Linguistic Literacy: Twenty Years Later

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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", *netspeak, 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 subsyllabic 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 "biliteracy" (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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