashkenazi et al., 2016: 507) (Table 1).

Whereas the root expresses the semantic core of the verbs, the *binyan* conjugation patterns group the verbs into syntactic, semantic and lexical aspect functions (Ravid, 2003, 2019; Ashkenazi et al., 2020: 511). Full (or regular) roots are considered to be structurally transparent, whereas defective (or irregular) roots often contain only a part of the root and lead to non-canonical and opaque stems, which are more difficult to identify and to acquire (Levie et al., 2020: 10).

Table 1 Five non-passive *binyan* conjugation patterns of the root *ħ-š-b* 'think'

Pattern	Semantic meaning of derivational pattern	Example	English translation
Qal	Basic	*xashav*	Think
Nif'al	Low-transitivity, middle voice, reflexivity, reciprocity	*nexeshav*	Be prominent
Hif'il	High-transitivity and causativity	*hexeshiv*	Consider
Pi'el	High-transitivity, but less causativity	*xishev*	Calculate
Hitpa'el	Middle voice, reflexivity, reciprocity	*hitxashev*	Be considerate

After Ashkenazi et al. (2016), Ravid (2019) and Levie et al. (2020)

The usage-based approach of Dorit Ravid's research group is characterized by the following innovative aspects (Ashkenazi et al., 2016: 509):

> First, it focuses on the root-and-pattern verb composition that has mainly been associated with later, derivational morphology development, showing why this structure is critical for the early learning of inflectional verb morphology. Second, it incorporates information on the development of verb structure in both CDS and CS, thus highlighting the foundations of verb learning in both parental input and child output and the relations between them.

Our colleagues' results (Ashkenazi et al., 2016, 2020; Levie et al., 2020) showed that Modal Cluster[1] stems based on defective roots (especially those belonging to the basic *Qal* category) serve as a starting point for the acquisition of verbal derivational morphology, with particularly high token frequencies in early caregiver-child interaction. However, type frequencies of full roots were higher than of defective roots (Ashkenazi et al., 2016). Full roots were also identified as the major contributors to children's derivational and lexical growth as well as to their inflectional development (Ashkenazi et al., 2020: 527). Overall, there were high correlations between CDS and CS corpora.

Contrary to Hebrew, German is a weakly inflecting Indo-European language. One major difference to Hebrew is that not all German verb patterns are derived from specific roots, at least from a synchronic perspective. Underived base verb forms are even the most frequent verb types in child speech and child-directed speech. Basic modal verbs (e.g., *müss-en*[2] 'must', *woll-en* 'want') also belong to this underived group, but they may be combined with separable particles in colloquial elliptic constructions when a main verb may be left out if it is clear from the context (e.g., *weg#müss-en* 'away.PTL must.V = have to (go) away', *rein#woll-en* 'into.PTL want.V = 'want (to come) in').

One important distinction concerns regular, irregular and subregular verb inflection because it also has an impact on derivation: Whereas regular verbs form their

[1] The Modal Cluster consists of infinitive, imperative and future tense forms, which fulfill important basic pragmatic functions in early input and output (Ashkenazi et al., 2016: 509).

[2] To distinguish the main categories of verb morphology to be investigated, we mark inflectional affixes with –, inseparable derivational affixes with + and separable particles with #. German verbs are usually listed in the infinitive form, which has an inflectional *-(e)n* suffix.

past tense[3] with the suffix *-t* and their passive past participle (PPP) with the circumfix *ge-X-t* without changing their stems (e.g., PPP *ge-land-et* 'landed'), subregular and irregular verbs often change their stems in these forms, subregular verbs in a more transparent way than irregular verbs, as in English (e.g., subregular *sing-en* – *sang* – *ge-sung-en* 'sing', a pattern that is found in several other verbs as well, in contrast to irregular *bring-en* – *brach-t-e, ge-brach-t* 'bring', which is isolated). Similar stem changes do not only occur in inflection but also in unproductive implicit root derivation of irregular and subregular verbs (e.g., inflection *gehen* – past *ging* – PPP *ge-gang-en* 'go' → derived N *Gang* 'walk; aisle' → unproductive causative root verb derivation with ablaut + weakly productive iterative *+el* suffix: *gäng* + *el-n* 'to boss sb around, lit. to make sb go repeatedly, see Table 2). Further

Table 2 German verb derivation patterns

Pattern	Productivity, morphosemantic transparency, frequency of derivational pattern	Semantic meaning of derivational pattern	Example	English translation
Underived	(Very frequent)	–	*geh-en*	'to go'
Root and/or suffix derivation	Less productive, weakly productive or unproductive, of medium frequency	Sometimes causative, iterative, diminutive, onomatopoetic	*gäng+el-n*	'to boss sb around'
(Separable) particle derivation	Very productive, transparent and frequent	Transitive or intransitive, sometimes causative	*mit#geh-en*	'to go with (sb)'
(Inseparable) prefix derivation	Less productive, often opaque, less frequent	Transitive or intransitive, sometimes causative	*be+geh-en*	'to commit' (e.g., a crime), 'to mark' (e.g., a ceremony), lit. 'to go on [transitive]'
Particle and prefix derivation	Partially productive and transparent, vvery rare	Transitive or intransitive, sometimes causative	*mit#be+geh-en*	'to commit (a crime) together with (sb/sth)', 'to mark (a ceremony) together with (sb/sth)'

[3] It should be noted that compound perfect forms (Aux + PPP) are largely preferred over past tense forms in oral Southern German. This holds for our corpus as well: We find 4224 tokens of past participles, but only 1055 tokens of past tense forms. 90.2% (or 952 tokens) of past tense forms occur with copular and modal verbs, the rest with predominantly stative verbs (e.g., *hab-en* 'have', *wiss-en* 'know', *find-en* 'find, consider to be') in mostly narrative contexts (see e.g., Welke, 2005). Therefore, the influence of past tense forms in CDS on children's acquisition of verb patterns will be rather limited.

root derivations are the less[4] productive conversions[5] (e.g., the above example *land-en* from N *Land* ‘land’ or *summ-en* from onomatopoetic *summ!* ‘hum, sound of bees’). Forms containing weakly productive iterative or diminutive suffixes like +*el* were also classified as part of the same pattern (root and/or suffix derivation) because they are often combined with root derivations and a further distinction between all these subcategories would be very hard to draw. Another category is the highly productive, transparent and frequent particle verb category containing a separable particle before the verb stem (e.g., *mit#geh-en* ‘to go with (sb)’, see Table 2). These particles are often homonyms of prepositions or adverbs, thus mostly transparent, and they are also very salient because they are both stressed and appear often in sentence final position, in finite verb forms appearing in main clauses, *ich geh-e mit* ‘I go with (sb)’. In contrast, inseparable prefix verbs (e.g., *be* + *geh-en* ‘to commit, to mark’, see Table 2) are often opaque and their prefixes are always unstressed and never appear sentence-finally. Combined particle and prefix derivations (e.g., mit#be+geh-en ‘to commit XX together with sb’) are productive, but they are very rarely used in everyday speech.

All studies on the acquisition of derivation in German find that for verbs, separable particle verb derivation emerges earliest and is largely acquired up to age 4 (e.g., Mattes, 2018; Sommer-Lolei et al., 2021a; Sommer-Lolei, in prep). In contrast, inseparable prefixes are rarely used productively until age 4 and continue to develop until school age (Behrens, 1998; Rainer, 2010; Mattes, 2018: 241). Root derivations (including conversions and implicit derivations with stem changes) as well as suffix derivations are occasionally used but there is little evidence of productivity before age 6 (Mattes, 2018: 247).

3 Socioeconomic Status (SES), a Crucial Factor in Children’s Language Acquisition

The influence of caretakers’ socioeconomic status (SES) on children’s language acquisition is a crucial topic in first language acquisition research. Dorit Ravid has been one of the leading researchers in this context, providing particularly groundbreaking evidence on acquisition of Hebrew morphology and literacy. Studies conducted by Dorit and her team have shown high correlations between SES and early as well as later language competencies. Their results (e.g., Ravid, 1995; Ravid & Schiff, 2006; Schiff & Ravid, 2012; Ravid & Zimmerman, 2017; Levie et al., 2017, 2019) are consistent with numerous studies from the US and Europe showing that SES has decisive effects on children’s linguistic and cognitive development (Hart & Risley 1995; Brito & Noble, 2014; Romeo et al., 2018a, b) and thus for school

[4] With “less productive” we mean here less than fully but still quite productive, i.e., more than weakly productive (for criteria of productivity see Dressler, 2007).

[5] Or zero derivations in other frameworks.

performance (Walker et al., 1994; Nelson et al., 2011): Especially a large vocabulary as well as the capacity to understand and produce complex grammatical structures (Vasilyeva & Waterfall, 2011) play an important role for the acquisition of various further academic skills relevant in the school context, e.g., reading (Verhoeven & Vermeer, 2006; Schiff & Lotem, 2011) and writing (Ravid et al., 2015) or mathematics (Verdine et al., 2014).

The most important mediating variable between SES and children's linguistic proficiencies is parental language input (Weisleder & Fernald, 2013; Weizman & Snow, 2001; Huttenlocher et al., 2010). In their seminal study on the language experience of 42 American children aged 1–3, Hart and Risley (1995, 2003) demonstrate that by age 3, children from professional (= HSES) families have had 30 million words of cumulative experience more than children from welfare (= LSES) families, an experience which is clearly reflected in their children's vocabularies and IQ scores at age 3.

HSES parents' child-directed speech differs not only in quantity, but also in quality from that of LSES parents (Hart & Risley, 1995; Hoff, 2003): HSES mothers, who also have a broader knowledge about children's development and child care issues (Rowe, 2008), are more likely to provide a stimulating home environment (Bradley & Corwyn, 2002): They engage more often in book reading and joint attention (Farrant & Zubrick, 2012), are more responsive to their children's verbalizations, initiate and sustain conversation with their children more frequently (Hoff et al., 2002), use a more diverse vocabulary and a more complex syntax (Huttenlocher et al., 2002) and encourage their children more often to talk by asking questions (Hoff, 2003; Ravid & Zimmerman, 2017; Korecky-Kröll, 2021). On the other hand, LSES mothers use more behavior-directing than conversation-eliciting strategies (Hoff-Ginsberg, 1991; Ravid & Zimmerman 2017; Korecky-Kröll, 2021) and are less likely to adapt their child-directed speech to their children's linguistic level, showing less fine-tuning and scaffolding (ibidem); therefore, their children are less likely to benefit from the linguistic input provided (Moerk, 2000).

Whereas a large number of studies have found clear SES effects on lexical development (Arriaga et al., 1998; Hoff-Ginsberg, 1998; Pan et al., 2005), there are not so many studies investigating morphological and morphosyntactic development. Many of them were conducted by Dorit Ravid and colleagues and focus on acquisition and processing of Hebrew in older children, adolescents and adults. When examining morphological constructions in Hebrew-speaking children, adolescents and adults from HSES and LSES backgrounds, Ravid (1995) finds a consistent lag in morphological knowledge in LSES participants. The same holds for LSES grade school children who score consistently lower on a Morphological Analogies Task concerning Hebrew root patterns (Ravid & Schiff, 2006) and on plural marking on nouns and adjectives (Schiff & Ravid, 2012): SES effects are most pronounced in the most difficult categories of nouns and adjectives (= changing stems with irregular and subregular suffix patterns), and processing time is also affected: Whereas HSES children's reaction times decline steeply with age, there is almost no decline in older vs. younger LSES children's reaction times (Schiff & Ravid, 2012). When testing reading of vowelized vs. unvowelized Hebrew scripts in HSES and LSES grade schoolers, Schiff & Lotem (2011) find lower levels of phonological and morphological awareness in LSES children, skills that strongly affect their reading abilities. Consequently, further literacy skills are affected as well. For example, Israeli 7th graders of LSES have more problems in expository text production than their HSES peers (Ravid et al., 2015).

However, not all linguistic categories are equally affected by SES effects, as has also been shown by Dorit and colleagues: In their case study on two Hebrew-speaking mothers (one HSES, one LSES) interacting with their young daughters aged 1;6,[6] Ravid and Zimmerman (2017) found considerably more noun and adjective tokens and a higher nominal and adjectival diversity in the high SES mother's CDS in comparison to the low SES mother's CDS. However, the SES effect was only small for verbs (Ravid & Zimmerman, 2017: 44). In addition, the distribution of the affixal *binyan* demonstrated a high similarity in HSES and LSES, although the overall verb input was "denser, less repetitive, more elaborative and temporally and conversationally more diverse" in the high SES mother (Ravid & Zimmerman, 2017: 44).

Similar results were found for older Hebrew speaking children aged 6–14: In their study on morphological production tasks conducted with typically developing and language-impaired grade school and middle school children from mid-high and low SES backgrounds, Levie et al. (2017) report that verbs were always the easiest category across all populations, whereas adjectives and derived abstract nouns were clearly more affected by the population type. Verbs were also the only category in which gaps between groups decreased with grade level. Thus, verbs are less affected by SES differences than nouns and adjectives are, not only in younger, but also in older Hebrew-speaking children. Therefore, one may conclude that nouns and adjectives are more affected by SES differences than verbs.

These results on different lexical categories are consistent with findings by our own group (Korecky-Kröll, submitted) indicating that SES effects are smaller in the verb vocabulary of 3–5-year-old German-speaking children and parents compared to their noun vocabulary. This may at least partially be attributed to the fact that verbs are important parts of directive speech acts – as mentioned before, directive speech acts are frequent in LSES parents' behavior-directing speech directed to their children. Nevertheless, when different categories of verb morphology (e.g., different *binyan* patterns) were examined in greater detail in different SES groups, clear SES effects were also found for verbs in the peer-talk of Hebrew-speaking preschool children (Levie et al. 2019).

Whether similar results can also be found for German CS and CDS will be the central question of the present chapter. We hypothesize that SES effects on verbal morphology will be found in both CS and CDS. They might be weakest in the most productive and frequent particle verbs because LSES parents and children will also use them to a great extent. However, it is questionable whether we will find any SES

[6] Children's ages in this chapter are given in years;months. For example, 1;6 corresponds to 1 year and 6 months.

effects in CS concerning the rare, complex and opaque prefixed verbs because, according to the literature, they are rarely used productively until age 4 and show particularly relevant progress only in the 6th year of life (Mattes, 2018). Age effects are expected to be found only in CS because parents' adaptation or scaffolding in relation to morphology is more relevant in interaction with younger children. However, age effects might be particularly strong in children's prefixed verbs.

4 Method

4.1 Participants

The participants of the present study[7] were 29 German-speaking parent-child dyads living in Vienna, Austria. The children had a mean age of 3;1 (age range: 2;11–3;3) at the beginning and a mean age of 4;8 (age range: 4;5–4;11) at the end of the project. For each child, we conducted four recordings over a period of 1.5 years (at children's mean ages 3;1, 3;4, 4;4 and 4;8). The children were almost balanced for SES and gender (see Table 3), whereas main caregivers had a large female dominance: All fifteen main caregivers in the HSES group and eleven main caregivers in the LSES group were mothers. One of these LSES mothers had fraternal twins that were both part of the study. The two remaining LSES main caregivers were fathers (one with a boy and one with a girl[8]).

As in most other studies on language acquisition (cf. Ensminger & Fothergill, 2003), SES was primarily assessed by the main parental caregiver's highest educational level (cf. OECD, 1999): The LSES group included ISCED-97 levels 1 to 3b

Table 3 Child participants

Child SES	Child gender	N of children	Subtotal SES
HSES	Female	8	15 HSES
HSES	Male	7	
LSES	Female	6	14 LSES
LSES	Male	8	
	Total	29	

[7]The data of this study are part of the project SSH11–027 "Investigating Parental and Other Caretakers' Utterances to Kindergarten Children (INPUT)" that was supported by the Vienna Science and Technology Fund (WWTF).

[8]However, the LSES father of the girl left the family before the fourth data point and therefore the mother, who had a higher educational level than the father and thus would have to be classified as HSES, was the main caregiver at the last recording. Nevertheless, the girl was classified as LSES because she was more attached to the father and the father had been the main caregiver in three out of four recordings. This special case as well as the case of the twins were considered in the statistical analysis (see also fn. 9).

(i.e., from compulsory school to apprenticeship and vocational schools, but without high school diploma), whereas the HSES group had ISCED-97 levels 3a to 6 (i.e., from high school diploma up to PhD).

The prestige of the parental profession was assessed according to the International Socioeconomic Index of Occupational Status (ISEI, cf. Ganzeboom & Treiman, 1996). However, the assessment of the ISEI values affected the SES classification of only one child in the sample: One boy's mother had a significantly better job than one would have expected from her formal educational level. Therefore, this boy was "upgraded" to the HSES group.

4.2 Procedure

We conducted four one-hour spontaneous speech audio and video recordings in the children's homes (Rowe, 2012). Parents were not given any detailed instructions, but they were asked to do what they normally do. Therefore, situations were as natural as possible, but also showed considerable variation: Some parents encouraged their children to choose a game, others decided to read storybooks, others just had spontaneous conversations. In a few cases, we also recorded mealtime situations (cf. Hoff-Ginsberg, 1991). Sometimes, siblings or other adults (e.g., the other parent, a grandparent or a visitor) were also present, whereas in other cases, the conversations were restricted to the parent-child dyads.

From each of these one-hour recordings, we selected the 30 min with the richest verbal interaction between the child and the main parental caregiver. Most often, these selected samples consisted of two parts of different lengths that, in total, were summed up to exactly 30 min.

All 30-min samples were transcribed according to the CHAT conventions of the CLAN program package (cf. MacWhinney, 2000) and were tagged for parts-of speech and morphology by using the lexicon-based approach (cf. ibidem). In this approach, new lexical entries and morphological forms are first identified, then manually coded and added to a lexicon file. Subsequently, the MOR program of the CLAN program package is used to automatically generate a morphological coding tier after each transcription tier on the basis of the coding in the lexicon file. Afterwards, ambiguous word forms were manually disambiguated (Korecky-Kröll, 2017).

The morphologically coded files were imported into MS Excel (Korecky-Kröll, 2017) by using the CLANTOCSV JavaScript program (Korecky, 2015). The final Excel file contained the entire corpus, one word token per row, following the timeline of the recordings. This allowed us to quickly filter for verbs to insert additional columns providing a more detailed tagging of verbs (see tagging categories in Table 4).

For the present chapter, we included spontaneous and imitated child speech, spontaneous child-directed speech of parents as well as book reading and singing songs or citing poems by both children and main caregivers (tagged with [+ cit]).

Table 4 Tagging categories of verbs

Tag (abbreviation)	Derivational type	Comment	Examples
V	Verb	Part of speech tagging	
0_under	Underived	All underived verbs	a. *sitz-en* 'to sit'
1_root+suff_der	Only root and/or suffix derivation	Includes unproductive and weakly productive derivation such as b. causative formation, c. implicit derivation, d., e., f. conversion from nouns, adjectives and onomatopoetic forms, g. diminutive formation of verbs h. iterative formation of verbs does not include verbs with actual prefixes or particles (from a synchronic perspective)	b. *setz-en* 'to put, set' (unproductive causative of a.) c. *glänz-en* 'to shine' (implicit derivation from the noun *Glanz* 'sheen') d. *fisch-en* 'to fish' (conversion from N *Fisch* 'fish') e. *trockn-en* 'to dry' (conversion from ADJ trocken 'dry') f. *summ-en* 'to hum' (conversion from *summ!* = sound of bees) g. *läch+el-n* 'to smile = to laugh slightly' (diminutive formation from V *lachen* 'laugh') h. *kling+el-n* 'to ring (the doorbell)' (iterative formation from the verb *kling-en* 'to sound')
2_part	Separable particle derivation	highly productive (e.g., i.) includes also cases of 1_root+suff_der that have a separable particle in addition (e.g., j.)	i. *weg#geh-en* 'to go away' j. *hin#setz-en* 'to put down'
3_pref	Inseparable prefix derivation	less productive (e.g., k.); includes also cases of 1_root+suff_der that have an inseparable prefix in addition (l.)	k. *zer+brech-en* 'to break (into pieces)' l. *be+ruhig-en* 'to calm sb down'
4_part_pref	Combined separable particle and inseparable prefix derivation	very rare, highly complex: without further derivations (m.) or including cases of 1_root+suff_der (n.)	m. *dazu#be+komm-en* 'to get in addition' n. *hin# und her#über+leg-en* ‚to ponder back and forth' (with even more complex gapping)

Speech of parents directed to other adults or to pets was excluded because the focus of the analysis was on child-directed speech of parents and these types of overheard speech are considered to be less relevant for children's language acquisition (Shneidman et al., 2013, see also Dressler, 1994). The corpus analyzed contains 62,598 total verb tokens (20,604 verb tokens of CS and 42,021 verb tokens of CDS).

For the statistical analyses, we used the lme4 package (Bates et al., 2015) of R (R Core Team, 2020) to perform linear mixed effects regression (lmer) analyses (cf. Winter, 2013) of the relationship between frequencies of different categories of verbs and children's SES in order to discover group differences between children as well as between parents. Children's and parents' participant IDs were entered as random factors[9] in all models. SES (two levels: HSES, LSES) and data point (DP: four levels) were defined as fixed factors. The dependent variables of the different models were the log-normalized type or token frequencies of the categories listed in Table 4. The following significance levels (SLs) were selected: *** $p < 0.001$, highly significant, ** $p < 0.01$, (medium) significant, * $p < 0.05$ weakly significant, . $p < 0.1$, non-significant trend.

5 Results

5.1 Lemmas

An overall lmer analysis of total verb lemmas in CS and CDS (see Table 5) yields significant SES effects for children as well as for parents (weak for children, medium for parents), indicating that LSES participants use fewer verb lemmas than their HSES peers. In addition, there are effects of data points in the children: Numbers of verb lemmas increase as the children get older (there is only a trend at DP2, but significant effects of DP3 and 4 in comparison to DP1, which was mapped to the intercept).

If the analysis includes only derived verb lemmas (i.e., all categories tagged as 1_ to 4_ in Table 4), we find very similar effects as for total verb lemmas. As shown in Table 6, the effects are just marginally weaker. And there is a trend for parents to use more derived verb lemmas at the last data point, when children are oldest (i.e., at their mean age of 4;8).

If only derived verb lemmas with root or suffix derivation are considered (see Table 7), the SES and age effects in children's data are quite similar to those in the previous tables. Parents' data show only a weak SES effect but also an effect of data point: They use more root and suffix derived verb lemmas as their children get older.

Table 5 Total verb lemmas in CS and CDS (fixed effects of SES and DP: t values, p values and SLs)

Fixed variable	CS: t	CS: p	CS: SL	CDS: t	CDS: p	CDS: SL
(Intercept)	38.769	<0.001	***	85.820	<0.001	***
Child.SESlow	−2.292	0.030	*	−3.391	0.002	**
DP2	1.884	0.063	.	0.312	0.756	
DP3	3.174	0.002	**	0.256	0.799	
DP4	4.513	<0.001	***	0.883	0.380	

[9]This allowed us to consider the two special cases mentioned at the beginning of Sect. 4.1 and in fn. 8:

1. One LSES mother was the main caretaker of two fraternal twins.
2. The last recording of one LSES girl was conducted with the HSES mother because the LSES father had left the family in the meantime.

The highly productive and frequent particle verb lemmas (see Table 8) show a significant SES effect only in CDS, but not in CS. Thus, LSES parents use significantly fewer particle verb lemmas than HSES parents, but the two groups of children do not differ significantly from each other. However, children show an age effect: They use more particle verb lemmas at the last data point.

The weakly productive and less frequent prefixed verbs (see Table 9) show even a highly significant SES effect in CDS but none in CS. But they show a

Table 6 Derived verb lemmas in CS and CDS (fixed effects of SES and DP: t values, p values and SLs)

Fixed variable	CS: t	CS: p	CS: SL	CDS: t	CDS: p	CDS: SL
(Intercept)	27.782	<0.001	***	58.210	<0.001	***
Child.SESlow	−2.142	0.041	*	−3.161	0.004	**
DP2	1.269	0.208		1.021	0.310	
DP3	2.807	0.006	**	1.019	0.311	
DP4	4.302	<0.001	***	1.722	0.089	.

Table 7 Root and suffix derivation of verb lemmas in CS and CDS (fixed effects of SES and DP: t values, p values and SLs)

Fixed variable	CS: t	CS: p	CS: SL	CDS: t	CDS: p	CDS: SL
(Intercept)	17.682	<0.001	***	32.520	<0.001	***
Child.SESlow	−2.478	0.019	*	−2.588	0.016	*
DP2	−0.113	0.910		1.946	0.055	.
DP3	2.763	0.007	**	1.911	0.060	.
DP4	4.608	<0.001	***	2.587	0.011	*

Table 8 Particle verb lemmas in CS and CDS (fixed effects of SES and DP: t values, p values and SLs)

Fixed variable	CS: t	CS: p	CS: SL	CDS: t	CDS: p	CDS: SL
(Intercept)	23.672	< 0.001	***	55.788	< 0.001	***
Child.SESlow	−1.574	0.127		−2.961	0.006	**
DP2	1.001	0.320		0.839	0.404	
DP3	0.970	0.335		−0.316	0.753	
DP4	2.213	0.030	*	0.263	0.793	

Table 9 Prefixed verb lemmas in CS and CDS (fixed effects of SES and DP: t values, p values and SLs)

Fixed variable	CS: t	CS: p	CS: SL	CDS: t	CDS: p	CDS: SL
(Intercept)	4.080	<0.001	***	12.775	<0.001	***
Child.SESlow	−1.555	0.132		−3.868	<0.001	***
DP2	1.666	0.099	.	0.270	0.788	
DP3	3.579	<0.001	***	0.230	0.819	
DP4	5.413	<0.001	***	1.473	0.144	

strong increase when children get older. This is consistent with the literature (e.g., Mattes 2018) showing that prefixed verbs are acquired much later than particle verbs.

As far as the most complex combinations of prefixed and particle verbs are concerned, no statistical analysis is possible: We do not find a single example in the children's data and only 7 lemmas/7 tokens in parents' data (5 of HSES and 2 of LSES parents).

5.2 Tokens

In contrast to the analysis of total verb lemmas (see Table 4), Table 10 shows only a non-significant SES trend for children's total verb tokens. However, children use significantly more verb tokens as they get older. In parents' data, the SES effect for total verb tokens is comparable to that of total verb lemmas.

If the analysis is limited to derived verb tokens (see Table 11), we do not find a significant SES effect in children and only a non-significant SES trend in parents, whereas SES had been a significant factor for both groups in the lemma analysis (Table 5). Nevertheless, derived verb tokens again show a significant increase at the two last data points in CS.

Table 10 Total verb tokens in CS and CDS (fixed effects of SES and DP: t values, p values and SLs)

Fixed variable	CS: t	CS: p	CS: SL	CDS: t	CDS: p	CDS: SL
(Intercept)	36.698	<0.001	***	76.974	<0.001	***
Child.SESlow	−1.720	0.097	.	−3.110	0.005	**
DP2	2.310	0.023	*	1.924	0.058	.
DP3	3.160	0.002	**	−0.485	0.629	
DP4	4.301	<0.001	***	0.413	0.681	

Table 11 Derived verb tokens in CS and CDS (fixed effects of SES and DP: t values, p values and SLs)

Fixed variable	CS: t	CS: p	CS: SL	CDS: t	CDS: p	CDS: SL
(Intercept)	24.578	<0.001	***	56.123	<0.001	***
Child.SESlow	−1.547	0.133		−1.909	0.068	.
DP2	0.906	0.368		1.093	0.278	
DP3	2.550	0.012	*	−0.059	0.953	
DP4	3.674	<0.001	***	0.959	0.340	

Similar effects and trends are found for verb tokens with only root and suffix derivation (see Table 12), but a stronger increase is found in children at the third data point (mean age 4;4).

The highly productive and frequent particle verbs (see Table 13) do not show any significant effects in the token analysis, neither in CS nor CDS. Only a non-significant trend of data point indicates that children use slightly more of these verbs at the last recording.

As for the lemmas in Table 9, prefixed verb tokens (see Table 14) also show a highly significant SES effect in CDS but not in CS. However, significant effects of data point in children indicate that this is a pattern that is acquired only at an older age.

As mentioned at the end of Sect. 5.1, the most complex category of prefixed and particle verb tokens is non-existent in the children's speech and too rare in that of the parents for a statistical analysis.

Table 12 Root and suffix derivation of verb tokens in CS and CDS (fixed effects of SES and DP: t values, p values and SLs)

Fixed variable	CS: t	CS: p	CS: SL	CDS: t	CDS: p	CDS: SL
(Intercept)	14.250	<0.001	***	30.494	<0.001	***
Child.SESlow	−1.701	0.100		−1.814	0.081	.
DP2	0.270	0.788		0.639	0.525	
DP3	3.770	<0.001	***	0.976	0.332	
DP4	4.191	<0.001	***	0.827	0.411	

Table 13 Particle verb tokens in CS and CDS (fixed effects of SES and DP: t values, p values and SLs)

Fixed variable	CS: t	CS: p	CS: SL	CDS: t	CDS: p	CDS: SL
(Intercept)	21.336	<0.001	***	47.016	<0.001	***
Child.SESlow	−1.316	0.199		−1.284	0.211	
DP2	0.655	0.514		1.312	0.193	
DP3	0.044	0.965		−0.828	0.410	
DP4	1.932	0.057	.	0.484	0.630	

Table 14 Prefixed verb tokens in CS and CDS (fixed effects of SES and DP: t values, p values and SLs)

Fixed variable	CS: t	CS: p	CS: SL	CDS: t	CDS: p	CDS: SL
(Intercept)	3.874	< 0.001	***	13.498	< 0.001	***
Child.SESlow	−0.820	0.420		−4.128	< 0.001	***
DP2	0.893	0.374		−1.036	0.303	
DP3	2.371	0.020	*	−0.129	0.897	
DP4	3.950	< 0.001	***	0.668	0.506	

6 Discussion, Conclusion and Outlook

As hypothesized, we find SES effects in several categories of verbs investigated – particularly in the lemma analysis as well as in CDS. Compared to HSES parents, LSES parents use significantly fewer overall verb lemmas and tokens, fewer derived verb lemmas, fewer verb lemmas with root or suffix derivation and fewer particle as well as prefix verb lemmas. In contrast, the token analysis of CDS yields significant SES effects only for overall verbs and prefixed verbs, whereas the other categories only show non-significant trends or – in the case of particle verbs – not even a trend. Also, in children's output, there are no SES effects for particle verbs, neither in types nor in tokens, which apparently shows that this frequent and transparent verb formation pattern is least affected by SES differences. This points to a sort of ceiling effect, indicating that children of both SES groups have acquired the basic structure of these derivations. However, there is still an age effect in CS particle verb lemmas and a trend in tokens, showing that acquisition of a larger particle verb vocabulary is still underway.

Interestingly, we also do not find any SES effect in the opaque and rather rare prefixed verbs of children, neither in types nor in tokens, although there are particularly strong SES effects in CDS for this category. Prefixed verbs thus show a sort of floor effect in CS, which means that even HSES children do not master them between age 3 and 5 but the acquisition of this complex category will continue during children's 6th year of life. Further evidence for this is the strong age effect found at the last data point, when children apparently start to make greater progress. These findings are consistent with those found in the literature on the acquisition of German derivation (e.g., Behrens, 1998; Rainer, 2010; Mattes, 2019). It is expected that pronounced SES effects would appear in prefixed verbs at a later age, especially because verb prefixes are characteristic of the literate lexicon (cf. Dewell, 2015).

CS shows SES effects only in lemmas, and not in tokens: This means that LSES children still seem to have a less diverse verb lexicon although they use almost as many derived verb tokens as HSES children. However, age effects tend to be stronger than SES effects in the children's data, whereas the only age effect in CDS is found in the weakly productive and unproductive categories of root and suffix derivation lemmas.

In contrast, SES effects are quite strong in CDS, particularly in lemmas. The category that is most affected by SES in CDS is that of the weakly productive, non-salient and opaque prefixed verbs. Even if all children acquire them late, LSES children will still be more disadvantaged around school entry if they have heard this verb formation pattern so much less frequently than their HSES peers. The most complex category of combined particle and prefixed verbs has not yet emerged in the children and is also very rare in the parents' data, thus it will still take a long time before children are able to use it productively.

Our results lead us to the following conclusions:

SES is clearly related to language exposure, and language exposure has an important impact on children's language development, as has been widely acknowledged by previous research. For example, two recent studies by Romeo et al. (2018a, b) find significant correlations between language input in daylong audio recordings of children of different SES and their structural neural connectivity as well as their language-related brain functions. However, they also show that the sheer quantity of words heard by the children is apparently less relevant than the specific dialogic experience measured via the number of conversational turns in caregiver-child interaction, a measure yet to be investigated in our corpus. Thus, the observed differences between verb categories might also be related to their input frequencies in specific conversational contexts (such as parents' expansions and reformulations of children's utterances, as highlighted by Ashkenazi et al., 2016: 519).

As predictable from the typological differences (as exposed in Sect. 2), root-derived patterns play a much bigger and earlier role in Hebrew than in German (Ashkenazi et al., 2016). This contrast is even bigger in derivation than in inflection. This difference also had an effect in SES differences: whereas these were considerable in Hebrew (cf. Ravid & Zimmerman 2017; Levie et al., 2017, 2019), they were much smaller in German.

Even if verbs are the lexical category least affected by SES differences (Levie et al., 2017; Ravid & Zimmerman, 2017; Rosemberg et al., 2020; Korecky-Kröll, submitted), there are still differences regarding different subcategories of morphologically complex verbs, as also shown by Ravid and Zimmerman (2017) for Hebrew. The summary of their study on the input to the two very young Hebrew-speaking girls already cited in Sect. 3 is also valid for our results on the input of our older children: "Taken together, lexical analysis results point to denser, less repetitive, more elaborative, temporally and conversationally more diverse morpho-lexical input in HSES verbs." (Ravid & Zimmerman, 2017: 44).

However, there is still more work to be done: A more fine-grained analysis according to syntactic categories (that makes it possible to study embedded morphological productivity) and semantic categories of verbs (e.g., causativity, transitivity, reciprocity etc., which have different morphological and syntactic representations in the two languages), as modelled by our Israeli partners for Hebrew, will also add new insights to our German data.

What we have not yet done (due to space limitations and in contrast to Levie et al., 2020) is investigate the developmental expansion of verb families in terms of family frequency, family size, family composition and the semantic coherence (i.e., in regard to transparency/opacity) of verb families, including the differential development of subregular and irregular verb patterns. We will also have to include nominal and adjectival derivations as well as the familiarity of all patterns (see also Sommer-Lolei et al., 2021b). We also want to go beyond formal families by also investigating the development of their semantic subfamilies (cf. Mattiello & Dressler, 2022). In a first basic step, we studied the development of structurally different verb patterns in HSES vs. LSES groups. First analyses of our longitudinal corpus of a German-speaking HSES boy (Mattes, 2018, Sommer-Lolei, in prep) show that derived verb lemmas (especially particle but also prefixed verbs as well as verbs with root or suffix derivation) in CDS remains quite constant over the entire period of investigation (1;3–6;0), whereas they show a particularly high increase in the boy's CS from age 5 onwards. Further analyses of our longitudinal corpora will also focus on the above-mentioned syntactic and semantic categories investigated by our Israeli colleagues and will provide us with new material for further cross-linguistic analyses.

Therefore, we wish Dorit a wonderful future with many years of continuing brilliant research and we would be very happy to be again part of it. Ad multos annos, dear Dorit!

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Early Literacy Intervention Programs for Populations at Risk

Elite Olshtain and Esther Cohen Sayag

Abstract This chapter describes three early literacy intervention programs in different linguistic contexts: Hebrew and Arabic as mother tongues in Israel, and Australian English for aboriginal children who speak an indigenous language or a Kriol at home. The target populations are underachievers at risk mostly due to low socioeconomic status.

The chapter discusses basic features of each program with special emphasis on the linguistic and socio-emotional needs of the participants. All three programs employ a structured tutoring approach and advance from intensive focus on decoding in the relevant language, to individual and autonomous reading strategies for comprehension. The chapter discusses the significance of defining relevant success in literacy and the need to ensure educational fidelity of the intervention.

Keywords Intervention · Early literacy · Populations at risk · Tutoring · Decoding · Reading for comprehension

1 Introduction

The present article focuses on the educational challenges of intervention programs targeting learners from low socio-economic background, assuming that these students will benefit from the different approach to instruction which the intervention program can offer. Both authors of this chapter have been involved in intervention studies in early literacy and it is our objective to reevaluate some basic features of such programs in an attempt to shape these programs so as to lead, eventually, to autonomous and strategic readers.

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Most intervention programs targeting students from low socio-economic status assume that language deficiency and limited exposure to literacy are the main reasons for low achievements in early literacy. Such intervention programs are intended to help reduce the gaps between students who have difficulty in acquiring reading and the regular students of their age group. The significance of such programs lies in the fact that gaps identified in first grade may persist and even increase all along the school years and thus shape the learners' motivation and self-concept as readers in the future (Bouffard et al., 2003; Guthrie et al., 2007).

In this chapter, three intervention programs in three different languages – Hebrew, Arabic and English – will provide the data to describe some of the challenges and successes facing low SES populations as they take their first steps in learning to read. A common feature of these programs is tutoring and focus on the individual. Furthermore, whenever possible, the use of computers was integrated in order to add accuracy and novelty to the program. The key objective of the three programs was to try and provide struggling readers with decoding, fluency, vocabulary and comprehension skills that will help them to eventually become autonomous readers.

The evaluation and success of such programs is often complex in nature: as program developers we need to concern ourselves with the selection of the target population, with their defined needs and with the planned intervention to reduce the gaps. A troublesome issue is how to define success. The major aim of intervention comes down to the consideration of how to ensure the long-term sustainability of the programs. Some of these issues will be raised in the discussion at the end of this chapter.

2 Early Literacy Intervention Programs

Most intervention programs centering around learning to read in the first three grades of elementary school were developed during the twentieth century. They tried to enhance the acquisition of phonological awareness, letter naming, syllable reading, word identification, and other skills related to decoding. A meta-analysis by Ehri et al. (2001) examined 52 studies of kindergarten and school age populations from different socioeconomic levels, and found that the impact of phonological awareness instruction on reading accuracy and spelling was high, as was the improvement in reading comprehension. Most programs directed at children between the ages of 6–13 involved teaching decoding in small groups while at the same time exposing participants to books.

In more recent years the significance of phonological awareness has been questioned with respect to languages other than English, with its opaque orthography. Share's (2008) article called for a careful consideration of the relative importance of phonological awareness, morphology and particular orthographic features, according to the language in which reading is acquired. His article is particularly relevant to Hebrew and Arabic, with their dual-script orthography (pointed vs. unpointed), described later in this article.

The relative importance attached to phonological awareness surfaced in various studies addressing languages other than English. Collazos-Campo et al. (2020) investigated predictors of early reading acquisition in Spanish among children from low SES. Their findings point to a significant relation between phonological awareness and the development of oral language. For children of low SES, school is the main context for language development since the home cannot provide a rich enough environment. Consequently, they found that phonological awareness and years of schooling are the best predictors of literacy for learners from low SES.

Other issues related to elements included in early reading intervention programs include a lack of writing, listening comprehension and discourse in general. It seems that few of the interventions focus on writing stories and on participating in meaningful communication. Berninger and Abbote (2010) summarized some of the reasons for neglecting the teaching of writing in the first grade in the American system: reading comprehension is perceived as more important than writing; separation between reading and writing processes is often favored; and the perception that writing depends on first acquiring reading is quite strong. Ten years later, Young-Suk (2020) analyzed the reading – writing connections in different languages, concluding that reading and writing is a co-developing system rather than two isolated systems. The researcher presents several models which show the overlap of component skills and knowledge.

Our approach in the three interventions described here is based on the "balanced reading approach", which fosters reading by research-based elements such as vocabulary, fluency, and phonemic awareness with reading for understanding and enjoyment implemented in whole groups, small groups and one-on-one instruction in reading writing, speaking and listening (Olshtain & Cohen, 2001; Castles et al., 2018). Yet another perspective of the balanced approach relates to top-down and bottom-up reading processing, integrating text-based and reader-based theories (Celce-Murcia & Olshtain, 2000, ch. 7 and 8; Snow & Juel, 2005; Mondesir & Griffin, 2020). It is the responsibility of intervention developers to design the combination of different language modalities as a new opportunity for the pupils at risk.

Discourse in reading literacy interventions, as part of planned discussions which create coherence and better comprehension of texts (Applebee et al., 2003; Almasi & Garas-York, 2010), eventually became integrated into learning to read. Studies show the importance of discussions based on texts, not only for better reading comprehension but also for improved personal relationships and classroom atmosphere (Mercer & Littelton, 2007; Henning, 2008).

Listening comprehension was often neglected in reading comprehension programs although all four literacy modalities (written expression, reading comprehension, listening comprehension and oral expression) are connected, as Berninger and Abbote (2010) wrote: "language is an invisible, internal, multicomponent system with subsystems that mediate interactions between the internal mental world, where thinking occurs, and the external world from which sensory systems receive information " (pg. 649). Obviously, aural-oral interaction is an important part of literacy development. Furthermore, much has been written in recent years on the shared interpretation processes of reading and listening comprehension (Olshtain &

Celce-Murcia, 2017). In particular, the analysis of Wolf et al. (2019) reveals the significant connections between reading comprehension and listening comprehension at the second and third grade levels. The researchers indicate that reading comprehension explained 34% of the variance in listening comprehension, and listening comprehension explained 40% of reading comprehension.

In the last two decades, there has been considerable development of computer-assistance in support of literacy programs. Research often compares computer-assisted programs with non-computer ones. These comparisons do not usually show significant differences, as reported in the Meta-analysis of Verhoeven et al. (2020): this meta-analysis pointed to several important findings which show high variability in the effect size of phonological awareness and knowledge of the alphabetic code on learning to read, which can be related to differences in interventions and research methods. The research points to the fact that in computer-assisted programs there is usually no report on fidelity, which limits the possibility of connecting the results to the effect of the program. We maintain that the use of digital activities has to be carefully integrated into the intervention program so as to enhance features of orthography, morphology and writing conventions.

As mentioned earlier, the study of Collazos-Campo et al. (2020) focused on low SES learners. Teachers and classroom environments are especially critical for children from low socio-economic background, who rely mainly on school for their literacy exposure and acquisition. Barone (2018) presents a detailed report on teachers' instruction with children from kindergarten up to third grade. The students were from low SES high-poverty schools, learning English as a second language. Observations of the ongoing instruction indicate that phonological awareness and decoding words were the focus of the intervention, showing a lack of implementation of the balanced approach described above. The observations also point to the lack of discussion related to meaning and a lack of individual treatment at the kindergarten and first grade levels. Nonetheless, most of the participants were above grade level by the end of the second grade. One conclusion was that such success is due to the fact that second grade teachers created a rich literacy environment and succeeded in closing the gaps between these students and their peers. This highlights the importance of the learning environment. In the intervention programs described below, special attention was devoted to the immediate environment in which tutoring took place.

Some intervention programs emphasize the importance of individual meetings with the learners. Holmes et al. (2012) examined results of the "Catch Up Literacy" program in the UK, based on several steps: formative assessment; selecting a book for every individual meeting; an individual session focused on reading a book, a related discussion, focus on several words and writing. The intervention placed importance on ongoing monitoring of each child's progress. A follow-up study of 184 students who participated in the programs showed that their achievements were maintained over time. As long as 7 years in the program, and 1 year after studying in it, students reached the required achievements similarly to their peers. The researchers emphasized the fact that targeted learners did not have any neurological problems but rather socioeconomic deficits or unsuitable learning contexts at school.

This study raised important questions related to the evaluation of success of an intervention program: Which of the particular features of the program create a lasting effect? It could be the systematic structure of the program or the focus on individual needs. It might also be the quality of teacher training or the emphasis placed on effective management of the program. These are questions that accompany the implementation of most intervention programs.

It seems that the most striking factor in implementing an intervention program is the choice of target population and the extent to which the intervention is then suited to the chosen population. The response to intervention framework (RTI) was developed in order to consider these issues.

Although the RTI (Response to Intervention) model suggests intensive individualized instruction for all students at high risk in class, some developers avoid taking responsibility for such a broad target population. Usually, they choose not to include learners with disabilities (LD), since they do not see themselves as experts in special education, realizing that this population should be treated by specialists. Secondly, developers are not sure that a program intended for low SES students could really enable LD learners to succeed. When these special education students are included, it might confuse the researchers' interpretations of the results, given different expectations for LD students. This situation usually leaves behind the weakest population, as nonresponsive students, who end up not benefiting from the program (Otaiba & Fuchs, 2002; Denton, 2012; Pesova et al., 2014).

To sum up the main factors to be favored for intervention programs in early literacy, based on the above literature review, here are some basic conclusions:

1. It is important to combine decoding skills with reading for comprehension even in very early reading intervention programs. Learners need to understand the significance and appreciate the knowledge gain made possible when one becomes an effective reader.
2. Phonological awareness was probably overrated in early intervention programs, yet again and again, in a variety of languages, it seems to be an important predictor for the acquisition of reading.
3. The four language modalities – listening, reading, speaking and writing – need to interact in the intervention program. This will ensure the aural-oral development of language as part of the whole literacy approach as well as reading and writing. The different modalities support each other and enhance general literacy. This is particularly important for learners from low SES. Furthermore, the interaction of modalities is compatible with a balanced approach to the acquisition of reading.
4. When working with learners from low SES it is particularly important to create a rich and conducive environment, where learners feel comfortable and respected.
5. Computers and digital materials need to be developed to support the acquisition of early reading programs with special attention to features of orthography and morphology which can be isolated and animated on the screen.
6. Choosing the target population has to be done carefully and the RTI framework should be utilized as best possible. In small-scale programs, special locations and unique contexts it may be difficult to implement RTI.

3 The Case of Three Tutoring Programs for Early Literacy Enhancement

The intervention programs to be described here combine the focus on decoding with exposure to writing and comprehension activities within a contextual situation. They are all structured-activity programs based on **tutoring** – whether the tutor is a peer, an older student, a teacher's aide, a student-teacher or the regular classroom teacher. The emphasis is always on the one-to-one encounter (or very small groups near a computer). Tutoring is viewed as crucial in order to provide the individual with personal human attention which can help induce cognitive excitement and a positive feeling of support and empathy.

The target populations are young learners from low socio-economic background, often suffering severe poverty. These students usually make up about a third of a regular class and are perceived as underachievers. They are often aware of the fact that they are "slower" than their peers, have developed uncertainty and a low self-esteem, and are not willing to take risks and venture into the unknown. It is important to make sure that these programs provide them with a second chance to succeed. The intervention program should provide them with pleasurable learning experiences, taking into consideration both cognitive and affective factors. In fact, elements of SEL skills (social and emotional learning) (CASEL, 2012–2013) are carefully embedded in the tutoring session, as will be described below, providing attention to both social and emotional factors (SEL). The participants are chosen in consent with the class teachers, not necessarily based on extra or external testing. The program implementors aim to exclude LD students who have been professionally diagnosed, since the present intervention program is not suited to special needs. Yet, for practical reasons, the implementors have to rely on the class teacher for selecting the target population.

Peer mentoring is widely used in many countries, at different educational levels, and in many subject areas. In the three programs described here, it is a pivotal feature of the intervention. This approach has been recognized as one of the most beneficial practices in comprehensive education and has been counted as one of the ten most effective methods (Walberg & Paik, 2000). Tutoring was recognized as an effective instruction practice for both the tutee and the mentor (Wright & Cleary, 2006; Grubbs, 2009; Bowman-Perrot, 2013; Webb, 2015). From the mentor's point of view, the need to organize one's thoughts in order to impart them intelligibly to others, the need to become conscious of the value of time, and the need to learn managerial and social skills are probably the main reasons for participating.

Key conclusions of the research body on peer mentoring is that both tutees and mentors enjoy the benefits of peer mentoring classes. Mentors have opportunities to learn content and skills while preparing to teach. They learn while they teach and through the relationship with the tutees. Formulating good questions at the tutoring meeting requires them to reflect on the content, combine prior and new knowledge, reorganize mental models, create conclusions and make use of cognitive monitoring (Duran et al., 2018, pg. 16).

When teachers act as mentors, the potential benefits of peer mentoring programs tend to be related to a drastic change in the role of the teacher, among other components. Duran et al. (2018) concluded that greater effectiveness is associated with the initial training of mentors, the existence of structured interaction within the duo, and the expansion of programs over time.

The three programs described here are: (1) "Reading Together in Hebrew – Power for All", (2) "Reading Together in Arabic", and (3) "English for Australian Aboriginal Children".

1. **"Reading Together- Power for all" – Hebrew as First Language**

"Reading together"- a peer tutoring program – was initiated in the early 1980s, with fifth or sixth graders in the elementary school acting as tutors for second graders. This was done as a major intervention program developed by the NCJW Research Institute for Innovation in Education, at the Hebrew University. The weaker third of second graders worked with the strongest sixth graders in their school. The activities were carefully structured to enhance accurate decoding, reading fluency and reading comprehension. The tutors received intensive training before and during the intervention. They were provided with the learning materials and were encouraged to provide the younger students with cognitive and social support, which would allow the tutees to develop a positive self-image as readers. The learning materials consisted of short passages for tutees to read and for tutors to identify lack of accuracy in reading. Tutors noted improvement in reading the same passage a second time and managed to provide the tutee with positive feedback. This was beneficial for both tutors and tutees. The tutors acquired leadership skills and became aware of the features of reading comprehension and the strategies that they themselves employed, and the tutees improved their reading ability and developed early strategies of effective reading. As a result of the intervention the tutees could join their peers in all literacy activities. The program presented the school with an organizational difficulty: While the tutees left their regular second grade, the other students in their class had to be employed in other areas, and the same was true for half of the sixth grade. Schools therefore asked for a revision of the program in order to involve all students in both classes – tutees and tutors. This led to the development of the program known as "Power to All".

"Power for All" was initiated in the mid-nineties. The first part of "Power for all" was designed to help the slower learners in the second grade to close gaps in the decoding/encoding skills and develop fluency in reading, in order to establish the basis for effective reading. It became evident that they could benefit from the tutoring program only after they had mastered the basics of decoding. For this first part, the "closing the gaps" tutor was the class teacher who met individually with each of the tutees. The teacher received tutoring materials, but she had to diagnose the difficulties encountered by each student, and she also had to select suitable practice matter. Once the gaps were reduced, the whole class could move on to the second part. During the first part of the program each tutee was tested for various sound-spelling issues and special, individually designed activities were carried out with the class teacher (the tutor in this case) on a one-to-one basis. This provided the tutee with individually tailored activities and the teacher with better insights as to the difficulties faced by the slower readers in her class.

The second part of the program was focused on reading comprehension and on motivation to read. The tutee/tutor relationship served as a platform to encourage reading among second graders while developing reading strategies and some writing capacity. The assumption was that fifth or sixth graders possess broader general knowledge and well-established reading skills. In order to accommodate a whole class of tutors and tutees, special attention was given to the way they were paired up. The stronger sixth (or fifth) graders were paired up with the weakest second graders, and the weaker sixth graders were paired up with the stronger second graders. This worked very well since the stronger sixth graders could really help the weaker second graders, while the weaker sixth graders seemed to work on a more cooperative level with the strong second graders who needed less help in accuracy or fluency of reading, and could thus embark on advanced reading and writing skills with focus on text prediction and expression of personal opinions.

Reading intervention programs for Hebrew (as well as Arabic) are faced with the major challenge of a dual-script situation: the phonologically transparent *pointed* script is acquired first, but starting from the later primary grades, learners transition into the phonologically underspecified *unpointed* script, which, lacking the diacritics (*nikud*), requires readers to rely on morphological pattern detection and sentential context (Ravid, 2006; Shimron, 2006, pg. 33; Share & Bar-On, 2017). In Arabic, the situation is even more complex, and partial pointing is maintained even in high school, in order to support learners' gradual transition into the unpointed script.

In the intervention programs described in this chapter, the focus is still on accurate reading of the pointed script and preparation of the learner for the requirements of the unpointed script. The focus on closing gaps in second grade deals exclusively with the phonologically fully specified script and therefore highlights accuracy and fluency. Yet, the focus on sight words often highlights morphology. Furthermore, when children move on to story writing, they begin to develop an understanding of the morphological features of Hebrew writing. In short, it is the objective of these intervention programs to prepare the young students to eventually become efficient readers by providing them with linguistic, cognitive and affective skills.

The basic assumption of the tutoring model is that optimal tutoring takes place only when it is carefully and strictly structured, guided and well supervised. Accordingly, the program described here is structured in content and learning materials, guided and supervised by researchers and advisors and by the teachers of the two classes. Since the target population of this tutoring was the whole class, second and fifth graders, the developers needed to adjust different reading levels. Mentors were carefully prepared for every meeting with their tutees and following the tutorial sessions they participated in a "reflection" session, sharing their thoughts and experiences. There was special emphasis on the social and emotional aspects of the interaction (SEL – CASEL 2012–2013).

The success of the program was first exhibited by the high enrollment of schools which joined the program. This indicated a need for this kind of program and a willingness on the part of schools and teachers to focus on populations at risk. The program leader collected reports from teachers, mentors and tutees, which together, presented a variety of factors indicating success of the mentoring intervention program:

(a) **The teachers' opinions of the program** were gathered in 2011 via a questionnaire administered to 66 teachers. They expressed satisfaction with the program and pointed out its contribution to the reading ability of tutees and the empowering of tutors and teachers. Specific findings are presented below:

    1. Tutors' interest in the program: 95% of the teachers responded that the students show high/very high interest in the program.
    2. Emotional/social empowerment of the tutees and mentors: 95% of the teachers reported high/very high emotional/social empowerment of the pupils during the year (the SEL elements).
    3. The contribution of tutoring to school climate: 86% of the teachers answered that the contribution of the program to the school climate is high/very high.
    4. Empowerment of moral development: 92% of teachers answered that the program empowers tutors' moral development to high/very high level.
    5. Contribution of the program to mentors' academic achievements: 45% answered that the program contributes to the academic achievements of the tutors, 40% answered that the contribution to the mentors' achievements is limited.

(b) **Pupils (tutee) achievements**. In 2010 we conducted a study to examine the improvement of reading accuracy and reading comprehension compared to a control group, which participated in a special intervention plan where teachers worked with small groups of underachievers. The experimental group included 191 students from seven schools, while the control group included 82 students from six schools. (Cohen-Sayag & Olshtain, 2012). The findings in reading accuracy indicated a significant advantage for the experimental group that worked on the "Power to All" program. A two-factor analysis of the common measure of accurate reading showed that the improvement which occurred in the experimental group was significantly greater than the improvement in the control group.

Each year, an evaluation study is conducted by the program developers. The evaluation examines the students' progress in knowledge of the alphabetic code, word reading speed, and accuracy of reading. (MAAKAV kit, Lachman et al., 2003). On all three measurements there was an increase of two scores in pupils' achievements. The data indicate that the majority of the students in the program closed the gaps and only a few who had learning disabilities did not reduce the gap in reading accuracy. A careful investigation of the implementation process found that the classes participating in the program fell into two groups: those who followed the program exactly as designed by the guidelines and those who had difficulties adhering to the program.

These findings again raised a question concerning the target population in the intervention program, as discussed earlier in the literature review. Since the program was not designed for students with learning disabilities but rather for those who came from lower economic and social status, the teachers were directed to exclude LD students from the program (as mentioned above). Some teachers, however, did not follow this instruction. They felt that some of the LD students in their class could also benefit from the program and refused to exclude them. Since the implementors relied on the class teacher for selecting the target audience, these students were often included in the analysis, blurring the findings of the study.

2. **The Case of "Reading Together in Arabic"**

This early literacy program was developed for struggling readers in Arabic also at the NCJW Institute for innovation in Education, at the Hebrew University, Jerusalem. It was based on earlier work done by Baha Makhoul in her doctoral thesis (2006), which investigated a balanced tutoring computer-assisted reading literacy program.

The main characteristics of speakers of Arabic in Israel is that they function throughout life in a multilingual context. They acquire the spoken variety of Palestinian Arabic at home and use it in their immediate environment, with dialectal differences according to location, and they encounter Standard Arabic at school. When first graders begin to cope with early literacy, they also have to cope with the phenomenon of diglossia in Arabic (i.e., the gap between the written language and the spoken language). This is an additional difficulty that results in a slower acquisition of the written language, as it differs from the spoken language in phonology, vocabulary and syntax (Ayari, 1996; Saiegh-Haddad, 2003, 2004, 2005). Sometimes speakers of Arabic are perceived as second language learners due to diglossia (Makhoul et al., 2014; Makhoul & Olshtain, 2017). Furthermore, the unique characteristics of the orthographic system in Arabic, morphological rules, syntax and other aspects, can delay the development of reading. Difficulties in learning Arabic were reported in orthographic, morphology and syntax in several studies (Feldman et al., 1995; Saiegh-Haddad & Henkin-Roitfarb, 2014;)

The basic premise of the program described here is that intensive exposure to the standard Arabic language in all four modalities (listening, speaking, reading and writing) creates both diffusion and mutual contribution among these four language skills, as suggested by Olshtain and Celce-Murcia (2017). The idea of the program is to create intensive exposure to the written standard Arabic language in a computer-based platform which enables manipulations and learning activities focused on the orthographic – phonological matching.

The use of computers in this program is intended to provide learners with specially designed activities that cope with the features of Arabic orthography. Thus, visual recognition of letters, including the changes that take place when letters appear in different positions within the word, can be practiced meaningfully. Computerized activities enhance the practice needed to foster early literacy: digitally dragging letters or coloring them to distinguish between the phonetic similarities or differences of letters that look alike, dividing words into syllables, and completing missing words within sentences based on the context. These are only some of the practices included in the computer-based program, which make the computer an integral part of the learning sequence.

Each mentoring session begins with a group discussion with the teacher, leading the students towards their individual or group activities. At the end of the session the teacher again leads a summary group discussion. The groups are small – ten to five students – one or two students per computer. The teacher, as mentor, is able to pay individual attention to each student during practice. All the activities are related to a reading passage or story which serves as the basis for teaching reading comprehension. Furthermore, these discussion sessions are designed to empower self-concept and involvement and for the students to gain a feeling of success and accomplishment. At the opening session, the discussions are directed to help learners become aware of some prediction strategies and also enable them to become engaged in the reading process. At the end of the unit, the teacher has a conversation about the pupils' sense of success and interest in the text they are listening to as well as reading. The teacher provides the pupils with positive feedback on their performance in reading.

The program has been tested in 92 elementary schools in the Southern District of Israel. A total of 2366 pupils participated in the program. Ten students in each class were selected by the educator to participate in the program according to unsatisfactory achievements in the four first tasks in the first grade of the RAMA (Israeli Authority Assessment and Evaluation) tests. The focus of the tests was on Accuracy in reading syllables; Phonological awareness; Reading letters as consonants; Letter identifications in a word. Pupils who could not read letters at all were not included in the program, on the assumption that they were not yet ready for individual learning in the program as they might fail and experience further frustration. Accordingly, the requirement for participating in the program is a general recognition of the Arabic letters of the alphabet.

The Results at the End-of-Year: students were tested in reading comprehension of sentences, reading accuracy of a text, reading comprehension of the text, and listening comprehension. Achievements on these tasks were compared between students in the program to students who worked in the regular class program with no assistance of computers.

The results show that the students in the program improved their listening comprehension, reading comprehension of sentences, and reading accuracy reaching the appropriate level expected according to RAMA tests. Moreover, these achievements were higher in comparison to the control group, who participated in the regular class program. The improvement in reading comprehension of a text did not reach the expected level and it is obvious that participants needed continuous intervention in the second grade, as well.

Teachers' satisfaction with the program was very high (on the Likert scale) but also exposed difficulties in the implementation of the program: (1) The target population was not chosen according to the criteria set, since many parents wanted their children to participate in a computer-based program and the teachers could not resist parental pressure. Therefore, in the examination of the results we had to analyze the results of the target population as a separate group. (2) According to observation reports, 32% of the classes did not follow the guidelines of the program. Teachers proposed two reasons for that: lack of computer technical assistance, and pupils' absence from school.

Correlations between posttests and pretests indicated improved reading accuracy with reading syllables and phonological awareness as the strongest predictors of success. Yet, beyond reading achievements, it became obvious that students gained confidence and improved their self-image. One little boy expressed it in his own words: "now I can read and I have friends and I have books".

3. The Case of Australian Aboriginal Children Learning to Read English

All children learning to read English, after exhausting the regular patterns of sound-spelling correspondences (consonant-vowel-consonant such as *fat, sit, cub*; or consonant-vowel-consonant + silent e such as *fate, site, cube*) have to cope with irregularity and lack of transparency in the writing system. In the case of most young aboriginal students in Australia, the acquisition of early literacy is further complicated by the fact that they may speak a different mother tongue at home or an English Creole (Kriol), so that Standard Australian English may be a second language for them.

The NCJW teams from Israel undertook the mission of trying to develop a program for aboriginal children, based on the tutoring experience. This seemed most suitable since it would allow children who may have experienced failure and a lot of frustration to receive special attention and detailed instruction in a one-to-one encounter. This program was carefully structured to begin with an assessment of decoding difficulties that the children exhibited, gradual and careful exposure to written matter and practice of the alphabet, phonological awareness, sight word recognition and reading and copying of key sentences in brief meaningful texts. The major emphasis of these encounters was to provide the individual with a sense of success and feeling of personal capacity.

The implementation project was carried out in a number of locations through Australia, each location presenting the implementors with unique features and requirements. In location A, the whole community was Aboriginal, and therefore over 90% of students in each class were aboriginal. The decision was to start working with all the children in first and second grades in order to provide a good basis for the acquisition of literacy in Standard Australian English. Most of the children came from families speaking an Aboriginal language, and English was their second language.

In location B, students arrived from different aboriginal language backgrounds and many of them knew English Kriol. Here again, English was almost a second language for most children and the school decided to put emphasis on third and fourth grades, in order to prepare them for the State literacy tests.

In location C the aboriginal children made up about 5% of the student population, and so their need was to get a head start type of program that would enable them to take part in the regular classroom activities at the level that of their non-aboriginal peers. Here the aboriginal children were extracted from their regular classes for short tutoring sessions on an almost daily basis. The objective was to enable these children to take part in the regular classroom activities. Students from different classes, first, second, third participated in the program. They were selected by the regular class teacher and the school principal.

The tutors were first the Israeli mentors and later local teacher aides. The tutoring session for the Aboriginal students was structured very much in line with the experience gained from the programs in Israel: a brief warming up opening aimed to create a positive atmosphere of good feeling as well as mutual trust. The opening was followed by a focused practice on sound spelling correspondence and then the reading of a passage which led to meaningful conversation about the passage. This was followed by focus on vocabulary items in the text and on personal reactions to the content. The children were encouraged to develop strategies and question-asking in order to predict the continuation of a story. This gave some of the kids a feeling of success and of a new-found ability to read. One child expressed this feeling of self-capacity by telling the tutor: "wow, you make me brainy".

In one of the schools in location C, the tutees received a type of head start on material that was studied in class and when they finished the individual tutoring session, they went back to their regular class and suddenly were able to participate with the others. This was a very significant event, since the teacher began to notice them and to pay attention to these kids that had been "transparent" before.

As in the other programs described above, writing became an important activity with the aboriginal children, but the difficulty seemed tremendous. In one of the schools in location A, the Israeli tutors decided to create a sequence of events which would help the students frame a story cognitively. The girls used to go out with their mothers to prepare reeds for basket weaving. They spoke about the process while carrying out the chore. They participated in the boiling of the strings and the coloring that followed, and they took active part in the weaving. When they came back to class, their assignment was to tell the boys what activities they had taken part in. Then, the whole class wrote a brief text on basket weaving. The sequence of activities created a meaningful use of the four language skills within a meaningful and familiar context. All learners were fully engaged.

Although the program for aboriginal children was very encouraging, the biggest problem for them was to pass the State reading tests. Participating in this type of evaluation requires much more than reading comprehension and creates anxiety and fear of failure. It was very hard to convince the authorities that reading to understand, enjoying the content and feeling improved reading capacity were important outcomes, even if these learners still could not achieve passing grades on State tests.

Consequently, the requirement for cooperation with the school, the teachers and the principals became very evident in Australia. In addition, it was important to interact with and be accepted by the community. Only when all these stakeholders cooperated was the program effective and actually improved both literacy achievements and self-efficacy. Yet, even when such success was obvious, it was not always possible to ensure the students' improvement on State tests.

4 Summarizing the Three Programs

Beyond intensive work on letter recognition, phonological awareness, decoding accuracy and fluency, individual writing and tutees participating in discussions, the three intervention programs described above laid down the foundation for the promotion of future independent and strategic readers.

Strategic readers (Olshtain & Celce-Murcia, 2017) are quick and effective decoders, who recruit all their background and linguistic knowledge to "make sense" of the text, they know which strategies will help them understand a new text, and they have a strong drive and motivation to comprehend. Strategic readers have a positive reading self-concept (Katzir et al., 2018), which develops over the years, since they gain successful reading experiences with a multitude of texts.

More specifically, the programs described here show how the developers of early literacy interventions need to carefully structure programs with an emphasis on both the cognitive and the affective skills. An important feature of the programs was the fact that they encouraged young readers to seek meaning in what they learn to read. This approach was carefully embedded in the activities focusing on linguistic challenges specific to the relevant language.

The challenges of early intervention lie in three components of reading instruction: the combination of the four literacy modalities in order to support a variety of difficulties; a meaningful relationship which supports the positive self-concept of the target population; the preparation of tutors/teachers creating a suitable school environment; and the school's commitment to cooperate.

Early intervention programs are naturally focused on decoding skills and on accuracy and fluency, but they must at the same time allow learners to taste the excitement of understanding a story, a joke or a poem. Materials that are especially written for such programs focus on reading matter that children will find attractive and of interest. Yet, the activities need to be tailored to their decoding ability so that they will be successful. The combination of listening comprehension, discussions and writing can enable students to gain command of different genres in reading and writing, encouraging positive experiences in the program.

The experience of success in reading will entail a feeling of self-esteem and motivation to "try again". These are only the first steps in the right direction, but if maintained over time, they will lead to the enhancement of reading strategies for a lifetime.

The intervention programs described in the present article place importance on two major features: attention to the individual learner and meaningful communication in context.

Attention Addressed to the Individual: the basic premise of "Power for all" was to allow slower achievers to close the gap vis-à-vis their more successful peers. It was necessary therefore to assess individual difficulties in decoding phonological awareness and design individually tailored activities. At the same time, learners were encouraged to write short individual stories with the learning theme of every lesson. These personal short stories were sometimes 2–3 sentences long but still created a coherent text. One such example was the practice of the vowel /u/ (represented by "shuruk" in the Hebrew pointed script). The words were *kadur* 'ball', *asur* 'forbidden', *xuc* 'outside'. An example of one of the stories was y*esh li kadur. asur lsaxek baxuc, ani mesaxek babayit* = translated as" I have a ball. It is forbidden to play outside. I play in the house." These turned out to be creative texts that the young learners produced, including short expositions, descriptions, and problem and solution texts.

Individual learning in "Reading together in Arabic" was mainly through the computer platform that enabled beginning readers to make their first steps in listening, reading and writing while focusing on a decoding issue.

For the aboriginal learners, the warming up initial activity was crucial in creating a positive atmosphere and a feeling of mutual trust. The session always began with a game involving the use of numbers and familiar words and leading to an assessment activity in order to identify the individual needs. When tutees entered the tutoring space children's faces lit up because they saw games and fun elements especially prepared for them.

Meaningful Communication in Context Tutoring has proven to be of special value in creating meaningful discourse. The texts and the activities which make up the materials to be used by tutors and tutees establish the context within which communication occurs. Tutors make special efforts to engage the tutees in talking about themselves and about the content which they are reading. In the tutoring situation, a well prepared tutor, whether s/he is a peer, a teacher or another adult, can encourage and support a tutee, leading the tutee to a more positive self-concept both as a learner and as a reader. This will hopefully help tutees promote positive attitudes and motivation towards reading.

The challenge of meaningful communication was particularly significant in "Reading together in Arabic". It was important to make tutees aware of the phonological – orthographic rules and to encourage them to take responsibility for this knowledge. They became metacognitively aware of what they are learning and how they remember it. Furthermore, they talked about the difference between spoken and written forms of Arabic. Tutors (teachers in this case) and tutees discussed pupils' attitudes and feelings towards standard Arabic. Through interesting stories, computer games, and group discussions, the teachers encouraged pupils to talk about the stories but also to talk about their success and failure in order to create a better self-image.

Many studies dealing with tutoring programs emphasize the gains for tutors over and beyond the gains for tutees. All tutors seem to develop greater commitment, a sense of responsibility, and self-esteem. They develop greater control over content and organization; they gain insights and awareness of the difficulties encountered by learners; and finally they improve their social interaction skills. In short, facilitators can learn by teaching (Duran et al., 2018). This was definitely the case with all the tutors in our programs.

5 Conclusion

The intervention programs presented here raise a variety of issues that could be discussed under the question: how can we ensure fidelity in educational intervention programs?

O'Donnell (2008) carried out a meta-analysis trying to define, conceptualize and understand the difficulties involved in measuring fidelity of implementation in education. Her conclusion is that fidelity of implementation aims to operationalize criteria and practice during implementation, but such procedures have to be done within a specific program and cannot be universally designed.

Feely et al. (2017) suggest practical ways to show how fidelity could be measured in intervention programs. Their claim is that even studies which attach importance to successful implementation of intervention programs do not usually provide enough guidance and information or detailed criteria for successful implementation. Without fidelity measures, it is much harder to assess the true outcomes of the intervention and to reach for scalability.

The plan of action they offer includes five guidelines that could be developed into a model which will define loyalty to the program in behavioral terms. This model has to be developed by the designers of the intervention and should provide the following:

1. Define clear goals at the individual level and the organization level (teachers, students, education system).
2. Provide clear guidelines for data collection.
3. Provide a detailed guide with respect to time allotment, teaching activities, independence and student involvement, proper use of materials and teacher training.
4. Design supervision over the implementation of the program.
5. Develop an indicator tool so that operators can know if they are implementing the plan correctly and faithfully.

What we have learned from the three interventions described above is that each intervention-context presents its unique elements of implementation, yet some features can be viewed as universal, such as:

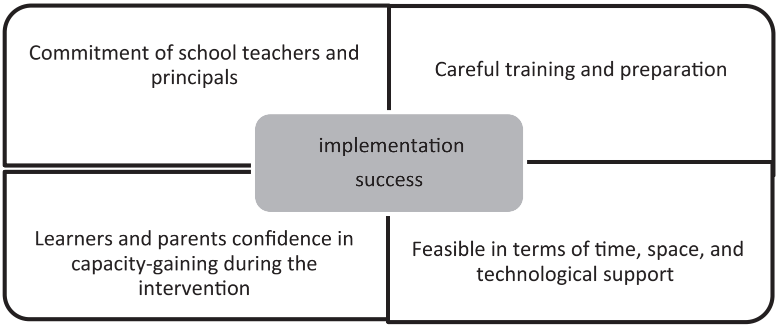
1. The institution receiving the program must be willing and ready to cooperate with the project leaders and make all necessary adjustments during implementation.

   In our case this meant that principals and teachers had to be fully committed to the goals of the intervention. In schools where this commitment existed the program was successful. Some of the principals and teachers in the Arab schools took longer to become convinced that the program suits them and the principals in some of the Australian schools never really believed in the goals of the program.

2. Teachers and tutors, whoever they are, require careful training and preparation before and during the implementation program. They need a leading hand for an extended amount of time.
3. Learners and their parents have to develop confidence in their capacity-gaining during the intervention, leading to improved SEL skills.
4. The operational plan of action has to be feasible in terms of time, space, technological support, and any other required features.

When the above four points are adhered to, can we hope for scalability and long lasting effect.

6 Conditions Required for Future Scalability



Even when the implementation is successful according to the elements presented in the table above, there might be gaps between an objective external evaluation (i.e., State tests) and a more subjective and local evaluation (that is, students seem to be happy and willing to read). The implementors and the local stakeholders have to decide how to define success in such cases. Sometimes the social emotional achievements need to be more highly valued than scores on State tests.

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Tel Aviv University Helps Bridge Linguistic Gaps in School-Age Immigrant Children; Preliminary Outcomes of a Language Intervention Program (LIP)

Shira Cohen, Bonnie Levin-Asher, Mor Levi, Anat Hamburger, and Liat Kishon-Rabin

Abstract In one of the most demographically diverse schools in Israel, the majority of the students belong to disadvantaged ethnic minorities from approximately 20 different countries. Many of these children experience difficulties acquiring language skills primarily due to poor and inconsistent language input from their parents. Not surprisingly, they often demonstrate delays in reading acquisition and poor academic achievements. To assist these children in overcoming the language barriers which have lifelong consequences, senior staff members from the Department of Communication Disorders (CD) at Tel Aviv University designed a language intervention program (LIP). The LIP was applied to 24 six-year-olds who showed a poorest language ability (matching 3-year-olds) of the 76 first graders who took the language test. The effectiveness of the program was increased by involving third and fourth year CD students in supervised intervention sessions and by providing guidance to the teaching staff. After 8 months of intervention, significant improvements in language proficiency were observed (vocabulary, imitation of sentences and production of narratives) compared to a control group who did not receive LIP. These results provide support to the vital role that academia can take in leading innovative and flexible language intervention programs in communities who have difficulty providing the necessary services to the underprivileged.

Keywords Language intervention · Low socioeconomic status · Language delay · School-age children · Ethnic minorities · Clinical practicum · Communication disorders

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1 Introduction

In recent years, there has been a vast increase in the percentage of disadvantaged ethnic minorities (D-EM) in Western countries as a result of political turmoil and civil wars in many third world countries, which has augmented the number of refugees, asylum seekers, and displaced persons (Coleman, 2006; Johnson & Lichter, 2010; United Nations Children's Fund-UNICEF, 2017). EM are social groups that differ from the majority of the inhabitants of a country or society in which they live in terms of language, race or religion, or a combination of these (Willemsen & van Oudenhoven, 2020). Although some EM communities are socioeconomically resourceful, many EM communities (especially when composed of first-generation immigrants), are disadvantaged. D-EM families are often faced with financial burdens due to precarious working conditions, low job profiles, low income, insufficient access to health services, a lack of formal education and strong feelings of social isolation (Lustig et al., 2004; Vostanis, 2016). These individuals and especially their young children face multiple challenges as they try to acculturate and re-start their lives in a new cultural environment. Research has also shown that EM may be more susceptible to mental disorders because of traumatic events prior to immigration and adverse circumstances in the new country (De Vroome & Hooghe, 2013; Gilliver et al., 2014; Liao et al., 2011). As a result, many children experience a variety of stressful environmental conditions such as family separations, unattended health problems, malnutrition and cultural conflicts between home and school, all of which negatively influence age-appropriate development (Suárez-Orozco et al., 2018). For example, it has been shown that parents' concerns about financial problems have adverse effects on the mental health of refugee children (Fazel et al., 2012), which in turn negatively impacts their academic achievement (Eamon, 2005; Suárez-Orozco et al., 2010).

Language proficiency in childhood (first language as well as second language) is considered to be a predictor of later social and academic success (e.g., Wang-Taylor & Milton, 2019; Hebert-Myers et al., 2006; Verdon et al., 2015), which are keys to socioeconomic mobility (Bleakley & Chin, 2004). The importance of meeting the challenge of mastering age-appropriate language skills is further underscored by findings indicating that language competence is one of the main predictors of successful acculturation (e.g., Jia et al., 2016; Chen et al., 2008). Unfortunately, children from D-EM families often manifest developmental and educational delays, primarily in language achievement (ASSAF, Aid organization for Refugees and Asylum Seekers in Israel, Recommendations, 2020). A disadvantaged parental background also often factors into child language outcomes (Van der Silk et al., 2006). Many parents of D-EM children have only a few years of formal education; others have an only primary school education (K-8) (Van Der Veen, 2003). Studies have shown that mothers with fewer years of formal education talk less to their children and use a more limited vocabulary and less complex syntactic structures (e.g., Hart & Risley, 1992; Hoff, 2003; Hoff & Tian, 2005; Rowe, 2008). Less frequent parental speech input and interactions (quality and quantity) early in a child's life have been found to be associated with altered brain development, delayed language development, lower pre-literate abilities and difficulties in learning to read (e.g., Engel et al., 2008; Fluss et al., 2009; Nittrouer & Burton, 2005; Noble et al., 2006; Zhang et al., 2013). Without appropriate early intervention, these disparities tend to aggravate throughout life, thus adversely affecting the chances of these children and their offspring to break the cycle of poverty and climb the socioeconomic ladder (e.g., Hackman & Farah, 2009; Hackman & Meaney, 2010; Hoff, 2003; Horton-Ikard & Ellis Weismer, 2007; Kishiyama et al., 2009; Raizada & Kishiyama, 2010; Turrell et al., 2002).

Another critical factor impacting language development in D-EM children is the multi-linguistic environment to which they are exposed, at times because the parents belong to different ethnic groups that speak different languages. In such cases, the parents communicate between themselves in a third language which often has never been fully acquired, thus exposing their children to a linguistic mixture of several languages, none of which is used consistently and are often used inappropriately. This results in a clinical condition called *semilingualism*, where children use smatterings of different languages because they have not been able to fully acquire the structure of at least one language, thus reducing their future ability to acquire advanced language capabilities (Hinnenkamp, 2005).

Despite the importance of early language intervention in children from D-EM, most intervention programs designed to improve D-EM wellbeing and future opportunities are restricted to assistance in accessing social services, health, mental health, and education (with a focus on emotional and vocational skills) (e.g., Furman et al., 2009; O'Hara, 2003). These support services are often skimpy and underbudgeted and are highly dependent on the type of intervention and the target population (Hart & Risley, 2003; Leffel & Suskind, 2013; Koutsoftas et al., 2009). There are a few reports of the significant influence on the cognitive abilities of D-EM children of indirect parental guidance interventions that address parenting strategies, but not their children's language competence (e.g., Leijten et al., 2017; van Mourik et al., 2017). Studies on language intervention in school-aged children from D-EM delivered through the school system have been reported to have either a modest effect (e.g., Snow et al., 2009) or minimal effect (e.g., Han & Bridglall, 2009; Niehaus & Adelson, 2014). In one series of studies using a language intervention program which promoted the expansion of vocabulary in 5–8 grade pupils, a modest positive effect was shown following intensive intervention, but only for those who began the program with higher linguistic capabilities (Hwang et al., 2015; Lawrence et al., 2017; Snow et al., 2009). In another study, Han and Bridglall (2009) addressed math and language skills in their intervention program for kindergarten to fifth grade pupils, but improvement was shown only in math. It should be noted that most of these intervention programs have been developed by trained educational staff and special intervention coaches who are not qualified in diagnosis of language delay and/or experienced in tailoring language intervention to the specific language needs of the individuals. It could be argued that the language level of some school-aged children from D-EM is so low that the linguistic capabilities they exhibit resemble language pathologies and therefore require diagnosis and intervention by experienced professionals such as trained Communication Disorders Clinicians (CDC)[1] or Speech Language Pathologists (SLP) (Ravid & Schiff, 2006; Romero et al., 2020).

In the last few decades, Israel has been confronted with a rapid rise in D-EM as a result of the legal and illegal entry of foreign workers and asylum seekers. Their lives before and after their arrival are characterized by poor living conditions that are considerably lower than the typical local Low Socioeconomic Status (LSES). There are approximately 300,000 foreign workers currently residing in Israel under temporary work visas, including Palestinians (Population and Immigration Authority in Israel, 2021). About 40,000 foreign workers live in Tel Aviv, and are concentrated in the underprivileged neighborhoods of the southern part of the city, together with approximately 19,000 asylum seekers, who mainly come from Eritrea and Sudan. Of these, more than 8000 are under 18, the majority of whom were born in Israel. According to Israeli law, residents of Israel, even when illegally in the country, are entitled to health and education services. Thus, these children must be enrolled in the municipal school system. Most D- EM community children living in Tel Aviv attend four elementary schools, of which the Bialik-Rogozin school is one (ASSAF, Aid Organization for Refugees and Asylum Seekers in Israel, Position Paper, 2021).

Bialik-Rogozin is an educational complex in south Tel Aviv that, during the years of the language intervention reported here, had about 1000 students who attend elementary school, middle school and high school. Fifty six percent of its students were D-EMs from about 20 different countries (such as, South Africa, Sudan, Darfur, Ghana, Burma, China, The Philippines, Thailand, Romania and the former Soviet Union), 10% of them refugees and the rest (46%) migrant workers. An additional 30% of the students belong to Israeli families from L-SES, 7% were new immigrants and 7% Arab-Israeli residents. As a result of their impoverished backgrounds, many families experience instability and uncertainty with respect to their basic living conditions, and all these families are exposed to poverty and economic distress. In addition, 65% were single-parent families. Hence, parents work many hours a day, while the children are looked after in informal and unsupervised daycare services where 20–30 children are often cared for in a single crowded apartment room. The exposure of these children to a combination of identities, traditions, religions and languages deprives them of the stable and consistent foundation needed for child development. These conditions constitute a risk to the physiological as well as the emotional and cognitive development of the child. As a result, many children enter kindergarten without an appropriate cognitive and educational background. For several years the municipality of Tel Aviv and the staff of the school have provided different types of support to the EM students enrolled at Bialik-Rogozin (see Dvir et al., 2014 for more information about the school and its

[1] In Israel, academic and professional organizations have adopted a dual specialty model for the disciplines of hearing (audiology) and speech and language pathology. Thus, in Israel, audiology and speech and language pathology are referred to as one discipline. A communication disorders clinician (CDC) is an individual who has been awarded a certificate from the Ministry of Health after completing the academic requirements for the profession as defined by law (Kishon-Rabin, 2016).

educational intervention strategies). While there were successes at the individual level (e.g., athletes recruited for the national track team, a prize winner in a scientific robot competition), the overall academic level of these students has remained low.

In 2008, in response to a request for assistance from the school head, the Department of Communication Disorders at Tel Aviv University (TAU) decided to develop a Language Intervention Program (LIP) tailored for the specific needs of Bialik-Rogozin school. The general guidelines were that the intervention should be affordable and include as many students as possible, aimed at different levels of language proficiency, and be ecologically integrated into the curriculum and in school activities. Importantly, the program would also include teachers, to empower them as agents of change. It was clear, however, that prior to implementing the LIP, additional decisions needed to be made. These included selecting the students who would be assigned to the intervention (should the program be aimed for the youngest age group or for the most difficult cases in each age group?), the language assessment tools used to define the baseline prior to the intervention, identifying the linguistic needs of the students, and determining the nature of the intervention (individual, group and/or class), (Liao et al., 2011; Culatta et al., 2003). The sections that follow detail these decisions and their implementation.

2 Choice of the Target Group (TG)

Unlike many elementary schools in Israel, the Bialik-Rogozin school has a kindergarten. Thus, our team deliberated as to whether preschoolers or first graders should be chosen for the intervention. The dilemma was that for the older children, this would be their last opportunity to receive specific language intervention and support. In contrast, interventions with younger children are known to be more effective (e.g., Moeller, 2000; Ruben, 1999). Moreover, by starting early and empowering the teachers to make changes, there was a greater likelihood of helping these children acquire better language skills. What tipped the scales was the fact that the kindergarten children had not experienced their first year in an official educational setting, and did not have the study habits for language intervention to be effective compared to a group that was a year older. In addition, many kindergarten children had not yet acquired enough functional Hebrew to allow them to benefit from language intervention. In contrast, the first graders had already been exposed to about a year of Hebrew in the school setting. The decision was thus made to target the first-grade age group (N = 73; 45 boys and 28 girls; mean age of 6;4 years; months).

3 Selection of the Language Assessment Battery

The assessment battery had to meet the following criteria: (1) suitable for children with very low language skills, while avoiding a floor effect or a ceiling effect, (2) provide extensive information on a range of language skills and (3) enable rapid testing of many children in a short period of time. One such instrument in Hebrew that meets these criteria is Goralnik's Speech and Language Screening Test (GSLT) (Goralnik, 1995), which provides information on different language skills of children aged 2; 6 to 6; 6. Although the first-graders selected for the program were 6 to7 years old, a ceiling effect was unlikely since teacher reports and the literature on the subject both confirm that their language skills lag behind their chronological age by at least 1 year. The GSLT consists of six subtests assessing vocabulary, articulation, comprehension, imitation, expression and storytelling (narrative). A score on the GSLT below one standard deviation from the mean score of the same age group in the same socio-economic status (low vs. medium-high) is considered a sign of potential language impairment and an indication that the child should undergo an in-depth language diagnosis by a CDC (Goralnik, 1995). The GSLT was administered to all 73 children individually in a quiet room. Note that although it is recommended to test children in their mother tongue, there was no realistic way to adapt the test to the many different languages these children speak. In addition, most children had not acquired basic functional language skills in their native language, so that testing this language would not necessarily improve their test scores. While the children speak pidgin English in their community, initial attempts to test in English were unsuccessful because of their limited proficiency in English. Thus, it was decided to test all children in Hebrew, primarily because Hebrew was the language spoken in the school and it is the language they heard as residents of Israel.

4 Language Proficiency of the Target Group (TG)

The GSLT provides norms for the general population as well as norms for medium-high and low SES (Goralnik, 1995). The raw score, in comparison to the standard score of low SES and the equivalent developmental age of the TG (prior to intervention) for each GSLT subtest, appear in Table 1. As shown, there were significant deviations on all subtests, except for the articulation subtest, which demonstrated age-appropriate performance.[2] Specifically, the mean total score on the test was lower than the norm of L-SES peers by more than four standard deviations and corresponded to the mean total score of 3; 0 to 3; 6 year olds, i.e., presented an average lag of 3 years from the expected performance in terms of chronological age when compared to average L-SES in Israel. The mean scores on the Vocabulary, Expression, and Narrative subtests were at least two standard deviations below the norm, whereas the mean scores on the Comprehension and Imitation subtests were at least one standard deviation below the norm. Moreover, the mean Vocabulary subtest score was lower than the average score of 2; 7 year olds.

[2] Since the scores obtained on this subtest are consistent with the literature indicating no difference in articulation skills between socioeconomic groups (Dodd et al., 2003; Goralnik, 1995), it was decided not to further address this subtest.

Table 1 Means and SDs of the first graders (target group, n = 73), standard scores, and age matched scores from L-SES for each subtest on the GSLT

GSLT subtest	Mean score (SD) of target group	Comparison to standard score L-SES	Age matched (y; m) L-SES
Vocabulary	11.02 (6.09)	−3.63	Under 2; 7
Articulation	29.92 (0.00)	0.45	5; 7–6; 00
Comprehension	19.83 (5.07)	−1.08	3; 1–3; 6
Imitation	16.42 (5.44)	−1.71	3; 7–4; 0
Expression	16.42 (6.47)	−2	3; 1–3; 6
Narrative	7.72 (4.74)	−2.55	3; 1–3; 6
Total score	100.93 (21.19)	−4.48	3; 1–3; 6

To examine the differences between the ethnic subgroups, t-tests for unrelated samples (DF = 44) were performed. The results revealed significant differences in vocabulary and language comprehension skills ($p = 0.007$, $t = 2.82$, $p = 0.007$; $t = 2.4$, $p = 0.02$ respectively) between children from African countries (n = 28) vs. Asian countries (n = 30), where the latter scored higher. No differences between ethnic subgroups were found on other subtests or for the total score ($p > 0.05$).

Twenty-four of the 73 children who demonstrated the lowest scores in the GLST were chosen to participate in the therapy sessions of the intervention program and were termed intervention group (IG).

5 Language Intervention Program (LIP)

LIP was designed to respond to two main guiding principles. The first was that the program should include as many children as possible. The second was to maximize the children's exposure to interaction and language. In order to include as many children as possible and still be attuned to the needs of each of them, it was decided to conduct the intervention sessions in pairs and small groups (Hart & Risley, 1980) and to include advanced TAU CDC third and fourth year students in the program. For this purpose, the children were grouped according to similarities in their language profile as reflected in the initial assessment scores. The TAU CDC students worked alongside the CDC's and under their supervision.[3] However, when the need arose, individual sessions were provided as a function of the child's behavior, emotional abilities, attention abilities and language skills. To increase the effectiveness of LIP, the teachers were provided with material and guidance as to how incorporate it in the daily curriculum in order to further enrich the children's language.

[3] According to the clinical practicum instructions of Tel-Aviv University, the clinical instructors at the practicum location are required to be qualified communication disorder clinicians with a minimum of 5 years of professional work and a Master's degree (Kishon-Rabin, 2016). In places that have more than one clinical instructor, at least one of them must meet the above criteria, while the others can instruct students if they have a BA degree in communication disorders and at least 3 years of clinical experience. All clinical instructors are required to undergo a clinical instructor's course.

5.1 The Intervention Protocol

The 24 children (IG) who demonstrated the poorest language skills in the TG took part in intervention sessions once a week for 45 min. Most children started at the beginning of the first semester, and participated in about 10 sessions. Based on an informal re-evaluation of the children's improvement at the end of the semester, some children left the program and were replaced by other children from the lower third of the baseline scores group, or according to the teacher's recommendation. The remaining children were given 10 more sessions. Overall, the IG children participated in 7–20 intervention sessions ($M = 12.58$; $SD \pm 4.42$). The sessions took place in a quiet room at school, during school hours, and were delivered by a senior TAU CDC or by a student under the direct supervision of the TAU CDC.

5.2 Language Therapy

A comprehensive language approach to early literacy requires that all levels of language be addressed (Culatta et al., 2003). Thus, a variety of language therapy methods were flexibly adapted to each child according to his/her language level (e.g., structured methods, semi-structured methods, ecological and holistic). Each treatment group progressed independently towards its specific goals according to the linguistic level of its members. In order to maintain large scale intervention, some of the topics, such as those that were derived from the school curriculum (e.g., holidays, seasons), were taught simultaneously in all groups with the focus mainly on expanding the vocabulary relevant to those topics. Additional practice in the content and vocabulary that were taught by the teachers in class was provided by TAU CDCs and students. This allowed the children within each group to receive repeated experience with the learning material (which was modified to their learning abilities), thus reducing the gap between the low and high- performing children and allowing the teachers to advance in the curriculum. There were additional topics that were group-specific which were selected according to the language goals of each group (e.g., morphological structures, pragmatic skills, syntax levels, etc.). These were learned according to developmental milestones in order to establish a stable language infrastructure that would allow the children to acquire higher language skills later on. For example, a newly acquired complex syntactic structure was implemented to achieve coherent narrative. To increase effectiveness, long-term, short-term and specific goals were set for each child according to individual functional needs, including reading and writing skills. At the end of the second trimester, phonological awareness skills were assessed in the group of children identified by their teachers as having reading difficulties. To promote their literacy, a dedicated group therapy was conducted for them.

5.3 Guiding Sessions for the Teachers

In addition to the intensive direct intervention, the TAU CDCs also worked with the teaching staff to assist them in becoming agents of change (Detrich, 1999). To this end, frequent meetings as well as spontaneous informal conversations were held. In these meetings, the teachers received guidance on the importance of linguistic input, and learned strategies for expanding them during routine classroom activities. In addition, they were updated on their students' progress during the sessions and learned how to transfer the new skills to the classroom. The teachers described the difficulties in the classroom, asked questions and sought solutions through mutual discussions. This two-way communication with the teaching staff provided information on the students' classroom activities and the children's performance, and supplied the teachers with practical tools for enhancing the children's language skills in class.

6 Efficacy of the LIP

To assess the efficacy of the LIP program, data from two groups of children were collected. The first was the IG described above (n = 24, 17 boys and 7 girls) with a mean age of 73.9 months (SD = 4.5 months). The second was a control group (CG) which consisted of 25 children (17 boys and 8 girls) with a mean age of 76 months (SD = 3.2 months). The demographic data for the IG and CG appears in Table 2.

Note that for ethical reasons we could not withhold treatment from children whose language level was so low. Thus, in the first 2 years of the LIP program, no control group participated in the study. At the beginning of the third year, the academic staff had to deal with an unexpected situation when 40 additional children were enrolled in first grade, thus doubling the number of students. Because the number of CDC could not be increased and therefore not all children could receive

Table 2 Sociodemographic data of the intervention group (IG) and control group (CG)

		Gender	Countries of origin			
Group	Mean age in years (SD in months)	M/F	Philippines	African countries	Other (less than 8% each)	% Families with parents speaking two different mother tongues
IG	6; 2	17/7	56.2%	22.9%	Israel	37.5%
N = 24	(4.5)				Turkey FSU	
					Burma	
					India	
CG	6; 4	17/8	48%	40%	Israel	20%
N = 25	(3.2)				Turkey	
					China FSU	

the needed intervention, it was decided that 25 of the first graders would serve as the CG. It should be noted that the division into groups was not based on homeroom class. That is, in each classroom some of the children were assigned to the IG and others to the CG**.**

6.1 Comparing the Progress of the Two Groups (IG vs. CG)

Data were collected on the GSLT language test before and after the intervention (measurements 1 and 2 respectively). For the CG, the GSLT test was administered in the first 3 months of the academic year, to parallel the sessions that took place in the IG. A t-test for unrelated samples confirmed no differences on the first measurement (M1) between the IG and CG scores ($p > 0.05$, $DF = 46$). After the intervention period (in which IG received the intervention and CG did not), all children (IG and CG) were re-assessed by the GSLT (M2). To examine the effect of the intervention on the GSLT scores, a two-way Repeated Measures ANOVA (RM-ANOVA) was performed separately on each of the GSLT subtests (Vocabulary, Comprehension, Imitation, Expression and Narrative). The within-subject variables in the RM-ANOVA analysis were the two measurements (M1 and M2) and the between-subject variables were the two groups (IG and CG). In addition, the M2 scores of IG and CG were compared to the norms of their L-SES peers.

The means and SDs (in parentheses) of the GSLT scores in M1 and M2 and the delta between them (in parentheses, the increase in percentages) for the five subtests in the intervention and control groups are presented in Table 3. The results of the two-way RM-ANOVA are presented in Table 4.

As shown in Table 4, a main effect for measurement, indicating a significant improvement between M1 and M2, was found on all subtests. A main interaction (measurement * group) effect was found for three of the subtests (vocabulary, imitation, narrative) and for the total score on the GSLT, reflecting a greater increase following the intervention in the scores of the IG compared to the CG. The interactions are presented in Figs. 1, 2, 3 and 4. No main effect of group was found for the subtests or for the total score on the GSLT ($p > 0.05$). Overall, these results indicate a greater improvement in the participants' language proficiency following the intervention (IG) compared to the control group (CG).

6.2 Second Measurement Scores vs. the Norms of L-SES Peers

The mean scores, SDs and standard scores at the second measurement (M2) for the IG and CG are shown in Table 5. The table shows that within 7 months of treatment, the IG children achieved scores within the norm for their L-SES peers on the Comprehension, Imitation and Expression subtests and scored close to the norm on

Table 3 The means and SDs (in parentheses) of the GSLT scores for the first and second measurements (M1, M2) and the improvement over time (M2 minus M1) on each of the five subtests for the intervention and control groups

	Intervention group, N = 24			Control group, N = 25		
Subtest	M1 scores	M2 scores	Improvement	M1 scores	M2 scores	Improvement
Vocabulary	10.25	19	8.75	11.76	16.68	4.92
	(4.98)	(5.60)	(85.37%)[a]	(7.03)	(5.33)	(41.84%)
Comprehension	19.5	24.33	4.83	20.16	23.88	3.72
	(5.00)	(3.16)	(24.77%)	(5.23)	(4.70)	(18.45%)
Imitation	15	22.63	7.63	17.40	21.84	4.44
	(6.07)	(5.23)	(50.87%)	(6.71)	(6.68)	(25.52%)
Expression	16.08	21.33	5.25	16.76	20.40	3.64
	(4.99)	(5.00)	(32.64%)	(5.93)	(4.92)	(21.72%)
Narrative	7	15.25	8.25	8.16	11.88	3.72
	(3.92)	(4.84)	(117.86%)	(5.44)	(7.17)	(45.59%)
Total[b]	**98.13**	**130.88**	**32.75**	**103.64**	**125.80**	**22.16**
	(18.26)	**(14.95)**	**(33.38%)**	**(23.74)**	**(21.08)**	**(21.02%)**

[a]'Improvement' in percent corresponds to (M2−M1)/M1 × 100
[b]Articulation subtest included

Table 4 The results of the two-way RM-ANOVA testing the effect of measurement (M1 vs. M2) on the GSLT scores in the intervention (N = 24) and control (N = 25) groups

	Measurement effect (DF = 1.47)		Interaction effect (DF = 1.47)			
Subtest	F	P	η^2	F	P	η^2
Vocabulary	70.64	<0.000	0.59	5.55	**0.023**	0.12
Comprehension	25.33	<0.000	0.35	0.43	0.52	0.01
Imitation	86.03	<0.000	0.65	5.99	**0.02**	0.11
Expression	41.41	<0.000	0.47	1.36	0.25	0.03
Narrative	6.53	0.01	0.12	6.53	**0.01**	0.12
Total	139.78	<0.000	0.75	5.19	**0.03**	0.10

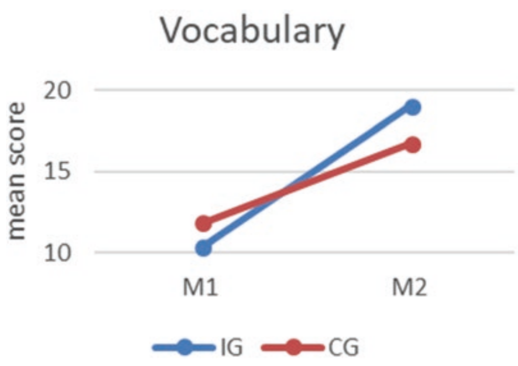

Fig. 1 The mean score on the Vocabulary sub-test in the first and second measurements (M1 & M2) in the intervention and control groups (IG & CG)

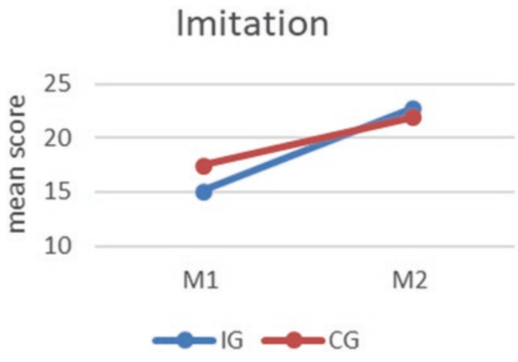

Fig. 2 The mean score on the Imitation sub-test in the first and second measurements (M1 & M2) in the intervention and control groups (IG & CG)

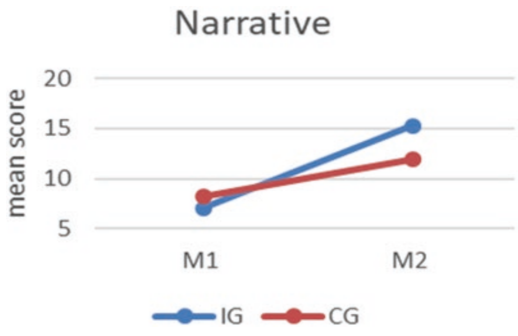

Fig. 3 The mean score on the Narrative sub-test in the first and second measurements (M1 & M2) in the intervention and control groups (IG & CG)

Fig. 4 The total score on the GSLT test in the first and second measurements (M1 & M2) in the intervention and control groups (IG & CG)

the Narrative and Vocabulary subtests. However, for the Total score, the IG children scored one SD below the mean of their L-SES peers. The CG standard scores were lower than those of the IG on all subtests as well as in the total score. Specifically, their scores were within the norm on only two subtests (Imitation and Comprehension) and were close to the norm only in the Expression subtest. Overall, the results show that IG scores were closer to the norm than CG scores.

Table 5 The mean scores (SD in parentheses) and standard scores on the second measurement (M2) for intervention group (IG) and the control group (CG)

GSLT subtests	IG score at M2 (SD)	Standard score of IG	CG score at M2 (SD)	Standard score of CG
Vocabulary	19.00 (5.60)	−1.10	16.68 (5.52)	−1.84
Comprehension	24.33 (3.16)	**−0.06**	23.88 (4.76))	**−0.16**
Imitation	22.63 (5.23)	**−0.49**	21.84 (6.65)	**−0.64**
Expression	21.33 (5.00)	**−0.77**	20.40 (4.16)	−1.01
Narrative	15.25 (4.84)	−1.07	11.88 (7.38)	−1.72
Total score	130.88 (14.95)	−1.69	125.80 (20.20)	−2.16

The standard scores that were within the norm (i.e., less than 1 SD) are in bold

7 Discussion

The purpose of this chapter was to describe the process of developing an intervention program for first grade children from a multicultural community and to present the initial findings that attest to its effectiveness. Despite the large gaps in all language domains and the brevity of the intervention, a significant improvement was found in the intervention group. The findings show that the set of principles and decisions that dictated the intervention strategies created an effective LIP. These include: (1) The choice of language, i.e., Hebrew, with which to diagnose the children using the GSLT test. As predicted, although the GSLT is aimed at pre-school children, there was no ceiling effect due to these children's significant language delay and yet there was no floor effect. The test was sensitive to show improvement in different linguistic categories; (2) Therapy in small groups (compared to classic individual therapy) which was focused on specific linguistic skills (based on the GSLT) was found to be effective; and, (3) The guidance sessions with the teaching staff seemed to promote language skills to all the children in the class as evident by the fact that both IG and CG showed improvement, thus making the LIP scalable. However, further confirmation of the effectiveness of the LIP should be attained by comparing performance with children from similar age and background that did not receive this language intervention program. Working with the teachers also provided important feedback to the CDCs on the transfer of language skills to classroom setting.

7.1 The Efficacy of LIP

The results of the post-intervention evaluation showed that the IG children made more progress than the CG on the verbal expression (imitation, vocabulary, and narrative) subtests and scored closer to the norms of their L-SES peers on all subtests. On the Comprehension subtest, both groups scored within the norm, whereas on the Expression subtest, only the IG scored within the norm (though the CG score was borderline). Overall, these findings suggest that the LIP had more impact on language production than on language comprehension. It is possible that the emphasis in the intervention on increasing classroom participation may have fostered these skills. Alternatively, there may have been a decline in avoidant and passive classroom conduct in children from Asian cultures. The intervention provided the children with a safe haven, individual interactions, and encouragement to take a more active part in verbal communication. This initiated positive cycles of using and experiencing language production.

Despite the greater improvement in the IG, the CG children also showed significant improvement in their language skills. One possible explanation may be related to developmental maturation. Another explanation may be due to the indirect effects of the LIP, since one of the goals of the program was to make teachers agents of change. Because the IG and CG children studied in the same classrooms, it is possible that the teachers' application of the knowledge they acquired through guidance affected all the children (IG and CG) and not just those who were part of the direct intervention program. In addition, for ethical reasons, in specific cases the LIP team advised and helped find solutions for children from the CG as well. Hence, while these children did not attend direct sessions, they still benefited from the professional knowhow of the CDCs. The similar progress made by both groups in language comprehension may indicate that the indirect component of the intervention (i.e., teacher training) mainly affected language comprehension skills, whereas the direct component of the intervention (i.e., intervention sessions) primarily affected language production skills. In order to substantiate this hypothesis, future studies should apply the LIP such that one group receives a direct intervention and the other group only receives an indirect intervention through teacher training.

Although many intervention programs have been designed to improve the well-being and future outcomes of D-EM children, to the best of our knowledge, only a handful have addressed the language proficiency domain as the central aim and none were administered by professional CDCs (e.g., Han & Bridglall, 2009; Hwang et al., 2015; Lawrence et al., 2017; Niehaus & Adelson, 2014; Snow et al., 2009). These studies have usually targeted one level of influence, involving direct intervention with students, parental guidance or teacher training and not a combination thereof. Because of the many differences between previous language intervention programs and the one implemented in the present study, including age of intervention, language intervention goals, the personnel that administered the intervention, the extent of the intervention and the layers of support, it is difficult to identify one key factor for the success reported in the present study.

7.2 The Benefits of Academic Intervention in the Community

The fact that the LIP was designed and executed by CDCs from Tel Aviv University has a number of advantages. One advantage relates to the fact that the academic supervision by senior professional staff adhered to evidence-based standards of assessment when monitoring the program's achievements. A second advantage is application of innovative theoretical and clinical knowledge in speech therapy for multilingual children. Such information may be not readily available or applied by CDCs either early in their careers or even by more experienced ones. A third advantage relates to the fact that participation in the program provided new clinical opportunities to TAU CDC students in challenging treatment conditions, giving them hands-on experience in the different ways to be involved and contribute to the community. The students who participated in the intervention reported that the practicum was extremely demanding, but that they learned how to exercise intensive and flexible clinical thinking in complex situations, and felt they made a significant impact to the well-being of the individuals in the society. Some expressed specific interest to return to the school and contribute as clinicians after their graduation.

8 Summary and Conclusions

The LIP was designed by researchers at Tel-Aviv University for first graders at the Bialik-Rogozin School, which caters primarily to immigrant children. The program was aimed at improving these children's language skills through a multilevel support and systematic intervention, including direct sessions for the children, as well as guidance for their teachers. The LIP was based on two main academic resources (1) cutting-edge theoretical and clinical knowledge in the field of speech therapy for multilingual children; and (2) a workforce that included communication disorders clinicians and students whose professional expertise has made it possible to provide a treatment tailored to the significant language difficulties of the children. The program was first administered on a group of 24 children. During the one-year program, several gains were made: (1) The children in the intervention group showed significant improvement in their language skills; (2) The teachers became agents of change so that children who did not participate in the program (e.g., the 25 children in the control group) probably benefited from the LIP as well; (3) Future first graders of these teachers are expected to benefit from the experience their teachers gained; (4) The Tel Aviv University practicum students gained a unique clinical experience that educated them for community involvement. Although the process was complex, the results are encouraging and highlight the benefits of an academic intervention in the community for both parties (a win-win situation). On the one hand, the community benefitted from improvement in the children's language skills, and the contribution to the expertise of the educational staff. On the other hand, the researchers acquired experience with added value for its students. In light of its success, the LIP model can be applied worldwide, in countries where there has been an influx of immigrant families or refugees. Future work will focus on recruiting parents to participate in parental guidance sessions which will add another layer of indirect but necessary language support.

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Children of Asylum Seekers and Migrant Workers in Israel: Language and Identity Dilemmas

Michal Tannenbaum and Ayelet Rimon Stern

Abstract This chapter describes an ethnographic case study conducted over a year in a school in Israel attended by children of refugees and migrant workers from close to fifty different countries, focusing on a third-grade class. Israel's education system seeks to socialize these children into Israeli culture and help them learn Hebrew, while the legal system enacts statutes enabling their deportation. Given the close association of language with identity and emotional interactions, it was chosen as a lens for exploring the children's paradoxical reality, asking how are their life experiences reflected in their perception and use of languages? Data was collected via participatory observations, and systematic documentation of the children's learning activities and language development. Several categories emerged in the analysis, suggesting complex interactions between language and education, emotional aspects, and family relations. Findings are discussed in light of critical theories, dispelling the dichotomous perception of education as serving either the individual or the society. Further recommendations suggest broadening the scope of languages these children learn and encouraging language maintenance in order to promote the children's development and well-being.

Keywords Asylum seekers · Family · Identity · Immigrant learners · Israel · Multilingualism

1 Introduction

Over the decades, Dorit Ravid – as a renowned linguist and psycholinguist – has researched various aspects of Hebrew language acquisition and the development of linguistic literacy. It was my (the first author's) great privilege to be her colleague

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for many years, in our small, yet flourishing Program of Multilingual Education, in which we shared teaching, supervising, and promoting our vision via research. This chapter shares a part of a year-long ethnographic case study, which was part of a thesis (of the second author). Given the unique characteristics of the school on which we focused and its student population, the study allowed us to explore in depth issues of language, education, and emotions, bringing together various aspects of Dorit's research interests along the years.

Education systems, and schools in particular, are key mechanisms for socializing children into a society's prevailing norms and values. As Dewey (1923) notes, the popular view of schools as conveying collective cultural knowledge differs from a reality showing that schools actually serve hegemonic groups (Dahan-Kalev, 2001; Freire, 1968/2018; Gor-Ziv, 2002). What happens, then, when the society beyond the schools' walls rejects the children inside them? This paper describes a year-long ethnographic case study conducted in a public school in Tel Aviv, Israel, where children of asylum seekers and migrant workers from about fifty different countries and language backgrounds study together. Applying a critical theoretical perspective, we focused for a year on a third-grade class, examining the children's experiences and their handling of societal messages that, on the one hand, seek to socialize them into mainstream Israeli culture and foster their acquisition of Hebrew and, on the other, enact laws enabling their deportation. We relied on a sociolinguistic perspective, using language(s) as a lens for exploring social, emotional, and educational processes.

2 The Israeli Immigration Context

Israel is an ethnic democracy (Smooha, 1997) as epitomized in its Law of Return (1950), which allows every Jew in the world to settle in the country and receive citizenship automatically. As for non-Jews, Israel's immigration policy is practically exclusionary since their presence challenges the ethnonational definition of the Israeli state (Raijman & Semyonov, 2004). Immigrants to Israel were indeed mostly of Jewish descent until the early 1990s, when two new groups began to seek entry: labor migrants, recruited to replace the non-citizen Palestinian workers from the West Bank and the Gaza Strip who were banned from entering Israel following the first Palestinian uprising, and African asylum seekers who, mainly from 2007 onward, began entering Israel illegally through the border with Egypt.[1] Israel's immigration policy has been criticized as incoherent, as leading to harsh living conditions and harmful work arrangements for immigrants (Avineri et al., 2010), as refraining from recognizing their rights as refugees (Yaron et al., 2013;

[1]According to the Population and Immigration Authority (2019), approximately 32,000 asylum seekers resided in the country in early 2019, and most of their requests were still awaiting consideration. There are also 101,000 legal work migrants, 17,000 work migrants whose visas have expired, and about 66,000 tourists without a valid permit.

Yaron-Mesgena, 2015), and as creating a hierarchy between citizens and non-citizens (Mundlak, 2003).

The status of immigrants has been extensively considered in Israeli courts, though less attention has been paid to the complex position of their children (HCJ, 2011), who are affected by the legal restrictions imposed on their parents and by the economic implications of their legal circumstances (Abrego, 2006). Immigrant children are integrated into Israeli frameworks as part of their right to education (Mayer & Slone, 2016), but only partially (e. g., their access to preschools is limited; Dvir et al., 2015).

Moreover, even though Israel is highly multilingual due to a large immigrant population, the superior status of Hebrew has consistently been preserved, serving historically as a mechanism for promoting cohesion and unity (Spolsky & Shohamy, 1999; Yonah, 2009).

3 Language and Identity in the Context of Immigration

Language shift is a common aspect of immigration, frequently affecting identity issues. Acquiring the majority language, however, need not imply loss of the mother tongue. Quite the contrary: first language maintenance enables the transfer of language and literacy skills to the new language, in turn predicting academic success (Cummins, 2013; Haim, 2015), and possibly involving a significant emotional and familial contribution (Fillmore, 2000; Sierens & Van Avermaet, 2014; Tannenbaum, 2010, 2012). Many studies have also shown that the first language is often more emotionally loaded than languages acquired later. Bi/multilinguals tend to report a somewhat different 'self' experience in the various languages they use, reporting a preference for the first language in emotional contexts (particularly intimate and family ones) and a sense of finer tuning in terms of identifying emotional states of mind when communicating in it (Dewaele, 2010; Pavlenko, 2006; Tannenbaum, 2012).

At the same time, mastering the language of the host country is obviously a necessary skill for immigrants, schoolchildren included. Parental proficiency in the majority language as well as the general level of literacy in the children's homes, are significant predictive factors of fluency in the new language, neither of which is available to most of the children in the population explored in this study.

4 The Present Study

The setting of the study was a third-grade class in an elementary public school that is part of a larger institution (K-12th grade, with 1300 students). The school's population includes a small percentage of Israeli citizens, though most of it is made up of children of migrant workers and asylum seekers of low socioeconomic status (SES), being highly diverse in terms of ethnicity, language, circumstances of arrival in Israel, and legal status. The chances of improving their living conditions and settling their legal status are, for most of them, rather low.

The class we studied included 27 children, 8–9 years old, of different legal status: labor migrants (11), asylum seekers (9), permanent residents (5), one refugee, and one Israeli citizen. The children and their parents had come to Israel from 11 countries, mainly the Philippines (most of whom came on a work visa), Eritrea and Darfur (most of whom are asylum seekers). There are also labor migrants from other African countries and from Thailand. Some of the children were born in Israel, others arrived as babies. In terms of language background, most prevalent among the children's mother tongues are Tagalog and Tigrinya. Other home languages include Turkish, Thai, Malingo, Fur, Swahili, and Twi. English and Hebrew are frequently used for parent-child communication but the parents' proficiency in those languages is often very low, which affects family dynamics.

The children participating in this study were challenged by having to integrate into a public educational system originally designed for the majority population where Hebrew, the medium of instruction, has long been used to foster cohesion and unity. They also face the risk of deportation, which is highly threatening to them and their families. Given the close association of *language* with personal and collective identity as well as its importance in intimate family interactions, we chose it as a lens for exploring the children's paradoxical reality and formulated our research question as follows: How are the experiences of their lives reflected in the children's perception and use of languages?

5 Method

This is an ethnographic case study, an approach that allows the examination of the characteristics of an individual unit (class, in this context), in a way that captures its complexity. We adopted a participatory design, where the second author was also the home teacher of the class explored in this study.[2] This approach enabled us to study the reality of the group in specific social and physical spaces in a longitudinal fashion, reflecting a rich story over a period of time (LeCompte & Schensul, 1999; Pole & Morrison, 2003).[3] The main research tool of participatory observation, a central practice in ethnographic methodology, fit well with our aim to describe this reality from the children's perspective. Without interfering with their daily routine through new and unfamiliar research interventions, we let the social space we examined lead to themes and emphases, resonating with its own unique voice.

[2] All ethical requirements were fulfilled. Pseudonyms were used for the children and some of the pertinent information was changed to ensure anonymity.

[3] It is important to note that we researched this specific class as a convenience sample, in the sense that the second author was also their home teacher, but this group is representative of the school in terms of the diversity of the children's background.

In the first phase of the study, information was collected through participatory observations and comprehensive recording in a journal of the children's learning, social, emotional/familial, personal, and linguistic experiences. The journal, written by the second author at the end of every week, reported on events in various settings—the classroom, meals, breaks, social activities, teachers' discussions, parent-teacher meetings, and conversations with the children. It also included ongoing personal reflections of the second author and insights about the different events. In the analysis of the data, which included dozens of entries in the journal, we used a combined technique of inductive and deductive thematic analysis. Thus, in the coding process we pinpointed significant events, thereby allowing us to identify and develop themes from the data before proceeding to interpretation (Boyatzis, 1998). Theme is defined as "a pattern in the information that at minimum describes and organises the possible observations and at maximum interprets aspects of the phenomenon" (Ibid, p. 161). In addition, we also used an inductive approach, which involved predefined templates, based on the research question and the theoretical framework. In the second phase, we merged the themes into categories, and also analyzed them vis-à-vis concurrent social-political events that may have affected personal processes. This phase was executed by both researchers, independently, yielding high inter-coder reliability.

6 Findings

In the analysis of the journal, several broad themes emerged (each in itself was divided into sub-categories), including 'presence and absence', 'power relations', and 'discourse'. In this chapter, however, we focus on those themes that interface with *language*, as follows: language and belongingness; the risk of deportation and the acquisition of Hebrew; and familial, educational and linguistic spaces. We present these themes below, each illustrated with several examples and in sequential order.

6.1 Language and Belongingness

Some of the examples below illustrate the children' quest for belongingness and the links of this search with language issues:

First day of the school year, September 1st:

> *First came Ruth, who happily left Miriam, her mother, and ran to hug me. I hugged her back. I was so happy to see her! From far, I heard Rose's mother chatting loudly with Shona's mother. Both mothers came into the classroom talking loudly in Tagalog and laughing… The two girls came to say good morning to me. Shona asked: 'Where should we sit? Are there fixed places?' I told her that there aren't any and she should sit wherever she wants. Shona stood for a long while and looked at the chairs. I went up to her and gave her*

a chair from the group close to my table. Happy with the offer, Shona put her small bag on it and she, Ruth, and Rose ran out to what sounded like an exciting round trying to find more kids from the class. In the course of the day, I was glad to see the kids who arrived but couldn't miss the nine empty chairs. Where are they all?! I thought to myself.

This description reflects the excitement with the renewed encounters together with the concern and hesitations about the still new and impermanent state of things. The girls and their mothers express a shared social identity through various actions. Although the school does not *encourage* the use of minority languages, it provides a secure space for the free use of them. The absence of some of the children that had been part of this space creates a shared experience of uncertainty.

A different kind of search for belongingness emerged in children's discussion about their previous educational frameworks:

November:

During breakfast, the children were talking very animatedly about their early childhood years and who got to know whom first. Rami said that Kan had been the first to meet him. When I asked where they had met, he said that at the kindergarten of Tita (=aunt) *Nono. Lucas stopped eating and said: 'I wasn't in Nono's kindergarten. I was walking with my mom* (referring to their flight from Eritrea, when refugees had escaped the country walking). *Sunwhite* (referring to one of his classmates) *and her mom also walked, but not with us.' Other children joined the discussion asking one another whether they too had walked … Luam joined in and said, 'I knew Moussa first. We used to sleep together as babies at the babysitter.'*[4] *Some of the children were surprised: 'You slept at the babysitter? With your mom?' They were quite shocked to hear that he had indeed slept there, but without his mother.*

In this passage, the children report about various childcare arrangements they had been part of in the past, all usually very poor in terms of teaching language skills. For the children, being in these frameworks implies being away from the family space (some occasionally spend the night there), and thus also away from the potential input of linguistic and social skills within the family context.

Not belonging to suitable educational frameworks at an early age proved harmful to the development of necessary skills before the children reached first grade, with potentially adverse effects on their language development and their scholastic achievements.[5] Such gaps are evident in tests of children's basic skills comparing their achievements with the requirements of the Ministry of Education, as evident in the next record:

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[4] 'Babysitter' is the term used to describe the settings attended by toddlers, where caregivers are mostly women migrant workers (some of West African origin, who speak English or French, or Philippines who speak English). Some of these settings are homes where children are merely watched, while others provide some educational activities common in kindergartens (Mayer & Slone, 2016).

[5] Significant changes have occurred in recent years in the structure of early childhood education in Israel, in the form of the Compulsory Education Law for 3–4 years old. The children included in this study are not covered by this law, and most of them attended settings characterized by substandard physical conditions, overcrowding, and lack of manpower, with some claiming risks, neglect, and developmental delays to the toddlers in them (Tel-Aviv Municipality, 2018).

November:

First I called Samson. I held the open booklet, pointed to the text, and asked him to read 'as much as you can.' He looked at the text and started: 'Sh…'. Since the title was 'The Cat on the Mat,'[6] *I was not quite sure where he had started reading. I pointed to the title, and he repeated the phoneme 'sh…' and stopped. I pointed to the C in Cat, asking him to name the letter. He said G. Then I pointed to a different place in the text with the letter R asking him to name it and he said 'L…' I then called Betiel, who had sat next to me and listened carefully to my explanation. When I finished, she pointed to the first word in the title and started to read in a very low voice 'Ro…' and stopped. I asked her to repeat after me, while I was pointing to the title's letter saying 'Th' and she said 'La'…. When I called Rami, he put his finger next to mine and tried to read the title saying 'B.' I pointed to the C and asked him to name the letter, and he said 'R.' I then pointed to the M asking him to name the letter, and he answered in a question: 'R?'*

The following excerpt presents a different example of the intersection between language and the quest for belongingness:

April:

During today's 'good morning' activities, we again heard the Senegal morning song. Recently, I've tried to bring non-Hebrew songs to the class in order to expand the children's exposure to diverse content and enable them to experience learning in other languages. When the bell rang, Jonathan approached me and asked me to put on a morning song in his language. I was a bit embarrassed because I wasn't sure what language his parents spoke and thought that, even if I knew, I didn't know how to find children's songs in it. In the next few days, I couldn't stop thinking about my inability to help Jonathan. After a few days of pondering this, I invited him to find in YouTube a song in his language that he'd like to hear. He rushed to the computer and in seconds he typed the name Ebone. 'She is a very famous singer in Ghana,' he said, while her soft and beautiful voice was heard in the classroom. He smiled broadly. 'She sings in Twi and in English. My mom told me about her. I love her'.

Jonathan's reaction after the song is heard in the class shows how important it is to him to highlight his language; its close ties with elements of his identity offer a sense of belongingness.

6.2 The Risk of Deportation and the Acquisition of Hebrew

The journal revealed how the children construct their perception of their social context in relation to the presence and absence of their relatives and schoolmates, and how the possibility of being elsewhere affects their perceptions of their own future and of their place in Israel.

January:

During the 'good morning' conversation, Jayoo told the children about a phone call with Jenna, who'd left two weeks ago and gone back to Thailand. Samson asked her whether she'd spoken with her in Hebrew and whether Jenna still remembers how to speak Hebrew…

[6] The actual text that was used for this was a short Hebrew story and *The Cat on the Mat* is presented here to illustrate the children's reading skills in a text familiar to non-Hebrew speakers.

> *Jayoo said they spoke in Hebrew but it was hard to understand her because Jenna was crying. Moussa broke the silence that had spread in the classroom saying: 'I wonder how it feels when you are born here and then leave to go to a new country.' Jonathan answered he was not sure how his sister (*who had been born in Israel and had left for Ghana when she was six*) feels, but he knew that she no longer remembers any Hebrew because when he speaks with her on the phone she doesn't know.*

Coping with a friend's leaving is a common experience that evokes complex reactions in the children, reflecting concern about their ability to sustain identity features related to their lives in Israel after their possible departure and their basic experience of instability in their immediate environment, given the unsettled status of many of them.

February:

> *Today we continued working on language skills the children had already been taught but seemed to have forgotten. We looked again at gendered nouns in Hebrew. I wrote the names of different objects on the board and asked the children to sort them by gender. Walking among them, I noticed that Samson was not really interested. I asked him why he wasn't working and before I finished he responded with a question of his own: 'Do they speak Hebrew in Canada?' Ruth, who sat close, replied quickly, 'No, you're confused; in Canada, they speak English.' I complimented her for knowing this and added that they speak French there as well and there are also others who speak other languages. Samson continued: 'Are there gendered nouns in English?' I said no, and Ruth asked – 'And what about French?' … I noticed that many children around us had stopped working and listened. While I was approaching the board, I heard Silvana asking: 'What do they speak in Sweden?'*

The children's behavior during the lesson described above, dealing with gendered nouns in Hebrew, reflects their ambivalent stance toward some of its contents in association with their perception of their future in Israel. Their questions show how they calculate their steps, examining the relevance of the contents to their current lives and their potential for future locations they might reach.

6.3 Familial, Educational, and Linguistic Spaces

Various records in the journal illustrated specific difficulties the children experience because they are immigrants, such as the special role that many of them play in transmitting and explaining contents to their parents largely due to differences in language proficiency.

February:

> *Silvana arrived only toward breakfast, around 9:20. It turned out that she and her younger sister were late because their mother had failed to wake them. I was very upset that she'd been assigned such a huge responsibility and wanted to speak with her parents. When her father answered the phone, I told him that the girls had again been late and it was very important that one of the parents should help them prepare for school in the mornings. The father answered in Tigrinya, in what sounded like questions. Feeling quite helpless, I transferred the phone to Silvana asking for her help. She stood with the phone, said one word, and then went quiet. After a few seconds, she said another word and then was silent again.*

It seemed that she wanted to explain but just couldn't. I asked her why she didn't answer and she said she didn't understand him.

Last Wednesday, Lucas was again absent. During the year, he'd missed school many times for many reasons and I always worried when that happened. During recess, I called his mother, and no one answered until my third attempt. I heard a lot of noise in the background. 'Where is Lucas?' I asked. She answered that they were 'at the visa.' I was upset that I had not been notified about this and asked her to keep me posted in the future so I wouldn't worry about him. She just said 'take, Lucas talk.' I then heard Lucas, speaking on a very low voice: 'Hi, I'm with my mom at the visa, to translate. She doesn't understand what the man tells her so I'm here'.

The following entry epitomizes the impact of language use on emotional dynamics: when the mother brings in her mother tongue, she emerges as a source of authority in the power relations between herself and her daughter and vis-a-vis the teacher/school:

When Sunwhite's mother came to meet with me, I used the opportunity to discuss that Sunwhite had again been disrespectful to one of the teachers. While I was telling her what had happened, she looked down and turned slowly to her daughter, telling her something in Tigrinya that sounded like a question. Sunwhite started talking in Hebrew saying 'because…' but did not complete her sentence as her mother interrupted her saying: 'Speak Tigrinya Sunwhite, I don't understand Hebrew.' It seemed that Sunwhite had trouble answering and, after several attempts, her mother accepted her statement and said in Hebrew (perhaps to include me): 'You cannot be disrespectful, Sunwhite. You can study now, and you are very lucky. You are not like me, who couldn't study. And instead of succeeding, you are busy with nonsense.'

7 Discussion

This study focused on the attempts of immigrant children, many facing the risk of deportation, to meet the language challenges confronting them during their stay in Israel's state education system, touching on issues of belongingness, the impact of previous educational settings on their acquisition of language skills, the effect of the legal and economic status of the children's families on the uses of language, and the influence of the children's views on their future concerning their efforts to acquire proficiency in the local language. Our analysis yielded insights on the interrelationships between the external socio-political agenda and the children's internal emotional dynamics, leading us to suggestions on how to ease the complex circumstances of their reality.

One persistent motif recurring in the themes that emerged in the analysis of the journal's entries across the different language themes, was *absence*—be it the absence of classmates who did not return to school after deportations, parental absence, absence of suitable educational frameworks, and absence of any clear idea about their future. Critical realist thinkers (Bhaskar, 2008; Norrie, 2010) do not view absence as merely indeterminate nothingness but as a causally effectual concept involving natural, social, and psychological outcomes. In the discourse related to minorities, it often serves to sharpen their exclusion, the difference between the ways society addresses and contains the majority while excluding, marginalizing, and ignoring various minorities (see its use, for example, in the analysis of curriculum (Stylianou, 2017; Wilkinson, 2014), museums (Zhang et al., 2018), or national identity (Johntson, 2014). The prominence of this concept in the data collected in this study proved intriguing, and the following discussion elaborates on the close intertwining of the absence motif with language issues.

7.1 The Educational Angle

The absence of appropriate preschool frameworks negatively influenced the children's development of language skills. The worrying absence of basic pre-reading skills illustrated in one of the excerpts indicates that most of the preschool frameworks the children had attended had lacked essential conditions for learning, severely harming the acquisition of linguistic abilities they should have purportedly mastered by then (Dvir et al., 2015; Mayer & Slone, 2016). Such deficits could obviously have other sources as well (Ministry of Education, 2007; Van der Linde et al., 2015), but given the prevalent low levels of language proficiency and the available information on those previous educational frameworks, attributing their language levels (not only in Hebrew) and their overall achievements to this absence appears highly plausible. Further research, explicitly exploring this aspect, may shed further light on this hypothesis.

The suspicions and alienation that emerged vis-à-vis the necessity of learning Hebrew (e.g., gendered nouns, wondering whether Jenna still uses Hebrew after her return to Thailand) can be understood in light of the children's experience of a gap between the contents they are studying and their *potential future* identity. The children rank the contents they are taught hierarchically, according to their future relevance, an approach predicated on assumptions about where they might end up living. Their ability to adopt such a pragmatic and rational approach when making decisions that will advance them, relying on their own understanding of the language and social reality surrounding them, is rather impressive.

Several scholars who have considered students' objection to learning (at times termed 'unlearning') from a critical perspective (e.g., Dahan-Kalev, 2001; Gor-Ziv, 2002; Kohl, 1992), point to its destructive implications, when teachers interpret this resistance as evidence of the students' limitations (see also Sierens & Van Avermaet, 2014). These scholars view the students' objection as a political (not necessarily conscious) declaration by immigrant children, who refuse to accept pseudo-collective agreements that operate against them. The risk entailed by this approach, however, is the potential strengthening of racist perceptions about the abilities of weaker groups. Rather than a reflection of the political problems inherent in the curriculum's contents or of attitudes of teachers and of the system toward them, the students' limited achievements are adduced as proof of their incompetence.

7.2 The Emotional Angle

Common to most of the children in the class (and in the school in general) is the absence of any constancy in their routine, manifest in the breakup of their day into various spaces, each with a different professional team, involving different rules, cultures, languages, and behavioral expectations. True, these settings do enable the children to be in a sheltered framework rather than in the street or in conditions of neglect or even at risk of injury. The absence of a defined center, however, especially one related to their culture and language of origin, poses a particularly complex challenge in terms of identity formation and of its potential for split and fragmentation (Tannenbaum, 2012).

The children's memories of their pre-migration days, of their migration journey, or of preschool (babysitter) frameworks, even from a very early age, are rather striking. Whether these are real memories or narratives based on the memories and stories of others, they do convey the extreme character of these events as well as the children's yearning for a clearer notion of who they are and a need for a defined beginning, perhaps in an effort to create a continuum and a less fragmented experience.

The excerpts presented reveal the children's full awareness of their circumstances. The sole constant is the lack of stability and of a clear future, either for themselves or for their family, acquaintances, and friends. They are in a kind of liminal space, between Israel where they currently live, and an unknown 'elsewhere' they may reach in the future. Emotionally, then, they are not fully here but not yet there, a liminality affecting their identity, their academic achievements, and their language development.

7.3 The Family Angle

The absence of a natural language of communication between the children and their parents has serious implications for the family dynamics. The excerpts presented examples of children assuming responsibility for the interaction with an institution playing a pivotal role in the family's very possibility of staying in Israel. These role reversals are complex and sometimes painful, though widespread in immigrant communities (Oznobishin & Kurman, 2009; Ponizovsky-Bergelson et al., 2015). In the present context, however, they are doubly significant because the state limits the parents' access to public service agencies while making others, such as education, available to their children (Mayer & Slone, 2016; Mundlak, 2003).

The data pointing to difficulties in parent-child communication are not unusual: about a quarter of the children lack any common language with either parent, and about another quarter can only communicate with them at a very basic level. Usually, such findings result from children spending many hours at an early age in educational frameworks that do not use their home languages (Fillmore, 2000).

The excerpts pointed to conflicts arising in the multilateral children-parents-school relationship around such issues as childcare, school attendance, and assistance in solving behavioral problems, including referrals of the staff to parents to involve them more closely in their children's upbringing. Although the school serves an extremely diverse population of immigrants, it hardly offers paths for bridging language gaps—translation, mediation, arbitration, giving higher visibility to languages in the school space, and so forth (Hélot, 2017; Wiley & García, 2016). The excerpt from the parents-teacher meeting, showing Sunwhite's mother changing the power structure by using her mother tongue with her daughter powerfully illustrates the advantage of parents maintaining their home language and using it with their children whenever possible. A similar dynamic resonates in the excerpt on Jonathan and Twi music, when appearing as representing his culture and possessing knowledge played a significant emotional role.

The balance of power between the participants in the study is also evident in organizational aspects (Bowles & Gintis, 2002), involving instances of multiculturalism v. homogeneity that affect each one's standing. Thus, the journal records illustrate how the school organization serves the hegemonic groups (Dahan-Kalev, 2001; Fanon, 1952/2008; Gor-Ziv, 2002) while somehow overlooking the difficulties confronting the population it is meant to serve, especially regarding language matters. The extreme (mainly economic) pressure that parents experience impacts the level and the nature of their involvement in their children's lives. Disregard of the power structures that create the parents' economic difficulties, failure to make contents accessible to the parents in their language, arranging meetings that are difficult for them to attend – all these factors aggravate their circumstances and contribute to a problematic, even discriminatory constellation.

8 Summary

The children's unclear legal status emerged as a significant influence on their emotional, social, educational, and language situation. Their integration into Israeli society is only partial and loaded with contradictions. On the one hand, they are cared for in unofficial settings and, on the other, they attend state schools. On the one hand, their presence in these schools influences the society's perception of their belongingness and, on the other, actual integration is hard because deportations pose a constant threat. On the one hand, they are socialized into Israeli society and language and, on the other, most of them will need a different language repertoire in their future. The divergence between the state's (official) attitude toward the children's parents and the attitude toward the children is problematic, leading to confusion regarding identity, language, and educational processes, all with further ripple effects. First, the immigration policy negatively affects the integration of the children's parents, leading them to send the children to unofficial and illegal childcare settings. The children's experiences in these settings hinder their optimal later integration in state schools due to the lack of basic language skills that they should have already acquired by then. Finally, due to the distance between the children and their parents resulting from their long stays in care settings, the children do not master cultural and language skills based on their original identity, which is in fact completely marginalized.

The public discourse in Israel regarding the deportation of immigrants' children who were born and educated in the country is often intertwined with perceptions about the role of education and its part in acculturation processes. Thus, state education is perceived as a mechanism that, in some way, gives immigrant children a right to stay once they have mastered the Hebrew language and values based on Jewish-Israeli culture. Due to the perception of public education as an instrument of the state and a tool for creating national cohesion (Labaree, 2010), state schools function as a key mechanism fostering belongingness to Israeli society. The policy that occasionally allows families with children who have met the criteria of adopting Hebrew-Israeli culture to stay, epitomizes the deep relationship between education and society. Yet, in this case, rather than the society framing education, education frames the society.

The current education language policy does not leave enough room for maintaining the students' mother tongues that serve in the development of their original ethnolinguistic identity, perpetuating instead the superiority of powerful hegemonic groups (Fanon, 1952/2008). Given the centrality of Hebrew, its influence on the children's emotional development and on their perception of the world is vast. The records show a consistent failure to leverage the linguistic abundance available, seemingly suggesting that the children's' languages are a 'problem' rather than a 'resource' (Ruiz, 1984; Tannenbaum, 2010). The advantages of multilingualism, and mastery of one's L1 in particular, are well-known in the research literature and include academic, cognitive, and pragmatic benefits (Bialystok, 2018; Cummins, 2013). They also entail significant emotional returns—heightening self-confidence, assisting in family communication, and strengthening affiliation to the original identity (Dewaele, 2010; Pavlenko, 2006; Tannenbaum, 2010, 2012).

The skills the children acquire in state schools do help in their integration and promote a social perception of them as belonging. The children, however, sense that their belongingness to Israeli society is only temporary and perceive their integration into the schools through a cost-effectiveness perspective. They are ambivalent about acquiring features of Jewish-Israeli identity and Hebrew skills in light of future hypothetical identities. These uncertainties also influence the acquisition of their original culture and many remain without a clear sense of identity in their own self-perception and without a dominant language of communication and self-expression. The study sharpens understanding of the integration processes and the links between the external public discourse and the children's internal experiences, pointing to a reality where the development of emotional, learning, and language aspects has in fact stopped, contrary to usual expectations.

We hold that children's access to the exercise of basic rights related to learning, identity, and language through the educational process can be a central tool in their social advance. At the same time, the position of state schools in the children's lives should consistently be questioned. Although integration in the school system holds many benefits in terms of the children's perception as belonging to and acquiring the majority's culture and language, two other identity options should be kept in mind – their identity of origin, which is in danger of disappearance, and their future identity. Rejecting the premise of a contradiction prevailing in heterogeneous societies personal and public benefits will help to promote the many advantages of a complex identity notion. The use of the language, culture, and other aspects of the identity of origin for promoting social and personal skills, together with the acquisition of the majority language, will create space within the educational framework for children to share their identity of origin with family members or with others, helping them to develop stronger links with their native culture as a legitimate and equal alternative to the hegemonic one, and may also contribute to family relations (Noguera, 2003; Richman, 1998). Moreover, given the political circumstances, the expansion of the curriculum to include universal subjects as well should be considered. Although changing the current program could be detrimental to the efforts to keep these children in Israel (because their integration into the schools as proof of their cultural affiliation, a claim frequently voiced by organizations lobbying to stop their deportation, will no longer be valid), it will serve them if and when they leave, an outcome that, unfortunately, is highly probable due to Israel's' immigration policy.

The findings of this study bear implications for education systems and for professionals working with children of asylum seekers and of other excluded or marginalized groups, though some caveats should be noted. First, this is a case study of a class. Although representative of the school as a whole, the school itself is unique in its ethnic diversity and in the small number of 'mainstream' children who attend it. Thus, future research, both in Israel and in other education contexts that face challenges related to this population could help to broaden understanding of the dilemmas confronting these children. In addition, expansion of the methodological compass when addressing similar questions to include questionnaires or external observers could also contribute to further insights.

Finally, the study showed that these children constantly face questions of belongingness and identity, closely intertwined with language(s). Monolingual, ideologically driven educational approaches, as the one common in Israel, including in the school where this study took place, may be harmful and excluding. Applying more inclusive, multilingual policies, enabling students to study in their mother tongue in addition to the dominant, local language, or translanguage freely using their full language repertoire (Hélot, 2017; Tannenbaum & Shohamy, 2019; Wiley & García, 2016), may prove to be a positive option. Further research is needed to learn more about the implications of such policies on children's language development and well-being, and specifically, children from populations such as the one examined in this study. Nevertheless, such understandings are clearly relevant not only to the Israeli context explored here but to every society or education system attempting to absorb children from varied backgrounds.

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Children's Command of Plural Marking on Hebrew Nouns: Evidence from Russian-Hebrew Bilingual Acquisition

Julia Reznick and Sharon Armon-Lotem

Abstract The production of noun plurals in Hebrew requires the application of both morpho-lexical and morpho-phonological knowledge. Bilingual children bring in a knowledge of this system in another language offering an additional window into this linguistic process. This chapter presents the acquisition process of the Hebrew plural system by Russian-Hebrew bilinguals, bringing data from 91 bilinguals and 81 monolinguals, aged 4–8, using a Hebrew pluralization task. Bilingual children demonstrate an early and rapid acquisition of the morphological rules of pluralization alongside a restricted lexical and morpho-phonological knowledge. Despite a monolingual advantage, the acquisition process follows the same fixed order in both populations. The rapid acquisition of the Hebrew pluralization rules by Russian-Hebrew bilinguals is explained by the high regularity and transparency of the regular Hebrew system, and the similarity in gender marking in Russian and Hebrew. The advantage of monolingual children over bilinguals is mainly lexical, being an expression of the bilinguals' lack of familiarity with different lexical forms due to insufficient experience. These central factors are discussed in light of the fundamental research on plural morphology acquisition among Hebrew monolingual children (Ravid D, Schiff R. Linguistics, 47(1): 45–63, 2009).

Keywords Pluralization · Hebrew · Russian-Hebrew · Bilingual language acquisition · Morphological rules · Lexical knowledge · Regular · Irregular · Stem type · Suffix type

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The acquisition of plural morphology in Hebrew has been studied extensively by Ravid and her colleagues, and the series of studies she has led has been fundamental to what we know about the properties of this acquisition process and the main factors underlying it among monolinguals (Ravid et al., 2008; Ravid & Schiff, 2009, 2012; Schiff & Ravid, 2011). However, not much is currently known about the impact of bilingualism on the process of plural acquisition in Hebrew. This chapter explores the acquisition of the noun plural system in Hebrew, the societal language of Russian-Hebrew bilinguals. Studying the acquisition of plural morphology in the context of two morphologically rich languages, each unique in its own way, takes the work of Ravid one step further and makes an important contribution to our understanding the impact of bilingualism on morphological processing (DeKeyser, 2005; Goldschneider & DeKeyser 2001; Grosjean, 1999; Jensvoll, 2003; Meisel, 1989; Prasada & Pinker, 1993; Rodina & Westergaard, 2017).

Our chapter starts with a short presentation of the relevant aspects of the Russian and Hebrew morphological systems, focusing on gender and number morphology. This is followed by an overview of studies of Hebrew plural acquisition in monolingualism and Russian-Hebrew bilingualism. We then present our findings from Russian-Hebrew bilingual children, ages 4–8 years, showing similarities and differences when compared to monolingual controls. The chapter ends with a discussion of the main conclusions in light of Ravid's findings and what is known about language acquisition processes in bilingualism and the central factors informing them.

1 Gender and Number in Russian and Hebrew

Russian Nouns in Russian are assigned to one of three primary genders: masculine (around 46% of the nominal lexicon), feminine (41%), or neuter (13%) (Corbett, 1991). The gender of most Russian nouns can be identified by the final phoneme in the nominative singular case: nouns that end in an unmarked nonpalatalized consonant are masculine (*stul* 'chair'); nouns that end in *-a* or its allomorphs are feminine (*knig-a* 'book'), and nouns that end in *-o* or its allomorphs are neuter (*okn-o* 'window'). Most Russian nouns are inflected for number (singular or plural), and the plural suffix is determined by the noun's gender and declension class. In Russian, noun pluralization is highly regular and usually requires no distinction between masculine and feminine in the nominative plural case (*malchik-**i*** Masc-PL 'boys'; *devochk-**i*** Fem-PL 'girls').

Hebrew As in Russian, Hebrew nouns are phonologically marked for gender (masculine or feminine). Most feminine nouns end with stressed *–a* or with suffixes ending in *–t*, while most masculine nouns are unmarked, ending with any other consonant or with a final stressed *-e*. The plural suffix carries information about number and gender, and the regular suffix *-im* indicates masculine plural (*yelad-im* 'boys', *tapux-im* 'apples'), while the suffix *-ot* indicates feminine plural (*yelad-ot* 'girls', *tmun-ot* 'pictures'). There are also irregular instances that do not obey these rules. For example, the plural form of the masculine noun *shulxan* 'table' is created by adding the feminine suffix *–ot,* yielding the irregular plural form *shulxanot* 'tables', and the irregular plural form *dvorim* 'bees' is created by adding the masculine suffix *–im* to a feminine noun *dvora* 'bee'. In addition to several qualitative differences between the two noun types, masculine nouns with an irregular plural form are considerably more frequent than feminine nouns with an irregular plural form (Ornan, 2003; Ravid et al., 2008; Ravid & Schiff, 2012). In plural production, word stems can undergo change, regardless of the regularity or irregularity of the plural suffixes. There are five main types of stem changes: vowel reduction or deletion; vowel change; insertion or deletion of *t*; stop/spirant alternation; full stem change, with the masculine plural being characterized by a wider variety of stem changes compared to the feminine (Ravid, 1995; Ravid & Schiff, 2009, 2012). Some stem changes are unpredictable, and so form idiosyncratic lexical items (like *isha/nashim* 'woman/women'). Other stem changes have a morpho-phonological structure shared by other nouns that are pluralized in a similar way (*kélev* 'dog' is pluralized as *klavim* 'dogs', and so is *gézer/gzarim* 'carrot/carrots'). These changes form different morpho-phonological clusters in Hebrew pluralization.

Russian and Hebrew present a considerable number of similarities: both have morphological systems in which gender is central and productive, and they even resemble each other in their phonological representation of the masculine/feminine distinction in the singular. However, the coding of the gender and number features in the plural is different in each of the languages. Additionally, the characteristics of the Hebrew plural system allow us to distinguish between the acquisition of the morphological rule (for example, in the case of words with a regular plural suffix) and acquisitions that rely more heavily on lexical learning (words with an irregular plural and/or stem changes), which might be more challenging for bilingual children. These characteristics of the Hebrew plural system make its acquisition in Russian-Hebrew bilingualism particularly interesting.

2 Hebrew Plural Morphology in Monolingual and Russian-Hebrew Bilingual Development

Monolingual Development Three main effects have been observed in the acquisition of the plural in Hebrew: grammatical gender (lower error rates for masculine words), stem type (lower error rates for words with a non-changing stem), and suffix type (lower error rates for words with a regular suffix), together with a significant interaction among these three factors (Binyamin, 2010; Lavie, 2006; Ravid & Schiff, 2009, 2012; Schiff et al., 2011; Schiff & Ravid, 2011). Compared with the earlier and more rapid acquisition of the plural system in its regular aspects, the acquisition of irregular forms takes longer, depending on the complexity of the form and how performance levels increase with age (Berman, 1981a, b; Ravid, 1995; Ravid & Schiff, 2009, 2012; Schiff, Ravid & Levy-Shimon, 2011; Schiff & Ravid, 2011). The acquisition of the different morpho-phonological clusters also depends on sufficient and diverse lexical exposure, emphasizing the effects of the linguistic input on children's performance (Ravid et al., 2008; see also Ornan, 2003; Tubul, 2003). The centrality of exposure throughout the acquisition of the plural system in its various aspects (regular and irregular) is highlighted by the observed imbalance in the distribution of different plural forms within Hebrew Child-Directed Speech, with a significant advantage for the masculine plural over the feminine plural, and a significant advantage for the regular over the irregular plural (Ravid et al., 2008).

Russian-Hebrew Bilingual Development Two studies have directly investigated the acquisition of Hebrew noun pluralization at a young age in Russian-Hebrew bilinguals (but see Alfi-Shabtay (2006) for adult Russian-Hebrew bilinguals ages 18–72 years). Schwartz et al. (2009) compared the acquisition of noun pluralization in Hebrew for Russian-Hebrew speaking sequential bilingual children (N = 65) with that of Hebrew monolingual children (N = 54). The participants were tested twice, at the beginning of second grade and at the beginning of third grade, with 24 nouns from four categories, based on type of suffix (regular, irregular) and type of stem (non-changing, changing). The bilingual children's performance was found to be significantly worse than monolingual children's performance on changing stems and the irregular suffix, but there was no difference between monolingual and bilingual participants in the regular categories (stem and suffix). In the second study, Schwartz et al. (2014) focused on acquisition of plural nouns in Hebrew in a longitudinal study of six early sequential Russian-Hebrew speaking bilinguals. At the beginning of the study, the children were 38–44 months old, about two months after their initial intensive exposure to Hebrew (around 70% of class time) in the bilingual kindergarten. The children's performance on the Hebrew task was evaluated three times: (1) half a year after beginning intensive exposure to Hebrew; (2) nine months after beginning exposure; (3) one year after beginning exposure. The structured task included 35 words, classified according to grammatical gender in Hebrew, stem type and suffix type. Two effects were found in children's performance: a stem type effect (higher error rate in words with a changing stem) and a suffix type effect (higher error rate in words with an irregular suffix). The findings of both studies suggest that monolingual and bilingual children acquire plurals in a similar way. The general delay in acquiring irregular forms among bilingual children (observed in Schwartz et al., 2009) was attributed to limited input in Hebrew. This pattern in the area of morphology was well established for bilingual children with diverse linguistic backgrounds (Jensvoll, 2003; Nicoladis et al., 2007; Paradis et al., 2007; Rispens & de Bree, 2015). Taking this into account, bilingual children's acquisition pace seems comparable to that of monolinguals, given the amount of input they receive (Rodina & Westergaard, 2017).

3 The Current Study

The current study examines the plural acquisition process in Russian-Hebrew bilingualism for a wider age range, following the children from pre-kindergarten to second grade, while providing an in-depth analysis of children's error types and looking at performance also at the level of individual participants. In doing so, the study explores the different factors that might explain the acquisition patterns among monolingual and bilingual children. Goldschneider and DeKeyser (2001) mention five factors which explain the characteristics of the acquisition process of various L2 morphological elements: perceptual salience, semantic complexity, morpho-phonological regularity, syntactic category, and frequency. As described above, both languages – Russian and Hebrew, while being rich and complex morphologically, are characterized by high regularity in their core grammatical gender and number systems (Corbett, 1991; Ravid et al., 2008), as well as by a considerable similarity between these systems. These two factors – regularity and interlingual similarity – were found to accelerate the acquisition of diverse morphological systems in bilingualism generally, and in Russian-Hebrew bilingualism more specifically (Armon-Lotem & Amiram, 2012; DeKeyser, 2005; Gathercole & Hoff, 2007; Goldschneider & DeKeyser 2001; Hawkins & Chan, 1997; Meir et al., 2016; Schwartz et al., 2009, 2014). Furthermore, studies report a significant similarity between bilingual (Russian-Hebrew) and monolingual children (Russian/Hebrew) in the qualitative properties of their acquisition of different morphological elements, such as the Hebrew plural system and Russian gender agreement (Schwartz et al., 2009, 2015, 2014).

The current study was designed to explore the different factors that might explain the acquisition patterns of plural morphology in Hebrew among monolingual and bilingual children. The study will first address the stem effect, the suffix effect and the grammatical gender effect at the whole-word level, exploring whether the difficulty hierarchy obtained at group level applies to children's performance at the individual level too. The study will further focus on different error types and explore the distribution and properties of stem and suffix errors, taking into consideration grammatical gender, both at the group and the individual level. The regularity of the system on the one hand and the stem and suffix irregularities on the other are expected to provide further evidence for bilinguals' rapid acquisition of rules in morphological systems together with poorer performance in tasks and items that depend more heavily on lexical knowledge.

4 Method

Participants A total of 172 children aged 4–8 years (from pre-kindergarten to 2nd grade) completed the pluralization task. This included 81 monolingual Hebrew-speakers and 91 bilingual Russian-Hebrew speakers. Study groups were matched for gender and maternal years of education. Bilingual groups did not differ with respect to age of onset of bilingualism when they were initially exposed to Hebrew. Table 1 presents the demographic information for the different groups.

Tools The pluralization task tested participants' ability to produce the plural form of target nouns, by completing 99 sentences of the form *Here there is a {noun}, and here there are many…,* for example: *Here there is a doll, and here there are many… (dolls)*. The nouns differed in stem type (non-changing, subtle change, significant change)[1], suffix type (regular, irregular), and grammatical gender in Hebrew (masculine, feminine). All nouns were regular in the singular in both languages.

Administration of the Task For each test item, visual stimuli – a pair of pictures presented in a randomized direction of presentation (right to left/left to right) – were presented followed by the presentation of an oral stimulus through headphones (sentence for completion) two seconds later.

Data Coding and Analyses A valid response was coded as the first response comprising a complete word (if produced). Stem and suffix errors were coded separately. Table 2 shows the main categories for error analysis.

Table 1 Background Information for the Participants

		Age (months) Mean (SD)	Boys N (%)	Mother Ed. (years) Mean (SD)	Age of Onset of BL (months) Mean (SD)
Pre-K	ML (N = 9)	51.89 (6.13)	2 (22.2)	14.67 (2.4)	
	BL (N = 14)	52.43 (4.54)	1 (7.1)	15.54 (1.98)	22.64 (14.24)
Kinderg.	ML (N = 26)	68.88 (5.19)	11 (42.3)	14.88 (2.55)	
	BL (N = 32)	70.78 (5)	15 (46.9)	13.97 (2.17)	26.97 (18.49)
1st grade	ML (N = 25)	83.08 (5.28)	11 (44)	13.80 (2.18)	
	BL (N = 24)	84.75 (3.67)	7 (29.2)	14.58 (2.96)	36.71 (22.05)
2nd grade	ML (N = 21)	94.57 (4.19)	10 (47.6)	15.24 (3.19)	
	BL (N = 21)	94.86 (3.84)	8 (40.4)	14.71 (2.69)	29.95 (23.59)

Fn. Pre-K = Pre-Kindergarten, Kinderg = Kindergarten, ML = Monolingual, BL = Bilingual

[1] There are five main types of stem changes: vowel reduction or deletion; vowel change; insertion or deletion of *t*; stop/spirant alternation; full stem change (Ravid, 1995; Ravid & Schiff, 2009). The first three change types were classified under the category of subtle stem change, and the remaining types under the category of significant stem change.

Table 2 The categories for error analysis

	Category	Examples
Stem properties	No change of the singular form	*gezer* 'carrot' – **gezerim* *rakevet* 'train'– **rakevetim*
	Incorrect change, when required, accompanied by an omission of *a/t/e*, if required	*gezer* 'carrot' – **gazerim* *magevet* 'towel' – **magvot*
	Partial stem change not involving omission of *a/t/e*	*tof* 'drum' – **tufim* *iparon* 'pencil' – **ipronot*
	Omission of *a/t/e* only, with no further change, when such a change is required	*simla* 'dress' – **simlot* *magevet* 'towel' – **magevot*
	Unrequired change (in addition to omission of *a/t/e*, if required).	*parpar* 'butterfly' – **perparim* *kcica* 'cutlet' – **pcicot*
	A significant error in the noun stem: more than one (consonantal) change have taken place	*rove* 'rifle'–**pelot* *daxlil* 'scarecrow' – **draxilot*
Suffix properties	Masculine instead of feminine	*shulxan* 'table' – **shulxanim* *buba* 'doll' – **bubim*
	Feminine instead of masculine	*pappar* 'butterfly' – **parparot* *dvora* 'bee' – **dvorot*

Non-parametric statistical measures were selected to address the non-normal distribution of error rates in the study groups (the non-normal distribution was found in the performance of 1st and 2nd grade bilinguals, Shapiro-Wilk, $p \leq .04$), and the low number of subjects in pre-kindergarten groups. Kruskal-Wallis and Scheirer-Ray-Hare tests (a non-parametric alternative to two-way ANOVA, Dytham, 2011) were performed to detect differences between independent groups based on the number of independent variables. Mann-Whitney U and Wilcoxon tests were used to identify the source of differences according to group characteristics.

In addition to group-level analyses, observation at the level of the individual participant was also maintained throughout this study, as in the one implemented by Friedmann and Lavi (2006) and Friedmann and Reznick (2021). As part of this observation, an attempt was made to organize participants' performance along a Guttman scale (Guttman, 1944), in which the presence of a higher-order skill indicates the presence of a lower-order skill.

5 Results

Study findings will be presented at two levels of analysis: the whole-word level and the word components (stem and suffix) level.

5.1 Whole Word Level

To explore the three main factors at the whole-word level, Table 3 presents participants' performance (error rate average, standard deviation and the range of errors) according to stem type (changing and non-changing), suffix type (regular and irregular) and grammatical gender (masculine and feminine).

Three main effects, already well documented in previous studies, were found. The grammatical gender effect was found starting from kindergarten, as each study group produced significantly more errors for feminine nouns compared to masculine nouns, $Z \leq -2.17$, $p \leq .03$. The stem type effect was observed for each of the groups, with significantly more errors in nouns with a significantly changing stem, compared to nouns with subtly changing stems and nouns with non-changing stems, $Z \leq -2.49$, $p \leq .01$. In six out of the eight groups, significantly more errors were produced for nouns with subtly changing stems compared to nouns with non-changing stems, $Z \leq -2.43$, $p \leq .02$. The suffix type effect was observed for every study group, with significantly more errors for nouns with an irregular suffix compared to nouns with a regular suffix, $Z \leq -2.67$, $p \leq .008$. The interaction found between the stem type and suffix type will serve as a basis for presenting analyses at the individual participant level. Table 4 presents the distribution of error rates by stem type (non-changing/changing) and suffix type (regular/irregular).

As expected, for all study groups, the lowest rate of errors was observed for nouns with a non-changing stem and a regular suffix: in these words monolingual children already achieved a 95% success rate in pre-kindergarten. Bilingual children also achieved, on average, an impressive success rate as early as kindergarten (90%), with a rapid and significant decline in error rates in the schoolgoing participants compared to the pre-kindergarten and kindergarten groups. By contrast, in words with a changing stem and/or an irregular suffix, significantly higher error rates were found, for both linguistic backgrounds.

In nouns with non-changing stems, each of the eight study groups had significantly more errors for nouns with an irregular suffix compared to nouns with a regular suffix ($Z \leq -2.67$, $p \leq .008$). A similar suffix type effect was also observed in changing stems (except pre-kindergarten bilinguals and 2nd grade monolinguals) ($Z \leq -1.99$, $p \leq .046$). The similarity of this suffix type effect for the two stem types is explained by the centrality of the suffix factor and by the heterogeneity of the category "changing stem," which includes several types of stem changes (Ravid, 1995), among which a clear difficulty hierarchy may be observed, as detailed below.

Table 3 Distribution of errors by stem type, suffix type and Hebrew grammatical gender (mean, SD, range)

		Stem type		Suffix type		Gender	
		Non-changing	Changing	Regular	Irregular	Masculine	Feminine
Pre-K	ML (N = 9)	25.1 (10.02) 11–37	43.21 (9.1) 27–56	21.54 (6.67) 11-31	55.88 (17.09) 32-79	33.33 (11.54) 14-47	33.33 (9.45) 21-48
	BL (N = 14)	40.61 (15.65) 20–81	63.33 (15.9) 33–100	43.08 (16.89) 17–85	65.97 (13.97) 44–100	51.88 (15.88) 25–93	49.66 (14.67) 26–86
Kinderg.	ML (N = 26)	13.89 (6.44) 4–28	25.73 (10.24) 7–49	13.02 (5.15) 5–26	31.22 (14.53) 9–62	16.4 (9.16) 4–37	23.17 (7.36) 7–33
	BL (N = 32)	25 (11.82) 6–57	43.96 (16.93) 11–80	25.19 (12.36) 3–60	49.72 (18.65) 9–82	31.3 (16.46) 4–70	36.76 (11.12) 14–64
1st grade	ML (N = 25)	10.37 (5.76) 2–24	17.51 (8.05) 4–33	8.86 (3.62) 3–15	22.71 (12.55) 0–47	10.53 (5.88) 4–25	17.81 (8.14) 2–31
	BL (N = 24)	17.13 (7.25) 9–41	35.28 (15.3) 13–82	17.76 (8.99) 6–46	39.95 (14.97) 24–85	22.81 (12.64) 7–63	28.87 (9.14) 14–55
2nd grade	ML (N = 21)	6.35 (3.08) 2–11	15.13 (7.94) 4–33	7.84 (3.61) 3–15	15.13 (8.94) 3–38	7.44 (5.08) 2–21	14.29 (6.39) 5–26
	BL (N = 21)	9.7 (5.88) 2–20	23.28 (12.08) 7–47	11.43 (6.48) 5–26	24.37 (13.16) 3–53	14.12 (8.9) 4–33	18.25 (9.01) 5–38

Table 4 Distribution of error rates by the two stem types and by suffix type (mean, SD, range)

		Non-changing stem		Changing stem	
		Regular suffix	Irregular suffix	Regular suffix	Irregular suffix
Pre-K	ML (N = 9)	5.56 (3.1) 3–12	58.33 (24.11) 25–90	39.07 (11.23)	52.38 (8.75) 36–64
	BL (N = 14)	25.84 (17.92) 3–71	65.71 (15.67) 40–100	61.98 (17.95) 32–100	66.33 (15.2) 36–100
Kinderg.	ML (N = 26)	3.17 (2.62) 0–9	32.12 (15.89) 10–60	23.82 (9.62) 10–45	29.95 (15.39) 0–64
	BL (N = 32)	10.2 (10.11) 0–41	50.16 (20.5) 10–85	41.63 (17.45) 6–81	49.11 (18.75) 7–79
1st grade	ML (N = 25)	3.06 (2.32) 0–9	22.8 (14.8) 0–60	15.23 (6.68) 6–29	22.57 (13.63) 0–50
	BL (N = 24)	5.15 (5.15) 0–18	37.5 (14.3) 25–80	31.59 (14.43) 10–77	43.45 (19.18) 14–93
2nd grade	ML (N = 21)	1.96 (1.94) 0–6	13.81 (7.89) 0–30	14.29 (6.89) 3–29	17.01 (12.26) 0–50
	BL (N = 21)	2.52 (2.51) 0–9	21.9 (13.18) 0–45	21.2 (11.52) 10–48	27.89 (17.48) 0–64

The challenge presented by stem changes was clearly reflected in the difference observed in nouns with a regular suffix: significantly more errors were observed for nouns with changing compared to non-changing stems ($Z \leq -2.67$, $p \leq .008$), but this difference between the two stem types was not observed, across study groups, for nouns with an irregular suffix ($Z \geq -1.86$, $p \geq .06$).

These findings clearly indicate the similar influence of the main factors in the area of plural formation across both linguistic backgrounds in ages 4–8, which conforms to what has been reported for 2nd and 3rd grade Russian-Hebrew speaking students (Schwartz et al., 2009).

To explore whether the influence of the discussed factors (stem type and suffix type) on plural formation and the difficulty hierarchy observed at group level applies to children's performance at the individual level, we used a Guttman scale. Figure 1 presents participant performance organized according to chronological age and noun type (stem type and suffix type). The cells present the error rates of each individual participant for each specific noun type. "Success" was defined as a performance level of at least 80% correct answers, and these cells are color-marked (orange for monolingual participants and green for bilingual participants). Figure 2 presents the same data by acquisition patterns (and not by participants' chronological age), allowing us to see that 95% of participants whose performance was analyzed in this chapter (163/172) belonged to one of the four following performance profiles: a) initial state: no success in any noun type; b) success for nouns with a non-changing stem and a regular suffix only; c) success for all nouns with a regular suffix; d) success for all nouns with a regular suffix and for nouns with a non-changing stem and an irregular suffix; e) success for all four noun types.

These findings show a clear acquisition order of pluralization system skills, as reflected in the performance of both monolingual and bilingual participants, together with a quantitative advantage for monolinguals over bilinguals. The ability to produce the plural forms of nouns with a non-changing stem and a regular suffix is established first, followed by the ability to produce the plural of nouns with a changing stem and a regular suffix. Then, proficiency with nouns having a non-changing stem and an irregular suffix is attained, and the ability to produce the plural of nouns with a changing stem and an irregular suffix is acquired last. It should be noted that children of similar ages presented varying success profiles: for example, alongside school children who have attained proficiency in nouns with a changing stem and an irregular suffix, there are school children showing earlier success profiles, such as successful performance (success rates of 80% or higher) in words with a non-changing stem and a regular suffix or words with a regular suffix only (with both stem types: non-changing and changing).

Seven children (five monolinguals and two bilinguals, listed at the bottom part of Fig. 2) presented very similar performance patterns to those described above – with success rates of 70% and higher in some word types (these cells are highlighted in a light color). Only two bilingual children presented different performance patterns from those described above. Thus, the performance profiles of all but two participants form a Guttman scale with respect to the acquisition of different noun types:

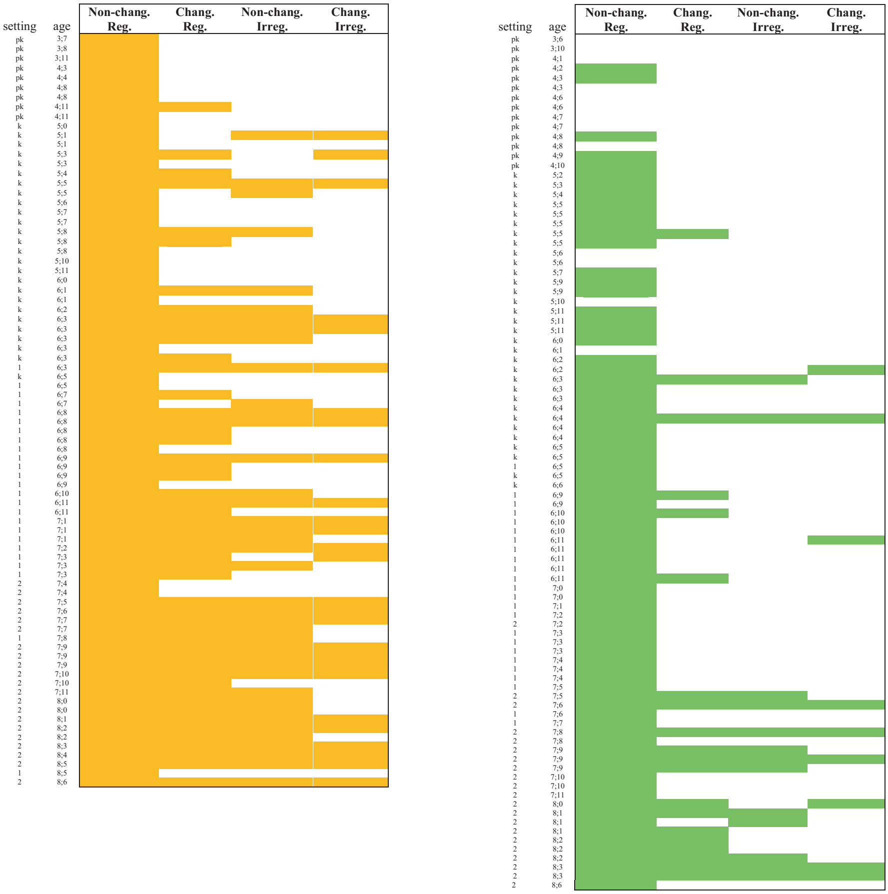

Fig. 1 Success Patterns by Chronological Age (pk = pre-kindergarten, k = kindergarten, 1 = 1st grade, 2 = 2nd grade; orange color for ML, green color for BL)

success with a noun type of a higher order guarantees success with noun types of a lower order.

The above findings were based on analyses at the whole word level. We will now elaborate on the performance properties in word components: stem and suffix. We begin by presenting findings first at the stem level, then at the suffix level.

5.2 *Stem Errors*

To explore the relative error rate for stem errors compared to other error types, study groups were compared for error distribution in accordance with three groupings: stem errors only, suffix errors only, and errors in both stem and suffix. Additionally,

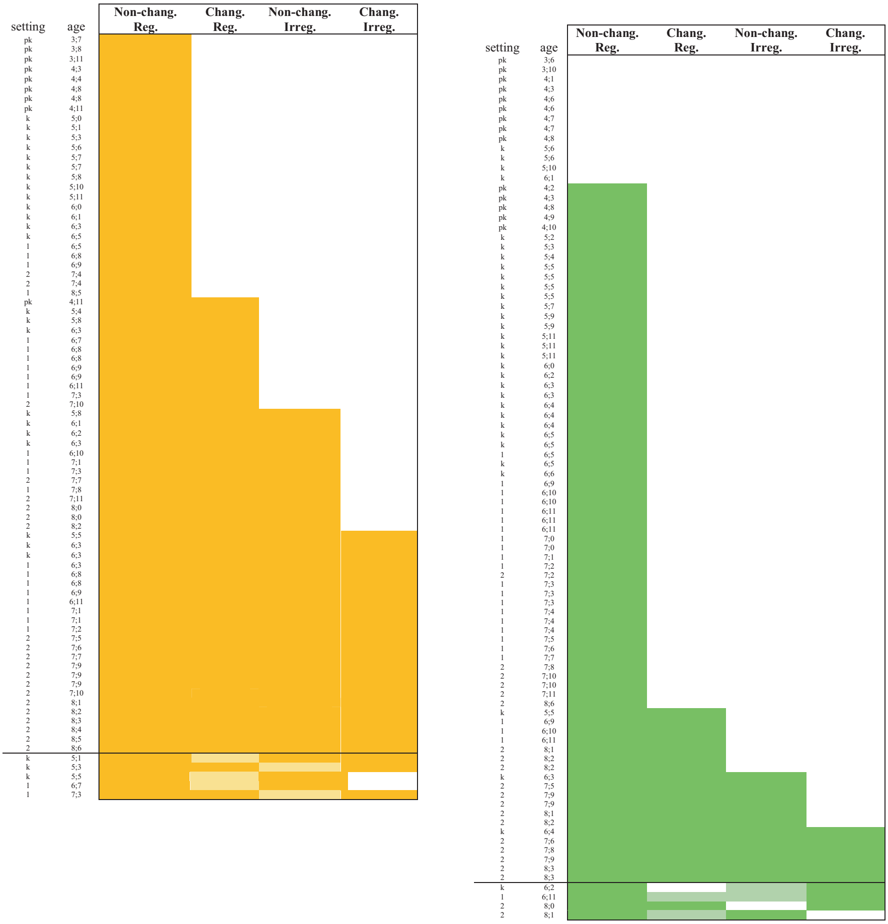

Fig. 2 Success Patterns by Noun Types (pk = pre-kindergarten, k = kindergarten, 1 = 1st grade, 2 = 2nd grade; orange color for ML, green color for BL)

analysis is presented for the percentage of errors consisting of responses in the singular (neologisms or existing nouns), and errors of the category "other" (no response, "I don't know" responses, responses in Russian, irrelevant speech).

In pre-kindergarten, for both monolingual and bilingual participants, the most prominent error type was suffix-only errors ($Z \leq -2.07$, $p \leq .04$). For kindergarten and 1st grade, the exclusive salience of suffix-only errors was moderated by the relative increase in stem-only errors: both monolingual and bilingual participants in each of these settings showed significantly fewer suffix-and-stem type errors compared to stem-only and suffix-only errors ($Z \leq -4.1$, $p < .001$), with no significant differences between stem-only and suffix-only errors ($Z \geq -1.06$, $p \geq .29$). Finally, in 2nd grade, errors in stem-only became the most frequent error type, compared to suffix-only errors (and no longer just in comparison to suffix-and-stem errors), for

Table 5 Distribution of stem error rates by stem types (mean, SD, range)

		Non-changing	Subtle change	Significant change
Pre-K	ML (N = 9)	2.06 (1.11) 0–4	18.33 (6.61) 5–25	40 (8.25) 24–52
	BL (N = 14)	8.47 (6.53) 0–19	26.79 (12.34) 0–45	50.57 (19.06) 8–72
Kinderg.	ML (N = 26)	1.92 (1.7) 0–6	10 (7.21) 0–30	27.69 (9.99) 12–56
	BL (N = 32)	3.82 (3.49) 0–15	21.56 (14) 0–60	50.13 (17.72) 16–84
1st grade	ML (N = 25)	1.78 (1.36) 0–4	7.2 (4.58) 0–25	21.44 (11.13) 4–44
	BL (N = 24)	2.47 (2.23) 0–9	17.08 (10.62) 5–50	39.17 (14.01) 20–84
2nd grade	ML (N = 21)	1.59 (1.47) 0–6	5.48 (3.5) 0–15	19.24 (9.93) 4–40
	BL (N = 21)	1.41 (1.42) 0–6	9.76 (6.61) 0–25	27.05 (12.77) 8–52

both monolingual and bilingual participants ($Z \leq -1.98$, $p \leq .048$). Consequently, participants from both linguistic backgrounds showed similar patterns of plural production, as measured by the inner distribution of the different error types: with increase in age a predominant tendency for stem-only errors emerges, concomitant with a decline in the relative rate of the other error types.

Given these findings, we next explore the distribution of stem errors by stem type (non-changing, subtle change, and significant change), followed by the different types of stem errors and their properties. Finally, we present findings on participants' sensitivity to stem consonants.

Distribution of Stem Errors by the Three Stem Types Table 5 presents the rates of stem error production (with or without production of suffix errors) by stem type (non-changing, subtle change, significant change).

First, we found that stem types formed a clear hierarchy, observable for all eight study groups, with respect to difficulty level, as expressed in the rate of stem errors in which each type differed significantly from the others. Non-changing stems posed the least difficulty for participants with a success rate of over 90% for this stem type among bilingual children already in pre-kindergarten followed by subtly changing and significantly changing stems, the latter incurring the highest rate of errors for participants ($Z \leq -2.66$, $p \leq .008$). Second, for each of the three stem types, bilingual participants produced significantly more errors compared to monolingual participants ($SS \geq 381201$, $SS/MS_{total} \geq 6.58$, $p \leq .01$). In other words, we again see a complete identity in the acquisition pattern of both backgrounds, along with a quantitative advantage for monolinguals over bilinguals. Additionally, children from both backgrounds presented an improvement in performance with increased age, although the trajectory of their progress was not always the same. For example, monolingual 1st and 2nd graders presented similar performance levels in all stem types, while bilinguals showed improvement in changing stems in the passage from 1st to 2nd grade. The same hierarchy of difficulty was also found when we tested separately within each grammatical gender.

Individual Performance Level Analysis of participants' performance shows that 100% of the participants whose performance was analyzed in this chapter (172/172) belonged to one of the three following performance profiles: (a) success for non-changing stems only; (b) success for both non-changing and subtly changing stems; (c) success for all three stem types: non-changing, subtly changing and significantly changing. The performance profiles of all study participants form a Guttman scale with respect to the acquisition of the different stem types, both for monolingual and for bilingual participants: all participants who succeeded for significantly changing stems also succeeded for subtly changing and non-changing stems, and all participants who succeeded for subtly changing stems succeeded also for non-changing stems. This scale also reflects the following order of acquisition of the different stem types, from easy to hard: non-changing stem, subtly changing stem, significantly changing stem. Here too, despite the clear acquisition order, individual differences in attaining proficiency with the different stem types were prominent, showing that the hierarchy between the different stem types also held at the level of the individual participant.

Word Stem Error Types The distribution of different stem type errors was different for the different nouns. As not all errors are liable to occur in every noun, we calculated the number of nouns in which every error could occur (the column "Number of Items" in Table 6). Table 6 shows the main error types, the noun categories for which every error type could be produced, and the number of test items belonging to that category. Order of presentation in the Table 6 reflects the frequency with which the listed patterns occurred among all participants (from most to least frequent).

For almost all categories, bilingual children produced significantly more errors than monolingual children ($SS \geq 381850$, $SS/MS_{total} \geq 6.82$, $p \leq .004$). Analysis of the differences between the various error types in each group indicates that more stem errors of the type "Partial change – omission of a/e/t only (without the additional required change)" were produced than any other type of error in all groups ($Z \leq -2.67$, $p \leq .008$). In other words, children were content with omitting the singular suffix (which is rule governed), without performing the additional stem change that required item based lexical knowledge and the derivation and application of a morpho-phonological rule, according to the pattern type. Rates of this error-type were high in all settings, from pre-kindergarten to 2nd grade. Another prominent type of stem error was "No change of the singular", although its frequency was significantly lower. For monolingual participants, the frequency of the first error type was 27%, while the frequency of this type was estimated at 6%. For bilingual

Table 6 Stem error types (from most frequent to least frequent)

No.	Stem error type	Examples	Method of calculating the no. of items	No. of items
1	Partial change – omission of a/t/e only, without further (required) change	*magévet* 'towel' – **magevot* *simla* 'dress' – **simlot*	All test items requiring omission of a/t/e and one additional change	12
2	No change of the singular form	*gézer* 'carrot' – **gézerim* *rakévet* 'train' – **rakévetim*	All test items, except masculine nouns ending with a consonant and having a non-changing stem	69
3	Partial stem change, with no incorrect changes among those produced	*gézer* 'carrot' – **gzerim* *tof* 'drum' – **tufim*	All test items requiring at least two changes, without omission of a/t/e	13
4	Unrequired change, with omission of a/t/e, if required	*parpar* 'butterfly' – **perparim* *kcica* 'cutlet' – **pcicot*	Nouns with non-changing stems (which may also require an a/e omission) and nouns ending with a *t* whose omission is the only change required	62
5	Incorrect (required) change, with omission of a/t/e, if required	*gézer* 'carrot' – **gazerim* *magévet* 'towel' – **magvot*	All test items, except masculine nouns ending with a consonant and having a non-changing stem	69
6	A more significant incorrect change, involving more than one consonantal change	*rove* 'rifle' – **pelot* *daxlil* 'scarecrow' – **draxilot*	All test items	99

children, error rates were 35% and 10%, respectively. What these two types of errors share is the avoidance of word internal vowel deletion or substitution, or significant stem change, treating the stem/word as a frozen form. The error of the third type "Partial change" was also significantly lower than the first type (and in kindergarten ages – also lower than the second type), with an average of 4% among monolinguals and 7% among bilinguals. Errors of the type "Incorrect change," "Unrequired change," and "Significant change" were produced at negligible rates in both backgrounds.

Errors involving stem consonants were rather infrequent among monolingual children, while bilinguals produced more stem consonants errors (omission, substitution, addition, migration of a single consonant) than monolinguals. These included: omission (*sulam* 'ladder' – **sulot*); substitution (*zxuxit* 'glass' – **zruxiyot*); addition (*pnina* 'pearl' – **pninmot*); migration (*bérez* 'faucet' – **bzarot*). While in 2nd grade these errors were almost non-existent among monolinguals, bilingual participants continued to produce them even at this age, though in significantly lower percentages compared to younger children. The majority of more significant stem consonant changes were produced by bilinguals, and in pre-kindergarten and kindergarten levels.

5.3 Suffix Errors

Turning to the suffix level, noun suffix error rates (either accompanied or unaccompanied by stem errors) were analyzed as dependent on suffix type (regular/irregular) and grammatical gender (Table 7).

As expected, for all study groups significantly more suffix errors were observed for nouns with an irregular suffix compared to nouns with a regular suffix ($Z \leq -2.67$, $p \leq .008$). Additionally, bilingual participants produced significantly more errors compared to monolinguals for each suffix type, and every older group had significantly fewer errors compared to any younger one ($SS \geq 30497.2$, $SS/MS_{total} \geq 12.34$, $p < .001$). However, it is certainly important to emphasize that in regular suffixes bilingual children presented success rates close to 90% already in pre-kindergarten. This advantage for the regular over the irregular suffix was also found for each grammatical gender separately, in each of the groups ($Z \leq -2.54$, $p \leq .01$), and bilingual children continued exhibiting impressive success rates in regular suffixes in each gender separately as well.

Individual Performance Level Analysis of participants' performance to examine whether the hierarchy between the different suffix types is also established at the individual participant level revealed that 94% of study participants whose perfor-

Table 7 Distribution of errors by suffix type and Hebrew grammatical gender (mean, SD, range)

				Regular		Irregular	
		Regular	Irregular	Masculine	Feminine	Masculine	Feminine
Pre-K	ML (N = 9)	5.13 (4.07) 0–14	49.35 (16.43) 29–74	2.02 (4.29) 0–12	8.33 (8.84) 0–28	43.52 (23.95) 8–75	63.33 (12.25) 40–80
	BL (N = 14)	12.75 (8.2) 0–32	49.16 (15.71) 12–68	10.39 (13.38) 0–48	15.18 (10.39) 0–41	45.83 (23.34) 4–79	57.14 (18.99) 20–90
Kinderg.	ML (N = 26)	1.78 (1.78) 0–8	27.04 (14.29) 9–62	1.4 (2.87) 0–12	2.16 (2.3) 0–9	14.58 (16.43) 0–63	56.92 (24.78) 20–100
	BL (N = 32)	8.22 (8) 0–32	44.39 (18.91) 9–79	6.82 (9.33) 0–33	9.67 (14.79) 0–66	33.07 (27.8) 0–88	71.56 (20.34) 0–100
1st grade	ML (N = 25)	0.98 (1.08) 0–3	20.47 (12.08) 0–47	0.61 (1.24) 0–3	1.38 (2.03) 0–6	11.67 (11.66) 0–42	41.6 (25.44) 0–90
	BL (N = 24)	4.10 (5.15) 0–17	34.8 (11.91) 18–59	2.65 (5.16) 0–21	5.6 (7.71) 0–28	23.78 (18.37) 0–75	61.25 (18.25) 20–90
2nd grade	ML (N = 21)	0.59 (1.14) 0–5	12.89 (7.92) 3–35	0.29 (0.91) 0–3	0.89 (2.24) 0–9	3.97 (5.96) 0–21	34.29 (19.12) 10–70
	BL (N = 21)	2.05 (3.09) 0–12	20.59 (11.8) 3–44	2.6 (4.91) 0–21	1.49 (2.73) 0–9	10.71 (12.61) 0–46	44.29 (24.61) 10–100

mance was analyzed (161/172) belonged to one of the following five performance profiles (one monolingual and ten bilingual participants showed unique profiles): (a) initial state: no success in any noun types; (b) success for masculine nouns with a regular suffix; (c) success for nouns with a regular suffix, both masculine and feminine; (d) success for masculine nouns, with either regular or irregular suffix, and for feminine nouns with a regular suffix; (e) success for nouns with a regular suffix and an irregular suffix, both masculine and feminine. In summary, it was found that in both linguistic backgrounds regular suffixes are acquired first, masculine followed by feminine. The irregular suffixes are acquired after the regular: again, masculine followed by feminine.

6 Discussion

Two main properties of morphological acquisition in Russian-Hebrew bilingualism were observed in this study: (1) an almost complete identity in acquisition patterns compared to Hebrew monolinguals, with the latter exhibiting a quantitative advantage over bilinguals and (2) early and rapid acquisition of the Hebrew morphological rules alongside restricted lexical knowledge pertaining to irregularities in the system. These properties echo findings of previous studies that studied properties of morphological and morpho-syntactic acquisition in bilingualism (DeKeyser, 2005; Gathercole & Hoff, 2007; Goldschneider & DeKeyser 2001; Nicoladis et al., 2007; Nicoladis & Paradis, 2012; Nir, 2021; Paradis et al., 2007, 2011; Rodina & Westergaard, 2013, 2017; Schwartz et al., 2009, 2014).

6.1 Identity in Acquisition Patterns

Alongside the quantitative advantage of the monolingual children, acquisition patterns for both linguistic backgrounds, at ages 4–8 years, in most contexts were identical. This similarity in acquisition patterns is reflected, first and foremost, in the central role of the three main factors in each of the backgrounds – grammatical gender, suffix type and stem type – which directly impact the obtained acquisition order of different morphological elements and the distribution of errors of different types, which were also identical in both backgrounds. This similarity in acquisition patterns was identified both at the group level and at the level of the individual participant, using a participant based analysis, similar to the one used in Friedmann and Lavi (2006) to identify Guttman scales in participants' performances (Guttman, 1944). This analysis indicated a precedence of the regular over the irregular suffix within each grammatical gender, with the masculine preceding the feminine: proficiency in the regular masculine suffix is established first, followed by the regular feminine suffix, then the masculine irregular suffix, and lastly the irregular feminine suffix. For the factors of suffix type and stem type a distinct order of acquisition was also obtained: proficiency in constructions with a regular suffix is attained prior to proficiency in words with an irregular suffix, and for each suffix type, proficiency is attained first for words with a non-changing stem and only later for words with a changing stem. Among the results presented in this context, one of the most prominent ones is the fixed acquisition order of different structures and components for both backgrounds, observed despite the diverse success profiles presented by each participant age-group. It indicates that the observed difficulty hierarchy exists simultaneously with great interpersonal variety for the ages at which proficiency for the different structures is actually attained. This interpersonal variability, primarily characteristic of the irregular aspects of the linguistic system, highlights the importance of exposing children to a rich and diverse linguistic input in the target language, for the purpose of acquiring the morphological system, both regular and irregular.

The similarity between the two backgrounds is expressed not only at the level of the three main factors, but also in the more subtle aspects of morpho-phonological performance and acquisition, as reflected in word stem errors. The word's stem challenges children's performance from their first steps in acquiring the Hebrew plural system (Levy, 1983; Ravid, 1995). For the purposes of this study, we distinguished among six error types, and error rates were calculated out of the total number of words in which this type of error could occur. The same hierarchy between different error types was obtained for both backgrounds. Starting from pre-kindergarten, children showed a significant preference to be content with only omitting the singular suffix while keeping the remaining stem unchanged although it requires an additional change (*simla* 'dress'- **simlot*), a preference represented by the most frequent stem error type produced during pluralization. An analysis which takes into account the potential for the occurrence of a specific type of error allows us to measure the extent of analyzed errors more reliably, because errors of the second type (*gézer* 'carrot'-**gézerim*) are more prominent, given the significant quantitative and qualitative differences between the masculine and the feminine plurals, in both Child-Directed Speech and Child Speech (Ravid et al., 2008).

6.2 Rapid Acquisition of the Hebrew Morphological Rules in Russian-Hebrew Bilingualism

The findings on the rapid acquisition of the regular morphological rules of Hebrew in Russian-Hebrew bilingualism suggest that Russian-Hebrew-speaking bilingual children have a similar level of control over abstract morphological knowledge to Hebrew-speaking monolingual children. Difficulties with the less regular forms echo previous findings of lower performance levels in tasks evaluating morphological knowledge connected with lexical knowledge (Shahar-Yames et al., 2018). Support for this also comes from the existing findings concerning the success of bilingual Russian-Hebrew-speaking children in pluralizing nouns with regular plural suffixes (Schwartz et al., 2009, 2014).

Why do we find this efficient acquisition of the regular morphological rules of the plural system in Russian-Hebrew bilingualism? First, it can be attributed to the high regularity, transparency and pattern frequency that characterize the Hebrew core gender and number systems and cut across all grammatical categories (Berman, 1981a, b, 1985; Ravid et al., 2008). The study shows that these factors impact the acquisition process in bilinguals as well, showing the effects of implementing the Formal Consistency Principle and Formal Simplicity Principle in plural production (Berman, 1981a; Clark & Berman, 1984; DeKeyser, 2005; Goldschneider & DeKeyser, 2001; Lavie, 2006; Ravid et al., 2008; Ravid & Schiff, 2009, 2012; Schiff & Ravid, 2011; Schiff et al., 2011; Schwartz et al., 2009, 2014). In addition, the findings of the present study underscore the importance and the central role of cues during the acquisition and/or learning of a language. Hebrew is a morphologically rich language in which gender is inherent and gender cues are robust and cut across all grammatical categories. The vast majority of plural forms in Hebrew (including Child-Direct Speech and Child Speech) are regular (Ornan, 2003; Ravid et al., 2008; see Ambridge et al., 2015 for the discussion of different kind of frequency), i.e., the plural suffix of these forms agrees with this morpho-phonological cue of the singular form. According to the Unified Competition Model (MacWhinney, 2008, 2013), learning efficiency depends on the process of cue identification within the linguistic input, in which cue strength is determined by cue validity. Cue validity is a product of cue reliability and cue availability, and in the case of Hebrew, morpho-phonological grammatical gender cues are not only reliable and available, but also have a high degree of detectability, which also contributes to gender cue strength in Hebrew (MacWhinney, 2008). These characteristics of the Hebrew language contribute directly to the efficient acquisition of the regular plural system in Russian-Hebrew bilingualism, as observed in this study.

The other factor explaining the efficiency of acquisition here is the similarity in the properties of the gender systems between Russian and Hebrew and the extensive overlap between the two languages in the morpho-phonological marking of masculine and feminine: in both languages, in regular cases, the feminine gender is marked by an *-a* vowel at the end of the word, and the masculine gender by non-palatalized consonants, an overlap which allows for positive transfer from L1 to L2 (Egger et al., 2017; MacWhinney, 2008, 2013 MacWhinney et al., 1989). This similarity in the coding of the grammatical gender using morpho-phonological cues in the singular form is essential for the acquisition of the regular plural, given that plural suffixes are directly determined by the grammatical gender of the words in these regular cases. However, despite this similarity in the morpho-phonological marking of the singular, the two languages vary widely in the plural coding itself. In Russian, in the nominative case both masculine and feminine nouns receive the same plural suffix: *malchik-**i*** Masc-PL 'boys'; *devochk-**i*** Fem-PL 'girls' (Corbett, 1991, 2006), while in Hebrew different plural suffixes are employed. In other words, this essential difference between the two languages (the lack of distinction between the genders in the plural in Russian, and the clear distinction between them in the plural in Hebrew), focuses bilingual children on these distinctions in the language in which they are relevant (Blom et al., 2012; Rispens & de Bree, 2015). This implies that the difference between the languages contributes positively to the performance of Russian-Hebrew-speaking bilingual children, as reflected in their acquisition of regularities in the Hebrew plural system.

The acquisition of grammatical gender in bilingualism (as in monolingualism) represents not only a cue-based assignment, but also the lexical learning of a gender category, and input measures play a significant role in the resulting acquisition process (Altman et al., 2016; Egger et al., 2017; Mitrofanova et al., 2018). The difficulties of bilinguals with irregular plural forms and/or plural forms involving stem changes are not surprising given the fact that bilingualism involves a reduction in lexical input in each of the languages (Bialystok et al., 2010; Gathercole & Thomas, 2005; Hoff et al., 2014; Kupisch et al., 2013; Marchman et al., 2004; Thordardottir, 2011), while proficiency in the Hebrew gender and number system, along with its irregular aspects, requires a command of irregular words and diverse morpho-phonological patterns, for which exposure and use play a crucial role in Hebrew (Berent et al., 1999, 2002; Gollan & Frost, 2001; Ravid et al., 2008; Ravid & Malenky, 2001; Ravid & Schiff, 2012; Schiff & Ravid, 2011; Schwartz et al., 2009, 2014; see Schiff and Ravid (2013) for a discussion of the difficulty with irregular plural forms even among university students), and in other languages (Gathercole & Thomas, 2005; Kupisch et al., 2013; Marchman et al., 2004; Nicoladis et al., 2007; Paradis et al., 2007, 2011; Rispens & de Bree, 2015; Thordardottir, 2011). Additional support for this conclusion concerning the (mostly) lexical (exceptional forms) and morpho-phonological (word stem changes) nature of the above advantage is derived from observing individual performance patterns, that indicate that the significant gaps between the two backgrounds lie in the irregular aspects of the pluralization. It is important to consider that this might not be not the case if the exposure to the societal language begins at a later age (such as adolescence), which may lead to difficulties in acquiring even in the regular aspects of the morphological system (Alfi-Shabtay, 2006).

Children from both linguistic backgrounds presented an impressive progress curve over the age-range included in this study. This progress reflects both the expansion of their vocabulary, which increased with age and the enhanced preoccupation with the written language and the increasingly established ability to identify the main change patterns occurring in the phonological structure of a word, and to execute said patterns according to the morphological pattern of target words. This again stresses the importance of vocabulary and language experience with target structures for morphological and morpho-syntactic acquisition (Marchman et al., 2004; Ravid & Schiff, 2009, 2012; Schwartz et al., 2009, 2014).

6.3 Differences in the Error Patterns of the Two Backgrounds

Beyond this similarity in stem error patterns, children from different backgrounds exhibited a differing level of sensitivity to root/stem consonants, as reflected in the extent of root/stem consonant errors produced in each linguistic background (omission, substitution, addition, migration). The observation of these errors, which relate to the cornerstone of the Hebrew word, is especially important given the widely different morphological structure of Hebrew and Russian words, and despite the fact that in most cases stem changes in Hebrew require a vowel (and not a consonant) change. It was found that for each of these error types, there is a greater number of productions by bilinguals compared monolinguals, with root/stem consonant errors appearing even among 1st and 2nd grade bilinguals. On the other hand, only a handful of monolingual children produced root/stem consonant errors, and only one monolingual participant (in the kindergarten group) produced an error (once only) involving more than one root consonant. The findings of this study support previous evidence concerning young Hebrew speakers' very early root awareness, which exhibits a steady and impressive development over the years (Clark & Berman, 1984; Ravid & Malenky, 2001), alongside a lower root sensitivity among some Russian-Hebrew bilingual participants – especially among those characterized by a smaller vocabulary in the societal language (Altman et al., 2018). This vocabulary is vital for discovering the rules of word formation in Hebrew which are essentially different from those of Russian, and therefore, given these considerable differences between the languages, a higher error rate in stem consonants among bilingual children is not surprising.

7 Main Conclusions

The acquisition patterns observed by Ravid and her colleagues for monolingual children (Ravid & Schiff, 2009, 2012) were replicated in this study for Russian-Hebrew bilinguals. Russian-Hebrew bilingual children present an early and rapid acquisition of the morphological rules pertaining to gender and number, with bilinguals and Hebrew monolinguals showing almost identical developmental patterns (characterized by the similar influence of the same factors). This similarity between the linguistic backgrounds was found at different levels of analysis, both in reference to the main factors level and in reference to subtler morpho-phonological aspects of their acquisition. The efficient acquisition of the (regular) morphological elements of L2 is possible for the high regularity, transparency and pattern frequency, reflecting L2 (regular) plural systems. In addition, the two languages both have a productive grammatical gender morphology, and partially resemble each other in their grammatical gender systems. Besides this fast acquisition of the morphological rules, bilingual children present limited lexical knowledge of irregularities in the system, both in word stems and in suffixes. That is, in acquiring the plural system, the advantage of monolingual Hebrew speaking children over Russian-Hebrew bilinguals is mainly lexical, where bilinguals lack familiarity or have insufficient experience with different lexical forms, mainly irregulars.

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Part V
Clinical Perspectives

Morphosyntactic Development After Auditory Brainstem Implantation in Three Dutch-Speaking Children with Profound Hearing Loss

Jolien Faes, Joris Gillis, and Steven Gillis

Abstract The present study is the first to investigate morphosyntactic development in congenitally profound hearing-impaired children without additional disabilities who received an auditory brainstem implant (ABI) in Flanders (Belgium). Auditory brainstem implantation (ABI) is a relatively recent development in paediatric hearing restoration. Very early implanted children's spontaneous language production has hardly been studied and reported on in the international literature. Our study is the first longitudinal investigation of ABI children's syntagmatic (syntactic) development, as indexed by mean length of utterance (MLU); and their paradigmatic (morphological) development, as measured by mean size of paradigm (MSP). The development of children with ABI is compared to that of children with cochlear implants (CI) and children with typical hearing (NH). These groups were matched to the ABI group in two ways: based on their chronological age, and based on their hearing age (i.e., the length of their hearing experience). The grammatical development of three-to-six-year-old children with ABI is considerably lagging behind their age-matched peers with CI and NH. But group differences decreased when the children were matched on hearing age instead of chronological age. However, the differences were still significant: children with ABI produce significantly shorter sentences (MLU) and fewer different verb forms per lemma (MSP). In addition, considerable variation was found between the children with ABI, but even the best performing child with ABI was not able to close the gap with hearing age-matched peers with CI and NH. To conclude, our results show that grammatical development is fairly limited in children with ABI, even in a group of children with ABI with a very advantageous profile in the ABI population.

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1 Introduction

With cochlear implantation, the auditory and speech perception of children born with a severe-to-profound sensorineural hearing loss improves considerably, ameliorating the hearing loss up to hearing levels between 20 and 40 dB HL (decibels hearing level). Even though the electrical signal provided by the cochlear implant (CI) is still degraded and underspecified as compared to unprocessed signals received by normally hearing listeners (Castellanos et al., 2020), this improved access to sound and ambient speech has also led to considerable improvements of children with CI's spoken language development (e.g. Faes et al., 2016; Gillis, 2018; Niparko et al., 2010; Toe & Paatsch, 2013; Warner-Czyz & Davis, 2008; Watson et al., 2006). For instance, soon after implantation, children with CI start to babble (Kishon-Rabin et al., 2005; Schauwers et al., 2008). Moreover, they seem to catch up with their normally hearing peers after several years of device use and after extensive speech and language therapy on some aspects of their linguistic development, such as morphological and syntactic complexity (Duchesne & Marschark, 2019; Faes et al., 2015). Still, there are large individual differences in children's performance after cochlear implantation, which have been attributed to factors such as the age at implantation, additional non-auditory disabilities, etc. (Boons et al., 2012; Pisoni et al., 2017; Ruffin et al., 2013).

Notwithstanding the relative success of cochlear implantation, some children receive little or no benefit from a CI. When severe-to-profound hearing loss results from anatomical malformations of the cochlea, from cochlear nerve deficiencies, or from the absence of the auditory nerves, i.e., cases in which a cochlear implant is impossible or does not lead to satisfactory outcomes, an auditory brainstem implant (ABI) may be a viable alternative option. Instead of inserting electrodes into the cochlea, an ABI is an array of surface electrodes placed on the cochlear nucleus in the auditory brainstem, thus bypassing the cochlea and the auditory nerve. ABIs have been used since the beginning of this century for paediatric hearing restoration (Puram et al., 2016).

1.1 Auditory Brainstem Implantation: History and Incidence

Auditory brainstem implants (ABI) were developed in the early 1980s to restore hearing in adults with neurofibromatosis type 2 (NF2) (Edgerton et al., 1982). NF2 causes inter alia tumours in the area of the auditory nerves and surgical removal of these tumours often causes damage resulting in hearing loss. Even though the ABI was designed for adults with hearing loss related to NF2, its use was soon rapidly extended to adults with other inner ear pathologies, such as cochlear (nerve) aplasia, cochlear ossification, cochlear malformation, and the absence of the auditory nerves (V. Colletti et al., 2009; Puram & Lee, 2015). Since 2001, the ABI is also used in paediatric populations in Europe (Colletti et al., 2001), and a good decade later, the first clinical trials were set up in the US (Puram & Lee, 2015).

A cochlear implant (CI) and an auditory brainstem implant (ABI) have an external and internal part. The external part of both devices consists of a microphone and a processor, which capture environmental sounds and convert them into a digital code. In the internal part, the digital code is sent to a number of electrodes, which transform it into an electric signal. In case of a CI, these electrodes are placed within the cochlea and stimulate the auditory nerve. As such, the CI bypasses absent or damaged hair cells in the cochlea itself. The electrodes of an ABI are placed directly on the cochlear nucleus of the brainstem, thus stimulating the brainstem directly. An ABI bypasses absent auditory nerves or a damaged cochlea in which no electrodes could be inserted (Puram & Lee, 2015).

In the case of absent auditory nerves and/or absent or damaged cochlea(s), a CI is not applicable and an ABI is the only option (Colletti et al., 2002). However, a CI trial period has been recommended whenever possible, before turning to an ABI (Buchman et al., 2011; Farhood et al., 2017). With little benefit of the CI in such a case, an ABI is an alternative option (Hammes Ganguly et al., 2019). In practice, many children receive first a CI and, at a later age, a contralateral ABI (Batuk et al., 2020; Sennaroglu et al., 2016a). Recent studies indicate that children with cochlear nerve deficiency seem to benefit from the combination of CI and ABI in speech perception, as compared to a condition with only a CI or only an ABI (Batuk et al., 2020; Friedman et al., 2018).

The number of cases of ABI surgery is relatively low. For instance, in Belgium (with approximately 11.5 million registered inhabitants in 2019), only eight children under the age of five received an ABI between 2015 and 2019. This figure is drawn from the statistics of RIZIV (National Institute for Health and Disability Insurance, NIHDI) of officially registered and reimbursed cases. To the best of our knowledge, there are no data available about the incidence of ABI candidacy relative to the birth figures in Belgium. However, for Flanders, the Dutch speaking part of Belgium, the region where the participants of the current study are living, an estimate can be extrapolated from the figures provided by the Flemish agency *Child and Family* (*Kind & Gezin*). In the period 1999–2018 there were on average 65,616 (SD = 3785) newborns per year. Over the same period, the average number of newborns with a bilateral hearing loss of more than 70 dB HL was 37.26 (SD = 8.99), or on average 0.56 per 1000 births. Assuming that these newborns constitute the group of potential CI recipients, and that 2.1% of those are potential recipients of ABI (according to Kaplan et al., 2015), an estimated 0.012 (SD = 0.002) per 1000 births are eligible for ABI.

1.2 Paediatric Auditory Brainstem Implantation

After implantation, children with ABI can reach hearing thresholds between about 30 and 60 dB HL (decibels hearing level) (e.g. Choi et al., 2011; Eisenberg et al., 2018; Sennaroglu et al., 2016a; Teagle et al., 2018; Wilkinson et al., 2017). With continued hearing experience, they can identify and discriminate sounds, phonetic contrasts and understand simple sentences with or without lip-reading (Colletti et al., 2002, 2004, 2014; da Costa Monsanto et al., 2014). The better performing children can even reach open set speech perception (without lip-reading) and some of them can even conduct a telephone conversation with familiar adults after at least five years of device use (Colletti et al., 2002, 2004, 2014; da Costa Monsanto et al., 2014; van der Straaten et al., 2019; Yucel et al., 2015). These well-developed speech perception skills are only reachable for children with ABI who are implanted early on (Aslan et al., 2020), have low hearing thresholds after implantation (Sennaroglu et al., 2016b) and have no additional disabilities (Colletti et al., 2014; Sennaroglu et al., 2016a; van der Straaten et al., 2019). These are also the children with the better speech production skills (van der Straaten et al., 2019).

According to early research on children with ABI's speech production skills, the best performing children appeared to be vocalizing, babbling and some were also producing words and sentences (e.g. Bayazit et al., 2014; Colletti et al., 2002, 2004; Eisenberg et al., 2008; Puram & Lee, 2015). More recently, the speech production development of children with ABI has been scrutinized in more detail. For instance, vocalizations, babbles and words were quantified using normalized measures, showing that children with ABI reach the babbling and word onset after several years of device use (Faes et al., 2019; Faes & Gillis, 2019a, b). As to lexical and phonological development, children with ABI produce ambient language phoneme(s) (features), syllables and basic word patterns, though often incorrectly (Eisenberg et al., 2018; Faes & Gillis, 2020, 2021; Teagle et al., 2018) and have a growing number of words in their lexicon (Faes & Gillis, 2019b). However, it should be reiterated that these developments pertain to the better performers, i.e. children without additional disabilities, with early implantation and with lower degrees of hearing loss after implantation.

But even the better performing children with ABI are lagging behind when compared to children with normal hearing (NH) and children with cochlear implants (CI) with a similar length of hearing experience. For lexical as well as phonological development, children with ABI mostly perform lower than the 95% confidence intervals of the children with NH and CI without additional disabilities (Faes & Gillis, 2019b, 2020). According to van der Straaten et al. (2019), the expressive language skills of children with ABI without additional disabilities can be situated between the means of children with CI with and those without additional disabilities.

In addition, considerable interindividual variation between children with ABI has been reported. Even after controlling for factors impacting the speech perception and production outcomes such as additional disabilities, age of implantation and hearing thresholds after implantation (Aslan et al., 2020; Sennaroglu et al., 2016a; van der Straaten et al., 2019), there still remain considerable differences between the (pace of) development of children with ABI (Eisenberg et al., 2018; Faes & Gillis, 2020, 2021). To date, it is unclear which (additional) factors cause and determine these differences.

1.3 The Present Study

In the present study, morphological and syntactic aspects of children with ABI's spontaneous speech were analysed. Three children with ABI (one child with a CI and a contralateral ABI) were followed longitudinally. A monthly follow-up design was set up, in order to capture small changes in the children's development, as for instance Teagle et al. (2018) indicated that children with ABI's slow and slight progress could not be captured by their 6-month interval design. The children in this study can be considered to be good performers, given their absence of additional disabilities, their early implantation and their low hearing thresholds after implantation. Their development was compared to that of children with CI and children with typical, normal hearing (NH).

To date, little is known about the children's longitudinal speech and language development. Some studies already investigated phonological and lexical aspects of their speech and language production, but – to the best of our knowledge – no information is available yet with respect to their morphosyntactic development. Morphosyntactic development will be measured in two ways: (1) Mean Length of Utterance (MLU) as a proxy for syntagmatic development, and (2) Mean Size of Paradigm (MSP) of verbs as a proxy for paradigmatic, inflectional development.

MLU, as presented by Brown (1973), is a measure of general grammatical development, which gives an indication of sentence complexity (Hammer, 2010) and morphosyntactic complexity (Mimeau et al., 2015) and is used as an indication of potential issues in linguistic development (Klee & Fitzgerald, 1985). MLU is measured by dividing the number of morphemes (or words or syllables) by the number of utterances in a speech sample (Brown, 1973; Flipsen & Kangas, 2014; Hickey, 1991; Parker & Brorson, 2005; Rice et al., 2010). It is shown to increase with age in different populations, such as typically developing children (Blake et al., 1993; Faes et al., 2015; Rice et al., 2010), children with SLI (Hewitt et al., 2005; Rice et al., 2010) and children with CI (e.g. Blamey et al., 2001; Faes et al., 2015; Hammer, 2010; Moreno-Torres & Torres, 2008; Nicholas & Geers, 2007; Nittrouer et al., 2014a, b; Schauwers, 2006). For the CI-NH comparison, research has pointed out that early implanted children with CI appear to catch up with their NH peers for MLU after five to seven years of device use (Faes et al., 2015; Hammer, 2010; Nicholas & Geers, 2007). Yet, no information about MLU in children with ABI has been reported in the literature.

Mean Size of Paradigm (MSP) is a measure of paradigmatic, inflectional richness in speech production (Xanthos et al., 2011; Xanthos & Gillis, 2010). It is calculated as the number of different inflected forms per root (or lemma) (Xanthos &

Gillis, 2010). The richer the paradigm, or in other words, the more inflected word forms per lemma, the higher the MSP. In the present study the development of the MSP of Dutch verbs in children's language is investigated. The reason for this restriction is that Xanthos et al. (2011) showed that in weakly inflected languages such as Dutch (Laaha et al. 2015), MSP of nouns hardly surpasses one, i.e., one word form per lemma, while the morphological richness of the verbal paradigm is relatively much higher in typically developing children's speech.[1]

For children with ABI, no information about their inflectional development is available in the literature thus far. For children with CI, MSP and inflectional development is shown to lag behind that of children NH initially, with fewer inflectional diversity, and, in addition, more errors in case and gender marking, avoidance of plural marking, etc. (Faes et al., 2015; Guo et al., 2013; Hammer, 2010; Laaha et al., 2015; Szagun, 2002). However, with extended device use, early implanted children with CI are able to catch up with their NH peers by five to seven years of age (Faes et al., 2015; Hammer, 2010).

2 Method

2.1 Participants

Three groups of children participated in this study: children with auditory brainstem implants (ABI, N = 3), children with cochlear implants (CI, N = 9) and children with typical, normal hearing (NH, N = 15). None of the children was reported with other health, developmental, motor or cognitive problems, except for their hearing loss in the ABI and CI groups. All children were raised in Dutch by parents with no reported hearing issues, and they belonged to the mid-to-high socio-economic strata of the population.

2.1.1 Children with ABI

Three children with ABI and their families participated in this study. In Belgium, only eight children were implanted with auditory brainstem implants between 2015 and 2019. Inclusion criteria for the present study were (a) Dutch-speaking, excluding children from the French- and German-speaking part of Belgium, and (b) children with no additional disabilities. These criteria reduced the available cohort to the three children participating in this study.

ABI1 was a female child who was born with profound sensorineural hearing loss with a Pure Tone Average (PTA) hearing loss of 120 dB HL (decibel hearing level). The hearing loss resulted from the absence of the auditory nerves. The child received

[1] A brief explanatory note on the morphology of Dutch verbs is appended at the end of this chapter.

a first ABI at two years of age. Nine electrodes were activated. A contralateral ABI was implanted later, at age 4;09 (years;months). Two years after the first ABI implantation, the child's PTA had improved to 37.5 dB HL. The child was raised in oral Dutch, with support of Flemish sign language. Data collection for this child started about a year after the first implantation (i.e., at age 3;02) and ended more than two years later, at age 5;07.

ABI2 was a female child, also born with profound sensorineural hearing loss as a result of the absence of the auditory nerves. The child's PTA before implantation was 116 dB HL. At age 2;01, she was implanted with an ABI and nine electrodes were activated. Two years after implantation, the child's PTA had improved to 43 dB HL. The child was raised in oral Dutch, supported with Flemish Sign Language, but to a lesser extent as compared to ABI1 and ABI3. Data collection of ABI2 started two years after implantation, at age 4;01 and ended two years later at age 6;02.

ABI3 was a male child diagnosed with auditory neuropathy with a PTA of 95 dB HL in the better ear. The child was first implanted with a cochlear implant (CI) at age 0;08. After cochlear implantation, the PTA had improved to 33 dB HL. Nevertheless, little effect on speech and language development was observed over the years. So, the child received a contralateral ABI at age 4;00. At implant fitting, all electrodes were activated. ABI3 was raised in oral Dutch, with support of Flemish Sign Language. Data collection started two months before ABI implantation and went on up to age 5;04. Between ages 4;10 and 5;00, no data were collected due to personal reasons.

2.1.2 Control Groups

Two control groups were included in this study: a group of children with CI and a group of children with NH.

Nine children with cochlear implants (CI) participated in this study as a first control group (Table 1). All children were born with a sensorineural hearing loss, with an average PTA of 112.50 dB HL (SD = 9.75) before implantation. The mean age at implantation was 11.14 months (SD = 5 months). Six out of eight children received a second CI at an older age (range 15 months to 75 months). After implantation, the mean PTA improved to 38.75 dB HL (SD = 8.66) at two years of age. All children were raised in oral Dutch, with a limited amount of lexical signs in support (i.e. supportive signs for a content words in a sentence). Data collection started immediately after implantation and went on monthly up to 30 months after first implantation, and yearly at the older ages up to the children's seventh birthday.

Longitudinal data of 15 children with normal hearing were drawn from the Dutch section of the CHILDES corpora (https://childes.talkbank.org/access/DutchAfrikaans/). The transcriptions of the following corpora were used, with the age ranges between brackets: from the Groningen Corpus Abel (1;10.30-3;04.01), Daan (1;08.21-3;03.30), Iris (2;01.01-3;06.15), Matthijs (1;10.13-3;03.05) and Peter (1;05.09-2;08.22), from the Utrecht Corpus Hein (2;04.11-3;01.24), from the

Table 1 Individual data of children with cochlear implants

ID	Gender	PTA unaided (dB HL)	PTA with CI (dB HL) (at age 2;00)	Age at CI implantation	Age at second CI
CI1	F	120	48	1;01	6;03
CI2	F	120	30	0;07	4;08
CI3	F	115	33	0;10	5;10
CI4	M	113	48	1;06	–
CI5	M	93	38	1;05	6;04
CI6	M	120	53	0;09	–
CI7	F	117	42	0;05	1;03
CI8	F	112	38	1;07	–
CI9	F	103	28	0;08	1;11
Mean	*112.50*	*38.75*	*11.14*	*52.50*	
SD	*9.75*	*8.66*	*5.02*	*27.03*	

Ages are presented in years;months
dB HL decibels Hearing Level, *PTA* Pure Tone Average
– = no second CI

Van Kampen Corpus Laura (1;09.04-3;06.09) and Sarah (1;06.16-3;05.30), two triplets from the Schaerlaekens Corpus: Gijs, Joost and Katelijne (1;8.29-2;10.23) and Arnold, Diederik and Maria (1;10.18-3;01.07). In addition, the corpus of the child Jolien (1;05.09-2;05.00) was selected from the CLiPS child language corpora.

In addition to these longitudinal data, a cross-sectional NH corpus was added, with 10 two-year-olds, 9 three-year-olds, 10 four-year-olds, 12 five-year-olds, 10 six-year-olds and 10 seven-year-olds. More information about these children can be found in Faes (2017).

2.2 Data Collection and Transcription

For all children, monthly audio and video recordings of approximately one hour were made at the child's home. These recordings involved spontaneous, unstructured interactions between the child and the caregiver(s). Sometimes, siblings were present as well. In the present study the data of 608 recording sessions were analyzed. The children's utterances were transcribed orthographically in CHILDES' CLAN according to the CHAT conventions (MacWhinney, 2000). All verbs were tagged automatically with the CLAN software tool minMOR for Dutch and disambiguated manually. Each verb was lemmatized, decomposed morphologically and assigned a part-of-speech tag.

2.3 Data Analyses

Morphosyntactic development was investigated by means of two measures: (1) Mean Length of Utterance and (2) Mean Size of Paradigm. Mean Length of Utterance (MLU) was calculated by dividing the number of words per utterance by the total numbers of utterances. This calculation was done with CLAN's MLU tool on the dependent %mor tier. Mean Size of Paradigm (MSP) was calculated by dividing the number of distinct word forms per verb lemma. For MSP only verbs were included in the present study. The software *MSP Meter* (J. Gillis, 2013) was used, which was run cumulatively over the consecutive files (ordered by increasing age of the child), automatically taking into account the entropy of each verb's paradigm as well as the frequency distribution of the various verb forms in a verb paradigm (i.e. the weighted entropy-based MSP, Xanthos & Gillis, 2010). The MSP calculations were done cumulatively over time without resampling.

Children with ABI were matched with the control groups relative to their chronological age (in the descriptive part of the results section) and relative to their hearing age, that is, the length of their device use expressed in months. For children with CI and ABI, hearing age equals their length of device use, in months. For children with NH, their hearing age is identical to their chronological age. For ABI1, monthly data started at a hearing age of 14 months up to a hearing age of 43 months. For ABI2, monthly data ranged between a hearing age of 24 months and 50 months. For ABI3, hearing age was expressed as a function of ABI use. Data of this child started at a hearing age of −2 months, i.e. two months before ABI implantation, but with already three years of CI use at that time, and went on till 16 months of hearing age.

2.4 Statistical Analyses

Statistical analyses were performed in R using multilevel models. Multilevel models are constructed with 2 parts: a random part and a fixed part. The random part of the model takes into account the variance and nesting of variables. In the present study, this nesting and variance between children and different ages is captured by adding a random effect of Hearing age and a random effect of child ID. In the fixed part of the model, either MLU or MSP is added as the dependent or predicted variable. Independent or explanatory variables were hearing age (in months), hearing status (CI or NH, ABI was set as intercept) and the interaction between both variables. Only utterances containing lexical items were considered in the analyses and, hence, MLU and MSP values equaling zero were excluded from the analyses.

For the statistical analyses, only the longitudinal datasets were included, the cross-sectional part of the data was not considered. For each child with ABI, two analyses were performed: one for MLU and one for MSP, with matching data of children with NH and children with CI for the hearing ages available of each child with ABI. For ABI1, data with hearing ages between 12 and 41 months were selected, for ABI2 between 22 and 48 months and for ABI3 between −2 (2 months before ABI implantation, but with CI) and 16 months. The intercept for each analysis was set at the beginning of the ABI data. That is, at 12 months of hearing age for ABI1, at 22 months of hearing age for ABI2 and at 2 months of hearing age (with ABI) for ABI3. For ABI3, no data with children with NH could be matched.

3 Results

3.1 Descriptive Comparisons Between Groups

In Fig. 1, the development of MLU is plotted for all children (ABI1, ABI2, ABI3, the CI control group and the NH control group) as a function of chronological age and hearing age. A similar plot is displayed in Fig. 2 for MSP. All longitudinal data for children with CI and children with NH were included into the graphs, in addition to the cross-sectional data of children with NH. Since the fitted data for the NH children are not only from longitudinal data, they should be interpreted with the necessary caution.

For both measures (MLU and MSP), the three children with ABI score considerably lower than the children with CI and children with NH when matched on chronological age. Only ABI2 seems to approach age-matched CI and NH levels of MSP development. In other words, the three-to-six-year-old children with ABI are lagging considerably behind their three-to-six-year-old peers with CI and their three-to-six-year-old peers with NH.

But given the later onset of hearing for children with ABI in comparison to children with NH and even in comparison to children with CI, a comparison based on chronological age may seem a bit off. The same holds for the CI-NH comparison since also children with CI have a later hearing onset as compared to children with NH. Even though a comparison on chronological age is an intuitive point of departure (parents want to know if their child with an implant will reach age-appropriate language levels, for instance), the difference in hearing experience skews the comparison. Therefore, hearing age is often suggested as a more appropriate alternative. That is, children's development is traced based on the length of their hearing experience, expressed as hearing age in months.

For instance, for MLU, the difference between children with CI and children with NH found in the comparison on chronological age disappears when their development is paralleled on hearing age (Fig. 1). The same effect is obtained for MSP, but only partially for hearing experience (Fig. 2). In other words, the differences between the two groups diminish when hearing age is used as an alternative yardstick. Thus, the comparison of children with NH and those with CI shows that the prominent difference in their MLUs disappears when the children are compared as a function of their hearing age instead of their chronological age. A similar observation can be made for MSP, though here it takes much longer for the two developmental curves to meet.

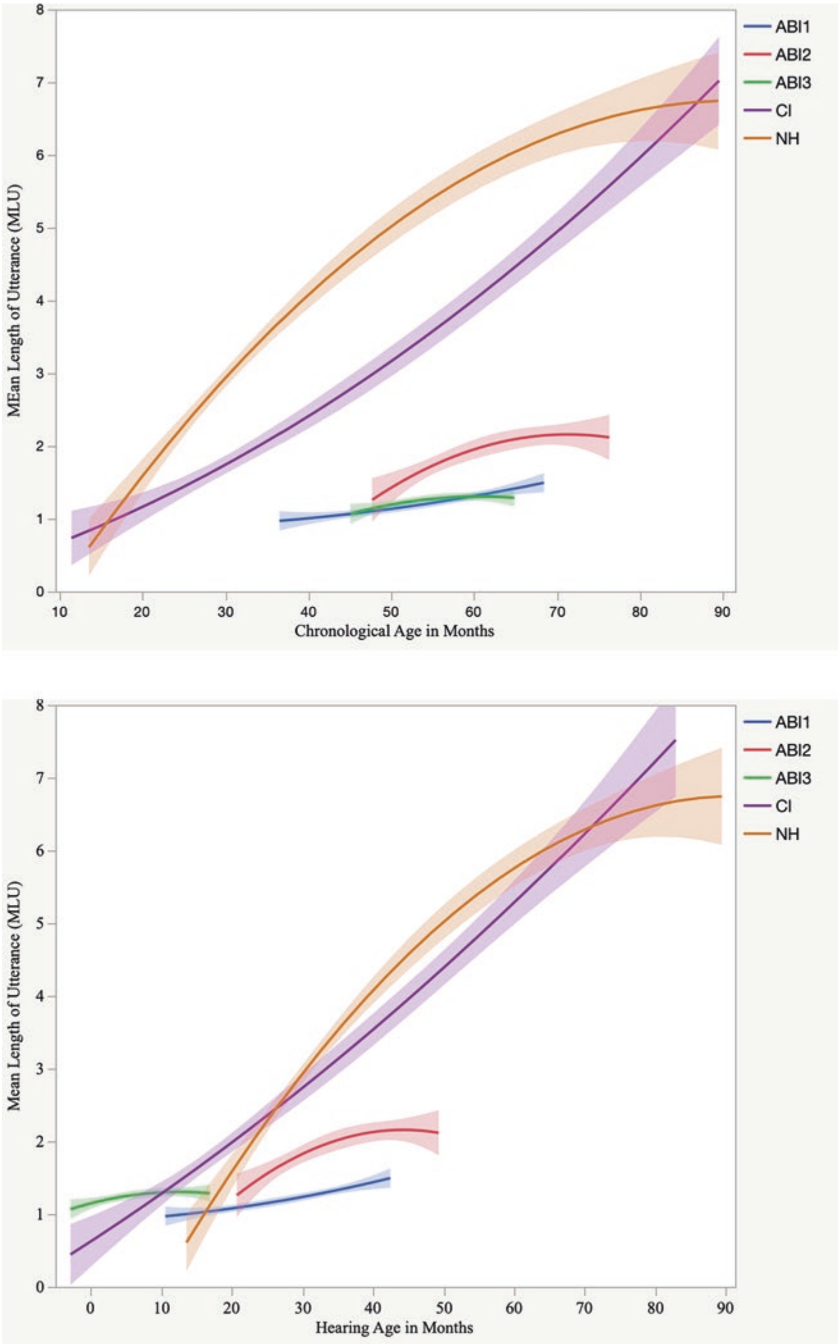

Fig. 1 Quadratic fit of observed MLU of all children: comparison on chronological age and hearing age

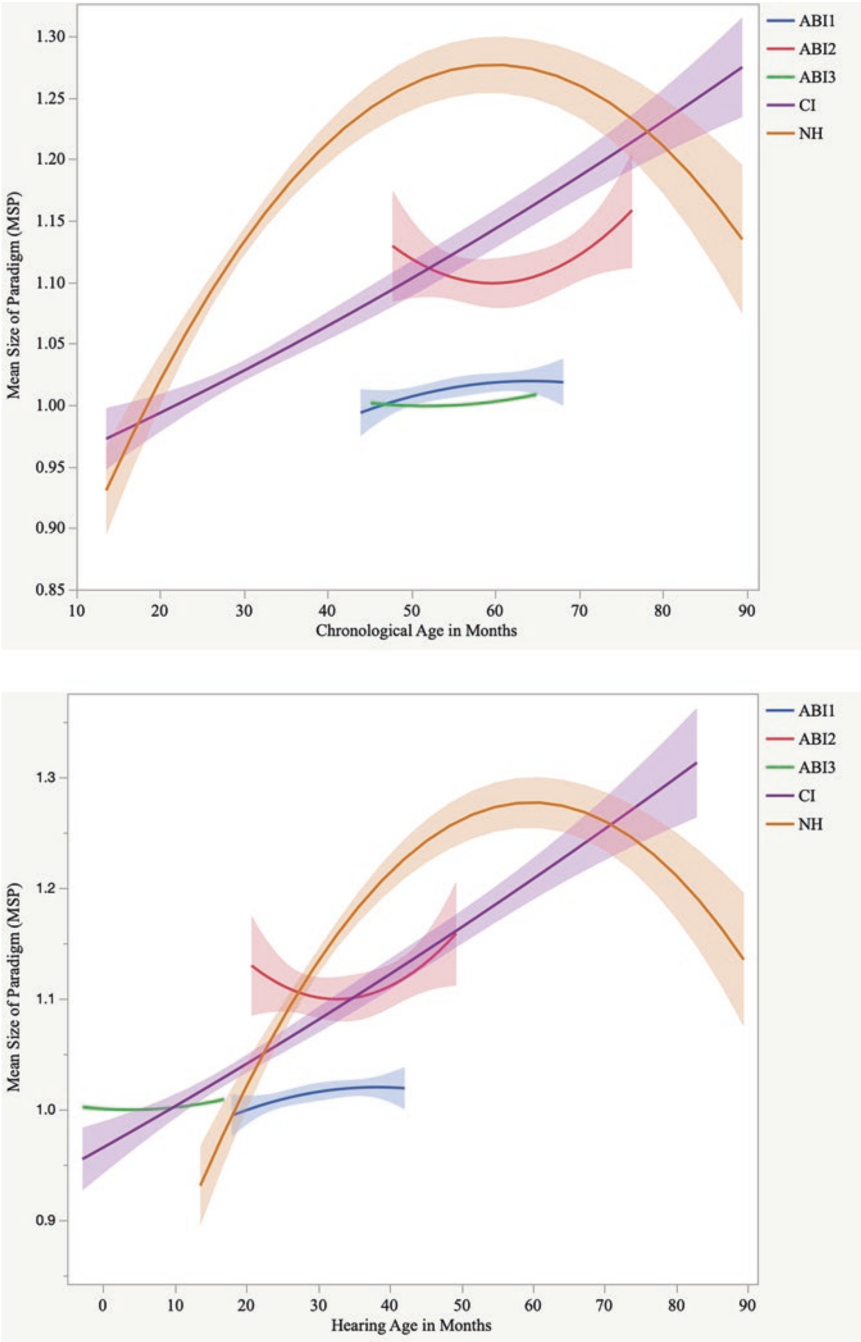

Fig. 2 Quadratic fit of observed MSP of all children: comparison on chronological age and hearing age

The difference in MLU and MSP between each child with ABI and the children with NH and CI – matched on hearing age – is less prominent when compared to the same comparison on chronological age. Especially for MSP, the values appear to approximate these of children with CI and children with NH. But these are the observed values. The statistical assessment of the differences will be presented in the next section.

3.2 Statistical Analyses: Comparisons on Hearing Age

In Table 2, the fixed effect results of ABI1 are shown, both for MLU and MSP. Longitudinal data of children with CI and children with NH are matched for hearing ages between 12 and 41 months, as these were the data available for ABI1.

At the intercept, i.e. 12 months of hearing age, MLU is estimated at 0.97 and MSP at 1.00 for ABI1. So, on average, an utterance comprises one word and the child uses only one form per verb. There is no significant effect of hearing age in the MLU and MSP values ($p > 0.05$ in both analyses). In other words, there is no significant increase of MLU and MSP between 12 and 41 months of hearing age in ABI1. For both measures MLU and MSP, there is no significant difference between ABI1 and children with CI nor between ABI1 and children with NH at the intercept. Both the main effect of hearing status [CI] and the main effect of hearing status [NH] are not significant ($p > 0.05$) in the analyses for MLU and MSP. But there are significant interaction effects between hearing age and hearing status [CI] and [NH] in the MLU analysis ($p < 0.0001$ for the two analyses shown in Table 2) and in the MSP analysis (resp. $p < 0.01$ and $p < 0.0001$ as shown in Table 2). These interaction

Table 2 Fixed effect results of ABI1 for MLU and MSP

	Estimate	SE	*t*-value	*p*-value
MLU				
Intercept	0.97	0.73	1.33	>0.05
Hearing age	0.02	0.01	1.43	>0.05
Hearing status [CI]	0.31	0.77	0.41	>0.05
Hearing status [NH]	−0.92	0.76	−1.22	>0.05
Hearing status [CI] × hearing age	0.08	0.01	6.42	<0.0001
Hearing status [NH] × hearing age	0.15	0.01	12.54	<0.0001
MSP				
Intercept	1.00	0.08	13.93	<0.0001
Hearing age	0.00	0.00	0.70	>0.05
Hearing status [CI]	0.00	0.07	0.03	>0.05
Hearing status [NH]	−0.07	0.07	−0.96	>0.05
Hearing status [CI] × hearing age	0.00	0.00	2.62	<0.01
Hearing status [NH] × hearing age	0.01	0.00	7.06	<0.0001

An estimate and/or SE of 0.00 indicates a value smaller than 0.01

effects suggest that there is a significant increase of MLU and MSP in both control groups as hearing age increases. In that sense, the difference between ABI1 – who does not show an increase of MLU and MSP with hearing age – and the other control groups becomes significant at the older hearing ages.

In Table 3, the fixed effect results of ABI2 are shown for MLU and MSP. Data of children with CI and children with NH are matched between hearing ages 22 and 48 months, i.e. the available data range for ABI2.

At the intercept, i.e. 22 months of hearing age, MLU is estimated at 1.54 and MSP at 1.10 for ABI2. The average sentence comprises one and a half word and the child uses approximately one form per verb. For MLU, there is a significant effect of hearing age ($p < 0.05$), showing that ABI2's utterances become significantly longer with prolonged hearing experience. For MSP, there was not such an effect ($p > 0.05$), indicating that the child did not increase the number of word forms per verb. At the intercept, i.e. 22 months of hearing age, there were no significant effects of hearing status [CI] and hearing status [NH], suggesting similar MLU and MSP values in all children ($p > 0.05$ in all analyses). However, there were significant interactions between hearing age and hearing status [CI] and hearing age and hearing status [NH] for MLU ($p < 0.001$ and $p < 0.0001$) as well as MSP ($p < 0.01$ and $p < 0.0001$). These effects point out that the increase of MLU and MSP values with more hearing experience is more prominent in the CI and NH groups than in ABI2. In other words, the differences between ABI2 and the two control groups significantly increase with hearing experience.

In Table 4, the fixed effect results for MLU and MSP of ABI3 are displayed. Only longitudinal data of children with CI were available, matched between hearing ages −2 and 16 months, i.e. ABI3's hearing ages with the ABI device. The intercept was set at the beginning of the ABI data, i.e. 2 months of hearing age.

Table 3 Fixed effect results of ABI2 for MLU and MSP

	Estimate	SE	*t*-value	*p*-value
MLU				
Intercept	1.54	0.80	1.92	>0.05
Hearing age	0.03	0.01	2.15	<0.05
Hearing status [CI]	0.72	0.84	0.86	>0.05
Hearing status [NH]	0.39	0.83	0.47	>0.05
Hearing status [CI] × hearing age	0.05	0.02	3.05	<0.001
Hearing status [NH] × hearing age	0.11	0.01	7.42	<0.0001
MSP				
Intercept	1.10	0.08	14.63	<0.0001
Hearing age	0.00	0.00	0.89	>0.05
Hearing status [CI]	−0.05	0.08	−0.65	>0.05
Hearing status [NH]	−0.06	0.08	−0.77	>0.05
Hearing status [CI] × hearing age	0.00	0.00	2.96	<0.01
Hearing status [NH] × hearing age	0.01	0.00	8.84	<0.0001

An estimate and/or SE of 0.00 indicates a value smaller than 0.01

Table 4 Fixed effect results of ABI3 for MLU and MSP

	Estimate	SE	*t*-value	*p*-value
MLU				
Intercept	1.19	0.30	4.03	<0.0001
Hearing age	0.01	0.01	0.97	>0.05
Hearing status [CI]	−0.56	0.32	−1.77	>0.05
Hearing status [CI] × hearing age	0.06	0.01	4.83	<0.0001
MSP				
Intercept	1.00	0.01	82.51	<0.0001
Hearing age	0.00	0.00	0.64	>0.05
Hearing status [CI]	−0.01	0.01	−1.00	>0.05
Hearing status [CI] × hearing age	0.00	0.00	2.23	<0.05

An estimate and/or SE of 0.00 indicates a value smaller than 0.01

At the intercept, ABI3's MLU is estimated at 1.19 and ABI3's MSP at 1.00. In other words, the child's utterances comprise on average 1.19 words and the child uses one word form per verb. The lack of a significant effect of hearing age ($p > 0.05$ in Table 4) suggests that MLU and MSP do not change significantly with longer hearing experience. At the intercept, children with CI's MLU and MSP values estimated at slightly lower values than those of ABI3, but these differences were not significant ($p > 0.05$ in both analyses). But whereas ABI3 did not show an increase with hearing age, children with CI did show an increase. The significant interactions between hearing age and hearing status [CI] for both measures ($p < 0.0001$ for MLU and $p < 0.05$ for MSP) indicate that the difference between ABI3 and children with CI increases with hearing experience, with children with CI outperforming ABI3 when they have used their implants for a longer period.

4 Discussion

The present study investigated the grammatical development of three children with an auditory brainstem implant and compared it with the grammatical development of congenitally hearing-impaired children with a cochlear implant and children with typical hearing. Two aspects were analyzed: mean length of utterance (MLU), as a proxy for syntagmatic development, and mean size of paradigm (MSP) of verbs, as a proxy for paradigmatic development. The children's longitudinal development was cast against their chronological ages, meaning that the ABI, CI and NH children's development was compared in the same chronological age time window. In addition, their development was aligned relative to the amount of hearing experience, i.e., their hearing age. Three conclusions can be drawn from the results: (1) as expected, the three children with ABI lag considerably behind their peers with NH and peers with CI when compared on chronological age. (2) When matching the groups instead on hearing age (i.e. length of hearing experience), the difference between the children with ABI and children with CI and NH diminished, but was still significant. And (3), ABI2 outperformed the other two children with ABI with respect to MLU and MSP, even at similar hearing ages, suggesting considerable interindividual variation among the users of ABI.

4.1 Group Comparisons

Compared to children with NH of the same chronological age, the hearing-impaired children have significantly lower MLU and MSP values. Their utterances are on average shorter and they use fewer different word forms per verb lemma. However, the development over time of the hearing-impaired children is quite different. Whereas the children with CI's MLU values show a considerable increase, the increase is far less prominent in the case of the children with ABI. Moreover, notwithstanding the initial delay of children with CI in comparison with their peers with NH, they seem to be closing the gap over time. This development has been reported in the literature: early implanted children with CI appear to catch up with their hearing age-mates and seem to have closed the gap around the age of five (Faes et al., 2015; Hammer, 2010; Nicholas & Geers, 2007). A similar development is not apparent in children with ABI: although their MLU and MSP increases very slightly over time, the increase is insufficient to even start closing the gap with their age-matched peers with CI and NH.

However, the group differences are smaller when hearing age is used as the basis for comparison. For instance, for children with CI, the differences with children with NH disappeared almost completely for MLU and partially for MSP (Figs. 1 and 2). For the three children with ABI, the differences were reduced as well, especially for ABI2, but they still caught the eye. In other words, the grammatical development of children with ABI lags considerably behind that of peers with NH and CI when matched on chronological age. Three-to-six-year-old children with ABI are far from approaching the syntagmatic and paradigmatic skills of three-to-six-year old children with CI and children with NH. In turn, children with CI are also lagging behind their age-matched peers with NH, but are catching up (Faes et al., 2015). When the groups were matched on hearing age, the differences between children with NH and those with CI became much smaller and disappeared almost completely. Children with ABI developed in the direction of those with CI and NH but their slower development and less pronounced progress was striking.

Even though children with ABI were matched on hearing age with children with CI and NH, their grammatical measures MLU and MSP were significantly lower. The children with ABI produced shorter sentences and used fewer different forms per verb lemma. For all children with ABI, their average utterances were one word long, and they produced one verb form per lemma. With the available longitudinal data, possible progress could be traced over a period of about two years of hearing experience in each child with ABI. However, the children did not seem to increase their sentence length or use more different forms of a particular verb. Neither of the three participants with ABI showed a significant effect of hearing age on their MLU and MSP values. The only exception was ABI2, whose utterance length (MLU) slightly increased with longer hearing experience. Children with CI and children with NH also started with one-word utterances and only one verb form per verb paradigm. But, in contrast to the three children with ABI, they expanded their utterances and verb paradigms with increasing hearing experience. Consequently, the difference between children with ABI and children with CI and NH enlarged with prolonged hearing experience.

At the beginning, there were no apparent differences in the data of each child with ABI and that of the control groups. This is not surprising given the chronological age – hearing age dichotomy discussed earlier. At the start of the data collection for ABI1, for instance, children with NH had a chronological (and thus also hearing) age of one year. At this age, children with NH are just starting to use basic word forms in one-word utterances. Also, the average child with CI had a chronological age of two years (with one year of hearing age) at the start of ABI1's data. At two years of age, multiword utterances are, on average, relatively rare in children with CI and NH's production. However, with increasing hearing experience utterance length increases and verb paradigms expand in the children with CI and NH. However, this development did not take place in the three children with ABI, not even in the most advanced, ABI2.

4.2 Individual Variation in Children with ABI

Although our study group of children with ABI is limited – only three children participated – there are some striking patterns: on the one hand, their development is fairly similar (e.g., hardly any significant effect of hearing age on MLU and MSP), but, on the other hand, there is a considerable amount of interindividual variation in the ABI group. First of all, the grammatical development observed in ABI3 seems largely due to the child's CI experience. A closer look at the graphs suggests that ABI3 reaches a MLU value of one already at earlier hearing ages, even before offset of ABI data (depicted by a negative hearing age), i.e., before the activation of his ABI. In a similar vein, ABI3 has a paradigm of one word per verb form already at the start of his ABI experience. This suggests that ABI3 is benefitting from the CI to reach these levels of grammatical development, rather than from the ABI already at these early hearing ages. For the period studied here, the child showed no substantial increase of syntagmatic or paradigmatic richness that could be taken to result from the use of the ABI device. For speech perception, Batuk et al. (2020) and Friedman et al. (2018) have already suggested that children seem to benefit from the CI-ABI combination rather than a CI-only or ABI-only condition. Therefore, it may be that the effect of the ABI on ABI3's grammatical performance is yet to come: the perceptual gain could generate some benefit to the child's productive speech skills with ABI experience.

Secondly, ABI2 is outperforming the other children and ABI1 is lagging behind compared to the other two. With respect to syntagmatic development (MLU), ABI1's values are lower than those of ABI2 and ABI3 at similar hearing ages, and ABI3 is probably benefitting from his CI experience resulting in markedly higher values. Also for paradigmatic development (MSP), the first verbs only appeared at 19 months of hearing age for ABI1 (see Fig. 2), even though data collection had already started at 12 months of hearing age. In contrast, ABI3 already had an MSP of one at earlier hearing ages, likely due to the CI use. But even with the benefit of the CI, the syntagmatic and paradigmatic development of ABI3 is less advanced than that of ABI2. In addition, ABI2 is also outperforming ABI1 on both measures. The difference between ABI2 and the other children with ABI can clearly be derived from the figures. But the statistical analyses pointed in the same direction: the intercept of ABI2 was set at 22 months of hearing age, whereas these for ABI1 and ABI3 were much earlier. Yet, the MLU and MSP values of ABI2 were not shown to differ significantly from the CI and NH groups of children at the intercept, but only at the older hearing ages. For ABI1 and ABI3, instead, the non-significant differences with CI and NH groups were present only at the much earlier hearing ages of 2 months and 12 months for ABI3 and ABI1, respectively.

So, overall, ABI2 is outperforming ABI1 and ABI3 on grammatical development, even though this last child may have benefitted from the CI. For lexical and phonological development, considerable variation between children with ABI is also found in the literature (Eisenberg et al., 2018; e.g. Faes & Gillis, 2019b, 2020, 2021). It is unclear which factors add to ABI2's more developed grammatical performance. Factors such as age at implantation and hearing thresholds with ABI – known to impact children with ABI's speech perception and speech production (Aslan et al., 2020; Sennaroglu et al., 2016a) – are similar in ABI1 and ABI2 and therefore cannot explain the differences between the two children. In a similar vein, none of the three children was reported to have additional disabilities, another factor often shown to impact children with ABI's speech and language development (Sennaroglu et al., 2016a; van der Straaten et al., 2019). More research is needed to disentangle the factors that contribute to these individual differences.

4.3 Concluding Remarks

Children with ABI are lagging behind their hearing age-matched peers with CI and NH on grammatical development (MLU and MSP). This delay is also apparent, though less pronounced, when the children are matched on hearing age. Initially, a similar observation holds for children with CI compared to children with NH but they appear to close the gap, which is definitely not the case for children with ABI. We can only speculate as to what causes these differences in the language development of children who are equipped with the two devices. Hence, the following observations are tentative and underline the urgent need for further research.

First of all, the speech signal provided by the CI and the ABI is poorer as compared to that available in normal hearing (Drennan & Rubinstein, 2008). Even though to date little is known about the precise difference in the speech signal provided by the ABI versus the CI, it may be assumed from the literature that the signal provided by the ABI is even poorer as compared to the CI (Wong et al., 2019). Especially for MSP, this degraded speech perception is likely to impact the results. In Dutch, verbs are predominantly inflected by adding a suffix (e.g., /t/ or /ə/) to the stem. Such unstressed suffixes are of low salience even for children with NH. Therefore, it is likely that children with ABI – and to a lesser extent also children with CI – are missing these low salient unstressed items in speech perception. As speech production relies on speech perception, this inevitably affects hearing impaired children's production of low salient suffixes as well. MSP takes into account the different forms of a verb that are produced. But these verb forms often differ only by a low-salience unstressed suffix. For instance, the difference between the first and the second and third person of most regular verbs is the suffix *-t*, similar to the third person *-s* in English (*ik werk 'I work' vs. jij werkt 'you work', hij werkt 'he works'*). The more limited perception of such suffixes most probably affects their production. In addition, children with CI are shown to be less attentive to speech as compared to children with NH (Houston & Bergeson, 2014) and to have lower executive functioning skills (e.g., attention deficits) (Kronenberger et al., 2014). Therefore, they are assumed to focus more on salient items in the speech signal (Svirsky et al., 2002) at the expense of the low-salience grammatical morphemes. In the future, research is needed to find out if similar effects play a role in children with ABI.

Secondly, different aspects of children's working memory skills are related to measures such as MLU and MSP. For the production of sentences (sentence planning, MLU) as well as for the production of different verb forms per lemma (MSP), children need to store information in their mental lexicon and working memory. Since little information is available for children with ABI, we will first explain the CI-NH difference and then come back to the ABI group.

For children with CI, it has already been shown that storage of information is problematic (Nittrouer et al., 2013). For MSP, this storage problem in children with CI is linked to the mental lexicon. In order to produce different word forms per lemma – which results in higher MSP counts, these word forms need to be stored in the lexicon first. If fewer word forms are stored, as in the CI group as compared to the NH group, fewer can be produced as well and, consequently, MSP values will be lower. Turning to MLU, problematic storage in working memory affects sentence length (MLU). When producing a sentence, two parts of working memory are especially active: phonological short-term memory for storing information, and the general executive (Baddeley, 2003). The longer the sentence, the more active the general executive will become, reducing the capacity of the phonological short-term memory. So, longer sentences increase the cognitive load, since more information must be stored and handled in a phonological short-term memory with reduced activity (Willis & Gathercole, 2001). For instance, children with NH tend to omit auxiliaries in longer sentences due to processing limitations (Valian, 1991). In other words, increased cognitive load will reduce sentence length (Charest et al., 2015). In children with CI, phonological short-term memory is poor as compared to children with NH (Burkholder & Pisoni, 2003; Cleary et al., 2001; Kronenberger et al., 2013; Pisoni et al., 2010; Pisoni & Cleary, 2003, 2004). Hence, when sentences become longer, phonological short-term memory is reduced even more. Therefore, it is likely that the performance on sentence length lags behind in the children with CI as compared to children with NH.

For children with ABI, it remains unknown if similar effects of reduced storage, phonological short-term memory and working memory are playing a role in their even poorer performance on grammatical measures such as MLU and MSP. However, delayed onset of language experience is often linked to poorer working memory skills in children (Holmes et al., 2010; Marshall et al., 2015). Given the fact that children with ABI had a prolonged time of auditory deprivation as compared to children with CI, the effects found in children with CI (such as poor phonological working memory skills, poor storage of information, poor executive functioning, poor attention to speech) are expected to be even more prominent in children with ABI. In that case, the effects of these working memory and storage problems will be even more prominent in the ABI group, resulting in poorer language scores – as witnessed by the literature on children with ABI in comparison to children with CI (and NH). Yet, more research is needed to test these hypotheses.

Thirdly, the poor performance of children with ABI on MLU and MSP can be linked to their lexical development. Research has shown that the children with ABI studied here expand their lexicon sizes continuously, but that they are lagging behind when compared to children with CI and children with NH (Faes & Gillis, 2019b - the same children with CI were included in both studies). But to produce longer sentences and more verb forms per lemma, these words must be acquired. For children with CI, poor attention to speech and reduced speech perception skills were already linked to their poor phonological representation of words and consequently to their poorer word learning skills. It may be the case that a similar effect is present in the children with ABI. Their speech perception is even more reduced, which may impact their novel word learning. For children with CI, lexical development is one of the better developed aspects of language (e.g. Duchesne et al., 2009). Moreover, in Faes et al. (2015), MSP is shown to be more closely related to lexical development than MLU: inflected word forms are unique words to be incorporated in the mental lexicon (e.g. Lukatela et al., 1980; Lukatela et al., 1987). Therefore, children with CI seem to catch up with their peers with NH earlier for MSP than for MLU. For children with ABI, it is as yet unknown if lexical development is one of their strengths in language development. In addition, even though they were expanding their lexicon size, this expansion was very slow (Faes & Gillis, 2019b). It is unclear if this slight increase in novel word learning could affect sentence length and verb paradigms. Therefore, more information is needed on the types of words learned by the children. To increase sentence length, for instance, children with ABI must be learning function words in addition to content words. To date, no information is available on development of open-class and closed-class words. In more general terms: the nature of children with ABI's lexical development is an uncharted territory that still needs to be explored.

To conclude, morphosyntactic development is extremely slow in children with ABI. Even four years after implantation, the mean length of utterance of the best performing child in this study (ABI2) did not surpass two words and the average number of verb forms per lemma ranged between one and one and a half. Currently, there is little other information available in the literature with respect to the morphosyntactic development of children with ABI. Whereas some studies already looked into lexical and phonological development (e.g. Eisenberg et al., 2018; Faes & Gillis, 2019b, 2020, 2021; Teagle et al., 2018; Wilkinson et al., 2017), other aspects of language development remain unresearched. Our results show that grammatical development is fairly limited, even in a group of children with ABI that can be considered as the better performers in the ABI population.

A Note on Dutch Verb Morphology

An extensive treatment of Dutch morphology is provided in Booij (2019) and for Dutch relative to other Germanic languages, the reader is reffered to i.a. König and van der Auwera (2002). Below we provide readers with some basic descriptive notes on Dutch verb morphology. Dutch verbs can only take a limited number of morphological forms. For instance, the regular Dutch verb *werken* (Eng. to work, literal translation) can occur as *werk* (e.g., *ik werk*, Eng. I work), *werk-t* (e.g., *hij werkt*, Eng. he works), *werk-en* (e.g., *wij werken*, Eng. we work), *werk-te* (e.g., *ik werkte*, Eng. I worked), *werk-ten* (e.g., *wij werkten*, Eng. we worked), *ge-werk-t* (e.g., *hij heeft gewerkt*, Eng. he has worked), and *werk-end* (e.g., *hij is werkend*, Eng. he is working). It can readily be seen that in principle seven verb forms are possible. In more general terms, Dutch verbs encode the grammatical categories of person, number, tense, mood and voice. Leaving irregular verb formation out of consideration for the sake of the exposition, the categories person (1st, 2nd, 3rd) and number (Sg., Pl.) are expressed synthetically by verbal suffixes in Dutch. But for regular verbs, the same verb form is used for the second and third person singular. And in the plural, a single verb form is used with no person distinction, which in turn is formally indistinguishable from the infinitive (e.g., *werk-en*, Eng. (to) work, *wij/jullie/zij werken*, we/you/they work, *wij gaan werken*, we are going to work).

The non-finite verb forms include the infinitive (*werken* 'to work'), the past participle (*ge-werk-t*, 'worked'), and the present participle (*werk-end* 'working'). The category tense is expressed by the present (ik *werk* 'I work', *jij/hij werk-t* 'you/he works') and the imperfectum (*ik werk-te, hij werk-te* 'I/he worked). These are the only synthetic forms. The perfectum, plusquamperfectum, futurum, and futurum exactum are periphrastic. For instance, the perfectum and plusquamperfectum are formed by a combination of the present, resp. the imperfectum of the auxiliaries *hebben* ('have') and *zijn* ('be') plus the past participle of the main verb. The imperative is formally (almost) indistinguishable from the present, and the conjunctive has disappeared from colloquial speech.

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Modality Effects in the Representation of the Root Morpheme in the Mental Lexicon of Hebrew-Speaking Adults with Dyslexia

Rachel Schiff, Shani Kahta, and Ayelet Sasson

Abstract There is a relatively broad consensus among scholars that readers with dyslexia have deficits in their phonological processing abilities. However, recent data has indicated that they may also score lower than skilled readers on tasks assessing their morphological knowledge. The main goal of this chapter is to review selected studies investigating the performance of Hebrew-speaking, high-achieving adults with dyslexia compared with skilled adult readers during a visual and auditory morphological primed-lexical decision task. The chapter aims to describe the conditions in which adults with dyslexia use morphological information, and whether they differ from controls in how morpho-semantic and morpho-orthographic information influences this facilitation. As will be further shown, in studies that utilized the visual modality, neither readers with dyslexia (neither the dyslexia group as a whole nor any of the subgroups) showed the morphological priming seen in both age- and reading-level control students. Conversely, when words were presented in the auditory modality, readers with dyslexia performed similarly to the age- and reading-matched control groups. The fact that morphological priming is not observed with visual presentation but is observed with auditory presentation serves as evidence for intact central morphological processes in adults with dyslexia that can support such auditory priming effects. The conclusions of this review align with the notion that morphological processing abilities among adults with dyslexia are modality and task dependent.

Keywords Morphological processing · Priming · Dyslexia · Auditory · Visual · Hebrew

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1 Introduction

Dyslexia is a neurological condition characterized by reading and spelling deficits that are unrelated to sensory impairments, impairments in intelligence, or inadequate educational experience (Shaywitz & Shaywitz, 2020). It is a persistent deficit that perseveres into adulthood. Dyslexia is commonly presumed to have linguistic bases, and there is a relatively broad consensus among scholars that readers with dyslexia have deficits in their phonological processing abilities due to inaccurate phonological representations (Diamanti et al., 2018; Spanoudis et al., 2019). However, recently, a growing body of data has accumulated that demonstrates lower morphological performance in individuals with dyslexia compared with skilled readers (Metsala et al., 2019; Schiff et al., 2016; Schiff & Raveh, 2007; Schiff & Ravid, 2007, 2013).

While a considerable number of studies on the relationship between morphological knowledge and dyslexia has concentrated mainly on children, the present chapter focuses on the morphological knowledge of adults with dyslexia. It demonstrates the modality effect in morphological processing among individuals with dyslexia using the morphological priming paradigm. As will be further shown, the fact that morphological priming is observed with auditory but not visual presentation serves as evidence for intact central morphological processes in adults with dyslexia that can support such auditory priming effects. Such a pattern of findings helps shed more light on the locus of the deficits that underlie dyslexia.

2 Implicit Morphological Processing and the Priming Paradigm

Morphological processing refers to the more implicit, less conscious processing of morphological information (Deacon et al., 2008). This word deconstruction process provides readers with additional syntactic, semantic, and phonological information that assists in word reading, reading comprehension, and fluency achievement (for reviews, see Amenta & Crepaldi, 2012; Marslen-Wilson, 2007). Studies with typically developing adult readers have indicated that morphological processing is likely to be impacted by orthographic and phonological variables (Feldman et al., 2002b; Nagy et al., 2006). These findings theoretically and methodologically justify exploring the nature of morphological processes in individuals with dyslexia.

Morphological processing in individuals with developmental dyslexia has not been comprehensively studied. A large body of research has focused on explicit morphological awareness, while the quality of dyslexics' implicit morphological knowledge has received little consideration. A commonly used research methodology that has been particularly beneficial for studying the effect of morphological structure on automatic word recognition is the priming paradigm, in which the prior presentation of a morphologically related word facilitates target identification. This task, as opposed to explicit morphological awareness tasks, does not require participants to consciously reflect on or structurally analyze words. Rather, it assesses online naming or lexical decision latencies (Raveh & Schiff, 2008). Findings from various studies have indicated that morphological priming has a strong effect that may assist in investigating how morphological knowledge is reflected in the mental lexicon and how it operates in the pathway of word recognition (Deutsch et al., 2003; Duranovic et al., 2020; Fiorentino & Fund-Reznicek, 2009; Fleischhauer et al., 2021).

Morphological priming has been utilized in the studies presented here to examine whether Hebrew-speaking adults with dyslexia extract and represent morphemic units similarly to normal readers during online word recognition (Boudelaa & Marslen-Wilson, 2011; Farhy et al., 2018). Morphologically related words are typically related by form (orthography and phonology) as well as meaning. Importantly, morphologically unrelated primes that are only orthographically or semantically similar to the target have little or no effect on the identification of the target under the same priming conditions (Duranovic et al., 2020). Moreover, the morphological priming effect is typically measured relative to form-related primes, which are as similar to the targets as the morphological primes (e.g., *scanner–scan* vs. *scandal–scan*), indicating that the detected morphological priming effect is above and beyond the effect of orthographic similarity. For that reason, the morphological priming effect reflects a morphological effect, which stems from the morphological connection between the prime and the target words.

The acceleration effect of morphological primes is assumed to be indicative of a transfer effect: The information related to the shared base morpheme is extracted from the prime and is transferred to the processing of the target. This effect reflects readers' construal of the morphological structure of words. Mental representations of morphological units (such as the root in Hebrew) and the manipulation of these units comprise morphological knowledge. The reader decomposes words into their morphemic components and then reconstructs these morphemic units to extract the meaning of the word (Grainger & Beyersmann, 2017; Perfetti, 2007).

As noted earlier, we refer to the above procedures as implicit morphological knowledge, as opposed to explicit morphological knowledge, because they are part of the reader's linguistic knowledge and are unconscious and automatic (Nagy et al., 2014).

3 Hebrew Morphology

Hebrew is a Semitic language, in which word structure reflects a wide range of semantic concepts (Deutsch et al., 2003; Ravid, 2019). In contrast to English, the basic morphemes that comprise Hebrew words are not sequentially arranged (Ashkenazi et al., 2016; Berent & Shimron, 2003; Ravid, 2003). Instead, the root and pattern create two interdigitated morphemes that together compose the basic Hebrew word (Ravid & Schiff, 2006; Schiff & Ravid, 2004). The Semitic root is an intermittent morpheme, typically comprised of three to four consonant radicals (e.g., *g-d-l* "grow") and conveys meaning common to words in the same morphological family (Ravid & Bar-On, 2005). Written roots look like continuous sequences at the base of Hebrew words, separated only by the letters W and Y; whereas written patterns are shown mostly as prefixes or suffixes (Bar-On & Ravid, 2011; Ravid, 2012; Ravid & Bar-On, 2005).

Due to its dominant function in Semitic morphology, root knowledge is an essential component of Semitic lexical and morphological processes (Ravid, 2003; Ravid & Schiff, 2006). Research suggests that roots have a major role in the classification of words within the lexicon in Semitic languages (i.e., Boudelaa & Marslen-Wilson, 2011). The Hebrew mental lexicon has been found to be categorized by morphology rather than by orthographic classifications; thus, when Hebrew-speakers process words, they unconsciously search for the root letters (Bick et al., 2011).

4 Visual Priming in Dyslexia

A number of studies have provided evidence to support the idea that morphological processing, assessed with the priming paradigm, is impaired in Hebrew-speaking adults with dyslexia. For example, Schiff and Raveh examined whether adult Hebrew readers with dyslexia extract and represent morphemic units similarly to normal readers by testing sixty-four Hebrew-speaking undergraduates (30 dyslexic students and 34 age-matched controls). Using the priming paradigm, the magnitude of morphological priming was measured and contrasted with the repetition priming effect. Results indicated significant differences in the patterns of repetition and morphological priming effects between the dyslexic and the control groups. Students with normal reading ability showed typical repetition priming effect, i.e., repeated primes significantly accelerated the completion of targets in the test phase. A similar repetition priming effect was also evident for the dyslexic group as a whole. However, additional analyses of the dyslexia subtypes exposed significant repetition priming effects only among participants with phonological dyslexia but not for the surface or mixed dyslexia subgroups. Furthermore, typically developed adults presented morphological priming that was as strong as their repetition priming effect. In contrast, the interaction between group and priming clearly revealed different morphological priming effects in dyslexic and normal readers. Dyslexic readers did not show morphological priming -- neither the dyslexia group as a whole, nor any of the subgroups.

Schiff and Raveh's findings are well aligned with Raveh and Schiff (2008), who examined whether undergraduate students with dyslexia decompose words into their morphemic constituents during word recognition in a manner similar to skilled readers (Experiment 1). The students with dyslexia were also classified into three dyslexia subtypes—surface, phonological, and mixed—according to their performance on orthographic and phonological judgment tasks (Olson et al., 1985). The stimuli consisted of 30 target words that were nominal root derivations, four to five letters long. These target words were paired with 30 sets of three primes each to create the three priming conditions: a word identical to the target for the repetition priming condition, a word derived from the same root as the target for the morphological priming condition, and a word orthographically (and phonologically) related to the target but unrelated morphologically for the baseline condition. Results indicated that the group with dyslexia as a whole, as opposed to both age- and reading-level control students, did not present visual priming when the prime and target words shared a morpheme, not even when the prime and the target were identical. The lack of visual priming was detected despite the fact that the priming measure relied on lexical decision latencies, which is assumed to be a more sensitive measure of priming. Furthermore, the comparison to the reading-matched control group yielded an interesting contrast. Although the participants with dyslexia and reading control participants demonstrated equal latencies in identifying the visual targets in the baseline condition, they exhibited clearly different priming profiles. This contrast suggests a qualitative difference in their word-recognition processes and indicates that their word-recognition difficulties constitute not a simple delay due to their reading level but rather a deficit specific to dyslexia (Banai & Ahissar, 2018).

The lack of repetition priming observed for the students with dyslexia in the abovementioned studies suggests that they struggle in the initial courses of recognizing written words. It reflects a deficit in their ability to automatically extract visual and orthographic characteristics from the printed word and to activate appropriate representations in the visual word-form system that is assumed to support repetition priming effects (Crepaldi et al., 2010). It is important to stress that the lack of repetition priming points to stark restrictions in their learning ability. Priming reflects primary and unconscious word recognition processes and is observed as early as the initial stages of reading acquisition (Feldman et al., 2002a, b). Students with dyslexia thus seem to have a deficiency in the very basic mechanism of perceptual learning. Although the adults who participated in the Raveh and Schiff's (2008) study were exposed to texts throughout their secondary and post-secondary academic careers, their visual-orthographic system did not seem to have benefited from the experience to a level that would enable them to preform similarly to typically developed adults.

This bottleneck at the level of the visual word-form system found in both studies raises the question of whether dyslexics' inability to demonstrate morphological priming stems from this primary deficit, or whether it reflects an additional problem at the morphological level. Because students with surface and mixed dyslexia in the above study demonstrated neither morphological priming nor repetition priming, it is difficult to determine whether the absence of morphological priming reflects a morphological processing problem over and above their perceptual deficit. In contrast to students with surface and mixed dyslexia, the students with phonological dyslexia (who exhibited relatively good performance on the orthographic judgment task) exhibited significant visual repetition priming. However, their morphological priming was weak and non-significant. This is an interesting finding, although the interpretation of this null effect should be made with caution given the small number of participants in the phonological subgroup (14 participants of the 72) and the relatively large variability in the size of the priming effects. This pattern may suggest that even when the orthographic representations are relatively intact and are good enough to give rise to facilitation from repeated exposure to an identical word, the morphological processes are nonetheless weak. We suggest that this design should be followed up with a larger group of adult participants with phonological dyslexia.

5 Auditory Priming in Dyslexia

Recent studies have suggested that morphological representations of dyslexic individuals may be intact, as measured in the auditory modality. Such a view of morphology playing a compensatory role for the phonological deficits in dyslexia is not new and is consistent with past research (e.g., Burani et al., 2008; Law et al., 2015). For instance, in a study that aimed to compare implicit morphological processing in Hebrew-speaking dyslexic and non-dyslexic adults in a between-subject design, Raveh and Schiff (2008) found an interesting pattern. In contrast to the visual priming results, in the auditory modality, both repetition and morphological priming effects of adults with dyslexia were found to be of magnitudes comparable to those of the age- and reading-matched control groups. A strong morphological priming effect suggests that when the words are presented auditorily, students with dyslexia are able to extract and activate the roots of the prime and the target words. These results necessarily indicate that their central lexicon contains morpheme-size representations and is organized by morphological principles. The dissociation between the performance in the visual and auditory priming tasks may shed light on the locus of the morphological deficit in visual word identification. It appears that the deficit may lie in the early morphological processes that operate on the visual-orthographic, but not the auditory representations.

Schiff et al. (2019) extended the investigation of implicit morphological processing to the effect of semantic information on the performance of Hebrew-speaking, high-achieving adults with dyslexia and skilled adult readers during an auditory primed-lexical decision task and a morphological awareness task. In this study, the researchers aimed to determine the condition in which adults with dyslexia use morphological information, and whether they differed from controls in how morpho-semantic information influenced this facilitation. When comparing accuracy across all four conditions (identical, M + S +, M + S−, and control), results indicated no differences in overall performance. In addition, although semantic information assisted both groups in increasing accuracy, it resulted in a reduction of response time only for the dyslexic participants. In other words, in comparison to the semantically unrelated condition, targets that shared both semantics and morphology with the preceding prime elicited a quicker reaction among participants with dyslexia. These results echo previous studies showing intact morphological processing abilities in individuals with dyslexia (Law et al., 2018; Leikin & Zur Hagit, 2006). As stated in the introduction, these abilities have often been interpreted in terms of a compensatory mechanism (e.g., Burani et al., 2008).

The results reported in Schiff et al. (2019) further explored this possible compensatory mechanism, reflecting the greater reliance on semantic processes in adults with dyslexia as compared with controls. This stronger reliance on semantic processes could be seen as one of the strategies dyslexics use to bypass the challenges in morphological processing (Cavalli et al., 2017; Goodwin et al., 2017; Schiff et al., 2016). It is likely that adult dyslexics rapidly break down words into morphemes and start to compute the meaning of these morphemes. The finding regarding the differences in response times provides support for the concept of "processing load" (Breznitz & Meyler, 2003). The analysis in Schiff et al. (2019) has the added appeal of explaining how relying on semantic information may still constrain and guide nontypically developing morphological processing performance.

Deficient orthographic knowledge, in addition to phonological deficits, is thought to be a hallmark of dyslexia. It may be possible, therefore, to think about different types of root morpheme that vary in complexity. An important distinction can be made between a regular root, in which all letters of the root are present in all derivations, and an irregular root, in which one root letter is missing and causes an irregularity in some of the derivations. Kahta, Poker-Hazan and Schiff (submitted) tested adults with dyslexia on a morphological priming task that included verbs that were derived from defective roots such that the first phoneme of the root is missing in some of the derivations (Ravid, 2019). The study aimed to take the discussion regarding the morphological mental lexicon of readers with dyslexia one step further by violating the three-consonant-root pattern. The results showed a significant priming effect for the defective root condition. The three-letter-root prime facilitated identification of words derived from that root even though they did not share all the letters of the root. This pattern was found in both typically developed readers and readers with dyslexia. Results showed comparable performance of dyslexic and non-dyslexic adults. This finding in the way readers with dyslexia perform on tasks that violate the main pattern of the Semitic root suggest that the auditory representations of morphological roots are intact even when the manifestation of the root is compromised.

6 General Conclusions

The Hebrew mental lexicon has been shown to be organized by morphology rather than by letter sequences; thus, when Hebrew-speakers process words, they automatically seek the root letters (Bick et al., 2011; Bitan et al., 2020). This chapter did not aim to present a comprehensive and detailed theoretical discussion of morphological processing abilities in dyslexia, but rather to review selected studies investigating the performance of Hebrew-speaking, high-achieving adults with dyslexia and skilled adult readers during a visual and auditory morphological primed-lexical decision task. It aimed to describe the condition in which adults with dyslexia use morphological information, and whether they differed from controls in how morpho-semantic and morpho-orthographic information influences this facilitation.

Altogether, the experiments described above suggest a dissociation between the performance of adults with dyslexia in the visual and auditory priming tasks, a finding which may shed light on the locus of the morphological deficit in visual word identification. Overall, this review indicates that the results regarding the morphological representations at the early processing stage of decomposing words into their morphemic constituents among individuals with dyslexia are mixed. It appears that Hebrew-speaking adults diagnosed with dyslexia exhibit normal priming effects when presented with auditory stimuli, but not when presented with visual targets. It is interesting to note that several studies on other languages that have also focused on repetition priming in individuals with dyslexia report a similar dissociation between visual and auditory repetition priming (Carlesimo et al., 1994; Samuelsson et al., 2000; see also Whatmough & Arguin, 1998). Importantly, their intact auditory morphological priming seems to be limited to semantic-based stimuli. As shown above, their stronger reliance on semantic processes could be seen as one of the strategies dyslexics use to bypass the challenges of morphological processing. However, this compensatory mechanism seems to result in a reduction of response time. That is, in comparison to the semantically unrelated condition, targets and primes that shared both semantics and morphology stimulated a faster response among participants with dyslexia.

In sum, that task-dependent characteristics such as modality can affect performance on a morphological priming task is no longer in question (Kimel & Ahissar, 2020). However, exactly how visual and auditory priming may be at least partially separable and independent modality-specific morphological processes is still not completely understood. It is possible that the visual and auditory systems operate competitively, rather than independently of or in cooperation with one another. It is difficult to draw a clear conclusion regarding implicit morphological processes among individuals with dyslexia based on the available information. More studies into the visual and auditory modalities would complement the evidence available and provide greater information about these processes in individuals with dyslexia. Gaining more insights into the idiosyncratic mechanism in which dyslexic readers process morphological input has important implications for more meaningful morphological instruction during the school years. The explicit teaching of morphological rules and methods for the morphological decomposition of words could potentially improve adult dyslexics' morphological awareness, consequently improving their word reading skills.

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The Clinical Profile of Young Children with ASD – Research and Clinic Under One Roof

Esther Dromi and Yonat Rum

Abstract This chapter describes the clinical symptoms typical of children with autism spectrum disorder (ASD). It begins with a short summary of the first clinical descriptions that were published on children with ASD. We then survey a range of behaviors that characterize the clinical profile of young children with ASD as seen today. The topics presented in our review are organized according to the DSM5 definition of ASD as comprised of two domains of difficulty: (a) The social communication domain and (b) the domain of restricted and repetitive behaviors and interests (RRBI). In the first domain, we examine findings on eye contact and visual gaze, emotional engagement, symbolic play abilities, language comprehension and speech production in autistic individuals. At the end of the chapter, we discuss the restricted and repetitive behaviors and interests (RRBI) that is viewed as defining criteria of ASD in the DSM5. Each section presents current research evidence and then provides our perspectives on the clinical implications derived from current research findings.

Keywords Autism · Autistic Spectrum Disorders (ASD) · Restricted and repetitive behaviors and interests (RRBI) · Eye contact · Emotional engagement · Symbolic play · Assessment · Intervention

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This chapter describes the clinical symptoms typical of children with autism spectrum disorder (ASD).[1] Although our understanding of ASD has changed considerably in recent years, the primary deficits it represents were initially described as far back as 80 years ago. The chapter begins with a short summary of the first clinical descriptions that were published on children with ASD. Written by Kanner and Asperger in the early twentieth century, their accurate and sensitive descriptions of the clinical symptoms of autism continue to stun researchers even today, even though we also know today to point where they misinterpreted the causes and the mechanisms underlying these symptoms (Happe & Frith, 2020). We then survey a range of behaviors that characterize the clinical profile of young children with ASD as seen today. In no way can one capture in a single chapter the extremely rich research evidence accumulated on young children with ASD in an infinitely large number of laboratories around the world. The following topics, which have direct implications for assessment and intervention, were selected for inclusion in the present chapter. The topics presented in our review are organized according to the DSM5 definition of ASD as comprised of two domains of difficulty:

(a) The social communication domain and (b) the domain of restricted and repetitive behaviors and interests (RRBI). In the first domain, we examine findings on eye contact and visual gaze, the important aspects of emotional engagement, symbolic play abilities, and finally, we present data on language comprehension and speech production in autistic individuals. At the end of the chapter, we discuss the restricted and repetitive behaviors and interests (RRBI) that constitute important criteria attributes in the DSM5 definition of ASD. Each section presents current research evidence and then provides our perspectives regarding the clinical implications derived from the illuminated research findings.

1 The Earliest Clinical Descriptions of ASD

In the first half of the twentieth century, Kanner (in the US) and Asperger (in Austria) reported unusual children that were treated in their psychiatric clinics (see Asperger, Frith, Translation, 1991; Kanner, 1943). In the articles they published (one written in English and the other in German), they both used clear and vivid language to characterize the children in this group, claiming that despite the substantial differences between patients in each group, they had certain characteristics in common. Both Kanner and Asperger noticed that these children preferred situations in which

[1] Several terms are used in the literature to refer to individuals with a diagnosis of autism. In this chapter we use the term ASD which is used in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5®) of the American Psychiatric Association (2013). We adopt the term *children with ASD* throughout the chapter as it reflects the heterogeneity in the clinical profiles of such individuals; but we recognize that there are individuals from the autistic communities who prefer identity first language (i.e., autistic children) or other terminologies, for example Autism Spectrum Conditions- ASC (see Kenny et al., 2016).

they were alone and not required to interact with others, and thought that these children exhibited a lack of interest in social communication. Kanner and Asperger also described these children as demonstrating a deep, intense interest in objects, having behavioral problems expressed in lack of response to their name being called, and having difficulty learning from examples. The two psychiatrists also identified emotional problems, noting that the children had flat affect with no emotional highs and lows in their tone of voice and few facial expressions, as well as speech that was monotonic with no genuine comprehension of the meaning of the words they used (Asperger, Frith, Translation, 1991; Kanner, 1943).

Interestingly, both Kanner and Asperger stated that the children were all intelligent, although they had difficulty learning. They described a common characteristic for all the children: a powerful desire for aloneness and sameness. Much progress in autism research has taught us that despite this impression of desire for aloneness, these children can take an interest in social relations, and in fact, feel lonely when they have no friends (Bauminger & Kasari, 2000). We also learned that they do possess social abilities and that manifestations of those abilities depend on, among other variables, the social partner with whom they are interacting. Children with ASD show better social skills when they interact with a partner whom they define as “a friend” rather than with a “non-friend” partner (Kimhi & Bauminger-Zviely, 2012), and they demonstrate rich reciprocal social interaction with their siblings (Rum et al., 2021).

Kanner and Asperger also noted that their patients had highly intelligent parents, but the general impression was that very few parents were warmhearted mothers or fathers (Asperger, Frith, Translation, 1991; Kanner, 1943). This impression may have resulted from the social and communicational challenges that are a core characteristic of autism, influencing the dyadic parent-child social interaction. It is important to note that this statement is no longer accepted by researchers or clinicians who study this population. In addition, the clients Kanner and Asperger served belonged to the higher social classes in society, and as to date, the parents who seek help come from various social classes and backgrounds, general awareness about autism is much greater today than it was about 80 years ago.

Asperger linked what he termed “autistic psychopathy” to difficulty in social integration. The children he described were of school age when they arrived at his clinic. For example, his 6-year-old patient Fritz excelled at constructing geometrical figures after a brief glance at the shape, but was unable to answer questions that demanded an understanding of concepts such as synonyms or causality. When tested, he sometimes responded with a meaningless series of sounds that were not words at all. On the other hand, Fritz had exceptional mathematical skills. For example, at that young age, he already understood the concept of negative numbers.

Research evidence on clinical characteristics of young children with ASD reveals that the original descriptions were to some extent representative of what we see today in the clinic. However, there has been much progress in research on the mechanisms, motivations and abilities of individuals with ASD (Dromi, 2018; Happe & Frith, 2020). Thanks to the self-reports of adults with ASD and to research on their lived experiences, we now have more insights into the experiences of individuals with ASD (e.g., Pascal, 2012). There is accumulating evidence leading to the theoretical framing of autism as neurodiversity, i.e., a mind wired differently from the neurotypical mind, thus having different challenges and advantages (Baron-Cohen, 2020; Silberman, 2017). For example, Temple Grandin, a famous autistic scientist and the author of *Thinking in Pictures* (2008), describes her personal experiences to explain how the autistic brain differs from the typical brain. Grandin states that, unlike most people who think in words, she thinks in images or pictures like others with ASD. She refers to three types of autistic 'thinking':

> I have observed that there are three different specialized autistic/Asperger cognitive types. They are: (i) visual thinkers such as I, who are often poor at algebra, (ii) pattern thinkers such as Daniel Tammet, who excel in math and music but may have problems with reading or writing composition; and (iii) verbal specialists who are good at talking and writing but they lack visual skills. (Grandin, 2009).

It is agreed upon today that the group of children with ASD is highly heterogeneous, and hence it is mandatory to evaluate the profile of each child while avoiding dangerous generalizations. In the following sections, we discuss present-day evidence on a set of parameters that attract much scientific attention and directly relate to the assessment of and the intervention with young children with ASD.

2 Focal Areas of difficulty in ASD – Contemporary Views

The most prominent feature of contemporary research on ASD is tied to the revolutionary publication of the DSM-5 in 2013 (American Psychiatric Association; APA, 2013), in which ASD is presented as a condition related to deficiencies in two domains: A. Social Communication and Interaction; and B. Restricted and Repetitive Behaviors and Interests (RRBI). In recent years, scientists in the field of autism research have focused on gaining a deeper understanding of specific areas of difficulty in each of these two defining domains of ASD. What follows is a summary of the latest findings published on these topics.

2.1 Social Communication and Interaction

2.1.1 Eye Contact and Atypical Gaze Behaviors

Many individuals with ASD report that looking at another person's face or eyes makes them uncomfortable and prevents them from concentrating on what is being said (Cook et al., 2021; Pascal, 2012). For example, Temple Grandin explains that, like many others on the spectrum, eye contact poses a major challenge for her. She contends that just as it is difficult for neurotypicals (i.e., individuals with typical brain development and function) to hold a conversation with someone without eye contact, it is difficult for a person with ASD to maintain eye contact when conversing (Grandin & Panek, 2013; Grandin, 2008, 2009).

Numerous studies have been conducted on the difficulty of initiating, responding to and sustaining eye contact and atypical gaze behavior among individuals with ASD at various ages and different levels of functioning. Early experimental studies by Ami Klin revealed gaze patterns among children with ASD that differed substantially from those of typically developing (TD) children (Klin et al., 2015). A series of studies showed that even when a child with ASD and a TD child appear to be playing together, their gaze behaviors are so different that each participant may be experiencing the same situation in a different way, and hence their brains may be receiving different stimuli: while TD children will tend to focus on a social focus in the face of a partner (i.e., the eyes and the mouth), children with ASD tend to focus on different details, for example, a door handle that is being open and closed during the interaction (Shultz et al., 2015). In their sibling studies on gaze behaviors in very young infants, Jones and Klin (2013) found that from 2 to 6 months of age, babies later diagnosed with ASD gradually reduced the length of time they looked in the eyes of other people and displayed a preference to focus on the lip movements of an examiner. Moreover, they found that the difference in gaze behaviors between siblings who later on were diagnosed with ASD and those who did not receive a diagnosis of ASD gradually increased to the age of 3. Jones and Klin concluded that visual behavior in the first 2 months of life is reflexive, while after 2 months, looking at someone's eyes is motivated by higher cognitive processes. It is the degree of pleasure that infants derive from social interactions and their desire to interact with adults that drive them to seek eye contact and respond to it or maintain it for any length of time. This intriguing theoretical proposition may explain the early source of the visual difficulties in children and adults with ASD.

In a study conducted in Israel, Meital Pascal (2012) conducted a narrative analysis of virtual written conversations among people with ASD that took place in the net over the course of a year. She did not participate in the conversations, and recorded them only with the permission of the participants. Regarding eye gaze, she found that adults with ASD often complained about the discomfort caused by having to look someone in the eye, noting the difficulty of following the conversation while maintaining eye contact. Below is an excerpt from one of the posts she analyzed:

> A person with a typical brain structure receives messages better when they are conveyed by more than one channel simultaneously (for example, a visual channel or an auditory channel). That's why eye contact isn't such an obsession. Eye contact enables the NT [neurotypicals, E.D.] to raise their level of attentiveness by using the auditory channel (hearing the person they are talking to) and using the visual channel (looking at the person's face) at the same time. The thing is that with us, when we have to make eye contact, it overloads our reception channels and thereby reduces our ability to attend to what we hear.

Similarly, a participant in a recent British study (Cook et al., 2021), in which autistic individuals were filmed interacting with NT individuals, describes his experience:

> I do make eye contact with people but you can see it is reduced here because, and that is generally where it is reduced, I tend to look away because I've got to think about what I'm thinking about and trying to look at someone at the same time is an extra burden.

*** Clinical Implications**

Such self-reports by individuals with ASD lead to the conclusion that intervention aiming to reinforce eye contact in children with ASD might interfere with ongoing processing of social as well as auditory input and might be exhausting and demanding. On the other hand, lack of eye contact might be considered as interference for communication on the part of the neurotypical social partner, such as a parent, a sibling, a teacher or a peer. It is recommended not to encourage children with ASD to initiate, respond or sustain eye contact if doing so damages their social interaction or their wellbeing. At the same time, it is recommended to educate the social environment of these children on this particular characteristic of ASD, and help children to develop tools of self-advocating for their preference not to continuously use eye contact during social interaction.

2.1.2 Emotional Engagement in Dyadic and Triadic Adult-Child Interactions

From the moment of birth, an emotional bond is formed between the infant and the adult caregiver. This bond, to which both partners (i.e., the adult and the infant) contribute, is regarded as the most essential prerequisite for the emergence of mutual processes that later on fuel development and learning. In the second year of life, collaborative play that involves the adult, the child and an external object of mutual interest considerably enhance learning within the context of this joint engagement (Adamson et al., 2019; Dromi, 2018; Dromi et al., 2018).

It is difficult for parents to create effective mutual emotional interactions with an infant or a toddler who cannot respond to social and emotional signals and does not initiate such signals themselves. Over time, this difficulty leads to a noticeable decline in the emotional bond and the frequency of engagement episodes that take place between the caretaker and the child with ASD. It has been argued that the reduction in mutual emotional engagement during the first 2 years of life diverts the child from the main road of typical development, sending them off onto an atypical track of development (Greenspan et al., 1998). In other words, the significant developmental delays displayed by young children with ASD cannot be attributed solely to their innate organic deficits but may also be strongly tied to a deficiency in social-emotional experiences with adult caregivers.

Children with ASD, in almost all cases, show low levels of emotional collaboration with adults and with peers. Many children present a flat emotional tone and very little reference to their partner's responses during dyadic or triadic interactions. This also involves a lack of social referencing for achieving reinforcement from others in the room.

*** Clinical Implications**

An important goal in early intervention with young children with ASD is to increase and support interactive experiences that enhance and increase emotional engagement levels. When the children enjoy the activities with their clinicians, parents and teachers, the quality of interactions increase, and their length expand. This observation is a core notion behind the design of several early intervention programs that highlight the importance of naturalistic-developmental intervention (NDI) programs in which interactional training procedures are utilized (Dawson et al., 2010; Dromi, 2018; Schreibman et al., 2015). We recommend that clinicians and parents be encouraged to foster and prompt emotional engagement with the child as a means for enhancing development and learning within collaborative interactions and activities.

2.1.3 Symbolic Play in Young Children with ASD

Difficulties in mentalization is a core characteristic in ASD (Frith, 2003). Children with ASD show considerable delays in acquiring early emerging gestures such as ‘bye bye’ and ‘give me’. They tend not to take part in cultural games that involve hand movements. They also exhibit considerable delays in developing symbolic play and can barely participate in games involving imagination (Dromi, 2018). As in other developmental areas, there is considerable variation among these children, but many display an obvious preference for activities that do not require symbolization, choosing instead to explore the mechanical features of an object or its parts (Greenberg et al., 2018). For instance, a child might spend hours arranging toy cars in straight lines according to their colors, or playing with the wheels of a toy car, spinning it again and again and unwilling to participate in playful collaborative activity with an underlying script such as ‘taking an injured doll to the hospital following a car accident’. Some high functioning children with ASD tend to show solitary pretend play, and for some of them, imaginative play becomes a preferred mode of expression, as they find it difficult to distinguish between imagination and reality (Dromi, 2018). Research has found a link between the delayed development of symbolic abilities on the one hand and language and speech acquisition on the other, which may explain the considerable interest in the study of symbolic representation in children with ASD (Happe & Frith, 2020).

*** Clinical Implications**

Working with young children with ASD always involves the construction of contexts for elevating and enhancing symbolic play. A key concept in this target area is to present elaborations to the child’s ideas, demonstrate creativity, and turn routines into productive and imaginative play scenarios. Collaborative symbolic play settings increase the feasibility of using communicative discourse with the child while presenting a model for learning new linguistic forms and structures.

2.1.4 The Development and Use of Language in Comprehension and in Production

Language abilities in ASD may range from no or minimal speech to a full range of linguistic competency in comprehension, production, and even literacy (Dromi et al., 2018). According to current estimates, 15–20% of individuals with ASD fail to learn even single words for communication purposes, while approximately 50% obtain complex, expressive skills by adolescence, and the remainder attains fluent and functional speech (Luyster & Lord, 2009). While phonology and syntax are generally viewed as less affected in ASD, semantics and pragmatics are areas of salient difficulty. The use of language in context, which includes both conversational skills as well as narrative abilities, is the core deficit in ASD. It is one which is noted even in individuals who acquire functional speech (Losh & Gordon, 2014), and which persists in a subtle way even in individuals with "optimal outcome" (Suh et al., 2014). The prognosis of children with ASD with respect to educational, adaptive, and emotional outcomes is closely linked to their linguistic abilities during the preschool years (Kuhl et al., 2013; Norbury, 2013).

It should be noted that over the last decade, it has often been argued that not all children with ASD will experience delays in language learning. Thus, it has been suggested by some researchers to view ASD and SLI (Specific Language Impairment) or DLD (Developmental Language Disorders), as comorbid conditions. Kjelgaard and Tager-Flusberg (2001) were the first who argued for the need to differentiate between autistic children with language impairment (ALI) and autistic children with normal language (ALN) whose scores are within the typical range on formal language tests (Loucas et al., 2008; Tomblin, 2011). Children who belong to the second group often do not show difficulties during the early stages of language learning.

Typically developing (TD) children, Late Talkers, and children with other developmental disorders usually show better comprehension abilities than production skills. As a group, young children with ASD are more likely to display weakness in comprehension even relative to their productive skills (Dromi et al., 2021).

Davidson and Weismer (2017) examined the hypothesis that the discrepancy between comprehension and production can be used as a clinical marker of ASD. They reported that between the ages of 24–30 months, 91% of participants in their experimental ASD group exhibited weakness in comprehension relative to their production scores, whereas none of the children in the two comparison groups of typically developing children or children with developmental language disorders displayed such discrepancy. Based on these results, the authors concluded that lower comprehension than production might be an age-specific marker of ASD with high sensitivity and very high specificity.

The difficulties in processing linguistic input explain why individuals with ASD lean on rote learning, use echolalia, and often reverse pronouns when they speak. Children with ASD compensate for their difficulty of internalizing grammatical rules by reciting what they hear. In the clinic, it is common to hear individuals with

ASD who produce memorized sets of words and sentences from television shows or books that they do not fully comprehend (Dromi, 2018).

An apparent characteristic of children with ASD is their noticeable delay in the onset of speech as well as variations in the content of early lexicons and the extending of word meanings (Dromi, 2018). Oren (2017) examined the age at which TD Israeli children and a comparison group of children with ASD reached productive lexicons of 40–70 different words in Hebrew. The growth rate of the lexicon in production was measured by the Hebrew Communicative Development Inventory (H-MB-CDI) (Gendler-Shalev & Dromi, 2021) at three time points: 2 months, and 4 months after reaching the 40–70 words criterion. In comparison with the TD toddlers who reached the first measurement point at an average age of 17 months, children with ASD exhibited a significant delay, and they reached the same measurement point at an average age of 28 months. Moreover, among the group with ASD, the variability at the age of speech onset was 10 times larger than in the TD group. Eighty-seven percent of the TD toddlers already possessed an expressive lexicon of 40–70 words by the age of 18 months, while none of the toddlers from the ASD group achieved this criterion before the chronological age of 20 months. It is interesting to note that following this lexical achievement, children in both groups had remarkably similar growth curves for accumulating additional words (Oren et al., 2021).

Rescorla and Safyer (2013) analyzed in detail the first words that TD toddlers and toddlers with ASD were reported by their parents to have acquired. Vocabulary composition of the first 100 words was remarkably similar between the TD and ASD groups, consisting mostly of labels for food, body parts, and people. However, vocabulary composition of lexicons greater than 100 words began to differ by group, with children with ASD producing fewer words for actions and household items.

The extension of new words beyond a single exemplar, a single context or a single time and place requires symbolic representational abilities that enable thinking about categories and not only about single objects, specific events, and particular relationships (Shteiman & Dromi, 2007). Results on word learning by children with ASD provide unique evidence for qualitative differences in linking words with the categories of their underlying meanings (Norbury et al., 2010; Dromi, 2018). Children with ASD often learn new words in a given context and do not detach them from this context. Thus, for example, a child can learn to name a specific ball 'a ball', but will not extend the word to referents of other balls in different sizes or colors. Another example would be that a child recognizes a picture of a dog in a book, but is unable to label real dogs. Irregular use of words that signify idiosyncratic, non-conventional meanings by individuals with ASD is also common. Even adults with ASD report their tendency to utter words with unusual connotations. Some participants with ASD self-reported that they enjoy using non-existing words or even "gibberish" sounds in conversations or when they speak for self-play (Dromi, 2018).

School-age children with ASD face semantic difficulties that impact their understanding of written texts. For example, McGregor et al. (2012) found that picture naming, definitions, and word associations were much more sensitive indicators of lexical learning in school-age autistic children than tests of lexical comprehension.

*** Clinical Implications**

The main two areas that are vulnerable in children with ASD are semantics and pragmatics. Therefore, language intervention programs should focus on training word extension, underlying semantic features, generalization of meaning, and using language in different contexts and for different functional purposes. It is recommended to teach new linguistic forms and structures in naturalistic contexts to avoid rote learning and citation from memory. While choosing targets for language intervention, it is important to consider the natural course of language development by typically developing children and match the program goals with the current developmental stage of the child with ASD. Collaboration between adults, who are experts in language, with young children (who are still novices) will enhance language learning by young children with ASD.

2.1.5 Speech Intelligibility – Pitch, Voicing and Intonation in ASD

Paul (2010) described the unique speech characteristics of children with ASD. She stated that atypical speech patterns often call unwanted attention to a speaker with ASD and contribute to low speech intelligibility. Children with ASD use flat intonation, often described as "strange", "excessive", or "robotic" (Green & Tobin, 2009; Naigles & Chin, 2017).

In a most ambitious attempt to characterize the speech characteristics of individuals with ASD, Parish-Morris et al. (2016) generated a Linguistic Data Consortium to analyze audio recordings of more than 1200 toddlers with ASD during their Autism Diagnostic Observation Schedule (ADOS) video assessments. One hundred language samples were analyzed in a computerized fashion to identify the specific speech markers for ASD. The following characteristics were found: individuals with ASD use a limited vocabulary in comparison with participants without ASD, they tend to often use filler words such as "um" and "uh", and they exhibit more instances of disfluency. In addition, their rate of speech is slower than expected for linguistic age, they wait longer before responding during the course of a conversation, their prosody (intonation and rate) is deviant, and their fundamental frequency is higher and more variable than in neurotypicals or children with other developmental disorders (Parish-Morris et al., 2016).

Non-comprehensible speech productions are noted by parents and clinicians of children with ASD, who report instances in which the child cannot be heard and often talks to self without addressing their listeners. This behavior might represent speech productions uttered by the child as a means of self-stimulation or simply self-play (Dromi, 2018). Speech productions that serve sensory stimulation often have characteristics of "gibberish", and it is impossible to describe or imitate them. When asked to complete complex learning or motor tasks, some individuals with

ASD produce sounds, words, and even sentences for self-regulation. This happens mainly in individuals who have established grammar and utilize speech as means of scaffolding their own behaviors (Shteiman & Dromi, 2007). We are not aware of research that addressed the acoustics or linguistic structures of such speech productions.

*** Clinical Implications**
During assessments as well as during therapy sessions, clinicians should pay attention to the speech characteristics of children with ASD. It is useful to highlight the communicative value of comprehensible speech and to encourage children with ASD to make sure that their statements and requests are heard and understood by the listeners. Many intervention programs focus on training individuals with ASD to become aware of the prosodic and pragmatic aspects of verbal expressions. It is important to help the child to pay more attention to the impact of his words and sentences on his social partners.

2.2 Restricted and Repetitive Behaviors and Interests (RRBI)

Children with ASD display a tendency to engage in repetitive activities and routinized behaviors. In the DSM-5 this tendency is regarded as a criterial attribute of autism, which is associated with high sensitivity or weakness in the domain of sensory regulation of external stimuli and a strong inner motivation to ignore external stimuli and attend to internal signals. Bishop and her colleagues proposed to divide the category of RRBI into two subcategories: (1) repetitive sensory and motor behaviors, including motor mannerisms, sensory-seeking behaviors, repetitive use of objects; and (2) seeking sameness and identity, expressed in the memorization and repetition of verbal texts, unusual attachment to certain rituals or specific objects, and resistance to change (Bishop et al., 2013). These authors defined six subcategories of sensory and motor irregularities observed in ASD: (1) stereotypy; (2) compulsive behaviors; (3) ritualistic behaviors; (4) insisting on sameness; (5) self-injury; and (6) restricted interest or activity.

Unlike other features of ASD that are allied with the child's age or level of cognitive functioning, no link has been found between RRBI and the severity of autism. This is particularly true regarding the search for sameness, which has not been found to correlate in any way with cognitive functioning (Bishop et al., 2013).

When people on the spectrum describe themselves, they devote considerable attention to their sensory experiences, which are very different from that of neurotypical individuals. Temple Grandin, for example, relates to the fact that over the years, she learned to hide her idiosyncratic sensory needs. A feature film produced about her life (*Temple Grandin*, 2010) reveals how she sees, hears, and feels the world through her senses.

In Pascal's (2012) study, she cites a post by a woman with ASD:

> I also walk in circles. Sometimes when I'm walking with other people, they go straight while I walk in circles around them. It might have something to do with the way some of us sense the world as the constant movement of the perspective of vision. I, for one, perceive every object or concept from all sides at once, which may also explain why circular motion connects things in a way that makes it easier to deal with the sensory overload.

*** Clinical Implications**

There is a difference of opinion regarding the manner in which sensory behaviors that attract the attention of others should be handled by clinicians, parents and teachers. The behavioral approach (Applied Behavior Analysis; ABA) argues for the need to eliminate or dramatically reduce occurrences of such challenging behaviors. The relational approach (Developmental, Individual Difference, Relationship-Based model; DIR) advocates the need to attune to and to join in the child's repetitive activities and to respond to the need for sameness even when it may seem meaningless for the observer. The naturalistic developmental approach (Naturalistic-Developmental intervention; NDI) contends that the child's need for repetitive behaviors, the child's desire for sameness and engagement in specific topics of interests should be respected while at the same time clinicians, teachers and parents may try and modify RRBIs into more broad or flexible and conventional patterns of behavior.

3 Concluding Thoughts

The most important generalization from the review of research on young children with ASD is the great variability in this population on the one hand, and the similarity among cases on the other hand. It should be remembered that within-group heterogeneity is the rule rather than the exception in this population. Each child with ASD presents a unique clinical profile. As this chapter shows, however, the present day understanding of common characteristics of this population is growing and does lead to important clinical implications. Clinicians, parents and teachers ought to gain as much knowledge as possible about ASD in order to be able to best characterize the profile of the specific child. Understanding the big picture may promote the selection of appropriate targets for early intervention, which is proven to be highly efficient when applied intensively and consistently early in life (e.g., Dromi, 2018; Dawson et al., 2010).

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Part VI
Hebrew Linguistics

On the Role of Suffixes in the Formation of Hebrew Nouns and Adjectives

Shmuel Bolozky

Abstract Optimal derivation processes are those that maintain the source of the derivation process as transparently as possible. The most transparent are linear derivations, and in particular those that involve suffixes, because both stem (whose syllabic structure is normally not affected by the derivation process) and the suffix, which in itself is prominent, transparent and fixed, maintain one-to-one correspondence between the "underlying structure" and the structure of the derivation output. We will show here that productive derivation of nouns and adjectives in Hebrew very often involves patterns with suffixes, often in linear derivation. We will go over the major semantic categories at the base of such derivations, classified by register, and show that although linear derivation is getting stronger, particularly in the middle and colloquial registers, discontinuous derivation is "alive and well," and that in many instances, linearly derived patterns with suffixes simultaneously incorporate a significant number of sub-classes of items that can also be regarded as discontinuous *miškalim* (noun and adjective formation patterns), and that the combination of linear derivation with discontinuous sub-patterns make the process of decoding even easier to process. Thus, insofar as the listener/reader is concerned, the derivation source is more transparent, and the syntactic information encoded in discontinuous Hebrew patterns is not a hinderance, but actually helpful.

Keywords Israeli Hebrew · Morphology · Word formation · Linear derivation · Discontinuous derivation · Suffixes · Derivational transparency · Productivity in word formation

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1 Introduction

The chapter will start with a definition of productivity in word-formation, specify the sources of data on which the research reported here is based, outline the three major criteria used by the author to determine relative productivity (dictionary comparison, productivity tests – both open and choice ones – and counting *hapax legomena* in large language corpora), and present the statistics for each major derivation pattern, whether discontinuous or linear, separated by register: High, Mid or Colloquial (Slang included). Based on the author's data, a table of pattern productivity is then proposed, followed by a table of overall pattern productivity rating across semantic categories. A more detailed discussion of each of the major categories follows, from adjectives and nominalizations, in which patterns with suffixes, +*i* and + *ut*, respectively, are the most productive (within the category, as well as generally in the language), through agents/agentive adjectives (where the suffix +*an* is very productive, as it is for instruments as well), locatives (including the productive suffix +*iya*) and diminutives (in which the suffix +*on* is the most productive). Linear as well discontinuous derivation patterns are discussed. The advantages of linear suffixation are considered, particularly maximal transparency, of the suffix itself and the (usually) unaffected stem as well, but although linear derivation is becoming commoner, discontinuous derivation, the hallmark of Semitic languages, remains productive as well. Finally, it is shown that in a significant number of cases, simultaneous interpretation of many forms as either linearly or discontinuously derived is possible, which the author argues functions to enhance their transparency.

Consciously or sub-consciously, every Israeli speaker of Hebrew is a potential neologizer, and one of the interesting questions raised by those who describe and analyze Hebrew morphology is how speakers choose word-formation patterns when they innovate, and what are the most productive patterns in each category. What is productivity?

One can define the productivity of a particular word-formation pattern as the statistical probability that a speaker would prefer one pattern over others in forming a new word to express some defined meaning (cf. Baayen & Renouf, 1996, following Bolinger, 1948). We are talking about spontaneous innovation by the average speaker – not just by erudite ones or by members of the Hebrew Language Academy. Bolozky (1999) suggests three criteria for measuring natural, spontaneous productivity of word formation: productivity tests on subjects, open ones as well choice from a number of alternatives offered; identifying lexical items in a new dictionary that were not listed in an older one (including slang dictionaries), or in a supplement to a dictionary, that are not found in the dictionary itself (the assumption being that most, though obviously not all, added items are neologisms); and counting *hapax legomena* in large language corpora, assuming that in a large enough corpus, even rare words will be repeated at some point, whereas items that occur only once represent true spontaneous creativity by individuals who form them in situations where an immediate neologism is called for. Thus, for instance, Baayen and Renouf (1996) claim (based on a large British corpus) that spontaneous innovation points to the adverbial pattern … + ly in English being more productive even than the nominal pattern … + ness, demonstrated by one-time occurrences of innovative adverbial forms like "headmistressly," and in Hebrew (Shlesinger, 2001) by (*sar*) *bli-tik* '(minister) without portfolio' > *blitikiyut* '(minister) being without portfolio,' ?*folkist* < *folkisti* 'folksy,' and by the first occurrence of *korban* 'victim' > *hitkarben* 'claim to be a victim' > *hitkarbenut* 'claiming to be a victim' observed by Bolozky in 2000 before the innovation caught on (unfortunately, no precise reference).

The research reported on in Bolozky (1999) was based on productivity tests conducted by Bolozky at the time, on data bases he constructed with data drawn from the most comprehensive, commonly used Even-Shoshan dictionary and its supplements, as well as the primary slang dictionaries available at the time, Ben-Amotz and Ben-Yehuda (1972, 1982) and Axi'asaf et al. (1993), as well as a limited corpus compiled by Bolozky. Since then, a newer Even-Shoshan edition came out, in 2003, Choueka's *Rav-Milim* (1997), and Ruvik Rosenthal's *Milon ha-Sleng hamakif* (The comprehensive Slang Dictionary) in 2005, and much larger corpora recently became available. Data from Choueka's *Rav-Milim* were later added to those that served as a base for Bolozky (1999), for the purpose of this research, but for pragmatic reasons it was not possible to sort out and incorporate the corrections/additions in Even-Shoshan (2003), nor those of Rosenthal (2005).

Although Bolozky (1999) introduced data from all registers (the colloquial register as well as slang entries), no systematic separation was made at the time according to register. Language register is a sociolinguistic term that usually refers to the degree of formality characterizing it, depending on settings and circumstances, and on what can be regarded as acceptable or "grammatical" in a particular sociolinguistic setting. In this sense, there can be a whole spectrum of registers, but pragmatically, one tends to distinguish between (a) a high register, which is appropriate for formal circumstances, and which follows rather strict norms of acceptability and "grammaticalness" at one end of the spectrum, and (b) a casual/informal register at the other end, which is the normal colloquial variant in everyday speech. (b) includes slang usage (slang is typically restricted to a particular context or group of people, who prefer its own creative vocabulary or expressions over those of the standard language, in order to establish group identity, and/or exclude outsiders.) Since the register spectrum can be wide, and thus not that easy to characterize in all its varieties, one can also opt for (c) a "middle" register, which contains items that may be acceptable in both the high and the colloquial register. Thus, the research reported here distinguishes three registers: High, Middle, and Colloquial/Casual/Slang. One should bear in mind, though, that each register, regardless of whether there are three as decided in this case, or any other number, is not to be regarded as less acceptable or "less grammatical" than the next. Each register is legitimate and acceptable on its own, based on pre-determined criteria. In particular, it should be emphasized that the high register and its normative criteria do not determine *per se* whether other registers are grammatical or not, even if in Hebrew, for instance, other registers appear to violate the normative standards of the Hebrew Language Academy. The Academy standards follow the norms of the high register, whereas the colloquial and middle registers follow other standards. For instance, it may be decided by consensus that the middle register or the colloquial norms are what any speaker of Hebrew with, say, high school education will agree is grammatically acceptable.

The claim made here is that although discontinuous derivation remains productive in Israeli Hebrew, linear (or mostly linear) derivation with suffixes has been getting stronger than it had been in earlier phases of the language – see also Schwarzwald (2001, 2006), Schwarzwald and Gross (2000). Most phonological changes start in the colloquial, and with time tend to be accepted in the middle and high registers; the question is whether this is also the case in word-formation, i.e., whether the role of linearly derived forms with suffixes in spontaneous neologisms is getting stronger in the colloquial at the expense of discontinuous derivation in the higher registers. We will start with some statistics, and later provide a tiny bit of the rich relevant data. Note that the total of percentages for each category are often less than 100%, either because the number of realizations of some patterns were so low that they were not included here, or because in open productivity tests, the forms suggested did not make any sense, or because some patterns simply did not show up in the corpus. Note: in productivity test data, the percentages for a pattern selected in choice tasks will follow those of comparable open tests, to save space – unless the preferred categories differ. (C) in the pattern template suggests the option of another consonant (or two). Abbreviations: Categ. = Category, Criter. = Criterion, Reg./Typ = Register/Type, Dict. = Dictionaries, Mid. = Middle, Coll. =Colloquial, Prod. = Productivity Tests, Open/Ch. = Open/Choice, Adj. = Adjectives, Nom. = Nominalizations, Agent. = Agents/Agentive Adjectives, Instr. = Instruments, Dimin. = Diminutives, Redup. = Reduplication, N = Noun, V = Verb (Table 1).

As will be explained in more detail below, one could also present a combined agents/instruments category, to reflect the tendency among non-normativist speakers to combine them into a single "performer of the action" category. But it will make the large table above too cumbersome.

It is common knowledge that a hallmark of word formation in Semitic languages is discontinuous word formation: fixed patterns of consonant-vowel configurations, plus affixes when required, in which non-concatenative consonant sequences (representing consonantal "roots" which often share some basic semantic content) are "inter-digitated," similarly to what happens in small groups of English "strong" verbs, e.g., SiNG-SaNG-SuNG, DRiNK-DRaNK-DRuNK, SiNK-SaNK-SuNK (Bolozky (1999). In the verb system it has always been the only *bona fide* mechanism, and in Hebrew referred to as *binyanim*; in nouns and adjectives, they are traditionally referred to as *miškalim*. At the same time, linear affixation (of prefixes or suffixes), as in most European languages, has also co-existed alongside discontinuous derivation in the noun/adjective system. Although both types of mechanism are productive in the language (see Berman, 1987, Bolozky & Schwarzwald, 1992, Bolozky, 1999, and elsewhere), linear derivation, which does not affect the structure of the derivation base (except for some predictable phonetic changes) has been on the increase for quite a while, in particular derivations that involve suffixes. Except for instruments in dictionary comparison and for locations in the high register in dictionary comparison, the most productive pattern in each category includes a

Table 1 Productivity order of patterns by category, criteria and register

Categ.	Criter.	Reg./Typ	Pattern	Illustration	Gloss	%
Adj.	Dict.	High	*+i*	*zgugiti*	glazed, glassy	86%
			meCuC(C)aC	*mevuzar*	decentralized	7%
			CaCiC	*hamir*	convertible	3%
		Mid.	*+i*	*'optimísti*	optimistic	93%
			meCuC(C)aC	*memuxšav*	computerized	4%
			meCaC(C)eC	*metaskel*	frustrating	1%
		Coll.	*+i*	*dósi*	orthodox	43%
			meCuC(C)aC	*mexurfan*	crazy	29%
			CaCuC	*šavuz*	devastated	2%
	Prod.	Open/Ch.	*+i*	*búldogi*	bulldog-like	51% [53%]
			meCuC(C)aC	*mexukan*	given enema	36% [37%]
			muCCaC	*mugral*	done on grill	3% [3%]
	Corpus		*+i*	*`atidi*	of the future	48%
			meCuC(C)aC	*memugan*	protected, shielded	19%
			CaCiC	*šafir*	not malignant	4%.
Nom.	Dict.	High	*+ut*	*partanut*	being detailed	49%
			CiC(C)uC	*hidud*	interaction	29%
			haCCaCa	*hadmaya*	simulation	9%
		Mid.	*+ut*	*yazamut*	entrepreneurship	78%
			CiC(C)uC	*šidrug*	upgrading	12%
			+izm	*kolonyalízm*	colonialism	8%
		Coll.	*+ut*	*hitxardut*	becoming orthodox	50%
			CiC(C)uC	*fintuz*	fantasizing	43%
			+izm	*sipuxízm*	belief in annexation	4%
	Prod.	Open/Ch.	*+ut*	*mazi`ut*	sweating	51% [59%]
			CiC(C)uC	*šnirkul*	diving with a snorkel	31% [29%]
			haCCaCa	*hašrafa*	making one sheriff	10% [7%]
	Corpus		*+ut*	*'íniyut*	being fashionable	35%
			CiC(C)uC	*divšuš*	pedaling	31%
			haCCaCa	*haklada*	entering on keyboard	14%
Agent.	Dict.	High	*+an/CaCCan*	*minhalan*	administrator	59%
			+ay/a'i	*kisay*	marsupial	32%
			CaCaC	*xavat*	one connecting wires	1%
		Mid.	*+an/CaCCan*	*taklitan*	DJ	33%
			meCaC(C)eC	*metargel*	tutor	25%
			+ay/a'i	*plastikay/a'i*	plastic surgeon	16%
		Coll.	*+an/CaCCan*	*mamci'an*	inventor; innovator	39%
			+ist	*balaganist*	disorderly person	27%
			+er/oner	*'ugdoner*	division commander	12%
	Prod.	Open/Ch.	*+ay/a'i*	*bastay/ta'i*	stall vendor	22% [37%]
			+an/CaCCan	*čarteran*	charter organizer	21% [31%]
			+ist	*šrimpist*	shrimp fisherman	14% [8%]

(continued)

Table 1 (continued)

Categ.	Criter.	Reg./Typ	Pattern	Illustration	Gloss	%
	Corpus		*+an/CaCCan*	*macxikan*	comedian	28%
			meCaC(C)eC	*mexasel*	annihilator	18%
			maCCiC	*maflig*	extreme	16%
Instr.	Dict.	High	*maCCeC*	*mavzek*	camera flash	42%
			maCCeCa	*magzera*	paper cutter	23%
			+an/CaCCan	*'afnan*	modulator	18%
		Mid.	*CaCaC*	*šalat*	remote control	21%
			meCaC(C)eC	*medalel*	thinner	21%
			+on	*'ašpaton*	dumpster	14%
		Coll.	*insuff. occur.*			
	Prod.	Open	*+iya*	*kuskusiya*	couscous maker	24%
			meCaC(C)eC	*mexames*	hummus maker	16%
			maCCeC	*maktej*	cottage cheese maker	14%
		Choice	*+iya*	*kotejiya*	cottage cheese maker	15%
			+an/CaCCan	*kuskusan*	couscous maker	14%
			meCaC(C)eC	*mexames*	hummus maker	14%
	Corpus		*+an/CaCCan*	*kolfan*	peeler	20%
			+on	*mešivon*	answering machine	20%
Loc.	Dict.	High	*miCCaCa*	*misla`a*	rockery (gardening)	56%
			miCCaC	*mivrac*	spillway	28%
			+iya	*šravraviya*	plumber's shop	17%
		Mid.	*+iya*	*kalbiya*	kennel	86%
			miCCaCa	*misrafa*	incinerator	7%
			miCCaC	*minsa'*	carrier	7%
		Coll.	*+iya*	*steykiya*	steak house	44%
			+iyáda	*trempiyáda*	hitchhiking stop	33%
			miCCaCa	*mizlala*	fast food restaurant	11%
	Prod.	Open/Ch.	*+iya*	*nagmašiya*	APC repair shop	64% [74]
			maCCeCa	*maxtela*	diaper factory	5% [6%]
			miCCaCa	*mixtala*	diaper factory	3% [6%]
	Corpus		*insuff. occur.*			
Dimin.	Dict.	High	*+on/ónet*	*ptilon*	felt-tipped pen	56%
			redupl.	*'avanban*	small stone	35%
			+it	*gonit*	nuance	9%
		Mid.	*+on/ónet*	*xavilónet*	small package	66%
			+it	*dugmit*	sample	31%
			redupl.	*gvarvar*	young man (derog.)	3%
		Coll.	*+čik*	*baxúrčik*	young man (affect.)	57%
			+on/ónet	*pargiyónet*	young inexp. woman	29%
			+íko	*xayalíko*	young soldier (affec.)	14%
	Prod.	Open/Ch.	*+on/ónet*	*mexdalon*	minor negligence act	67% [76%]
			+it	*xataltulit*	tiny cat	5% [11%]

(continued)

Table 1 (continued)

Categ.	Criter.	Reg./Typ	Pattern	Illustration	Gloss	%
			+čik	*gagónčik*	tiny roof/awning	5% [8%]
	Corpus		*+on/ónet*	*'omleton*	small omelette	33%
			+it	*xataltulit*	tiny cat	27%

Table 2 Overall pattern productivity rating across semantic categories

Rank	Pattern	Illustration	Gloss
1	*+i*	*'adrixali*	architectural
2	*+ut*	*mecuyanut*	excellence
3	*CiC(C)uC*	*mixzur*	recycling
4	*meCu(C)CaC*	*mekutav*	polarized
5	*+an/CaCCan*	*te'uran*	lighting operator
6	*meCaC(C)eC*	*metadlek*	gas station attendant
7	*haCCaCa*	*haklada*	typing on keyboard
8	*+on*	*'arnavon*	small rabbit
9	*+ay/+a'i*	*maškonay/na'i*	pawnbroker
10	*CaCiC*	*šafit*	that can be evaluated

suffix – generally in linear derivation, but not necessarily. Except for adjectives and nominalizations, in which *+i* and + *ut* dominate **all** categories, including productivity tests, the preference for patterns with suffixes stands out in the colloquial and to some extent in the middle register as well. In the higher registers there still appears to be preference for the characteristically Semitic discontinuous derivation patterns. Usually there is a tendency for natural changes to begin at the colloquial and middle registers (see, for instance, Dressler, 1975, Zwicky, 1972), until they take some hold in the high register, which tends to be more conservative, and one can already see some signs of it in increasing use in the high register of *+an* and of *+ay/+a'i* for agents instead of *CaCaC*, and in preference for *+on/+ónet* for diminution instead of reduplication. As will be shown below, however, discontinuous derivation is "alive and well," and there are significant groups of items where the two modes of derivation, linear and discontinuous, support each other and increase derivational transparency.

Based on these statistics and on the relative weights of the various categories, Bolozky (1999) suggests the following hierarchy of the first ten most productive patterns in the formation of new nouns and adjectives in Israeli Hebrew, **across semantic categories**. The hierarchy relies on dictionary comparison and corpus data only, since in productivity tests, subjects **had** to be presented with target meanings, so test data were excluded when looking for preferences across semantic categories. Representative illustrations were taken from the Middle register as reflected in dictionary comparison (Table 2):

Out of the ten patterns in the hierarchy, seven involve suffixes, and of those one is discontinuous, *haCCaCa*. The six patterns with suffixes may in some instances be discontinuous, e.g., most cases of *CaCCan*,[1] but the (mostly) linearly-derived patterns with suffixes, particularly +*i* and + *ut* at the top, are dominant. Even when discounting cases that could be argued to be marginally-linear, e.g., *hitCaCeC* > *hitCaCCut* owing to the required *e*-deletion no longer constituting an automatic phonetic process, linear derivation in these two patterns with +*i* and + *ut* is still the most productive. The relatively high productivity of the discontinuous *CiC(C)uC* is due to its being the default nominalization of *pi'el*, the most productive verb pattern for the huge class of agentive verbs, including causatives (see Bolozky, 1999). *meCuC(C)aC* is productive as well, as the default realization of verb-related adjectives, owing to its direct connection to *pi'el* as its often-automatic passive (or passive participle), its transparent *u…a* passive marker, and its bi-syllabic stem, which allows the inclusion of more consonants from the base. Still, in absolute terms, *CiC(C)uC* and *meCuC(C)aC* are less productive than either +*ut* or + *i*, respectively. *meCaC(C)eC*'s ranking is due to its transparent relationship to *pi'el*, as its active participle, to its bi-syllabic stem again, and to its colloquial standing in capturing the 'performer' category, which may refer to either an agent or an instrument. It is, however, less productive than +*an*, which serves in a number of functions, for agents/agent attributes, instruments, and collectives/groups. It is also definitely preferred to the "classical" agentive pattern *CaCaC* (with *dagesh forte*). The productivity of the suffix +*on* is lower than that of *meCaC(C)eC*, but stands out among patterns reflecting what Bolozky (2017) calls "focused" productivity – limited in scope in absolute terms, but within a specific category, here the diminutive, it is the default, dominant pattern (*'avatixon* 'small watermelon,' *'ekdaxon* 'small revolver,' *bdixónet* 'small joke,' etc. – see detailed discussion below). The same applies to *CaCiC*, which is ranked fairly high in the category of 'able-type' adjectives: *'axif* 'enforceable,' *hadir* 'repeatable, *mamiš* 'touchable,' etc. – see below, as well as in Gadish (2008), Bolozky (forthcoming). Clearly, then, discontinuous derivation continues to be productive, but linear derivation by appending suffixes is becoming stronger.

2 Adjective Formation

The first reason for the dominance of linear derivation with the suffix +*i* in the adjective category is its constituting the "default" pattern for deriving adjectives which denote "minimal" modification of the stem noun, meaning 'having the quality of,' or 'related to,' e.g., *šulxan* 'table' + *i* > *šulxani* 'of table,' as in *yáin šulxani*

[1] Some would argue that a subgroup of items related to *pa'al* verbs, like *'asaf* 'collect' ~ *'asfan* 'collector,' are derived linearly, but since the deletion of *a* here is not an automatically-necessitated phonetic process, it is hard to substantiate such claim. However, even in the case of +*an*, linear derivation, especially among children and in spontaneous adult neologisms, is quite common, e.g., *mecic* 'peep' ~ *mecican* 'peeping Tom,' *mafsid* 'lose' ~ *mafsidan* 'loser,' *macxik* 'funny' ~ *macxikan* 'comedian.'

'table wine,' *tel aviv* 'Tel Aviv" + *i* > *telavivi* 'of Tel Aviv (resident of Tel Aviv, etc.),' *yaldut* 'childhood' + *i* > *yalduti* 'childish,' etc. Derivations like these could already be found in Biblical Hebrew, but their distribution then was limited (only 65), and served primarily to denote gentilic terms (*yehudi* 'Judean,' *kna'ani* 'Canaanite,' *plišti* 'Philistine,' *'arami* 'Aramaic, '*emori* 'Amorite'), or to 'residents of…' (*gil'adi* 'from Gilead,' *tišbi* 'from Tišb,' *yevusi* 'from Yevus, Jebusite'), for direction (*cafon* 'north' + *i* > *cfoni* 'northern'), etc. In Mishnaic Hebrew the use of this pattern expanded (by another 65 entries), e.g., to other directions (*darom* 'south' + *i* > *dromi* 'southern,' *mizrax* 'east' + *i* > *mizraxi* 'eastern,' *ma'arav* 'west' + *i* > *ma'aravi* 'western'), but it was still rather limited. In Medieval Hebrew, when the influence of Arabic peaked, the strong effect of the comparable Arabic *nisba* (gentilic adjectives, generally denoting affiliation with a geographical, national or religious entity by adding the suffix +*i* to a base noun) caused a significant jump in similar coinages in Hebrew (another 320). In Israeli Hebrew the number of words with the suffix +*i* (foreign borrowings included) is quite large (augmented by 1655) – cf. also Berman (1978), Ravid and Shlesinger (1987), Ravid et al. (2016), Schwarzwald (1999). As will be shown below, *nisba*-type "minimal" adjective formation extended well beyond its original gentilic affiliation reference. There are numerous realizations of neologisms with +*i*; we will only present a few, taken from data drawn by selecting items in the *Rav-Milim* dictionary (Choueka, 1997) that were not listed in earlier dictionaries (Note that in this case and in the following tables, examples were selected so as to partly illustrate the variety of sources/bases, as well as quasi-linear, and occasionally discontinuous, derivation where applicable) (Table 3):

One can already see that in the high register neologizers tends to concentrate on native words (some of them erudite), while the middle and colloquial registers are more open to borrowings.

Table 3 Relatively new adjectives with +*i*

Register	Base	Gloss	+*i* Form	Gloss
High	*oryan*	learning, literacy	*oryani*	literate
	dika'on	depression	*dik'oni*	depressive
	xulya	link; part; vertebra	*xulyati*	of link; of vertebra
	taharan	purist	*taharani*	puristic
Middle	*'adrixal*	architect	*'adrixali*	architectural
	'ugda	division (mil.)	*'ugdati*	of division (mil.)
	'optimist	an optimist	*'optimísti*	optimistic
	budhist	Budhist	*budísti*	Budhist Adj.
Slang/Colloquial	*'ašaf*	expert, wiz	*'ašafi*	expert Adj.
	dos	orthodox Jew[a]	*dósi*	orthodox Adj.
	xalturist	moonlighter	*xalturísti*	shoddy, amateurish
	yáxne	busybody (Yid.)	*yaxna'i*	busybody Adj.
	frik	a freak	*fríki*	freaky

[a]From the Ashkenazi pronunciation of *dat* 'religion'

The strong current productivity of the *+i* pattern is due to the following reasons:

- The perceived need for a "minimal"/basic adjective meaning 'of the Noun, related to the Noun'
- Double transparency, of the base as well as of the suffix
- The prominence of the suffix, primarily owing to its position at the end of the word.

The most important reason is the pattern's transparency. The more transparent the base is, the easier it is for the hearer (or reader) to decode the meaning of a new word, and the easier it is for a neologism to be accepted by the speakers' community (Berman, 1987; Dressler, 1989). Discontinuous derivation, the hallmark of all Semitic languages, continues to be productive, as shown by Berman (1987), Bolozky and Schwarzwald (1992), Bolozky (1999), Ravid & Shlesinger, 1987, and others, but at the same time, linear derivation is getting stronger. Dressler (1989) points to a universal tendency to preserve transparency – semantically as well as morphologically – in word formation, and emphasizes that in linear derivation transparency tends to be preserved because the base maintains its form a well as its meaning: the suffix adds its fixed (and usually only) meaning without changing the form of the base, i.e., there exists an essentially invariable correspondence between form and meaning in each of the derivation components and its result. Since linear appending of a suffix does not change the syllabic structure of the base, by its very nature linear derivation maintains its transparency better. The suffix is also more prominent, particularly owing to its position at the end of the word, where attention tends to focus. There is a connection between prominence and transparency, but also between prominence and frequency. The more frequent the suffix, the more prominent and more readily available it is, and the more it facilitates the identification of the derivation pattern. Dressler notes that empirical data also show that linear derivation is more common in world languages than discontinuous derivation, and that it is easier to acquire and decode. As already noted, it does not change the structure of the base except for automatic phonetic modifications required to facilitate pronunciation. There are still cases of quasi-linear derivation, which in the past reflected minimal modifications that used to be automatic-phonetic, but are no longer required phonetically to facilitate articulation, and cannot truly be claimed to be linear. It may be argued, however, that the morpho-phonological processes can be identified by relating them to surface configurations, and that derivation from a surface string to another is through these phonological processes, e.g.,

cafon 'north' + *i* > *cfoni* 'northern' *darom* 'south' + *i* > *dromi* 'southern'
garon 'throat; neck' + *i* > *groni* 'throaty, guttural'.

Originally, deleting the vowel /a/ two syllables before the main stress was phonetically motivated. This motivation no longer exists, but one may claim that nevertheless, there still operates a phonological process that enables one to connect between the string with /a/ and the string without it. Even if the derivation is not truly linear, the residual phonological rule allows one to make the connection. In other words, although this is only quasi-linear derivation, that residual phonological rule facilitates the connection. This ties in with the concept of Output-to-Output Correspondence concept within Optimality Theory, according to which many forms are derived not from underlying deep structures, but rather through the intermediacy of related ones observed on the surface, a process that is fairly common in languages of the world – see, for instance, Ussishkin (1999) in deriving denominative verbs in Hebrew and in Bat-El (2012) in deriving Hebrew segholate nouns. Note that derivations like *makom* 'place' + *i* > *mekomi* 'local' are included in the *cafon* 'north' + *i* > *cfoni* 'northern' group as well; maintaining the *a* in the reduced form *e* is a phonetic necessity required to maintain the sonority hierarchy: *ma-ko-mi* > **mko-mi* > *me-ko-mi*.

Regarding the productivity of other adjectival pattens, the reasons for *meCuC(C)aC* occupying the fourth position in the proposed 10-pattern productivity hierarchy and *CaCiC* being the tenth were already specified above. But there are also some innovations originating from the various participial forms of the *binyanim*, whose productivity is lower, but significant. For additional discussion of the relatively productive *meCuC(C)aC*, see Mirkin (1962) and Rosén (1956). As shown in Werner (1983) and Muchnik (1997), in Hebrew discontinuous derivation of adjectives is fairly common. If the form is directly related to a particular verb, adjectives are likely to be realized in the participial *benoni* (participial) forms. Deverbal adjectives that are identical to the passive participle (the so-called endstate 'resultative' adjectives, like **closed**, **written**, etc. in English), are derived in discontinuous *miškalim*. There four possible sources for resultatives: the verb patterns *CaCaC*, *niCCaC*, *CuC(C)aC* and *huCCaC*, yielding *CaCuC*, *niCCaC*, *meCuC(C)aC* and *muCCaC*, respectively. Other participial forms, the 'active' ones (*meCaC(C)eC*, *maCCiC*, *mitCaCeC*, *CoCeC*), can also function as adjectives, but those tend to be **agentive** adjectives, and are sometimes indistinguishable from their agentive noun counterparts. The same applies to +*an* forms. Below are some data, from the 1983 supplement to Even Shoshan, Ben-Amotz & Ben-Yehuda (1982/92), Axia'asaf et al., (1993) and Choueka (1997); these items were not listed in earlier dictionaries (Table 4):

As expected among the adjectival patterns other-than– + *i*, *meCuC(C)aC* is realized in at all registers. *CaCiC* and *CaCuC* innovations tend to occur at the high register. Most of the verb-related participial forms are at the high or middle register.

3 Nominalizations/Gerunds

As noted above, after the adjectival +*i* at the head of the general productivity list comes the suffix +*ut*. It dominates the categories of gerund and other nominalization patterns. In the *binyan*-related gerund system it is automatic only in two *binyanim*, *hitpa'el* and *nif'al* (*hitCaCCut* as in *hitnaged* 'object' + *ut* > *hitnagdut* 'objection',

Table 4 Relatively new adjectives realized in discontinuous patterns

Register	Base	Gloss	Adj. Form	Gloss
meCuC(C)aC				
High	*bizer*	decentralize	*mevuzar*	decentralized
	diver/dṓ'ar	mail, post	*meduvar*	mailed, posted
	mador	compartment	*memudar*	compartmentalized
	kav	line	*mekuvan*	online
Middle	*'iyer*	illustrate	*me'uyar*	illustrated
	mixšev	computerize	*memuxšav*	computerized
	sibsed	subsidize	*mesubsad*	subsidized
	kitleg	catalogue V	*mekutlag*	catalogued
Colloquial/Slang	*birdek*[a]	mess up	*mevurdak*	messed up, disorderly
	ziyen	"screw" one	*mezuyan*	fucked up, screwed up
	fisfes	miss (bus etc.)	*mefusfas*	missed, wasted
	xirfen	drive crazy	*mexurfan*	crazy
	smartut	rag	*mesmurtat*	worn out
CaCuC				
High	*kalav*	join V	*kaluv*	joined
	yida	throw, hurl	*yaduy*	thrown, hurled
	šaga	err	*šaguy*	erroneous
CaCiC				
High	*'axaf*	enforce	*'axif*	enforceable
	hadar	repeat	*hadir*	repeatable
	hemir	convert	*hamir*	convertible
Middle	*kalat*	absorb	*kalit*	absorbable, comprehensible
	šafat	judge/evaluate	*šafit*	that can be evaluated
CoCeC				
High	*ga`aš*	rage, storm	*go`eš*	stormy
	yakad	blaze	*yoked*	burning hot
Middle	*`akaf*	go around	*`okef*	by-passing
niCCaC				
High	*p-l-c*	be distorted	*niflac*	distorted; scary
	r-h-b	be stunning	*nirhav*	amazing, stunning
meCaC(C)eC				
Middle	*'ixzev*	disappoint	*me'axzev*	disappointing
	hamam	daze, stupefy	*mehamem*	dazing
	sigseg	thrive	*mesagseg*	thriving
	tiskel	frustrate	*metaskel*	frustrating
maCCiC				
Middle	*he`eliv*	insult V	*ma`aliv*	insulting
	hiflil	implicate	*maflil*	implicating
	hiršim	impress	*maršim*	impressive
muCCaC				
High	*zgugit*	glass	*muzag*	glazed (with glass)

(continued)

Table 4 (continued)

Register	Base	Gloss	Adj. Form	Gloss
	klor	chlorine	*muxlar*	chlorinated
Middle	*y-l-d*	give birth/	*mulad*	congenital, from birth
		be born		
Colloq./Slang	*t-r-p*	be crazy	*mutraf*	crazy, wild

[a]From Turkish *bardak* 'whorehouse.'

Table 5 Children's coinages with *+ut*

Base	Gloss	*+ut* Form	Gloss
ra`	bad	*ra`ut*	being bad
kosem	magician	*kosmut*	magic
ke'ev/ko'ev	pain/painful	*ke'evut*	being in pain

and *hiCaCCut*, as in *hitakel* 'encounter (infinitive construct)' *+ut* > *hitaklut* 'encounter N'), and is only partially-productive in some other *nif'al*-related forms, following the *niCCaCut* pattern (as in *nifkad* 'absentee, present participle' *+ut* > *nifkadut* 'being absent'), some *pa'al*-related ones, following *CoCCut* (as in *soxen* 'agent, present participle' *+ut* > *soxnot* 'agency'), some *pi'el*-related forms following *meCaCCut* (as in *meyaled* 'obstetrician' + *ut* > *meyaldut* 'obstetrics'), some *meCuCaCut* forms (as in *meyuman* 'proficient, present participle' *+ut* > *meyumanut* 'proficiency'), and some *huf'al*-related forms following *muCCaCut* (as in *murkav* 'complex, present participle' *+ut* > *murkavut* 'complexity'). In the rest of the nominalization derivational system, however, it is very productive. As in the case of *+i* for adjectives, derivations with the linear suffix *+ut* involve minimal semantic change, whose sole purpose is to add to the base to which it is appended the abstract nominal feature 'being…' or 'a condition/situation of…' (see Rosén 1977, Berman, 2020). Abstract nominalization which does not involve any deviation from the base except for the nominalization itself is realized with *+ut* as the default choice. Therefore *+ut* is regarded as transparent and global, and as marking the most general nominal category, and consequently preferred at the initial intuitive stage of coinage. Children use it in non-normative coinages as early as age 4 (Berman & Sagi, 1981) (Table 5):

and adults prefer it over any other pattern of coining abstract nominalization. Below are some of the items in Choueka (1997) that were not listed in earlier dictionaries (High and Middle), and some from Ben-Amotz & Ben-Yehuda (1972/1982) (Colloq.) not listed before (Table 6):

As is the case with *+i*, the number of the occurrences of *+ut* in Biblical Hebrew is small (about 80 instances, out of a total of 3700 in the total lexicon), and it is still not that productive in Mishnaic Hebrew (about 250). It is more productive in Medieval Hebrew, and most productive in Modern Hebrew (close to 2800). Note that although the total numbers of nouns ending with *+ut* is larger than the number of those realized with the suffix *+i*, it does not necessarily mean that it is more productive. As noted above, Bolozky's (1999) claims regarding relative productivity

Table 6 Relatively recent nominalizations ending with +*ut*

Register	Base	Gloss	+*ut* Form	Gloss
High	*kfiyati*	compulsive	*kfiyatiyut*	compulsiveness
	muvxan	distinct	*muvxanut*	distinctiveness
	minani	sexist	*minanut*	sexism
	`odef	redundant	*`odfut*	redundancy
Middle	*sarid/sarad*	remnant/survive	*hisardut*	survival
	yazam	entrepreneur	*yazamut*	entrepreneurship
	kóax	power, force	*koxanut*	belligerence
	mecuyan	excellent	*mecuyanut*	excellence
Colloquial/Slang	*hitxared*	become orthodox	*hitxardut*	becoming orthodox
	xévreman	one who gets on	*xevremániyut*	getting on well with people
		well with people		
	hitparper	philander/skip classes	*hitparerut*	philandering; skipping
				classes
	poc	jerk	*pociyut*	being a jerk
	kúter	complainer	*kúteriyut*	constant complaining

Table 7 Relatively recent nominalizations ending with +*iyut*

Base	Gloss	+*i* Form	+*iyut* Form	Gloss
nóax	comfortable	**noxi(yi)*	*noxiyut*	comfort
gibor	hero, heroic	**gibori*	*giboriyut*	heroism
galmud	lonely	**galmudi*	*galmudiyut*	loneliness
hefreš	difference	**hefreši*	*hefrešiyut*	differential status
klum	nothing	**klumi*	*klumiyut*	nothingness
levad	alone	**levadi*	*levadiyut*	being alone

are based not only on counting of total realizations, but also on criteria suggested for measuring natural, spontaneous productivity of word formation. Furthermore, the total dictionary numbers are partly misleading: counting by the final +*ut* ignores the fact that many of them, 617 in the Even Shoshan dictionary, are part of an +*iyut* sequence, which in many cases should be regarded as a merged, single "atomic" unit, with no independent +*i* at their bases, as can already be seen in the last two examples in the previous list (*poc*, *kuter*), as well as in many others, e.g., (Table 7)

+*uti*, on the other hand, is almost always derived from a free-standing +*ut* base.

An interesting question is what happens when suffixes like +*i* and + *ut* occur more than once. Take *yéled* 'child' > <u>*yaldut*</u> 'childhood' > *yalduti* 'childish' > *yaldutiyut* 'childishness.' The fact that the derivation cannot continue with another +*i* has nothing to do with the relative productivity of either suffix. The reason is very simple: one cannot keep on adding suffixes when they do not add any semantic load to the earlier base. **yaldutiyuti* would have been semantically identical to *yalduti*, so it is totally redundant [see Ravid & Shlesinger, 1987 and earlier references there]. Both +*i* and + *ut* look like Class II suffixes (Chomsky & Halle, 1968), which generally can be attached to previously appended suffixes, whereas Class I generally cannot. Regardless, being able to append a suffix to another suffix that is already there, when semantically possible, is in itself an indication of productivity.

We already mentioned the reasons for the placing of *CiC(C)uC* in third position in the productivity hierarchy, after +*ut*. A few illustrations from Choueka (1997) that were not listed in earlier dictionaries (High, one in Middle), from Ben-Amotz & Ben-Yehuda (1972/1982) (Colloquial) not listed before, and from the 1983 supplement to Even-Shoshan (Middle) that were new at the time (V = Verb, N = Noun) (Table 8):

CiC(C)uC is, of course, a discontinuous pattern *par excellence*. So is *haCCaCa*, the seventh position in the productivity hierarchy. Although it has a suffix, and + *a* is, of course, a very common suffix as a marker of feminine gender, the continued productivity of *HaCCaCa* is essentially limited to the high register, as the nominalization of *hif'il*-related causatives, and the suffix +*a* as such does not contribute much to its productivity, being too general and not having a direct relationship to the basic causative meaning, unlike a suffix like +*on* being associated with diminution, for instance. But it maintains some productivity at the higher registers. In the lower registers it encounters strong competition with *CiC(C)uC*, which is very productive as an agentive nominalization, causatives included. Here are a few examples of *haCCaCa* from the 1983 supplement to Even-Shoshan, and from Choueka (1997) which had not been listed earlier (Table 9):

There is a certain tendency today to add linearly derived innovations with the suffix +*izm*; it is not high on the productivity hierarchy, but nevertheless provides speakers with another linear derivation with a suffix. At the higher and middle registers the items are usually borrowed, but speakers are aware of +*izm* being a nominalization suffix; in the colloquial register most stems are native. Below are items from the 1983 supplement to Even-Shoshan (High, Middle) that were not listed in earlier dictionaries, and from Ben-Amotz & Ben-Yehuda (1972/1982) (Colloquial) not listed before (Table 10):

Table 8 Relatively new nominalization in the *CiC(C)uC* pattern

Register	Base	Gloss	*CiC(C)uC*	Gloss
High	*'avzar*	accessory	*'ivzur*	equipping
	'itxel	reboot	*'itxul*	rebooting
	davar	mailman	*divur*	mailing
	hadadi	mutual, reciprocal	*hidud*	interaction
Middle	*šidreg*	upgrade V	*šidrug*	upgrading
	mixzer	recycle	*mixzur*	recycling
	moked	focus	*mikud*	focusing
	`imet	confront	*`imut*	confrontation
Colloquial/Slang	*bilgen/balagan*	(make a) mess	*bilgun*	disarray N
	xirben	defecate; ruin	*xirbun*	defecating; ruining
	fintez	fantasize	*fintuz*	fantasizing
	fisfes	miss (target, bus...)	*fisfus*	missing
	tixmen	scheme, contrive	*tixmun*	scheming, contriving

Table 9 Relatively new nominalization in the *haCCaCa* pattern

Register	Base	Gloss	*haCCaCa*	Gloss
High	*hidma*	simulate	*hadmaya*	simulation; imaging
	hehedir	compile; edit	*hahadara*	compilation (comp.); editing
	hixpif	subjugate	*haxpafa*	subjugation
	mexula	container	*hamkala*	containerization
Middle	*klid*	key (computer)	*haklada*	typing on keyboard
Colloq./Slang	*hisnif*	snuff (drugs)	*hasnafa*	snuffing (drugs)

Table 10 Relatively new nominalization with +*izm*

Register	Base	Gloss	+*izm* Form	Gloss
High			*indeterminizm*	indeterminism
			konseptualizm	conceptualism
Middle			*'otizm*	autism
			hindu'izm	Hinduism
			fundamentalizm	fundamentalism
			kolonyalizm	colonialism
Colloquial/Slang	*bicúa`*	implementation	*bicu`izm*	being an achiever, go-getter
	bitaxon	security	*bitxonizm*	being security-minded
	sipúax	annexation	*sipuxizm*	believing in annexation
	snob	snob	*snobizm*	snobbism

4 Agents and Agentive Adjectives

When combining all neologisms designating agents – which in a good number of cases also refer to agent-quality adjectives, as in *kamcan* referring to 'a miser,' or to the adjective 'stingy,' *batlan* referring to 'a loafer' or to 'lazy,' etc. – patterns with +*an*, including the discontinuous *CaCCan*, are the dominant agentive patterns. Note that *CaCCan* often has the adjectival counterpart *CaCCani*, which – interestingly enough – often tends to denote adjectives associated not with humans, but with abstract nouns. Thus, in the cases above, *kamcani* and *batlani* are normally used in phrases such as *hitnahagut kamcanit/batlanit* 'miserly/lazy behavior.' One may also claim that the dominance of +*an* (fifth place in the ranking above), which (as already noted) also refers to instruments, is aided by some shifts in patterns referring to instruments. As noted in Bolozky (1999), the border between the agent and the instrument categories, especially in the lower registers, is often blurred, since they are both conceived of a single category of 'the performer of an action.' Because of the blurring of categories, and also owing to orthographic similarity in texts with no vowel marking (which is the normal way Hebrew texts are written/printed), the normative pattern for instruments, *maCCeC*, tends to partly merge with the agentive pattern *meCaCeC*: *maghec* 'iron' > *megahec*, *maxšev* 'computer' > *mexašev*, *makrer* 'refrigerator' > *mekarer*. Thus, this partial merger of the instrument and agent categories preserves the dominant role of +*an* in the merged category by "eliminating" some competing occurrences of *maCCeC* instruments. The suffix +*ay* (and its adjectival counterpart +*a'i*, which in the colloquial register usually refers to the agent as well) is fairly productive, but far less so than +*an*. So are +*er*/+*oner*, +*ist* and + *čik*, particularly in the colloquial register. There are few new agents in the *meCaCeC* and *CaCaC* patterns. Thus, the agent/agent quality category is clearly dominated by patterns with suffixes – mostly linear, but some are discontinuous. Below are a few illustrations of agents/agentive adjectives in the commoner patterns drawn from Choueka (1997), in the high and middle registers and a few colloquial ones that were not listed in previous dictionaries, and from Ben-Amotz & Ben-Yehuda (1972/82) in the colloquial that were not listed earlier; the +*an* category includes discontinuous *CaCCan* realizations as well (Table 11):

5 Instruments

In the category of instruments (including "performers of action" that can function as either agents or instruments), the two "classical" (discontinuous) instrument patterns, *maCCeC* and *maCCeCa*, are still dominant in the higher register, and to an extent, so is +*an*. In the middle register and the colloquial, we also find the patterns with suffix +*on* and + *er*. The examples below are taken from the 1983 supplement to Even-Shoshan and from Choueka (1997) that were not listed earlier, and just a few from Ben-Amotz & Ben-Yehuda (1972/82) and Axi'asaf et al. (1993) that were not included in earlier dictionaries (Table 12):

An insightful analysis of morphological variation and change in the formation of instrument nouns in Hebrew is provided in Laks (2015). When pattern distribution is statistically evaluated throughout the lexicon, regardless of semantic category, instrument-formation patterns are not placed that high on the realization count hierarchy. On their own, however, their distribution supports what has been pointed above regarding the continued productivity of verb-related participial discontinuous templates, as shown in the case of participles functioning as adjectives. In cases of variation and change among instrument nouns, Laks notes that it is normally from non-participle templates to participial ones. Thematically, the participial instrument noun corresponds to a thematic role that the verb assigns, which makes that instrument noun quite transparent. Thus, additional support is provided to the observation that although linear affixation is strong, discontinuous patterns still maintain their productivity.

Table 11 Relatively new realizations of agents and agentive adjectives

Register	Base	Gloss	Agent Form	Gloss
N+*an/CaCCan*				
High	*zaxa*	win V	*zaxyan*	concessionaire
	našaf	blow V	*našfan*	wind instrument player
	dyéta	diet	*dyetanit*	diet expert (fem.)
	tadmit	image	*tadmitan*	image maker/counsellor
Middle	*yx"c* acronym	PR	*yaxcan*	PR person
	siya`	help, aid V	*say`an*	collaborator
	te'ura	lighting	*te'uran*	lighting operator
	taklit	record (music)	*taklitan*	DJ
Colloquial/Slang	*madlif*	leak (info)	*madlifan*	one leaking information
	zével	garbage	*zablan*	prattler
	ke(y)f	fun (from Ar.)	*kayfan*	one always having fun
	male/milyon	full/million	*malyan*	a very rich person
	šifcer	prattle	*šafceran*	prattler
+ay/+a'i				
High	*mivne*	structure	*mivnay*	structural engineer of planes
	cmig	tire	*cmigay*	flat tire fixer
	ra`ayon	idea	*ra`ayonay*	copywriter
	taxzuka	maintenance	*taxzukay*	maintenance person
Middle	*'analíza*	analysis	*'analitikay/a'i*	analist
	maškon	pawn	*maškonay/a'i*	pawnbroker
	plastik	plastic	*plastikay/a'i*	plastic surgeon
Colloquial/Slang	*xelm*	town of fools	*xelma'i*	a fool; foolish
	yáxne	busybody N	*yaxna'i*	busybody Adj
	kiyosk	kiosk	*kiyoska'i*	kiosk owner/attendant
+er/+oner				
Colloquial/Slang	*širyon*	armor	*širyoner*	armor corps soldier
	bizayon	disgrace	*bizyoner*	blunderer, bungler
	máfya	mafia	*mafyoner*	mafioso
	miškafáim	eyeglasses	*miškafófer*	person with eyeglasses
	fášla Ar./*fišel*	screw-up/N & V	*fašloner*	one who often screws
				up, flops
	kríza	craze	*krizyoner*	crazy person
+ist				
Colloquial/Slang	*balagan*	disorder	*balaganist*	disorderly person
	xaltúra	moonlighting	*xalturist*	moonlighter
	kariyéra	career	*kareyrist*	career seeker
	šékem	the Israeli PX	*šekemist*	PX worker
	tixon	high school	*tixonist*	high school student
+čik				
Colloquial/Slang	*balagan*	disorder	*balagánčik*	disorderly person
	xarsína	porcelain	*xarsínčik*	installer of wall tiles

(continued)

Table 11 (continued)

Register	Base	Gloss	Agent Form	Gloss
	politúra	lacquer	*politúrčik*	applier of lacquer
	tikun	fix, repair N	*tikúnčik*	fixer, repair person
meCaC(C)eC				
High	*'ifnen*	modulate (elec.)	*me'afnen*	one modulating wave
				frequencies
Middle	*'ivxen*	diagnose	*me'avxen*	diagnostician
	'iyer	illustrate	*me'ayer*	illustrator
	tidlek	fuel V	*metadlek*	gas station attendant
	tirgel	drill V	*metargel*	tutor
CaCaC				
High	*xut*	wire	*xavat*	one who connects wires

6 Location Patterns

As Bolozky (1999) shows, in the locative category, *miCCaCa* and *miCCaC* are the most productive patterns only in the high register. In the middle and colloquial registers, the linear suffix patterns are the most productive, and their use is widening, primarily +*íya*, which is becoming more and more productive, as are two other suffixed patterns, of still-limited productivity: +*iyáda* and + *eríya*. Below are some items from the 1983 supplement to Even-Shoshan and from Choueka (1997) that were not listed earlier, and just a few from Ben-Amotz & Ben-Yehuda (1972/82) that were not included in earlier dictionaries (Table 13):

7 Diminution Patterns

In choosing diminution pattern one can also note significant differences between the three registers. Except for the reduplication diminutive pattern, which is essentially restricted to the high register, the category is dominated by patterns with suffixes; +*it* realization can be found in both the high and middle registers; +*čik* is found only in the colloquial. The +*on* pattern, as already mentioned, is the default diminutive pattern – for detailed descriptions of the historical development of the diminution category and its pattern distribution, see Bolozky (1994, 1999), as well as Ravid (1998) and Hora et al. (2006) on the acquisition of Hebrew diminutives. +*on* may also refer to some other semantic categories (see Schwarzwald, 2019a, b); it can denote certain abstract nouns (such as *zikaron* 'memory,' *dimyon* 'imagination'), list of items (*mexiron* 'price list,' *še'elon* 'questionnaire'), types of periodicals (*švu'on* 'weekly,' *mekomon* 'local newspaper'), temporary units of residence (*paxon* 'tin shack,' *badon* 'tarp unit; tent'), statistical units (*xecyon* 'median,' *'asiron* 'decile'), geological period units (*šlišon* 'Tertiary,' *revi'on* 'quartile'), or instruments

Table 12 Relatively new instrument nouns

Register	Base	Gloss	Instr. Form	Gloss
maCCeC				
High	*bazak*	flash	*mavzek*	camera flash
	hixliv	stitch (sewing)	*maxlev*	stapler
	nipek	issue V	*manpek*	dispenser
Middle	*hidpis*	print V	*madpés(et)*	printer
maCCeCa				
High	*gazaz*	cut, shear	*magzeza*	sheep shears
	gazar	cut paper/cloth	*magzera*	paper cutting device
	našam	breathe	*manšema*	respirator
	kara	read	*makre'a*	magnetic info reading device
Middle	*malgez*	pitchfork	*malgeza*	motorized pitchfork
	hikrin	project image	*makrena*	movie projector
meCaC(C)eC				
High	*xacac*	gravel	*mexacec*	device crushing rock
				to gravel
	kótev	pole	*mekatev*	polarizer
Middle	*dilel*	thin V	*medalel*	thinner
CoCeC				
Middle	*kécev*	rhythm	*kocev (lev)*	pacemaker
	garar	pull, drag	*gorer(et)*	tow vehicle
CaCaC				
High	*nataf*	drip, sprinkle	*mataf*	fire extinguisher
	ciyen	note	*cayan*	index; identifier
Middle	*šalat*	control V	*šalat*	remote control
+an				
High	*'ifnun*	modulating	*'afnan*	modulator
	cinor	pipe	*canran*	snorkel
	kalat	receive	*koltan*	receptor
	xaš	feel, sense	*xayšan*	sensor
Middle	*xiyeg*	dial V	*xaygan*	auto dialer
Coll./Slang	*šidex*	bring together	*šadxan*	stapler
+on				
Middle	*'ašpa*	garbage	*'ašpaton*	dumpster
	halax	walk	*halixon*	walker
+er				
Coll./Slang	*kveč*	mush	*kvéčer*	stapler
	špric	splash, spray	*špricer*	sprinkler

(*'ašpaton* 'garbage container, *mešivon* 'answering machine'), each with limited productivity, but +*on* (and its feminine counterpart +*ón* + *et*) is most productive in denoting diminutives. Below are some data from new items listed in the Even-Shoshan (1983) as well as from Choueka (1997), and from Ben-Amotz & Ben-Yehuda (1972/82); V = Verb, redupl. = reduplication (Table 14):

Table 13 Relatively new location nouns

Register	Base	Gloss	Loc. Form	Gloss
miCCaCa				
High	*beres*	tan leather V	*mivrasa*	leather tanning factory
	gazar	cut	*migzara*	cloth cutting facility
	nasa'	carry	*minsa'a*	ammunition carrying device
	pexam	coal	*mifxama*	factory turning wood to coal
Middle	*saraf*	burn V	*misrafa*	incinerator
Coll./Slang	*zalal*	devour	*mizlala*	fast food restaurant
miCCaC				
High	*barac*	flow over	*mivrac*	spillway
	cómet	junction	*micmat*	junction (electronics)
	racif	platform/wharf	*mircaf*	access to a platform
	našak	touch	*minšak/mišak/mimšak*	interface
Middle	*nasa'*	carry	*minsa'*	carrier
+iya				
High	*'arig*	cloth	*'arigiya*	cloth weaving factory
	šravrav	plumber	*šravraviya*	plumber's shop
Middle	*kélev*	dog	*kalbiya*	kennel
	ma`adan	delicacy	*ma`adaniya*	delicatessen shop
	šmartaf	baby-sitter	*šmartapiya*	office providing baby-sitters
	pag	premature baby	*pagiya*	ward for premature babies
Colloquial/Slang	*steyk*	steak	*steykiya*	steak house
	kambac	operations officer	*kambaciya*	operations officer's post
	káčke	duck (Yid.)	*kačkiya*	girls' quarter
	xúmus	hummus	*xumusiya*	hummus restaurant
	picúax/ picuc	cracking	*picuxiya/picuciya*	kiosk where nuts are sold
+iyáda				
Colloquial/Slang	*tremp*	hitchhiking	*trempiyáda*	hitchhiking stop
	káčke	duck (Yid.)	*kačkiyáda*	prattling
	steyk	steak	*steykiyáda*	steak house
+eríya				
Colloquial/Slang	*píca*	pizza	*piceríya*	pizzeria
	glída	ice cream	*glideríya*	ice cream place

Table 14 Relatively new diminutive forms

Register	Base	Gloss	Dimin. Form	Gloss
***+on*/+ón+et**				
High	*dov*	bear	*dvivon*	racoon (also redupl.?)
	magévet	towel	*magvon*	pre-moistened towelette
	ptil	wick; fuse	*ptilon*	felt-tipped pen
	kéta`	segment	*kit`on*	small segment
Middle	*'ekdax*	pistol	*'ekdaxon*	small pistol
	bdixa	joke	*bdixónet*	little joke
	xavila	package	*xavilónet*	small package
	xasil	type of locust	*xasilon*	shrimp
Colloquial/	*pargit*	young chicken	*pargiyónet*	young, inexperienced girl
Slang	*tipa/tiptipa*	drop	*tiptipónet*	a very tiny bit (also redupl.)
Reduplication				
High	*bahir*	light colored	*beharhar*	quasi-light colored
	bacal	onion	*b(e)calcal*	small onion
	déreg	rung, step	*dragrag*	small ladder
	xadaš	new	*xadašdaš*	sort of new
High/Middle	*géver*	man, male	*gvarvar*	young man pretending to be a man
+it				
High	*gáven*	color, shade	*gonit*	nuance
	mištax	flat surface	*mištaxit*	cart w/o roof or railings
Middle	*dugma*	example	*dugmit*	sample
	koxav	star	*koxavit*	asterisk
	sulam	ladder	*sulamit*	# sign
	markol	supermarket	*markolit*	mini-market
	cinor	pipe	*cinorit*	narrow pipe; capillary
+čik				
Colloq./Slang	*baxur*	young man	*baxúrčik*	boy (affectionate)
	katan	small	*katánčuk*	very small (affectionate)
	napolyon	Napoleon	*napolyónčik*	small, but with big ambitions
+íko				
Colloq./Slang	*xayal*	soldier	*xayalíko*	young soldier (affectionate)

The productivity of +*on* as the preferred diminutive category is also manifest in its being appended even to forms to which other diminutive suffixes have been attached earlier, even to a form to which an earlier +*on* suffix had been appended. This is not semantically vacuous suffixation, which as noted above is not allowed, since further suffixation further diminutivizes the form – a clear indication of productivity. +*it* and + *čik* may be appended to other diminutives as well (Table 15):

The feminine counterpart of +*on*, +*on* + *et* deserves an additional separate mention, since in some cases it exists independently from +*on*, mostly for inanimate nouns (where no masculine counterpart exists), as in (Table 16):

Table 15 Diminutive forms that can be dimutivized further

Form	Gloss	Diminution	Gloss	Further Dim.	Gloss
xatul	cat (m.)	*xataltul*	kitten (m.)	*xataltulon*	tiny kitten (m.)
xatula	cat (f.)	*xataltula*	kitten (f.)	*xataltulónet*	tiny kitten (f.)
		xataltulit	tiny kitten (f.) (in open productivity tests)		
		xataltulonit	tiny kitten (f.) (in open productivity tests)		
gag	roof	*gagon*	small roof; awning	*gagonon*	tiny roof/awning
				gagónčik	very small roof/awning (in open productivity tests)
				gagonit	very small roof/awning (in open productivity tests)

Table 16 Some +*on*+*et* diminutive forms

Form	Gloss	Redup./+*on*	+on(+et)	Gloss
mapit	napkin	**mapon*	*mapiyónet*	small napkin
giv'a	hill	**giv'on*	*giv'ónet*	small hill
simla	dress	**simlon*	*simlónet*	small dress
dira	apartment	**diron*	*dirónet*	small apartment

Nevertheless, it still denoted diminution. The diminution category, then, is generally dominated by patterns with suffixes.

Linear as well as an alternative discontinuous pattern? The (very) partial merger of +*i* and + *ut* to +*iyut* noted above also seems to apply to +*on* and + *i*, merging into +*oni*, as well as +*on* and + *ut*, merging into +*onut* (Table 17):

In such cases, it is not that easy to evaluate whether the pattern is linear or discontinuous. In the case of *pérax* > *pirxoni* we know that the base for the segholate is /pirx/, so it looks linear, but some may claim not **truly** linear, since the syllabic structure of the base is affected by the derivation. The problem does not arise in the case of *\`ir* > *\`ironi*, for instance, but although the intrusive *n* can be regarded as an automatic onglide, it may still be claimed that it is only quasi-linear. However, there are cases in which a pattern can be truly linear, and at the same time the stem can also be claimed to belong to a discontinuous pattern when there are a number of stems sharing exactly the same syllabic structure, and there are scores and scores of resulting sub-patterns. For example, the pattern *CaCCan* + *ut* is linearly derived from *CaCCan*, but at the same time, *CaCCanut* may also be regarded as an independent pattern – 171 occurrences in the "live" lexicon, such as (Table 18):

A similar sub-group among linearly derived +*i* forms is *CiCuC* + *i*, which at the same time can also be regarded as a discontinuous *CiCuCi* pattern (65 forms in the "live" lexicon) (Table 19):

Table 17 Some +*oni* and/or +*on*+*ut* forms

Base	Gloss	+*i* Form	+*oni*/+*onut* Form	Gloss
céva'	color	**civ'on*	*civ'oni*	colorful
pérax	flower	**pirxon*	*pirxoni*	flowery
'ir	town, city	**'iron*	*'ironi*	municipal
'adom	red	**'admon*	*'admoni*	reddish
xol	non-sabbath day **xilon*	*xiloni*		secular
cémax	plant	**cimxon*	*cimxoni*	vegetarian
			cimxonut	vegetarianism
kim'a	a little	**kim'on*	*kim'oni*	of retail
			kim'onut	retail

Table 18 Some *CaCCanut* forms

Base	Gloss	+*ut* Form	Gloss
'axlan	glutton	*'axlanut*	gluttony
'asfan	collector, hoarder	*'asfanut*	collecting, hoarding
badlan	isolationist	*badlanut*	isolationism
batlan	loafer	*batlanut*	idleness
bayšan	shy person	*bayšanut*	shyness
baxyan	cry-baby	*baxyanut*	behaving like a cry-baby
daykan	punctilious person	*daykanut*	precision
daršan	exegete, sermonizer	*daršanut*	exegesis, sermonizing

Table 19 Some *CiCuCi* forms

Base	Gloss	+*i* Form	Gloss
bidur	entertainment	*biduri*	entertaining
dibur	speech, speaking	*diburi*	colloquial
xišuv	computation	*xišuvi*	computational
tipul	treatment	*tipuli*	therapeutic, related to treatment
yicug	representation	*yiccugi*	representational
yisum	application	*yisumi*	applied
limud	instruction	*limudi*	instructional
sipur	story	*sipuri*	narrative

Linear derivation with +*i* also includes the discontinuous *CaCCani* pattern (137 occurrences). Note that the same stem, *CaCCan*, is the base for *CaCCanut* above; it is clearly a commonly used base, apparently owing to the importance of the agentive semantic category it represents (Table 20):

Similarly, the groups of participial patterns mentioned above, to which +*ut* is linearly attached to form nominalizations, i.e., *niCCaCut* pattern (as in *nifkadut* 'being absent'), *CoCCut* (as in *soxnot* 'agency'), *meCaCCut* (as in *meyaldut* 'obstetrics'), *meCuCaCut* (as in *meyumanut* 'proficiency') and *muCCaCut* (as in *murkav*

Table 20 Some *CaCCani* forms

Base	Gloss	+*i* Form	Gloss
batlan	loafer, lazy person	*batlani*	loafing
bayšan	shy (person)	*bayšani*	shy
baxyan	cry-baby	*baxyani*	weeping, crying
balšan	linguist	*balšani*	linguistic
daykan	meticulous person	*daykani*	meticulous
daršan	preacher, sermonizer	*daršani*	preaching, sermonizing
vatran	indulgent person	*vatrani*	indulgent
zalelan	glutton	*zalelani*	gluttonous

murkavut 'complexity'), are clear examples of patterns in which either linear or discontinuous derivation may be claimed to be involved.

Bolozky (2020) shows that there are many such linearly derived patterns with suffixes whose realizations simultaneously constitute linear as well as discontinuous sub-patterns; see also Muchnik (1997), Schwarzwald (2009). The claim we wish to make here is that this "dual status" of many related forms is a very powerful reason accounting for why patterns with suffixes and parallel nonconcatenative ones are so productive: the parallel linear and discontinuous patterns reinforce each other.

8 Conclusion

What distinguishes Semitic languages from most other world languages is the role in word formation of discontinuous morphological patterns. This is, essentially, the only mechanism operating in the verb system; in other categories, both mechanisms exist. In part owing to the influence of European substratum languages when Hebrew speech was revived starting at the end of the nineteenth Century, but for other reasons as well, linear derivation is becoming stronger and more productive. Nevertheless, discontinuous derivation has maintained its strength – certainly in the verb system, but in the nominal and adjectival system as well. When linear derivation takes place, even if it is only quasi-linear in nature, it is essentially the suffix that determines the overall general character of the neologism – generally its categorial affiliation, but often some semantic traits as well: is it an agent, an instrument, a location, etc.? If a particular form is also a member of a sub-pattern that reveals its other semantic and syntactic characteristics, it is very helpful for the listener/hearer to decode its meaning and its syntactic role in the sentence. In other words, the linear (or even quasi-linear) nature of the derivation maintains the essential information required to decode the neologism, and the discontinuous pattern of the sub-pattern that is simultaneously involved provides additional information required to complete the process, be it semantic, syntactic, or both. In other words, two simultaneous derivation mechanisms support each other in filling in whatever information is required to complete the decoding process.[2]

Linear processes involving suffixes and their discontinuous sub-patterns like the ones illustrated above mostly involve +*i* and + *ut*, which as the author's research has shown are the most prominent and the most productive; others end with +*an*, +*on*, +*it*. Although most of them do not consist of as many realizations, the fact that discontinuous patterns are involved in a significant number does facilitate processing of neologisms. This is one of the reasons today for preferring patterns with suffixes; the main reason, of course, is the prominence and the transparency of the suffixes, particularly when the patterns concerned are linearly derived.

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[2] Possible additional support for this claim may be provided by a model proposed in Shatil (2014), according to which there exist a very limited number of *miškalim* in Hebrew, since strictly speaking (according to formal structuralist methodology), many supposedly-independent ones constitute mere allomorphs of others, and many others "merge" with partially-similar ones through suppletion, since no root interdigitates with both variants, and may thus be regarded as having the same function.

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Tracking a Morphological Pattern: *miCCaC* in Hebrew

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Abstract The unmarked nominal pattern miCCaC is very productive in Hebrew and takes various sub-patterns depending on phonological and morphological factors. The phonological factors are determined by the first guttural consonant of the root, while the morphological factors are determined by weak roots in which only two consonantal roots occur. Several nouns belong to miCCaC pattern but need special consideration because they cannot be categorized by the above features. The semantic analysis of the nouns in this pattern shows that the majority of the nouns (61%) express rather general concepts, abstract as well as concrete, and a number of these can be considered as action nouns (gerundives). Only about 23% of the words indicate location and 16% denote tools or instruments.

Keywords Root · Pattern · Phonology · Morphology · Orthography · Gutturals · Weak root · Semantic load

1 Introduction

This paper will focus on various morphophonological and semantic aspects of the miCCaC pattern in Hebrew. It will be shown that this pattern appears phonetically in a variety of different ways as determined by the root's phonological and morphological features. My contention is that although the phonemic shape of a word might not appear to indicate the basic miCCaC pattern in many cases, a comparison with other morphophonological processes and phonological and morphological considerations lead to the conclusion that they do indeed adhere to this form. There are also a number of words that appear to adhere to the miCCaC pattern when this is not the case. As it is clear that linguistic changes occurring in Modern Hebrew are heavily influenced by the phonological and orthographic system of Biblical Hebrew, it is

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important to be aware of historical Hebrew language development processes. Semantic analyses of words which adhere to the miCCaC pattern demonstrate a wide variety of meanings.

Section 2 will discuss root and pattern combination and demonstrate how this differs from other modes of Hebrew word derivation in relation to miCCaC. Section 3 will elaborate on the description of the data included in my research and examine the justification of Modern Hebrew allomorphs which adhere to the miCCaC pattern. While semantics will be addressed in Section 4, Section 5 will comprise of a summary and conclusions.

2 Roots and Patterns in Modern Hebrew

One of the most productive ways in which verbs and nouns in Semitic languages in general and in Hebrew in particular are formed, is by the combination of a discontinuous root and a pattern. The root is consonantal in most cases, and is most frequently composed of three or four consonants. Patterns feature vowels which are interwoven between the root consonants (henceforth: radicals), but may also comprise of additional elements at the beginning or end of a word (Berman, 1987, 2012; Ravid, 1990, 2003, 2020; Goldenberg, 1994; Schwarzwald, 2002, unit 4). The examples in (1) show the realization of the root *d-g-m* in various patterns (final stress is unmarked; only non-final stress is marked).

(1) *dagam* 'sample.V (in statistics),' *dégem* 'model, pattern.N,' *hidgim* 'demonstrate, exhibit.V,' *hudgam* 'be demonstrated,' *dugma* 'example, sample.N,' *mudgam* 'demonstrated.ADJ,' *dgima* 'sampling.N,' *hadgama* 'demonstration.N,' *digum* 'modeling,' *midgam* 'sampling, sample.N, *medugam* 'patterned (fabric).ADJ'.

The patterns in (1) are CaCaC, CéCeC, hiCCiC, huCCaC, CuCCa, muCCaC, CCiCa, haCCaCa, CiCuC, miCCaC, and meCuCaC respectively, where C stands for the consonantal root slot. Each of these patterns occurs in other combinations of roots, three of which are demonstrated in (2), all with the roots *p/f–l–t*, *k–l–t*, *k–c–v*.[1]

(2) CaCaC.V: *palat* 'discharge,' *kalat* 'comprehend,' *kacav* 'allot; set the rate or the tempo'.
CéCeC.N: *pélet* 'output,' *kélet* 'input,' *kécev* 'pace, speed'
miCCaC.N: *miflat* 'escape,' *miklat* 'shelter, refuge,' *mikcav* 'rhythm'

The root *d–g–m* in all the examples in (1) share the meaning of "demonstrating and exemplifying" which the patterns modify. Semantic relations exist in the roots presented in (2) as well: the abstract notion of "outwards" in *p/f–l–t*, the notion of "inwards" in *k–l–t*, and the notion of "giving boundaries" in *k–c–v*, either mentally or physically.

[1] There are alternations of *p–f*, *b–v*, and *k–x* in Hebrew words, residues of the Spirantization Rule (Schwarzwald, 2001: 14–15). They are marked when relevant as *p/f*, *b/v*, *k/x*.

Many patterns also suggest specific meanings, e.g., muCCaC and meCuCaC typify adjectives, CCiCa, CiCuC and haCCaCa relate to action nominals (gerundives in traditional terms), and some words in CéCeC denote abstractness (Berman, 2020; Ravid, 2020; Bolozky & Berman, 2020). However, patterns do not necessarily demonstrate a one-to-one relation with any specific meaning: the same pattern can suggest several groups of meanings and vice versa; likewise, the same meaning can be expressed by different patterns. For instance, although CiCuC and haCCaCa mean primarily action nominals, they can also imply other meanings as in *gidul* 'tumor' or *hadmaya* 'simulation.' The meaning of action nominals can be expressed using other patterns such as miCCaC as in *midgam* above or CiCCa as in *simxa* 'joy' (Ravid, 1999).

Root and pattern combination entails the existence of the root in more than one pattern, and the realization of the pattern in several roots. Therefore, it is important to note that at times, the syllabic structure of a word may look as if it is derived by root and pattern, but it might be either an AS-IS (non-derived) word, or a word derived by other means (Schwarzwald, 2009). The examples in (3) present such cases.

(3) a. *gímel* 'Gimel, the third letter of the Hebrew alphabet,' *sapir* 'Saphire,' *zéret* 'pinkie'.
b. *xaydak* 'bacterium,' *min'ad* '(music) range'.

The word *gímel* in (3a) includes the same consonants as the root *g-m-l* which exists in many words (e.g., *gamal* 'recompense; detoxify.V,' *gmul* 'payback.N,' *gimla* 'pension, benefit.N'), but *gímel* is not connected to this root, and its stress is penultimate, unlike regular Hebrew words that take the ultimate stress in such a syllabic structure (cf. *gidél* 'raise.V,' *gibén* 'hunchback.N'). *Sapir* seems to take the pattern CaCiC like the words *xalil* 'flute,' *camid* 'bracelette,' or *tapil* 'parasite,' from the roots *x–l–l*, *c–m–d*, and *t–p/f–l*, respectively. However, the consonants *s–p–r* in *sapir* do not have any connection to any other word in another pattern because the word is borrowed. The feminine word *zéret* follows the syllabic structure of many Hebrew masculine words of pattern CéCeC, but the consonants *z–r–t* do not have any other related words, unlike *péret* 'odd number; itemized list,' *yéled* 'child,' of this pattern that have many related words (e.g., *parat* 'cash (a bill into coins).V,' *peret* 'detail.V,' *tafrit* 'menu,' root *p/f–r–t*; *yalad* 'give birth,' *yaldut* 'childhood,' *hityaled* 'behave childishly.V,' root *y–l–d*).

Xaydak in (3b) is a concatenation of two words, *xay* 'living thing' and *dak* 'thin' and in spite of its resemblance to the syllabic structure of *lamdan* 'diligent.ADJ; Torah scholar.N' (pattern CaCCan, root *l–m–d*) or of *zamzam* 'buzzer' (pattern $C_1aC_2C_1aC_2$, reduplicated *z–m* root). Finally, the word *min'ad* looks like a word formed by the pattern miCCaC, the focus of this paper, but it is actually a concatenation of *min* 'from' and *'ad* 'until' which means a musical range. All the words in (3) are not root and pattern derived. The words *gímel*, *sapir*, and *zéret* in (3a) are considered AS-IS (non-derived) words, whereas *xaydak* and *min'ad* in (3b) are derived by word concatenation. The term I used, AS-IS (non-derived) words, is defined by others as basic or primitive nouns (Berman & Seroussi, 2011).

The pattern miCCaC as demonstrated in (1) and (2) forms the focus of this paper. Its occurrence in various morphophonemic realizations and its semantics will be analyzed in the following sections.

3 The Pattern miCCaC and Its Morphophonemic Variants

3.1 General Comments

Several nominal masculine patterns are composed of three radicals with an initial *m* (excluding those with final endings such as *–a*, *–et*): miCCoC (*mistor* 'hiding place'), maCCoC (*maxsof* 'cleavage'), maCCuC (*malbuš* 'garment'), miCCaC (*mišmar* 'guard'), miCCeC (*misped* 'eulogy'), meCCaC (*merxav* 'wide open space'), *maCCaC* (*margaš* 'general feeling'), and maCCeC (*maxbeš* 'roller, steam-roller') (Bolozky, 2020: 311–367).

The two patterns, maCCeC and miCCal with initial *m* encompass very large numbers of Hebrew nouns. Both of these patterns, and especially the first, have been extensively researched by a number of scholars (Gesenius, 1910: 236–237; Bauer & Leander, 1965: 492; Cohen, 1997; Gadish, 2010; Shatil, 2014: 97, 121; Laks, 2017). Historically, both miCCaC and maCCal are considered to be derived from the same reconstructed structure **maCCaC* (Bauer & Leander, 1965: 489–492), but based on morphological considerations and number of occurrences, I have separated these, as will be explained below. The number of nouns derived from the pattern maCCaC is not as extensive as those which follow miCCaC. A few nouns which allegedly employ miCCaC can be attributed to maCCaC or to non-derived (AS-IS) words. For the remainder of this article, I am going to exclusively concentrate on miCCaC.

The examples included in this article are not limited just to Modern Hebrew words. Moreover, the lists include a few new words coined by the Academy of the Hebrew Language.

3.2 The Data

The pattern miCCaC is quite a rich masculine noun formative in Hebrew. My study is based on around 300 nouns from all Hebrew language periods which were either gathered from dictionaries or from a list provided to me by Ronit Gadish and Rachel Rosenberg from the Academy of the Hebrew Language. I have excluded a more detailed list of words that take the syllabic structure miCCaC but which have no existing root in any other pattern. For example, *mizran* 'mattress' (*mizron* in colloquial Hebrew) has an unclear origin; its consonants *z–r–n* are not related to any other word; *micxaf* 'codex' was borrowed from Arabic in Medieval Hebrew, and is considered an AS-IS word; and *min'ad* 'musical range' has already been explained above in Section 2. In such cases, as the consonants which appear after *m* do not constitute a root and bare no relation to any other words or patterns in Hebrew, they could not be considered as radicals.

About half of the 300 words demonstrate the phonetic structure miCCaC with no exception, as in (4), in addition to the single examples demonstrated in (1) and (2). These are all derived from the combination of the pattern miCCaC with a regular triconsonantal roots.

(4) *mixtav* 'letter,' *migdal* 'tower,' *minyan* 'amount,' *mizrax* 'east,' *mimtar* 'shower, strong rain,' *mivxar* 'selection,' *migraš* 'empty lot,' *mifrac* 'bay,' *micrax* 'consumer good,' *mišlav* 'register,' *mivta* 'pronunciation,' *midraš* 'Midrash, homiletic interpretation, *mivxan* 'test,' *miš'al* 'quastionnaire'.

In the following section I will describe the allomorphic variants of the other half of words derived by miCCaC which form sub-patterns depending on the radical structure. The claim will be made that sub-patterns (or allomorphs) of a pattern can only be justified if they fit into the Hebrew morphophonemic system as a whole. The approximate number of examples in each category is mentioned only when they exceed 20 (out of the total of 300, but in fact out of the 150 remaining examples).

3.3 Phonological Factor

The phonological factor is determined by the first guttural consonant (G) of the root, which is directly related to orthography. Historically, guttural consonants included the glottal stop ˀ, the glottal fricative *h*, the pharyngeals ˁ and *ḥ*, and the uvular *γ* or ʁ, which are represented by the following Hebrew letters: *álef*, *he*(*y*), *áyin*, *xet*, and *resh*, respectively. For most Hebrew speakers today, ˀ, ˁ and *h* are hardly pronounced; *x* reflects the historical **ḥ* as well as *x* (the fricative counterpart of *k*, called *kaf rafa* in Hebrew), although ˁ and *ḥ* are still pronounced by Hebrew speakers, descendants of Arabic speaking immigrants to Israel, and can be motivated phonologically (Pariente, 2010; Shatil, 2014, chapter 2; Bolozky, 2016; Gafter, 2016; Klein, 2020). Modern Hebrew includes the consonants ˀ (alternating with Ø, marked below in word medial position by ('), *x* and ʁ, but orthography still reflects the historical usage of *ˀ, *ˁ, **h*, **ḥ*, and **r* and often influences newly derived words. As a direct consequence of this, in all of the following cited examples, the orthographic realization is represented, and the reader needs to bear in mind that *ḥ* is realized phonetically as *x*, while ' (ˀ, ˁ and *h*) is not always pronounced and *r* stands for ʁ. ˀ in final position is omitted, and features in plural forms.

There are two ways in which gutturals affect miCCaC formed words (Blau, 1981; Bolozky, 1997, 2016; Shatil, 2003):

(a) They lower the vowels that precede them, hence the vowel *i* in miCCaC changes to *a*, and rarely to *e*, resulting in the sub-patterns maGCaC or meGCac, as in (5a, 5b) below.
(b) An additional mirror vowel *a* is added after the initial guttural, as in (5c).

(5) a. **maGCaC**: *maḥmad* ‘darling,’ *maḥsan* ‘storeroom,’ *maḥcav* ‘inorganic mineral,’ *maḥbar* ‘connector, transactor,’ *maḥmal* ‘sweetheart,’ *maḥšax* ‘deep darkness,’ *maḥnak* ‘suffocation’.

b. **meGCaC**: *meḥdal* ‘failure (to do something),’ *meḥlaf* ‘interchange,’ *meḥkar* ‘research,’ *meḥbar* ‘connecting road, ramp,’ *meḥlak* ‘special (police) department,’ *meḥtax* ‘cut part,’ *meḥdar* ‘(geology) intrusion,’ *merḥav* ‘wide open space,’ *merkaz* ‘center,’ *merḥac* ‘public bath house,’ *merḥak* ‘distance,’ *merkav* ‘body (of a vehicle)’

c. **maGaCaC**: *ma’ahal* ‘tent encampment,’ *ma’arav* ‘ambush,’ *mahalax* ‘process, step,’ *mahapax* ‘dramatic change,’ *ma’agal* ‘circle,’ *ma’arav* ‘west,’ *ma’anak* ‘grant, scholarship’ (about 40 examples)

These two processes exist across the Hebrew morphophonemic system and can be observed in verbs as well as in nouns, where the vowel *i* is realized as *a* in front of a guttural, e.g., *y**a**ḥšov* ‘think.3M.SG.FUT’ (cf. *y**i**ftor* ‘solve.3M.SG.FUT’), lowered to *e*, e.g., *n**e**ḥrad* ‘be terrified.3M.SG.PST’ (cf. *n**i**frad* ‘be separated.3M.SG.PST’), and reduplicated, e.g., *y**a’a**mod* ‘stand.3M.SG.FUT,’ *t**aḥa**na* ‘mill’ (cf. *y**i**šmor* ‘guard.3M.SG.FUT,’ *t**i**kva* ‘hope’).

The sub-pattern maGCaC in (5a) only occurs with root initial *ḥ* [x] in orthography. It never appears when *x* is a reflection of *kaf rafa*, as the following examples demonstrate: *mixtav* ‘letter’ (cf. *ktovet* ‘address’), *mixpal* ‘multiplication’ (cf. *kaful* ‘duplicated’), *mixraz* ‘(commerce, administration) tender’ (cf. *karoz* ‘announcer’). This suggests that orthography plays an important role in the formation and perception of Hebrew patterns and sub-patterns (Ravid, 2012).

The sub-pattern meGCaC (5b) is restricted to the initial consonants *ḥ* and *r* [ʁ]. There are eight occurrences of maḥCaC in (5a) and seven of meḥCaC in (5b) with the initial radical *ḥ*. In one case there is a semantic distinction between *maḥbar* ‘connector, transactor’ and *meḥbar* ‘connecting road, ramp’ derived from the same root *ḥ–b–r*. Four of the maḥCaC pattern words are inherited from the Bible (*maḥmad* ‘darling,’ *maḥmal* ‘sweetheart,’ *maḥnak* ‘suffocation,’ and *maḥšax* ‘deep darkness’; the biblical words do not always carry the same meaning as today, but this does not change the arguments.); *maḥcav* is inherited form Medieval Hebrew and *maḥsan* is a new word based on the Arabic (مخزن [maxzan]) which has the root *ḥ–s–n* that is productive in other Hebrew words (e.g., *haḥsana* ‘storing,’ *huḥsan* ‘be stored’).

Out of the seven words which take the pattern meḥCaC in (5b), six are new innovations, and only *meḥkar* ‘research’ could be found in the Bible. Other than lowering the vowel, I could not find any reason for the choice of the vowel *e* in these cases which follow the pattern miCCaC. In Biblical Hebrew, *a* and *e* alternations can be explained on morphophonemic grounds, cf. *yaḥaroš* ‘plow.3M.SG.FUT’ and *yeḥeraš* ‘be silent.3F.SG.FUT,’ but this is not the case with miCCaC (Schwarzwald, 2012).

The apposition of miCCaC and meCCaC in the case of root initial *r* [ʁ] presents a different picture. There are seven words formed using the mirCaC pattern, and five using merCaC. Three of the mirCaC pattern words were formed during previous periods of Hebrew usage, Biblical or Medieval Hebrew: *mirbac* ‘(geology) deposit, stratum,’ *mirmas*, ‘trampling,’ *mirvaḥ* ‘space.’ The other four words are new to the language: *mirkam* ‘texture,’ *miršam* ‘prescription,’ *mirdaf* ‘chase, pursuit,’ and *mir’aš* ‘sensation’ that the Academy of the Hebrew Language coined (instead of the more commonly used *sensácya*).

Because *r* is no longer considered a guttural consonant, the vowel *i* in mirCaC adheres to the same rules as other words that use this pattern, and is formed in the same way as miCCaC in (4). However, there is a common denominator to the words which follow the sub-pattern merCaC with initial *r*: the second radical is either *ḥ* or *k*, both of which are back-low consonants (*merḥac* 'public bath house,' *merḥak* 'distance,' *merḥav* 'wide open space,' *merkav* 'body (of a vehicle),' and *merkaz* 'center'). It seems that the proximity of the *r* to the back-low consonants influenced the lowering of the vowel *i* in these cases. Similar phenomena occurs in the verbal system: compare *her'a* 'show.3M.PST' of root *r–'–y* in *hifʕil* to *hirba* 'increase.3M.PST' of root *r–b–y*; the second radical *'* in *her'a* affected the first vowel.

The addition of a mirror vowel in (5c) occurs when the first radical is *'* or *h* which represent the orthographic and historical ʾ, ʿ, and *h* leading to the sub-pattern maGaCaC. The actual pronunciation in such cases is in fact maaCaC, e.g., *maahal* ~ *maaal*, *maarav*, *mahalax* ~ *maalax*. The number of examples which use these patterns in this category is the largest because of the number of initial guttural radicals (Shatil, 2014: 25–59).

To sum up, the lowering of the first vowel in the miCCaC pattern is caused by guttural consonants that occur as the first radical of the root. The orthographic weight of these consonants still has an important impact on newly formed words which adhere to these sub-patterns in Modern Hebrew.

3.4 Morphological Factors

Roots of three radicals or more are considered to be full or canonic roots. Phonetic two radicals also exist, and are called defective or weak roots (Bolozky, 2007; Seroussi, 2014; Ravid, 2020). In these cases, a third radical can be reconstructed by comparison to other words or inflections. Thus a word like *xiba* 'affection' is reconstructed as having the root *x–b/v–b/v* when compared verbs such as *xibev* 'be fond of'; the word *xov* 'debt' is reconstructed as having the root *x–y–v* or *x–w–v* when compared to the nouns *xiyuv* 'obligation; acquiescence; conviction' and *xova* 'obligation, requirement' and the verb *xiyev* 'coerce; agree with'; *tošav* 'resident, inhabitant' is reconstructed as taking the root *y/w–š–v* because of its relation to *yašav* 'sit; settle,' *yišuv* 'settlement'; and *kana* 'buy' is reconstructed as the root *k–n–y* because of *kniya* 'purchase,' *kanuy* 'bought,' etc.

The synchronic analysis of weak roots is as follows (Rosén, 1956: 199; Schwarzwald, 1984; Gonen, 2009):

I. Roots with initial V (historical roots *w/yCC).
II. Roots with initial *n* (which is omitted; these also include several roots starting with *y* followed by *c* and the root *l–k–x*).
III. Roots with medial V (historical roots *Cw/yC).
IV. Roots with final V (historical roots *CCy and *CCʾ).
V. Duplicate second and third radicals (*$C_1C_2C_2$).

The pattern miCCaC occurs with weak roots and takes the following sub-patterns in descending order of the number of words which adhere to each form: maCoC (III; 6 below), miCCe (IV; 7 below), moCaC (I; 8 below), meyCaC (I; 9 below), and miCaC (II; 10 below). In three sub-patterns, moCaC, meyCaC, and miCaC, the vowel *a* occurs between the second and third radicals, as in the pattern miCCaC. The final vowel is not *a* in the case of root medial vowel (maCoC; III) and root final vowel (miCCe; IV). In the discussion below I will analyze these sub-patterns and justify why it is that they adhere to miCCaC. Roots of type *CCˀ resemble full or canonic roots except that the final consonant is phonetically absent in the singular, even though this is represented in orthography.

The sub-patterns below are presented according to their rate of distribution. A sample is listed when many examples exist in a category.

(6) **maCoC** (root *C–w/y–C): *mavox* 'maze,' *maxog* 'hand (on a clock),' *manof* 'crane (instrument),' *matos* 'airplane,' *mašot* 'oar,' *manos* 'escape,' *mavo* 'introduction' (about 40 examples)

The words exemplified in (6) contain two consonantal roots whose semi-vowels are revealed in other nouns and verbs, e.g., *mavox* from root *b/v–w–x* as in *hevix* 'embarrass.v,' *mev**u**xa* 'embarrassment'; *maxog* from root *x–w–g* as in *xag* 'circle.v,' *mex**u**ga* '(geometry) pair of compasses'; *manof* from root *n–w–f* as in *henif* 'lift up,' *tn**u**fa* 'movement, drive'; *mašot* from root *š–w–t* as in *šat* 'sail.v,' *hašata* 'rowing.TRNS,' *šá**y**it* 'cruise'; *manos* from root *n–w–s* as in *nas* 'flee,' *men**u**sa* 'flight, retreat,' etc.

The first vowel in the sub-pattern maCoC is realized as *a*, as this occurs in other instances of roots with medial *w*. The same vowel change appears in the verbal system. The future tense of *tas* 'fly.3M.SG.PST' is *y**a**tus* (root *t–w–s*), of *ba* 'come' is *y**a**vo* (root *b/v–w–ˀ*), cf. *šamar* 'guard.3M.SG.PST' – *y**i**šmor*.3M.SG.FUT.'

The medial semivowel *w* becomes *o* in the sub-pattern presented in (6) where the root appears with two consonants. The realization of *w* between the consonants as *o* is phonetically motivated: the back semi-vowel *w* surfaces phonetically as the back vowels *o* or *u* (see 8 below). Although one might expect the vowel *u* to occur in such cases, there is no sub-pattern of the structure maCuC in Hebrew where C is the first radical (there is maCuC with the initial radical *n*, e.g., *mapúax* of root *n–p/f–x*, but this is not related to miCCaC; Bolozky, 2020: 328–329). There are of course many words which take the structure CaCuC, some of which start with *m*, e.g., *madud* 'measured,' *macuy* 'existent,' like *gamur* 'completed,' *xacuy* 'split,' etc.; however, these are not related to the pattern miCCaC under discussion here.

The word *maxoz* 'district' is excluded from (6) despite having a similar syllabic structure, because the look-alike root **x–w–z* is not semantically related to any other words. Although it appears in the Bible, this is a non-derived (AS-IS) orphan word, probably borrowed from Akkadian.

(7) **miCCe** (root *C–C–y): *mivne* 'building, structure,' *mixse* 'cover,' *mir'e* 'pasture,' *mišne* 'deputy,' *mište* 'feast,' *mitle* 'rack' (about 25 examples)

The reconstructed final semi-vowel *y* in (7) is represented by the final vowel *e* in this sub-pattern. Ending these words with a final vowel *a* as in miCCaC would turn the nouns feminine, hence dissociating them from the masculine miCCaC pattern (cf. *micva* 'commandment.F' from the root *c–v–y*). Historically, the vowel *e* at the end of C–C–y roots is a result of the contraction of diphthongs or triphthongs, where **ayu* shifted to become ε and **ay* gradually turned into *e*, both of which are realized in Modern Hebrew as *e* (Bauer & Leander, 1965: 406–413). Synchronically, the appearance of a final *e* in different forms and conjugations proves that it is the productive equivalent of the vowel *a* in roots with final *y*, e.g., *yikn**e*** 'buy.3M.SG.FUT,' root *k-n-y* (cf. *yilm**a**d* 'study.3M.SG.FUT,' root *l–m–d*), *mufn**e*** 'directed (toward),' root *p/f–n–y* (cf. *mufk**a**d* 'deposited,' root *p/f–k–d*), *nišne* 'repeated,' root *š–n–y* (cf. *niškaḥ* 'forgotten,' root *š–k/x–ḥ*).

(8) **moCaC** (root *w/y–C–C): *molad* 'birth (beginning),' *mosad* 'institution,' *morad* 'slope,' *mošav* 'seat; settlement,' *motar* 'leftover,' *modaʕ* 'acquaintance,' *moval* 'duct,' *mofaʕ* 'performance,' *moca* 'extraction,' *mora* 'fear'.

The roots in the sub-pattern (8) show alternations between initial *y* and occasionally *v* (**w*), and the vowels *e* or *o* in various verbal and nominal forms. For instance, the word *m**o**lad* from the root *y/w–l–d* is related to ***y**alad* 'give birth,' ***y**éled* 'child,' ***te**led* 'give birth.3F.SG.FUT,' *n**o**lad* 'be born.2M.SG.PST,' *yi**v**aled* 'be born.3M.SG.FUT,' ***to**lada* 'consequence'; the word *m**o**rad* from the root *y/w–r–d* is related to ***y**arad* 'go down.3M.SG.PST,' *h**o**rid* 'lower.3M.SG.PST,' ***y**erida* 'descent,' etc. Historically the vowel *o* also resulted from a diphthong contraction where **aw* became *o* (Bauer & Leander, 1965: 376–385).

(9) **meyCaC** (root *y–C–C): *meyzam* 'project,' *meytav* 'best, utmost,' *meytar* 'string, cord,' *meycag* 'display,' *meyšar* 'prison service officer,' *meydaʕ* 'information,' *meyzaʕ* 'sweatshirt,' *meytad* 'screw anchor,' *meycav* '(art) installation'.

The sub-pattern in (9) includes examples where the initial radical is *y* which never alternates with **w*, unlike the examples in (8). Of these nine words, three are already attested to in Biblical Hebrew, *meytav*, *meyšar*, and *meytar*. The other six are derived from words with initial *y* (cf. e.g., *yazam* 'initiate.V; initiator.N, *yozma* 'initiation'; *yiceg* 'represent,' *yicug* 'representation'; *yated* 'stake, peg (tent)'; *yaciv* 'steady,' *yicuv* 'stabilization'). Although historically there was a diphthong contraction of **ay* into *e*, in Modern Hebrew the diphthong *ey* exists as a direct result of spelling pronunciation. The process in the pattern miCCaC is equivalent to its occurrences in the verbal system. Verbs with root initial *y* formed with the verbal pattern *hif'il* take the vowel *e(y)* rather than *i*, e.g., *heyníka* 'breast feed.3F.SG.PST,' *meynika*.PRES, *meynéket* 'wet nurse' (root **y–n–q*); *heyšir* 'direct straightforward' (root *y–š–r*); *heymin* 'go to the right' (root *y–m–n*, etc.; cf. *hifkid* 'deposit.3M.SG.PST,' *hilbin* 'whiten').

The sub-pattern miCaC is very rare and only includes three nouns:

(10) **miCaC**: (root *n–C–C): *mišak* '(carpentry) join,' *micav* 'status,' *mikax* 'taking'.

The noun *mišak* is derived from the root *n–š–k*, *micav* from the root *y–c–v*, and *mikax* from the root *l–k–x* which systematically behaves in the same way as roots with an initial *n*. I do not consider the sub-pattern maCaC with root initial *n* or *y* before *c* as a derivative of miCCaC as explained below in Section 3.6.

3.5 Interaction Between Phonological and Morphological Factors

The combinations of a guttural first radical and a final root vocalic element have led to the sub-pattern maG(a)Ce, as in (11).

(11) **maG(a)Ce**: *maḥaze* 'theater play,' *maḥane* 'camp, *maḥase* ~ *maḥse* 'shelter,' *ma'ate* 'cover,' *ma'ale* 'slope, hillside,' *ma'ane* 'response,' *ma'ake* 'banister,' *ma'ase* 'act, story,' *ma'are* 'empty space,' *ma'afe* 'pastry,' *maḥave* 'pointer'.

These words demonstrate a lowering of the vowel *i* in miCCaC to *a* in front of a guttural consonant, and the change of the final vowel to *e* in roots which end in *y*, as discussed above regarding (5) and (7).

3.6 Miscellaneous

(a) The phonetic realization of the sub-pattern maCaC in (12) deserves special consideration because a number of researchers treat it as a sub-pattern of miCCaC (Segal, 1936; Bauer & Leander, 1965; Cohen, 1997; Gadish, 2010; Shatil, 2014: 97, 121). Here are a few examples:

(12) **maCaC** (root *n–C–C/*y–c–C): *mabat* 'glance, view,' *mapal* 'waterfall,' *mapax* 'breath (of wing),' *macat* 'spark plug,' *matan* 'giving,' *makaš* 'key (in a keyboard),' *macav* 'situation,' *maca* 'bed; (political) platform' (about 25 examples)

Most of the words in (12) are primarily derived from roots with initial radical **n* where the *n* is omitted (and orthographically hinted at by the *dagesh* in the following radical), e.g., *mapal* from *n–p/f–l* related to falling, *matan* from *n–t–n* related to giving; a few are derived from initial *y*, often followed by *c*, e.g., *mada* 'science' from *y–d–ˁ* related to knowledge, *macag* 'presentation' from *y–c–g* related to representation. Would it be accurate to suggest that this is a sub-pattern of miCCaC?

The strongest argument against considering maCaC as a sub-pattern of miCCaC is its lack of similarity to other instances of roots with an initial *n*: whenever the radical *n* or *y* in front of *c* is omitted, the basic vowel of the pattern or conjugation does not change. For instance, compare (a) *higdil* 'enlarged.3M.SG.PST' formed from the root *g–d–l* with *hipil* 'dropped.3M.SG.PST' from the root *n–p/f–l* or *hicit* 'ignite, set fire.3M.SG.PST' from the root *y–c–t*; or (b) *yišmor* 'guard.3M.SG.FUT' from the root *š–m–r* to *yipol* 'fall.3M.SG.FUT' from the root *n–p/f–l*, and *yitol* 'take.3M.SG.FUT' from the root *n–t–l*. In both cases the original vowel is retained either in the pattern *hifʕil* or in the conjugation of the future tense when *n* or *y* is omitted. If miCCaC formed the base pattern for the examples cited in (12), they should undoubtedly have become **mibat, *mipal*, **mipax*, etc., as in (10), rather than *mabat*, *mapal*, *mapax*. For these reasons, it is clear that maCaC cannot be considered as a sub-pattern of miCCaC, and that the examples shown in (12) undeniably fit the pattern maCCaC.

(b) A number of words look like a sub-pattern maCCe (cf. 11 above). Although the last radical of the root is *y*, the roots themselves do not include a first guttural radical, as in (13). It is clear then that these adhere to another pattern. Here are the examples:

(13) **maCCe**: *masve* 'mask,' *mar'e* 'sight,' *maške* 'beverage,' *matpe* 'fire extinguisher,' *makle* 'toaster,' *matle* 'slipnot (for hanging),' *mamxe* '(kitchen) blender'.

There are only seven examples in this category, six of which indicate a tool or instrument, as is typical of maCCeC.

(c) I did not include the examples in (14) as representing miCCaC because there is no justification for the use of the vowel *a* at the beginning of each of these words. They certainly comply very closely with the pattern maCCaC. The examples in (14a) are in the singular whereas those in (14b) are pluralia tantum which takes the ending *–im*.

(14) a. **maCCaC**: *mat'am* 'delicacy,' *mal'ax* 'angel,' *malmad* (*habakar*) 'shepherds staff,' *mamtak* 'sweet, candy,' *maš'av* 'resource,' *mašmaʕ* 'meaning,' *marvad* 'carpet,' *margaš* 'feeling,' *matxal* '(botany) spathe'.
b. **maCCaCim**: *mat'amim* 'delicacy,' *mamtakim* 'sweets' (cf. 10a)

The examples given in (15) are pluralia tantum and look like they adhere to miCCaC along with the dual ending *–áyim* (15a) or the plural ending *–im* (15b). I have used the term "ending" rather than "suffix" because in my view all these words were formed adhering to the patterns miCCaCáyim or miCCaCim.

(15) a. **miCCaCáyim**: *migzazáyim* 'scissors for cutting sheep's wool,' *migzaráyim* 'plier for cutting wire,' *miglašayim* 'skis,' *mixnasáyim* 'trousers,' *misparáyim* 'scissors,' *micbatáyim* 'pair of pincers,' *miškafáyim* '(eye) glasses,' *melḥacáyim* 'clamp,' *melkaḥayim* 'tong'.
b. **miCCaCim**: *midganim* 'cereals,' *mišmanim* 'body fats'

In general, there is a connection between nouns formed by suffixes in either linear derivation or inflection, e.g., *šavúa* 'week' + *–áyim* > *švu'áyim* 'two weeks,' + *–on* > *šavu'on* 'a weekly publication,' + *–i* > *švu'i* 'weekly'; *kaf* 'palm' + −*áyim* > *kapáyim* 'hand palms'; *élef* 'thousand' + −*áyim* > *alpáyim* 'two thousands,' + −*im* > *alafim* 'thousands,' + −*it* > *alpit* 'thousandth.' In all of the examples shown in (15), there is no way in which the nouns featured could have derived from any other words. The word *mispar* 'number' is not semantically related to *misparáyim* 'scissors'; the word *migzar* 'sector' and *migzaráyim* 'plier for cutting wire' are also not related. The former is derived from the root *s–p/f–r* which conveys cutting and the latter from the root *g–z–r* which also carries the inference of cutting. In all the other examples in (15), no singular noun could be the basis for the featured words, so they must therefore be root derived. Incidentally, in colloquial Hebrew the word *mixnasáyim* serves as the basis for the back formation of *mixnas* 'pants leg' and by generalization to 'pants'; likewise, *miškafáyim* functioned as the basis for the back formation of *miškaf* 'visor' and 'glasses.'

All the nouns in (15a) refer to tools or instruments which have two arms or sides, as exemplified by the dual ending *–áyim*. The last two nouns in (15a) have the vowel *e* instead of *i* (meCCaCáyim). The word *melkaḥáyim* appears in the Bible (Isaiah 6: 6), and it seems that *melḥacáyim* was coined by following this biblical source; notwithstanding, both roots start with *l* and are followed by the guttural consonant *ḥ* which caused the lowering or the vowel *i* (cf. discussion regarding meGCaC in (5b) in Section 3.3).

3.7 Summary

Two kinds of allomorphic sub-patterns of miCCaC generated by phonological and morphological considerations are presented in Sects. 3.3, 3.4 and 3.5 above. The phonological factor involves first guttural radical, whereas morphological variants result from weak root structure. All these generalizations follow classical Hebrew forms and are not new innovations. They are motivated independently in other morphological systems including other nouns and verbs; therefore, they seem to be as productive in Modern Hebrew as they were in classical Hebrew. The miscellaneous examples in Section 3.6 demonstrate other patterns that show some similarities to miCCaC, but nevertheless cannot be considered as following the pattern miCCaC. Two such cases, (13) and (15), also demonstrate semantic generalizations which imply that they are tools, and this leads us to the next section.

4 The Semantic Load of miCCaC

References to the semantics of miCCaC stress that this pattern infers location, as in Peretz (1936), Ravid (2020: 235), and grammar textbooks like Sadka (1990: 229), Goshen-Gottstein and Shapira (1996: 141), Avinun (1997: 201), and Amir Coffin and Bolozky (2005: 150). Linguistic research of Classical Hebrew displays a different classification.

Gesenius (1910: 236–237) and Joüon and Muraoka (2011: 236–238) discuss every biblical noun which takes the initial performative *m*, and indicate that they share various common connotations such as reference to locality, or tool or instrument functionality (although Joüon & Muraoka also stress the abstract meaning of these words). Segal and Yellin also refer to all Hebrew nouns that begin with *m*, including those with the endings *–a* or *–et*. Segal (1936: 80) classifies nouns starting with *m* in Biblical and Mishnaic Hebrew as (1) active nouns and gerundives (action nouns), e.g., *mimkar* 'sale'; (2) passive nouns, especially those representing the result of an action, e.g., *ma'afe* 'pastry'; (3) instruments, e.g., *min'al* 'footwear'; (4) location nouns, e.g., *merḥac* 'public bath house.' Yellin (1945: 177–178) asserts that many nouns that start with the letter *m* indicate (1) location (2) instruments and (3) abstract ideas. In each case the first example he cites adheres to the pattern miCCaC: *midrax* 'foothold'; *mixbar* 'kitchen rack'; *mif'al* 'enterprise (today also 'factory').' Yellin gives location as the most common inference of miCCaC pattern words, while Segal places this connotation in fourth place. The first two most common meanings of miCCaC pattern words as suggested by Segal correspond to Yellin's third most common insinuation.

Cohen (1997) also refers to masculine nouns that start with *m* (without the endings *–a* and *–et*) in Mishnaic Hebrew. He discusses both miCCaC and maCCeC, and compares biblical to Mishnaic distribution of these patterns. His research shows that biblical words which utilize these forms primarily serve as gerundives which indicate abstract nouns relating to existing verbs, a meaning which was lost in Mishnaic Hebrew. The connotation that these two patterns refer to tools or instruments increased in Mishnaic Hebrew (Cohen, 1997: 111). His classification concords with two of the pattern meanings suggested by Segal and Yellin; however there is no emphasis on the inference of location in his research.

Both Glinert and Bolozky specifically refer to miCCaC and conclude that it primarily denotes location. However, while Glinert (1989: 431) also suggests that actions and consequent results are characterized by this pattern, Bolozky (1999: 135; 2020: 330) argues that it can also represent abstractness.

Gadish (2010) analyzes the four patterns: maCCeC and maCCeCa, miCCaC and miCCaCa. She refers to nouns used in Hebrew today which are either derived from previous layers of the language or are new innovations, many of which have been coined by the Academy of the Hebrew Language. According to her very thorough study, about half of the nouns which adhere to the miCCaC pattern can either be categorized as gerundives or represent the result of an action (a premise on which Segal and Cohen, and to a lesser extent Yellin, also agree). A few tens of nouns refer to tools or instruments; however, there are also groups of words which relate to geography or geology. Gadish notes that a number of words are culinary related, some of which take the plural form, e.g., *mitbal* 'dip,' *mimsax* 'alcoholic beverage,' *mat'amim* 'delicacy,' *maḥmacim* 'pickles,' *mamtakim* 'sweets (candies),' and *midganim* 'cereal' (cf. 15 above). According to Gadish, the suggestion that the pattern miCCaC can sometimes imply location is notable, but of secondary relevance.

In my own analysis of the connotations of the 300 miCCaC pattern nouns, I found that location is alluded to in about 23% of the words, as in (16), and 16%

denote tools or instruments, as in (17). The majority of the nouns (61%) express rather general concepts, abstract as well as concrete, and a number of these can be considered as action nouns (gerundives), as in (18).

(16) *mitbax* 'kitchen,' *minzar* 'monastery,' *ma'axaz* 'outpost,' *mexlaf* 'interchange,' *masof* 'terminal,' *micpe* 'vantage point,' *mosad* 'institution,' *ma'ayan* 'wellspring,' *maxane* 'camp'.
(17) *midras* 'insole,' *misxak* 'game,' *micnax* 'parachute jump,' *manóa* 'engine,' *mitle* 'rack,' *ma'ake* 'banister,' *meytar* 'cord'.
(18) *mivzak* 'news flash,' *migbaš* 'conglomeration,' *migvan* 'variety,' *ma'avak* 'struggle,' *ma'amac* 'effort,' *mikre* 'incident,' *milve* 'loan,' *ma'of* 'imagination,' *mavox* 'maze'.

Although the number of words analyzed is not sufficient for making further generalizations, it is notable that 30 of the examples in (4), 5 in (5b), 10 in (6), and 5 of the 10 in (8) indicate location. I did not check empirically if these words are more often used than others, but perhaps daily use frequency has resulted in the perception that miCCaC pattern words primarily indicate location. (On the role of frequency on linguistic perception, see e.g., Schwarzwald, 1981, 2019; Bolozky, 1986; Bybee & Hopper, 2001; Tribushinina et al., 2014; Ambridge et al., 2015).

Two more points should be taken into consideration regarding the semantic classification of words which adhere to the miCCaC pattern: a. a number of the 300 miCCaC words are newly coined and are therefore not known of or used by contemporary Hebrew speakers; b. some of the words can be classified as inferring more than one meaning: *ma'ake* in (17) is listed as a being a tool, but it can also mean a place that people should not cross over; *mavox* in (18) is listed as being an abstract noun, but it can also be classified as a noun suggesting location.

5 Conclusion

An analysis of approximately 300 masculine nouns which adhere to the miCCaC pattern demonstrates that roughly half of these feature three consonantal roots which do not change form, while all the others display allomorphic variations due to phonological or morphological constraints depending on specific root features. From this second half, approximately 40% (60 examples) of the phonological allomorphs are determined by the first guttural radical, while morphological variants are mainly caused by weak roots which feature the semi-vowels *w* and *y*; the number of roots which have *n* as initial radical is very scarce (see 10 above). As for the semantics of the words which adhere to the miCCaC pattern, meanings vary greatly from high, abstract allusions to gerundives or unspecified inferences, and also to basic, physical tools or instruments. A number of words which utilize this pattern insinuate location, but this is certainly not its most extensive inference.

The miCCaC pattern can serve as a model for the examination of other morphological Hebrew forms (and also those found in other Semitic languages). It leads to several observations:

(a) The pattern denotes the basic morphological shape of a word that enables the formation of more derivations and inflections. The basic pattern miCCaC and its sub-patterns are pluralized by + − *im*, and can take derivational suffixes such as *–an* or *–i*, e.g., *mivzak* 'news flash,' *mivzakim*.PL, *mivzekan* 'news flash broadcaster,' *mivzaki*.ADJ. Exceptions to plural forms are very scarce and only occur in very few of the words presented in the morphological allomorphs given in Section 3.4 above. These exceptions have found their way into the modern language from classical periods of Hebrew usage, e.g., *mosad-mosadot*, *morad-moradot* (cf. 8 above).

(b) There are many words which seem to adhere to the miCCaC pattern when this is not the case. For a word to be considered as taking the miCCaC form it must have a root that also occurs in other patterns. Therefore, although words such as *migdan* 'sweet pastry,' *mivrac* 'sluiceway,' and *min'ad* 'diapason' might appear to adhere to the miCCaC pattern, this is only because they are constructed using the same syllabic elements, and as such do not fit the definition of root and pattern combination. *Migdan* is a back formation from *migdanot* 'sweet delicacies,' which itself was formed from a combination of *méged* 'pleasant thing' + −*an* + −*ot*. *Mivrac* has no real root and does not occur in any other word or pattern, and *min'ad* is a concatenation of *min* 'from' + *ad* 'until,' as explained in Section 2.

(c) Patterns, including miCCaC, may be realized in a number of different ways (as demonstrated in Section 3). The so-called "segolites" are a good example of this (Bolozky, 1995; Bat-El, 2012). The basic masculine pattern CéCeC is realized as CéCeC, CéCaG (where G stand for a guttural as in Section 3.3), CáGaC, CáWeC, CéCi, etc., e.g., *béged* 'cloth, garment,' *métaḥ* 'tension; horizontal bar,' *bá'al* 'husband, owner,' *mávet* 'death,' *téli* 'coat hanger,' from the roots *b–g–d*, *m–t–ḥ*, *b–ʿ–l*, *m–w–t*, *t–l–y*, respectively. All of these examples use the same plural formation CCaCim, which is realized phonetically depending on the Hebrew consonantal clusters system: *bgadim*, *metaḥim*, *be'alim*, *tlayim* (*mavet* has no plural in Hebrew).

(d) Many biblical Hebrew words adhere to the miCCaC pattern, and the number of words which take this form has increased over the years. New words in Modern Hebrew which take this pattern follow the same phonological and morphological variations discussed above, e.g., *mivrak* 'telegram' which uses the root *b/v–r–k* (cf. 4 above), *mahpax* ~ *mahapax* 'dramatic change' where the root is *h–p/f–x* (cf. 5a, 5c above), *mofaʕ* 'performance, show' using the root *w–p/f–ʕ* (cf. 8 above), *meyzam* 'initiation' from the root *y–z–m* (cf. 9 above), etc. Cohen's (1997) study suggests that the semantics of the miCCaC pattern changed from Biblical to Mishnaic Hebrew whereby dominant abstract and action nominal meanings in Biblical Hebrew became more concrete, and mostly indicate instruments and tools in Mishnaic Hebrew. However, in all era of Hebrew usage, the miCCaC pattern has also implied location.

Modern Hebrew features words from all historical periods which have been adapted to adhere to the miCCaC pattern. The meaning of some of these words has also changed over time (see Section 4 above). The miCCaC pattern is a familiar and comfortable container which can easily absorb a root and modify its meaning where necessary.

(e) The inclusion of allomorphic sub-patterns in this paper was carefully based on an examination of the morphophonemic processes that the nouns in question may have undergone as a result of the Hebrew grammatical system. This is the reason why the pattern maCaC which is composed of radicals with an initial *n* has been excluded in this study (see 12 above).

Regarding the guttural initial radical as shown in (5a) and (5c), one could argue that the basic pattern here is maCCaC rather than miCCaC because of diachronic considerations as gutturals are known to retain archaic language processes. However, this argument does not hold synchronically due to the fact that the maCCaC pattern is quite rare, as demonstrated in the examples in (14).

Moreover, synchronically, the change from *i* to *a* in front of a guttural consonant occurs in Hebrew verbs as well as nouns. Compare *y**i**šmor* 'guard.3M.SG.FUT' from the root *š–m–r* to *yaḥlom* 'dream.3M.SG.FUT' from the root *ḥ–l–m*; *tizmóret* 'orchestra' from the root *z–m–r* to *ta'aróvet* 'mixture' from the root *ʕ–r–v/b*. In both cases the vowel *i* changes to *a* in front of a guttural. The same process occurs in the miCCaC pattern as it shifts to maGCaC. It is therefore not justified synchronically to suggest that the examples given in (5) adhere to the pattern maCCaC.

(f) When examining the Hebrew pattern system in general, other than for the pattern CaCaC and CaCCan with the repeated vowel *a*, and CéCeC with the repeated vowel *e*, most patterns are di- or tri-syllabic and display varied vowels (Schwarzwald & Cohen-Gross's, 2000), e.g., CaCiC (*savir* 'reasinable'), maCCeC (*maxbeš* 'steamroller'), CiCaCon (*zikaron* 'memory'), CóCeC (*gódel* 'size'), taCCiC (*talmid* 'student'), maCCeCa (*maclema* 'camera'), tiCCóCet (*tilbóšet* 'uniform') as well as many more. I call this tendency "vowel polarity" in Hebrew word formation, and it occurs in verbs as well as in nouns (Schwarzwald, 2012). This tendency can be seen in the basic miCCaC pattern (4) and also in sub-patterns with weak roots: maCoC (6), miCCe (7), moCaC (8), meyCaC (9), miCaC (10) maGaCe (11) as well as in (5b).

The discussion above regarding the influence of phonological and morphophonemic considerations would suggest that orthography still influences the formation of new Hebrew words today (Ravid, 2012). Although not realized phonetically, the pattern maGCaC is dominant when the first consonant of the root is a guttural. Gutturals continue to strongly influence newly formed words that utilize this and other patterns (Bolozky, 2016).

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Life and Death Expressions in Hebrew Through Time

Hava Bat-Zeev Shyldkrot and Einat Kuzai

Abstract This paper deals with expressions of life and death in Hebrew and their development from biblical to contemporary usage. Based on several corpora, it is shown that these expressions tend to acquire a great number of meanings, evoking several situations or events, e.g., momentary urges, affection, and significant activities. Even though some of those senses appear as early as Biblical Hebrew, the most considerable changes took place in Modern Hebrew, and nowadays they seem to be very frequent expressions of speech. A diachronic analysis illustrates that death-related expressions are more prone to change compared to life-related ones, constituting a more varied class in present-day Hebrew. Additionally, these expressions, which were first associated with negative situations, have extended their meaning and now refer to various kinds of situations.

Keywords Semantic change · Life and death · Metaphor · Intensification · Negativity

1 Introduction

Lexical items denoting life and death regularly acquire various meanings in addition to their original ones. We refer here to such items as life and death expressions.[1] It is not improbable that their consistent development of new meanings is motivated by the fact that these expressions mark concepts central to human existence.

This paper is dedicated to Prof. Dorit Ravid upon her retirement from active duty in souvenir of multiple fruitful collaborations and good times in Tel Aviv and Paris.

[1] Metaphorical expressions referring to life and death are not included in this definition.

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Thus, several life and death expressions, including metaphorical ones, are found as early as Biblical Hebrew. However, many expressions referring to death have evolved into constructions in Modern Hebrew expressing intensification or disagreement, completely losing their lexical meaning, as demonstrated in (1).

(1) a. *lacum beʃavu'ot? **lama mi met**?*
‘Fasting in Shavuot? **I don't think so**’ (lit. ‘Why who died?’; HeTenTen).
b. *'ani **meta 'al** xacil.*
‘I'm **crazy about** eggplant’ (lit. ‘I'm dying on eggplant’; HeTenTen).
c. *A: 'ani haxatan. B: **hayita met!***
‘A: I'm the groom. B: **you wish**!’ (lit. ‘You were dead’; Hebrew Corpus).

Similarly, expressions referring to the concept of life have also extended beyond their meanings in present-day Hebrew, even though the main sense has remained to some degree the same, as illustrated in (2).

(2) a. *hasignon hamuzikaly ʃel ʃiri hu **gadol mehaxayim**.*
‘Shiri's musical style is **bigger than life**’ (HeTenTen).
b. *pa'am **hayu li xayim**.*
‘Once I **had a life**’ (HeTenTen).
c. *hu **lo yode'a mehaxayim ʃelo***
‘He **doesn't know shit**’ (lit. ‘He doesn't know from his life’; HeTenTen)

In this corpus-based study, we seek to present the evolution of life and death expressions from biblical times to Contemporary Hebrew, including the spoken mode. We intend to explore the paths of change that life and death expressions have gone through over time, aiming to uncover the processes underlying those changes as well as their origins. For these purposes, we will use Jewish corpora, including Biblical, Mishnaic, and later Judaic and Israeli literature, e.g., Responsa Project, The Historical Dictionary Project, Historical Jewish Press, CoSIH, HeTenTen, and Hebrew Corpus.[2] It is important to note that Hebrew expressions involving life and death have been studied mainly from a cultural perspective (e.g., Medina, 2010;

[2] Each corpus represent a different stratum of Hebrew: the Responsa Project documents Biblical and Mishnaic Hebrew (1300 BCE-600 CE), The Historical Dictionary Project includes literary, liturgic, and scientific texts from Medieval Hebrew and the time of Hebrew Revival (600 CE–1930 CE), Historical Jewish Press contains about 1B tokens covering journals from the 18th until the twentieth century, CoSIH contains recordings capturing about 9 h of talk between friends, family members, and colleagues from the years 2000–2002, HeTenTen is a web corpus that contains approximately 1B tokens harvested in 2014, and finally Hebrew Corpus includes about 150 M tokens from various genres such as literature and media.

van Uchelen, 1994). Diachronic semantic studies investigating those items have yet to be conducted, to our knowledge.

The first part of the paper presents the semantic analysis and classification of life and death expressions in Contemporary Hebrew. The second part is devoted to their diachronic analysis. In the third and last part, we conclude the paper by discussing recurring principles of evolution.

2 Life and Death Expressions in Contemporary Hebrew

In this part, we analyze the above-mentioned expressions in Contemporary Hebrew. Based on the corpora consulted, we found 26 different expressions accommodating life and death nouns (e.g., *xayim,* 'life'; *mavet*, 'death') or verbs (e.g. *xay* 'living'; *met* 'dying') in present-day Hebrew. These 26 expressions were classified into four types of constructions according to parameters of meaning (metaphorical/pragmatic), degree of compositionality (low/high), and appearance as freestanding units (yes/no). The four types are metaphorical constructions (e.g. *'asu xayim meʃuga'im*, 'time of their life'), propositional intensifiers (e.g. *gadol mehaxayim*, 'bigger than life'), illocutionary intensifiers (e.g. *meta lesigarya*, 'dying for a cigarette'), and interpersonal constructions (e.g. *hayita met*, 'you wish!'). Table 1 presents the distribution of the four construction types in the HeTenTen corpus. The numbers in parenthesis refer to the total token frequency of each type of construction per million words based on a random sample of 1000 tokens.

As can be seen in Table 1, death expressions display more variation vis-a-vis life expressions though they are relatively equal in token frequency. The following subsections present several of the life and death expressions found, respectively, illustrating the four types of constructions while focusing on the extent to which the core meaning of life and death concepts are preserved in present-day Hebrew expressions.

Table 1 The distribution of life and death expressions in Contemporary Hebrew according to construction type

	metaphorical constructions	propositional intensifiers	illocutionary intensifiers	interpersonal constructions	Total
Life expressions	11 (0.2)	2 (0.025)	0	0	13 (0.225)
Death expressions	4 (0.1)	2 (0.01)	5 (0.09)	2 (0.009)	13 (0.209)

2.1 Life Expressions

As illustrated in Table 1, most of the life expressions in the corpora are metaphorical constructions. In this type of use, the concept of life is metaphorically evoked to express notions associated with life, e.g., experiences limited in time, meaningful activities, the essence of existence, cherished objects, uncontrolled processes, and the total of one's experiences. These expressions are syntactically, semantically, and pragmatically varied and stretch from clauses to vocatives, denoting both positive and negative meanings, sometimes pragmatically utilized to express speakers' stances. However, in all cases, the concept of life seems to be preserved. Consider, for instance, the tokens in (3).

(3) a. *xaʃavtem ʃehem yaʃvu kol haxofeʃ babayit vehitga'age'u elexem? tiʃkexu mize.* ***hem 'asu xayim meʃuga'im***.
'You thought they sat at home all vacation missing you? Forget it. **They had the time of their life**' (lit. 'They did crazy life'; Hebrew Corpus).
b. *harikud biʃvili ze hakol,* ***ze haxayim****, lo yexola bli ze.*
'Dancing is everything for me, **it's my life**, can't do without it' (lit. 'It's the life'; Hebrew Corpus).

In (3a), the writer remarks that the addressees' children did not miss them, and they in fact had a crazy time without them. The word *xayim* ('life') here is embedded in the semi-schematic construction *X la'asot xayim Y* ('X do life Y'), with X referring to the agent and Y serving as an optional adjective denoting the nature of an experience. In this token, life indicates a dynamic occurrence limited in time. In other tokens found, life may refer to difficult or easy experiences, yet in all these cases, the expression refers to an activity limited in time, similar to one of life's central characteristics – an ongoing process with a beginning and an end. In (3b), the writer stresses that dancing is everything for her, she can't be without it, and that it is her life. The existential construction *ze haxayim* ('it is the life') describes the essence of existence, as subjectively viewed by the speaker.

A similar existential construction appears in the negative form, indicating a lack of significant activities within a certain timeframe. These expressions appear with dative pronouns, marking the logical subject as an experiencer, as illustrated in (4).

(4) a. *lo halaxti lemixlala, lo xaverim, lo klum,* ***mamaʃ lo hayu li xayim***.
'I didn't go to college, no friends, no nothing, **I really didn't have a life**' (Hebrew Corpus).
b. *'eyn lo ma la'asot, 'eyn lo sipuk miklum, uvekicur* ***'eyn lo xayim***.
'He doesn't have anything to do, he doesn't feel satisfaction from anything, and to make a long story short, **he doesn't have a life**' (HeTenTen)

In (4a), the writer is reflecting on the past, at a time in which he did not go to college and didn't have any friends. He then uses the existential construction 'I really didn't have a life', characterizing this period as one lacking any meaningful experiences. In (4b), the same idea is expressed differently – the writer refers to a third person, complaining about his inactivity and lack of satisfaction. He then concludes that 'he has no life', i.e., he is not currently doing anything significant that can bring a person a sense of purpose and accomplishment.

Another expression that metaphorically evokes life is the vocative *xayim ʃeli* ('my life'), which may be also phonologically reduced to *xayim* ('life'). In (5), for example, the speaker is addressing her friend as *xayim ʃeli* while telling him she loves him and thanking him for everything he has done for her. Thus, in this type of vocative, the concept of life is evoked to express the notion of a precious object to be cherished. It is worth noting, however, that this expression seems to become a general way to address somebody in informal speech, even someone that the speaker hardly knows.

(5) *'oʃer 'ohevet male* ***xayim ʃeli*** *toda 'al hakol.*
'Osher, I love you so much, **my dear**, thanks for everything' (lit. 'My life'; HeTenTen).

A different life expression refers to certain experiences as uncontrolled processes. In this type of use, life metaphorically describes a notion of lack of power over feelings or occurrences, as demonstrated in (6).

(6) a. *haxarada hazo nexona legabey kulam.* ***ze haxayim*** *vezehu.*
'This anxiety exists within everyone. **That's life** and that's it' (HeTenTen).
b. *'ima xalta besartan vehayu harbe rivim baayit. ma la'asot?* ***'ele haxayim***.
'Mom had cancer and there were a lot of fights at home. What can you do? **That's life**' (HeTenTen)

Both in (6a) and (6b), this notion is accentuated using either the particle *zehu* ('that's it') which indicates completion (Shor & Inbar, 2019), or a reversed-polarity question expressing the claim that there is nothing to do (Koshik, 2002).

In the last metaphorical expression that we present here, the word *xayim* is part of a prepositional phrase (PP) and refers to the totality of one's experience and occurrences which contribute to the degree of knowledge and education. As exemplified in (7), by saying someone 'doesn't know from his/her life', writers are looking down on addressees' or third parties, completely denying their judgmental capacity.

(7) a. *'eyn lexa ma lehit'acben 'alav!* ***hu lo yode'a mehaxayim ʃelo.***
'You shouldn't get mad at him! **He doesn't know shit**' (lit. 'He doesn't know from his life'; HeTenTen).
b. *kula bat 12* ***lo yoda'at mehaxayim ʃela.***
'She's just 12, doesn't know shit' (lit. 'Doesn't know from her life'; HeTenTen)

As mentioned above, the second semantic category of life expressions, propositional intensifiers, consists of only two constructions according to our data. Even though the constructions are clearly based on a metaphor, they also express propositional intensification, i.e. they modify propositional content (Bazzanella et al., 1991). In both examples, the word *xayim* appears as PP with the preposition *me-* ('from', 'than'), indicating a high degree of incomprehension. The first expression is a fixed construction *gadol/gdola mehaxayim* ('bigger than life'), in which life, as a totality of occurrences and experiences, is evoked to express the notion of 'to a high degree'. This expression is mainly used in positive connotations as in (8) in which a character (8a) or love (8b) are propositionally intensified.

(8) a. *habicu'a ʃelo hicig* ***dmut gdola mehaxayim.***
'his performance presented **a character bigger than life**' (Hebrew Corpus).
b. *zehu sipur 'al* ***'ahava gdola mehaxayim***.
'This is a story about **a love bigger than life**' (HeTenTen)

In the second expression, exemplified in 9 below, the prepositional phrase *mehaxyim sheli* ('from my life') is equivalent to the PP *mimeni* ('from me'). The speaker in this example states that he does not understand what a third party wants from him. The phrase *mehaxyim sheli* then seems to evoke the concept of life, as the total of one's experiences, to indicate a strong degree of bother.

(9) *'ani lo hevanti* ***ma hi roca mehaxayim ʃeli.***
'I didn't understand **what she wanted from me**' (lit. 'What she wanted from my life'; HeTenTen).

2.2 Death Expressions

Like life expressions, death phrases are also in use as metaphorical constructions and propositional intensifiers in Contemporary Hebrew. However, contrary to life expressions, death phrases are members of two other categories – illocutionary intensifiers, i.e. expressions upgrading speakers' inner states of hopes and desires (Bazzanella et al., 1991) and interpersonal constructions marking disagreement and rejection of an interlocutor's stance or claim. In this subsection, we discuss several cases found in the corpora to exemplify the varied and productive use of death expressions in present-day Hebrew.

Similar to life expressions, the concept of death may be metaphorically used to refer to physical and abstract notions associated with death, e.g., the end of a process (10a), lack of vitality (10b), and the absence of meaningful experiences (10c). Hence, these expressions often denote negative meanings, preserving the dreary connotation of death. Syntactically, the component referring to death is embedded in the clause as a predicate or an adjunct.

(10) a. *lelo migvan de'ot* ***hademokratya tiye meta***.
'Without a variety of opinion **democracy will be dead**' (HeTenTen).
b. *'aba* ***met mibifnim***.
'Dad is **dead from inside**' (Hebrew Corpus).
c. *haderex ha'ultimativit lahafox* ***zman met*** *lizman 'exut.*
'The ultimate way to turn **dead time** into quality time' (HeTenTen).

Nevertheless, other metaphorical expressions referring to the concept of death may mark unpleasant experiences, not necessarily leading to severe and dramatic outcomes, as in (10a) or (10b). In the tokens in (11), for instance, the direct object *mavet* ('death') is a complement of the semi-auxiliary verb *la'asot* ('doing'), with the dative pronoun marking the experiencer. These tokens may refer to a person being nagged (11a) or more seriously suffering from harassment (11b). In both cases, though, the concept of death marks an unfavorable experience.

(11) a. ***miki 'asa li et hamavet*** *'al xoser hahitxaʃvut becimxonim.*
'Miki gave me a hard time for not being considerate toward vegetarians' (lit. 'Miki did me the death'; HeTenTen).
b. *mi ʃeya'ez lehafer et hakod hanukʃe haze,* ***ya'asu lo et hamavet*** *bebeyt hasefer.*
'A student who dares break this strict code **will be given a hard time** at school' (lit. 'Will do to him the death'; Hebrew Corpus)

The second type of use of death expressions is as a propositional intensifier. In these kinds of expressions, the component referring to death is embedded in the clause as a predicate complemented by the PP [*me* ('from') + NP] or as an objective genitive. In both kinds, the concept of death intensifies a particular mental or physical state explicitly expressed to the highest degree, e.g., boredom (12a), quietness (12b), or laughter (12c). Similar to metaphorical death expressions, most of the propositional intensifiers we found mark a negative experience or situation. The only expression referring to a positive experience is the phrase *met/a micxok* ('dying from laughter'), as in (12c).

(12) a. *'axʃ*av 'ani yo*ʃev bebeyt xolim,* ***met miʃi'amum***.
'Now I'm sitting in the hospital, **dying from boredom**' (HeTenTen).
b. *hakol sviva haya ʃaruy* ***bidmamat mavet****, keʃeket lifney hase'ara.*
'Everything around her was quiet as death, like calm before the storm' (lit. 'In the quietness of death'; HeTenTen).
c. *ʃom'im oti bareka* ***meta micxok***.
'You can hear me in the background **dying from laughter**' (HeTenTen).

The third category of death expressions consists of illocutionary intensifiers. This type of use is particular to death expressions. In this category, the idea of death, which is syntactically represented as the predicate, intensifies a desire, urge, or need for something to a high degree. Interestingly, unlike the examples in (12) above, the inner state intensified in these expressions is not explicitly expressed. Rather, the lexical noun denoting sensation is absent, resulting in a construal of the concept of death as either a negative or positive experience, depending on the complement of the death predicate. The meaning of death then seems to be more bleached in this type of use, mostly marking a heightened emotion. Consider, for instance, the following tokens.

(13) a. *'ani haxi 'ohevet et hasxiya ki* ***'ani meta 'al hamayim****.*
'I love swimming most because **I really love being in the water**' (lit. 'I'm dying on water'; Hebrew Corpus).
b. *hu be'acmo benadam xamud me'od,* ***'ani met alav****.*
'He's a very nice person, **I really like him**' (lit. 'I'm dying on him'; HeTenTen).
c. *'ani* ***meta lesigarya****.*
'I'm **dying for a cigarette**' (HeTenTen).
d. *'ani crixa et haʃixrur* ***ve'ani meta livkot****.*
'I need the release **and I really need to cry**' (lit. 'I'm dying to cry'; HeTenTen).

In (13a), the structure *'ani meta 'al* (lit. 'I'm dying on') followed by an inanimate noun *mayim* ('water') is used to describe the speaker's love of being in the water, upgraded by the use of the verb *meta* ('dying'), thus explaining her passion for swimming. In (13b), a similar structure followed by an animate pronoun denotes the speaker's fondness for a person, intensified by the predicate *met* ('dying'). In (13c), the structure *'ani meta le* ('I'm dying for') marks a momentarily strong urge for a cigarette. In (13d), the predicate *meta* complemented by the infinitive *livkot* ('to cry') also expresses a strong momentary urge. In this example, this urge is directed toward the experience of crying. Note that while the concept of dying in (13a)–(13b) represents a lasting state, the expressions in (13c)–(13d) represent a momentary situation. This difference may stem from the expressions' distinct use of prepositions. According to Vardi (2015: 38), both constructions using the preposition *'al* and the preposition *le-* have a directional meaning. However, we suggest that the preposition *le-* ('to') is more associated with notions of dislocation, e.g. transfer and movement, while the preposition *'al* ('on') may refer to stable and durable situations, as demonstrated in the constructed examples in (14). This may explain the difference of meaning between (13a)–(13b) and (13c)–(13d), though more extensive research on this topic is needed.

(14) a. *natati* ***leraxel*** *et hasefer.*
'I gave the book **to Rachel**.'
b. *hu ʃoxev* ***'al*** *haricpa.*
'He is lying **on** the floor.'

A related expression to the tokens in (13) is the phrase *ba le-X lamut* ('X feels like dying'). This phrase is a part of the more schematic construction *ba le-X Y* ('X feels like Y') which refers to momentary urges and needs. Accordingly, the phrase *ba le-X lamut* describes a speaker's urge to die. This phrase metaphorically evokes the concept of death to indicate the strong, involuntary effect of a stimulus over the speaker (Kuzai & Shyldkrot, 2022), as in (15).

(15) *kʃe'ani koret et yomaney ne'uray* ***ba li lamut****.*
'When I read through the diaries from my youth **I feel like dying**' (lit. 'Come to me die'; HeTenTen).

The fourth and last category of death expressions, according to our data, is interpersonal constructions. Two kinds of expressions were found in the corpora under this category, both most frequent in informal daily speech. The first one is a rhetorical question emphasizing surprise or objection to a claim introduced in a previous proposition. Thus, similar to the previous category introduced, the concept of death in this type of expression is bleached, as demonstrated in (16).

(16) a. *'ani lo mevina lama 'adam normativi boxer 'al da'at 'acmo laruc 42.2 kilometer […]* ***lama mi met?***
'I don't understand why a normative person chooses to run 42.2 km […] **Who died?**' (lit. 'Why who died?'; HeTenTen).

b. *higi'a macav ʃebo morim mexalkim et mispar hatelefon ʃelahem lxol 'exad. lama? ma kara?* ***lama mi met?***
'Teachers nowadays tend to hand out their telephone number to anyone. Why? What happened? **Who died?**' (lit. 'Why who died?'; HeTenTen).

c. *hanevelot ha'ele yikxu 5 dolar 'al kol zug taxtonim ʃeniʃlax lixvisa?* ***lama mi met?***
'Those bastards are going to charge 5 dollars for underwear sent to the laundry? **Who died?**' (lit. 'Why who died?'; HeTenTen).

In (16a), the speaker questions the motivation of marathon runners nowadays to make such an effort and emphasizes her lack of understanding using the phrase *lama mi met* ('who died?'). In (16b), the speaker is surprised that teachers hand out their phone numbers to students. The expression is combined with two other rhetorical questions, *lama* ('why') and *ma kara* ('what happened') to accentuate the speaker's astonishment at the situation. In (16c), the speaker is commenting on the price of laundry services. The following phrase *lama mi met* expresses the speaker's objection to such a price and indicates his refusal to send an item for laundering.

The second kind of interpersonal expression found is the phrase *hayit/a met/a* ('you wish'). This expression signals speakers' rejection of interlocutors' claims, arguments, or speech acts, framing the plausibility of their occurrence as improbable. This is also emphasized by the use of the past tense. In (17a), for example, the first speaker demands that the addressee come along with her. She, in turn, replies 'you wish, I'm not coming', completely rejecting the demand and explicitly expressing her refusal to do so. In (17b), a discussion by two players takes place. One of the players asks what the score is and suggests that he is winning. Once again, the answer is ‘you wish’, declaring that this is wrong and wishful thinking on his behalf while the truth is completely different. In (17c), the speaker is insinuating that she is as valuable as the addressee by using a rhetorical question. She uses the death expression *hayit meta* (‘you wish’) to emphasize the rejection of the addressee’s implication.

(17) a. *A: ‘at ba’a. zo lo ʃe’ela zot ‘uvda.*
B: ***hayit meta****, ‘ani lo ba’a.*
‘A: You’re coming. That’s not a question; it’s a fact.
B: **You wish**, I’m not coming’ (lit. ‘You were dead’; HeTenTen).

b. *A: kama ‘anaxnu? 10? 12 letovati?*
B: ***hayita met****.*
‘A: What’s the score? 10? 12 in my favor?
B: **You wish**’ (lit. ‘You were dead’; Hebrew Corpus).

c. *ma ‘ani paxot tova mimex?* ***hayit meta!*** *‘ani bidyuk kamox.*
‘What, am I not as good as you? **You wish!** I’m just like you’ (lit. ‘You were dead’; HeTenTen).

To sum up this section, the examples discussed above clearly show that life and death expressions do not behave the same way. While the concept of life is preserved, at least partially, in all the expressions found, the sense of death is bleached in some of the constructions (*met ‘al*, *lama mi met*) and becomes an intensifier or an interpersonal marker. As will be illustrated in the third part, these tendencies already partially existed in earlier stages of Hebrew and they have accentuated over time up to Modern Hebrew.

3 Diachronic Paths

In this section, we present how life and death expressions were used in earlier Hebrew strata and what mechanisms of change were involved in their evolution through time. Due to limitations of space, we do not address the specific evolution path of each expression. Rather, we aim at portraying a general picture according to the four types of categories discussed in the previous section. Section 3.1 outlines the use of life and death expressions in earlier Hebrew strata. The following subsection discusses the mechanisms of change involved in the evolution of these expressions through time.

3.1 The Use of Life and Death Expressions in Earlier Hebrew Strata

Like their use in Contemporary Hebrew, life and death expressions appear as metaphorical phrases since Biblical Hebrew. While the concept of life is often associated with favorable attributes such as wisdom, prosperity, and vitality, the concept of

Table 2 An illustration of metaphorical life and death expressions found in earlier Hebrew strata

	Metaphorical life expressions	Metaphorical death expressions
Biblical Hebrew	*pri cadik* ***'ec xayim*** 'The fruit of the righteous is **a tree of life**' (Proverbs 11:30 KJV)	*'afafuni* ***xevley mavet***. '**The sorrows of death** compassed me' (Psalms 116:3 KJV)
Mishnaic Hebrew	bedavar ʃeyeʃ *bo* ***ruax xayim*** 'In a thing that has **the spirit of life**' (Jerusalem Talmud)	*vesartem miderex xayim* ***lederex mavet***. 'And you deviated from a way of life to **a way of death**' (Sifre to Deuteronomy)
Medieval Hebrew (1000–1500)	**begiʃmey xayim** tixye 'adama '**In rains of life** the land will be fertile' (1050)	'atem **miʃoreʃ** ***mavet.*** 'You are **from the root of death**' (1056)
Haskalah (1700–1900)	*uleha'iram* ***be'or haxayim*** 'And to lighten them **in the light of life**' (1765)	**veze'at mavet** 'al 'pi nigra. '**And the sweat of death** dripped down my nose' (1809)
Hebrew revival (1901–1930)	*ve'ani me'orero, mosif lo* ***sam xayim ze***. 'And I arouse interest in him, adding to him **this drug of life**' (1901)	***velibi met*** *bekirbi.* '**And my heart died** within me' (1902)

death is associated with negative notions, e.g., sin and terror. Table 2 presents several of the metaphorical life and death expressions found in the corpora according to timeframe – Biblical Hebrew, Mishnaic Hebrew, Medieval Hebrew (1000–1500), Haskalah (1700–1900), and Hebrew revival (1901–1930).

As opposed to the category of metaphorical constructions, life and death expressions are distinct regarding their use as propositional intensifiers. While life expressions modifying propositional content such as the phrase *gadol mehaxayim* ('bigger than life') are found only after the Hebrew revival, death expressions functioning as propositional intensifiers are found as early as Biblical Hebrew, though to a lesser degree. The content modified by these expressions relates only to negative experiences. The expression *met micxok* ('dying from laughter') found in contemporary Hebrew and discussed above is attested only since the Hebrew revival, according to the available data. The tokens in (18) demonstrate the use of death expressions as propositional intensifiers through time.

(18) a. *vayomer heytev xara li* ***'ad mavet***.
'And he said, I do well to be angry, even **unto death**' (Jonah 4:9 KJV).
b. *ʃeyefaxadu* ***'eymat mavet.***
'That they will be scared **to death**' (lit. 'Terror of death'; 1100).
c. ***vetardemet mavet*** *nafla 'alay.*
'**And sleep deep as death** came upon me' (lit. 'Sleep of death'; 1853).
d. ***mar mimavet*** *haya li be'odesa.*
'I had an experience more **bitter than death** in Odessa' (1909).

The other two categories unique to death expressions, i.e. illocutionary intensifiers and interpersonal constructions, are found only in Modern Hebrew. Illocutionary intensifiers are attested in the corpora beginning in the mid-twentieth century (19a), while interpersonal death expressions are attested only toward the end of the previous century (19b).

(19) a. ***'ani met 'al tupim**, 'ani muxrax tupim.*
'**I really love playing drums**, I must have drums' (lit. 'I'm dying on drums'; 1965).

b. *lama carix lekabel 'iʃur 'al yecu yeda cva'i velo yeda xakla'i,* ***lama mi met?***
'Why do you need a permit to export military knowledge but not agricultural knowledge, **who died?** (lit. 'Why who died?'; 1991).

In what follows, we discuss the mechanisms of change involved in the evolution of life and death expressions through time according to construction type. We argue that three processes have taken place in the emergence of these expressions: metaphorical mapping, pragmatic strengthening, and constructional extension. We particularly address the varied use of death expressions relative to life expressions by reviewing the motivation for the change of emotive intensifiers suggested by Jing-Schmidt (2007) – the negativity bias.

3.2 Mechanisms of Change

As illustrated in Sect. 2, the core meaning of concepts of life and death is preserved to varying degrees according to construction type. In metaphorical expressions, for example, these concepts convey notions associated with them. In the case of life, the notions relate to favorable attributes whereas in the case of death, they relate to negative ones. Metaphors and the processes responsible for their emergence have received considerable attention in the relevant literature. It is beyond the scope of this paper to provide a thorough review. Instead, we focus here on the conceptual account of metaphors as discussed by Lakoff and Johnson (1980). According to the authors, abstract ideas are often presented in everyday speech in terms of physical notions. Thus, when talking about love, one may conceptualize romantic relationships as journeys, as evidenced by expressions such as 'we're at a crossroads' and 'this relationship isn't going anywhere'. Thus, in our understanding of abstract notions, there is a metaphorical mapping of features from the physical world, the source domain, onto the abstract world, i.e. the target domain (ibid.). When a new expression, coined via metaphorical mapping, is used frequently in the speech community, it may become a conventionalized phrase in a given timeframe in the history of the language (Langacker, 1987). Accordingly, we find various metaphorical life and death expressions in different strata of Hebrew, some of which are still in use in Contemporary Hebrew, though mostly restricted to a specific genre and register, e.g. *'ec haxayim* ('the tree of life'), *libi met bekirbi* ('my heart died within me'). However, the mechanism involved in the emergence of all these types of expressions is metaphorical mapping. Consider, for instance, the tokens in (20).

(20) a. *bney ha'adam yafixu* ***ruax xayim*** *bexol davar 'aʃer 'eyneno ʃam.*
'Humans will instill **a spirit of life** in every object in which it does not exist' (1913).
b. *hu yode'a harbe yoter tov mimeni 'eyx* ***'osim xayim*** *bayam.*
'He knows how **to have fun** at sea much better than me' (lit. 'To do life'; HeTenTen).

Although these examples are structurally different and are attested in different timeframes, the same conceptualization underlies both, namely 'living is doing'. Life is therefore conceived as the opposite of stillness, identified with constant motion. In this conceptualization, a sensori-motor feature from the source domain 'motion' is mapped to the abstract idea of life. Since life is the essence of human existence, it is no wonder it is associated with positive attributes compared to the concept of death. This concept, in turn, is often conceptualized as an end of a process, explaining the appearance of metaphorical death expressions in negative contexts, as illustrated in (21).

(21) a. *kol hfsaka be'avodat hakolonizacya* ***tavi mavet*** *lexol ha'inyan.*
'Any break in the work of the colonization **will bring death** to the whole matter' (1903).
b. ***bifvili*** *hu* ***met****.*
'He's **dead to me**' (Hebrew Corpus).

As suggested by Vardi (2015), based on a synchronic analysis, a metaphorical mapping may have also been involved in the emergence of the illocutionary intensifier *X met 'al Y* (lit. 'X is dying on Y'). According to the author, the concept of death evolved into expressing inner states of adoration, desires, and urges due to the projection of features such as totality and passiveness from the source domain, death, to the target domain, love/desire. In fact, as discussed by Vardi (2015: 45–46), evidence for the conceptualization of both domains as intense experiences may be found in the biblical verse presented in (22).

(22) *ki 'aza kamavet 'ahava.*
'For love is strong as death' (Song of Solomon 8:6 KJV).

It is worth noting that the emergence of death expressions functioning as illocutionary intensifiers may have been motivated by analogical thinking (Traugott, 2011). Since death adverbials modifying negative propositional content are already attested in Biblical Hebrew, as illustrated in the previous subsection, the concept of death has been associated with the notion of intensification throughout the history of the Hebrew language. Therefore, it is conceivable that speakers may have exploited this association to express positive intensification, especially since similar expressions to *X met ʻal Y* are also present in languages spoken during Hebrew revival, i.e. Yiddish (Rosenthal, 2018: 755).[3]

Other than metaphorical mapping, the mechanism of pragmatic strengthening may have also played a part in the changes described in Sect. 3.1, particularly in the evolution of death expressions into propositional intensifiers. According to the Invited Inferencing Theory of Semantic Change (IITSC; Traugott & Dasher, 2002; Traugott & König, 1991), speakers may innovatively use an expression, inviting hearers to infer the implicature conveyed beyond the literal meaning of the phrase. At this stage, the implicature is particularized, but as the expression is used more frequently in various usage-events to convey this inference, the implicature may become generalized through pragmatic strengthening, leading to the emergence of a new coded meaning. Concerning death expressions or adverbs modifying propositional content, previous studies have found that these items tend to evolve along a similar path. First, the item modifies meanings characteristic of death or ones which may lead to death such as ‘pale’ or ‘sick’. Interpreters may infer that death in these contexts indicates ‘to a high degree’ due to it being the ultimate limit in human existence. As this implicature pragmatically strengthens with ongoing usage, it may become a coded meaning, leading to the expansion of the expression with other kinds of propositional contents, ones not necessarily associated with death (Blanco-Suárez, 2014; Gyselinck & Colleman, 2016; Margerie, 2011). In the case of Hebrew, as mentioned in the previous subsection, death expressions functioning as propositional intensifiers are attested as early as Biblical Hebrew. However, these examples are very rare, with only three tokens found. In Medieval Hebrew and Haskalah, however, death adverbials increasingly modify features related to death (‘terror’) or physically similar to death (‘silence’), as demonstrated in (23). These instances may be interpreted as indicating or causing death, but at the same time they may imply scalarity by the implicatures – (a) ‘if something may cause death, then it is potent to a high degree’ (b) ‘if something seems to be dead, it displays characteristic X to the highest degree’.

(23) a. ***ve'eymot mavet*** *naflu ʻalav mize.*
‘**And terrors of death** befell him from that’ (1500).
b. *dumiya misaviv!* ***dumiyat mavet!***
‘Silence all around! **Deathly silence!** (lit. ‘Silence of death’; 1853).

Similar to the change path described in other languages, in later strata we find death expressions modifying features not necessarily associated with death, such as ‘boredom’ (24a) and ‘laughter’ (24b), suggesting that death adverbials evolved into intensifiers via pragmatic strengthening of the implicature ‘to a high degree’.

[3] Some of the expressions are probably borrowed from other languages, particularly Yiddish and English, e.g. Yiddish *max aleyben* (‘time of one’s life’) and English *dying for X*. It might be interesting to further pursue this line of research and investigate how these expressions became a frequent part of the Hebrew language.

(24) a. *xavrehem yac'u laevalot vehem niʃ'aru badira.* ***ʃi'amum mavet.***
'Their friends went to have fun and they stayed in the apartment. **Bored to death**' (lit. 'Boredom of death'; 1987).
b. ***macxik 'ad mavet****, halo ken?*
'He is **dead funny**, isn't he?' (lit. 'Funny till death'; 1990).

The last change mechanism we discuss here, constructional extension, relates to the emergence of the death expression functioning as an interpersonal construction indicating disagreement and rejection – *lama mi met* ('why who died?'). Since the work of Goldberg (1995), numerous studies have shown how semi-schematic argument structure constructions restricted to a limited number of predicates may evolve into more productive structures, appearing with a variety of lexical items from different semantic fields (e.g. Barðdal, 2007; Perek, 2016). Israel (1996), for example, studied the development of the way-construction in English and found that the construction evolved from a structure restricted to verbs describing physical actions which enable the creation of a path ('They hacked their way through the jungle') to a construction appearing with a wide range of verbs generally indicating a way of achieving an agent's goal ('She typed her way to a promotion'). Another illuminating study in this respect is the work of Borochovsky and Sovran (2003). In their research on the idiom *X 'ibed 'acmo lada'at* ('X committed suicide'), the authors found that this fixed expression is expanding in present-day Hebrew, appearing with a variety of verbs to convey the meaning of intense activities, e.g. *hu pitpet 'acmo lada'at* ('He talked to death'). Based on these studies and the data at hand, we suggest that the interpersonal expression *lama mi met* ('who died?') evolved by the process of constructional extension. Consider the following examples:

(25) a. *lama 'ani crixa lehargiʃ kmo hameʃaretet ʃelxa?* ***lama mi met****?*
'Why do I need to feel like your servant? **Who died**?' (lit. 'Why who died?'; HeTenTen).
b. *'anaxnu nos'im […] befaxad.* ***lama ma kara****? milxama? 'im 'ani lo yaxol lehistovev xofʃi, gam hem lo yistovevo xofʃi.*
'we drive […] in fear. **Why what happened**? War? If I can't move freely, neither will they.' (1984).

The rhetorical questions in (25), *lama mi met* and *lama ma kara*, are structurally similar and they both signal an objection to an accessible proposition or implicature in the discourse. Since *lama ma kara* appears in the corpora earlier than its counterpart, we suggest that the interpersonal death expression emerged by constructional extension, i.e. the embedding of the lexical items *mi* ('who') and *met* ('died') in the now generalized semi-schematic construction *lama [question word] [verb]* signaling objection and disagreement. The emergence of an interpersonal death expression on the basis of an existing construction may have been motivated by speakers' need for expressivity (Meillet, 1912), i.e. intensifying strong emotions of disagreement. A verb referring to death is suitable for this purpose since it indicates an extreme occurrence. Thus, when speakers ask rhetorically *lama mi met* ('who died?') when it is apparent no such drastic event took place, they express the claim that there is absolutely no justification of interlocutors' stances and arguments.

Throughout this paper, we have demonstrated how the concept of death has evolved into expressing a wide range of meanings, some of which are not necessarily associated with death. These developments seem to be intrinsically linked to signaling extreme situations and intensified inner states and emotions, among them positively connotated concepts of love, adoration, and desire. The concept of life, though also evolving into several types of expressions, seems to be preserved in its various uses in Contemporary Hebrew. This seeming anomaly, whereby a negative concept changes into expressing positive intensification over a more positive related concept, may be explained by the negativity bias, as discussed in Jing-Schmidt (2007). Based on a cross-linguistic study on emotive intensifiers, the author argues that emotive intensifiers tend to evolve from negative concepts in different languages since negative experiences have more influence on human behavior and cognition compared to positive ones. According to this argument, the greater impact of death on human cognition may underlie speakers' linguistic choices in describing extreme situations and heightened emotions (see also Shefer & Shyldkrot, 2020: 46–47; Vardi, 2015: 47).

4 Conclusions

This paper explored the usage of life and death expressions in Hebrew, both synchronically and diachronically. Unexpectedly, it was found that the concept of death is much more productive than the concept of life, even in earlier strata of Hebrew. Other than the obvious metaphor of death as an ending point, which is found only in some expressions, death appears in three other kinds of constructions: propositional intensifiers (*met mi-X*), illocutionary intensifiers (*met 'al X*), and interpersonal constructions (*lama mi met*). Over time, the meaning of death has become less transparent in specific kinds of constructions (e.g. *lama mi met*) and has completely bleached in others (e.g. *met 'al*). In contrast, life expressions appear only in metaphorical constructions and propositional intensifiers. However, the range of metaphors used in these expressions is much more diversified. Life may indicate positive attributes (e.g. wisdom and beauty), experiences limited in time, meaningful activities, the essence of existence, cherished objects, uncontrolled processes, and the total of one's experiences. Nevertheless, life expressions are less productive in Contemporary Hebrew and, unlike death constructions, their lexical meaning seems to be retained both diachronically and synchronically. This difference is suggested as resulting from the negativity bias, i.e. the widespread influence of negative experiences on human behavior and cognition compared to positive ones. This negativity bias may also explain the extensive range of mechanisms of change involved in the emergence of death expressions contrary to life ones. As mentioned by Ravid (1995: 171), some changes are more successful than others. In this study, we have shown that the development of death expressions is by far more extensive, than life ones, a finding which indicates the more successful evolution of death expressions. Future research may shed light on patterns of change of life and death expressions in other languages, thus contributing to the issue of whether these patterns are universal.

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