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Editors

Media Exposure During Infancy and Early Childhood

The Effects of Content and Context on Learning and Development

Foreword by Aletha C. Huston

Springer

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Foreword

This book is dedicated to John C. Wright, my late husband and research partner, who was a pioneer in understanding the cognitive and social processes involved in children's learning from media, primarily from television. Television reached most American homes during the 1950s. In 1950, about 10 % of homes had a set; by 1960, the number was close to 90 %, a rate of dissemination that seemed extraordinary at the time though it pales in comparison to the spread of smartphones and the Internet.

The introduction of each new medium in the twentieth century elicited a storm of apocalyptic predictions about its harmful effects as well as wildly optimistic hopes for its capacity to enrich the lives of viewers. The research that followed typically demonstrated that both are true, depending on the content and features of programming as well as the characteristics of the viewer and his or her environment. As John once paraphrased Marshall McLuhan's idea that the medium is the message: "The message is the message."

Two questions dominated television research in the 1950s and 1960s. (a) What are the effects of the medium itself? (b) How does television violence affect aggressive behavior? Both were concerned primarily with negative influences of TV. The first question was typically answered with fairly simple correlational studies, a trend that unfortunately continued well beyond the time when more nuanced and sophisticated investigations had made it clear that viewing television per se does not have simple effects on children. The second question gained momentum because of the high rates of violence in fictional programming, including programming for children, and because television news was broadcasting footage of graphic violence in the war in Vietnam and in urban riots in many major American cities. In response to these concerns, the US Surgeon General appointed an Advisory Committee on Television and Social Behavior, which in turn requested that the National Institute of Mental Health fund a program of research on the topic.

Research on potential positive influences of television emerged in the late 1960s. With a grant from the NIMH initiative on TV and Social Behavior, Lynette Friedrich and I launched a series of investigations. Although we included violent programs in the first study, we were more interested in the potential of TV to teach prosocial behavior. We chose Mr. Rogers' Neighborhood because it had a clear basis in developmental theory and presented a range of positive behavior including helping, sharing, task persistence, cooperation, and delay of gratification.

Around the same time, Sesame Street began production with the explicit goal of reaching children in minority families and those living in poverty. Although the idea of educating young children with television seems obvious now, many were skeptical that such programming could reach beyond an elite audience of children with well-educated parents. Hence, the funding for the first 2 years included two large-scale evaluations of impact on the target audience. A strong tradition of both formative and summative evaluations of Sesame Street and other educational programs ensued.

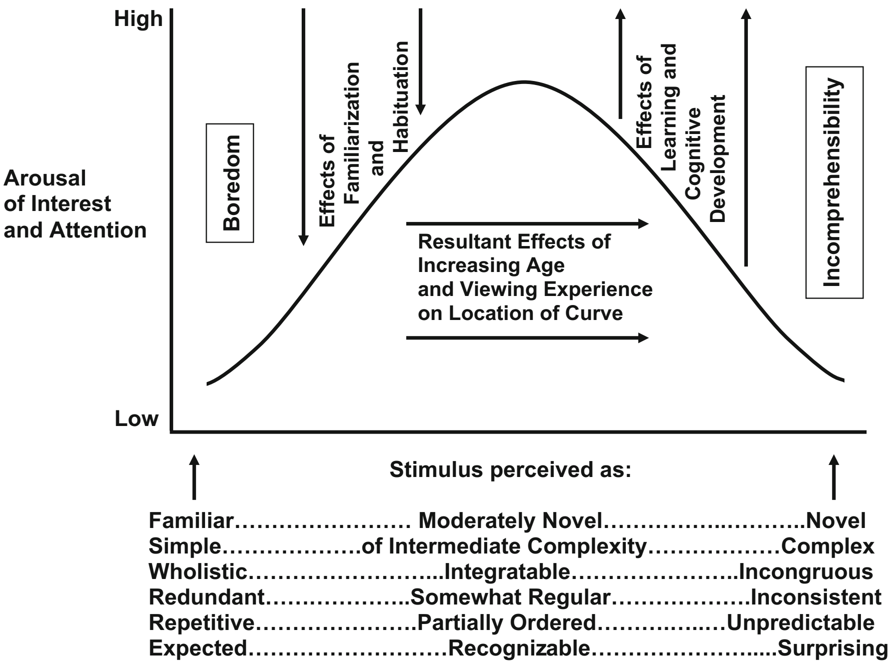
In the 1970s and 1980s, research on the processes by which young children learned television content, both positive and negative, arose in the fields of communication and child development. With the advent of cartoons and other programs specifically directed to young children, both parents and researchers became concerned about commercialism and advertising to young children. Action for Children's Television, an advocacy group headed by Peggy Charren, pressed for restrictions on such advertising. As a result, an important body of research provided information about developmental differences in children's processing including their ability to comprehend the purposes of advertising and their susceptibility to persuasion by favorite television personalities and characters.

In the late 1970s, John Wright and I created the Center for Research on the Influences of Television on Children (CRITC) at the University of Kansas, which John directed for many years, to carry out research that brought together his expertise in cognitive development and mine in social development. One major theme was understanding how TV formal production features (e.g., action, pace, special effects) and content affected attention, comprehension, and social behavior. We did laboratory studies of children's attention to and learning from programs selected or edited to contain particular combinations of form and content, and we also conducted some longitudinal studies of children's home viewing experiences.

Around the same time, at the University of Massachusetts, Dan Anderson conducted seminal studies of the relations of comprehension to attention and launched a large investigation of children's home viewing. Ultimately, we collaborated to follow up the Kansas and Massachusetts home viewing samples when they were adolescents, showing that preschool viewing of educational programs predicted some aspects of school achievement. For a review of late twentieth century media research, see Huston and Wright (1997).

Many of the themes of the earlier work are evident in the contents of this volume. First, although it seems obvious that theories of cognitive and social development apply to and can be tested by studies of media, the research on media has often been segregated from developmental psychology and early education. The authors in this volume apply concepts of learning and social development to media in ways that inform both basic and applied science. They extend analyses of content and production features to understand the messages presented to children. They make good use of experiments disaggregating the components of media stimuli (both form and content) to test their effects on learning. In various chapters, the authors investigate children's understanding of the connotations and conventions of TV, their understanding of fiction-reality distinctions, and, echoing the advertising research on character appeal, their parasocial relationships with characters.

A second theme of the earlier work was a clear developmental perspective with a focus on both micro and macro levels. At the macro level, children's capacity for learning from media changes over time as their cognitive capabilities grow, but also as a function of their experience with particular media. But, change also occurs at the micro level. At any point in time, attention and comprehension are greatest when stimuli are moderately complex and novel; interest is diminished when content is either too easy or too hard. As illustrated in Wright's "traveling lens model," for example, changes with time and experience occur such that content that is moderately difficult becomes easier and less interesting, and content that was too difficult attracts more attention and interest. By definition, a developmental perspective requires that the match between the media content and the child's level be considered in understanding children's learning—a pervasive assumption in this volume.



Still another theme was that learning from media is active. Many observers argued that learning from television was by definition passive because it offered one-way communication from screen to child with little or no opportunity for children to interact with or affect the content. We and other early investigators contended that such learning could be and often was active because children attend selectively, exert mental effort, and use their existing knowledge to interpret television content (Huston & Wright, 1989). As technology has changed, no one questions the idea that a child can be "active" in learning, but there are still issues of when and how children transfer that learning to other contexts. The newer work also allows a better understanding of the biological processes underlying children's interactions with media.

Still another thread of the early work was context, particularly the context of viewing at home. The home viewing diaries collected in Massachusetts and Kansas produced information about co-viewing of different types of programs with parents and siblings, and the videotapes of viewing collected in Massachusetts offered an in-depth understanding of viewing in a natural context. The current work on co-viewing and parent-child interaction reported in this volume advances our understanding of how media are integrated into family life. Possible impacts on parent-child relationships are ever more urgent with new media. For example, anecdotes abound about parents being absorbed by their phones while children sit passively (or perhaps play on their own devices).

The papers in this book have their roots in themes from early research, but the newer work goes well beyond TV because there is a proliferation of media platforms. Researchers can now investigate interactivity and a much wider range of content and form including carefully planned games for children (and perhaps those not so carefully planned). Although young children still spend a great deal of time with television, many of them also play games on phones and tablets. At the same time, the range of programming and games has grown on both television and other media, with many more claims by manufacturers that content is beneficial to children.

The age groups targeted by media (and presumably affected by them) have shifted to include infants and toddlers, a trend that is reflected in the research in this volume. When Sesame Street was introduced, it was aimed at 4-year-olds, an age group that seemed very young at the time. Despite warnings from the American Pediatric Association, viewing data over the years have made it clear that very young children are exposed to a great deal of television, often because older family members are viewing, and programming for infants and toddlers on both TV and other platforms has followed, creating new questions for research.

Screen media now allow children to engage in various forms of social interaction with fictional characters and real people. The papers in this volume document children's "parasocial" relationships to media characters as well as Skype interactions with parents and other important adults who are far from home. This line of research has only begun to answer interesting questions about how such mediated interactions are perceived by children and how they affect other aspects of social relationships.

Finally, the contributions of practitioners, educators, and media professionals to this volume follow in a strong tradition of interactions among research, media policy, and practice. The research on violence, advertising, and prosocial television has been used in policy proposals with varying degrees of success over the years. Although research was not the only influence on the 1990 Children's Television Act, the legislation would probably not have happened without it. Perhaps more relevant to this volume, many of the best children's television shows have used research to plan their content and to evaluate their successes. Building in the thoughts of practitioners for each chapter strengthens the likely contribution of this work to design and evaluation of new media as well as old.

In summary, the papers in this book build on themes of earlier work while presenting a range of important advances in understanding the multiple roles of screen media in the lives of children. Although the technological changes in media are occurring at a rapid rate, always raising new questions and issues, much of the knowledge generated in this research deals with lasting and important questions of children's development. It draws on a strong tradition of past work to make major interesting and new contributions to the field.

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Preface

The New Blooming, Buzzing Confusion: Introduction to Media Exposure During Infancy and Early Childhood

> The baby, assailed by eyes, ears, nose, skin, and entrails at once, feels it all as **one great blooming, buzzing confusion** (p. 488; William James, 1890)

William James's conception of the infant captured the prevailing view that the infant's world is dominated by sensations that lack order and assail themselves on the infant as if, as Locke argued in 1689, the infant is a "white paper [tabula rasa] void of all characters, without any ideas" (Book II, Chap. I, 2). This view has dominated developmental psychology even into the late twentieth century: infants were thought to be born knowing little of their larger world and, over time and with experience, must organize the buzzing confusion. This phrase, while not unique to the study of media and subsequent effects on infants (e.g., Anderson & Hanson, 2010), was the impetus for this book. Infants are not born into a world of confusion; instead, they are sophisticated learners with functional memory systems (for review see Rovee-Collier, Hayne, & Colombo, 2001; Saffran, Aslin, & Newport, 1996) who develop gradually and systematically across the first few years of life. As we sat in Rachel's garden creating a prospectus for this book, our goals were twofold. First, we wanted to encourage scholars who study media and young children to present complex and scientifically rich descriptions of their own research programs by focusing on how very young children might learn from media and the ways in which the content of said media and the context surrounding exposure interact to influence how and whether learning occurs. Second, we wanted leading industry experts, content creators, journalists, and policymakers to read these scholarly chapters and discuss the relevance and application of this research for their own practice. In all, we wanted the research and its translation into practice to present a more nuanced and balanced view of babies and screen media that reflects a rigorous application of developmental science to how, whether, and why infants learn from screen media.

Current Media Landscape

Since 1997, there has been an unprecedented surge in media content produced for young children coupled with the advent and rapid mass production of touchscreen tablets and mobile phones. In just the 2 years between 2011 and 2013, the use of mobile devices skyrocketed: use by children under 2 increased from 10 to 38 % whereas use by children 2–4 years old increased 39 to 80 %. But a more recent study conducted in France (Cristia & Seidl, 2015) estimated that 58 % of 5–24-month-olds had used a touchscreen device. Smartphones comprise the most frequently used touchscreen device (51 % of children have used this device at least once) although tablets are close behind (44 %; Rideout, 2013). Estimates of daily usage also vary. Recent studies one in the USA (Rideout, 2013) and one in France (Crista & Seidl, 2015) indicate that about 20 % of infants and toddlers use a touchscreen-enabled device each day. Two studies with more racially and socioeconomically diverse samples, one in the USA (Kabali et al., 2015) and one in Northern Ireland (Ahearne, Dilworth, Rollings, Livingstone, & Murray, 2016), indicate a much higher estimate, approximately 70 %. While it is important to note that the way these data have been collected also varied over time (see Barr, Danziger, Hilliard, Andolina, & Ruskis, 2010; Certain & Kahn, 2002), it is quite clear that children's exposure to screen media is shifting across platforms. Unlike any other point in time, young children are exposed to media content via multiple devices in multiple locations and in multiple formats, potentially leading to a new blooming, buzzing confusion. This technology explosion is shifting the use of screen media from a centrally located television set in the family's living room to anywhere and everywhere a child might be. From the family car to the local restaurant, while visiting the doctor's office and when riding on public transportation, exposure to media content is inescapable. As researchers and industry leaders, it is challenging to keep pace with such rapid proliferation in order to generate basic evidence about its effects as well as guidance on just what families and educators can or should do.

Moral Panics About Children's Time Spent with Media

As each new wave of technology takes hold, different facets of the population express varying opinions about the role that such technology should play in young children's lives ranging from trepidation about the perils to extreme optimism about the promise of the technology (Chap. 1). McLuhan (1964) wrote that "each new technology creates an environment that is itself regarded as corrupt and degrading" (p. ix). The promise lies in the ability of media to widely and rapidly increase children's access to information and education (Mielke, 1994). At the same time, others have voiced concerns that early use places young children's developing attentional system at risk for concurrent and later developmental problems while simultaneously disrupting sleep and displacing important childhood experiences. Throughout the book, how parents and early educators are responding to these profound changes to the media landscape is discussed. The context in which media exposure occurs is more relevant and important than ever before.

Historically, child media research has focused on relations between outcomes and the total amount of media exposure a child has (see Anderson, Huston, Schmitt, Linebarger, & Wright, 2001 for a discussion). This narrow focus on amount of exposure has constrained our ability to interpret both the short-term and long-term impact of media on early socio-cognitive development and slowed the accumulation of knowledge about which child when exposed to what content and under what circumstances experiences particular outcomes. As the field matured, there was a shift from total effects to an examination of the differential impact of media content. Multiple studies document that high-quality and well-designed educational media help young children learn the content featured in that media. For instance, in a longitudinal study following children from age 5 to age 15, researchers determined that young children who spent more hours viewing Sesame Street evidenced higher grades, more leisure book reading, and stronger academic self-concepts in adolescence whereas young children who spent more hours viewing Mr. Rogers had higher creativity scores and reported greater participation in creative extracurricular activities (e.g., drama, art; Anderson et al., 2001).

At present, there is a dizzying array of content options available for young children. The Apple app store contains well over 80,000 applications tagged as educational (Apple, 2015). Unlike the development of traditional television content (both educational and entertainment), the speed with which new technologies are created has led to an equally rapid explosion and deployment of content for these technologies. As a consequence of the academic research process, we know very little about how this new content delivered via new technologies is developed, whether it is developmentally appropriate, and, perhaps most importantly, whether and how it is effective for learning. To deal with the lag between technology and research, Zosh and colleagues (Chap. 17) have proposed ways to identify app-based content as truly educational by using basic learning science research.

Welcome to the New Blooming, Buzzing Confusion

This book was born from an invitation by Springer to consider submitting an edited volume that investigated the consequences of early media use; and so began our own blooming buzzing confusion. We met the challenge by inviting many of the top academics in the field to author chapters on the perils and promise of early media exposure firmly embedded within a developmental science perspective. As we considered their potential research topics, we simultaneously identified key industry leaders and child advocates who could comment on the implications of the research for their own practice. Consequently, this book moves the research debate from the early focus on cause/effect relations dominated by total exposure and even total exposure broken into content categories to models where multiple and interacting factors of the child, the content, and context in which exposure occurs are considered (Barr & Linebarger, 2010; Guernsey, 2012). Through careful consideration of the potential interactions between and among the content and context of early media exposure, we will address under what conditions this new blooming buzzing confusion can be deciphered by young children including how they come to make sense of it. These issues are timely and relevant not only to academics but also to parents, early educators, and policymakers who are making key decisions about their children's access to, use of, and potential learning from media.

The book is structured to present information from different perspectives. Each research chapter provides state-of-the-art research about the content and context of media exposure during early childhood. Known leaders of industry and parenting advocacy groups and think tanks were then asked to write a commentary chapter to provide insight into how the research is or could be translated into practice. These research and practice chapters are designed to be read together. By highlighting both research and practice, we have been able to review and identify factors that might realize the promise of technology while simultaneously reducing or mitigating the potential risks for very young children.

We identified several crosscutting themes across the chapters and commentaries. These themes demonstrate how research that incorporates greater complexity and sophistication across questions, methods, and theories enhances our understanding via simultaneously considering the multiple and interacting effects of individual child characteristics, content type, and the context in which exposure occurs. These themes include:

1. *Cognitive constraints on the child*. Throughout the book we will closely consider how the age of the child influences learning. We consider attentional and cognitive constraints on processing information from screens during early childhood (Chaps. 3 and 5) and how these factors influence children's ability to learn in media settings. We discuss the relevance of developmental science principles in understanding not only how children learn from technology but in the design of media content and consideration of the context of learning as well.
2. *Importance of the delivery of content*. The delivery of media content will be discussed from multiple perspectives, with consideration of preschool television content (Chaps. 7 and 8), the development of characters (Chaps. 9 and 10), and the development of touchscreen apps (Chaps. 3, 4, 17, and 18). We discuss the importance of character development, the careful design of the educational and prosocial content, and the need to develop and implement age-appropriate curriculum and leveling. We also discuss how it may be possible to use features of new media to more effectively level content to capitalize on technology but we will also need to carefully consider how to focus the learning without overwhelming young learners with extraneous information.
3. *Importance of the context*. Co-viewing is now extended to co-using and joint media engagement. More than ever before it is important to consider how learning from media occurs in the context of other social partners. We focus on impacts of parental mediation and scaffolding during media exposure (Chaps. 11–15).

4. *Shift to newer media devices*—There has been a rapid adoption across socioeconomic status of touchscreen-enabled phones and tablets and a vast array of software in the form of applications (apps) has been developed to deliver content on these devices. These new devices are mobile making them available in multiple locations. These devices are interactive both due to the touchscreen-enabled functionality and the connectivity with other devices in order to engage in activities like videochat. These dramatic changes in technology have increased the contingency and interactivity of content available to young children. We will expand upon the recent dramatic shift to mobile and interactive technology (Chaps. 1, 2, 13, 17, and 18). We integrate the extensive findings obtained from the study of children's exposure to television to the more recent findings with this new digital media. We also discuss the challenges of the new media.
5. *Parenting and educational implications of early media exposure*. Throughout the book we consider the educational ramifications of new media content and devices and the role that parents and early educators will need to play in order to maximize child outcomes. This will be considered from the Science of Learning perspective (Chap. 17), in the early education environment (Chaps. 1–4 and 6), and from the parenting perspective (Chaps. 11–16).

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Contents

About the Editors

Rachel Barr, Ph.D. is Associate Professor of Psychology at Georgetown University and Director of the Georgetown Early Learning Project. Dr. Barr received her Ph.D. from the University of Otago, New Zealand. She is primarily interested in how children bridge the gap between what they learn from media and how they apply that information in the real world. She has written frequently about the transfer deficit which is the consistent finding that infants and toddlers learn less from television and touchscreens than from face-to-face interactions due to memory constraints and also how the transfer deficit can be ameliorated by including repetition, additional language cues, and appropriate use of television features to enhance learning. She has also examined how parents can facilitate learning from both touchscreens and television. Finally, she has provided developmental expertise while working with media developers, and she has collaborated on a project that has used media content as part of an early intervention parenting program for incarcerated teen fathers.

Deborah Nichols Linebarger, Ph.D. is Associate Professor of Human Development and Director of the Children's Media Lab at Purdue University. Dr. Linebarger received her Ph.D. from the University of Texas, Austin. She is primarily interested in the interface between children's cognitive development (i.e., learning, language and early literacy skills, executive function) and educational media and how and whether these relations vary by important demographic and social indicators including poverty status, culturally and linguistically diverse populations, age, and location of residence (e.g., rural or urban). To examine this interface, she conducts descriptive work to detail media access and use patterns and relations among these patterns and child development; micro-level experimental work to detect the features used in media that direct attention and contribute to content comprehension; and macro-level intervention work that combines the knowledge gained through both descriptive and basic research and applies it in various real-world contexts. In the latter capacity, she has extensive experience evaluating the efficacy of various media products and media interventions (i.e., 22 different products and interventions evaluated across 52 different studies) using theoretically and empirically rigorous research methods and evaluation techniques. Recent projects and consultancies include Sesame Workshop, PBS Kids/CPB, Between the Lions, WGBH public TV, Sprout, LeapFrog, Disney, Nickelodeon, the World Bank, and members of Congress.

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Claire Lerner, LCSW, is the Senior Parenting Strategies at ZERO TO THREE where she translates the science of early childhood for parents, professionals and policy makers. Claire is also a practicing clinician. In this role she provides guidance to families with young children, consults with early childhood programs on developmentally appropriate practice and parent engagement, and provides workshops on early childhood development and parenting in the community.

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Chapter 1
The "New" Technology Environment: The Role of Content and Context on Learning and Development from Mobile Media

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For decades we have seen the wave-like reaction to new media technology. First the increased panic that whatever new device of the time—whether it is radio, TV, movies, DVDs, or computers—will have a negative effect on our youth; then a plateau as children use these devices, regardless of recommendations from policy organizations, teachers, or parents; and finally a decrease in concern and a sense of actual acceptance as that device becomes part of everyday culture and another device enters the market to restart the wave. Coinciding with this wave of panic is a wave of excitement and opportunity driven by those who see the novel opportunities of each device to expand our everyday experiences. Wartella and her colleagues have addressed this ongoing historical trend in children's media technology over the decades (Wartella & Jennings, 2000; Wartella & Reeves, 1985; Wartella & Robb, 2007). In this chapter we update this discussion with a focus on newer mobile media and the impact it has on young children today. Rather than focusing solely on the effects of the device itself, we build on the historical literature by expanding our focus on two specific factors: the content provided on new mobile media devices and the context in which these devices are used.

1.1 Historical Trends

Historically, the concerns about media technology have focused on the specific device (e.g., television, video games, movies, etc.; Wartella & Jennings, 2000), when in reality the content was driving the concern (e.g., violence). With older children and youth, there is evidence that exposure to violent content in TV

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programming, video games, and even music lyrics can have negative effects on development (Bushman & Huesmann, 2006). Over the decades, we have minimized the concern associated with the devices by improving the content. For example, *Sesame Street* and *Mister Rogers' Neighborhood* calmed much of the worry related to children and TV viewing with their educational curricula and demonstrated success as teaching programs (Ball & Bogatz, 1970; Friedrich & Stein, 1973).

In the late 1990s, however, a change in the target audience of TV programming and DVDs resulted in new concerns regarding media and child development (Wartella & Robb, 2007). With a vast increase in infant-directed content (e.g., *Baby Einstein*) in the late 1990s, the American Academy of Pediatrics (1999) originally recommended that parents refrain from allowing children under 2 from watching screen media out of fear that parents would rely on these products too heavily and that important caregiver–child interactions would be displaced. Despite this recommendation, parents were allowing their young children to view screen media. Reports in 2002 indicated that 83 % of young children used screen media in a typical day, and 74 % of those under 2 had watched TV (Rideout, Vandewater, & Wartella, 2003); by 2005, children under 6 were spending nearly 2 h per day with screen media (Rideout & Hamel, 2006).

In part, the concern over infant-directed programming arose from the claims by many companies that their products were educational when in fact little if any research had been conducted to determine the validity of these claims. In the years since these DVDs were created, a series of content analyses have been conducted to assess the presence of educational concepts within the content of the programs. One small-scale content analysis (Garrison & Christakis, 2005) examining educational media found that 76 videos on Amazon.com's top 100 best-selling list for babies ages 2 and under made educational claims. Many videos for young children also claimed that they encouraged parent–child interaction. Similarly, the titles and claims of many computer programs for young children suggested or directly stated that they were educational and would have positive educational effects on children (Garrison & Christakis, 2005). Unfortunately, this study did not assess the actual content by watching or playing the games, instead relying on the best-selling list and company reviews as the main indicator of content. A second content analysis, conducted in 2007 and 2008, of 57 DVDs targeting infants and toddlers between the ages of 0 and 3 years found that educational claims were prominent on baby DVDs (Fenstermacher et al., 2010). This study went further and determined that often times the claims in the title, packaging, and promotional materials overstated the content of the DVD (see also Chap. 7, Linebarger, Brey, Fenstermacher & Barr, 2016; and Chap. 8, Santomero, 2016).

In addition to studying the specific content that was being marketed and sold to parents of young children, researchers responded to concerns by examining whether infants and toddlers were learning from content presented in video form. Anderson and Pempek (2005) provided an excellent review of the literature to date, suggesting that young children struggle to learn from one-directional TV or DVD screen content and coined the term the "video deficit." Other scholars continued to explore this controversy to determine whether infants and toddlers could learn from "baby media" (e.g., DeLoache et al., 2010; Richert, Robb, Fender, & Wartella, 2010;

Robb, Richert, & Wartella, 2010; Vandewater, 2011), generally finding mixed results from commercially available products. Some researchers looked at more basic factors of content, such as character familiarity (Krcmar, 2010; Lauricella, Gola, & Calvert, 2011), to determine if altering content features influenced young children's learning from screen media. While there was some consideration for the context of infant media, such as time spent watching TV in childcare centers (e.g., Tandon, Zhou, Lozano, & Christakis, 2011) or the role of parent–child interactions during media use (e.g., Barr, Zack, Muentener, & Garcia, 2008; Fidler, Zack, & Barr, 2010), the focus with infant-directed media research was primarily on the effects of the content on very young viewers' learning.

1.2 Mobile Media Trends

More recently, there has been a boom in digital media technology used by young children that differs vastly from the technology of the past. In 2007, Apple introduced the first iPhone, and just 3 years later the first iPad was released, providing the world with a new type of mobile technology driven by the touchscreen. This technological advancement incidentally also created a more developmentally appropriate medium for young children as they could now manipulate and control these devices more easily without the help of an adult (Geist, 2012). New mobile technology saw the same wave-like reaction from parents, press, and policymakers as seen historically. Concerns spiked that these devices would negatively affect young children's development, and new policy statements were released cautioning parents about potential negative effects (e.g., AAP 2011, 2013). Simultaneously, educators and school systems immediately bought into the hype that mobile technology could revolutionize the education system, spending millions of dollars investing in new technology for their students (e.g., Garner, 2015; Paczkowski, 2013).

With the influx of new devices, two key policy statements have provided recommendations for parents and educators to handle this new media environment. While the American Academy of Pediatrics (1999, 2011, 2013) traditionally recommended no screen time for children under 2 years old and limited screen time for older children, the organization's most recent recommendations in 2015 recognized that strict screen time limits are no longer plausible in today's media-saturated world (AAP, 2015). The AAP (2015) even acknowledged the potential benefits of high quality educational content, such as *Sesame Street*, for children's learning and development, as long as screen time occurs in moderation and with caregiver guidance. Additionally, the National Association for the Education of Young Children (NAEYC) and the Fred Rogers Center (2012) released a joint position statement supporting developmentally appropriate and intentional use of technology in early childhood education. The NAEYC/Fred Rogers Center (2012) statement emphasizes the importance of using technology to support, not substitute, learning, suggesting educators should create a balance of traditional and digital activities in their centers and classrooms. Further, as with the AAP (2015) recommendations, NAEYC/Fred Rogers Center (2012) emphasizes the need for quality social interactions around technology to support young children's learning.

Despite these policy recommendations, we are still in the nascent years of understanding how these technologies influence children's learning and development. However, unlike prior work that has primarily focused on the devices themselves, today there is more of a focus on what Lisa Guernsey (2007) describes as the three C's—the child, the content, and the context. Recognition of the importance of taking these three factors into account when understanding how media technology affects young children has led to the development of new research and theoretical models, such as Valkenburg and Peter's (2013) Differential Susceptibility to Media Effects Model that focuses on the differential effects media has on young children's learning and development.

Given that the AAP (2015) and NAEYC/Fred Rogers Center (2012) recommendations provide suggestions on how to choose and use media to support young children's learning and development, it is critical to understand what types of content are available and how parents and educators are constructing digital media contexts for young children. As such, the remainder of this chapter focuses on new media technology with regard to the content that young children are engaging with and the context in which these interactions occur.

1.3 New Media Content

The advent of mobile touchscreen technology has led to a very different type of media use. While television remains the most prominent media technology used by young children, time spent with smartphones and tablets is increasing dramatically as family ownership of these devices reaches new highs (Rideout, 2013). Importantly, while some content is being moved from traditional television or computer games to touchscreen devices, we are also seeing an increase in novel content that is being created specifically for mobile touchscreen devices. An important distinction between traditional media content and the new mobile touchscreen content is the opportunity for increased user-influenced interactivity and user-created content, something that was impossible with TV content. Most research examining new technology has been conducted on electronic books (e-books); however, new studies are being conducted to examine the content and quality of children's apps and to understand the way children create and develop their own content on touchscreen devices.

1.3.1 E-Books

Decades of traditional children's storybooks have led to the relatively seamless transition to children's e-books that can be read on computers or handheld devices. The earliest versions of e-books were created for desktop computers, played via

CD-ROM technology, and ranged considerably in their interactive features (De Jong & Bus, 2003; James, 1999). Most research has focused on the effects of e-books on story comprehension, vocabulary, and phonological skills. An early study by Ricci and Beal (2002) showed kindergarten children had better story comprehension and recall from interactive e-book CD-ROMs with audiovisual and interactive features compared to children who only had audio narration without any visuals. Similarly, Chera and Wood (2003) demonstrated that exposure to voice-narrated e-books increased 4-year-old children's phonological awareness compared to a control group. More recently, Gong and Levy (2009) found that word highlighting in e-books could enhance preschool children's print and letter concepts. These types of interactive components also seem to enhance children's motivation and engagement (Ciampa, 2012, 2014; Colombo & Landoni, 2014; Gong & Levy, 2009; James, 1999; Lauricella, Calvert, & Barr, 2014).

Other studies have determined that e-books can be particularly beneficial for children from special populations. Verhallen and Bus (2010) found that the very foundation of an e-book providing multimedia pictures instead of static images, as in the case with traditional books, could help increase second-language learners' vocabulary skills. Another study showed that low- and middle-income students who used e-books with dictionaries or e-books in the "read and play" mode outperformed their peers in the "read only" condition on word meaning and recognition as well as phonological awareness (Korat & Shamir, 2007). Shamir and colleagues (Shamir, Korat, & Fellah, 2012; Shamir & Shlafer, 2011) also showed interactive e-books could be especially useful in increasing vocabulary, print concepts, and phonological awareness for children with learning disabilities. Taken together, these studies suggest the importance of interactivity as opposed to simply reading a book on an electronic device.

However, other studies contrast these findings and demonstrate that interactive features either had negative effects (e.g., De Jong & Bus, 2002; Kozminsky & Asher-Sadon, 2013), no impact (De Jong & Bus, 2004; Willoughby, Evans, & Nowak, 2015), or mixed effects (Doty, Popplewell, & Byers, 2001) on children's learning. In an early study, De Jong and Bus (2002) demonstrated that the interactive features of e-books, such as hotspots, games, pictures, and interactive texts, may negatively influence children's understanding of the storyline. Similarly, Kozminsky and Asher-Sadon (2013) found kindergarten children who were read to from a traditional book by an adult had significantly higher literacy outcomes compared to their peers who listened to and played with an e-book.

Multiple studies with young children have found no effect of e-books. Willoughby and colleagues (2015) found no discernible differences in phonological awareness for 4-year-old children who were exposed to repeated readings of ABC e-books compared to children who were exposed to repeated readings of traditional ABC storybooks. De Jong and Bus (2004) showed that kindergarteners who read an e-book independently had similar story comprehension and retelling abilities as students who worked with adults, despite the e-book having hotspots. Finally, Doty and colleagues (2001) found that second-grade children who read an e-book on

CD-ROM showed increased story comprehension compared to students who read a printed book, but no differences were found for retelling the story.

When trying to interpret the mixed effects of interactivity and new mobile technology, we must acknowledge that "interactivity" can be defined, measured, and assessed in a multitude of ways. With each individual study examining specific features of interactivity, it is not surprising that current results are not yet consistent or streamlined. A second limitation with some of the interactivity research is a function of the stimuli used to test "interactivity." Specifically, many of the studies that find positive effects of e-books used researcher-created e-books, where the interactive components are intentionally aligned with the story content and skills being assessed, as opposed to commercially available content, which may lack such intentionality (Salmon, 2013).

An extension of interactivity research is now exploring how haptic technology can be added to e-books as a way to increase young children's interactivity with the reading experience. Haptics provide tactile vibration feedback, providing a more multisensory reading experience above and beyond audiovisual cues. While few have investigated the effect that haptic technology has on young children's learning (Alam, Rahman, & El Saddik, 2013), companies such as Disney Research are in the process of developing haptic displays for children (Kim, Israr, & Poupyrev, 2013). Only one exploratory study investigating the application of haptics to children's e-books has been conducted, and the authors found that while younger children (3- to 5-year-olds) enjoyed the addition of haptics more than older children (6- to 8-year-olds), parents felt that younger children were more distracted by the haptics (Cingel, Blackwell, Connell, & Piper, 2015). As such, the tension between engagement and distraction around enhanced e-books will likely continue as the technology advances.

In sum, new mobile technology does offer children an opportunity to interact with and manipulate some or all of the content on the device, but the effects of these interactive features require continued research. Factors like child age and previous exposure to traditional storybooks, e-books, and touchscreen technology may play an important role in the overall effects associated with these types of experiences. Additionally, defining and measuring "interactivity" is increasingly challenging as interactive features and opportunities continue to develop and change. Research has begun to assess certain aspects of interactivity, such as hotspots and haptic technology, but just as there is a long list of formal features used in video presentations (e.g., cuts, zooms, pans, etc.), the list of interactive features that need to be studied and understood is far from complete. Finally, the relationship between the developmental abilities, experience, and the interactive technology must be understood in context. Specifically, this relationship should be investigated with commercially available content and in the places where children are using these devices (e.g., home, school, and even in transit), both with and without parent involvement, to better reflect the realities of children's engagment with these new technoolgies.

1.3.2 Apps

With more than one million apps available for IOS and Android devices, it is important to examine the type of content that young children are engaging with and what is available for them to download and use. The Michael Cohen Group (2011), in partnership with the United States Department of Education, identified three types of tablet computer apps for young children—gaming apps, creation apps, and electronic books. The first describes apps that are interactive, goal oriented, and level up to make game play progressively harder; the second describes apps that allow children to draw or build; and the third, as described in the previous section, include animated e-books that can be read by children (or adults) or have audio narrators telling the story.

The Joan Ganz Cooney Center at Sesame Workshop has conducted content analyses of apps available in the Apple iTunes Store. Reports found that the vast majority (80 %) of top-selling paid apps in the Education Category targeted children, with almost three-quarters specifically targeting preschool or elementary-aged children (Shuler, Levine, & Ree, 2012). Of the apps in the Education Category on iTunes, Google Play, and Amazon, the most popular paid apps targeted basic language and literacy skills, but differences arose where the most popular apps on one site were not the same on another site (Vaala & Ly, 2014). Other work has assessed the gaming category in the Apple iTunes Store and found that one-third of apps in the Games Category claim to be educational (Shuler, 2012). Furthermore, research looking specifically at educational quality of apps in the Kids section of the Apple iTunes store found that “freemium” apps—or apps that offer limited-time free content before requiring users to make a purchase—demonstrate the highest educational quality, followed by paid apps and free apps (Hurwitz, Lauricella, & Wartella, 2015). Falloon (2013) also found that free apps were more likely to have features that may impede learning, such as popup or banner advertisements as well as embedded external web links.

Despite research on the varied types of apps, their quality remains unclear. Hisrich and Blanchard (2009) suggested that few quality apps exist for emergent literacy skills, and Vaala and Ly (2014) found that the majority of apps primarily target only basic literacy skills of phonics/word recognition and letters/sounds. Additionally, Falloon (2013) confirmed that while educational quality is difficult to discern, specific content features are more likely to be associated with learning than others. For example, apps that scaffold children’s interactions or provide a step-by-step process to learning concepts are more likely to promote learning compared to apps that were game- or practice-based (Falloon, 2013). Additionally, apps with text-to-speech capabilities that provide information aurally in addition to visually may also be beneficial to learning (Falloon, 2013; see also Chap. 3, Hipp et al., 2016).

However, unlike research on e-books, where studies have explored how the interactive features of digital books affect young children’s learning, few studies have empirically explored children’s learning from specific types or features of apps. In a small-scale study investigating PBS content on iPods, researchers found that children aged 3–7 years who used the *SuperWhy* and *Martha Speaks* apps over a 2-week period showed gains in vocabulary, letter sounds, and rhyming, with the greatest gains experienced by the 3-year-olds (Chiong & Schuler, 2010). A recent experiment by Neuman (2015) found that low-income preschoolers who played the *Learn with Homer* app showed increased phonological awareness, print knowledge, and letter sounds compared to children who used math and music apps. Two additional studies have investigated how the intrinsic characteristics of touchscreen devices (e.g., audiovisual, touchscreen) can aid learning, but these studies did not focus on specific app content. Kirkorian, Choi, and Pempek (2016; see also Chap. 5, Kirkorian, Pempek & Choi, 2016) showed that toddlers who engaged with interactive videos on touchscreen tablets had increased word learning compared to toddlers who engaged with noninteractive videos on touchscreen tablets, while Roseberry, Hirsh-Pasek, and Golinkoff (2014; see also Chap. 17, Zosh et al., 2016) showed that toddlers could learn novel words just as well from video chat as from live interactions, but not from non-interactive videos. Finally, a recent study examining preschoolers' STEM learning from interactive versus non-interactive apps found that learning differed as a function of interactivity (Aladé, Lauricella, Beaudoin-Ryan, & Wartella, 2016). Specifically, preschoolers were better able to succeed at an exact transfer task when they played the interactive tablet game but children who watched the non-interactive video were better able to transfer their learning to more novel tasks.

In addition to the focus on the educational quality of apps, others have investigated the ways in which children can use apps and mobile devices to create their own content rather than simply relying on the content produced by others. Common Sense Media provides a search option where parents can search for apps based on creativity, and apps such as *Little Builders* and *BugArt* were created to encourage interactive, creative thinking for young children. Similarly, *Doodlecast* and paint and play apps were developed to support children in their creation of art and storytelling. Apps by Toca Boca for younger children were designed to replicate aspects of children's free play on digital devices. This type of content is truly novel and is largely a function of the affordances of mobile technology. Other types of older technology—TV, DVDs, and even computer or videogames—require the creation of content by other individuals and simply allow the child to engage or play with the material in the largely scripted way it was designed. These new types of apps allow children to take the creative lead and develop their own media content. While not necessarily novel in the broader context of digital media, given that children have extended storylines and characters from TV into their real-world play, the ability for children to take more creative agency in apps is a more recent development.

Several studies have begun to investigate the influence of apps on children's creativity and engagement, showing mixed results. Kucirkova, Messer, Sheehy, and Panadero (2014) found that children who worked with peers while playing story-making, drawing, and construction apps engaged in joint problem-solving and collaboration. Additionally, Couse and Chen (2010) found that while teachers reported most children's digital and traditional self-portraits were similar in quality, 20 % of the children were "above expectations" for their digital portrait compared to their traditional ones. Similarly, two related studies investigating toddlers' (1.5 to 3 years) mark making found young children made more marks and engaged in a range of mark making practices when finger painting on tablet computers compared to traditional paper (Crescenzi, Jewitt, & Price,2014; Price, Jewitt, & Crescenzi, 2015). While the digital device afforded sustained engagement, the authors note that the tablet restricted the number of fingers children could use and lacked sensory tactile features important to young children's development (Crescenzi et al., 2014; Price et al., 2015). Alternatively, Picard, Martin, and Tsao (2014) found that kindergarten children's digital drawings on a tablet computer were worse than drawings with paper and pencil. Importantly, while these studies represent international and culturally diverse young children, they are limited in scope and sample size ($N<50$); additionally, these studies primarily draw on qualitative or mixed methods, which provide rich details of children's interactions with tablets but are unable to make causal conclusions.

The world of children's apps continues to change and develop and the research simply has not caught up with the technological developments. We are beginning to understand the content available to young children via this new media platform, but the effects—both positive and negative—of exposure to and engagement with app content are far from known. Much more research is needed to understand how children use these apps, what they learn from them, and how the opportunity to create and design their own content influences development, learning, and creativity.

1.4 Context

With the advent of mobile devices, defining the context in which new media are used becomes increasingly complex. No longer are young children tied to watching television in the living room or playing computer games on a desktop computer; they can now access digital media content anywhere, anytime on laptops, handheld gaming devices, smartphones, and tablet computers. Thus, what once was a stationary context that used to exist primarily in the home has now become an ever-changing environment in which children access and use digital media.

1.4.1 The Home Context

There is no question that young children have more access to mobile technology today. The most recent 2013 Common Sense Media report of families with children ages 0–8 found that 75 % of young children now have access to some type of mobile device compared to only 52 % two years earlier in 2011 (Rideout, 2013). When it comes to tablets specifically, there was a fivefold increase in family ownership, with 40 % of families reporting they have a tablet compared to only 8 % in 2011

(Rideout, 2013). With increased access comes increased use, as young children now spend an average of 15 min a day on mobile devices compared to only 5 min a day in 2011 (Rideout, 2013).

For many young children, they do not actually have their own mobile device, but their parents engage in what Chiong and Schuler (2010) describe as the “pass-back effect.” This phenomenon derives from the image of a parent “passing back” a mobile device in the car to a child in the back seat to keep him/her occupied, but it can occur in any location at anytime. Research has continually shown that parents use technology to keep children occupied in order to complete parental tasks (Rideout & Hamel, 2006; Zimmerman, Christakis, & Meltzoff, 2007), and mobile devices allow parents more flexibility. Indeed, a nationally representative survey of parents of 0- to 6-year-olds found that parents use mobile devices in many situations, from making dinner, to eating out at a restaurant, to calming a child down (Wartella, Rideout, Lauricella, & Connell, 2014). Often, the child uses the device to play a game, and the interaction is relatively short (Chiong & Schuler, 2010).

Interestingly, despite parents engaging in this pass-back behavior, they do not necessarily have positive attitudes toward these new mobile devices. Only 29 % of parents surveyed by Wartella and colleagues (2014) believed that newer mobile devices have made parenting easier, reporting that mobile devices have a lot of fun activities for their children, as well as educational content. On the other hand, 70 % of parents reported that these devices do not make parenting easier. For these parents, the top three reasons why these devices have not made parenting easier were as follows: (1) fears over children not developing important social skills; (2) having a harder time getting their children’s attention; and (3) fears over children getting addicted to the devices (Wartella et al., 2014). Additionally, 37 % of parents believed mobile devices could aid math, reading, and creativity skills, 38 % believed these devices have negative effects on children’s attention span and 50 % believed tablets and smartphones have negative effects on children’s social skills (Wartella et al., 2014). As such, there appears to be tension between what parents do and what they actually believe in terms of the benefits and drawbacks of mobile technology.

Despite these mixed views, there is increasing evidence of the importance of co-using technology, where parents or caregivers share in the media experience with their children. Research has shown that when parents ask questions or reiterate the learning messages from educational television, children learn the concepts better (Ball & Bogatz, 1970; Chiong, Ree, Takeuchi, & Erickson, 2012; Reiser, Tessmer, & Phelps, 1984; Strouse, O’Doherty, & Troseth, 2013; Takeuchi & Stevens, 2011). With the influx of newer media platforms and the opportunities for parents to not just co-view but co-engage in media activities, the Learning in Informal and Formal Environments (LIFE) Center coined the term “Joint Media Engagement” (JME), defined as:

> Spontaneous and designed experiences of people using media together, and can happen anywhere and at any time when there are multiple people interacting together with media. Modes include viewing, playing, searching, reading, contributing, and creating, with either digital or traditional media (Stevens & Penuel, 2010).

Despite the interest in JME, Rideout (2013) found that only 9 % of parents report co-engaging on mobile devices on an average day and that the engagement only lasts for 3 min. Instead, the majority (52 %) of parents reported co-engaging while watching TV and spent an average of 49 min doing so, suggesting that parents of young children are primarily co-engaging on more traditional platforms (Rideout, 2013). This was supported by Connell, Lauricella, and Wartella (2015), who also found that more parents co-engaged with television and books compared to smartphones and tablet computers. One potential reason for this may be the ease with which parents can pass back their tablets and smartphones, such that they are less likely to co-engage on mobile devices.

One exception to co-engagement with mobile devices is parent–child e-book reading. Researchers have recently investigated the ways that e-book interactivity influences how parents interact with their children during co-reading, and the potential impact these interactions may have on young children's learning (Chiong et al., 2012; Krcmar & Cingel, 2014; Lauricella et al., 2014). More specifically, these studies demonstrate that parents engage in fewer content-related interactions when reading enhanced or interactive e-books with children compared to traditional print books (Chiong et al., 2012). E-books do seem to increase parents' comments related to the mechanics or technical components of the book, such as verbalizations regarding when to push or interact with the features and how to operate the device (Krcmar & Cingel, 2014; Lauricella et al., 2014). However, these comments may distract children from the book content and lead to decreased levels of story comprehension and literacy outcomes (Krcmar & Cingel, 2014; Parish-Morris, Mahajan, Hirsh-Pasek, Golinkoff, & Collins, 2013). Krcmar and Cingel (2014) further suggested that this distraction talk and the added features of e-books increases cognitive load, making it more difficult for children to learn from e-books.

Apart from parent–child e-book reading, few studies have explored the effects of joint media engagement on children's learning and development. A recent study by Connell and colleagues (2015) investigated differences in parents' joint media engagement with children age 8 and under by family demographic characteristics and technology type. Results showed that younger parents and fathers were more likely to co-engage with videogames and mobile technology, and Hispanic parents were more likely to co-engage with tablet computers compared to white parents, even when controlling for parent age, parent education, child age, child gender, parent's time with the device, and parent's time with the child (Connell et al., 2015). The authors speculate that fathers are more likely to co-use videogames and mobile technology because these offer opportunities for fathers to engage in more play-like activities with their children, which is consistent with previous research on father-child engagement in non-digital contexts (Lamb, 2000). However, this study did not examine associations between co-engagement and child outcomes. While anecdotal accounts suggest that JME can enhance social and academic learning (e.g., Barron, Martin, Takeuchi, & Fithian, 2009; Stevens & Penuel, 2010; Takeuchi & Stevens, 2011), no large body of empirical evidence exists to support such claims on newer mobile devices.

1.4.2 The School Context

Across the United States, schools are increasingly integrating newer mobile devices into the classroom. As of 2013, Apple reported 4.5 million iPads in American educational institutions, triple the number reported just a year earlier in 2012 (Paczkowski, 2013). In early childhood specifically, 20 % of educators report having access to e-readers, while 55 % report having access to tablet computers, which is almost twice the amount reported in 2012 (Blackwell, Wartella, Lauricella, & Robb, 2015). On average, these teachers reported using e-readers 4.25 days per month and tablet computers 11.66 days per month (Blackwell et al., 2015).

With the increase in mobile devices in early childhood education, it is important to understand how teachers are using these devices in their classroom. A survey of over 1,400 early childhood educators found that for those with access to tablets, 29 % used tablets across the curriculum, with the majority using them for science, math, and literacy (Wartella, Blackwell, Lauricella, & Robb, 2013). Further, 56 % reported also using tablets for social–emotional learning (Wartella et al., 2013). Indeed, Blackwell (2013) found that preschool and kindergarten teachers believe that tablets can help children learn to share and can increase social interactions, such as in the situation when more technology-proficient children help less proficient children use the devices. Similarly, teachers in Beschorner and Hutchison's (2013) study reported an increase in social learning, including communication and sharing between peers while using iPads. Henderson and Yeow (2012) also found that using iPads encouraged collaboration between students.

In addition to the learning areas in which mobile technology is being integrated, mobile devices could have important influences on the pedagogical context as well. Teachers may choose to use tablets in addition to or in place of more traditional activities because tablets are highly engaging for young children (Couse & Chen, 2010; Henderson & Yeow, 2012; Kucirkova et al., 2014). While organizations like NAEYC/Fred Rogers Center (2012) promote the use of technology as a supplement to hands-on activities, this is not always how the technology is actually used. Blackwell and colleagues (2015) found that 54 % of early childhood educators reported using tablet computers for children to practice material they already learned, while 64 % reported using the devices to teach basic user skills. Indeed, Mishra and Koehler (2006) suggest that in order for teachers to effectively integrate technology into their classrooms, they require Technological Pedagogical Content Knowledge (TPACK). That is, teachers need to know how technology can (1) enhance the representations of specific content and make subject matter easier or harder to learn; (2) be matched with specific pedagogical practices that enhance the teaching of specific subject matter; and (3) build on students' prior knowledge and instigate new learning (Mishra & Koehler, 2006; Koehler, Mishra, & Cain, 2013). In order for teachers to achieve high levels of TPACK and use technology as a supplement instead of a substitution for non-digital activities, however, additional professional development and support are necessary to provide teachers with the skills and tools to make this a reality.

The integration of technology into the classroom can encourage more student-centered, or constructivist, pedagogy—an alternative classroom environment to traditional skill and drill teaching practices that may lead to higher learning outcomes (e.g., Dewey, 1902; Jonassen & Reeves, 1996; Rogers, 1983; Vygotsky, 1978). Means and Olson (1997) defined student-centered learning with technology as "promot[ing] student learning through collaborative involvement in authentic, challenging, multidisciplinary tasks by providing realistic complex environments for student inquiry, furnishing information and tools to support investigation, [and] linking classrooms for joint investigations" (p. 9). In contrast to traditional learning that promotes skill and drill practices and the recitation of facts, student-centered practices leverage technology as a way for students to engage in real-world experiences that promote critical and higher order thinking. Blackwell and colleagues (2015) found some examples of this type of use in their national survey, as 55 % of teachers reported at least sometimes using tablet computers for free choice time where children could choose any app to play with, while 58 % of teachers reported at least sometimes using tablet computers for creation activities. Beschorner and Hutchison (2013) also found teachers integrated iPads in many different contexts, including center time where children could choose any app to play with, small group time where several students listened to stories or played apps together, and for creating digital storybooks.

While mobile technology has been often been praised for providing individualized learning, several studies suggest that teachers use them in other types of learning contexts as well (Beschorner & Hutchison, 2013; Blackwell, 2013; Blackwell et al., 2015). For example, while 62 % of teachers in Blackwell and colleagues' (2015) survey reported using tablet computers for individualized instruction, 66 % reported using tablet computers for paired (two students) learning, 54 % for small group (three to five students) learning, and 53 % reported using tablets for whole group instruction. Beschorner and Hutchison (2013) also described how teachers used tablets for whole group learning activities, such as checking the weather during the morning meeting and circle time. Several studies have also suggested that using e-readers and tablets for individual learning in kindergarten may not be the most effective approach (Blackwell, 2015; Shamir, Korat, & Barbi, 2008). Shamir and colleagues (2008) found that children who used e-books in pairs, as opposed to individually, made significantly greater literacy gain. Similarly, Blackwell (2015) showed that kindergarteners who shared tablet computers significantly outperformed their peers in 1:1 or non-iPad classrooms on end-of-year achievement tests, even after controlling for baseline scores and demographic characteristics. Blackwell (2015) argued that collaborating around a tablet device may be more effective than 1:1 learning in early childhood due to the peer-to-peer scaffolding that can occur, which may be more beneficial than scaffolding afforded by the technology alone. McManis and Gunnewig (2012) note that teachers tend to pay less attention to interacting with children and scaffolding their learning experiences when students use technology alone, such that sharing tablets may replace this lack of teacher interaction with increased opportunities for peer-to-peer interaction. Indeed, research has found that face-to-face collaboration around technology, especially with dyads or small groups, can lead to better learning outcomes compared to individual learning settings (Johnson & Johnson, 2009; Lou, Abrami, & d'Apollonia, 2001). For example, Gomez and colleagues (2013) showed that small group collaborative learning using a single display computer led to greater achievement in language, math, and social skills for kindergarten children compared to children in classrooms where they did not engage in co-learning activities. Several studies have also noted that one of the main affordances of tablet computers over other mobile technology is the ease with which students can collaborate around the technology (Chou, Block, & Jesness, 2012; Henderson & Yeow, 2012).

With the increase in mobile technology use in the classroom, the dynamics between teachers, children, and technology once again changes, given that children can easily use mobile devices anywhere in the classroom. This flexibility also enables teachers to use technology in different ways, especially in early childhood education where classrooms are usually set up with specific activity stations instead of the traditional rows of desks. Children are often constantly moving around the early childhood classroom and not tied to a specific location, such that mobile technology especially complements the physical needs of early learning environments. While teachers can still use tablet computers for whole group learning by projecting the screen on a Smartboard, they can now also have children use mobile devices at different stations around the classroom, during transition times when some students may be done earlier than others, and even outside of the classroom. Blackwell (2013) found that kindergarten teachers especially value the mobility of tablets. In one case, a teacher had children go on a nature walk and take pictures on their tablet computers and then come back to the classroom and label their pictures. Another teacher used tablets on the bus ride for a field trip so that children did not lose that valuable learning time. Henderson and Yeow (2012) also found that tablet computers made learning more accessible and productive in elementary school classrooms because the devices could be used anywhere in the classroom and were easily shared among students. Early childhood educators also have confidence in adapting their classroom for technology, with 57 % of teachers of 0- to 8-year-olds agreeing or strongly agreeing that they know how to accommodate their classrooms for different technology tools (Blackwell et al., 2015). In ideal cases with active teacher and school involvement, mobile technology can be a beneficial resource to the educational activities within and outside of the classroom.

1.4.3 Home–School Context

While mobile technology provides unique affordances for the home and school environments separately, these devices may also help bridge the home–school divide (Lemke, Coughlin, & Reifsneider, 2009). A large body of research suggests the critical importance of parent engagement to children's academic and social outcomes (e.g., Fan & Chen, 2001; Hill et al., 2004). Traditionally, parent engagement has included such actions as volunteering in the classroom, attending parent–teacher conferences, or serving on the PTA, but more recent work has explored how technology can be used to leverage the relationship between schools and families. Indeed, in a recent survey of early childhood educators, 55 % of educators agreed or strongly agreed that they use technology to strengthen home–school connections (Blackwell et al., 2015).

Several early initiatives focused on providing families, especially low-income families, with home computer and Internet access as a way to both increase students' out-of-school resources as well as connect families with online school resources, like websites and bulletin boards (e.g., Blanchard, 1998; Penuel et al., 2002). More recently, with many schools providing 1:1 tablet computers to students, schools are increasing access to newer mobile devices and providing more opportunities for children and parents to engage in learning at home (e.g., Blackwell, 2013; Lemke et al., 2009).

In addition to providing access to technology, more recent interventions have focused on leveraging the unique affordances of cell phones, which many families already own despite income level, to increase parent engagement and strengthen the home–school connection. Several studies have investigated how texting in particular can increase parent engagement (e.g., Bigelow, Lefever, Carta, & Borkowski, 2013; Hurwitz, Lauricella, Hanson, Raden, & Wartella, 2015; Horowitz et al., 2006; York & Loeb, 2014). For example, Bigelow and colleagues (2013) found that Head Start mothers who participated in an enhanced version of a home-visit training program that included twice-daily text messages and phone calls between home visits were twice as likely to complete the intervention compared to mothers who received the home-visit program without the cell phone component. Similarly, Hurwitz and colleagues (2015) found that Head Start parents participating in a daily text messaging program that provided educational activities and parenting tips engaged in more types of learning activities with their children compared to parents who did not receive text messages. This intervention was particularly helpful for engaging fathers and parents of boys in their children's learning. Furthermore, a study of the text message program READY4K! found that parents who received text messages engaged more frequently in specific home literacy activities and were more likely to ask teachers questions about their child's learning (York & Loeb, 2014). This study also demonstrated that children in the treatment group had improved literacy skills compared to those whose parents did not receive the READY4K! text messages (York & Loeb, 2014). Several other studies have shown increased safety and health behaviors among parents (e.g., Ahlers-Schmidt et al., 2012; Bigelow, Carta, & Lefever, 2008; Stockwell et al., 2012) as well as increased parent efficacy as a result of receiving text messages (Evans, Wallace, & Snider, 2012; Gazmararian, Elon, Yang, Graham, & Parker, 2013; see also Chap. 17, Zosh et al., 2016).

Additionally, there has been an increase in apps targeted at connecting parents to their children's classrooms and teachers, such as *MyChild, SchoolCircle*, and *MySchoolsApp*. Whereas many childcare centers and schools use websites to keep parents up to date on what is generally happening in their children's education, these new apps provide individualized platforms for teachers to provide tailored updates for each family, including individual children's academic achievement and social and behavioral development. They can also be adapted to fit the type of school or childcare program, and many of these platforms include two-way communication, as opposed to more traditional online platforms that focused on one-way broadcasting of information to parents (Selwyn, Banaji, Hadjithoma-Garstka, & Clark, 2011). However, there remains a lack of empirical evidence on the effectiveness of these and other newer platforms for increasing parent engagement and ultimately student achievement (Lewin & Luckin, 2010).

1.5 Conclusions and Policy Implications

Historically, media technology has elicited panic and opportunity for young children's learning and development. From radio and television to smartphones and iPads, the uncertainty around the potential effects of such media often leads to both negative backlash and fast adoption without a solid research foundation for such actions. The uptick in adoption of smartphones, e-readers, and tablet computers by parents and schools in recent years is evidence of this phenomenon, given the lack of research supporting these devices for children's learning and development. While these devices in and of themselves offer a mobility unheard of from prior technology, it is necessary to go beyond such physical components to understand the new types of content afforded by these technologies as well as the contexts in which they are being integrated.

Despite the hype around mobile technology, little is actually known about the vast amount of content available and how such content influences learning. Further, little research has examined how the dynamics of the home and school environment are being affected by these new technologies and whether or not the technology lives up to its promised results. While some parents may find mobile technology makes their lives easier, many others remain concerned over the potential negative consequences for young children's social skills. Similarly, while teachers are integrating mobile devices at increasing rates and in various ways, they still use e-readers and tablet computers infrequently in the classroom and primarily as substitutions for more traditional learning activities.

To move forward in understanding how mobile technology and its related content and contexts affect children's learning and development, several important policy steps must be considered. First, organizations like the American Academy of Pediatrics must realize that technology is becoming a staple in the lives of children and families and that policy recommendations for no or limited screen time are just not realistic for today's families. The updated AAP (2015) statement is a step in the right direction as it suggests that quality educational media can have positive effects, especially when parents are actively co-engaged in their children's media experiences.

Second, while organizations like NAEYC/Fred Rogers Center (2012) promote the developmentally appropriate use of technology in the classroom, a clear definition of what "developmentally appropriate use" means with regard to young children is lacking. It is clear that early childhood educators are using mobile devices in diverse ways, but to what extent they are actually implementing media in developmentally appropriate ways remains unclear. Strong professional development specifically in educational technology is needed to help support teachers' understanding of how to use technology to effectively support young children's learning in the classroom. This includes not only providing support for understanding the structural components of use, such as functionality and content, but helping teachers develop their TPACK.

Finally, a shared definition of “educational quality” of apps and a more streamlined taxonomy of how to determine such quality is needed (see also Chap. 17, Zosh et al., 2016). This will assist efforts by both teachers and parents as they sort through what Guernsey and colleagues (2012) describe as the “fast evolving and chaotic Wild West of digital apps” (p. 15) to select the most appropriate content for the young children in their lives (see also Chap. 2, Guernsey, 2016).

Taken together, the content and context of new media technology provides important considerations for families, schools, and policymakers moving forward. Having a sound research foundation on what makes a quality e-book and app as well as how such technology can be used effectively at home and in school will provide much needed evidence and better information to all those involved. As such, parents, teachers, and policymakers will be better informed to make their own decisions regarding what and how technology should be integrated into the lives of young children.

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Chapter 2
Who's By Their Side? Questions of Context Deepen the Research on Children and Media: Commentary on Chapter 1

Lisa Guernsey

How refreshing. In years past, as I tried to translate research articles about the impact of media on young children, I usually found myself with no choice but to describe results in hours, minutes, days, and weeks. Studies focused almost exclusively on how much time a child was exposed to a screen. Was it more than an hour a day? Two hours? Three? The higher the number, one could only assume, the more troubling the implications: Here were children being left alone with an electronic babysitter when they should have been playing with toys, napping, or singing nursery rhymes with mom.

This chapter by Lauricella, Blackwell, and Wartella takes us much further in our understanding of screen media's impact. It synthesizes dozens of new studies, going beyond the use of time with screens to examine how the content and context is playing a role. It also shows how basic science—such as the findings from experiments and intervention research—are lending evidence to new theories in media research. One example is the Differential Susceptibility to Media Model (Valkenburg & Peter, 2013) which recognizes that different children and adolescents in different contexts may have different reactions to different media experiences. Rules and recommendations for simply limiting time feel arbitrary without understanding all those differences. One size does not fit all.

This more textured approach will demand much more from our media researchers and learning scientists. Questions are streaming in regarding daily routines in child care centers, prekindergarten classrooms, public schools, afterschool programs, and individual households everywhere. A focus on content begs important questions about design features, teacher training, age-appropriate materials, language-rich narratives, and more. Context is an even more challenging terrain to understand because it comes with so many settings and scenarios—from a toddler reaching for Dad's smartphone to a long-distance grandmother reading an e-book with her grandchildren to "app time" at a desk in a school classroom.

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In the next few pages, let's consider the implications of one of the biggest context questions prompted by the Lauricella, Blackwell, and Wartella review: When does it help for kids to "go solo" in using screen media and digital devices, and when is it more beneficial for them to share those devices with peers or adults?

A child's age, for example, could make a difference here. In the world of edtech for tweens and teens, for example, the word "personalization" has taken hold, and school districts are striving for one-to-one computing in which every student has his or her own device. At the same time, experts continue to call for socialization around media and point to the significance of joint media engagement (JME) in fostering learning (Takeuchi & Stevens, 2011). Much of that research has focused on the needs of infants, toddlers, and children in their very earliest years of school. In what contexts and at what stage in a child's development should "personalization" trump the desire to use media to promote shared experiences? When do shared moments lead to more learning more than individualized learning? Is there a blend that hits a sweet spot for different ages of children in different circumstances? (Consider the combination of individual and shared learning moments that surface during collaborative sessions with 7- or 8-year-old children building worlds in Minecraft, for example.) Should educators and parents be looking for a mix of the two? What kind of mix might that look like?

2.1 On-the-Ground Implications

The answers to these context questions cannot arrive soon enough. In the past few years school district leaders and principals have come under increasing pressure to update their classrooms with tablet computers and new apps. Library administrators have had to make tough choices between purchasing printed books and investing in e-books, e-book readers, and digital materials. Children are begging parents for chances to play with apps on their smartphones, while parents are awash in conflicting advice on what to do. For adults working with young children, the confusion has been the most acute, ranging from the American Academy of Pediatrics' recommendation to avoid all screen media before age 2 and its recognition of the need to modernize that approach (AAP, 2013; Brown, Shifrin, & Hill, 2015) to the marketing messages about learning opportunities emanating from technology products such as the Vinci Virtual School for Toddlers (Herold, 2015; Strauss, 2015).

Consider the case of Manassas City Public Schools, a district in the northwestern region of Virginia, which in June of 2015 announced a new approach to prekindergarten education. According to district leaders, many low-income families want to enroll their children in the state-funded pre-K program, known as the Virginia Preschool Initiative, but the district does not have enough classroom space and teachers to meet demand. It receives some pre-K funding from the state but is required to match that funding with local dollars, and local leaders have balked at paying more from their local coffers to open more classrooms. In 2015, more than 100 children were on a waiting list.

Eager to support those waitlisted children somehow, Manassas leaders created what they are calling a "blended" model in which the children spend 2–3 days a week in a classroom, instead of the customary five (Balingit, 2015). On their non-school days, the children are encouraged to use Footsteps2Brilliance, a computerized program that works on tablets, smartphones, and desktop computers. The software includes e-books with audio narration, highlighted print, and clickable words; when children come across a word they do not know, they can click on the word and the software pronounces it for them. The software is free for the families to use, and parents are encouraged to come to the school for support sessions and are connected to teachers whom they can call for assistance.

The Manassas approach begs many questions. One is whether evidence exists to show that this software can be effective with young children. A three-year study commissioned by an organization called NapaLearns did show impressive results when comparing kindergartners who did not use the software in the 2010–11 school year to kindergartners who used it in the following years. But those results have not been published in a peer-review journal (Maddocks & Redmond, 2015). Other studies are underway. Another, and possibly even more important, question is *how* the software is being used. For example, according to officials for Footsteps2Brilliance, the software—which is rolling out in school districts across the country—is typically used in classrooms with trained teachers. Some teachers use projectors to display books and media clips from the software onto big screens as they lead group discussions about words, letters, and stories. They may also distribute tablets to children for literacy lessons they can complete at classroom tables. In many of these cases, as documented in YouTube videos about the software, the children are jointly watching, reacting to, and "reading" the stories in large groups, or they are interacting with the software in smaller groups, sharing tablets between two and three children. Often, teachers are close by, guiding children to certain activities or books, answering children's questions, or responding to their exclamations and reactions to the games and stories.

The context changes dramatically now that Manassas is actively promoting *home use* of Footsteps2Brilliance as part of an experience for children who may be 1 or 2 years younger. When used at home, will four-year-old children continue to have joint learning moments with adults who can support and guide? Could opportunities arise in which they are sharing the tablets and e-books with siblings and friends, and how might those shared moments change the learning experience? Or will they be primarily using the software and e-books on their own?

Another case comes from Los Angeles Unified School District, where an accelerated rollout of iPads for all students quickly turned into a logistical nightmare that contributed to the resignation of the district's superintendent (Lapowsky, 2015). Yet the problem was not confined to the task of getting devices into the hands of 35,000 students. It went deeper because of failures in the Pearson-designed software that was loaded onto each of the iPads. The vast majority of students had trouble gaining access to the content they needed to learn. They would click on links to missing content or suddenly find themselves logged out. What's more, the content did not meet standards for accessibility for English language learners who make up a significant portion of L.A's population. Teachers and students alike needed huge amounts of support—in short, they needed someone by their side to guide them—and yet instructional support teams could not take time to train teachers on using the software with their students. “Time that should have been spent providing professional development and other instructional support has been devoted, instead, to troubleshooting technical issues,” wrote the initiative’s director Bernadette Lucas in a now-public memo to Ruth Perez, the district’s deputy director of instruction (Lucas, 2015).

These are just a few examples of recent news accounts that may lead educators, parents, and the public at large to wonder: When do young children need teachers and parents by their sides, and when does a “go solo” approach to technology suffice?

Cutting across all of these developments are the implications for children who need the most support. Children in low-income families, in economically depressed neighborhoods, and in other disadvantaged situations may be the least likely to have access to the kind of quality preschool that enables social interactions with teachers and peers *around technology*. Keen observers of the evolution of the digital divide over the past several years have pointed to a “participation gap” (Jenkins, 2009), in which some students have the knowledge and wherewithal to use technology to participate in learning and civic engagement, and some don’t. But for young children in particular, there may be a different type of gap to worry about. With the advent of technologies that are so responsive and interactive, parents and teachers may be led to believe that kids can just go it alone, contributing to what could be termed a “media mentorship gap.” Some children will have teachers and parents who see an important role for themselves and who have a sense of how to provide guidance in using apps and e-books, and some won’t.

To keep a watchful eye on whether technology is exacerbating inequality and whether children have equal access to human capital (teachers, librarians, and other educated adults, including parents), education leaders and policymakers need a deeper understanding of content and context—and some good professional development to help them get there. Lauricella, Blackwell, and Wartella provide a good overview of the guidance that exists so far: the technology position statement from the National Association for the Education of Young Children, the Screen Sense guide published by the research and advocacy group Zero to Three, and the recommendations from the American Academy of Pediatrics. But these documents are nowhere near enough. Leaders need to know more about how children from varying backgrounds learn from *joint engagement* with different forms of media and different interactive tools, and how much they learn when they are *left alone* with those media and tools. Understanding these dynamics could help them make smarter decisions about where and how to deploy new technologies with families and young children.

2.2 Going Solo

Let’s start with the question of whether children can learn from screen media on their own at all. So far the science tells us they can, even as young as 6 months of age (Guernsey, 2013, see Hipp and colleagues Chap. 3 and Kirkorian and colleagues Chap. 5, this volume). Research on television shows such as *Sesame Street*, *Blue’s*

Clues, *Cyberchase*, and *The Adventures of SuperWhy*! shows that children can learn from watching well-designed video by themselves many years before they have reached the ability to read by themselves.

Today, technology has advanced to include interactive e-books, videogames, and apps—technologies that not only present and display information but that also prompt children to interact and actively respond to that information. Given that the act of interacting with something or someone is viewed as a key mechanism for learning, these interactive technologies raise significant questions about how they should be used independently versus jointly. Some studies are showing that interactive features have potential to benefit children when they use them on their own, with some important caveats. The study by Gong and Levy (2009), for example, showed that children benefit from the highlighting of words as they are watching and reading along in an e-book without an adult. Research from Korat and Shamir (2007) shows children gaining an understanding of vocabulary and print concepts when using an interactive e-book that is designed to be educational. These studies point to the significance of certain features within the e-books, such as word highlighting and educationally oriented design, that can serve as instructional scaffolding and help children reach for higher levels of understanding.

Other research shows that, in e-books at least, hotspots, embedded games, and poorly designed interactive features can be distracting, leading children on their own to gain less of an understanding of the plot and narrative from reading an e-book as opposed to a print book (Bus, Takacs, & Kegel, 2015). Whether a child can learn from a solo experience with the technology appears to be dependent on the content (the curricular design or the use of certain features and affordances, such as text highlighting, for example) and, not to be forgotten, the individual child (his or her age and stage of development, for example).

2.3 Sharing Devices

For decades, research has pointed to the importance of sharing a media experience with an adult or peer. Again, much of what we know comes from television research. Lauricella, Blackwell, and Wartella sum up the results of four landmark studies showing that "when parents ask questions or reiterate the learning messages from educational television, children learn the concepts better." This co-using shares many beneficial attributes with the concept of "dialogic reading"—the practice of pausing and engaging in questions and dialog during storytime—that permeates research on emergent and early literacy (Whitehurst & Lonigan, 1998). Studies of e-book use that involves parents and children talking together and interacting with the content together also show positive results (Korat & Or, 2010; Strouse & Troseth, 2014).

Yet it is still to be seen whether habits of coviewing and dialogic reading can transfer to the realm of apps and mobile devices. There are some signs that instilling those habits will be an uphill battle (Connell, Lauricella, & Wartella, 2015), particularly because of the "pass back" effect, in which parents are more likely to "share" their devices by giving them to their children to use by themselves instead of joining them to attend to games or videos together.

Fortunately, a study by Courtney Blackwell, “iPads in Kindergarten,” sheds more light on what could be gained from shared attention and joint engagement around interactive technologies (Blackwell, 2015). The quasi-experimental study involved three elementary schools in a suburban Midwestern school district with a majority white, middle-class population. In six classrooms, students shared iPads (typically used in a 2:1 ratio); in another six classrooms, students each had an iPad to themselves (1:1 ratio), and in the third group of six classrooms, no iPads were available. There were no measurable differences in teacher pedagogy, no differences in measures of how teachers interacted with students, and no significant differences between all three groups on students’ test scores in the fall semester. In terms of content used by the students, the study did not address how individual students or groups of students used specific apps or piece of curriculum. All of the classrooms that included iPads used some collection of an average of 10 apps, with only two apps used by all the teachers (*DoodleBuddy*, a creation app, and *10 Frame Fill*, a math app.)

An analysis of students’ test scores on the spring assessment showed that students in 1:1 classrooms did no worse and no better than children in classrooms with no iPads. It was the children in the *shared* condition who performed significantly better compared to both of the other groups. There was one demographic group of students who scored higher without the iPads and those were the Asian/Pacific Islanders, though Blackwell cautions that the sample size for that group was low and that more research is necessary on the interplay between ethnicity, tablet use, and achievement.

One theory for the better performance among the shared iPad users is the interaction between the students as they used the devices together. Blackwell notes that the shared condition may have “increased opportunities for peer-to-peer interaction and scaffolding that helped students better construct knowledge.” She raises the notion of Computer-Supported Collaborative Learning, a term coined in the late 1980s and 1990s to describe environments and teaching strategies that foster collaboration and interaction between individuals, helping student to build knowledge and insight through their discourse (Lauricella and colleagues, Chap. 1 this volume). The research field could do a huge service by testing this theory with young children in home environments. For children in Manassas, for example, participating in the home-based digital-software program may cause them to miss opportunities to use the software in collaboration with their peers, though possibly that could be mitigated by the presence of siblings. It is unclear so far whether school officials are evaluating the impact of those factors.

2.4 When to Share, When to Enable Independent Use, and What Research Is Needed Now

These results have big implications for school districts’ technology decisions. The Blackwell study suggests that school leaders in districts—at least those in districts with similar demographics—may be wise to consider rolling out technology programs that enable shared use of touchscreen tablets among young children instead of pushing for 1:1 use. Studies showing that e-books can promote independent learning when they are embedded with educational features, such as text highlighting or research-based curricula, suggest that parents and educators should choose e-books with those features, especially if they are expecting children to have time alone with the devices. And research on the positive effects of coviewing of media as well as dialogic reading of printed and electronic books suggests that community and education leaders should build environments that encourage teachers, parents, and other adults to engage jointly with children around media where possible. School leaders may want to consider the benefits of a buddy system in which young children could be paired in technology use with children in a grade or two above them, enabling children to learn from each other and for older children to gain skills in mentoring.

More research is desperately needed on the impact of solo versus joint use of technology on minority children and those in low-income households. The Blackwell study, for example, was based in a majority white suburban school district. And the Manassas City program offers rich ground for comparison studies, with its bifurcated model in which some children go to 5-day-a-week preschool and others go for fewer number of days supplemented with software use at home. A key question, for example, is whether Manassas parents will be using the software together with their children on their days off from school, or whether parents will assume their kids should use it solo. Across all studies, many variations need to be considered. It may be too much to ask researchers to answer questions at the level of individual apps, with details on specific features within those apps, and the effects of their use, solo and jointly, with individual children and peer groups, but studies that bring us closer to the ground and that help make differentiations across content and context are incredibly valuable. With the adoption of technology moving so quickly, and with parents and school leaders relying on software purchases to reduce costs for traditional teaching or increase costs for equipment, the stakes are high. Not only are the implications significant for what children learn and the foundation that they build for their future learning and success in school, they also have large bearing on the allocation of scarce dollars in educational settings and they are likely to set the course for the habits and routines of daily school and home life for the twenty-first century. It's a relief to see that research has finally started to ask these questions instead of continuing to fixate on the hollow measure of hours per day.

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Chapter 3
The Dimensional Divide: Learning from TV and Touchscreens During Early Childhood

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3.1 Introduction

The ubiquity of television and traditional computing interfaces in contemporary culture, as well as the recent advent of tablet computers and smart phones, poses an interesting set of problems for the developing human perceptual and cognitive systems. Screen media, and television in particular, attract attention by acting as *sensory cheesecake*; their bright, rapidly changing imagery characterize our world and tickle our senses in an evolutionarily novel way. One might argue that television and other screen media became so popular precisely because of the degree to which these media cater to our evolved perceptual systems. This is especially true during development, when evolved predispositions and the neural plasticity of early childhood (Burgaleta, Johnson, Waber, Colom, & Karama, 2014; Edelman, 1993) facilitate rapid adaptive acquisition of knowledge about the world.

Despite the prevalence of screen media targeting children, the American Academy of Pediatrics (AAP 1999, 2011, 2013) has cautioned parents that children under 2 years of age should not be exposed to screen media at all. These recommendations have not, however, been followed by many parents. Television remains the primary form of media exposure for children under 2 years, who are watching

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55 min of TV/DVDs a day, and for 2–4-year-olds, who are watching 90 min a day (Rideout, 2013). Use of other types of media, such as touchscreens, is rapidly increasing (Radesky, Schumacher, & Zuckerman, 2015).

Given the prevalence of media usage, psychologists have examined the circumstances under which children learn and fail to learn from screens, with the goal of eventually informing parents and educators how to better utilize technology-based educational tools. For instance, infants and young children learn less from video and other two-dimensional (2D) media than they do from live interactions (Anderson & Pempek, 2005; Barr, 2010; Dickerson, Gerhardstein, Zack, & Barr, 2013; Troseth & DeLoache, 1998; Zack, Barr, Gerhardstein, Dickerson, & Meltzoff, 2009). Although originally termed the *video deficit effect* (Anderson & Pempek, 2005), this phenomenon has more recently been characterized as a wider-reaching transfer deficit (Barr, 2010, 2013) because the deficit applies not only to learning from video, but to learning from all 2D representations including books, touchscreens, and computers. The transfer deficit is due to a shift in the physical and perceptual environment between learning and test. For example, within the imitation paradigm, infants and toddlers watch an actor demonstrating a series of actions with an object followed by a test during which the infant is given the object and their ability to reproduce the demonstrated actions is measured. Thus, the *transfer of learning* deficit arises when infants learn the target actions by watching the demonstration in one dimension such as television and are then tested for this learning with the real world 3D object. Generalizing learning across the screen media and real-world contexts may seem trivial to adults, but the modality change is highly cognitively demanding (Barnett & Ceci, 2002), particularly for young children who have fewer cognitive resources available (Barr, 2010; Davidson, Amso, Anderson, & Diamond, 2006; Hayne, 2004; Zack et al., 2009).

Precisely why transfer of learning is so difficult in this context continues to be the focus of research. Characterizations of the transfer deficit have thus far been predominantly descriptive and pre-theoretical, tending to focus either on physical features of the task or on limitations of the developing mind. By failing to address both parts of the transfer problem concurrently, these accounts fail to make concrete and comprehensive predictions. This chapter considers both cognitive constraints on the developing child, the physical features of the task and the context of the media presentation. In doing so, we first carefully examine research elucidating the conditions under which children fail to transfer what they learn from screens to real interactions. We then turn our focus to the evaluation of perceptual and social differences between 2D and 3D displays and how these factors influence children at different ages. As it is clear that screen media use will continue to increase, we conclude with take-away messages for parents and early educators who use 2D screen media.

3.2 Transfer Learning and the Transfer Deficit

The transfer deficit can be conceptualized in terms of transfer deficit, a concept advanced by Barnett and Ceci (2002). In memory processing theory, *transfer distance* is defined as the extent of change to either cues or context between learning and retrieval. Such studies explicitly manipulate transfer distance and then examine whether and under what circumstances knowledge learned using a particular set of cues and in a particular context is transferred and applied to a new set of cues or a new context. Expressed in terms of distance, transfer success is most challenging under conditions of *far transfer*, when the disparity between learning and retrieval is greatest (Barnett & Ceci, 2002). Barnett and Ceci define transfer distance along a set of different dimensions, including both content and context changes over which transfer can take place. For example, learning from a 2D source and being tested in the real 3D world constitutes a contextual change, whilst learning with a pastel pink rabbit and being tested with a pale grey mouse constitutes a content change. Thus, it is possible to investigate which aspects of the context and the content are most challenging for young children. It is also possible to examine, both within and across ages, how the transfer deficit can be reduced.

3.2.1 Transfer Learning from Television

Transfer learning has been examined using a variety of tasks, including object search, object recognition, language learning, and imitation tasks. In object search tasks, for example, young children are shown the location of an object either by watching a person hide the object in a room through a television screen or by photographs showing the location of the object in the room. Children are then asked to enter the room and retrieve the object (e.g., DeLoache, Simcock, & Marzolf, 2004; Troseth, 2003a, 2003b; Troseth & DeLoache, 1998; Troseth, Saylor, & Archer, 2006). Researchers found that 2-year-old children exhibit a transfer deficit and are unable to find the object after viewing the hiding event via a television screen, but by 2½ years children do not show this transfer deficit and can find the hidden object (Troseth, 2010; Troseth & DeLoache, 1998). With respect to language learning, the role of parental scaffolding and repetition in facilitating infants' transfer has been emphasized, oftentimes assessing whether object labels that are acquired through television can be applied to 3D objects (e.g., Krcmar, 2014; Strouse & Troseth, 2014). When 2-year-olds watched a 5-min video in which a novel object was labeled four times, children were able to label the object during the video test, but did not transfer the label to the 3D object (Strouse & Troseth, 2014). However, when the parent reinforced the similarity between the object on the screen and the real object during learning, they could transfer the novel label to the 3D object (Strouse & Troseth, 2014).

Imitation is an essential tool by which infants learn new behaviors through observing others and copying them. Indeed, starting at 1 year of age, children learn one to two new behaviors a day through imitation, including sounds, gestures and different forms of play (Barr & Hayne, 2003). Imitation has most frequently been used to examine transfer learning from media, and thus the imitation procedure offers a relatively ecologically valid measure of the transfer deficit. Imitation is supported by the explicit or declarative memory system, defined as memory for specific facts and events (Barr & Hayne, 2000). Infants participating in imitation studies are required to learn from a single event and subsequently hold a representation of the event in their memory to be recalled at another time. Imitation measures can therefore be used to track developmental changes in declarative memory.

Although the memory demands of a particular task will depend on the age of those tested, infants, toddlers, and preschoolers tested with multiple different imitation tasks have exhibited a transfer deficit when imitating from television (e.g., the puppet task, Barr & Hayne, 1999; Barr, Muentener, & Garcia, 2007; the rattle and animal tasks, Barr & Hayne, 1999; Barr & Wyss, 2008; Hayne, Herbert, & Simcock, 2003; the magnet puzzle task, Dickerson et al., 2013). Young children not only show inferior levels of imitation following a televised demonstration, they also retain their memories for a shorter period of time than after a live demonstration. For example, when 1½-year-olds were shown a three-step action with a rattle, they were able to reproduce the target actions up to 2 weeks after a televised demonstration (Brito, Barr, McIntyre, and Simcock, 2012), although they were able to successfully reproduce the actions 1 month after a live demonstration (Hayne & Herbert, 2004). Similarly, 2-year-olds recalled the same target actions for 1 month after learning from television (Brito et al., 2012), compared with 3 months after learning from a live demonstration (Herbert & Hayne, 2000). The length of time over which a memory can be retained is clearly reduced when learning from television.

Infants are also sensitive to auditory cues when learning from television. Barr, Wyss, and Somanader (2009) added sound effects to a video of the puppet imitation demonstration. Sound effects accompanied the target actions, such as a squelch sound when a mitten was replaced on the puppet's hand, and either explicitly matched or mismatched the target actions. Overall, the mismatched sound effects were detected by children in both video and live conditions and significantly disrupted deferred imitation performance by 6–18-month-olds (Barr et al., 2009; also see Barr, Shuck, Salerno, Atkinson, & Linebarger, 2010 for disruptive effects of adding background instrumental music).

However, increasing the number of times that the target actions are demonstrated reduces the transfer deficit displayed by 1- and 1½-year-olds when learning from televised action demonstrations (Barr, Muentener & Garcia, 2007; Barr, Muentener, Garcia, Fujimoto, & Chávez, 2007). For example, when the number of demonstrations increased from three to six, infants reproduced the televised actions following a 24-h retention interval at the same level as infants who saw a live demonstration (Barr, Muentener, Garcia, Fujimoto, et al., 2007). Repetition has also facilitated word learning of objects in 6-month-olds and 2-year-olds (Krcmar, 2010), demonstrating that the utility of this effect. Additional exposure may increase the number of cues that infants encode in their memory representations and may therefore reduce the transfer problem by increasing the number of cues that can subsequently trigger retrieval.

The addition of language cues during learning and retrieval also reduces the transfer deficit (e.g., Barr & Wyss, 2008; Seehagen & Herbert, 2010; Simcock, Garrity, & Barr, 2011). For example, Seehagen and Herbert (2010) used maternal narratives to develop naturalistic scripts ("Look! What's this? You put the ball in here. And then you put this on there. And what do we do now? We shake it, wheee!"). They found that 1½-year-olds reproduced the target actions when the demonstrator used naturalistic language cues during the televised demonstration (e.g., but not when the demonstrator used empty language cues, which were designed to provide no additional information about the target actions or the goal during the demonstration (e.g., "Let's have a look at this. Then we have this bit. That was pretty neat, wasn't it?"). Descriptive language cues presented at the time of test also enhance memory from picture books and television for 1½- and 2-year-olds (Simcock et al., 2011).

Understanding the memory capabilities of young children offers insights into ways to alleviate challenging cognitive demands imposed by transfer tasks, such as learning from television. The transfer deficit can be ameliorated (see Barr, 2010, 2013; Troseth, 2010 for review and discussion) through repetition (Barr, Muentener, Garcia, Fujimoto, et al., 2007), social engagement (Nielsen, Simcock, & Jenkins, 2008; Subiaul, Anderson, Brandt, & Elkins, 2012; Tennie, Call, & Tomasello, 2006; Zimmermann, Moser, Gerhardstein, & Barr, in press), contingency cues (eye contact, directed gaze, directed pointing; Csibra & Gergely, 2006) and perceptual realism (Simcock & DeLoache, 2006; Simcock et al., 2011). Thus, researchers have documented a number of parameters that constrain and facilitate transfer learning from television during early childhood.

3.2.2 Taking a Novel Approach: Comparing Transfer of Learning Across Multiple Devices

Touchscreen technology provides researchers with a unique way to examine how perceptual factors contribute to transfer of learning. Touchscreens offer quite different learning opportunities compared to television because children can receive contingent feedback from these interactive devices. Multiple unique learning features can be embedded within apps (see Chap. 17, Zosh et al., 2016 and Chap. 18, Boyle & Butler, 2016) including active learning such as figuring out where a puzzle piece goes or scaffolding capability built within the app to control the content according to a child's responses (Hirsh-Pasek et al., 2015). Touchscreens still have limitations; they deliver perceptually impoverished information relative to real world experiences.

Researchers can use touchscreens to explore within-dimension 2D–2D learning, or across-dimension 3D–2D learning (e.g., Dickerson et al., 2013; Moser et al., 2015; Zack et al., 2009; Zack, Gerhardstein, Meltzoff, & Barr, 2013; Zimmermann et al., 2015) to examine how the dimensional divide affects learning. This approach enables researchers to compare learning directly from the touchscreen, as well as, transfer of learning in both directions: 2D–3D or 3D–2D. From this design, it is possible to determine whether the transfer deficit is bidirectional due to difficulty transferring information across the dimensional divide or whether infants simply learn less from the perceptually impoverished touchscreen demonstration. Zack and colleagues (2009) showed 15-month-old infants a one-step action, either on a touch screen (2D) or using a 3D button box. For example, the experimenter either pushed a virtual button on a touchscreen cow image to make a "mooing" noise, or she pressed a real button on a 3D box with a cow face to make a “mooing” noise. Infants reproduced the target action more often when the demonstration and test sessions occurred across the same dimension (e.g., 2D–2D or 3D–3D). Infants also reproduced the target action when the demonstration and test occurred across different dimensions (e.g., 2D–3D or 3D–2D), but they imitated significantly fewer actions in the between-dimensions compared to the within-dimensions conditions, exhibiting an overall transfer deficit. The results demonstrate that the transfer deficit is likely to be due to infants’ difficulties transferring their memory across *far transfer* changes between the demonstration and test and not due to the perceptual impoverishment of the 2D learning experience per se. Of course, the difficulty of the transfer is affected by the age of the participant; older children and adults have much more experience navigating the relationship between objects depicted on screens and their real world counterparts. What constitutes a “far” transfer problem for an infant may test like a “near” transfer problem for an adult; these terms are maximally heuristic when interpreted as reflecting an interaction between task parameters and participants’ task competency.

Although past approaches have been able to examine factors that influence learning from television or touchscreens during infancy, these studies were limited in a number of ways. First, they did not directly compare learning from touchscreens and television to one another. Second, although researchers had been able to examine ecologically valid responses on touchscreens, the sequences presented on television were longer and involved more complex motor-spatial manipulations than the touchscreen sequences. Third, the tasks were suitable for children 2 years and younger, but other research suggests that the transfer deficit might persist beyond 2 years. For all these reasons, Dickerson et al. (2013) devised a novel puzzle task that could be presented on video, touchscreen, and a magnet board. The experimenter demonstrated how to construct a multi-piece puzzle to make a fish or boat (see Fig. 3.1). The puzzle sequences could differ in number of pieces in order to vary the cognitive load. The touchscreen and the magnet board were identical in size, allowing for this variable to be equated across dimensions. The puzzle pieces themselves were flat abstract shapes, and the background was solid. This design feature meant that additional perceptual details could be added to both the puzzle pieces and the background context to increase the semantic meaningfulness of the test stimuli. Finally, the puzzle task involved complex motor-spatial movements in order to slide the pieces into place. Figure 3.1 shows how the magnet puzzle could be shown on the magnet board and then converted to present the 2D touchscreen test allowing for transfer distance to be systematically varied.

Through a series of studies, we were able to manipulate the transfer distance, the social partner, and the child’s level of experience interacting with the device to assess how perceptual and cognitive constraints might interact with context of learning to influence transfer of learning.

In our first study, we established the magnet puzzle task and measured both goal and gesture learning. Children ranging from 1½ to 3½ years were randomly assigned to the live, video or baseline condition. The transfer deficit persisted until 3½ years, with performance on the video condition significantly and consistently poorer than

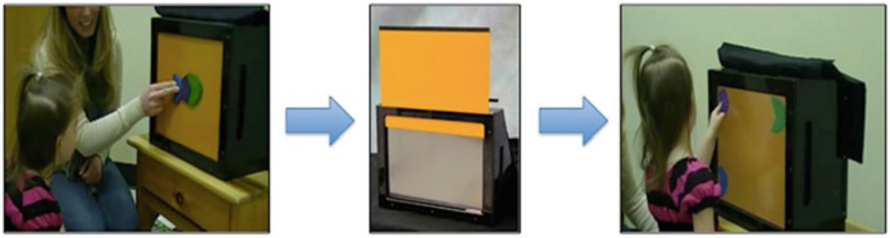

Fig. 3.1 Experimental procedure highlighting transfer from a 3D demonstration to construct a fish to a 2D touchscreen test phase with a 3-year-old child. The *middle image* shows that the magnet board can be removed to reveal the touchscreen underneath. The screen could also play video demonstrations. Children could be tested either on the magnet board or the touchscreen

on the live condition (Dickerson et al., 2013). We next examined whether the bidirectional deficit reported by Zack and colleagues (2009) persists in older children on a more complex task (Moser et al., 2015). Two-and-a-half and 3-year-old children were shown either a touchscreen demonstration or a live demonstration of the assembly of the three-piece puzzle. The design was fully crossed for transfer distance (within-dimension or across dimension) and transfer direction (2D to 3D or 3D to 2D). The outcome clearly confirmed Zack et al.'s (2009) finding; within dimension groups produced higher imitation performance than across dimension transfer groups. Both young (15-month-olds) and older (2½- and 3-year-olds) children showed the effect of transfer distance, and both failed to transfer learning across dimensions regardless of transfer direction.

Why might perceptual impoverishment contribute to the transfer deficit? In cases in which transfer is necessary, perceptual impoverishment effectively diminishes the physical similarity between training and test contexts, making the mapping between these contexts more difficult (Thorndike & Woodworth, 1901). Using Barnett and Ceci's (2002) framing of this problem in terms of transfer distance and the host of perceptual differences described above, it is abundantly clear that across-dimension tests involves greater transfer distance than within-dimension tests.

The design of the magnet puzzle box also allows for the social scaffold to be systematically varied (see Fig. 3.2). During a touchscreen or a magnet board demonstration an experimenter demonstrated how to assemble the puzzle on the touchscreen or the magnet board. This is in contrast to a video demonstration, or a ghost demonstration where the pieces moved on the screen by themselves and the child and experimenter simply watch. Zimmermann and colleagues (in press) showed a ghost demonstration on the touchscreen to 2½- and 3-year-olds. Children were then tested with the 2D virtual puzzle on the touchscreen (near transfer) or they were tested with the real 3D magnet pieces (far transfer). Surprisingly, children tested with the 3D pieces after the ghost demonstration outperformed children tested on the touchscreen (see Fig. 3.3). In a follow-up experiment with touchscreen practice, children's performance did not improve, suggesting poor performance was not due to inability to interact with or manipulate the touchscreen

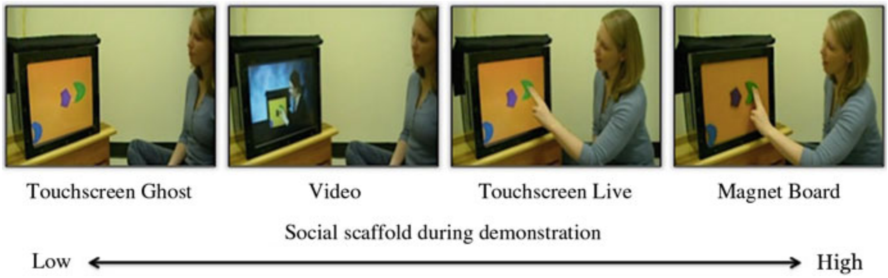

Fig. 3.2 Images of the differences in social scaffold during demonstration. Adapted from Zimmermann et al. (in press): Fig. 2

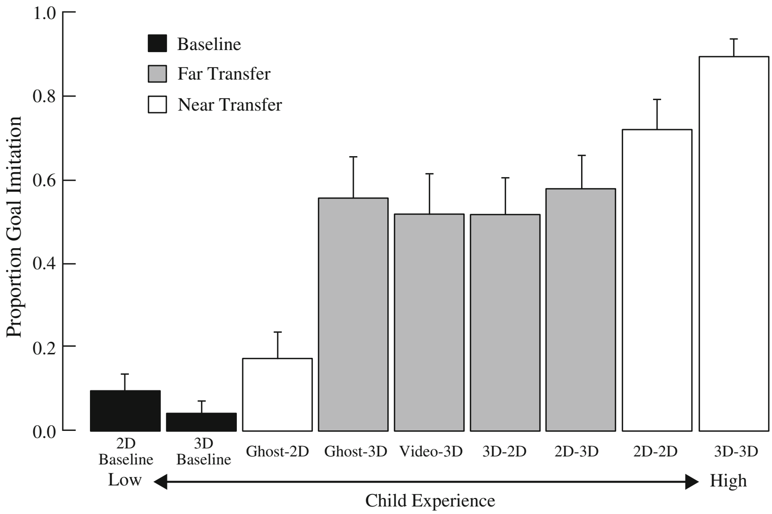

Fig. 3.3 Goal Performance as a function of transfer distance, child experience, and social scaffolding. Data from Zimmerman et al. (in press)

apparatus. Lastly, a cross-experiment comparison examined the role of social scaffolding by including participants who received a social demonstration (Moser et al., 2015). Compared to the ghost demonstration, the social demonstration group had improved performance only in the near transfer group. These results suggest that social factors may play a crucial role in learning from the novel touchscreen tool.

Effects of transfer distance, child experience, and social scaffold. How can we explain these findings as a whole? We found that each of these factors—transfer distance, child experience, and social scaffold—are associated with changes in 2–3-year-olds' transfer learning. In terms of child experience, although children do have daily exposure to touchscreen devices and learn to interact with objects in 2D environments, in relative terms this engagement pales in comparison to the experience they accumulate interacting with real world objects. Table 3.1 summarizes

Table 3.1 Transfer distance as a function of child experience, social scaffold during learning, test context, and transfer of learning

		Social Scaffold during demonstration Low <--> High			
Child experience	Test context	Limited social interaction	Person on screen	Person live	Person live
		Ghost	Video	Touchscreen	Live 3D
Low	2D Touchscreen	Near	–	Near	Far
High	3D Object (Magnet Board)	Far	Far	Far	Near

experimental conditions and manipulations of the levels of child experience with objects in the real world (3D puzzles) versus experiences in the 2D virtual world, taking into account social scaffold, test context and transfer distance.

As shown in Fig. 3.3, children were best able to complete the goal of connecting the puzzle pieces in the 3D–3D condition when both the demonstration and the test occurred on the magnet board. The 3D–3D condition maximizes learning because it is a near-transfer test, there is a real person present, which maximizes social learning, and children have prior haptic experience with real objects similar to those in the demonstration and test. This performance is in stark contrast to performance in the ghost demonstration 2D conditions. Even though these conditions are also near transfer, there is no social demonstration and children have much less experience navigating 2D virtual space. As can be seen in Fig. 3.3, children's performances in the video and both touchscreen transfer conditions were similar. All tasks involved far transfer, and the test context was with 3D magnets, but social scaffold varied. It seems that when the child has experience with the test context (3D test pieces), the social scaffold does not bolster learning. When they lack this experience (in a 2D test context), however, learning can be enhanced by social guidance. The results clearly demonstrate that children can readily interact with the touchscreen, but that this interaction is insufficient to bring their imitation performance up to 3D–3D levels.

Effects of perceptual context and labeling. The design of the magnet puzzle task also permits insertion of a semantically meaningful context to examine whether the transfer deficit can be ameliorated by increasing semantic congruence. Zimmermann and colleagues (2015) presented 2- and 2½-year-olds with a live or video demonstration of an experimenter making a fish or a boat on the magnet puzzle board. Half of the children were assigned to a meaningful semantic context of the ocean and waves, and the other half were not (see Fig. 3.4). Critically, the majority of children had fish (79 %) and boat (85 %) in their vocabulary.

Consistent with previous findings using this task, this study showed that young children displayed a significant transfer deficit. Two- and 2½-year-old children who received a video demonstration reproduced significantly fewer gestures and goals than children receiving a live demonstration. There was an age-related effect of context in the live condition, supporting the hypothesis that the addition of peripheral contextual information would enhance learning. The addition of a semantically meaningful visual

Fig. 3.4 *Top panel*: Start and end configurations for the boat puzzle (Context condition). *Bottom panel*: Start and end configurations in the No-Context condition. Adapted from Zimmermann et al. (2015): Fig. 2

context did not, however, eliminate the transfer deficit. Importantly, the context did not interfere with learning either, indicating that the context did not increase cognitive load. Rather, these findings suggested that toddlers may first form representations that contain primarily central cue information, resulting in neither a disruptive nor a facilitative effect of background context. The fact that the context enhanced learning in the live, but not the video, condition suggests that there is a lag between the ability to utilize novel cues in conditions of transfer relative to direct learning.

Despite the absence of any effect of semantic context on transfer performance, there were individual differences in self-generation of a label to describe the puzzle (e.g., boat). When children in the video group labeled the puzzle (39 % of children), they were more likely to transfer learning and assemble the puzzle than children who did not label. This research suggests that language cues may enhance recognition and learning under perceptually impoverished conditions and high cognitive load (Gerson & Woodward, 2013; Hayne & Herbert, 2004; Miller & Marcovitch, 2011; Simcock & Hayne, 2002; Troseth, 2010). Both the age of the child and the self-generation of the label may be important variables. The provision of a label during infancy, was not sufficient to overcome the transfer deficit (Zack et al., 2013).

3.3 A Coherent Theory: How Child Constraints, Perceptual Content and Social Context Combine to Result in the Transfer Deficit

What makes transferring knowledge to and from screen media a particularly difficult challenge during development? It is intuitive to attempt to explain this deficit in terms of the perceptual or social factors that are absent from screens but present in typical, *live* interactions. Clearly screen media differ physically and socially from live and reciprocal interactions, but these differences alone cannot account for the findings. Instead, developmental changes in the way that children are impacted by physical or social factors are more likely to account for this effect. Below, we combine prior theoretical explanations to provide a more coherent theory that accounts for the constraints due to the developmental level of the child, perceptual constraints inherent in the media content, and constraints in the social context that moderates learning during early childhood.

3.3.1 Perceptual Factors

Physical differences between screen media and live interactions led a number of researchers to consider the relatively perceptually impoverished screen media as a potential source of the transfer deficit (e.g., Anderson & Pempek, 2005; Barr, 2010; Barr & Hayne, 1999; Schmitt & Anderson, 2002; Suddendorf, 2003; Suddendorf, Simcock, & Nielsen, 2007). The most obvious physical/perceptual difference is that screen-presented content simply occupy less visual space. Even with the recent commercial shift towards large, high definition televisions—with the average household television set now 46 in.—2D screens and the characters they display are typically smaller than their real-life counterparts, both in absolute size and in subtended visual angle.

Attention to a screen generally restricts one's attention to a small portion of the visual field. Why should this be problematic? Many implicit calculations within visual processing, such as stereoscopic depth perception resulting from binocular disparity, depend on comparative visual angle calculations (Qian, 1997). Such cues are not meaningful when viewing 2D images. In fact, while some depth cues, such as occlusion and relative size, are preserved in 2D screen media, most other visual cues indicating relative and absolute depth (e.g., stereo cues, motion parallax) are fundamentally altered or absent within these displays (Anderson & Pempek, 2005). Furthermore, luminosity is greater for LCD and plasma televisions than normal reflectance, and enhanced luminosity is a salient exogenous attention cue (Carrasco, 2011), meaning that the salience hierarchy of items in a screen display may differ from the 3D version of the same item or scene, which contributes to the perceptual cheesecake effect of screens. Furthermore, many television programs, even those created for children, contain rapid shifts in viewpoint. These perspective shifts are considerable and frequent; Anderson and Hanson (2010) report that visual transitions occur approximately every 6 s during typical television programs. Adults are experts at stitching together the disparate "cuts" that make up a televised scene, but children must first acquire the syntax of television programming, which limits the expediency of using television as a primary tool of instruction (Anderson & Pempek, 2005). For young children, the differences in luminosity and depth cues accompanied by rapid scene changes pose a perceptual challenge for translation between cues presented on screen media relative to those in the real world (Fig. 3.5).

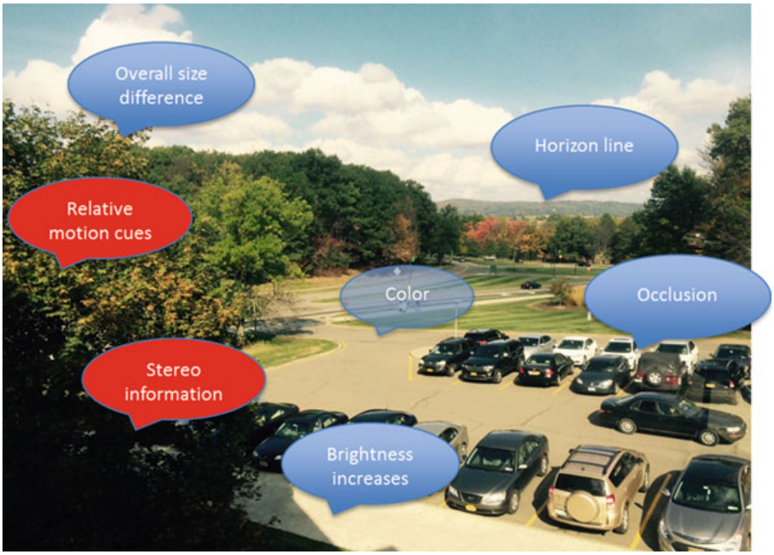

Fig. 3.5 Bubbles in *blue* are features that are present in 2D. Some cues are quite accurate such as occlusion cues and the horizon line; these are known as artists or pictorial depth cues. Other cues are distorted, e.g., colors are not exact, but are dependent upon the camera used to take the image. Still other perceptual cues (in *red*) are absent: Stereo information for binocular depth perception requires actual 3D information, which a photograph does not contain. Relative motions cues are also absent because the image is a surface plane and does not supply movement of objects relative to a fixation point, which provides feedback about the relative distance of objects in the world

Of course, the differences between screen media and live instruction are not merely visual. Perhaps just as important as the visual impoverishment is the unnatural auditory environment of screen viewing. Typical televisions use either mono or stereo audio as the default option. This means that all sounds, regardless of their source, originate from the same point in space, and that events depicted on screen as visually separate are depicted as spatially the same in the auditory domain. Even when true surround sound is achieved, only a loose mapping between on-screen visuals and auditory location is achieved, and these often track the rapid perspective shifts described above. The sounds themselves also differ from the real world; children's programs often contain a greater number of attention-grabbing sound effects (Goodrich, Pempek, & Calvert, 2009).

The relative lack of sensory data provided by video and touchscreens provides a partial explanation of the transfer deficit. Screen images lack or are limited in terms of their multimodal perceptual feedback, particularly tactile, haptic, and auditory cues that guide motoric behavior and attentional allocation. Some of the normal multimodal (e.g., haptic-visual) cues that assist perception under non-screen conditions are completely absent (e.g., the fingertips obtain no information about "furriness" when touching an image of a cat, as compared to touching/stroking a real cat). Limited haptic cues have been incorporated into video games since 1997 and are beginning to be introduced within smartphones and their touchscreen interfaces.

Adults immersed in a virtual reality game were more accurate and faster to detect events (e.g., ball bouncing off wall) within the 2D environment when naturalistic multimodal cues (visual, auditory, and haptic) were available compared to when only two modal cues were available, and both showed significant improvement over unimodal presentations (Sella, Reiner, & Pratt, 2014). Event related potentials showed that multimodal cues initiated faster processing than unimodal presentation (Sella et al., 2014). These congruent cues may provide bottom-up as well as top-down attentional allocation to events on screen. In doing so, these cues may provide feedback to engage more dynamically with the environment. To our knowledge, research on multimodal feedback within a 2D space has not been performed with children, but may provide answers concerning the importance of multimodal feedback on perception of 2D events and explain the relative ease with which children navigate the real world.

Any one of these limitations could hinder the ability of a child to learn from screens. Taken together, the physical/perceptual differences of screen media compared to live interactions delineate screen media as a substantively separate context from the real world. Events on screen are causally isolated from the wider context in which the screen and the observer are jointly contained. Children come prepared for a world in which causality knows no such boundaries (Hickling & Wellman, 2001). This separation effectively establishes the on-screen events as contextually separate from the outside world; children therefore must discover this causal segregation on their own. This is likely to be no small issue; the learning curve for this information appears steep, as it in many ways contradicts the real-world information that has already been acquired. For all of these reasons, it appears that acquisition of adult-level expertise in processing information presented on screen media occurs gradually over a protracted developmental time course (Anderson & Hanson, 2010).

3.3.2 Social Factors

A different line of thinking attributes the transfer deficit to the social differences between live and screen media learning environments. Social learning is thought to have evolved for rapid transmission of information and is highly developed in humans, becoming a catalyst for learning how to navigate the world from infancy onwards (Baldwin & Moses, 1996; Csibra & Gergely, 2006, 2009). This process involves joint attention and contingent interactions between two interacting individuals, that depend on subtle and dynamic changes in eye contact, body movements, vocal changes, and shared context (e.g., Goldstein et al., 2010; Huang & Charman, 2005; Nielsen & Blank, 2011; Nielsen et al., 2008; Over & Carpenter, 2012). Contingent interactions, easily detectable during early childhood (Barr, Wyss & Somander, 2009), are absent in typical video presentations and touchscreen applications. As with the perceptual differences noted above, these differences guarantee that the context in which the events on screen occur is distinct from the viewer's social context (Anderson & Pempek, 2005). Some children's commercial programs attempt to break the "fourth wall" and communicate directly with young children (Anderson et al., 2000), but these attempts (and their success) are limited. These programs approximate an interactive component, including pauses after on-screen questions and attempts to mimic the joint attention between two interacting people (Anderson & Pempek, 2005; Krcmar, 2010). The fact that many children in this situation respond to these (typically verbal) cues is a suggestion that the social cues can potentially provide an important bridge across the dimensional divide.

Despite these attempts, the lack of joint attention, contingent interactions, or both may continue to be problematic for young children. Meltzoff (2007) frames all of social cognition as dependent on the ascription of *like-me* status to people with whom we interact. Meltzoff argues that imitation may be an effective mechanism for young children to learn the correspondence between one's own behavior and that of others; newborns contain a basic capacity to imitate orofacial gestures (Meltzoff & Moore, 1989), and by a few months after their second birthday infants recognize when they are being imitated and smile more at imitators (Meltzoff, 1990). Importantly, behavioral contingency alone is insufficient to garner this response; infants respond best to social demonstrators rather than inanimate demonstrations (e.g., Mahajan & Woodward, 2009; Zimmermann et al., in press). For example, the difference between learning from a touchscreen when there is a live demonstration versus a ghost control (Zimmermann et al., in press) suggests that social scaffolds contribute to learning from touchscreen displays directly (see Fig. 3.3).

Not surprisingly, recent studies have demonstrated that the transfer deficit can be ameliorated by increasing social contingency cues. For example, Roseberry, Hirsh-Pasek, and Golinkoff (2014) found that 2- and 2½-year-olds could learn verbs during face-to-face interactions or during contingent video chat interactions but not from a video demonstration. Similarly, Troseth et al. (2006) showed enhanced object retrieval by 2-year-olds after a demonstration via video chat; controls viewing a regular video showed the typical transfer deficit. That is, social contingency enhanced transfer of learning via a screen presentation (see also Chap. 15, McClure & Barr, 2016). Other studies using familiar video models suggest that social relevance may also be an important variable in facilitating transfer of learning (Krcmar, 2010; Seehagen & Herbert, 2010). Despite the fact that none of these studies properly controlled perceptual differences between live and video demonstrators, the partial amelioration of the transfer deficit when socially contingent information is added to video displays shows that social interaction is relevant to understanding the transfer deficit: Accounts invoking only perceptual factors are insufficient to explain the transfer deficit.

3.3.3 Developmental Constraints: Cognitive Factors

Learning from screen media requires active and efficient memory encoding, storage, and retrieval by the child. Investigating where and how children fail relative to older children and adults will shed light on how developmental differences may account for the transfer deficit. Transfer learning is highly constrained by memory flexibility, which increases rapidly across early childhood (Barr, 2010, 2013; Barr & Brito, 2014). Memory flexibility accounts of the transfer deficit explain children's failure to transfer knowledge as a function of their inability to generalize across physical and social context shifts that would be trivial for an adult (e.g., Barr & Hayne, 1999; Barr, Muentener & Garcia, 2007; Barr, Muentener, Garcia, Fujimoto, et al., 2007; Dickerson et al., 2013; Moser et al., 2015). In this manner, the theories combine stimulus and child-based contributions to the effect.

Manipulating factors that typically enhance memory encoding and retention can ameliorate the transfer deficit. For example, the transfer deficit can be reduced in 1–2-year-olds by repeating target actions; simply doubling the number of target actions presented by the video model relative to the number of repetitions provided during the live demonstration erases the transfer deficit (Barr, Muentener, Garcia, Fujimoto, et al., 2007). Introducing additional, contextually meaningful content, such as sound effects or background context, can increase representational strength and enhance learning (Barr et al., 2009; Barr, Shuck, et al., 2010; Zimmermann et al., 2015). In some cases, adding language cues (Barr & Wyss, 2008; Simcock et al., 2011) and self-generation of labels (Zimmermann et al., 2015) can enhance transfer, but only among older children (Zack et al., 2013). Finally, matching the perceptual cues to the content by enhancing iconicity of the images enhances learning from books and from television (Simcock & Dooley, 2007; Simcock et al., 2011). The success (and limitations) of all of these manipulations supports the idea that there are significant constraints imposed by developmental level on the memory capacity and flexibility of the system that can limit transfer of learning.

3.3.4 Developing a Coherent Theory

Taken together, these perspectives suggest that transfer learning between 2D and 3D is grossly constrained by perceptual and social factors. The effects of these constraints interact with age-related differences in multisensory perceptual processing and integration, as the neural systems responsible for these functions have different developmental trajectories. First, the lack of multimodal cues and the inability to process and interpret cues in the 2D virtual environment is likely to impede transfer of learning to 3D contexts as well as learning within the 2D context on touchscreen. Second, constraints on memory flexibility limit the child's ability to flexibly map information presented across dimensions. Third, the degree of information processing required to solve the transfer problem severely taxes an already limited cognitive capacity, making transfer of learning highly susceptible to changes in cognitive load. To unite all of these perspectives, a coherent theory must account for interactions between environmental (social, perceptual) factors and cognitive constraints across development (see Fig. 3.6).

While flexibility is certainly important, it is likely that cognitive processes other than, or subordinate to, memory flexibility also constrain transfer learning. The impact of cognitive load on transfer suggests that working memory capacity and duration might also affect this system (e.g., Barr et al., 2016; Barr et al., 2009; Zack

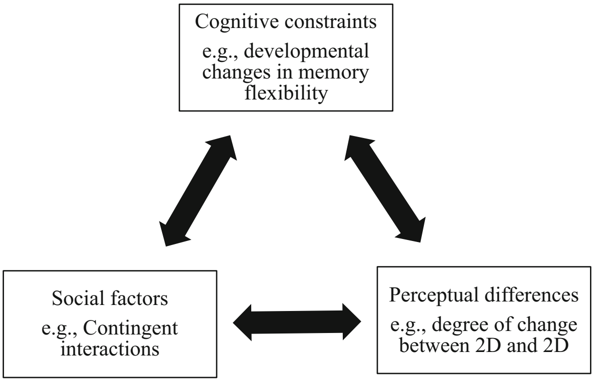

Fig. 3.6 The interaction between the cognitive, social, and physical/perceptual factors that contribute to the transfer deficit in children

et al., 2013; Zimmermann et al., 2015). Working memory, the process responsible for "actively holding information in your head", is another aspect of cognition that develops rapidly across early childhood and shows a great deal of individual variation. To list each cognitive system would be excessive, but successful transfer learning in complex environments certainly requires that a large number of systems interact efficiently, meaning that each system's unique developmental trajectory likely contributes to children's transfer performance.

A great deal of research remains to be done in this exciting field of study. For example, with respect to cognitive limitations researchers could systematically manipulate cognitive load and collect separate, individualized working memory data to see the relation between performance and working memory capacity. The addition of methods designed to index processing of attention such as eye tracking or brain activity (e.g., fNIRS and EEG) may more precisely pinpoint when and how information processing breaks down during these tasks.

3.4 Enhancing Transfer Learning: Strategies for Parents and Early Educators

Touchscreen technology has a growing presence in early education with the use of tablets in the classroom and the large number of educational applications being developed (see Chap. 1, Lauricella et al., 2016; Chap. 4, Robb, 2016; Chap. 6, Liebeskind & Bryant, 2016 and Chap. 17, Zosh et al., 2016). There may be potential educational benefits to including media in preschools, including enhanced engagement and interactivity, but additional scaffolding by early educators may be necessary to facilitate transfer in young children (Lauricella, Barr, & Calvert, 2009; Lauricella, Barr, & Calvert, 2014; Levine, Ratliff, Huttenlocher, & Cannon, 2012; Zimmermann et al., in press). What lessons can parents and early educators take from the panoply of research findings about learning from digital media? A main point to keep in mind is that adults have accumulated extensive expertise navigating technology; they understand the vast set of conventions employed in television, tablets, and computers to such a degree that these differences generally do not rise to the level where they are actively noticed. It is likely as a consequence of this level of facility with technology that adults greatly overestimate how much children can learn from media alone.

There are several key take-home messages from this research for early educators using screens with young children:

1. Transferring knowledge from 2D applications to 3D, real-world scenarios is **cognitively demanding**. To reduce these deficits, educators need to consider the perceptual and memory flexibility constraints of young children (e.g., features that make 2D learning environments distinct, such as the absence of depth or haptic cues). Parents and educators need to make explicit connections and emphasize similarities between 2D and 3D material. This will reduce the transfer distance and lead to more flexible learning.
2. **Transfer deficits are bidirectional**. That is, information acquired via a robust 3D demonstration may not necessarily transfer to the 2D setting as assumed by educators and parents alike (or the reverse). Learning via an app is presumably supported by the child's existing knowledge and representations gained from interacting with the 3D world, but learning acquired with real objects may not readily transfer to a virtual setting within an app. To provide a concrete example, 3D blocks used to teach math might not be easily translated to 2D block depictions in an app. Consider evaluating learning both within the app and within the 3D environment.
3. Despite the interactive or content-rich nature of media, just like any other tools, **children need to learn how to use media**. Media are constructed using conventions and syntax that children need to learn. Children's superficial facility for navigating digital media should not be confused with expert comprehension. Rather than presenting children with decontextualized *ghost-like* demonstrations, early educators should provide social scaffolds to guide children's initial explorations within the 2D environment.

3.5 Conclusion

Studies examining the transfer deficit have uncovered a number of constraints on learning. Specifically, learning is constrained by changes in visual perceptual processing across dimensions, as well as lack of consistent inter-sensory processing cues. The mismatch of cues places considerable cognitive demands on a memory system that is not yet well developed. The limits of memory flexibility are easily exceeded, causing cognitive overload to occur. This mental burden is coupled with the fact that, despite daily exposure, children have relatively limited real-time exploration experience with the 2D environment. Perceptual constraints can be reduced by increasing encoding time via repetition, increasing the match in visual characteristics between the image and the real world object, and providing social scaffolds in

Table 3.2 Strategies to use in early education settings to increase transfer learning

Manage cognitive demands
Repetition: Repeat media presentations of new activities.
Adjust cognitive load: Identify age-appropriate task difficulty, adjusting the task on an individual basis as needed.
Integrate technology into existing teaching method.
Enhance perceptual similarity
Increase physical similarity between the 2D app and the 3D real objects.
Increase realism of 2D objects to facilitate comparisons to familiar, real-world exemplars.
Perceptual matching: Provide experience with 3D objects during teaching to draw comparisons to 2D objects.
Increase social cues
Social attention: Use social cues like pointing to engage the child.
Scaffold with labels: Label content and reward novel word use within and across contexts.
Add contingency: Take advantage of video chat technology.
Guided Intervention: Increase scaffolding and tech talk when learning involves new media tools.

the form of adult-directed gaze to key screen referents and demonstration of key skills. These factors are critical considerations for early educators who are designing media environments to facilitate interactive playful learning (see Chap. 1, Lauricella et al., 2016; Chap. 4, Robb, 2016; Chap. 6, Liebeskind & Bryant, 2016 and Chap. 17, Zosh et al., 2016). Understanding the constraints on young children's learning will allow educators to adequately plan to compensate for and ameliorate learning deficits, and will help children to gain mastery over content within a supportive learning context. Unfortunately, due to our vast personal experience of media usage as adults, we have underestimated the need among young children for scaffold-rich learning from television and tablets. Screen media applications have huge educational potential, but the constraints on learning due to perceptual differences inherent in the media, within the individual child, and the social context within which the child is exposed to screen media must be considered (Table 3.2).

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Chapter 4
Bridging the Dimensional Divide in the Real World: Commentary on Chapter 3

Kara Garrity Liebeskind and Alison Bryant

The rise of digital media has pervaded the lives of nearly every person in recent years, and young children are no exception. In fact, this age group may be one of the largest target audiences and consumers of apps and mobile technology. Mobile devices are becoming a large presence not just in children's home lives but also in school. Indeed, although the most common mobile activity among young children is playing games, the majority of these games fall under the category of educational. Over half of children ages 2–4 sometimes or often play educational games, whereas 43 % play games just for fun (Common Sense Media, 2013). Parents view the potential educational value of these platforms as paramount (PlayScience, 2015). This pattern suggests that there is a real demand among this age group—or more specifically, their parents and teachers—for mobile apps that offer beneficial learning experiences.

The format of digital media does provide a unique platform for developing interactive and engaging educational content. By utilizing the opportunities of the technology as well as the features of the device itself, apps can go well beyond traditional learning experiences to tailor lessons to children's cognitive development and physical abilities and to continually adapt to children's developing skills and knowledge. In addition, the mobile nature of digital media devices allows for learning anywhere and anytime, meaning that the separation between school and the outside world is no longer as distinct. Although the transfer deficit suggests that children do not learn as well from screens compared to live presentations and have difficulty applying 2D learning to 3D contexts, there are several approaches to presenting information through interactive mobile technology that can ameliorate some of these difficulties and create a more effective learning experience.

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4.1 Technology in the Classroom

Despite the rapid rise of digital media in the home, these technologies have been slower to be adopted in the early childhood classroom. The lack of teachers' knowledge of and confidence in using the tools effectively within the learning environment likely plays a large role in this more gradual adoption; however, a potentially more important consideration is the insufficiency of funds within early education to support the purchase of such devices (Zevenbergen, 2007). As a result, some digital technologies are more common in the classroom than others. Nearly all early childhood educators have access to digital cameras (92 %) and televisions with DVD players (80 %), but fewer than one-third have tablets (29 %), interactive whiteboards (21 %), e-readers (15 %), or iPod Touch devices (15 %) (Wartella, Blackwell, Lauricella, & Robb, 2013). Those who do have these devices in their classrooms are more likely to use them with their students. Two-thirds of educators with access to interactive whiteboards, 52 % with access to tablets, 44 % with access to iPod Touches, and 25 % with access to e-readers use these tools at least once a week. In fact, newer technologies are more likely to be used than traditional media; only 16 % of educators use their television at least once a week and most use it less than once a month (Wartella et al., 2013). Clearly, early childhood educators are willing and eager to use touchscreen devices with their students, if given the opportunity.

As technology becomes more affordable and younger educators, who are more personally comfortable with the devices, enter the workforce, the presence of digital media in the classroom will undoubtedly increase. However, this rise will need to be accompanied by corresponding professional development. Educators have reported that the main barriers to using technology with their students, besides access, are lack of technical support, inability to find enough appropriate digital content, and uncertainty about how to actually integrate the technology into their lessons in a relevant way. While digital media offer a multitude of opportunities for learning, the mere presence of technology in the classroom is not enough to reap the expected rewards, nor should it be blindly incorporated into every activity. Rather, as aptly stated by the National Association for the Education of Young Children (NAEYC) in their 2012 position statement, "technology and media should be used in moderation and to enhance and be integrated into classroom experiences, not to replace essential activities, experiences, and materials" (NAEYC, 2012, p. 7).

4.2 Importance of Social Scaffolding

One of the ways that educators potentially misuse media in the classrooms is by assuming that children are capable of using and learning from the devices by themselves. Children's early digital exposure should not be assumed to equate to digital competency. Chapter 3 by Hipp and colleagues points out that, not only do children need to first learn how to use digital media tools, they also must contend with the cognitive demands required to transfer knowledge between 2D screens and the 3D world. In a series of studies by Zimmermann and colleagues (in press), researchers found that children who viewed a ghost demonstration, where pieces moved on a digital screen by themselves, were unable to replicate the target actions on a screen. In contrast, those who were shown a social demonstration, where an experimenter moved the pieces, performed successfully. Social scaffolding is particularly effective when children are unfamiliar with the learning context, as they often are when it comes to digital technology.

Learning from educational apps—as with any media—is severely limited when children are left on their own. Indeed, the potential impact of any digital media in the classroom "is mediated by teachers' use of the same developmentally appropriate principles and practices that guide the use of print materials and all other learning tools and content for young children" (NAEYC, 2012, p. 4). Educators are needed to scaffold the digital content for their students. They are in a unique position to do so in a way that is based on their familiarity with each child's existing knowledge and prior experience. As Hipp et al. summarize at the end of their chapter, conversations and support from educators can make it easier for children to process information at a deeper level and transfer it to a novel context, specifically from 2D to 3D. However, as with the introduction of technology in the classroom, this scaffolding needs to be done appropriately and intentionally to have the great educational benefit.

Apps do exist that include features encouraging teacher–student collaboration, both within and outside of the device. For example, in some apps, educators can access premade instructions for incorporating the app into their classroom activities, as well as tutorials on creating their own lesson plans. In other apps, educators can track each student's progress, creating reports as detailed as the number of times children attempted to answer a question with replays of their incorrect responses. Educators can then use this information to communicate with children through the app about their performance, as well as manually set a learning pathway for each individual child. Indeed, some apps allow educators to customize gameplay to focus on specific topics or concepts for every student. There are fewer features that encourage engagement between teachers and students beyond the screen, but some apps do offer ideas for incorporating the app concepts into offline activities or provide worksheets that educators can download to help children transition from digital to paper learning.

Although these app features are varied and promising in their support of social scaffolding, they are also few and far between and more often found in traditionally academic apps for older children. There is a wonderful (and rapidly growing) array of mobile apps for young children, many of which have characteristics and engagement experiences that make them potentially powerful learning tools, but they may not lend themselves as easily to the inclusion of educator resources. In particular, apps that focus on creativity, problem solving, and free play can be incredibly valuable, but the lack of formulaic engagement and inflexible response options make them more challenging to incorporate into a classroom setting. Unfortunately, this is a challenge that is currently left almost entirely to educators to tackle.

4.3 Effective App Features for Learning

While social scaffolding is a key component in an effective digital learning experience, there are other app features that can also aid children's comprehension and retention of information, even when children are playing by themselves. In particular, repetition, contingency, and adaptive play all work to create a more valuable educational process and to support children's understanding of the content.

Repetition allows children more time to process and learn a concept, and research has found that repeated exposure to media content can lead to greater engagement and comprehension (e.g., Barr, Muentener, Garcia, Fujimoto, & Chávez, 2007; Crawley, Anderson, Wilder, Williams, & Santomero, 1999). This approach is especially effective when the repetition occurs across multiple different contexts because it provides children with a wider variety of cues for recognition and recall. In the digital world, apps can employ repetition by presenting the same problem with slightly differing content—for example, solving an ABAB pattern repeatedly with several types of objects or identifying the color green across a range of images. Research by Barr et al. (2007), as discussed in the Hipp et al., Chap. 3, demonstrated that simply doubling the number of televised demonstrations of the target actions erased the transfer deficit.

Repetition can also come into play in mobile educational games when children are asked to redo problems that they solved incorrectly or insufficiently the first time. By giving children the opportunity to try again, especially when accompanied by substantive hints and feedback on their original response, these apps can increase the likelihood that children will learn from their mistakes and employ this new knowledge correctly the next time. In addition, the nature of mobile games allows for repetition not only within the app, but also with the app itself. Since children can play wherever and whenever, they can engage with the content as often as they want or need.

Another unique and potentially valuable feature of digital media is immediate and relevant contingent responses. Older media—most notably television—have attempted to create these interactive experiences for children by having characters speak directly to the camera and pause periodically in hopes that the child viewer will respond (which they often do) (e.g., Anderson et al., 2000). However, the prerecorded nature of television lends itself to awkward timing and sometimes-inappropriate reactions from the characters. As discussed in the Hipp et al., Chap. 3, these faux-conditional responses ensure that the context of the information children are being shown is separate from their own social context, and therefore less effective. Digital media, on the other hand, can respond directly and accurately to children's actions, the moment they touch the screen. This contingent interaction can range from animations coming to life when children tap them, to offering immediate feedback on whether a child's answer is right or wrong—and why. Contingency can also take the form of adaptive play, where apps align to children's individual abilities and learning progression. This approach involves scaling the difficulty of problems based on children's previous performance in the app, rather than just presenting increasingly challenging questions over a set period of time. In this way, the app is flexible and personalized, responding to children's individual behavior so that they can meet their goals at a pace that is most effective for them.

Luckily, repetition and contingency are fairly common features in children's apps, especially those claiming to be educational. Repetition is a well-known process by which young children learn (as any parent who has had to read the same storybook over and over can tell you), while contingency is an inherent quality of digital media that has not been seen before in older screen technology. Both are easily integrated into children's apps and offer a range of potential learning experiences. As with technology itself, however, all of these features—repetition, contingent responses, and adaptive play—need to be implemented thoughtfully and selectively. Even in the digital realm, where options and opportunities abound, sometimes less can be more. This is particularly true for young children, who may still be learning how to use the device and may not have enough cognitive resources left to handle a multitude of features and mechanisms, no matter how novel or engaging.

4.4 Bridging the Real and Digital Worlds

While learning from and improving their performance within an app can be a challenge for young children, applying that learning outside of the digital context is even more difficult. The transfer deficit (Barr, 2010, 2013) describes the difficulty children encounter transferring information between 2D and 3D formats, and Hipp and colleagues provide several examples of the transfer deficit using a variety of media, visuals, and methodologies. As discussed earlier, educators can play an important role in guiding children to make a connection between the content they are learning on 2D devices and the problems they encounter in the 3D world, but the apps themselves can also help integrate children's digital and real-life experiences to create a more seamless bridge between the two. This technology has the potential to help support the transfer of knowledge in both directions.

There are two types of apps that fall into this category. One involves using real-world materials to interact in a digital space, and the other involves engaging in each world individually through related content. For the first type of app, children might have a toy that they can place on the touchscreen to activate a reaction in the game, or they might have to use features of the media device, such as the camera or microphone, to collect information from the world around them in response to a question or prompt. One example is the set of mathematics apps for preschoolers, created by Tiggly. Children place physical counting tools on the screen to solve problems. While both the app and the counting tools can be played with independently, a richer learning experience occurs when the two worlds are combined (Fig. 4.1).

For the second type of app, children might create something on the device that they can then print out and play with in the real world, or the app may include suggestions for games or learning activities based on the child's current location. One example is the set of Foldify apps that allow children to design 3D figures on the tablet to be printed out and constructed. This app takes advantage of the endless options and creativity inherent on a digital device, while also challenging children's spatial reasoning and dexterity in the real world (Fig. 4.2).

Fig. 4.1 Child using physical counting toys while playing *Tiggly Chef* (photo credit: www.tiggly.com)

Fig. 4.2 Child cutting out the 3D figure designed on and printed from the *Folidfy* app (photo credit: www.foldifyapp.com)

Apps that allow for this interplay between the real and digital worlds are not only engaging, but they also offer an educational experience that caters to a wider variety of learning styles while capitalizing on children's love of novelty. Especially for very young children, who often learn through touching, feeling, and doing, apps that connect real-world objects and environments with the unique features of digital gameplay have enormous potential as learning tools. These apps can also foster interactions between children and those in the world around them—whether it be teachers, parents, or peers—and create situations in which social scaffolding becomes a natural reaction. As a result, digital-to-real world apps can help young children learn more effectively and, by bridging the two worlds, also help them take the information they learn and transfer it back and forth between the 2D and 3D contexts.

These types of features are becoming more common in children's apps, but they are still hard to find, especially those that are well done. There is no specific data on the presence of such apps, but a perusal of the iTunes App Store or Google Play Store makes it readily apparent that the vast majority of apps exist solely within the digital realm, and those that do integrate real-world interactions are not necessarily considered traditionally educational (meaning, once again, that it is up to educators to figure out how to effectively use these tools in the classroom).

4.5 Defining "Educational"

Before educators can even begin to integrate digital media into their classrooms, they need to find apps that are relevant to their students and their curriculum. For early childhood educators, this search for quality educational apps can be overwhelming. For example, in the iTunes App Store, "Education" is a subcategory under "Games," as well as a main category on its own, with subcategories including "Tools for Teachers," "Homework Projects," "Classroom," and "Teaching," not to mention groupings by every grade level and subject area. Over 80 % of apps in the "Education" category are targeted toward children, with apps for toddlers and preschoolers being the most popular and fastest-growing segment (Shuler, Levine, & Ree, 2012). This trend not only reveals how important this young audience is to developers but also highlights just how much content is out there for educators to sift through. In fact, only 4 % of educational apps for toddlers and preschool-aged children specifically mention usage in a school setting (Shuler et al., 2012). Even for knowledgeable educators who plan to use technology in their classroom strategically and efficiently, the process of finding a high quality app to fit their needs is challenging and likely frustrating.

When it comes to educational apps for children, entertainment is still key. After all, children will not be able to learn from an app that they do not use. Entertainment needs to be balanced with and integrated into the educational content, a relationship that is more difficult to achieve than it may sound. When done successfully, children are more likely to stay engaged with the material since the fun is part of the learning and they are not being distracted by irrelevant animations or interactivity (Hirsh-Pasek et al., 2015). Quality educational apps also need to include active involvement, which refers not to the simple movement of tapping and swiping but rather to challenging activities that require children to engage in deep thinking and problem solving (Hirsh-Pasek et al., 2015). These activities are most effective when they involve content that is personally and meaningfully related to children, which brings into play many of the app features previously discussed (Hirsh-Pasek et al., 2015; Zosh, Lytle, Golinkoff, & Hirsh-Pasek, 2016). For example, apps that encourage children to take pictures around their home in response to questions or that offer resources for parents and educators to extend the lessons beyond the screen both create learning experiences that are specific to the individual child.

As you might imagine, finding apps that effectively integrate active learning with engaging gameplay in a way that is meaningfully relevant to the child and fosters social interaction can be extremely challenging. In the current marketplace, it may be unrealistic for an app to contain all of those features, but the inclusion of even one or two can have a significant impact on the educational potential of the experience, and the hope is that the development of future apps will take into account the recent research that has been conducted in this area. Even as more quality apps are created, the challenge of how early childhood educators can successfully identify these apps and effectively assimilate them into their lessons will still exist. In order for mobile devices and other technology to become a meaningful addition to the classroom setting, steps need to be taken to provide guidance to educators, especially those of young children, on which apps to use and when and how to use them. The solution may take the shape of a rating system in the app store or professional development courses across the nation's school districts (see also Chap. 17, Zosh et al., 2016).

Regardless of the approach that is used, these tools should incorporate and emphasize the important takeaway messages outlined in Hipp et al.'s chapter (Chap. 3). Educators should make explicit and meaningful connections to reduce children's cognitive load, evaluate learning in both the 2D and 3D realms to facilitate children's transfer of information between the two, and provide children with social scaffolds to help them understand how to use the device and maximize the depth of their learning. There is clearly a great deal of potential for using apps as an educational tool for young children, but a thoughtful and research-based solution is needed to capitalize on these benefits before such technology can become a useful component of the modern classroom.

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Chapter 5
The Role of Online Processing in Young Children's Learning from Interactive and Noninteractive Digital Media

Heather Kirkorian, Tiffany Pempek, and Koeun Choi

5.1 Introduction

It is well documented that toddlers exhibit a *transfer deficit* whereby they have difficulty learning from one medium (e.g., two-dimensional screens) and applying that information to solve a problem using another medium (e.g., three-dimensional objects; Barr, 2013). While most research suggests that this transfer deficit declines by 3 years of age, some studies demonstrate that it can persist beyond the third birthday when using more difficult learning tasks (Dickerson, Gerhardstein, Zack, & Barr, 2013; Roseberry, Hirsh-Pasek, Golinkoff, & Parish-Morris, 2009). Having established that this transfer deficit exists using a variety of symbolic media (such as photographs, scale models, television, touchscreens) and learning tasks (such as word learning, imitation, object retrieval), researchers have turned their attention toward understanding the mechanisms underlying this behavioral phenomenon. Most researchers have emphasized the role of memory retrieval (or lack thereof) in explaining the transfer deficit, suggesting that toddlers can acquire information from video but then lack the ability to correctly retrieve the relevant memory when faced with the challenge of transferring this information to real-life stimuli. While memory retrieval most certainly plays a role, we propose that the transfer deficit may also be due in part to differences in acquiring information from video in the first place. In this chapter, we consider the extent to which toddlers may attend to

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and encode information differently when observing live demonstrations, watching video demonstrations, and using interactive media. We first describe methods for observing online processing of video and in-person events and discuss research on sustained and selective attention during video viewing. We then describe conditions under which toddlers have been shown to learn from video and consider the extent to which these conditions may support encoding and retrieval processes. We conclude with a synthesis of the extant literature and an agenda for future research.

5.2 Online Processing During Video Viewing

In describing how children process events on video, it is useful to conceptualize attention as a hierarchical set of processes (see Anderson & Kirkorian, 2015, for a detailed discussion). This conceptual framework is depicted in Fig. 5.1. At the most basic level, children may choose to enter or leave the room while a television program is playing, to pick up and put down a handheld device such as a touchscreen tablet, or to turn a program or application on or off. This often constitutes measures of media use and exposure. However, it tells researchers little about what children actually process. When in the room while a television program is playing, children selectively attend to the television screen as well as objects and people in the room, and, when they do look at the screen, viewers selectively attend to some aspects of the content more than others, such as fixating talking heads while ignoring objects in the background. Finally, when looking at certain content on the screen, viewers can devote more or less cognitive effort to processing that content; for instance, the extent to which viewers engage in sustained attention may vary with respect to individual traits (such as age), program characteristics (such as child- versus adult-directed content), and contextual factors (such as whether there are toys in the room). In this section, we focus on methods and empirical findings regarding children's online processing of video content, particularly as it relates to developmental differences in selective and sustained attention while viewing.

5.2.1 Selectively Attending to the Television Screen

There is a vast literature in which researchers have recorded looking time by young children to better understand many aspects of perceptual, cognitive, language, and social abilities (see Aslin, 2007). This approach is grounded in the assumption that overt gaze (e.g., a look toward a television screen) is indicative of the focus of attention. There are myriad ways to operationalize looking time. For purposes of this chapter, visual attention is an observational measure that captures episodes of overt orientation towards the video screen. Onsets and offsets of looks are defined by moments when the viewer's eyes are directed at or away from the screen in a naturalistic viewing situation (Anderson & Levin, 1976). In a typical study, children are

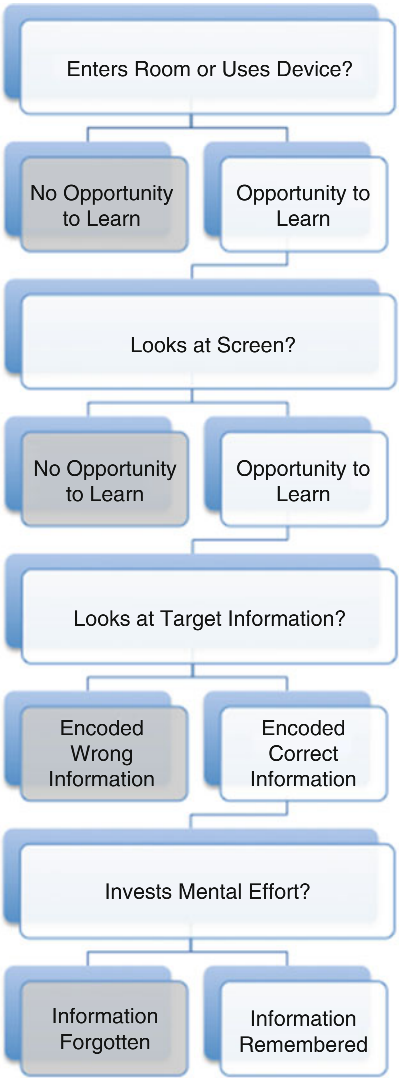

Fig. 5.1 Graphical representation of information processing activities during video viewing

in a comfortably furnished room (either at home or in a lab) that is stocked with toys, coloring books, or similar activities to engage them while a television program plays on a nearby screen. Of particular interest in these studies is when and for how long children look at the television screen.

Numerous studies have demonstrated that viewers look at and away from the television often during a viewing session (Anderson & Levin, 1976; Burns & Anderson, 1993). Most looks toward the screen are relatively brief, lasting no more than 3–5 s in duration. By comparison longer looks toward the screen are rare, even though they constitute most of the cumulative time looking at the screen. Thus distributions of look durations are positively skewed, with many shorts looks and relatively infrequent long looks. This pattern is consistent across viewers as young as 2 months of age through adults (see Richards & Anderson, 2004, for a review). The implications of look duration for learning are described later in this chapter in the section on sustained attention. In the current section we focus instead on developmental differences in cumulative looking time and the kinds of content that elicit looks toward the screen (selective attention). These content attributes include formal production features and the comprehensibility of content.

The term "formal features" refers to audiovisual production techniques that structure, mark, and represent content; examples include camera cuts, zooms, and sound effects (Huston & Wright, 1983). In general, changes in formal features elicit selective attention from viewers of any age. However, as age increases, children come to use formal features strategically, attending more to some than to others. For instance, preschool-age children are more likely to look at the television when there are puppets or child actors on the screen than when actors are adult men, and they are more likely to look at the screen when there are many camera cuts and rapid action than during extended zooms or in the absence of movement (Alwitt, Anderson, Lorch, & Levin, 1980; Calvert, Huston, Watkins, & Wright, 1982). It is believed that young children select some features over others because they come to associate certain features (such as child actors and animation) with child-directed content while they associate other features (such as adult male actors) with adult-directed—and therefore incomprehensible or irrelevant—content (Huston & Wright, 1983). This is consistent with the finding that the relative influence of program pacing decreases across infancy (Gola & Calvert, 2011) while preferences for some types of features over others increase with age (Gola, Kirkorian, Anderson, & Calvert, 2011).

It is also well documented that the content of a program can influence selective attention by young children. Rather than simply reacting to visual and auditory formal features, children are cognitively active as they try to make sense of what they are watching. This was first demonstrated in a lab setting when Anderson, Lorch, Field, and Sanders (1981) showed preschool-age children normal and distorted segments of *Sesame Street*. Some vignettes were intact, whereas others were edited to distort the canonical order of events (by playing shots in a random sequence) or the linguistic content (by playing the Greek overdub or by reversing utterances, thereby rendering the language incomprehensible). Contrary to the supposition that children are cognitively passive while watching television and fail to process the content (Singer, 1980), Anderson and colleagues found that these young children selectively attended to the screen more often during comprehensible vignettes than during incomprehensible ones. Similarly, preschool-age children are more likely to look at the television during child-directed programming than during adult-directed programming (Schmidt, Pempek, Kirkorian, Lund, & Anderson, 2008; Schmitt, Anderson, & Collins, 1999).

Although children as young as 2 years of age prefer to watch television programs that are comprehensible, this preference appears to develop during the second year of life. For instance, we found that it is not until at least 18 months of age that toddlers begin to exhibit longer looks toward comprehensible versions of *Teletubbies*, a television program designed for infants and toddlers, than to versions that are rendered less comprehensible by either sequential or linguistic manipulations (Pempek et al., 2010). Similar results were found when comparing infants' attention to a child-directed movie versus computer-generated audiovisual displays that lacked meaningful content (Richards & Cronise, 2000). Thus the ways by which formal features and program content influence selective attention appear to change dramatically during the first few years of life, at least with respect to commercially produced narrative programming for infants and young children.

The fact that toddlers pay more attention to comprehensible content than to incomprehensible content demonstrates that ongoing comprehension processes have an impact on selective attention. In other words, comprehension drives attention. However, the extent to which attention drives ongoing comprehension and subsequent learning is less straightforward. Most studies fail to find a relation between a child's cumulative amount of looking time toward the screen and that child's subsequent performance on learning tasks. In fact, toddlers may be more visually engaged with video than with in-person displays, despite relatively poor performance on video learning tasks (Schmitt & Anderson, 2002). Yet while performance on learning tasks is not clearly related to the *cumulative* amount of looking time at the screen, it may be related to the *duration* of time that viewers sustain attention to the screen before looking away again. We will revisit the association between attention and learning in the subsection on sustained attention.

To summarize research on selectively attending to television programs, there are clear developmental trends regarding whether and when children look at the screen. Young infants appear to look indiscriminately at the screen in response to almost any auditory or visual change. With age and experience, toddlers come to attend more in the presence of some features than others, particularly those that tend to be associated with child-directed content (e.g., child actors, puppets, animation) rather than those associated with adult-directed content (e.g., adult male actors). Similarly, children begin to preferentially attend to comprehensible video content during the second year of life, and the magnitude of this effect increases throughout early childhood. Next we describe the relatively small body of literature on exactly what children look at when their gaze is directed at the television screen.

5.2.2 Visually Selecting Specific Screen Content

Even when children are selectively attending to a television program, there are individual differences in what they choose to attend to on the screen. For instance, they may be following the trajectory of a moving object, watching characters as they speak, or scanning the background. One way to observe selective attention to on-screen content is with an eye tracker. Eye tracking typically involves specialized cameras and software that determine the exact location of a viewer's gaze from moment to moment. This is a particularly useful paradigm for observing online information processing insofar as the location of gaze is typically associated with the focus of attention during natural viewing (Henderson, 2003). Gredeback, Johnson, and von Hofsten (2010) provide a detailed description of eye-tracking approaches, particularly in infancy research. Most published eye-tracking studies describe eye movements toward static images or simple video displays with relatively little movement. Thus studies of eye movements toward dynamic scenes, including edited video, are relatively rare, and such studies of infants and young children are few and far between. Here we summarize this relatively small body of literature.

Several studies with adults have demonstrated that there is substantial consistency in the location of gaze across individuals; that is, adults tend to look at the same thing at the same time as each other when watching video (Dorr, Martinetz, Gegenfurtner, & Barth, 2010; Frank, Vul, & Johnson, 2009; Goldstein, Woods, & Peli, 2007; Kirkorian, Anderson, et al., 2012; Mital, Smith, Hill, & Henderson, 2010; Stelmach, Tam, & Hearty, 1991; Tosi, Mecacci, & Pasquali, 1997). Adults' visual fixations toward video are predicted by perceptually salient formal features, particularly movement (Mital et al., 2010). However, like overt gaze toward the screen, adults' eye movements during natural viewing are also driven by top-down processes such as searching for specific objects within a complex visual scene. For instance, when performing a familiar activity with real objects (e.g., making tea), adults are more likely to look at task-relevant objects (e.g., cup) than the most perceptually salient objects in the room (Hayhoe, Shrivastava, Mruczek, & Pelz, 2003; Land, Mennie, & Rusted, 1999). Similar findings have been reported in studies when adults watch animated video clips (Frank et al., 2009).

Studies that include infants and children suggest that visual selection of on-screen content changes with age. For instance, individual differences in the location of gaze decreases with age, such that adults often look at the same thing at the same time as each other whereas infants' fixations tend to be more scattered across the screen (Frank et al., 2009; Kirkorian et al., 2012). Differences between children and adults are reduced when watching incomprehensible video (random shot sequences), suggesting that the tendency for adults to look at the same things as each other is at least partly driven by comprehension of the video and is therefore disrupted when the ability to comprehend is reduced (Kirkorian, Lavigne, Hanson, Troseth, & Anderson, 2014). Moreover, while bottom-up, stimulus-driven features continue to influence visual attention even in adults, the relative influence of top-down processes increases with age. For instance, unlike attention in young infants, adults' eye movements were more strongly predicted by meaningful information (faces) than perceptually salient features (sharp edges and movement) when watching animated video clips (Frank et al., 2009).

There are also age-related differences in the extent to which viewers shift visual attention in response to visual changes such as camera cuts, likely reflecting increased experience with viewing and interpreting sequences of video shots. Several studies demonstrated that adults tend to look toward the center of the screen immediately following cuts to new scenes, likely in response to the tendency for important content to appear in the middle of the screen following a cut to a new scene (Kirkorian et al., 2012; Le Meur, Le Callet, & Barba, 2007; Mital et al., 2010; Tosi et al., 1997; Tseng, Carmi, Cameron, Munoz, & Itti, 2009). We found that 4-year-old children demonstrated a similar tendency to look at the center of the screen following a cut to a new scene, but 12-month-old infants did not (Kirkorian, Anderson, et al., 2012). Furthermore, we found that adults were more likely than were 12-month-old infants and 4-year-old children to anticipate the reappearance of an object in a new scene by looking at the correct part of the screen immediately after the cut but before the object reappeared (Kirkorian & Anderson, in press). Together these findings suggest an age-related increase in the systematic and strategic deployment of attention when watching dynamic and edited video.

As with overt looks toward the screen, there is growing evidence that comprehension processes drive visual fixation, but the extent to which visual selection of on-screen content predicts subsequent learning is less clear. A few studies have examined infants' learning from video as a function of their pattern of eye movements to the video, and results have been mixed. Some evidence suggests that when infants do selectively attend to target information on video, they are more likely to demonstrate learning. For instance, 2-year-olds who spent more time fixating the eyes of an on-screen speaker were more likely to show evidence of learning a novel word from that speaker (Roseberry, Hirsh-Pasek, & Golinkoff, 2014). Similarly, 6- to 12-month-olds who paid relatively more attention to an on-screen actor than to the background were more likely to imitate that actor's behavior immediately following the demonstration (Taylor & Herbert, 2014). On the other hand, such a relation between visual selective attention to video events and subsequent imitation was not found in another, similar study of infants by the same researchers (Taylor & Herbert, 2013).

One reason for conflicting evidence may be differences in the cognitive demands of stimuli across studies. We compared the visual fixations of 24-month-olds watching video versus in-person hiding events in an object-retrieval task. We found that 24-month-olds spent more time fixating the target location when viewing hiding events on video than when watching hiding events in person, even though children were less successful when searching for the hidden object (a sticker) after watching video events (Kirkorian et al., 2016). Results indicated that toddlers were usually able to find the sticker after watching in-person hiding events even if they paid relatively little attention to the target location while the sticker was being hidden; conversely, toddlers who watched video hiding events were only successful at finding the sticker if they preferentially attended to the target location during the hiding event. These results suggest that video demonstrations may be harder to process and therefore require more time selectively attending to target information. This interpretation is consistent with our earlier finding that age differences in the location of gaze decrease as a function of time into a shot, suggesting that infants simply need more time to process each new scene before identifying the location most critical to comprehension (Kirkorian, Anderson, et al., 2012). This interpretation is also supported by the finding that infants take longer to discriminate between novel and familiar items when presented as two-dimensional images than when presented as three-dimensional objects (as measured by electroencephalography; Carver, Meltzoff, & Dawson, 2006) and that repetition of a target action increases infants' imitation from video (Barr, Muentener, Garcia, Fujimoto, & Chavez, 2007).

Together eye-tracking research using video stimuli indicates that visual fixations are driven by perceptually salient stimulus features (especially movement) at all ages, but the relative importance of meaningful content in driving attention increases with age. In other words, as with overt looks toward the screen, top-down processes become more important with age even as bottom-up processes continue to drive visual fixation. Moreover, older viewers are more likely to allocate attention strategically while watching edited video, seemingly in an effort to maximize the likelihood of fixating important content, such as centering fixations on the screen or anticipating the reappearance of a moving object following a cut to a new scene. However, as with overt looks toward the screen, there is not a clear relation between cumulative fixation time on target content and subsequent learning of target information. One reason for the inconsistency across studies may be differences in the relative difficulty of the tasks, insofar as the fixation time required to comprehend video content will increase as a function of cognitive load created by that content. Another reason for inconsistent findings may be differences in sustained attention that are not captured by measures of cumulative selective attention. This is the topic of the next subsection.

5.2.3 Sustaining Attention While Viewing Video

The inconsistent relation between cumulative looking time toward the screen and subsequent learning, as well as that between visual selection of specific onscreen content and subsequent learning, is likely due in part to differences in the amount of mental effort that viewers invest in processing the content while looking at the screen. In particular, depth of processing appears to increase as attention is sustained over a period of time. Sustained attention, or the ability to focus on a specific stimulus, has often been utilized as a measure of the depth at which children process video content. Common measures of sustained attention used to assess processing of video include visual attention, secondary-task reaction time, and heart rate, which we will describe in turn.

Visual attention can be indicative of selective attention as described previously in this chapter. In addition, look length averaged across a media event is useful in determining depth of processing (Anderson, Alwitt, Lorch, & Levin, 1979). Look length is typically defined as look duration beginning when the viewer first looks toward the screen and ending when the viewer looks away.

Similarly, secondary-task reaction time refers to the speed of behavioral responses to distractor stimuli or a secondary task. For instance, viewers may be instructed to press a button every time a tone is heard. Reaction time under these conditions has been used to assess engagement insofar as viewers who are more deeply engaged with television content should be slower to respond to distractors and secondary tasks, if they respond at all (Anderson, Choi, & Lorch, 1987).

Lastly heart rate is a physiological measure used to assess sustained attention through identification of characteristic patterns of deceleration presumed to indicate active processing of stimuli (Richards & Casey, 1991; Richards & Cronise, 2000).

Heart rate is assessed with electrocardiogram, which can be used to calculate inter-beat interval, or the duration between cardiac cycles (Richards, 2008; Richards & Cronise, 2000). Deceleration of heart rate is associated with active processing (Reynolds & Richards, 2007). Inter-beat interval is the inverse of heart rate (i.e., the time that elapses between successive beats) and, thus, increases with cognitive engagement. Inter-beat interval can be matched with observational measures of looking to assess attentional engagement over the course of each individual look towards the screen (e.g., Pempek et al., 2010; Richards & Cronise, 2000).

Researchers have used these measures both individually and in combination to better understand how viewers of different ages process video. Findings from these studies reveal significant developmental changes in sustained visual attention across the first year of life. Some researchers have reported a progressive decrease in look duration with development (Shaddy & Colombo, 2004), while others note an increase (Richards & Cronise, 2000). In a review of the literature, Richards (2010) addresses these seemingly conflicting results, noting that studies finding shortening look durations with age typically use simple, static stimuli, such as a checkerboard pattern, while studies finding lengthening look duration typically use more complex, dynamic stimuli, such as video of a person. Courage, Reynolds, and Richards (2006) found direct evidence for the differential effect of stimuli varying in complexity across the first year of life in their assessment of look durations for both simple and complex stimuli in infants 14–52 weeks of age. Of relevance here are findings indicating increased look duration with development to complex, dynamic stimuli, including video.

While the overall likelihood of relatively long looks to video increases throughout infancy, the underlying mechanisms of cognitive engagement over the course of a look, as well as the general pattern of look distributions, appear to be consistent across ages from infancy onward (Richards, 2010). Put differently, even though infants are less likely to engage in long, sustained looks toward the screen, the way in which attentional engagement changes over the course of a look appears to be similar in infants, children, and adults when attention is captured. Anderson et al. (1979) first described patterns of sustained attention to television among 3- to 5-year-old children. They observed that the longer a look at the television persisted, the less likely it was to be terminated. They called this phenomenon "attentional inertia". As described earlier in this chapter, this pattern yields a distribution of look lengths that is lognormally shaped, with many looks lasting only a few seconds in duration and fewer long looks (Anderson & Lorch, 1983). Attentional inertia has been observed for television viewing across all ages, from infants to adults (for a review see Richards & Anderson, 2004). This pattern has also been observed during toy play in children, indicating that it is a function of the attention system more generally rather than screen viewing specifically (Choi & Anderson, 1991).

In addition to the general pattern of look lengths that results from attentional inertia, researchers have noted an increase in engagement as a look progresses, peaking at approximately 15 s. As this 15-s threshold is approached, the effectiveness of external distracters is diminished. For example, during viewing of a children's television program, Anderson et al. (1987) presented 3- and 5-year-old children with a series of distractors consisting of a tone followed by a still image located at a 90° angle from the television screen. They found that children at both ages were less likely to turn their head towards the distractor and were slower at doing so if they had been looking continuously at the television for 15 s or longer when the sound signaled the appearance of the distractor.

Research indicating deeper engagement as a look towards the television progresses has been corroborated by studies utilizing heart rate as a measure of sustained attention. Richards and Casey (1991) proposed several distinct phases through which heart rate progresses during the presentation of a stimulus, beginning with a sharp decrease in heart rate in the orienting phase, a period of lowered heart rate during the sustained attention phase (and, conversely, an increase in inter-beat interval), and a return to pre-stimulus heart-rate levels in the attention termination phase. Of relevance here, active processing of a stimulus is presumed to occur during the sustained attention phase. Many studies have replicated this pattern of heart rate deceleration during attention (e.g., Colombo, Richman, Shaddy, Greenhoot, & Maikranz, 2001; Colombo, Shaddy, Richman, Maikranz, & Blaga, 2004; Richards & Cronise, 2000; Richards & Gibson, 1997). For instance, in infants 6 months to 2 years of age, lower sustained heart rate was found in conjunction with longer looks and less distractibility in response to an adjacent distractor video playing simultaneously during a viewing situation (Richards & Turner, 2001). As with look duration, complexity of the stimuli appears to influence engagement by 6 months of age: Greater change in heart rate was found for stimuli that were more complex and dynamic (e.g., video) as compared to static displays (Courage et al., 2006).

The sustained attention patterns detailed above clearly demonstrate an increase in engagement with longer look durations and heart-rate deceleration. However, deeper engagement does not necessarily indicate processing of information. A relation between sustained attention and comprehension of video has been documented by a handful of studies. Assessment of secondary-task reaction times provides evidence linking increased engagement (as measured by long looks) to comprehension of media content. For example, researchers observed that 5-year-olds invested more mental effort during long looks to comprehensible video than to video in which comprehensibility was reduced by reversing the speech or arranging scenes in a random sequence (Lorch & Castle, 1997). Additionally, Burns and Anderson (1993) found that adults' recognition memory for information presented toward the end of long looks was greater than that for the first half of long looks or for short looks, demonstrating that the increased engagement associated with long looks is in fact associated with greater processing of information.

Attentional inertia plays an important role in the link between comprehension and attention described earlier in this chapter and may facilitate learning in ways other than increased information processing. For instance, attentional inertia operates independently of television content and, in this way, serves to maintain attention across content boundaries, such as when switching from a television program to a commercial break (Anderson & Lorch, 1983). Recall that preschool-age children selectively attend to television content that is comprehensible, and they tend to look away from the screen when content becomes incomprehensible (Anderson et al., 1981). Perhaps attentional inertia enables children to sustain attention and process more complex material rather than terminating attention immediately when material becomes difficult to comprehend (Anderson & Lorch, 1983). We have speculated that this may be an important bootstrap mechanism for the development of media processing skills during infancy because, if attentional inertia increases the likelihood that attention is maintained when material becomes difficult, this may help infants learn to draw connections between actions that unfold across multiple scenes, and, in turn, begin to understand video montage (Pempek et al., 2010).

To summarize, the literature on sustained attention during television viewing characterizes a phenomenon known as attentional inertia, whereby longer looks at the television have a lower probability of termination for individuals of all ages. This enables infants to occasionally engage in longer looks toward the screen, which have been found in children and adults to relate to increased processing of video content, resulting in lower distractibility and increased recall. While patterns of heart rate and look duration have been established for television viewing across the lifespan, much less is known about newer media. To our knowledge, no research has been done to directly assess the characteristics of sustained attention for newer mediums such as videogame consoles and touchscreen tablets.

5.2.4 Summary of Research on Online Processing of Television

Together the research on attention to television reveals both change and stability across infancy and early childhood. With respect to selective attention, research on visual selection of specific screen content appears to parallel that on overt gaze toward and away from the screen. First, attention is driven by perceptually salient stimulus features (especially movement) at all ages, but the relative importance of meaningful content in driving attention increases with age. In other words, top-down processes become more important with age even as bottom-up processes continue to drive visual fixation. Second, older viewers are more likely to allocate attention strategically while watching edited video, seemingly in an effort to maximize the likelihood of fixating important content, such as centering fixations on the screen immediately following a cut to a new scene. Third, there is not a clear relation between cumulative attention to target content (measured as either overt gaze toward the screen or visual fixation to specific content on the screen) and subsequent learning of target information.

The absence of a clear association between cumulative selective attention and subsequent learning is likely due to the simple fact that looking is only an indirect measure of information processing. Looking time is a complex measure that encapsulates many hidden processes, such as attention, encoding, and integration with existing information in memory (Aslin, 2007). Thus it is not always clear whether a long look to a television screen indicates greater encoding of information or whether a long look is just a proxy for the relative difficulty of processing information from video (Carver et al., 2006; Kirkorian, Lavigne, et al., 2016) or individual differences related to processing speed (Colombo, Mitchell, Coldren, & Freeseman, 1991). Further research is needed to disentangle these processes in order to understand the relation between visual selective attention and subsequent learning.

In line with this interpretation, there appears to be a more consistent relation between sustained (rather than selective) attention and subsequent learning. While selective attention is clearly a necessary process in learning—one is unlikely to learn from something to which one did not attend—simply looking at a stimulus does not mean that the viewer effectively encodes information and represents it in memory. In other words, selective attention is a necessary but insufficient process for learning. Sustained attention further supports learning through increased investment of cognitive resources in a primary task (e.g., watching television) and improved resistance to distraction.

Although infants are less likely than older viewers to engage in sustained attention, particularly when viewing complex visual stimuli such as video, the behavioral phenomenon of attentional inertia appears to ensure that even young infants occasionally engage in sustained attention. Once attention is captured, the underlying mechanisms of attention appear to be consistent across infants, children, and adults. Specifically, long, uninterrupted looks toward the screen are associated with greater engagement with and processing of video content, as measured by decelerated heart rate, slower reaction time to secondary tasks, and increased memory for content that was encoded during sustained attention. It is likely that this reflects general attention mechanisms that apply to interactions with real three-dimensional objects as well as video (Choi & Anderson, 1991); however, the vast majority of research to date—particularly with infants and young children—is limited to investigations of attention to two-dimensional video.

Together the findings demonstrate the value in considering both selective and sustained attention in understanding young children's processing of digital media content. Traditional measures of attention to video, namely cumulative looking time, have done much to explain the types of features and content that elicit attention to television at different ages. Similarly, researchers have begun to adopt eye-tracking methods to observe infants' and children's attention to specific on-screen content. This research suggests that measures of selective attention—both attention at and away from the screen, as well as, attention to specific content on the screen—primarily reflect ongoing comprehension processes: Viewers spend more time looking at the screen when attention is necessary for comprehension, which is a complex process that is influenced by prior knowledge, processing speed, inference ability, and working memory capacity, to name a few. However, such measures of selective attention have limited value for predicting what children will learn and transfer from screen media. Rather, measures of sustained attention, which include individual look durations, secondary-task reaction times, and heart-rate changes, seem to better reflect a viewer's engagement and investment of cognitive resources. Thus researchers may be better able to predict subsequent learning from the duration of fixations toward the screen rather than cumulative looking time. We recommend that future research capitalize on multiple methods to assess both selective and sustained attention in order to fully capture online processing of video content.

5.3 Conditions Under Which Toddlers Can Learn from Video

Observations of selective and sustained attention during video viewing have revealed a great deal about how infants and children process video stimuli. However, most studies of attention to video do not compare online processing of video versus in-person events, nor do they explore the extent to which subsequent learning is a function of how demonstrations were processed in the first place. Therefore, it is not completely clear whether or how differences in attention and encoding (in addition to memory retrieval) lead to the transfer deficit (but see Kirkorian, Lavigne, et al., 2016, for an exception). On the other hand, researchers have identified certain conditions under which toddlers are better able to learn from video. We next describe several of these experimental manipulations and discuss how each might support both encoding of information during demonstrations and retrieval of information during subsequent tests of learning. Our hope is to provide a more comprehensive framework to motivate future research that considers the full range of cognitive processes involved in learning from digital media.

5.3.1 Clarifying the Symbolic Relation Between Video and Real-Life Events

Understanding symbolic artifacts such as pictures in books or images on television requires *dual representation*—understanding that a symbol is itself an object as well as a representation of its referent (DeLoache, 1987, 1991, 2000; DeLoache, Miller, & Rosengren, 1997). By 2 years of age, children realize that symbols are not real objects, but they continue to experience difficulty in connecting symbols to their referents (Troseth, 2010). If toddlers' poor symbolic understanding is related to their transfer difficulty, experience in clarifying symbolic relations may facilitate transfer.

Prior experience with symbolic media is likely to facilitate learning by emphasizing the correspondence between symbols (e.g., an image on television) and real-life counterparts (Troseth, 2003; Troseth, Casey, Lawver, Walker, & Cole, 2007). For instance, Troseth (2003) examined the impact of experience with live video on 2-year-olds' object retrieval. She asked parents to connect a video camera to their family television so that the children could see themselves and their families in real time on the television screen. After receiving 10-min correspondence training five times over a 2-week period, 2-year-olds were more likely to use information from a video presentation to find a toy in a laboratory task as compared to same-aged peers without this training. Moreover, this video-based training appears to have transferred to other symbolic media, insofar as these toddlers also outperformed peers in the control group on a task using a different type of symbolic media (photographs). The results suggest that experiencing symbolic relations might help young children realize the connection between two-dimensional symbols and their three-dimensional referents and thereby facilitate the use of information from video in real-life circumstances.

In addition to their training study, Troseth et al. (2007) explored whether children's natural experience with symbolic artifacts is related to learning from screens. Researchers asked parents of 120 2-year-old children to complete a questionnaire on their children's naturalistic experience with symbolic media and activities (e.g., videos, pictures, drawings). Even after controlling for children's vocabularies and parents' education, 2-year-olds' exposure to and understanding of live video significantly predicted their object retrieval in the lab. The results suggested that toddlers require sufficient experience with symbolic media in order to reliably transfer between symbols and referents.

Only a few studies have directly examined the role of symbol experience in the transfer deficit. Thus far the results indicate that understanding the relation between two-dimensional images and their three-dimensional referents is an important aspect of transfer, insofar as clarifying the correspondence between symbolic artifact and real-life counterpart facilitates transfer.

5.3.2 Reducing Cognitive Load

Transfer from symbolic media to real-life tasks requires a range of cognitive abilities: paying attention to the right information at the right time, representing the right information in memory, and retrieving the right memory regardless of contextual changes. Young children's limited cognitive resources may hamper their performance at each level of processing. Here we summarize several successful attempts to reduce cognitive load and thereby improve transfer. These strategies include lowering transfer demands, providing repeated exposure to screens, using familiar onscreen characters, and decreasing memory-updating load.

Unlike learning from live, unmediated experiences, learning from video requires children to complete additional tasks such as processing two-dimensional stimuli and then transferring their learning to three-dimensional objects. When these transfer demands are reduced, toddlers are better able to learn from video. For example, using an imitation paradigm, Zack, Barr, Gerhardstein, Dickerson, and Meltzoff (2009) showed that when 15-month-olds watched an action on screen (pressing a button on a touchscreen) and were tested on the same screen, their performance was as good as that of children who watched and were tested with a real object (pressing a button on a real toy). In contrast, children who had to transfer between contexts—either from real objects to screen or from screen to real objects—were less successful regardless of the direction of transfer. This study suggests that transfer across media is a cognitively demanding task, but young children may learn from screens as well as from real-life demonstrations if transfer demands are reduced. These findings highlight the importance of the contextual mismatch between encoding and retrieval in understanding the transfer deficit.

In addition to reducing transfer demands, decreasing cognitive load through repetition may facilitate transfer. Most of the studies focusing on the transfer deficit have allocated an equal amount of time for both video and live demonstrations, which results in relatively poor learning outcomes when infants watch video.

Research providing repeated or elongated presentations of video, on the other hand, found an increase in learning from video (Barr et al., 2007; Barr & Wyss, 2008). For instance, children between 12 and 21 months of age were able to imitate the actions performed by an on-screen actor after a 24-h delay only when they watched the video twice as often as they watched the corresponding live demonstration (Barr et al., 2007). Similarly, 2-year-olds could imitate target actions from screens when the action was demonstrated twice and at a slower rate (Strouse & Troseth, 2008). These findings further suggest that processing two-dimensional images on screens requires more resources than processing real objects, perhaps due to infants' relative inexperience with video as compared to real-life interactions. As a result, allowing additional processing time via repeated exposure to screen demonstrations, or presenting information more slowly, can increase transfer. As described previously, this is consistent with both eye-tracking (Kirkorian, Lavigne, et al., 2016) and EEG studies (Carver et al., 2006) suggesting that toddlers process two-dimensional images more slowly than they process three-dimensional objects.

Decreasing cognitive load during encoding might also be possible by using on-screen characters that are familiar to young children. In one study, 21-month-old toddlers watched a puppet demonstrate how to seriate cups by ordering them from smallest to biggest and then stacking the smaller cups inside of the larger ones. Watching a video demonstration by Elmo—a familiar character to most young viewers in the United States—led toddlers to perform the behavior on their own; however, watching DoDo—an unfamiliar character—did not (Lauricella et al., 2011; see Chap. 9, Richards & Calvert, 2016). In a follow-up training study, a group of 18-month-olds was encouraged to play with DoDo toys and watch DoDo video with parents at home for 3 months. At age 21 months, toddlers viewed DoDo demonstrating the seriation task on video and were then given the opportunity to imitate using real cups. The toddlers who were familiarized with DoDo showed higher performance than did the toddlers who remained unfamiliar with the character (Gola, Richards, Lauricella, & Calvert, 2013). One possible explanation for this familiarity effect involves cognitive load: Familiar characters may free up cognitive resources so that task-relevant information can be processed. Consistent with this hypothesis, Kirkorian, Hanson, et al. (2012) found that 24-month-olds spent more time looking at Dodo than at Elmo during video demonstrations of the seriation task. This increase in visual attention to the unfamiliar character was accompanied by a decrease in attention to the seriation demonstration. These eye-movement data suggest that children process images on the screen differently depending on their prior experience, insofar as familiarity with the character apparently enabled the toddlers to spend less time looking at the character and more time watching the demonstration. However, as described previously, the exact relation between cumulative fixation time and subsequent learning remains unclear. Further research is needed to examine the role of familiarity in online processing of video content and screen-based learning.

A fourth task scenario that may increase cognitive demands is proactive interference caused by previous learning trials. For instance, in the object-retrieval task, children are asked to watch an experimenter hiding an object and remember the location so that they can later search for the hidden object (e.g., in an adjoining room); these studies often entail several search trials using a random sequence of hiding locations, enabling researchers to observe performance over time

(Troseth & DeLoache, 1998). In these studies, children must simultaneously update their mental representation of both the real and symbolic location during information encoding (hiding event), while also inhibiting their representation of the previous search trial during memory retrieval (search event; Kirkorian, Lavigne, et al., 2016; see also Troseth, 2010). Thus, the object-retrieval task may be relatively easy on the first search trial but then become more difficult on subsequent search trials when there is the possibility of outdated mental representations producing proactive interference. Indeed, several studies have demonstrated that toddlers are more likely to commit perseverative errors when learning from video than when learning from real-life events, searching the location that was correct on the previous trial rather than the location that is correct on the current trial (Kirkorian, Lavigne, et al., 2016; Schmidt, Crawley-Davis, & Anderson, 2007; Schmitt & Anderson, 2002; Troseth, 2003). These perseverative errors are also commonly found during object-retrieval tasks using other symbolic media, such as a scale model, indicating a general challenge in symbolic mapping. For example, Sharon and DeLoache (2003) analyzed a large set of experiments on 2.5-year-olds' object retrieval and found that 47 % of errors were perseverative in symbol-based retrievals whereas 14 % of errors were perseverative in memory-based retrievals. In these studies, it is often reported that children produce high performance on the first search trial, whether learning from video or in-person hiding events, but they exhibit worse performance on subsequent trials in the video condition. This is consistent with the hypothesis that children have difficulty negotiating the symbolic relation between video and real-life stimuli, making it harder for them to accurately update their representations of the current hiding location as task demands increase, that is, when children are required to update two representations simultaneously (Troseth, 2010). This interpretation is further supported by the finding that performance remains high across all search trials, even when using video hiding events, when the possibility of perseverative errors is eliminated by using a different search space on each trial (Suddendorf, 2003). Eliminating the possibility of proactive interference caused by outdated representations helps toddlers to overcome the transfer deficit.

Together these studies are consistent with the general hypothesis that transferring from video to real-life objects is cognitively demanding. The finding that toddlers' ability to transfer from video to real-life objects is predicted by working-memory capacity further supports this hypothesis (K. Choi, Kirkorian, Pempek, & Schroeder, 2015). This cognitive demand appears to be due in part to the overlap (or lack thereof) in perceptual cues that are available during encoding and retrieval of information (Zack et al., 2009) and in part to the need to inhibit irrelevant information in the case of subsequent learning trials (Troseth, 2010). Toddlers' performance on video-based learning tasks improves significantly when cognitive demands are reduced, such as by matching the features available during encoding and retrieval, providing slower or repeated exposure to video stimuli, and using familiar characters. A third class of experimental manipulations that appears to facilitate screen-based learning by toddlers is the incorporation of social interactivity, to which we turn next.

5.3.3 Incorporating Social Interactivity

Technological innovations have altered the ways in which children experience media. Traditionally, screens have been considered to be one-way communication tools; however, advances in both software and hardware allow users to engage in two-way communication through screens. Using either closed-circuit video or live video chat, several studies have been conducted to examine the impact of socially contingent interactions on toddlers' ability to learn from video. These researchers defined social contingency as a two-way exchange in which the adult on video established herself as relevant and interactive by referring to the child by name and by asking questions about the child's own siblings and pets (Nielsen, Simcock, & Jenkins, 2008; Roseberry et al., 2014; Troseth, Saylor, & Archer, 2006; see also Chap. 15, McClure & Barr, 2016).

Using an object-retrieval task, Troseth et al. (2006) examined whether social contingency could help toddlers to overcome the video deficit. For 5 min prior to the object-retrieval task, an experimenter interacted with a child on closed-circuit television about personally relevant information (e.g., saying the child's name, asking about pets, playing games). Twenty-four-month-olds were randomly assigned to one of three conditions: live interaction, socially contingent video, and noncontingent (yoked) video training. Toddlers' success on the object-retrieval task using socially contingent video was similar to that when experiencing live interactions and was significantly better than their performance when viewing yoked video that depicted prerecorded interactions with a different child. These findings suggest that social contingency can promote transfer from screen media.

The facilitative effect of social contingency has been replicated in other domains. Nielsen et al. (2008) examined whether social engagement facilitated 24-month-olds' imitation, finding that toddlers were more likely to imitate the exact actions of a model who could communicate with them via a closed-circuit video system than a videotaped model who could not provide socially contingent feedback. With regard to word learning, Roseberry et al. (2014) examined whether socially contingent interactions through video chat could facilitate 24- to 30-month-olds' verb learning from screens. They found that children in the live and video-chat groups learned novel verbs whereas children in the noncontingent video group did not.

Although these studies suggest that socially relevant and adaptive information is important to assist learning from screens, what remains to be answered is how social contingency is related to online processing of the information on screen. Roseberry et al. (2014) reported that time spent looking at the experimenter's eyes was positively related to subsequent word learning. However, cumulative fixation time was not different between video and real-life conditions, despite the difference in learning outcomes between conditions. Further research is needed to address this discrepancy and investigate the mechanisms by which socially contingent video influences on-line processing of video.

5.3.4 Providing Nonsocial Contingency via Interactive Media

Social contingency seems to be a promising way to help young children link information on screen to the real three-dimensional world. Perhaps a socially contingent interaction is effective because it involves socially relevant and adaptive personal information (e.g., child's name or pets) or because it provides responses that are contingent on the child's own behavior (Kuhl, 2007). The research on socially contingent video does not address whether toddlers can benefit from interactive video in the absence of social interactions with on-screen actors. Examining this question is especially important in that young children are increasingly exposed to interactive media such as digital computer-based systems, which respond to the user's actions in a nonsocial way by presenting content such as text, graphics, animation, video, or audio (Rideout, 2013).

Recent research findings suggest that contingency supports early learning even in the absence of reciprocal social interactions. For example, Lauricella, Pempek, Barr, and Calvert (2010) found that interactive computers facilitated learning at 30 months of age. Children who played an interactive computer game and those who observed a live demonstration performed significantly better on an object-retrieval task than children who observed a noninteractive video. However, the computer interface that was used to conduct this study proved challenging for younger children who might normally exhibit a transfer deficit, and even 30-month-olds required special instructions and apparatus to play the computer game correctly (e.g., covering irrelevant computer keys). Newer advances in technology may provide better opportunities for toddlers to learn from intuitive touchscreen interfaces. The impact of different types of contingency on toddlers' learning has been recently investigated using touchscreen tablets. We created three types of video presented on a touchscreen device: noninteractive (advancing automatically), general-interactive (accepting touch input anywhere on the screen), or specific-interactive (requiring touch input on particular areas of interest). In both object-retrieval (K. Choi & Kirkorian, 2016) and word-learning studies (Kirkorian, Choi, & Pempek, 2016), younger 2-year-olds performed better than chance only in the specific-interactive condition, whereas this condition disrupted learning by older 2-year-olds who performed well when using noninteractive or general-interactive videos. These findings suggest that carefully designed interactive media may enhance toddlers' learning; however, the specific conditions that lead to the best learning outcomes may vary with age. Moreover, the impact of interactive video in our studies was not as strong as the impact of interactions with a contingent social partner in prior studies.

Although previous research reveals that contingency alone works without socially relevant and adaptive interactions, the underlying mechanisms of its effect remain unclear. We suggested three possible ways that interactive experience would support learning from screens (Kirkorian, Choi, et al., 2016). First, interactive media may assist learning by increasing engagement or arousal and thus increasing available resources. Second, interactive media may allow children to pace themselves through the content and thus slow the influx of information and reduce cognitive load. Third, interactive media may emphasize important content on the screen and thereby reduce the amount of information to be encoded. In the first two scenarios, any kind of interactivity should facilitate learning. However, when considering younger 2-year-olds, our studies (K. Choi & Kirkorian, 2016; Kirkorian, Choi, et al., 2016) revealed that the specific-interactive groups outperformed the general-interactive groups, suggesting that touching a specific location of interest (e.g., the location of a novel object that is being labeled) may draw children's attention to the most relevant information on screen. This finding is consistent with eye-tracking studies showing that younger children have more difficulty identifying the most important information on the screen when they watch traditional, noninteractive video (Frank et al., 2009; Kirkorian, Anderson, et al., 2012). Moreover, this is directly supported by preliminary data in our lab revealing that 2-year-olds who complete an object-retrieval task using specific-interactive video spend more time looking at the target location than distractor locations during the hiding event (Kirkorian, Choi, Schroeder, & Etta, 2015). Thus by directing attention appropriately, interactive experience has the potential to enable children to spend more time looking at the right information at the right time.

Taken together, increasing evidence suggests that toddlers' ability to learn from screens can be improved through contingent experiences with screen media. However, many questions remain regarding whether and how certain screen experiences facilitate early learning. The experiences that produce the best learning outcomes appear to vary depending on a child's age and abilities.

5.3.5 Summary of Research on Learning from Video

There are several hypotheses regarding the existence of the transfer deficit, which are likely complementary rather than mutually exclusive. The transfer deficit might partly be explained by toddlers' difficulty recognizing the symbolic relation between screen images and their real-life referents. Moreover, there is strong evidence that transferring from video is a cognitively demanding task that can be improved by reducing cognitive load in a variety of ways. Effective strategies include matching cues that are available during encoding and retrieval, repeating information to be learned from video, and using familiar characters that enable viewers to focus on novel to-be-learned information. Some of these scenarios apparently increase toddlers' ability to selectively attend to target information during the initial acquisition of information, while others increase the likelihood that children retrieve target information when faced with real-life stimuli.

The finding that toddlers are more likely to make perseverative errors in an object-search task when viewing hiding events on video (vs. in person) may serve to bridge these two hypotheses of the transfer deficit: The combined difficulty of updating representations of both video symbols and real-life referents as well as transferring information across perceptually disparate stimuli is likely to result in poor learning by toddlers with relatively weak working-memory skills, particularly when also faced with the challenge of inhibiting outdated information from previous learning trials, as in the case of many object-retrieval studies.

Other strategies that have been demonstrated to increase screen-based learning include social and nonsocial interactivity with on-screen people and characters that respond contingently to the viewer's own behavior. On the surface, this may appear contradictory to the hypothesis that learning from video is cognitively demanding, insofar as the need to generate responses should increase cognitive load for the viewer. However, such interactions may facilitate early screen-based learning by clarifying the symbolic relation between screens and real-life events, increasing arousal and engagement, and directing attention to target information on the screen. Thus the many advantages of interactive media may compensate for the added burden of generating a response.

5.4 Conclusions and Future Research Agenda

More than a decade of research has demonstrated that toddlers have difficulty transferring from screens to real-life experiences. Nonetheless, toddlers are capable of learning from video under specific circumstances, particularly when the connection between video and real-life events is emphasized and when cognitive load is decreased. Moreover, interactivity appears to facilitate learning by younger viewers.

There are many unanswered questions regarding the impact of screen media on attention and learning during the first few years of life. Foremost among them are the reasons for the transfer deficit. There are several complementary hypotheses, yet most authors have focused on the relative difficulty of retrieving information from video when transferring to real-life stimuli. We propose that in addition to difficulty retrieving this information, toddlers may encode information differently when viewing video versus real-life events. This likely includes differences in both selective and sustained attention.

Research on the development of selective attention to video demonstrates age-related change in the features that drive attention to the screen. In particular, infants' attention is primarily driven by perceptually salient features, whereas comprehension processes appear to become more important in driving selective attention as children age and gain experience with video. Thus selective attention appears to reflect ongoing comprehension processes, rather than being the sole cause of comprehension. Furthermore, younger viewers are less likely than are older viewers to allocate attention strategically when viewing edited video, insofar as they do not preferentially look at comprehensible (versus incomprehensible) video, and they are less likely to respond to cuts to new scenes by looking at the center of the screen or integrating information across content boundaries in order to anticipate the reappearance of objects. Supporting toddlers' limited selective-attention skills may facilitate learning from screens, for instance by utilizing familiar characters and integrating interactive features that help direct attention to important information. However, more research is needed to understand the specific conditions under which toddlers can learn from video and the role that selective attention plays in the learning process.

Sustained attention, on the other hand, may serve to increase comprehension at any age. In particular, attentional inertia may enable viewers to maintain attention even as content remains or becomes incomprehensible. It has been hypothesized that this phenomenon may enable early learning across many activities, including television viewing and toy play. However, research is limited, particularly with infants and young children. Future research should explore the relation between sustained attention and learning with a variety of methods and across a wide range of ages and activities.

Despite the still-growing literature on attention to television, there is almost no analogous literature on interactive media, including video games and mobile applications. Presumably many research findings are applicable across media platform (just as similar findings have been reported for toy play with real objects), but the interactive nature of newer technologies raises new questions about how selective and sustained attention are deployed during these activities, as well as how readily children retrieve information that was encoded during media use in order to solve a real-world problem.

Another important area for future study is how to more directly assess different processes involved in attending to and learning from screen media. We noted previously that a look is a complex behavioral measure that reflects many underlying cognitive processes. Future studies should incorporate other measures of attention that may help researchers to disentangle these processes including those described earlier in this chapter (eye tracking, secondary-task reaction time, heart rate) as well as those that have been used to study attention elsewhere but have yet to be applied to the study of children's television viewing (e.g., neural imaging and electroencephalography, pupil diameter).

In conclusion, infants and young children are using interactive screen media at unprecedented rates, yet researchers know little about the potential impact of these new media. Moreover, infants and toddlers continue to spend substantial amounts of time viewing noninteractive video, despite consistent research findings suggesting that this activity holds limited educational value for young viewers. Some studies have suggested that young children may learn better from interactive video than from traditional, noninteractive video. It may be that newer technologies have the potential to foster early learning and better prepare children for school. However, scientifically rigorous research is greatly needed to establish whether, how, and for whom digital media can be educationally valuable throughout infancy and early childhood. By understanding how infants and children attend to and encode information that is presented on screens, researchers can contribute to the development of educational media that supports learning by young viewers.

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Chapter 6
What's in a Look? How Young Children Learn from Screen Media and Implications for Early Educators: Commentary on Chapter 5

Michael Robb

Children 3 years and younger are often considered a "special audience." Given the rapid changes across multiple areas of development (cognitive, social, emotional, linguistic, physical, etc.), researchers have emphasized the importance of the first 3 years of life for later personal and academic outcomes. Great importance is placed on the experiences young children have, and how they help to support development. Promoting interactions with the world, and the people in it, are often of greatest concern to those responsible for taking care of young children. How does media use, passive or interactive, linear or nonlinear, fit into young children's day-to-day lives? How can parents and educators make good decisions about how much and what media to put in front of their children, and what will shape those media experiences? The increasing ubiquity of screens of all kinds—smartphone, tablet, television, and other screens—in the lives of children starting at birth make this especially relevant.

This chapter is an excellent synthesis of the most current research available on how young children learn from screens. Drs. Heather Kirkorian, Tiffany Pempek, and Koeun Choi have developed an extensive review about the mechanisms underlying how, when, and why infants and toddlers attend to, retain, recall, and transfer information delivered via televisions and interactive devices. They also deliver a useful review of methodologies that have been used to assess children's online processing from screens, including respective strengths and weaknesses of different approaches. Lastly, they provide guidance regarding techniques and conditions under which children can successfully transfer information from screens to real-life scenarios. The implications for educators, families, and media makers are profound and actionable.

A key theme that reoccurs frequently in the chapter is the importance of understanding development, and not treating all children's viewing as monolithic. For

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instance, Kirkorian and colleagues summarize research showing that infant viewing is often driven by visual and auditory changes, but attention is later driven by the child's ability to comprehend what is on screen, and the presence of features that signify child-directed content (like animation or child actors). Looking at screens becomes much more strategic as children get older, with older children becoming better at responding to common elements of programs, such as refocusing on the center of a screen after a cut, or anticipating where objects would appear in a new scene based on what they had seen before a cut. The authors convincingly portray viewing as a very cognitively active process, in contrast to common press depictions of children as mindless zombies, passively viewing screens.

However, the information processing load put on children as they attend to and try to comprehend what they are seeing may prevent them from transferring what they see on screens to the real world. Understanding that infants and toddlers in particular may struggle with learning from screens, except under limited circumstances, can inform early educators about if, how, and when technology should be used with young children. Educators need to know that learning from media can be much more demanding than learning from physical reality because of the ways that 2D symbolic content (videos, apps, books, pictures, etc.) play with time and space, because it is perceptually different than the real world (2D vs. 3D), and because even interactive media have limited ability to replicate the situations in which young children are thought to learn best—in the context of social interactions.

Given the difficulty infants and toddlers have learning from television, and the limited research on learning from interactive devices like tablets, it is in caregivers' best interest to limit exposure to screen media in favor of real-world experiences, and interactions with people and objects in the environment. Screen use that displaces high-quality interactions between children and caregivers should be avoided.

Does that mean that educators should discount media as a tool for supporting and engaging infants and toddlers? Not necessarily. The National Association for the Education of Young Children and the Fred Rogers Center for Early Learning and Children's Media at Saint Vincent College issued a position statement (2012) providing guidance for educators to use media and technology in age-appropriate and highly intentional ways. This document recognized that very young children present a special challenge when it comes to integrating technology. It places the very-real cognitive issues that infants and toddlers face when learning from media within a broader developmental context. Decades of child development research shows that social interaction is a very natural and effective means of helping children learn. Thus, if media and technology are used with young children, placing it within the context of human interactions is more likely to lead to positive outcomes.

There are many ways this could be done. For example, allowing an 18-month-old to swipe through pictures on a tablet may have limited pedagogic usefulness. However, an educator could take digital pictures of family, friends, animals, events, or objects in the child's environment, sit the child in her lap, and talk about the pictures as they swipe through them together. Research suggests that meaningful learning experiences connect to our existing knowledge and may be more sustainable (Hirsh-Pasek et al., 2015). The interaction around the digital pictures could involve joint attention, labeling, vocabulary building, and other learning activities. Similarly, ebooks could be treated like print books. Instead of assuming that a young child can use an ebook by herself, a caregiver could get close to a child and use it with her, engaging in similar dialogic reading behaviors that characterize effective read-alouds.

Another option for ebook developers is to embed cues within software that direct children and parents to important content or objects, while keeping distracting or irrelevant foci to a minimum. These cues could take the form of highlighted objects or words, question prompts, or other interactive features that enhance the reading experience. For parents who may struggle with their own reading abilities, assistance from software may make reading experiences more useful and enjoyable.

Social contingency is one of the factors that can ease learning from media, with research demonstrating that children as least as young as 30 months could learn new words through video chats or to find relevant objects in the real world. Socially contingent interactions are more relevant, and adaptive to young children, which may drive their attention to the screen. As such, educators could consider the use of video chats to allow children to interact with people they might not otherwise encounter. For example, children could communicate with people in other classrooms, or even other countries (see also Chap. 15, McClure & Barr, 2016; Chap. 16, Truglio & Kotler, 2016).

The authors make a convincing case that traditional, noninteractive video may be too difficult for young children to learn from, especially when used independently. However, one could imagine conditions in which videos could be made valuable. For toddlers, attention to videos can be improved with the use of comprehensible video. An age-appropriate video that is slow-paced, repetitive, and uses formal features judiciously, could aid children's attention by reducing the cognitive load. Using a familiar character could also decrease the cognitive load (see Chap. 7, Linebarger, Brey, Fenstermacher & Barr, 2016; Chap. 9, Richards & Calvert, 2016). Most importantly, although most video does not provide contingent interaction, a live teacher could support children's learning from the screen by commenting on what is being viewed, asking questions, and building activities off of the video.

Imagine a teacher who wants to talk about tigers in class. Picture books about tigers can help children know what tigers look like, but they are limited to static images. A teacher could cue up a short video of a tiger crawling through the grass and roaring. Better yet, he could combine a book about tigers with a short video, providing multiple ways to gain background knowledge and helping children understand what tigers look like, how they move, how they sound, what they do, etc. His facilitation of the viewing experience and discussion about the tiger could help children process what they are viewing beyond what children could do by themselves. Such an exercise would be an excellent way to prepare children for a visit to the zoo, and would also be important for situations where a visit to the zoo was impossible. In all of the examples provided above, the use of technology serves as a way to strengthen adult–child relationships, rather than displace them.

As pointed out by the authors, we are also just beginning to understand how young children attend to and understand interactive media, including mobile apps and video games. An advantage of interactive media like apps or computer programs is that they are responsive to user input. How interactions with media occur varies tremendously. Depending on the software, children may be able to set their own pace, advancing through chapters of an interactive book, progressing through levels of a game, or exploring a digital environment at their own speed. Children using an interactive book for example, could reexplore particularly enjoyable sections of a book over and over again, for enjoyment or comprehension purposes. The child has a strong role in the outcome of the interactive experience, as opposed to a linear television experience, in which a child always progresses from beginning to end, regardless of whether the child understood what was happening. Clearly, there are many opportunities for self-directed learning. However, a knowledgeable teacher who is observing the child and is familiar with the software being used can help determine content limitations, and facilitate a more robust human-guided learning experience (for example, by planning related activities, finding and reading relevant books, and engaging in conversations).

The authors cite evidence finding that interactive media can support learning in children at least as young as 24 months, and that age may even shift downward as touchscreen devices become even more intuitive for young children to use. In particular, interactive media may be especially useful when they require children to be active around specific areas of interest. With television, children could potentially look anywhere, and not understand the message because their attention was not focused on where the creators intended. Based on the research reported by the authors, with interactive media, app developers can ensure that children *have to* focus on a particular area because the program could not advance without it. This focus reduces the overall amount of information processing required by emphasizing the important content required to succeed. As mentioned in the chapter, interactive experiences thus can provide more cues about relevant information, and by giving children control, can give more time for children to process content.

However, because touchscreens are still relatively new, compared to television, the research literature has many gaps. The authors note that there is much to learn about how interactive media can sustain attention, and how children encode and retrieve information obtained through new technologies. Interestingly, the research so far indicates that although interactivity can support learning, the impact is still not as strong as having a real human partner, who can provide contingent interactions with a child.

For educators, the implications for practice are murky. Just because a touchscreen can provide a learning experience does not mean it will. It is clear from the research that a toddler will attend to an interactive experience, and may be engaged by it, but a warm, responsive caregiver is still essential to the learning process. In the absence of a large research base, educators should rely on their professional judgment when deciding what devices and media may support their learning goals, and use tools like the *Checklist for Identifying Exemplary Uses of Technology and Interactive Media for Early Learning* (Robb et al., 2013), which guides the selection, use, integration, and evaluation of digital materials in early education settings. For example, educators must insure that their use of technology supports early learning goals or curricula, that technology is age-appropriate, and that they can evaluate whether they are meeting learning objectives. Thoughtful use of technology might involve planning the physical environment to accommodate individual use, small group use, or whole class use.

Creators of digital media often make implicit, and sometimes explicit, claims about learning outcomes for young children which are often not supported by independent research. Educators must be wary when selecting, using, integrating, and ultimately evaluating interactive media use with young children, and make sure to consider the developmental level, interests, abilities, and needs of the children they care for (Hirsh-Pasek et al., 2015; Robb et al., 2013; see also Chap. 4, Liebeskind & Bryant, 2016; Chap. 17, Zosh et al., 2016). To help separate quality educational apps from ineffective apps, Hirsh-Pasek and colleagues (2015) suggest four "pillars" that parents, educators, and others can use to evaluate an app's learning potential: active participation that requires deep mental effort, sustained engagement through thoughtful feedback and judicious (not distracting) uses of interactive features, meaningful connections to children's interests or prior knowledge, and social interaction through conversation, cooperation, or even competition.

Again, there are certainly instances when thoughtful use can enhance classroom experience. Consider a classroom focused on teaching about "vehicles" that is exploring trucks, cars, boats, airplanes, and other things that go. A teacher could download an app for a tablet with a picture board of different kinds of vehicles on it. Children could touch a picture of a bulldozer, for example, and be shown a 20-s video of a bulldozer pushing dirt into a pit. Touching the bulldozer again could pull up another clip of a bulldozer in a new location, digging up a field. The interaction is simple enough for a child to control and direct, and gives the educator several opportunities to describe what is happening in the videos, connect it to children's other experiences, and otherwise follow the child's interests. The child is able to experience contingent interactions from the app, and contingent social interactions from the teacher.

Educators could play an especially important role translating and communicating the research to parents. Educators are often the conduit for delivering important information about children's development to parents, and there is much confusion surrounding the role of screen media in children's lives. Parents, too, need guidance cutting through the complicated messages around television and digital media. Suggesting that infants and toddlers not be exposed to screen media at all may be an impossible request for many families, especially when older siblings are present. However, conveying the difficulties children have in learning from screen media, the ways in which cognitive demands can be reduced, and most importantly, parents' important role in mediating technology use would be tremendously helpful. The message need not be one of fear, but rather of empowering parents to get a better handle on the role they have as curators of their children's media experiences.

Future research will ultimately tell us more about when and how infants and toddlers learn from interactive media, and media creators may come up with interesting and exciting uses of interactive media that are hands-on, engaging, and well matched to young children's developmental levels. However, the current chapter does support promising uses of technology for children aged 2–3 years. Although children under two have a more difficult time learning from media, there is no hard line that says learning from interactive media is impossible, especially when thoughtfully and intentionally integrated into the learning environments in homes and school. As such, caregivers should think more about how they themselves can be interactive with young children, both in the contexts of interactive media use, and outside of it.

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Chapter 7
What Makes Preschool Educational Television Educational? A Content Analysis of Literacy, Language-Promoting, and Prosocial Preschool Programming

Deborah Nichols Linebarger, Elizabeth Brey, Susan Fenstermacher, and Rachel Barr

7.1 Educational Television

Since the introduction of *Sesame Street* in 1969, producers, educators, and researchers have worked together and in parallel to create and evaluate the impacts of educational TV. Despite the rapid increase in the availability of mobile devices (see Chap. 3, Hipp et al., 2016; Chap. 5, Kirkorian, Pempek & Choi, 2016; Chap. 6, Robb, 2016; Zosh, Lytle, Golinkoff, & Hirsh-Pasek, 2016), 80 % of U.S. preschoolers' media exposure is still via video content for an average of 55 min of educational programming per day; the major distinction between today and historic trends is that content is now typically streamed rather than viewed at consistent times or on a single television set located in a family room (Rideout, 2013). The focus on preschool content arises from two factors. The first is pragmatic: Preschoolers are more likely than older or younger children to view television content, both due to decreasing daily sleep requirements relative to infancy and toddlerhood and the fact that most have not yet begun formal schooling. The second is more ideological: The initial impetus for creating educational programming was to reduce the school readiness gap, a problem that persists into the present day (U.S. Department of Education, National Center for Education Statistics, 2006). In fact, the language and literacy skills that children develop between birth and age 5

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are crucial for their future academic achievement (Lonigan & Shanahan, 2009). Children who begin formal schooling already lagging behind their peers in these skills rarely catch up and often fall further behind as they continue in school (Hart & Risley, 2003; Stanovich, 1986; Walker, Greenwood, Hart, & Carta, 1994). A relatively large body of research indicates that educational television programs focused on language and literacy can boost children's communication and reading skills and encourage their general interest in reading (e.g., Anderson, 1998; Anderson, Huston, Schmitt, Linebarger, & Wright, 2001; Linebarger, Kosanic, Greenwood, & Doku, 2004; Mates & Strommen, 1995; Moses, 2008; Wright et al., 2001). One longitudinal study demonstrated that the benefits of watching educational television programming at age 5 persisted into the adolescent years, leading to higher grades, increased book reading and more creative thinking (Anderson et al., 2001). Because children are able to actively listen and interact with well-designed educational television, programs that use language-promoting strategies have the potential to improve children's language and literacy skills by modeling these skills and then encouraging viewers' interaction in a way that lets them practice these skills (Moses, 2008). Children spend a great deal of their free time watching television (Rideout, 2013), suggesting that this activity is inherently enjoyable. This enjoyment is enhanced by the sense that they can apply and practice the skills and other information they observe on television in their own lives as they learn to read and communicate (Linebarger, 2000). When programs are created using entertaining formats guided by developmental theory, researchers document increases on various outcomes including school readiness (e.g., Wright et al., 2001), problem solving (e.g., Crawley, Anderson, Wilder, Williams, & Santomero, 1999), and literacy (e.g., Linebarger et al., 2004).

We identified both molecular and molar components that can be found in educational television or used by educational television content creators. The molecular components of educational television include both learning strategies embedded within individual episodes that are used to convey or denote program content and the presence and quality of character-based interactions. The molar components of educational television include the target viewer age, the program structure (e.g., narrative, expository), and the program curriculum emphasis.

7.2 Molecular Components of Educational Television

7.2.1 Instructional Strategies

Educational television programs feature an array of specific instructional strategies that function to support children's internal mental processes of learning (Gagne, 1970). Strategies can gain or direct attention, inform the viewer regarding key content, prompt the viewer to recall prior knowledge, present actual content, provide guidance or sequence learning, elicit viewer participation, provide feedback, assess comprehension, and enhance retention of program content and transfer (Gagne, 1970;

Linebarger, 2015; Linebarger & Piotrowski, 2010; Piotrowski, 2010). In this study, instructional strategies fell into one of four broad areas: (1) cognitive instructional strategies (e.g., use of familiar scenes, repetition, perspective-taking); (2) language instructional strategies (e.g., questions, prefacing and summarizing, eliciting viewer interaction); (3) code-related literacy instructional strategies (e.g., depicting and highlighting onscreen print, letter and sound identification, spelling words onscreen); and (4) character interactional quality (e.g., positive peer interactions).

7.2.1.1 Cognitive Instructional Strategies

The capacity to understand and learn from televised content is enhanced when key content is paired with strategies that support viewers' processing of this content. Cognitive strategies can act as rehearsal devices, scaffolds, or prompts to facilitate the encoding of new information. For instance, researchers have carefully tracked early memory development and documented that the use of familiar contexts, provision of multiple exemplars, and repetition are key ingredients to early knowledge acquisition (Rovee-Collier & Barr, 2010). These three strategies help young children accurately develop mental representations of everyday experiences that, in turn, allow them to use these representations when encountering new content and information. During early childhood, learning from educational television occurs most rapidly when content is embedded within familiar routines, such as scenes in the home or in a park. These scenes can be more easily mapped onto preschoolers' existing knowledge or experiences. Embedding content within narrative structures also provides a familiar context for young children (Linebarger & Piotrowski, 2009, 2010) and, as such, children are often better able to learn content that is embedded in stories when compared to non-story formats (see below). Because early memory retrieval is quite specific to the conditions of encoding (i.e., cues and settings in which initial encoding/exposure took place), generalizing beyond learned information can be challenging when settings are not familiar (see Chap. 3, Hipp et al., 2016). Moreover, young children require multiple exemplars to learn new categories. For these reasons, providing multiple examples to increase categorization and generalization is crucial (e.g., showing different colors of the same object, or different animals engaging in the same task allows the young child to go beyond the specifics of the situation and generalize to broader superordinate categories).

In addition to cognitive strategies that provide memory support, other cognitive strategies can support executive function (EF). EF comprises a complex cognitive regulatory system that helps guide goal-directed behavior (Hughes, 2002). It includes: (1) working memory (the ability to hold information in mind in order to complete a task); (2) inhibition (the ability to refrain from performing an action, particularly those that are incompatible with the task at hand); (3) set shifting (the ability to shift attention between two competing tasks); and (4) the ability to regulate and modulate emotions. EF skills develop rapidly across the preschool years (Espy, Kaufmann, Glisky, & McDiarmid, 2001; Zelazo, Carter, Reznick, & Frye, 1997) and are critical for school readiness because schools require children to control impulses, follow directions, transition smoothly between activities, regulate emotions, and focus attention on relevant task information. Previously, content analyses of educational television programs have not considered the ways in which EF might be fostered via educational television, although research has indicated that viewing educational content is both associated with and causally linked to better EF whereas viewing entertainment content is associated with and causally linked to poorer EF (Gatewood & Linebarger, 2015; Lillard & Peterson, 2011; Linebarger, Barr, Lapierre, & Piotrowski, 2014). To this end, the current content analysis measured the presence of the following EF-related cognitive strategies: metacognitive strategies, problem solving strategies, making comparisons or similarities, and modeling of perspective-taking and pretense.

7.2.1.2 Language Instructional Strategies

Cognition and language are intimately linked and reciprocal aspects of development during early childhood (Deák, 2014). A relatively large body of research indicates that educational television programs focused on language can boost children's language skills (Anderson, 1998; Anderson et al., 2001; Linebarger & Walker, 2005; Mates & Strommen, 1995; Moses, 2008; Rice, 1983; Wright et al., 2001). Facilitating language skills in preschoolers involves engaging them in complex verbal reasoning, encouraging verbal interactions, and teaching new vocabulary (Wilcox, Murphy, Bacon, & Thomas, 2000). There are a number of strategies that have been identified in the language facilitation and intervention literatures that support the development of these three different language practices.

Verbal reasoning involves processing content by thinking about that content in a logical way and then constructively organizing one's thoughts about that content using language (Burton, Welsh, Kostin, & Essen, 2009). Preschoolers' verbal reasoning is supported by the inclusion of wh-questions (who, what, why) that prompt them to make predictions, classify, and identify similarities and differences (National Early Literacy Panel, 2008; Reese, Sparks, & Leyva, 2010). Other relevant strategies include commenting and labeling objects and actions when they are visually displayed, and storytelling (Reese et al., 2010). Matching verbal referents to visual displays, and repeating and generalizing content are particularly important for learning from video presentations where mismatches between the screen and the real world will be compounded (see also Barr, 2010, 2013).

Preschoolers learn new words quickly, at a rate of about 2 root words per day (Biemiller, 2005); however, this learning is highly dependent on the range of words to which they are exposed (e.g., Hart & Risley, 2003; Marulis & Neuman, 2010). Facilitating young children's vocabulary learning can be accomplished through making conversation, posing questions, defining words, providing examples of words, and repeating content (NICHD, 2000), all techniques possible to embed in educational television (e.g., Rice, 1983). Experimental research indicates that children learn specific words embedded in educational television (Linebarger et al., 2014; Rice & Woodsmall, 1988; Singer & Singer, 1998). Moreover, these effects appear to be lasting; preschoolers who watched educational television showed generalized gains in vocabulary (Rice, Huston, Truglio, & Wright, 1990; Wright et al., 2001) that were sustained into early adolescence, with preschool viewing of educational television associated with higher grade point averages and more leisure book reading (Anderson et al., 2001).

7.2.1.3 Code-Related Literacy Instructional Strategies

Exposing young children to print in their everyday lives is a means of boosting their literacy skills. Familiarizing children with environmental print by labeling materials with signs and by ensuring the availability of writing utensils in a classroom encourages understanding of forms and functions of written language while assisting children with label learning and general print knowledge (Pullen & Justice, 2003; Whitehurst & Lonigan, 1998). Furthermore, the more time children spend visually attending to print, the faster they will acquire emergent literacy skills such as letter identification and phonemic awareness, skills that are crucial for successfully learning to read (NICHD, 2000).

Many producers of children's educational television focus on spurring the development of young children's language and emergent literacy skills. The National Early Literacy Panel (2008) identifies a variety of precursor skills that are fundamental to an individual's literacy development, including: alphabet knowledge, phonological awareness, letter and number identification, writing, understanding the form and functions of print, and oral communication (Lonigan & Shanahan, 2009). Mastering these skills will set a preschool child on the path to success in the subsequent development of advanced literacy skills such as spelling, decoding, fluency, and comprehension—skills that are essential for academic achievement once a child enters school (NICHD, 2000). Because preschool-age children naturally spend more time looking at pictures than words, making onscreen print more salient can direct their attention to the text, thereby helping them to develop pre-literacy skills such as letter identification, letter-sound knowledge, and print-concepts. Research indicates that drawing children's attention to storybook print by enhancing the salience of the print helps children become more familiar with print concepts, letters, and eventually words (Evans, Williamson, & Pursoo, 2008). For example, the size of print may be enlarged in order to catch the eye; it may be accompanied by a visual representation (Pullen & Justice, 2003); it may be written in an interesting font (e.g., bubble letters), pointed to, or read in a funny voice (Evans et al., 2008). In addition, studies using electronic books have demonstrated that techniques such as print movement increase the likelihood that children will pay attention to print and internalize the lesson presented (Pullen & Justice, 2003).

A number of studies indicate that educational television programs designed around a language and literacy curriculum are successful in teaching many of these skills to preschoolers, including letter and word identification, phonemic awareness, knowledge of letter sounds, and print concepts (Linebarger, 2000; Linebarger et al., 2004; Mates & Strommen, 1995; Moses, 2008). Furthermore, in at least one study, the gains associated with viewing these types of programs were most pronounced among at-risk children who had weak existing language and literacy skills at the start of the study (Linebarger et al., 2014).

7.2.2 Character Interactional Quality

Observing and engaging in positive social interactions with adults and peers fosters young children's socio-cognitive and language development (Hartup, 1992) Though television may not always provide direct opportunities for social engagement, it can facilitate the experience of positive social interactions through modeling of such behaviors. Learning from television may involve imitation, whereby young children copy behaviors that they have seen modeled by another person or character. Bandura (e.g., 1965) noted that imitation takes place through processes of social learning, which can occur when viewing both live and televised behavioral models. Beyond modeling appropriate behavior, televised characters may also model social relationships by attending to one another and engaging in conversations. Imitation of such interactions by both children and caregivers may thus constitute an additional socio-educational benefit of prosocial educational programming.

In addition to modeling positive parent–child and peer-to-peer interactions onscreen, educational media can facilitate social interactions in a variety of ways, eliciting interactions from viewers (e.g., Dora directly asking the audience to participate), and providing contingency (e.g., after eliciting an interaction, the onscreen character pauses and then provides some general feedback acknowledging the child's [expected] response). Television producers have developed content that uses such social cues to create conversational exchanges that are consistent with Brown's (2001) "explicit prompting routines" (p. 225). These routines provide direction regarding what children should say, although this definition was expanded to encompass not only specific prompts for participation but also requesting and reinforcing child participation across multiple simulated character-viewer exchanges (see Linebarger & Vaala, 2010). Preschoolers who viewed programs with these explicit prompting routines (e.g., *Blue's Clues*, *Super Why*) learned from and also actively engaged with program content more compared to those who viewed the same episode with the routines removed or programs that never included such routines (Anderson et al., 2000; Calvert, Strong, Jacobs, & Conger, 2007; Piotrowski, 2010).

Overall, few studies have closely examined the specific content features (e.g., cognitive strategies, language instructional strategies, code-based strategies, or character interactional quality) that are most successful at boosting preschool children's language and literacy skills when embedded in educational television programming. Thus, while we know that quality programming *can* teach, we have a much weaker understanding of precisely *how* it does so.

7.3 Molar Components of Educational Television

The molar components of educational television include the target viewer age, the program structure (e.g., narrative, expository), and the program curriculum emphasis.

7.3.1 Target Viewer Age

Educational television programs typically target a narrow age range (Jordan & Sullivan, 1997) due to variations in developmental competencies across early childhood. For instance, research indicates that the reading program *Between the Lions* is most effective for prekindergarten and kindergarten children (Linebarger et al., 2004; Prince, Grace, Linebarger, Atkinson, & Huffman, 2002) and much less effective for first grade children due to its focus on specific phonological and phonemic awareness content. These skills typically develop between 4 and 6 years of age (Paulson, 2004). Correspondence among program content, instructional strategies, and developmental competencies is necessary to ensure that children can effectively learn from and engage with program content. For example, while all children are likely to benefit from well-organized content that promotes prosocial behavior, younger preschoolers are more likely to benefit more from interactions that involve adult or peer models, that promote language, and that involve clear cognitive strategies (Barr, 2006; Vygotsky, 1978). In contrast, older preschoolers are more capable of code-related literacy skills including the addition of print, as well as learning from peer-to-peer interaction and presentation of more diverse content (Fisch, 2004; Linebarger et al., 2004).

7.3.2 Program Structure

The influence of the program structure used by different television programs to deliver content has been the focus of recent research. Broadly speaking, program structures include narrative formats and expository formats. Narrative programs use a common set of conventions (e.g., setting, character, goals, resolutions; van den Broek, Lorch, & Thurlow, 1996) to deliver program content. Expository formats, whose primary purpose is to deliver information, usually do so through short vignettes loosely strung together around a common theme. Conventions in expository formats vary depending on the type of information to be presented (e.g., compare/contrast, sequencing, cause/effect; Duke & Kays, 1998) and may include limited narrative elements (e.g., *Reading Rainbow* typically presents a book along with multiple vignettes surrounding the presentation of the book to supplement knowledge of the story presented). These types of shows are hybrids although they contain mainly expository content. In addition to differing conventions, expository programs often contain more unique content ideas and greater structural complexity when compared with narratives (Linebarger & Piotrowski, 2010). As a result, children tend to have more difficulty learning key educational content (Linebarger & Piotrowski, 2009, 2010), likely because they have to simultaneously process both the format conventions of variable expository macrostructures along with the educational content embedded within a program (Fisch, 2004). Narrative formats have been linked to larger gains across language, literacy, and program comprehension outcomes when compared with expository formats (Linebarger & Piotrowski, 2009, 2010). Programs like *Arthur and Friends* and *Clifford the Big Red Dog* are considered non-interactive because characters interact only with each other onscreen. The experience is similar to picture book reading, where viewers are observers of a story but not active participants. Research investigating non-interactive narratives indicates that preschoolers learn more vocabulary words and demonstrate greater program comprehension when compared with expository formats (Linebarger & Piotrowski, 2009). Although most narrative formats share common conventions, there are two narrative variations currently used by educational TV producers that differ in their approach to the active inclusion of home viewers. Programs like *Blue's Clues* and *Super Why* include multiple viewer participatory elements that are designed to elicit greater involvement by viewers. Onscreen characters will look into the camera, ask viewers questions or invite them to participate, pause to give viewers an opportunity to respond, and then provide pseudo-contingent feedback (e.g., Good job!). Participatory strategies that structure the viewing experience help young children become more actively involved with the content. Preschoolers who view programs using these types of pseudo-contingent exchanges demonstrate increases in content comprehension and viewer interactions (e.g., clapping, shouting back at the television; Crawley et al., 1999; Piotrowski, 2010). Learning effect sizes associated with interactive narratives tend to be larger than learning effect sizes associated with non-interactive narratives (e.g., Linebarger & Walker, 2005).

7.3.3 Curriculum Emphasis

Much of the research investigating the effects of educational television on preschoolers' social and cognitive development indicates that children learn the specific content featured in programs (see Fisch, 2004 for a review). However the distribution of different learning strategies within educational programs has not been determined. This is necessary to understand why programming is effective and how it can be improved. Program selection for the present study was determined according to three criteria: First, the funding agency supporting this project was the U.S. Department of Education's Institute for Education Sciences' Ready to Learn (RTL) program which funded various phases of development for five educational television programs. All five of these programs (*Super Why*, *Martha Speaks*, *Between the Lions*, *Sesame Street*, and *Word World*) are included in this content analysis. Second, RTL's main purpose during the 2005–2010 funding cycle was to support young children's acquisition of language and literacy skills. As such, the next five programs selected for the content analysis (*Arthur & Friends*, *Clifford the*

Big Red Dog, *Reading Rainbow*, *Barney & Friends*, and *WordGirl*) were either supported in previous RTL funding cycles or included language and literacy content and were aired on PBS affiliate stations. Finally, five additional educational television programs (*Blue's Clues*, *Dora the Explorer*, *Go Diego Go*, *Franklin & Friends*, and *Curious George*) that were Nielsen top-rated programs for preschoolers but did not fit into one of the two previous criteria were included. While programs were initially selected for the aforementioned reasons, an examination of the curricular goals of each of these 15 educational TV programs indicated four different curricular emphases:

1. Code-related literacy programs: Early literacy goals centered on the development of code-related skills including children's understanding of the rules for translating print into sounds or sounds into print: grapheme knowledge (letter identification); phonological awareness (rhyming, syllable manipulation); syntactic awareness (grammar); phonemic awareness (letter-sound correspondence); and emergent writing (phonetic spelling; Whitehurst & Lonigan, 1998).
2. Language programs: Early language goals centered on the development of vocabulary and conceptual knowledge.
3. Prosocial programs: Prosocial goals centered on the development of friendships and the support of social and emotional development.
4. General learning programs: Early learning goals centered on specific content knowledge or a broad set of skills and content. Comprehensive early learning goals refer to programs whose primary purpose is not centered on language- or literacy-skills. Instead, the program could target Science, Technology, Engineering and Math (STEM) content (e.g., *Curious George*), animal knowledge (e.g., *Go Diego Go*), or comprehensive and multifaceted content (e.g., *Sesame Street*).

TARGETED AGE

- ***Younger (2-4yo)***
  - Barney & Friends
  - Blue's Clues
  - Curious George
  - Clifford the Big Red Dog
  - Go Diego Go
  - Dora the Explorer
  - Sesame Street
  - Super Why
  - Word World
- ***Older (4-7yo)***
  - Arthur & Friends
  - Between the Lions
  - Franklin
  - Martha Speaks
  - Reading Rainbow
  - WordGirl

PROGRAM STRUCTURE

- ***Traditional Narrative***
  - Arthur & Friends
  - Curious George
  - Clifford the Big Red Dog
  - Franklin
  - Martha Speaks
  - WordGirl
  - Word World
- ***Interactive Narrative***
  - Blue's Clues
  - Dora the Explorer
  - Go Diego Go
  - Super Why
- ***Hybrid/Expository***
  - Barney & Friends
  - Between the Lions
  - Reading Rainbow
  - Sesame Street

CURRICULUM EMPHASIS

- ***Code-Based Literacy Skills***
  - Between the Lions
  - Super Why
  - Word World
- ***Language Skills***
  - Martha Speaks
  - Reading Rainbow
  - WordGirl
- ***Prosocial Programs***
  - Arthur & Friends
  - Clifford the Big Red Dog
  - Franklin
- ***General Learning Skills***
  - Barney & Friends
  - Blue's Clues
  - Curious George
  - Dora the Explorer
  - Go Diego Go
  - Sesame Street

Fig. 7.1 Program titles grouped by key factors

7.4 The Present Study

A comprehensive content analysis of preschool programming was conducted to examine whether strategies known to be effective in other educational settings were embedded into preschool content, and whether such strategies were embedded taking into consideration the most appropriate strategies for the target audience. Given that preschool children spend so much of their free time with media, it is important to understand which aspects of program structure and which content features facilitate children's language learning and emerging literacy skills, and then to apply that knowledge to the production of high quality television programming. One necessary step in this process is to document the distributions of various strategies known to promote young children's language and literacy development (in live contexts) currently embedded in language-based and non-language-based television programming for preschoolers, as well as the manner in which these strategies are presented. Justice and Ezell (2004) explain that children must be exposed to a skill in a variety of contexts in order for a lesson to be successful. Exposure to content presented in different ways and through different modalities (e.g., through song, visuals, direct experience, etc.) supports young children's comprehension and application of new knowledge and skills (Lawhon & Cobb, 2002). Television programs have the potential to be one of the many contexts that contribute to literacy development if they present language- and literacy-promoting skills in a manner that encourages and facilitates learning (Lawhon & Cobb, 2002).

7.5 Method

7.5.1 Sample

Two episodes from each of the 15 series were randomly selected for inclusion in our final sample of 30 videos.

7.5.2 Content Coding

Each episode was coded first for pace (see Goodrich, Pempek, & Calvert, 2009). In this step, each of the 30 episodes was separated into discreet scenes to be used as the unit of analysis. Based on the pace coding scheme developed by Wright and colleagues (1984), a scene change was coded for each change in physical location where some action took place. If a scene was not considered part of the program content (e.g., credits, disclaimers, advertisement), it was coded as "other," not coded for instructional strategies and interactional quality, and not included in analyses. More information about pace coding is available in Goodrich et al. (2009). Each remaining discrete program scene was then coded for the presence of specific instructional strategies. Each code was applied only once in a given scene when that instructional strategy was featured in a scene (i.e., codes reflect the presence or absence of that code in the scene). Thus, strategies were only coded once per scene regardless of the number of times the strategy may have been featured in the scene (e.g., if multiple words were defined during one scene, only one vocabulary definition code would be applied to the scene). Definitions of each code are presented in Table 7.1.

7.5.2.1 Reliability

For ease of coding, the individual codes were grouped into multiple coding schemes. Each of the 30 episodes went through five separate coding "passes" (i.e., learning strategies, language-promoting strategies, parent–child interaction, executive function, scaffolding, and joint attention). Two coders coded all of the videos. Each coder served as the "primary coder" on several passes (i.e., coded all of the episodes for a pass), while serving as the reliability coder on the other passes. Inter-rater reliability was established by double coding 20 % of videos in each pass. Kappa values for double-coded episodes ranged from 0.68 to 1.0, and the mean value was 0.83 reflecting high inter-rater reliability.

7.5.3 Analytical Approach

All individual codes were subjected to a series of factor analyses based on a priori categories. Specifically, three factor analyses were conducted based on: (1) strategies related to cognition and language; (2) strategies related to literacy skills; and (3) strategies related to character interactions. The resulting analyses yielded 11 factors, described in Table 7.1. *The cognition and language analysis* yielded the factors of person cognition, object cognition, questions, and conversation building. Two codes, verbal definitions and mislabeling, loaded on the final (conversation building) factor. Both of these codes occurred infrequently compared to other codes and were more likely to co-occur in the same programs despite one code representing a positive strategy and the other a negative strategy; this factor will be described in further detail in the results. *The literacy analysis* resulted in three separate factors: integrated onscreen print, techniques and forms of onscreen print, and isolated onscreen print. *The character interaction analysis* resulted in three factors: peer interactions, peer modeling, and adult interactions. In addition to these three primary constructs, three other structural features of the programs were examined: scene type, scene repetition, and scene context. These are also described in Table 7.1.

To create the composite factors, the presence of strategies per scene was summed. As a consequence, it is possible for the number of strategies per scene to be greater than the number of available scenes. Each instance where this occurred is highlighted in the results tables. For instance, conversation building strategies occurred in 81.05 interactive narrative scenes, whereas interactive narratives averaged just 35.63 scenes. This means that, on average, 2.28 conversation building strategies were used per scene in these programs.

Next, repeated measures ANCOVAs were computed to examine (1) the relations among each of the factors comprising the three educational content areas (i.e., language/

Table 7.1 Codes and definitions for factors within categories of cognition and language instructional strategies, onscreen print and literacy instructional strategies, character interactions, and cognitive instructional support. A factor analysis yielded 11 factors.

Factors	Cognition and language instructional strategies
Questions	Coded whenever questions were asked between characters and/or narrators. Includes "wh" questions (i.e., open-ended questions like "where" and "why") and "yes/no" questions (i.e., closed-ended questions that can be answered by a simple yes or no).
Conversation building strategies	1. *Matched labeling objects/actions* was coded whenever the name of an object or action was presented onscreen. Simple matched labels were coded whenever an object or action was named using one word (e.g., "ball"). Descriptive/Elaborative matched labels were more detailed (e.g., "This is a red ball"). 2. *Prefacing* was coded when any language or language and visual presentation was used to preface the upcoming educational content (e.g., sequencing words such as next, then; predicting statements [e.g., I wonder what we're going to do next]). 3. *Summary* was coded for any language and/or visual presentation that provided a simple summary or restatement of relevant prior knowledge that learners had learned in a previous lesson. 4. *Praise and reinforcement* was coded when a character praised or commented positively about or to the audience or another character (e.g., "You are working hard"). 5. *Proto-conversational strategies* was coded when a character looked directly at the viewer and spoke or asked a question, or if the narrator asked a question. Time to respond (i.e., a pause of at least 2 s for the viewer to respond) and contingent feedback (e.g., "That's a great answer; I was thinking of...") were also coded.
Person cognition	1. *Problem solving* was coded when the character/narrator showed or verbalized the steps viewers can take to solve the problem themselves. 2. *Comparisons or similarities and contrasts* was coded when any language/ or visual presentation was used to provide a framework or schema for new learning by comparing a similar known entity to it. This code also included antonyms (e.g., a tree is not a flower) and opposites. 3. *Persistence* was coded when a character showed persistence in attempting to complete a task, or willingness to continue a task in the face of discouragement or challenges, to overcome frustration, to try again after experiencing failure, and to take risks when trying something novel.
Object cognition	1. *Pretense with implicit transformation of object, space or character* was coded when transformation occurred without explicit statement of pretense (e.g., child pretends to "drive a bus" (space); characters taken to another place, e.g., *Dragon Tales* to Dragonland (space); child dresses up as a princess but no verbal information about pretend play roles (character)). 2. *Pretense with explicit verbal transformation of object, space, or character* was coded for explicitly stated transformations (e.g., "We can pretend these rocks are chairs" (object); "Let's pretend this is a bank" (space)). 3. *Orienting to objects* was coded when attention-directing words/phrases (e.g., "See.") were used by the character/narrator, when visual production techniques (e.g., close-up) were used to elicit attention, or when the object moved by itself (e.g., print moving itself to attract attention). 4. *Perspective taking* was coded when characters showed evidence of taking the perspective/recognizing the point of view of others, including recognizing others' desires and intentions.

(continued)

Table 7.1 (continued)

Factors	Cognition and language instructional strategies
Defining and mislabeling	1. *Verbal vocabulary definition* was coded when the meaning of a word was explicitly provided. 2. *Mismatched labels* were coded when the label offered was not a clear indication of what the image or action depicted, or if labels and images were not in sync (i.e., they did not appear in the program at the same time).
Factors	Onscreen print and literacy instructional strategies
Integrated onscreen print	1. *Environmental print* was coded when there was a clear visual focus on print that was physically displayed in the environment, and/or characters interacted with the print in some way (e.g., child wearing a shirt with writing on it). 2. *Print onscreen with visual and verbal referent* was coded when single words, numbers, and phrases were onscreen with a visual referent (a depiction of the referenced object or action) and verbal referent (print is spoken aloud). 3. *Onscreen print center of screen* was coded whenever print was centered on the horizontal axis and in the middle third of the screen vertically. 4. *Onscreen print font* was coded every time print was presented onscreen (excluding credits and environmental print). The codes for all capital letters, and capital letter followed by lowercase, loaded on this factor. 5. *Alphabet/letter identification* was coded when a character or narrator specifically named a letter (e.g., "This is the letter W") or recited the letters of the alphabet in sequential order. 6. *Spelling* was coded when a character or narrator verbally spelled out the letters in a word or phrase (in some instances accompanied by the onscreen letters).
Techniques and forms of onscreen print	1. *Print visual technique* was coded when a visual technique accompanied print onscreen and was used to draw attention to the font including print movement (e.g., print flies across the screen on its own—not directed by a character) and visual production technique (e.g., print flashes or is highlighted). 2. *Onscreen print font* was coded for type of font used. All-lowercase or other inappropriate font (font that did not resemble the way children would learn to write in school, e.g., mixed up capitals, indecipherable font choice, or typeface letters like "a" and "g") loaded on this factor. 3. *Phoneme letters and sounds code* was coded when specific letter sounds or parts of words were emphasized by a character or narrator. 4. *Storybook* was coded when onscreen print was embedded within a storybook presented on the television.
Isolated onscreen print	This code was used when onscreen print was not accompanied by either a visual or verbal referent or it was accompanied by a visual referent but no verbal referent.
Factors	Quality of character interactions
Peer modeling	1. *Peer parallel play* was coded when a child was depicted as playing independently next to a peer and/or observing the peer's play behavior. 2. *Older child or peer active (direct) model* was coded when modeling was active (model aware and engaged with the at home viewer). 3. *Older child or peer passive model* was coded when modeling was passive (model unaware of viewer).

(continued)

Table 7.1 (continued)

Factors	Cognition and language instructional strategies
Peer interactions	1. *Peer cooperative active visual interaction* was coded when nonverbal cues indicated participation in a cooperative activity (e.g., a group of children playing soccer). 2. *Peer cooperative visual verbal interaction* was coded when interaction occurred with dialogue and nonverbal cues (e.g., children working together to solve a problem or reach a common goal). 3. *Peer uncooperative visual/visual verbal interaction* was coded when uncooperative verbal and nonverbal behaviors (e.g., shouting, arguing, aggression, and bullying) were present.
Adult interactions	1. *Adult active model* was coded when direct modeling was active (model aware and engaged with the at home viewer). 2. *Adult passive model* was coded when modeling was passive (model unaware of viewer). 3. *Adult monitoring* was coded when an adult in the scene was watching (but not just glancing) without interacting with the child. 4. *Adult passive interactions* was coded when an adult in the scene was uninterested but responsive to child requests and/or was shifting attention between the child and another activity. 5. *Adult active visual interaction* was coded when the content was portrayed visually, where the adult's primary focus was on the child and nonverbal cues indicated interactions beyond responsiveness (e.g., shared attention, close physical proximity). 6. *Adult active visual verbal interaction* was coded for verbal and visual interactions where the child was the primary focus of the adult and interactions went beyond responsiveness (e.g., verbal initiation, suggestions).
Scene level: Cognitive instructional support	
Scene type	Definition of scene: A scene is a physical location where some action takes place. 1. *New Scene* was scored for each new physical location shown (i.e., it had not appeared before in that episode of the program). A new scene was not coded if the "camera" shifted to another part of the same location (e.g., moved from one part of a room to another or zoomed in on one aspect of the room. 2. *Familiar Scene* was scored if the physical location had already appeared earlier in the program.
Repetition	*Repetition* was coded if the exact or similar content was repeated. It was scored if repetition occurred within scenes or across scenes (e.g., the same video clip is shown multiple times over the course of a video).
Context depicted in scene	The familiarity of each scene was scored on a scale of 1–3. 1. High familiar context—everyday setting, e.g., the home 2. Low familiar context—not everyday setting, e.g., outer space 3. No context—stage set

cognition, literacy, character interactions) as well as the cognitive instructional support associated with scenes (i.e., scene type, repetition, context) and (2) the interactions among the three educational content constructs and three scene structural features and each of the between-subjects factors: program structure, curriculum emphasis, and age-related differences. Tables 7.2, 7.3, 7.4, 7.5, and 7.6 provide

Table 7.2 Number of scenes with cognitive- and language-promoting strategies

Predictor	Total scenes[#]	Person cognition	Object cognition	Questions	Conversation building	Defining and mislabeling	Overall F
Overall	69.27	8.24[abc] (2.5)	24.87[ade] (6.3)	18.29[bfg] (2.9)	69.13[cdfh] (17.5)	19.18[egh] (1.9)	21.10***
Younger programs	59.50	9.16 (1.79)	25.64 (4.64)	14.88 (2.20)	79.61[1] (11.96)	3.87 (1.43)	20.22***
Older programs	83.92	5.12 (3.19)	20.22 (8.39)	24.09 (3.94)	37.01[1] (21.57)	6.71 (2.60)	
Traditional narrative	73.79	10.11 (2.51)	20.73 (6.49)	24.28[1] (2.80)	38.52[2] (10.26)	4.72 (1.99)	5.94***
Interactive narrative	35.63	5.77 (1.60)	19.38 (4.17)	9.09 (1.78)	81.06[23] (6.56)	3.71 (1.28)	
Hybrid/expository	95.00	3.23 (4.56)	28.79 (11.88)	13.68[1] (5.04)	46.55[3] (18.62)	4.28 (3.61)	
Code-related skills	53.67	7.51 (3.22)	41.38[12] (6.60)	10.79 (3.54)	49.38 (19.97)	2.42 (10.50)	3.40***
Language skills	91.33	5.48 (4.93)	37.81 (10.32)	21.83 (5.48)	44.75 (31.05)	10.50 (3.74)	
Prosocial skills	71.50	6.01 (3.86)	7.65[1] (8.08)	27.96 (4.29)	29.17 (24.31)	3.50 (2.93)	
General learning skills	64.92	37.07 (2.53)	18.57[2] (5.19)	15.52 (2.79)	102.51 (15.58)	4.87 (1.88)	
Arthur	128.00	3.33	9.60	34.94	33.02	4.74	
Barney	76.50	0.08	7.42	13.31	23.18	1.07	
Blue's Clues	17.00	0.37	10.73	9.84	53.45	4.44	
Between the Lions	63.00	0.69	2.39	7.31	17.89	0.06	
Curious George	57.50	16.33	5.35	15.18	31.86	1.04	
Clifford the Big Red Dog	48.00	4.85	12.24	17.81	19.78	2.64	

(continued)

Table 7.2 (continued)

Predictor	Total scenes[#]	Person cognition	Object cognition	Questions	Conversation building	Defining and mislabeling	Overall *F*
Dora the Explorer	33.50	5.16	6.97	7.74	90.85	1.68	
Go Diego Go	27.50	11.88	6.44	1.87	61.24	2.28	
Franklin	38.50	4.81	0.04	20.33	21.37	2.16	
Martha Speaks	109.50	6.79	4.16	29.78	38.87	14.67	
Reading Rainbow	63.00	4.10	31.00	9.83	46.56	7.43	
Sesame Street	177.50	9.05	80.05	20.59	94.43	4.44	
Super Why	64.50	2.52	71.27	9.09	65.53	1.55	
WordGirl	101.50	5.38	72.37	29.44	38.27	9.44	
Word World	33.50	10.28	26.90	10.12	38.22	1.88	

Note. Percentages in rows bearing the same superscript alphabet letter significantly differ at $p < 0.05$. Percentages in columns bearing the same superscript numeric value significantly differ at $p < 0.05$.

[#]Scenes in which the number of strategies is higher than the total scenes available occurs when there are more than one strategy per category found in each scene

***$p < 0.001$; **$p < 0.01$; *$p < 0.05$; $^{+}p < 0.10$

Table 7.3 Number of scenes with onscreen print and literacy-promoting strategies

Predictor	Total scenes[#]	Integrated onscreen Print	Techniques/forms of onscreen print	Isolated onscreen print	Overall F
Overall	69.27	29.99[ab] (7.97)	12.47[a] (4.78)	2.22[b] (0.55)	6.03**
Younger programs	59.50	27.85 (8.98)	8.63 (5.36)	2.20 (0.60)	0.56
Older programs	83.92	31.97 (15.52)	19.47 (9.23)	2.18 (1.09)	
Traditional narrative	73.79	38.81 (12.54)	7.75 (7.45)	3.54 (0.81)	1.29
Interactive narrative	35.63	6.95 (7.98)	5.06 (4.74)	0.39 (0.53)	
Hybrid/expository	95.00	48.45 (21.28)	33.16 (12.64)	2.47 (4.75)	
Code-related skills	53.67	72.67[123] (9.60)	41.91[123] (5.10)	2.20 (0.91)	5.57***
Language skills	91.33	26.94[1] (16.35)	4.74[1] (8.68)	3.65 (1.55)	
Prosocial skills	71.50	18.30[2] (12.80)	1.57[2] (6.79)	0.86 (1.22)	
General learning skills	64.92	8.50[3] (8.24)	1.43[3] (4.41)	0.78 (0.78)	
Arthur & Friends	128.00	48.00	1.92	0.38	
Barney & Friends	76.50	25.17	2.68	2.68	
Blue's Clues	17.00	0.02	0.02	0.02	
Between the Lions	63.00	54.56	73.84	2.02	
Curious George	57.50	4.37	0.86	1.84	
Clifford the Big Red Dog	48.00	11.18	0.05	8.06	
Dora the Explorer	33.50	2.71	0.47	0.03	
Go Diego Go	27.50	0.03	0.03	0.03	
Franklin	38.50	6.16	2.00	0.04	
Martha Speaks	109.50	19.27	1.75	2.52	
Reading Rainbow	63.00	34.27	7.56	2.33	
Sesame Street	177.50	53.43	12.43	0.18	
Super Why	64.50	45.02	35.73	2.97	
WordGirl	101.50	16.75	2.03	5.99	
Word World	33.50	83.68	20.74	1.54	

Note. Percentages in rows bearing the same superscript alphabet letter significantly differ at $p < 0.05$. Percentages in columns bearing the same superscript numeric value significantly differ at $p < 0.05$.

[#]Scenes in which the number of strategies is higher than the total scenes available occurs when there are more than one strategy per category found in each scene

***$p < 0.001$; **$p < 0.01$; *$p < 0.05$; $^{+}p < 0.10$

Table 7.4 Quality of character interactions and modeling

Predictor	Total scenes[#]	Adult interactions	Peer modeling	Peer interactions	Overall *F*
Overall	69.27	23.69[ab] (5.20)	7.48[bce] (1.80)	26.60[de] (3.74)	43.67***
Younger programs	59.50	23.44 (5.71)	8.09 (1.96)	26.78 (3.99)	2.39⁺
Older programs	83.92	21.65 (10.32)	5.12 (3.52)	23.08 (7.13)	
Traditional narrative	73.79	21.40 (7.97)	3.69[1] (2.29)	33.50 (5.61)	3.08*
Interactive narrative	35.63	18.24 (5.10)	2.74[12] (1.46)	14.54 (3.60)	
Hybrid/expository	95.00	23.94 (14.54)	24.42[12] (4.18)	20.43 (10.26)	
Code-related skills	53.67	5.80 (9.28)	2.79 (3.17)	32.36 (6.39)	2.25*
Language skills	91.33	19.82 (14.43)	2.37 (4.93)	16.44 (9.95)	
Prosocial skills	71.50	19.88 (11.30)	5.93 (3.86)	36.32 (7.79)	
General learning skills	64.92	34.67 (727)	11.95 (2.47)	21.55 (5.00)	
Arthur & Friends	128.00	28.29	11.65	49.92	
Barney & Friends	76.50	36.18	42.38	10.10	
Blue's Clues	17.00	26.98	0.73	1.51	
Between the Lions	63.00	13.29	4.66	14.62	
Curious George	57.50	35.48	3.22	7.02	
Clifford the Big Red Dog	48.00	8.30	1.39	32.06	
Dora the Explorer	33.50	2.28	2.01	22.41	
Go Diego Go	27.50	6.24	3.14	13.75	
Franklin	38.50	16.94	5.01	17.94	
Martha Speaks	109.50	41.17	3.50	35.04	
Reading Rainbow	63.00	4.66	2.02	1.32	
Sesame Street	177.50	41.00	48.99	85.73	
Super Why	64.50	10.64	5.93	24.12	
WordGirl	101.50	20.50	1.42	20.10	
Word World	33.50	0.03	0.03	34.04	

Note. Percentages in rows bearing the same superscript alphabet letter significantly differ at $p < 0.05$. Percentages in columns bearing the same superscript numeric value significantly differ at $p < 0.05$.

[#]Scenes in which the number of strategies is higher than the total scenes available occurs when there are more than one strategy per category found in each scene

***$p < 0.001$; **$p < 0.01$; *$p < 0.05$; ⁺$p < 0.10$

means, standard errors, interaction results, and pairwise comparisons. The overall sample size was small (30 episodes) and the sample programs split into each of the three between subjects-factors (target age, program structure and curriculum emphasis) was small (see Fig. 7.1). Cohen's d effect sizes were calculated to better estimate the size of the differences regardless of sample size in addition to statistical significance for all pairwise comparisons. These results are provided in Table 7.7. Effect sizes at or above small (i.e., ≥±0.20) are then discussed in the text.

Table 7.5 Scene type and scene repetition

Predictor	New scenes	Familiar scenes	Overall F	Repeat across	Repeat within	Overall F
Overall	42.47[a] (6.0)	26.80[a] (3.1)	10.44**	5.47[a] (1.52)	10.25[a] (1.45)	12.59***
Younger programs	37.2 (7.8)	22.3 (3.8)	0.04	6.43 (1.67)	10.77 (1.55)	0.04
Older programs	50.4 (9.5)	33.5 (4.7)		2.85 (2.85)	8.31 (2.69)	
Traditional narrative	40.4 (7.9)	33.4[1] (4.1)	5.36*	1.77[1] (1.99)	5.39[12] (1.92)	4.20*
Interactive narrative	21.6[1] (10.4)	14.0[1] (5.3)		6.91[12] (1.28)	7.66[1] (1.21)	
Hybrid/expository	66.9[1] (10.3)	28.1 (5.4)		5.70[2] (3.42)	20.14[2] (3.23)	
Code-related skills	29.3 (13.9)	24.3 (6.5)	0.66	3.54 (2.52)	6.17 (2.31)	0.17
Language skills	50.5 (13.9)	40.8 (6.5)		2.74 (4.29)	10.50 (3.93)	
Prosocial skills	46.2 (13.9)	25.3 (6.5)		1.50 (3.36)	5.43 (3.07)	
General learning skills	43.2 (9.7)	21.8 (4.6)		8.96 (2.14)	14.09 (2.01)	
Arthur & Friends	85.0	43.0		0.64	4.99	
Barney & Friends	45.5	31.0		0.08	18.13	
Blue's Clues	11.5	5.5		4.23	4.96	
Between the Lions	39.5	23.5		5.29	7.62	
Curious George	25.0	32.5		0.86	5.52	
Clifford the Big Red Dog	27.0	21.0		1.54	4.90	
Dora the Explorer	29.5	4.0		11.99	7.74	
Go Diego Go	11.5	16.0		3.14	3.14	
Franklin	26.5	12.0		1.00	3.35	
Martha Speaks	52.5	57.0		2.41	12.92	
Reading Rainbow	46.5	16.5		4.03	9.83	
Sesame Street	136.0	41.5		13.49	58.93	
Super Why	34.0	30.5		3.55	14.38	
WordGirl	52.5	49.0		0.51	7.00	
Word World	14.5	19.0		2.01	0.03	

Note. Percentages in rows bearing the same superscript alphabet letter significantly differ at $p < 0.05$. Percentages in columns bearing the same superscript numeric value significantly differ at $p < 0.05$.

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$; $^{+}p < 0.10$

Table 7.6 Context depicted within scenes

Predictor	Total scenes[#]	High familiar context	Low familiar context	No context	Overall F
Overall	69.27	25.91[ab] (2.56)	15.24[a] (1.94)	18.43[b] (1.87)	9.65***
Younger programs	59.50	24.93 (2.80)	13.33 (2.20)	7.79 (2.14)	0.95
Older programs	83.92	25.76 (4.78)	18.04 (3.86)	13.76 (3.69)	
Traditional narrative	73.79	32.91 (3.84)	15.94 (3.03)	7.23[1] (2.58)	4.10*
Interactive narrative	35.63	12.86 (2.42)	10.08 (1.92)	3.14[2] (1.64)	
Hybrid/expository	95.00	24.80 (6.46)	15.68 (5.13)	26.60[12] (4.37)	
Code-related skills	53.67	19.48 (4.56)	9.50 (3.49)	5.04[1] (3.38)	1.11
Language skills	91.33	28.86 (7.85)	22.01 (6.03)	27.67[12] (4.66)	
Prosocial skills	71.50	29.03 (6.15)	13.59 (4.72)	1.72[2] (3.65)	
General learning skills	64.92	25.45 (3.90)	15.97 (2.99)	9.74 (2.86)	
Arthur & Friends	128.00	49.15	32.38	2.94	
Barney & Friends	76.50	0.08	7.57	17.52	
Blue's Clues	17.00	10.95	2.21	0.77	
Between the Lions	63.00	6.99	11.59	3.34	
Curious George	57.50	27.20	18.57	2.47	
Clifford the Big Red Dog	48.00	20.93	9.02	2.40	
Dora the Explorer	33.50	11.69	12.70	3.05	
Go Diego Go	27.50	3.96	10.84	2.50	
Franklin	38.50	15.25	0.04	0.04	
Martha Speaks	109.50	54.86	32.08	10.18	
Reading Rainbow	63.00	12.10	14.11	27.66	
Sesame Street	177.50	75.97	26.98	71.00	
Super Why	64.50	19.67	14.71	8.00	
WordGirl	101.50	25.98	20.91	38.16	
Word World	33.50	0.03	0.03	3.48	

Note. Percentages in rows bearing the same superscript alphabet letter significantly differ at $p < 0.05$. Percentages in columns bearing the same superscript numeric value significantly differ at $p < 0.05$.

[#]Scenes in which the number of strategies is higher than the total scenes available occurs when there are more than one strategy per category found in each scene

***$p < 0.001$; **$p < 0.01$; *$p < 0.05$; $^{+}p < 0.10$

7.6 Results

7.6.1 Overall Patterns

Cognition/Language Strategies. Five factors comprised the cognition/language strategies. Overall, conversation building strategies were used most frequently; that is, 69.13 of 69.27 scenes contained at least one conversation building strategy. Object cognition strategies were used in 24.87 scenes followed by questions (18.29

scenes) and person cognition strategies (8.24 scenes). One factor was particularly low; providing appropriate definitions and mislabeling visual content with verbal labels occurred in just 4.92 scenes (see Table 7.2).

Onscreen Print and Literacy Strategies. Integrated onscreen print occurred in 29.99 scenes, followed by techniques and forms of onscreen print (12.47 scenes). Isolated onscreen print occurred in only 2.22 scenes (see Table 7.3).

Character Interactions. Both peer interactions and adult interactions were found in just over a third of all scenes (i.e., 26.60 and 23.69 scenes, respectively). Peer modeling occurred in 7.48 scenes (see Table 7.4).

Scene Type and Repetition. Scenes featuring new backdrops and settings were more frequent (42.47 scenes) than scenes depicting previously presented backdrops and settings (26.80 scenes). Repetition of content across scenes (10.25 scenes) was more frequent than repetition of content within scenes (5.47 scenes; see Table 7.5).

Scene Context. Most scenes featured backdrops and settings that would be highly familiar to young children such as the home (25.91 scenes) followed by low familiar context such as outer space (15.24 scenes) and no context/stage set (9.97 scenes; see Table 7.6).

7.6.2 Molar Components: Target Viewer Age

Cognition/Language Strategies. Programs targeting younger children contained more person cognition (9.16 scenes), object cognition (25.64 scenes), and conversation building strategies (79.61 scenes) when compared with programs targeting older children (5.12, 20.22, and 37.02 scenes, respectively). Questions were slightly more frequent in programs targeting older children (older = 24.09 scenes; younger = 14.88 scenes). Defining and mislabeling occurred similarly across programs targeting younger and older children.

Onscreen Print and Literacy Strategies. Programs targeting younger children featured similar levels of isolated onscreen print (younger = 2.20 scenes; older = 2.18 scenes) whereas techniques and forms of onscreen print were higher in programs targeting older children (19.47 scenes) versus programs targeting younger children (8.63 scenes). Integrated onscreen print did not differ significantly by target age (younger = 27.85 scenes; older = 31.97 scenes).

Character Interactions. All character interactions occurred more frequently in programs targeting younger children (adult interactions = 23.44 scenes; peer modeling = 8.09 scenes; peer interactions = 26.78 scenes) versus programs targeting older children (adult interactions = 21.65 scenes; peer modeling = 5.12 scenes; peer interactions = 23.08 scenes).

Table 7.7 Effect sizes for all pairwise comparisons across all factors

		Age	Program structure			Curriculum emphasis					
	Factor	Young v. old	Trad v. Int	Trad v. Hyb	Int v. Hyb	Code v. Lang	Code v. ProS	Code v. Gen	Lang v. ProS	Lang v. Gen	ProS v. Gen
Interactions	Adult interactions	0.34	−0.58	0.10	0.66	0.29	−0.46	−1.13	−0.17	−0.87	−0.70
	Combo interactions	0.45	0.24	0.05	−0.19	0	−0.94	−0.25	−1.00	−0.31	0.66
	Peer modeling	0.55	−0.24	−1.83	−1.60	0.21	−0.25	−1.03	−0.47	−1.27	−0.81
	Peer interactions	0.63	0.17	0.86	0.70	1.66	0.37	1.05	−1.35	−0.60	0.70
Cognition and language	Person cognition	0.75	−0.21	0.83	0.85	0.63	0.44	−3.29	−0.20	−4.03	−3.84
	Object cognition	0.58	−0.84	−0.07	0.75	1.35	2.51	1.81	1.22	0.49	−0.68
	Asking questions	−0.24	0.55	1.34	0.81	−0.27	−1.35	−0.26	−1.13	0	1.09
	Conversation building	1.07	−3.53	0.06	3.55	0.54	0.64	−0.82	0.11	−1.39	−1.47
	Defining/mislabeling	−0.15	−0.41	0.19	0.60	−0.86	−0.18	−0.44	0.72	0.42	−0.27
Literacy	Integrated OP	0.14	0.55	0.03	−0.53	2.66	2.74	2.95	0.10	0.40	0.30
	Techniques OP	−0.24	−0.10	−0.68	−0.59	3.43	3.57	3.43	0.14	0.14	0
	Isolated OP	0.26	0.93	0.55	−0.38	0.03	0.76	0.74	1.07	0.71	0

		Age	Program structure			Curriculum emphasis					
	Factor	Young v. old	Trad v. Int	Trad v. Hyb	Int v. Hyb	Code v. Lang	Code v. ProS	Code v. Gen	Lang v. ProS	Lang v. Gen	ProS v. Gen
Scene type	New scenes	−0.41	0.66	−0.96	−1.65	−0.69	−0.55	−0.44	3.09	0.23	0.09
	Familiar scenes	−0.72	1.34	0.36	−1.00	−1.11	−0.07	0.16	0.41	1.26	0.23
Scene repeats	Repeat within	0.65	−1.76	−0.37	1.41	0.35	0.43	−0.67	0.09	−1.00	−1.08
	Repeat across	0.77	−1.54	−1.50	0.03	0	0.41	−1.04	0.41	−1.01	−1.40
Scene context	High context	0.58	0.46	1.00	0.56	0.25	−0.22	−0.15	−0.47	−0.39	0.07
	Low context	0.06	−0.46	0.35	0.83	−0.44	−0.09	−0.46	0.35	−0.03	−0.37
	No context	−0.22	0.08	−1.46	−1.58	−1.63	0.55	−0.39	2.45	1.12	−0.92
Effect sizes:			Program Structure:			Curriculum Emphasis					
Trivial	−0.19 to 0.19		Trad = Traditional narrative			Code = Code-related skills					
Small	±0.20 to ±0.49		Int = Interactive narrative			Lang = Language-related skills					
Medium	±0.50 to ±0.79		Hyb = Hybrid/expository			ProS = Prosocial skills					
Large	≥±0.80					Gen = General learning skills					

Scene Type and Repetition. Programs targeting younger children had significantly fewer overall scenes (familiar scenes = 22.3; new scenes = 37.2) when compared with programs targeting older children (33.5 and 50.4 scenes, respectively). Both repetition types occurred more frequently in programs targeting younger children (within = 6.43 scenes; across = 10.77 scenes) when compared with programs targeting older children (within = 2.85 scenes; across = 8.31 scenes).

Scene Context. There were no significant differences in scene contexts across different ages.

7.6.3 Molar Components: Program Structure

Cognition/Language Strategies. Cognition/language strategies varied by program structure. Person cognition strategies were most frequent in both narrative types (traditional = 10.11 scenes; interactive = 5.77 scenes) when compared with hybrid/expositories (3.23 scenes). Object cognition strategies were highest in hybrid/expositories (28.79 scenes) when compared with traditional narratives (20.73 scenes) and interactive narratives (19.38 scenes). Questions were found most frequently in traditional narratives (24.28 scenes) followed by hybrid/expositories (13.68 scenes) and interactive narratives (9.09 scenes). Conversation building strategies were highest in interactive narratives (81.06 scenes) compared to both hybrid/expositories (46.55 scenes) and traditional narratives (38.52 scenes). Defining concepts and mislabeling objects occurred most frequently in traditional narratives (4.72 scenes) when compared with both hybrid/expositories (4.28 scenes) and interactive narratives (3.71 scenes).

Onscreen Print and Literacy Strategies. Literacy strategies varied by program structure. The use of integrated onscreen print was lowest in interactive narratives (6.95 scenes) when compared with both traditional narratives (38.81 scenes) and hybrid/expositories (48.45 scenes). The use of specific techniques and forms of onscreen print was highest in hybrid/expositories (33.16 scenes) compared with both traditional (7.75 scenes) and interactive narratives (5.06 scenes). Finally, although occurring rarely, isolated onscreen print occurred most frequently in traditional narratives (3.54 scenes) versus interactive narratives (0.39 scenes) and hybrid/expositories (2.47 scenes).

Character Interactions. Character interactions differed by program structure. Adult interactions occurred similarly across interactive narratives (18.24 scenes) when compared with both traditional narrative (21.40 scenes) and hybrid/expositories (23.94 scenes). Peer modeling occurred more frequently in hybrid/expositories (24.42 scenes) when compared with traditional (3.69 scenes) and interactive narratives (2.74 scenes). Finally, traditional narratives contained significantly more peer interactions (33.05 scenes) when compared with hybrid/expositories (20.43 scenes) and interactive narratives (14.54 scenes).

Scene Type and Repetition. Scene type varied significantly by program structure. Interactive narratives had significantly fewer overall scenes (familiar scenes = 21.6; new scenes = 14.0) when compared with both traditional narratives (40.4 and 33.4 scenes, respectively) and hybrid/expositories (66.9 and 28.1 scenes, respectively). Scene repetition also varied by program structure. Interactive narratives used the most overall repetition (6.91 scenes repeated the same content within a scene and 7.66 scenes contained content repeated in other scenes). Hybrid/expositories most frequently repeated the same content within scenes (20.14 scenes) with little repetition across scenes (5.70 scenes). Traditional narratives followed a similar pattern as hybrid/expositories although at much lower levels (5.39 scenes repeated content within scenes; 1.77 scenes repeated the same content across scenes).

Scene Context. High familiarity and low familiarity scene context did not differ by program structure. Hybrid/expositories were more likely to feature no context (26.60 scenes) when compared to traditional narratives (7.23 scenes) and interactive narratives (3.14 scenes).

7.6.4 Molar Components: Curriculum Emphasis

Cognition/Language Strategies. Person cognition strategies were most frequently used in general learning programs (37.07 scenes) when compared with code-based literacy programs (7.51 scenes), prosocial programs (6.01 scenes), and language programs (5.48 scenes). Object cognition strategies were highest in code-based literacy programs (41.38 scenes) versus language programs (37.81 scenes) and general learning programs (18.57 scenes). Prosocial programs contained just 7.65 scenes with object cognition strategies. Questions occurred most frequently in prosocial (27.96 scenes) and language (21.83 scenes) programs followed by general learning programs (15.52 scenes) and code-based literacy programs (10.79 scenes). Conversation building strategies were most frequently used in general learning programs (102.51 scenes). Code-based literacy programs (49.38 scenes) and language programs (44.75 scenes) used conversation building strategies similarly followed by prosocial programs (29.17 scenes). Finally, language programs (10.50 scenes) defined concepts and mislabeled objects more frequently than general learning programs (4.87 scenes), prosocial programs (3.50 scenes), and code-based literacy programs (2.42 scenes).

Onscreen Print and Literacy Strategies. Both integrated onscreen print (72.67 scenes) and techniques and forms of onscreen print (41.91 scenes) were more frequently found in code-based literacy programs when compared with language programs (integrated = 26.94 scenes; techniques/forms = 4.74 scenes), prosocial programs (integrated = 18.30 scenes; techniques/forms = 1.57 scenes), and general learning programs (integrated = 8.50 scenes; techniques/forms = 1.43 scenes). Both code-based literacy programs (2.20 scenes) and language programs (3.65 scenes) featured isolated onscreen print similarly and at higher rates when compared with both prosocial programs (0.86 scenes) and general learning programs (0.78 scenes).

Character Interactions. Adult interactions occurred most frequently in general learning programs (34.67 scenes) versus prosocial programs (19.88 scenes) and language programs (19.82 scenes). Code-based literacy programs contained relatively few adult interactions (5.80 scenes). Peer modeling was highest in general learning programs (11.95 scenes) followed by prosocial programs (5.93 scenes), code-based literacy programs (2.79 scenes), and language programs (2.37 scenes). Peer interactions were highest in code-based literacy programs (32.36 scenes) and prosocial programs (36.32 scenes) when compared with both language programs (16.44 scenes) and general learning programs (21.55 scenes).

Scene Type and Repetition. New scenes were most prevalent in language programs (50.5 scenes), prosocial programs (46.2 scenes), and general learning programs (43.2 scenes) versus code-based literacy programs (29.3 scenes). Familiar scenes were highest in language programs (40.8 scenes) followed by code-based literacy programs (24.3 scenes), prosocial programs (25.3 scenes), and general learning programs (21.8 scenes). General learning programs used the most overall repetition (14.09 scenes repeated the same content within a scene and 8.96 scenes contained content repeated in other scenes). Code-based literacy programs (6.17 scenes), language programs (10.50 scenes), and prosocial programs (5.43 scenes) used repetition within scenes more frequently than across scenes (3.54, 2.74, and 1.50 scenes, respectively).

Scene Context. Scene context varied little by curriculum emphasis. Low familiarity contexts were more common in language (22.01 scenes) and general learning programs (15.97 scenes) although both prosocial programs (13.59 scenes) and code-based literacy programs (9.50 scenes) used slightly fewer low familiar context scenes. Language programs were much more likely to include scenes with no context (27.67 scenes). General learning programs included no context in 9.74 scenes, code-based literacy programs in 5.04 scenes and prosocial programs in 1.72 scenes.

7.7 Discussion

This comprehensive content analysis of preschool programming reveals a number of strengths of current programming as well as areas for growth. The approach taken was to examine strategies known to be effective in other educational settings as well as known developmental constraints and to apply this information to the analysis of content delivery. Specifically, molecular instructional strategies (cognition, language, literacy and the quality of character interactions) were examined alongside several molar features (target viewer age, program structure, and curriculum emphasis).

7.7.1 Molecular Components of Educational Television: Embedding Instructional Strategies

7.7.1.1 Cognitive Instructional Strategies

Recent research on the development of learning, memory, and higher order executive functioning skills indicates that during early childhood these skills emerge rapidly; however, the development of these skills places significant constraints on learning (Barr, 2013). Specifically, young children are highly sensitive to mismatched cues and to cognitive overload due to complexity or quantity of information. Significant gains occur when educational materials are presented by competent individuals and when this content is well-scaffolded with frequent opportunities for contingent responding. The current content analysis reflects how some producers of educational television have created curriculum that incorporates these new findings and considers these developmental constraints. Specifically, the introduction of the interactive narrative (e.g., *Blue's Clues*), where conversation building strategies were dramatically higher compared to traditional narratives or hybrid/expositories and where pseudo-contingent interactions were embedded, created opportunities for more naturalistic social interactions where language learning can occur.

On the other hand, levels of cognitive strategies to support the relatively fragile but rapidly emerging higher order executive functioning skills of young children were noticeably absent or infrequent in much of the preschool content. Specifically, factors that are associated with enhanced science, technology, engineering, and math skills (STEM skills), including problem-solving strategies or comparisons of physical similarities and differences, occurred infrequently. This may reflect the fact that the programs included in this content analysis were on-air in 2009 and 2010 when content was more focused on language and literacy skills, although shows that included a more general learning curriculum focus also included few instances of these strategies. Producers may want to consider the value of the televised medium for conveying such information especially taking advantage of the dynamic nature of television compared with the challenges that occur when such material is presented in static books (see Simcock, Garrity, & Barr, 2011 for a similar argument).

7.7.1.2 Literacy and Language Promoting Strategies

The last 40 years have seen a strong emphasis across developmental and educational fields on the importance of school readiness with a primary focus on language and literacy skills. To a certain extent that emphasis is reflected in the high quality embedding of code-related and language-promoting instructional strategies in this preschool educational content. Conversation building and integrated onscreen print and the inclusion of phonemic and letter identification strategies were used frequently and, for the most part, in ways consistent with best evidence-based educational practices. The cognitive and language instructional strategy of object cognition which included orientation, perspective-taking, and transformation of objects was also done consistently well across programs. In particular, literacy curriculum-based programs were highly effective. This is the overall good news. Surprisingly, however, defining vocabulary occurred infrequently. Vocabulary definitions tend to occur frequently and spontaneously during book reading (e.g., Lauricella, Barr, & Calvert, 2014) and are linked to better language development and conceptual understanding (Lonigan & Shanahan, 2009). Their low frequency in this set of programs, particularly given the research that indicates young children can learn new words effectively from television content (e.g., Linebarger, Moses, Garrity Liebeskind, & McMenamin, 2013; Rice & Woodsmall, 1988), is unfortunate. Mislabeling, or mismatching visual objects with verbal labels, was also found, a strategy that is problematic for novice language learners. These are two things that producers could actively change to enhance preschoolers' developing conceptual knowledge and language skills. The potential to expose children to less common yet sophisticated or rare vocabulary words, especially with the ability to visually and verbally define these words, is a strength of educational television, but is currently under-utilized.

7.7.1.3 Interactional Quality

Socio-cognitive strategies portraying prosocial interactions, persistence, or emotion regulation were also fewer in frequency than might be expected. Programs such as *Mr. Rogers* with a prosocial emphasis have been related to prosocial outcomes in preschoolers (Stein & Friedrich, 1972), and future programming should continue to build upon this success. Although prosocial depictions were low overall in the surveyed videos, the content included vignettes that depicted conflict and then prosocial resolution embedded within familiar contexts. That is, rather than depicting only positive interactions that would portray an unsustainable view of peer interactions, both positive and negative peer interactions were depicted as part of a typical narrative, showing that children fight but also showing how to negotiate and resolve conflict.

Since the time that the programs used in the present analysis aired, producers of educational media have begun to include more strategies aimed at increasing emotion regulation. Recent experimental research suggests that these strategies are effective. For example, preschoolers who watched Cookie Monster practice delaying gratification on *Sesame Street* were able to wait significantly longer during the "marshmallow task" (~12.5 min) when compared with preschoolers who watched an unrelated *Sesame Street* clip (~8 min; Gatewood & Linebarger, 2015). In addition to these specific socio-cognitive strategies, general character interaction levels in the present analysis are simply too low. Increasing interactions between adults and children and between peers will be an important vehicle to convey this complex socio-cognitive content. Embedding approaches to learning, persistence, and other metacognitive and theory of mind strategies is likely to show considerable growth in future content. Developmental scientists need to work harder to disseminate this research to media producers and parents.

7.7.2 *Molar Components of Educational Television: Target Viewer Age, Program Structure, and Curriculum Emphasis*

7.7.2.1 Target Viewer Age

For both older and younger children, the curriculum emphasis was relatively well developed via instructional strategies that promote language and cognitive development. For example, the content was embedded in high familiar or low familiar contexts for a high proportion of the scenes instead of more ambiguous no context settings. The pacing was also slower for programs directed at younger children. This is important because younger children process information more slowly than older children (e.g., Barr & Hayne, 2000; Rovee-Collier & Barr, 2010).

There were also a number of areas where producers could continue to improve program quality. Although content was presented in context in fewer and longer scenes for programs directed toward younger children, repetition of content occurred relatively infrequently. Producers have previously considered the relevance of repetition for younger viewers, demonstrating, for example, that repetition of the same episode of *Blue's Clues* across a week enhanced comprehension for the younger 3-year-old viewers (Anderson et al., 2000; Crawley et al., 1999). Producers of educational media for young children should look for more opportunities to build in repetition.

There were more conversation building and cognitive strategies embedded in content directed toward younger children, reflecting their cognitive and language competence and the explicit need to scaffold language development. Object orientation strategies were embedded particularly well in shows directed toward younger audiences using interactive narrative formats. There were also more adult interactions in shows directed toward younger children and more peer interactions in shows directed toward older children reflecting the shift in preferred playmates as a function of child age (Hartup, 1992).

Surprisingly, producers did not maximize the presence of either adult or peer interactions or modeling. In a previous content analysis of infant-directed programming (Fenstermacher et al., 2010) we found low levels of interactions (10 %); we predicted that the frequency of interactions would be much higher for preschool content, but it was not. Television provides an ideal medium to present quality interactions and both intervention studies (e.g., Barr, Brito, & Simcock, 2013; Pempek et al., 2010) and experimental studies (e.g., Barr, 2013; Barr, Muentener, & Garcia, 2007; Barr, Muentener, Garcia, Fujimoto, & Chavez, 2007) overwhelmingly indicate that young children can learn from televised models.

Furthermore, although print was well-integrated onscreen, overall levels of print for programs directed at younger children were high. Producers may have chosen this strategy in order to prepare children for print as well as to expand the target age range of the program, with the print content directed at older children viewing the show. The problem for younger children is that print content may be distracting and poorly comprehended and, for both of these reasons, may detract from learning other embedded content. Some evidence suggests that learning letter sounds in the absence of seeing letter names can benefit young children's letter sound knowledge although this may be limited to letter names that are more confusing or challenging (e.g., letters that do not contain the sound like "w" or two letters that co-occur and form one sound like "ph" = /f/; see Block & Duke, 2015). Other research suggests that additional details, like pop-ups, can detract from learning (Tare, Chiong, Ganea, & DeLoache, 2010). Because onscreen print often includes production techniques to highlight the print (e.g., growing/shrinking, highlight bars), it is possible that attending to the print or to the feature used to highlight that print might impair comprehension of key program content. Finally, research indicates that specific and developmentally inappropriate reading instruction at very young ages is associated with greater anxiety, lower self-esteem, and lower levels of engagement with print and book reading than waiting to introduce instruction until later ages (Hirsh-Pasek, Hyson, & Rescorla, 1990; Neuman & Roskos, 2005). One strategy that producers of educational media might consider is that addition of print could be added as an optional level so that the program would be available for a younger audience without the print component but for an older audience with the print component. This would work well in the context of newer technologies while maximizing repetition and familiarity of content for older children when learning more challenging print concepts.

7.7.2.2 Program Structure

Recent changes to programming structure allowed for the direct examination of structure and strategies in the current content analysis. Specifically, structure was examined as a function of traditional narrative v. expository/hybrid type shows alongside interactive narrative content. Interactive narrative programs had higher levels of peer and adult interactions but lower levels of both peer and adult modeling than either traditional narrative or expository structures. Interactive narrative shows also had significantly higher levels of conversation building strategies than other program structures with much less onscreen print. Traditional narrative and expository/hybrid shows included more integrated print and code-related information. Traditional narrative shows also included more peer than adult interactions. Overall, the expository/hybrid shows included the most scenes; however, repetition across scenes to enhance learning of the content was frequent, whereas interactive narrative scenes had fewer scenes, and traditional narratives were intermediate between the two.

Although the proportion of mislabeling and definition of vocabulary terms was very low overall, this category occurred most frequently in the traditional narrative programs. This combination of mislabeling and lack of vocabulary definitions interferes with comprehension because they both make it difficult for children to map an object to its referent (Fisch, McCann Brown, & Cohen, 2001) and increase information processing demands on preschoolers (Fisch, 2004; Linebarger & Piotrowski, 2010).

7.7.2.3 Curriculum Emphasis

The curriculum focus of each program to a certain extent results in significant curriculum-associated strengths. *Code-related programs* (*Between the Lions*, *WordGirl*, *Super Why*) present literacy information using the best instructional strategies. They include high levels of object cognition to map objects to language, integrated print to link print to objects and language, and peer interactions to enhance attentional engagement. These shows are also balanced in terms of new and familiar scenes, suggesting that they are building in frequent repetition of content. *Language-promoting programs* are typically narrative driven and include high levels of conversation building strategies and maximized matched labeling and a limited number of cognitive strategies. Together this combination of strategies and structure supports language and vocabulary growth. Unfortunately, these programs typically failed to build in prefacing, summarizing, and pausing, which would significantly contribute to the curriculum emphasis. As mentioned above, definitions of vocabulary were infrequent across all programs surveyed. The levels of conversation building and labeling were not higher than general learning programs. In addition, general learning programs included more and higher level cognitive strategies. It is possible that if language growth was specifically compared between these types of curricula there would be no difference or even an advantage for general learning programs in language outcomes. Overall, the combination of a general learning curriculum and interactive narrative formats used by programs like *Blue's Clues*, *Dora the Explorer*, *Super Why* and *Go Diego Go* resulted in the best combination of language-promoting strategies (Table 7.8).

Table 7.8 Pros and cons of preschool educational content design

	Pros	Cons
Cognitive strategies	Programs included repetition both within and across scenes and included some imaginative play strategies.	Programs included limited metacognitive or problem solving strategies.
Language strategies	Conversation building strategies were very well embedded, particularly in narrative interactive shows.	Vocabulary definitions were low and programs included mismatched labeling which is confusing.
Code-related literacy Strategies	Onscreen-print integration was consistently high and code-related skills particularly strong in literacy focus programs.	Overall levels of print for younger children were too high. Although infrequent, context-free print and mislabeling occurred.
Character interactional content	Quality adult and peer modeling and interactions were included.	The frequency of interactions was low.

(continued)

Table 7.8 (continued)

	Pros	Cons
Age factors	Scenes were longer and included contexts to help frame learning for younger children.	Scenes often included onscreen print that might distract younger audiences from the narrative.
Program structure	Programs included predominantly familiar or moderately familiar contexts.	Programs for younger children did not include more repetition within and across scenes.
Curriculum emphases	The curriculum goals for literacy (for code-related content) and for language-promoting (for general learning) were generally met.	Expository/hybrid content presented a large amount of information. Language-promoting shows were narrative driven but could have included additional language-promoting strategies.

7.7.3 Five Key Considerations for Parents and Producers

This content analysis provides important clues for parents when choosing educational content and new directions for producers to consider in creating this content.

For parents: selectively choose content.

1. *Look for curriculum emphasis.* Parents often find it difficult to select media content. Parents should examine curriculum emphasis (e.g., language-promoting), which producers should prominently provide (*PBSkids.org* is a good example).
2. *Examine the context*. Parents should pay attention to the familiarity and relevance of the content and context, particularly when choosing content for younger children. For younger children, highly familiar everyday contexts will be easiest to process.
3. *Pay attention to the speed and amount of information*. Programs developed for younger children have longer scenes which allow children more time to process information.
4. *Don't be afraid to repeat a viewing* if child seems to have missed content. Learning new content from media is challenging and repetition makes it more likely that children will pick up the new information the second time around.
5. *Look for shows that include frequent adult–child and peer-to-peer interactions*. For example, adult models can demonstrate new skills and positive peer-to-peer interactions such as conflict resolution can be modeled.

For producers: continue to incorporate the latest developmental science findings.

1. *Include developmental scientists* in the development of new media content.
2. As has already been done with games, *take advantage of availability of streaming options to level content*. For example, episodes of a program suitable for older children can be revised for younger children to include repetition of labels but fewer onscreen print integration segments. In the same way, interactive narrative clips may be added into existing content.

3. *Concretely depict and explicitly define words* to aid in program comprehension.
4. *Increase socio-cognitive and executive functioning content* including both STEM-relevant skills, like problem solving and identifying similarities, and socio-cognitive relevant information, like persistence and emotion regulation.
5. Continue to increase the amount of peer-to-peer and adult-to-child quality interactions depicted in program content.

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Chapter 8
Is Preschool Programming Educational?—Commentary on Chapter 7

Angela C. Santomero

I am often asked to speak to the question, "Is preschool programming educational?" As cited in this inspiring chapter, study after study has proven that, if created with the intent to teach and by utilizing the tenets of educational preschool curriculum, media can indeed have an immediate and lasting effect on education. Even still, parents want reassurance. Therefore, studies like this one by Linebarger, Brey, Fenstermacher, and Barr, 2016, Chap. 7 help to break down the questions and provide insight as to what makes educational television truly educational.

As a content creator, this chapter underscores what my team works on day in and day out to maximize the effect that our programs have on our audience. I utilize studies like this one that drill down and emphasize the basic issues of child development and learning as it relates to media, as my team and I continue to develop new content. As cited in this chapter, "While we know that quality programming can teach, we have a much weaker understanding precisely how they do so." My comments will reflect on the study presented in this chapter and give more context to the "how"—explaining the thoughtful production process we use to create programs that, we are proud to say, have been empirically proven to educate kids.

8.1 Key Learning Strategies and Curriculum Emphasis: Super WHY!

In developing any one of my series, the producers, writers, and researchers on the team sit down together to identify key learning strategies within a core curriculum that we are targeting. As the authors of this paper discuss, the learning strategies are "embedded within individual episodes." After choosing and writing a core curriculum

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we put that curriculum to the test within an individual episode. It is imperative that the goals of the series are directly translated to the media, or they will, of course, have no impact on the audience they wish to reach. Therefore the next step is critical. We carefully craft each episode of a new series, using the core curriculum, to ensure that the learning strategies are embedded within the story, rather than tacked on as an afterthought to meet educational standards. Having a background in child development and learning theory enables me to ensure that the learning is baked into the pie. It tastes delicious, but you should not see all the work that went into each individual bite. We know that the way preschoolers learn from media is to have the learning be inexplicably intertwined within the story. In other words, the curriculum has to occur on the story through line.

When setting out to create *Super WHY!*, our literacy-based preschool series on PBS, for example, our curriculum centered around the key reading skills as set forth by the National Reading Panel (NICHD, 2000): letter identification, word decoding, word encoding, reading comprehension and fluency, and in later seasons, we added vocabulary to go one step further in exploring definitions. In order to keep the reading curriculum and strategies embedded within the core of each episode, we realized it was imperative to have each character's superpower centered on a literacy skill. It was also important to have the characters jump directly and literally into storybooks, in every episode, to solve the problem at hand. In doing so, we surround preschoolers who are growing up in today's digital age, with print, as well as modeling the usefulness of books as a resource for life. In addition, some research indicates, kids who watch media or play with screens spend significantly less time reading (Comstock, 1991; MacBeth, 1996; Wright & Huston, 1995). What better way to use the influential nature of media than to celebrate books and show the adventures which are discovered inside?

Once we jump into a storybook, the characters are immediately on an adventure with the home viewer, using literacy-based superhero skills to find the solution to the problem of the day. Take, for instance, Super Why's "Three Little Pigs" episode. We chose this archetype as many kids already know the fairytale story, and as cited in the research, "being familiar with the content enhances learning." Kids watching are motivated to participate alongside the Super Readers on screen as we jump into the book, help find the word we need, and stop the big bad wolf from blowing down the pigs' houses. Our first obstacle on the adventure is to find the wolf. This requires us to build the word "wolf." In order to do this, preschoolers at home need to be actively involved to propel the storyline forward: they need to sing the alphabet with visuals (practicing letter identification), find the letters in the word "wolf" (letter identification), and read the word "wolf" (decoding). They also have a higher order understanding that the word "wolf" will help us find the wolf, based on the context of the story. As the episode continues, preschoolers at home experience and practice skills for a total of three problems that progress in level of difficulty towards decoding, encoding and comprehension. And ever since the introduction of a fifth Super Reader in Season Two, we also stop to define a vocabulary word that is integral to the story and necessary to propel the adventure forward. Each problem is an opportunity for game play, which in turn, enables the viewers at home to practice these skills. In addition to embedding the learning goals and strategies within each episode, we also have goals across the series as a whole. For example, with *Super WHY*, we make sure that kids will have the opportunity to practice both upper and lowercase letters across the series, as well as identify and read key words. In a summative evaluation of the series, it was determined, "Not only did children's early literacy skills demonstrate significant and sustained growth associated with watching *SUPER WHY!*, they also loved the program and it's characters. This high level of appeal suggests that SUPER WHY! has been successful in supporting learning in a highly engaging environment that is likely to maintain children's interest." (Linebarger, McMenamin, & Wainwright, 2009).

8.2 Character Interactional Quality and Social Competence: Daniel Tiger's Neighborhood

Another interesting point the authors discuss is that "social interactions, both observed and directly participated in, are key to fostering young children's developmental competencies." It was also determined how infrequently programs provide this rich and important area of development. Many shows have called themselves "socio emotional" when in fact, they are simply story-based. What we know about educational media is that a show with a strong socio emotional curriculum is able to move the needle and help kids learn important life strategies. As cited by the authors, "Programs such as 'Mister Rogers' Neighborhood, with a prosocial emphasis, have been related to prosocial outcomes in preschoolers" (Stein & Friedrich, 1972). When we set out to create *Daniel Tiger's Neighborhood*, we wanted to make sure that learning every aspect of Fred's curriculum was as sticky as learning to sing the ABC's. But how? What does it look like in a show format? In a nutshell, we utilized many of the learning strategies identified in this chapter. We start and end the show in a familiar environment of Daniel Tiger's home. As cited in the chapter, once kids are familiar and comfortable, they can relax and learn. Every episode, Daniel greets the home viewer, looking into the camera, with his signature "Hi, Neighbor!" In a similar process to the one described above with *Super WHY*, key producers, researchers and writers sit around and discuss ideas for emotional storylines that will meet preschoolers right where they are. For instance, we wanted to cover the issue of separation anxiety in young children. Our story centered on Daniel as he was going to school. Dad drops him off at school and Daniel begins to get upset. Dad kneels down to Daniel's level and sings to him, "Grownups come back." He gives Daniel a hug and explains that he will be back at the end of the day. Daniel then has that strategy in a little song that he can sing to himself, as needed. We show Daniel feeling better and better as the episode progresses and we even show Daniel helping a friend by singing his new strategy to her. Then, we show Dad come back, just as he said he would. When researching an early draft of this episode with preschoolers during our formative research process, we saw kids nearly in tears and on the edge of their seats! They were engaged, talking with Daniel, and feeling for him, but most importantly, they were learning these strategies and using them for themselves. Throughout our stories, we have Daniel stop and check in with the home viewer, to include them in his thinking process and emotional resonance. Because of this, kids at home are bonded with Daniel. They feel for him when he is sad, mad, has to go potty, or needs to try a new food. They celebrate with him when his dad comes back, they take a deep breath with him and count to four when they are mad, feel proud when they try banana smash and stop when he stops to remember to go potty. According to the New York Times article by Rasha Madkour, real children and parents are using these strategies to help them navigate their world. Madkour states, "Daniel Tiger teaches social skills discreetly—that is, he explicitly spells them out and the episodes feature multiple examples of those skills in use—and he's a peer model. Children tend to learn better from other children than from adults. It's one thing when your parents tell you to share; it's another when you hear it from a cast of characters who are as familiar as a friend. And so, Daniel Tiger has become a second language in our household."

8.3 Program Structure: The Importance of the Pause

Another area that the authors discuss is program structure. All of our shows, *Blue's Clues*, *Super WHY!*, *Daniel Tiger's Neighborhood*, *Creative Galaxy* and *Wishenpoof*, fall into the category of "multiple viewer participatory" which has "demonstrated increases in content comprehension and viewer interactions" (Crawley, Anderson, Wilder, Williams, & Santomero, 1999; Piotrowski, 2010). In addition, "learning effect sizes associated with interactive narratives tend to be larger than learning effect sizes associated with non-interactive narratives" (e.g. Linebarger & Walker, 2005). In the spirit of this chapter, I will take a deeper dive into what makes an interactive narrative structure work. For *Blue's Clues*, we set the bar in 1996 by pausing on television. This "pause" allowed for so many things to happen. The pause allowed preschoolers to stop.. collect their thoughts.. "listen" and digest. The pause allowed for Steve, our main character, to look to camera and ask a direct, explicit, preschool appropriate question and wait. The pause allowed preschoolers to talk with us. In a sense, the addition of the pause gave preschoolers a voice. And most importantly for our educational mission, the pause allowed preschoolers to actively practice the curriculum we set out to teach. The reason this format works so effectively is because preschoolers become aware of when they are going to get to participate, and in turn they pay more attention. In fact, with *Blue's Clues*, we saw preschoolers grow increasingly verbal as a half an hour episode continued on. They also became more confident and louder with their responses, as they watched the same episode for a week. Repetition, as discussed by the authors, is also a key component in learning theory. If used correctly, repetition in format or playing the same game more than once can help kids to feel comfortable and familiar and free up their brain to work harder, retain more information, and obtain mastery. Even the same joke gets funnier each time you tell it! It is no surprise that a working title for the *Blue's Clues* series was "The Mastery Show". Our goal was to have preschoolers not just learn what we show on the program but to actually master those skills and generalize to their learning in everyday life. For instance, in a research session, after watching an episode about shapes, one little girl stood up, pointed to a light switch and said, ‘Hey! That’s a rectangle!” We hoped that she pointed to shapes all around her environment for the rest of the day! *Super WHY* has adopted a similar style of active participation but with a different curricular goal of learning to read. Similarly, for *Creative Galaxy*, our creativity show for *Amazon Kids*, our mission for preschoolers to “use art to solve problems” uses the same interactive format—this time, our main character Arty looks to the home viewer for help in making art. Pausing while Arty is making crafts enables kids to create along with us, as we supply them with art vocabulary and ways to problem solve. Making and doing makes learning stick! For *Daniel Tiger’s Neighborhood*, the participatory model is less about game play and more about the emotional bond and empathy with Daniel which helps to ensure that our curriculum sticks. In *Wishenpoof*, our kid empowerment show for *Amazon Kids*, our goal is for kids to learn executive functioning skills as identified by Ellen Galinsky’s *Mind in the Making*. We use the active participatory format so our viewers will be invested in Bianca, learn from her and with her, and contribute to her solution. *Regardless of the curriculum goals, across all of our shows, the interactive tool is the same*.

8.4 My Recipe for an Educational Show

My mission statement when creating content for preschoolers has always been, “to empower, challenge, and build the self-esteem of preschoolers, all while making them laugh.” As a researcher at heart, I want to marry the very best preschool curriculum with a compelling story, characters you would want to be friends with and the formal features of television. In addition, borrowing from what Malcolm Gladwell said about *Blue’s Clues*, I want to make all of my shows “sticky.” The truth is, we as content creators can have the very best intentions, curriculum and vision; but if preschoolers do not want to watch that content, they are certainly not going to learn from it! When creating our shows we utilize a formative research process that tests the content with preschoolers at various stages in the development of the series. This enables us to make certain we are delivering the very best series that will meet the needs of our audience from an education and entertainment point of view. When choosing meaningful educational media for preschoolers, parents and future creators can and should look to the areas outlined by the Linebarger and colleagues. In a thumbnail, here is my recipe for a successful educational show that kids will WANT to watch:

- An age appropriate curriculum—that is needed in today’s society
- Embed the learning strategies on the story through line
- Create strong, relatable characters, that are not afraid to fail
- Use an interactive show format that incorporates the pause
- Have a strong passion and vision for the show

As the authors state, "Overall, the combination of a general learning curriculum and interactive narrative formats used by programs like *Blue's Clues* and *Super Why* result in the best combination of language promoting strategies." Thank you, Deborah Linebarger, Elizabeth Brey, Susan Fenstermacher, and Rachel Barr for bringing to light the key aspects for successful content, and for inspiring more wonderful educational programs for children.

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Chapter 9
Media Characters, Parasocial Relationships, and the Social Aspects of Children's Learning Across Media Platforms

Melissa N. Richards and Sandra L. Calvert

Amid today's electronically saturated world, childhood is a period of development that is crucial for learning both social and academic skills. Indeed, the foundational cognitive skills learned during the infant and toddler years may have a large impact on future scholastic success (Bryant, MacLean, Bradley, & Crossland, 1990; Wagner et al., 1997). Media characters and the affective bonds that children form with them while interacting with programs and apps on various media devices (e.g., televisions, touchscreen tablets, computers, robots, intelligent agents) hold unfilled promise as they influence the ways that children are learning in the digital age (Brunick, Putnam, McGarry, Richards, & Calvert, 2016).

Many parents, educators, and researchers recognize that the pathways for children's learning are changing. Early childhood is now filled with opportunities for informal learning in a twenty-first century world in which technologies permeate daily existence, with children under the age of 8 spending approximately 2 h with screens each day (Common Sense Media, 2013). Although there are vast opportunities for children and parents to learn from onscreen educational content, limitations in how well children learn from screen presentations compared to live presentations (i.e., the video deficit; Anderson & Pempek, 2005; Barr, 2013) have created challenges in this area. The solution to these problems may be rooted, in part, in the social presence that the technology is able to afford through media characters.

The following chapter examines the issues surrounding how children learn from media, with a specific focus on language and STEM (Science, Technology, Engineering, and Mathematics) subject areas. We will first describe the components

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that define *parasocial relationships*, i.e., the one-sided connections viewers form with media characters (Horton & Wohl, 1956). We then discuss theories and studies that emphasize the importance of social factors in learning of academic content. We turn particularly to the importance of parasocial interactions and parasocial relationships in these social foundations of learning, looking first at current common technologies in children's homes and then looking forward to future research directions as robotics and intelligent agents become more common in children's lives. Characters, we argue, are a key element of the transmedia spectrum that stay constant, and thus, are the hub of the wheel in children's media landscape and subsequent learning. In other words, the parasocial relationships that children form with characters can potentially unite a large number of media platforms, such as television, video, computers, iPads, robots, and intelligent agents.

9.1 What Is a Parasocial Relationship?

One of the first studies to thoroughly investigate the components of children's parasocial relationships was conducted by Bond and Calvert (2014), who surveyed parents about their children's favorite media characters. Researchers sent an online survey to parents with children between 6 months to 8 years old and asked them to describe their child's favorite media character and the child's feelings and behaviors toward the character. As seen in Fig. 9.1, factor analyses revealed that parents viewed certain characteristics as important in the development of parasocial relationships. Twelve survey questions comprised three factors with eigenvalues greater than 1.0. These were as follows: (1) *character personification* (six questions), e.g., does the favorite character have thoughts and emotions? (2) *attachment* (three questions), e.g., does the favorite character makes the child feel safe? and (3) *social realism* (three questions), e.g., does the child believe the favorite character is real? These three factors were used to conceptualize and operationalize the multidimensional nature of children's parasocial relationships with media characters.

Bond and Calvert (2014) also created a descriptive model of this parasocial relationship development among very young children that includes parasocial interac-

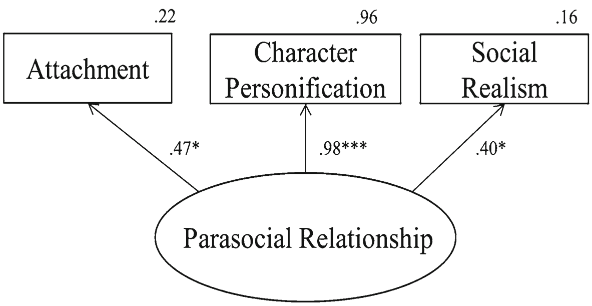

Fig. 9.1 Components of parasocial relationships (Bond & Calvert, 2014, used with permission of the *Journal of Children and Media*)

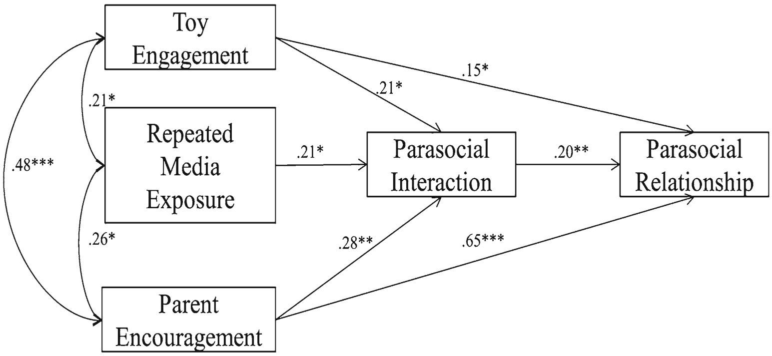

Fig. 9.2 Parasocial relationship development model (Bond & Calvert, 2014, used with permission of the *Journal of Children and Media*)

tions, media use, toy play, and parent scaffolding. *Parasocial interaction* behaviors included questions such as "how often does the child act out toward the screen, like waving or pointing?" *Parent encouragement* was measured with questions such as "I encourage my child to think that the [favorite character] has thoughts and emotions." Parents were asked about *repeated media exposure*, that is, how often children had been exposed to their favorite media character on a variety of media platforms over time. Finally, *toy engagement* was measured, that is, how often the child played with a toy version of their favorite media character and treated the toy as having humanlike needs, such as engaging in pretend caretaking behaviors.

The results from this study suggest that there are strong associations between parasocial relationships and parent encouragement, toy play, repeated media exposure across platforms, and parasocial interaction. Path analyses revealed that toy engagement and parent scaffolding were related directly to the formation of parasocial relationships (see Fig. 9.2). In fact, the strongest predictor in their model of parasocial relationship development was between parent scaffolding and the formation of the child's parasocial relationships. Toy engagement, repeated transmedia exposure, and parent scaffolding predicted parasocial interaction with the characters onscreen, with parasocial interaction then predicting parasocial relationships. Therefore, children's play with toys, repeated media exposure, and parent scaffolding leads to children's parasocial interactions, which in turn, is another pathway that is associated with the formation of children's parasocial relationships (Bond & Calvert, 2014). Two alternate models for the development of the parasocial relationship were also tested, with the current model depicted here remaining the best fit with the data (Bond & Calvert, 2014). Nevertheless, causality still cannot be determined given that data was collected at only one time point. Future research using longitudinal methods should be conducted to further explicate the directional nature of these pathways.

Although not tested in this model, a different potential pathway for the development of parasocial relationships is through watching characters' interactions with each other side by side (Calvert, 2015; Calvert & Richards, 2014), as takes place in social cognitive theory when children view social models onscreen (Bandura, 1977). This kind of interaction occurs when viewers watch two or more characters talk to each other and engage in behaviors with one another. Various studies have suggested that seeing characters talk to each other aids learning. For example, children were able to learn novel words just as well from watching two people interact with, hand over, and talk about an object onscreen as they did in person (O'Doherty et al., 2011). Therefore, children watching their favorite characters interact with other characters onscreen may be another pathway for the development of parasocial relationships and subsequent learning of new skills and facts.

Richards and Calvert (2014) adapted the parental survey of Bond and Calvert (2014) to be administered to children. Their factor analyses revealed similar conceptual categories of children's parasocial relationships with their favorite characters (i.e., *attachment and friendship*, *social realism*) from child report and earlier parent report data, with child and parent report accounting for approximately the same percentage of variance. However, children reported *humanlike needs* as a component of parasocial relationships. The authors speculated that this difference in the third factor was due to the concrete nature of children's reasoning given the strong link between findings in this child self-report study and behavioral findings of parasocial relationships in which children fed characters and tucked them in for a nap in prior behavioral research (Calvert, Richards, & Kent, 2014; Gola, Richards, Lauricella, & Calvert, 2013). Young children also strongly preferred characters that were the same gender as them, as has been found in prior research with older children (Calvert, Kotler, Zehnder, & Shockey, 2003).

In a follow-up study (Richards & Calvert, 2016), the child survey reports of children's parasocial relationships were compared to assessments made by their own parents. *Social realism, attachment, and character personification* (parents) or *attachment and friendship* (for their children), and *humanlike needs* emerged as factors among both parent and child reporters. Like their children, parents were overwhelmingly more likely to report their child's favorite character as the same gender as their child. Parent–child pairs, however, identified the same favorite character only 30 % of the time (Richards & Calvert, 2016).

In Hoffner's (1996) interviews of 7–12-year-old children about their relationships with their favorite media characters, children described how attractive, strong, humorous, prosocial/antisocial, and intelligent they found their favorite character to be. Children also answered questions about their relationship with the character, such as "[character] makes me feel comfortable" or "I feel sorry for [character] when he/she makes a mistake." Results revealed that a majority of boys and girls reported that their favorite character was the same gender as them. Intelligence was the most appealing trait the character had for boys, while attractiveness was the most important one for girls. Other researchers have also found that physical attractiveness was most important to girls when choosing a favorite character, yet physical strength was most important for boys (Reeves & Greenberg, 1977). Children also rated physically attractive characters as nicer than unattractive ones, especially at younger ages (e.g., 3–5-year-olds) (Hoffner & Cantor, 1985). Finally, 5–12-year-old children had stronger parasocial relationships with characters that they regarded as real (Rosaen & Dibble, 2008). Therefore, parasocial relationships among older children are also multidimensional and may be based on attractiveness, gender, social realism, intelligence, and strength, qualities that are somewhat different than those found for younger children.

9.2 Social Aspects of Learning

Learning is often grounded in social relationships and social interactions. Theorists such as Bandura proposed that children learn new behaviors through observing others as a model, and later use this information as a guide for how to act in future situations (Bandura, 1977). Similarly, Vygotsky believed that children learned new facts "only when the child is interacting with people in his environment and in cooperation with his peers" (Vygotsky, 1978, p. 35) in what he described as a *zone of proximal development*. This zone is the difference between the child's current skill level and the skill level that they are capable of reaching when they receive guidance from adults or highly capable peers. In Vygotsky's (1978) view, moving to the next knowledge level is not possible unless children have a social influence to aid their learning. Through a process called *scaffolding*, parents act similarly to tutors, helping their children solve problems gradually through the introduction of increasingly difficult steps (Wood, Bruner, & Ross, 1976). Thus, scaffolding by parents and caregivers is a crucial part of learning and moving forward to the next phase of knowledge acquisition.

Very young children often focus on interpersonal interaction and the nonverbal cues of adults (Baldwin, 2000). For instance, toddlers (18–20 months) who only heard an audio input of the name of an object had lower comprehension of the object name than toddlers who were accompanied by an adult who labeled and gazed at the object with the child (Baldwin et al., 1996). When focusing on STEM skills specifically, children also learn math and science better with help from adults. One study, for example, reported that fifth graders had higher math skills when they had parents with better scaffolding techniques than children who did not (Pratt, Green, MacVicar, & Bountrogianni, 1992). Thus, learning is a social process aided by skilled others.

Some researchers posit that learning from a screen has an essential social component (e.g., Richert, Robb, & Smith, 2011), and uses the same kinds of elements, such as observational learning, social interaction, and social meaningfulness, as is the case in face-to-face encounters. For instance, Reeves and Nass (1996) suggest that "individuals' interactions with computers, television, and new media are *fundamentally social and natural*, just like interactions in real life" (Reeves & Nass, 1996; p. 5). Consistent with this idea, the lack of social cues present in onscreen presentations may serve as one of the reasons why children are not able to learn as well from videos as they can from live presentations (Troseth, Saylor, & Archer, 2006). That is, video may not be able to provide social cues that are present in real life such as eye gaze, contingent responses, and pointing. Some have theorized that this lack of social information leads children to discount information that has been presented on screens, and hence they do not learn as well from them as they would from an active social partner (see Troseth, 2010).

We turn now to the role of social and parasocial relationships in the current technological environments where children live and learn. Then we examine the implications of future learning as robots and intelligent agents join the rapidly emerging plethora of technologies that are embedded in children's homes, schools, and everyday worlds. Children's parasocial relationships with media characters, we believe, have great possibilities for unifying their learning across media platforms.

9.3 Learning from Current Technologies in Children's Homes and Lives

Common Sense Media (2013) paints a very comprehensive picture of 0–8-year-old U.S. children's current media environments. In their national survey of contemporary U.S. children, parents reported that 96 % of their children had access to a television set (78 % with a DVD player and 28 % with a DVR), 76 % to a computer (with 69 % of those children having high speed Internet), 63 % to a smart phone, and 40 % to a tablet. Although mobile media access was particularly on the rise, viewing television programs, DVDs, and videos was the most common experience of young children. We link those technologies to our emerging knowledge of social learning from screens, including the literature on parasocial relationships.

9.3.1 Traditional Observational Media

The importance of incorporating social elements into traditional media has been demonstrated in experiments that directly manipulate the presence of social cues in video-based demonstrations. In one study, 2-year-old children saw a video of a person onscreen who provided directions for where to find a hidden object in the other room. Other children saw a live person in the room explain where to find the hidden object. As expected, children performed significantly better when the live person told them where the object was than when a person onscreen told them where it was (Troseth et al., 2006).

In a follow-up experiment using closed circuit television, some children saw the experimenter onscreen act in a responsive manner by, for instance, calling the child by name and talking about that child's siblings, pets, and favorite songs. Another group of toddlers saw a noncontingent, pretaped video where the experimenter called the toddler by the wrong name and talked about unfamiliar siblings and pets. Because the video demonstration was not perfectly contingent with the child's actions, those onscreen experimenters also did not respond immediately to the child's prompts. Children received the same instructions for where the toy was hidden through these two video presentations. Toddlers who saw the socially relevant interaction did significantly better in finding the toy than children who did not have the socially relevant interaction. In fact, children in the socially relevant video condition performed just as well as the children who interacted with a live person (Troseth et al., 2006).

Krcmar (2010) built on this concept, separating Troseth's idea of social relevancy into two parts—*social contingency* and *social meaningfulness*. Social meaningfulness is when children are familiar with and have experience with the objects and events on the screen (Krcmar, 2010), an idea consistent with the concept of parasocial relationships (Calvert & Richards, 2014). By contrast, social contingency is when these media characters and onscreen figures appear to reply to what the child says through the use of questions, program pauses, and comments, which is consistent with the idea of parasocial interaction (e.g., when *Dora the Explorer* asks viewers to respond aloud to her questions; Lauricella, Gola, & Calvert, 2011).

In order to investigate social meaningfulness and social contingency, Krcmar (2010) had either a mother or an unfamiliar experimenter demonstrate a series of actions. Some children saw the demonstrations in person, and others saw them onscreen. Krcmar found that between 13 and 20 months of age, children have difficulty imitating actions and learning words from a video compared to a live demonstration, as would be expected from the transfer deficit. Further analyses revealed that having the socially meaningful parent onscreen rather than a stranger onscreen helped these toddlers overcome the transfer deficit (Krcmar, 2010). Therefore, the *social meaningfulness* that was provided by a mother may help young children grasp onscreen information.

9.3.1.1 Social Contingency

Contingency is extremely important for child engagement. For example, Johnson, Slaughter, and Carey (1998) found that 12-month-olds were more likely to look at humans if they spoke and waved at the child. Additionally, children were more likely to look at objects if they contingently interacted toward them, that is, if they beeped and flashed lights (Johnson et al., 1998). In the world of media, beeping and flashing lights are perceptually salient production features that can facilitate contingency by creating orienting responses that get nonlooking children to attend to specific content (Calvert, 1988).

An example of social contingency that children may witness onscreen is a pseudo face-to-face interaction, as when the characters on the screen directly address children (Calvert & Richards, 2014). Often, a short pause is incorporated into the programming where the character will not say anything, as if waiting to respond to the child (Lauricella et al., 2011). Although there is not technically an interaction occurring, children may perceive that there is one taking place. This method cannot provide perfectly contingent feedback, yet it aids children's learning from the screen. For example, Calvert and colleagues found that children who were more active in their physical and verbal participation, such as pointing at the screen and replying to the character's queries, had higher comprehension of the program content (Calvert, Strong, Jacobs, & Conger, 2007). Therefore, children readily and actively engage in socially contingent interactions with onscreen media characters, and this may aid their learning.

Parasocial interaction may affect language learning as well. Kuhl, Tsao, and Liu (2003) examined different instructional methods for teaching 9-month-old infants Mandarin Chinese. Over the course of 4 weeks, children went to twelve, 25-min long sessions. One group of children watched a DVD of a native Mandarin speaker playing with a toy or reading a book, and another group played games or read books with the native speaker in person. Children in the video condition did not learn as well as children in the live condition (Kuhl et al., 2003). The authors argued that much of this difference was due to the lack of social cues and immediate contingency available to children who watched the DVD versus those who interacted with the speaker in person. This interpretation of the findings is bolstered by the fact that even seeing two people onscreen talk to one another onscreen in a contingent, reciprocal manner may be enough interaction to help children who are viewing the conversation onscreen learn novel words from their exchange (O'Doherty et al., 2011). Therefore, social contingency and parasocial interaction may be important for children's language development, perhaps by increasing their engagement with the onscreen person in some way.

9.3.1.2 Social Meaningfulness

Numerous studies have illustrated the importance of socially meaningful parasocial relationships in adulthood. For example, Eyal and Rubin (2003) found that college students who behave aggressively have higher wishful identification scores with aggressive characters (i.e., they want to be like that character), which is, in turn, moderated by the strength of the emotional parasocial relationship the person has formed with the characters. Kassing and Sanderson (2009) also found that adults had formed strong parasocial relationships with the professional cyclist Floyd Landis, even though they had probably never met him (Kassing & Sanderson, 2009).

Just like adults, children also form meaningful relationships with onscreen figures (Gleason, Sebanc, & Harp, 2000). These parasocial relationships and affective bonds children form with media characters are important to study during early childhood because they may have a large influence on children's behaviors and personal identity in the digital age (Hoffner, 2008; Meyer, 1973) and may have an enduring impact on children over time. For example, children who were "TV focused" and spent more time watching violent television at age 5 exhibited higher levels of aggression once they reached adolescence (Anderson, Huston, Schmitt, Linebarger, & Wright, 2001). Parasocial relationships are of crucial importance because there is a strong link between learning and the parasocial relationships that children form with the media characters who present the onscreen content (Calvert et al., 2014; Gola et al., 2013).

Children under the age of 2 are able to learn from the characters that they frequently watch onscreen. In one study, 21-month-olds saw a demonstration of the popular Elmo character from *Sesame Street* perform a seriation cup-nesting task (an early STEM skill) onscreen. Another group of children viewed the exact same demonstration, but instead of seeing Elmo, they saw a character unfamiliar to them named DoDo (a popular media character in Taiwan but unknown to U.S. children) perform the same seriation task. Both of the characters in these demonstrations were dubbed so that they spoke with the friendly, high-pitched childlike voice of Elmo. When children were given their own set of nesting cups to play with, children who watched Elmo were able to nest their own set of cups significantly better than children who saw DoDo nest the cups, and better than a control group who did not view a seriation demonstration. However, toddlers who saw DoDo perform the task did not perform any better than the no-exposure control group. The authors posited that children's meaningful relationship with the Elmo character facilitated their learning from his onscreen presentation (Lauricella et al., 2011).

A follow-up study was designed to build a parasocial relationship between the child and an unfamiliar media character. One group of children was introduced to a stuffed, plush toy version of the Taiwanese character DoDo at 18 months of age, and they played with him over the course of 3 months. In addition to the plush toy, children played with DoDo stickers, coloring books, a backpack, and were able to watch a short 10-min DVD featuring DoDo as he did familiar activities like jump in a puddle and enjoy his birthday party. The experimenters visited the child's home when he or she was 21 months old to show a new video of DoDo, this time performing the cup stacking seriation task. At age 21 months, another group of children, who were unfamiliar with DoDo, also saw the video demonstration, and a third group did not view a demonstration at all. All children then completed the cup-nesting task. The results indicated that children who had played with the DoDo character over the course of 3 months performed significantly better than the group who did not view a demonstration, while the group that was unfamiliar with the character did not perform significantly differently from the other two groups. Within the treatment condition that was exposed to DoDo for 3 months, toddlers who exhibited parasocial, nurturing behaviors with the DoDo plush toy during playtime, which are indicative of the *human needs* parasocial relationship factor discovered by child and parent reports (Richards & Calvert, 2014, 2016), had higher seriation scores than those who did not nurture the toy version of the character. The results suggested that parasocial relationships, even one that has been built over the course of only 3 months, are influential in helping very young children learn STEM skills from onscreen presentations (Gola et al., 2013).

A later study manipulated the toddlers' familiarization with personalized or nonpersonalized interactive toys over the course of 3 months (Calvert et al., 2014). All children in the treatment conditions received a plush puppy that was interactive and responded to the child when he or she pressed its paws. At 18 months of age, one group of children received a puppy that was personalized to the toddler: i.e., the toy called the child by name, was the same gender as the child, and was programmed to have the same favorite food, song, and color as the child. Another group of children received a puppy that was not personalized to them, i.e., the toy called the child by the nongeneric name "pal," was the opposite gender of the child, and had a different favorite food, song, and color as them (nonpersonalized condition). Each group played with their respective interactive toy for 3 months.

Table 9.1 Studies examining STEM learning from familiarized characters

	Study 1 (Lauricella et al., 2011)	Study 2 (Gola et al., 2013)	Study 3 (Calvert et al., 2014)
Pretreatment	None	One condition was familiarized with novel character DoDo puppet for 3 months before testing session	One condition was familiarized with novel personalized interactive character for 3 months before testing session
			One condition was familiarized with *non*-personalized novel interactive character for 3 months before testing session
Characters demonstrating STEM task onscreen	Elmo	DoDo	Personalized interactive character
	DoDo		Nonpersonalized interactive character
Results	Enhanced learning from meaningful Elmo character	Enhanced learning from DoDo puppet after familiarization with him when compared to a no exposure control group; child nurturing of character improves seriation scores	Enhanced learning from personalized interactive character when compared to no exposure control group; child nurturing of interactive personalized character improves seriation scores

At age 21 months, children saw a video of their respective character performing the cup stacking seriation task. Children in the personalized condition performed significantly better than the control group that did not view a demonstration, while the children in the nonpersonalized condition did not perform significantly differently from the other two groups. Within the personalized condition, children who demonstrated an increase in nurturing behaviors (an indicator of an emotionally tinged, parasocial relationship with the character) over time scored higher on the seriation task. The authors suggested that stronger parasocial relationships are fostered with characters who interact with children in ways that are consistent with children's interests, which subsequently leads to enhanced learning when the character presents content onscreen (Calvert et al., 2014). Table 9.1 depicts this line of studies.

Taken together, these studies documented the role of the emotionally engaging aspects of parasocial relationships for children's learning. Alternately, children may learn better from characters with whom they have parasocial relationships because children have a limited amount of cognitive processing power which is allocated to understanding who the character is, rather than to understanding the educational content (Lauricella et al., 2011). For instance, working memory is devoted not only to processing the narrative content of an onscreen presentation but also to processing the educational content (Fisch, 2000). When the child is familiar with a character onscreen and subsequently does not have to process who it is, additional working memory resources may also be freed up, allowing the child to understand the educational messages on the screen (Lauricella et al., 2011). By contrast, when the child does not know the character, precious resources may be spent trying to determine the identity of that character rather than processing the educational task. This problem may be particularly potent during the early years of life when attachment issues, such as fear of strangers, are prevalent.

9.3.2 Computers

The advent of computers has led to a plethora of online games that are interactive and that can respond contingently to children's actions, an important aspect of human interaction (Calvert, Strong, & Gallagher, 2005). Computers and other new technologies that allow children to be active learners may help children pick up information more readily than if they are observing information from a screen (Lauricella, Pempek, Barr, & Calvert, 2010). Computer games are also unique in that they are customizable and can feature characters that are seen on other media outlets such as television, thus providing another space in the transmedia spectrum in which children can access and play with the character in an interactive environment.

Lauricella et al. (2010) tested the effectiveness of the contingency that computers provide when children played with characters from *Nick Jr.'s Curious Buddies*. The experimenters worked with 30- and 36-month-old children and assigned them to one of three conditions. In one condition, the children saw stuffed versions of the Curious Buddies characters hiding in an adjacent playroom through a one-way mirror only once. Children in another condition saw the characters hiding on a screen in a representation of the playroom in a prerecorded video, which was repeated six times. Children in the third condition played the Curious Buddies game in an onscreen representation of the playroom in which children pressed a spacebar to make the characters pop out of their hiding places. Children watched the experimenter demonstrate the game once and then played with the interactive computer game themselves five times.

After children were exposed to the three respective demonstrations, all children then went in the adjacent playroom and searched for the characters that they had seen hidden on the screen or through the window. Children who played with the interactive video game or observed the characters hiding through a window were more likely to find the stuffed characters in the playroom than children who simply viewed the characters onscreen via a prerecorded video. In addition, attention to the observational video condition was lower than in the other groups. Therefore, interactivity of computers and increased engagement, as indexed by looking time, helped children grasp information that was presented to them onscreen by characters (Lauricella et al., 2010).

One component of interactivity is control (Rafaeli, 1988). Calvert et al. (2005) manipulated the amount of control that 4-year-old children had while playing a computer program. Specifically, children played with an online storybook that would display an audio or visual embellishment if the user rolled the mouse over an image (e.g., rolling the mouse over the image of a bird would make the bird move and chirping noises occurred). Children either watched the online storybook as an adult experimenter controlled the game with the mouse, they took turns with the adult experimenter in controlling the mouse, or the child completely controlled the mouse. Participants played the game four times over the course of two sessions. Children were much less attentive over time in the conditions where the adult controlled all or part of the game. The findings suggest that children become most immersed in online games when they can control the onscreen content.

9.3.3 Touchscreen Tablet Devices

Touchscreen tablets may provide cutting-edge learning opportunities for very young children. Tablets are highly interactive and are easy for children to manipulate with their limited motor skills (Chiong & Shuler, 2010). Mobile touchscreen devices also can be used at any time in any place, allowing children to connect with the characters that they see on these applications in a variety of settings (Shuler, 2009).

Applications (i.e., apps) that feature media characters that are available through other media outlets (e.g., television) have been effective in teaching children new skills. In one study, 3–7-year-olds showed enhanced vocabulary skills after playing *Martha Speaks: Dog Party App* for 2 weeks. This particular app taught children new vocabulary by playing mini-games and then having them take a quiz (Chiong & Shuler, 2010). Similarly, children who played with the literacy learning app *Super Why* for 2 weeks had significant gains in their generalized literacy skills such as rhyming and sentence completion (Chiong & Shuler, 2010). Therefore, well-designed apps featuring popular characters may act as efficacious teachers for very young children.

One thing that may contribute to these findings is the interactive nature of these iPad apps. In basic research without the use of screens, Bedford and colleagues found that 2-year-olds were able to learn the name of a word for a novel object through a live presentation if they were given contingent feedback on their correct and incorrect answers (Bedford et al., 2013). For example, the person may say "'Yes, this is the modi. What a nice modi!" Or "No, this is the modi. What a nice modi." Similarly, Moreno and Mayer (2005) found that feedback that gives an explanation for why a fact is correct aids in user learning from technology.

Although the research on touchscreens is just emerging, it appears that iPads hold strong promise in promoting children's learning from screens, due in large part to children's abilities to determine who is a credible source of information, even at very young ages. In a series of three experiments by Richards and Calvert (2015), 24- and 32-month-old children judged the credibility of information about familiar and afterward, novel fruit names presented on a touchscreen tablet by a meaningful (Elmo) and nonmeaningful (DoDo) media character. Depending on the condition, either the meaningful or nonmeaningful character accurately labeled the familiar fruits. Regardless of age, prior familiarity with the meaningful character, or corrective feedback provided by the tablet, children trusted the previously accurate character when they had to select the names of the novel fruits. The results suggest that knowledge conveyed by popular characters, with whom children are likely to form parasocial relationships, is discounted when the characters are incorrect. It also lends support to the thesis that children look at their relationship with these onscreen characters as horizontal—that is, viewing these characters as their friends—rather than as authoritative information sources that they find in vertical relationship with adults who are their teachers (Calvert, 2015; Richards & Calvert, 2015).

9.4 The Future of Parasocial Relationships: Robotics and Intelligent Agents

The literature on children's parasocial relationships with media characters is only beginning to emerge. What does the future hold as technologies continue to develop and enter the lives of young children? What will happen, for instance, when the perception of interaction with these characters is much more realistic and contingent on what children say and do through new developments in robotics and intelligent agents? What are the characteristics of these highly interactive platforms that make them lifelike to users and that may foster parasocial relationships? Will parasocial relationships matter, and if so, should popular media characters now begin to take on those new forms? Will children's perceptions of, and the impact of, parasocial relationships change as there is a shift from a one-way to an increasingly two-way contingent interaction? These are the questions that we address in the final section of this paper, as we look forward to an emerging world of interactive robots and intelligent agents that can respond (or who appear to respond) contingently to users. We will include studies of adults as well as children in this discussion for two reasons: (1) many of the studies focus on adults; and (2) adults appear to treat robots and intelligent agents in much the same way that children do (i.e., as humanlike with emotions and needs).

9.4.1 Robots

Just as children create relationships with media characters, so too may they create parasocial relationships with humanoid *robots*. Early developmental theorists such as Piaget noted that children personify nonhuman objects to make them more human and lifelike, a phenomenon known as animism (Piaget, 1929/2007). Animism is consistent with parasocial relationships in that children breathe life into previously nonresponsive objects (Calvert & Richards, 2014).

As robotic technologies develop and become more commonplace, children of the future may engage in more animism because their toys appear to be autonomous. For instance, children aged 34–50 months of age and 58–74 months of age were more likely to attribute lifelike qualities to an autonomous, robotic dog than a conventional stuffed dog (Kahn, Friedman, Perez-Granados, & Freier, 2006). In this study, children played with either a robotic dog or a stuffed dog, both of which were roughly the same size and color. The children attributed more autonomy to the robotic dog than to the stuffed dog; that is, they believed that the dog would do something (rather than just sit in place) if the experimenter hid the dog toy. Children who played with the electronic dog were more likely to be apprehensive around him (e.g., startled when he stood up, leading the child to back away), as well as expect reciprocity (e.g., children anticipated that the dog would respond when he or she put the toy ball in front of the dog). This type of expectation of contingent responding is similar to a component of social realism that parents identified when responding to the survey item: "When [character] acts out a behavior on screen (like dancing, singing, or playing a game), [child] believes that [character] is performing the behavior in real life" (Bond & Calvert, 2014; Richards & Calvert, 2016). Thus, belief that the robot can act out behaviors, and is doing it in real life in front of the child's eyes, may enhance children's scores in beliefs that the character portrayed in a robotic form is real.

By contrast, children who played with the stuffed dog were more likely to mistreat the toy (e.g., throw the dog across the room) as well as animate it (e.g., child makes dog hop over to pick up the toy ball) (Kahn et al., 2006). Overall, then, children with the stuffed toy engaged in more pretend play, but they were also less likely to treat the toy in a way that they would treat a real dog, as demonstrated with their rough behavior with the stuffed dog.

Some research has also examined how children and adolescents respond to a robotic dog compared to a real dog (Melson et al., 2009). The 7–15-year-olds in this experiment were more likely to have social speech (e.g., greeting the dog) and ask questions to the real dog than the robot dog. Nonetheless, large majorities of children still believed that the robotic dog had the ability to be a social companion and could be his or her friend (70 %), also a major component of parasocial relationship development (see Richards & Calvert, 2016), as well as believe that the dog was subject to moral standing and should *not* be thrown in the garbage (76 %). The study suggests that although there is a difference between real and robotic dogs, most children still attributed humanlike qualities to the robotic dog, which fits well with our findings of character personification as a property of parasocial relationships (Bond & Calvert, 2014; Richards & Calvert, 2016).

An additional study expanded on this basic moral reasoning research and examined the rights and privileges children believe robots should have (Kahn et al., 2012). Nine-, 12-, and 15-year-olds interacted with the humanoid robot named Robovie, which could talk to the child, act contingently, and appear to move around the room autonomously (although he was still controlled by an experimenter in the other room). The authors found that for the most part, children interacted with the robot in social ways, namely, by shaking his hand, following his commands, and hugging him, the latter being a component of attachment in our research (see Bond & Calvert, 2014). Over 80 % of children believed that the robot was acting autonomously. At the end of the experiment, the researcher forced the robot into a closet, despite the robot's pleas to not put him there because he was afraid. In an interview afterward, most children believed that Robovie had mental states; for example, they believed that he could be sad, which we found to be a property of character personification in parasocial relationships (Bond & Calvert, 2014). Most children also looked to Robovie as a social other, e.g., they said they would spend time with Robovie if they were lonely (a component of the attachment dimension), and they believed that he could be a friend (a component of character personification) (see Bond & Calvert, 2014). Although 54 % of children believed that it was not appropriate to put Robovie in the closet, 100 % of them thought it was okay to put a broom in a closet (Kahn et al., 2012). Overall, then, many children considered an autonomous, humanoid robot to be humanlike.

Robots often elicit the same emotions that adults would feel for a real human being. For example, Rosenthal-von der Putten, Kramer, Hoffmann, Sobieraj, and Eimler (2013) showed adult participants a video of either a robot being tortured, which made the robot cry and protest, or a video of the same robot getting treated nicely by getting stroked and fed. Participants who saw the video of the robot getting tortured had significantly higher physiological arousal (measured through skin conductance response) and had more negative affect, more pity for the robot, and anger toward the person in the video who was torturing the robot. They also viewed the robot as less happy than those who saw the video of the "happy" robot. Furthermore, some participants interacted with the robot before seeing the videos for 10 min by being able to play with him and feed him (again, behaviors that can lead to the formation of a meaningful, parasocial relationship; i.e., Gola et al., 2013). These familiarized subjects found the video less entertaining than those who were previously unfamiliar with the robot and did not get a chance to play with him. Thus, very strong emotions can be felt for robots if they appear lifelike and engage in humanlike behaviors, especially if humans have the opportunity to interact with the robot beforehand (Rosenthal-von der Putten et al., 2013).

Taken together, the results from these studies suggest that humans (starting in childhood and continuing into adulthood) hold animistic beliefs about robots when the robot acts in a lifelike emotional manner that is similar to the experiences of live people. Furthermore, the feelings and actions that humans project onto robots parallel the components of parasocial relationships, as ascertained through parent and child survey, in the realms of social realism, attachment, humanlike needs, and character personification (Bond & Calvert, 2014; Richards & Calvert, 2014, 2016). Emotional expressions by the robots were central to this lifelike assessment.

It is important that the robot exhibits some physical humanlike qualities in order for individuals to look at robots as realistic, live beings. For instance, Broadbent et al. (2013) introduced adults to one of three robots—one that had a humanoid face, one that had a silver face with blank holes where the eyes would usually be, and one that did not have a face. A majority of participants preferred the humanoid face, which was also rated as the most humanlike. Participants also viewed the humanoid display as more amiable than the other two displays. Participants who rated the face as being humanlike also perceived the robot as being alive and having agency (Broadbent et al., 2013).

Some research has examined how children react to robots with completely nonhuman characteristics. Meltzoff (1995) discovered that 18-month-old toddlers who viewed an adult attempt to complete a target action but fail (e.g., the adult would try to pull apart a dumbbell, but the experimenter's hands accidentally slid off the end of the dumbbell), were still able to complete this target action. However, when the toddler saw machine pinchers engage in this action, he or she did not perform the target action. These pinchers, though robotic, were not anthropomorphic, which may explain why young children had difficulty interpreting their actions. Consistent with these findings, 3- and 4-year-old children judged whether or not an object should be called by a name by whether or not the object had a face (Jipson & Gelman, 2007). The latter studies, then, highlight the importance of a robot looking like a living being before humanlike qualities are attributed to it, and being embodied is one quality that we have argued is essential for parasocial relationships to occur (see Calvert & Richards, 2014).

9.4.2 Intelligent Agents

Intelligent agents refer to computer-generated characters that are able to mimic many of the social patterns of real human interaction with a user. Intelligent agents can provide joint attention and gaze, can deliver verbal and subtle nonverbal feedback, and can demonstrate in real time how to complete a particular task (Johnson, Rickel, & Lester, 2000). All of these uniquely social features of intelligent agents distinctively contribute to an agent's ability to teach new information and skills effectively to users. At present, little research exists on the use of intelligent agents with very young children under the age of 5, but there is some research with adults and older children on this topic.

The *Ethopoeia Concept*, originally coined by Nass and Moon (2000), suggests that if there are social cues present in human computer interaction, the human will act in a pseudo-social way toward the computer. Taking these social cues into account, many scholars studying human–computer interaction have been able to quantify the specific features that allow users to look at intelligent agents as social companions, and friendship is an aspect of character personification in parasocial relationships (Bond & Calvert, 2014).

Some theorize that greetings and humanlike interaction between computers and users lead the person to believe that the computers are more reliable, capable, and subsequently more trustworthy (Cassell & Bickmore, 2000). Embodied agents that engage in humanlike behaviors such as small talk are also more likely to elicit trust than those who do not engage in small talk (Bickmore & Cassell, 2001), and trust is a component of parasocial relationships, specifically an aspect of character personification (Bond & Calvert, 2014). Similar results have also been discovered with children. Bickmore and Picard (2004), for instance, found that if an intelligent agent was programmed to have a relationship with the child user, that is, if the intelligent agent engaged in social dialog and exhibited humor and empathy toward the child, then the users liked her significantly more than children who had an agent who did not engage in these social behaviors. Characters that have emotions represent aspects of the character personification factor of parasocial relationships (see Bond & Calvert, 2014).

Intelligent agents and the increased social presence afforded by them have promise to be efficacious teaching tools to both adults and children. For instance, Moreno, Mayer, Spires, and Lester (2001) gave seventh graders an educational biology game to play. The game featured an animated agent named Herman, a bug with an engaging voice. Children in one condition received their information from Herman, while another group received all of their information via text box on the screen (they did not see, hear, or interact with Herman). Students with Herman received significantly higher transfer scores when asked to solve a brand new problem than those who just received text-based instruction. Those with the pedagogical agent also had higher interest in learning the material than those who did not have Herman (Moreno et al., 2001).

Similar results were found with younger children. Ryokai, Vaucelle, and Cassell (2003) found that intelligent agents could provide scaffolds that improved 5-year-old children's language skills. In this study, children played with an intelligent tutor during a storytelling game. During the playtime with the agent, the children actually increased in their spatial expression skills (describing exactly where an event took place) and quoted speech (describing what the character in their story said), which the intelligent agent had previously modeled, compared to children who played alone or with another child. Therefore, intelligent agents can serve as social models that can aid children's learning.

The reasons that people may be able to learn from these agents could be because they appear to exhibit social intelligence. For example, researchers used an intelligent agent to teach college students chemistry. Students who received a polite tutor (e.g., used responses such as 'Shall we calculate the result now?' versus 'The tutor wants you to calculate the result now') had higher learning scores than those who did not. The authors proposed that the polite conversation allowed the students to look at the machine as a social conversational partner, encouraging them to understand the message (McLaren, DeLeeuw, & Mayer, 2011). Similarly, Wang et al. (2008) also found that college students who received a polite intelligent agent learned more than those who had a nonpolite tutor.

The type of voice that the agent uses may affect learning. College students, for instance, had higher problem-solving scores after instruction from an intelligent agent that used a humanlike voice than from one with a voice that was synthesized by a machine. Once again, students who perceived intelligent agents on a screen as more humanlike learned more from them (Atkinson, Mayer, & Merrill, 2005). Overall, then, when users view intelligent agents as having qualities that are consistent with the parasocial relationship factor *character personification* (e.g., viewing the character as a friend, trustworthiness; Bond & Calvert, 2014), they learn better from the intelligent agent, suggesting the importance of parasocial relationships in the study of learning from intelligent agents.

Intelligent agents that can act in ways that are contingent to another person's actions and that are emotionally responsive to users through the use of physiological sensors may, then, be robust teaching agents for young children (Woolf et al., 2009). One study used an intelligent agent that acted contingently to school-aged children's emotions (Woolf et al., 2009). The intelligent agent was able to measure the child's emotions through a camera that determined the child's feelings through facial recognition. The intelligent agent was also able to read physiological signals such as posture through seat cushion sensors, pressure on the computer mouse through sensors, and a bracelet that could measure arousal through skin conductance. Using the input from these devices, the intelligent agent on the screen would directly respond to the student's feelings and could effectively mirror the child's emotions (e.g., showing confusion, boredom, frustration) in order to display empathy for the student, adding a layer of social realism which is an important element of parasocial relationships (Bond & Calvert, 2014; Richards & Calvert, 2014, 2016). Students who were more engaged with this contingent, emotionally responsive tutor had higher posttest mathematics scores (Woolf et al., 2009).

Gender differences may exist in human interaction with intelligent agents. Burleson and Picard (2007) conducted research on an affect sensitive computer game with 11–13-year-olds. In their project, they measured skin conductance, facial expressions, pressure put on the mouse, and posture in order to sense the user's emotions. The agent on the screen would provide affective feedback by mirroring the user's feelings. Students also received task-related help from the agent, e.g., "if you move this disk out of the way, one may be able to move this disk over to the goal position." The boys in the sample responded more when they received the task-related help and hints than when they received the affective feedback; by contrast, girls performed best when they received more affective feedback than task-related assistance. These findings suggest that character personification, in the form of emotional expressions (Bond & Calvert, 2014), may be more important for girls' than for boys' learning.

Although intelligent agents hold immense potential for acting as dynamic teachers in the twenty-first century for very young children under the age of 5, little research has directly investigated this age group. The promise of using intelligent agents as learning tools lies in the perfect contingency and customizable nature of the characters that could foster strong parasocial relationships so important to onscreen learning (Brunick et al., 2016). Yet, there are challenges in using this kind of technological interface with young children. Intelligent agents are expensive to produce, largely prototypical, and have limited mobility (i.e., equipment needed to create intelligent agents is currently bulky), and there is concern that very young children will become socially isolated if their favorite social partner is an intelligent agent (Brunick et al., 2016). The fundamental nature of parasocial relationships may also change as parasocial interactions become increasingly realistic, thereby making the one-way nature of parasocial relationships even blurrier for those who interact with robots and intelligent characters who are capable of contingent replies. Nevertheless, future research on intelligent agents, particularly in the form of intelligent media characters, is an important next step, as it capitalizes on children's parasocial relationships with their favorite media characters to engage children and to enhance their learning (see Brunick et al., 2016).

9.5 Conclusion

Children today grow up in an increasingly sophisticated digital world surrounded by an array of onscreen messages, which are often delivered by media characters. Although there is considerable evidence that very young children have difficulty learning from screens, much of this difficulty may stem from the fact that media presentations lack social meaningfulness or social interaction. To address this limitation, media presentations can simulate interactivity and enhance meaningfulness by incorporating social relevancy into their design.

Research should be conducted that further investigates the social nature of learning from content presented via onscreen characters. More specifically, future studies should investigate the benefits of using touchscreen technology and the unique features of mobile apps that include children's favorite media characters. Parasocial relationships have historically been a one-way experience from child to character. Future technological developments in the field of robotics and intelligent agents will further blur the lines of what a one-way and a two-way interaction is, as well as what a relationship is.

To address this rapidly changing technological environment, studies should look at intelligent agents and robots that children can bond with and these agents' ability to detect social cues from users that can enhance children's learning. Future research can also link the literature on parasocial relationships and intelligent agents by creating intelligent characters, as children's favorite media characters can easily transcend media platforms (Brunick et al., 2016). By more fully understanding the parasocial relationships that children have with onscreen figures as well as the parasocial interactions that they engage in with these characters, we will have a richer understanding of how children can effectively learn from screens.

As citizens of the twenty-first century, we need to begin to consider the new types of social relationships and interactions that exist for the digital natives who are growing up today. The fundamentals of friendships and relationships are taking on new meaning with advancements in interactive technology. We should question what a relationship 'is' for children, and who (and what) can provide scaffolds for children's learning. Technological innovations hold promise in teaching children skills that are foundational for their future success. Understanding the social nature of onscreen learning will provide new methods to harness that potential. In today's increasingly technological world, we need to find ways to make these characters who come to life in television programs, computers, apps, and as robots and intelligent characters become responsive guides of children's lives in order to make children in the digital age happy, healthy, and educated citizens of the future.

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Chapter 10
Character Development in Practice: How Producers Craft Engaging Characters to Drive Content Delivery: Commentary on Chapter 9

Linda Simensky

Richards and Calvert (Chap. 9) discuss parasocial relationships, which they define as the connections that viewers have with the characters they watch on television, in the movies, and on apps. In particular, their research examines how children form these connections to characters, and the authors consider the implications and impact of how these relationships affect children's ability to learn from characters.

In this commentary, I will discuss the way PBS KIDS develops characters for the content for our shows. In the commentary I highlight the overlap between our process and the findings presented by Richards and Calvert. Much of our knowledge comes from watching children in focus groups, where we test shows for appeal and efficacy. We listen to how children talk about having favorite characters and why they like them. Then we develop characters we think kids will enjoy and connect with. The information in Richards and Calvert's chapter is helpful to us as we assess how effective series are in connecting with viewers, as well as teaching them. The research does however leave us as content developers with many questions as we produce series to be viewed on multiple platforms. I end the commentary with a discussion of those unresolved questions and why answering them may be pivotal to the development of new content in the digital age.

10.1 How Character Development Works in Practice

The mandate of the Public Broadcasting Service (PBS) for children (PBS KIDS) in the US is for the programming to be entertaining, educational, and most of all to help viewers from 2 to 8 years become lifelong learners. I head the PBS KIDS programming department. We oversee the entire process of programming for these

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viewers. Show creators develop original characters and series, or adapt existing beloved characters from written or illustrated books into characters and series.

The producers create pilots to test the show ideas to see if they will both excite viewers and inspire them. We determine if children are learning the key takeaways within the content, which we do in the piloting process by asking the viewers questions about the content and assessing the accuracy of the answers. If needed, with research from focus groups, we work with the producers to adjust the characters, tweak the stories or the tone of the stories, or repeat key points to enhance what young children can learn from the content. Not every pilot makes it to series production, but when we identify that an idea has merit, we work closely with the producers to move the idea forward.

Although I am focusing on television shows, the content that PBS KIDS produces takes a transmedia approach and exists on several platforms including digital devices, and apps for smartphones and tablets. Given how rapidly the media universe changes, we also consider as we develop content that additional forms of media may emerge and gain in popularity in the course of a series' production. The Programming department works closely with our colleagues in the Digital department and other areas at PBS KIDS to make decisions together about what will work best on all platforms, not only television.

Some of the series we run include *Curious George*, *Peg + Cat*, *Daniel Tiger's Neighborhood*, *Super Why*, *Wild Kratts*, *Dinosaur Train*, *Sesame Street*, *Arthur*, and *Odd Squad*. Each of these shows has a *character-based narrative* structure. Each series also contains humor and calculated "kid appeal" so that viewers will connect with the characters, see themselves in the show, want to be the character in some fashion, or "be friends with the character." One hope is that viewers will want to see themselves doing what our characters do as they explore, make discoveries, and solve problems. We often hear anecdotes from parents about fans of series such as *Wild Kratts*, for example, pretending that they are the brothers Chris and Martin Kratt and their inventor friend, Aviva, and playing "Wild Kratts" with their friends or siblings. We view this play encouragingly, and we believe that a series works particularly when viewers want to pretend they are the characters in a show and replicate what they saw the characters do. This seems to be the essence of the parasocial relationship Richards and Calvert (Chap. 9, 2016) discuss.

When developing a show idea with creators and producers, we always ask them for "great characters that kids will love, great stories, and great design," as well as an interesting, challenging, and age-appropriate curriculum. Yet throughout this process with so many elements, strong character development is paramount. We know that preschool viewers must enthusiastically enjoy the characters in a show, so that they will be motivated to watch the program.

Based on the ideas that have been discussed over the years about children modeling their behavior on characters they've seen on television, we've conjectured that if done correctly, enthusiastic characters can act as role models and motivate viewers to learn or to develop an interest in a topic. Richards and Calvert (2016, Chap. 9) underscores the idea that if viewers relate to characters, if they see themselves or their families in certain shows, they will most likely learn more from the show. We also have seen from ratings and anecdotes from parents that kids watch shows to see their favorite characters.

Character development is crucial. Developing a character isn't a matter of coming up with a few adjectives for each character in the series. It's about a series creator thinking up real and believable characters and putting them in a world that is so interesting and unique that viewers are intrigued and are compelled to watch more. The characters can also be aspirational, where a viewer sees someone in the show and wants to be like that character or be friends with him or her. This idea builds on the Richards and Calvert's point that viewers believe their favorite characters have thoughts and emotions, and are real.

Preschool viewers are a curious group. They are eager to make sense of the world, to know how things work and why people do things, to understand the rules of the world. The best characters are not paragons of perfection, but are real characters who make mistakes, who misunderstand things, who have real fears and concerns – just like the viewers themselves. These imperfections make characters likeable, believable, and relatable. The stories built around real characters have resonance for preschool viewers who are looking to understand the rules of the world and how people work. A perfect person who doesn't make mistakes and approaches everything with the appropriate attitude won't teach anyone much, as children generally aren't perfect and will not relate to such characters. The characters' unique and compelling personalities and flaws lead to interesting stories.

We also find that while most parents are not looking to television to drill their children in facts, they are looking for well-designed educational content on all platforms. We, as content developers therefore look for age-appropriate and interesting curriculum areas. For the shows, we develop a main character interested in the curriculum topics of the show and seamlessly integrate the curriculum into the storylines and dialog. When we present a particular curriculum, we model curiosity and enthusiasm for that particular subject. In the series *Peg + Cat*, the main character Peg is particularly enthusiastic about how helpful math can be when solving any sort of problem that comes up, and at the end of an episode, she will point that out to her friend, Cat. And this idea dovetails neatly with Richards and Calvert's findings confirming that the parasocial relationship between the character and the very young viewer impacts learning of new facts and skills. The philosophy of PBS KIDS is based on this very idea. This is a crucial bit of information for those of us who use programs to introduce viewers to ideas and information, use characters as role models, and count on these relationships to further the connection between kids and television shows web games and apps.

However, we are also modeling what it is like to be enthusiastic about any topic. We want to build on viewers' natural curiosity to understand things and move to the next level of interest. If characters can model the feeling of "I am so interested in this topic, I can't get enough of it," we believe that kids will see this as admirable and appealing. We know from feedback on both *Peg + Cat* and the series, *Sid the Science Kid*, that this kind of enthusiasm is imitable and appealing.

With great characters and an interesting world, the next part comes naturally. Viewers want to see what happens to these characters, which makes the storytelling piece very important. Once there are interesting and complex characters, a character in a good story always encounters a challenge. A good story usually has some element of surprise, as well.

There are other elements that are required, as well, for shows to work. Humor is frequently a crucial piece of a program. To connect with preschool viewers, it helps if a show is funny for the viewers in the target age group. Sometimes, shows for this age group are merely cute, rather than funny, and while that works sometimes, it usually causes the show to skew to a younger age group. A unique sense of humor and unusual sensibility will help a show stand out.

As PBS is the American public broadcaster, we share the view that all American children should see themselves somewhere on television. We prefer to have characters represent the American public, in terms of racial and ethnic diversity and socioeconomic backgrounds. It helps to be able to depict different viewpoints and experiences in stories, as well.

For us one leading indicator that the character is resonating with our target audience is ratings. We can make certain assumptions based on those program ratings, web traffic, streaming numbers, and app downloads. Higher ratings show that a program is successful and that viewers enjoy the show, appreciate the characters, and are willing to return to watch the series repeatedly. In terms of the program's impact, based on what we hear from our curriculum advisors on each show, along with what we know about the process of learning in general, we operate on the idea that repeated viewing will reinforce the shows' messages or lessons (see also Chap. 7, Linebarger, Brey, Fenstermacher & Barr 2016; Chap. 8, Santomero, 2016).

10.2 Unresolved Questions

In light of our approach to producing character-driven curriculum-based programming, Richards and Calvert's research brings up many questions to consider.

Over the last 10 years, many additional viewing options have appeared. There are new platforms, including Video On Demand and streaming options that can be accessed from mobile phones and tablets. These options provide another opportunity to view existing content and in some cases introduce completely new programs and characters leading to the opportunity for young children to view many more series and characters. We are seeing that preschool viewers cycle through characters much more quickly now as opposed to 10 or even 5 years ago. This may help to expose to children to many characters with many interests and affinities, but it may also keep viewers from going in-depth with any particular programs. How does the jump in the number of series impact kids? How do they choose what to watch? How long do they like a character before they move on to the next character? Should this matter?

We are always curious to know if younger viewers believe the characters they are watching are real. We know very little about what 2-year-olds believe about animation and puppets. At what age do kids start to understand that the characters are not real, and does this have any impact on learning? If these characters are real to viewers, even if they are cartoons and not subject to the rules of the world (such as gravity) can there still be age-appropriate fantastical elements and/or cartoony gags for preschoolers? Or are these only appropriate for the 6- to 11-year-old audience?

Another area that garners much discussion in children's programming is gender. Richards and Calvert pointed out that young children strongly preferred characters who were the same gender as they were. There have been questions about children, gender, and programming for years. The biggest gender-specific question about children's programming from the 1980s to 1990s was if it was true that girls would watch programming for boys but boys would not watch shows about girls. This question emerged in an era when the toy industry was closely involved with the development of most series, and most shows were toy based. By virtue of this, the shows were almost always specifically for girls or for boys, developed around the show's play pattern. It was obvious at that point that girls would prefer the girl characters and boys would prefer the boy characters, as the shows were specifically designed that way.

In the early 1990s, under the direction of Gerry Laybourne, Nickelodeon produced several gender-neutral series, including *Rugrats* and *Doug*, which were meant to be equally appealing to boys and girls, and this changed the direction of children's television somewhat. Years later, it's not a requirement that shows be based on toys or skewed specifically toward boys or girls, although that still happens. Until recently, most preschool shows were gender neutral, and it was less common to focus preschool shows toward girls or boys.

However, as older children are now focusing more on electronics and games and devices, the target age range for toys is becoming younger. Some cable channels are making toy-based series for preschoolers, which was not as common a few years ago. Toys based on shows (*Sesame Street*, *Barney*) had been more traditional for preschoolers than shows based on toys produced by toy companies (e.g., *Paw Patrol*, produced by the toy company, Spin Master). Toy-based series tend to be more gender specific than other series, and we are seeing more series with accompanying toy merchandise, skewing completely toward one gender. If younger children do indeed prefer characters who are the same gender as they are, how does this impact learning and how does this impact what series will get made or watched?

Another question that emerges from the research is the question of humans vs. animation. Do children learn more from humans on television than from animated characters? This brings up some interesting implications. Based on ratings, it's generally been accepted that preschooler viewers love animation. If the goal of a show is to teach, and children prefer animation, but actually learn more from watching humans, how does this impact what we produce? At what age do children learn equally from animation and humans, and is there a point where children will learn more from animation?

At PBS KIDS, we premiere new shows every year. When it comes to learning, are familiar characters better than new characters in new shows? Is there an educational benefit to characters who look like other characters children already know? If a child learned more from a character he or she was already familiar with, how would preschool viewers react to a character who looked similar to characters they were already familiar with? For example, would a child who loved the Muppet Elmo, from Sesame Street, then prefer a Muppet from the Sesame Street universe like Murray over a puppet from another show? Does this difference matter, or are children only looking at the characters they completely recognize and are familiar with? Given that producers will not stop creating new shows and new characters, does this information tell us that viewers will absorb more from a show if we put additional effort into introducing new characters to younger kids through on-air promos before the show comes on? Should we promote familiarity with the introduction of characters on the website first?

Finally, Richards and Calvert mention that children learn better when parents are in the room, coviewing with their children. This idea of coviewing is frequently discussed in-depth among children's programming executives, who hope that parents are sitting with their children, watching programs, pondering plot points, and reinforcing the key takeaways with them. While coviewing is more common with children 2–3 years of age (who watch with their parents 40 % of the time, according to Nielsen), once children turn four, their coviewing slips down to 31 % of the time, and by the time children are five, they are coviewing with their parents 24 % of the time (Source: Nielsen NPOWER, 1/26/2015–2/22/2015, L+7, P18-49 Co-view. Kids Multi-weekly programs on DSNY, DISNY JR, NICK, NICK JR, TOON, SPROUT.) Through research at PBS, PBS KIDS coviewing numbers are notably larger than for the other cable networks that provide child-directed programming. This may be due in part to PBS's prevalence in broadcast-only homes with fewer TV sets, or extended families that have grandparents or other adults available to watch with children. (Source: Nielsen NPOWER, 1/26/2015–2/22/2015, L+7, P18-49 Co-view. Select Kids Multi-weekly cable programs). This data is somewhat difficult to interpret, partly because any information we have about actual coviewing is generally self-reported by parents. And these parents may wish they coviewed more with their children. We don't know if parents are putting on the show and leaving the room, sitting in the room with the child but doing something else, quietly watching the show intently with the child, or watching the show and talking over it. Most importantly, we have limited knowledge about the most effective ways for parents to coview with their children (but see Chap. 11, Anderson & Hanson, 2016).

10.3 Conclusion

As is evident throughout this commentary, at PBS KIDS, we are particularly interested in developing complex characters that model enthusiasm and curiosity to help viewers become more interested in the curriculum and more curious to explore other topics as well. The ideas in Richards and Calvert's chapter about the importance of the parasocial connections provide robust empirical evidence for this approach. At PBS KIDS, we continue to encourage the development of these new relationships and approaches as we move beyond teaching academic subjects and social emotional learning, and we experiment with finding new ways to teach increasingly abstract skills such as executive function, critical thinking, collaboration, global awareness, creativity, and flexibility.

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Chapter 11
Screen Media and Parent–Child Interactions

Daniel R. Anderson and Katherine G. Hanson

Screen media have a direct influence on children via content that can teach, inform, misinform, and induce prosocial and antisocial behaviors. But there can also be important indirect effects of media, specifically how they influence the parent–child relationship. The quality of the social interactions between parents and children is a significant factor in children's cognitive, language, and social development. If a large portion of parents' time with their children is spent in the presence of screen media, and if these parent–child interactions are of different quality than interactions in the absence of media, then screen media can have a large indirect impact on development. This chapter focuses on parent–child interactions in the presence of screen media with an emphasis on very young children and video.

For about 65 years, the television screen has been a social meeting place for parents and their children. A study by our research group during the early 1980s placed video cameras for 10 days in the homes of 106 families with young children. The cameras, which were automatically activated when a TV set was switched on, recorded viewer behavior (Anderson, Field, Collins, Lorch, & Nathan, 1985). Detailed analyses of 50 viewers from five different age groups (from 2 years to adults) indicated that, while the TV was on, in addition to looking at the screen, viewers engaged in a large variety of other activities such as toy play by children or chores by adults. Important for the present purposes was the amount of time spent with television when viewers were socially engaged: 39 %, 27 %, 24 %, 20 %, and 17 % for 2-, 5-, 8-, 11-year-olds, and adults, respectively. There is a clear trend; the younger the child, the more likely it was that social interactions were taking place while the TV was on. Family television viewing clearly provided an occasion for social interactions especially for the youngest children (Schmitt, Woolf, & Anderson, 2003). This was easy to see as we watched the videotapes; young children frequently used television time as an opportunity to interact with their parents.

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For example, when a particular father came home from work, he would sit down on a couch to watch TV news. Every day, his young son and daughter used the occasion to climb into his lap or sit on his shoulders and try to get him to rough-house play. In this and other families, the TV was on as the family ate dinners or snacks, engaged in personal grooming of their children, played board games, exercised together, helped older children with homework, and engaged in numerous other social activities. More recent research suggests that social interaction while viewing is still common among families, especially among the youngest viewers. For example, 53 % of mothers of 11- to 18-month-old infants reported that the television is on at least half of the time or more while they play with their children, and 92 % of parents said that they played with their children in front of the television for at least some of the time (Masur & Flynn, 2008). Of central concern for this chapter is whether parent–child interactions in the presence of screen media are of greater or lesser quality than parent–child interactions in other common situations.

It is important to note that parent–child coviewing is of two types: foreground and background (Anderson & Evans, 2001). Foreground coviewing occurs when program content is directed at children; ordinarily, during foreground viewing children are more attentive to the TV than are their parents. Background coviewing occurs when a child is present but the TV program content is directed at adults; not surprisingly, in this scenario the adult coviewers are more attentive to the TV than are their children (Schmitt, Anderson, & Collins, 1999). In either situation the parent may or may not be actively engaged with the child. The amount and nature of that engagement is the central topic of this chapter.

Coviewing television is common, although it varies considerably across families, depending in part on how much parents and children watch TV. For example, in one of our studies that focused on 1-year-old video viewing, diaries kept for 2 weeks by parents indicated that foreground coviewing occurred an average of 9.2 h per week and background coviewing occurred 9.5 h per week (Lavigne, Hanson, & Anderson, 2015). In another recent study, based on a national sample telephone interview of parents of children aged 0–8 years, researchers found that 31 % of parents reported that they coviewed television all or most of the time and 58 % indicated that they coviewed TV at least some of the time (Connell, Lauricella, & Wartella, 2015). In addition, as with other everyday activities, coviewing tends to decline with age as children become increasingly more independent (St. Peters, Fisch, Huston, Wright, & Eakins, 1991). Consequently, coviewing has the potential to have the greatest impact among infants and toddlers.

Producers of educational television have long recognized that parents frequently coview with their children. Children often use coviewing time to ask their parents questions about the program or to make comments on the content. In fact, children's comprehension of educational TV program content is improved if they watch with a parent rather than alone, especially if the parent is actively involved in watching the program with the child (e.g., Strouse, O'Doherty, & Troseth, 2013). Recognizing this, the producers of *Sesame Street* developed the program with a "double-premise" format; while the content was primarily designed to entertain and educate preschoolers, there was also a layer of meaning (often humorous) intended for coviewing adults. The goal of this double-premise format was to encourage active parent coviewing by providing a level of adult entertainment, thereby enhancing the positive impact on the child (Lesser, 1974). That said, in an unpublished dissertation from our laboratory, we found that coviewing *Sesame Street* among parents and their 5-year-old children was not more likely to take place than coviewing other types of programs (Field, 1987). Instead, the best predictors of coviewing *Sesame Street* were the amount of time the TV was on in the home and parents' total viewing time. Coviewing in the home was more of a random confluence event rather than a concerted effort to view together in order to enhance learning from television. This finding mirrors other recent research suggesting that the strongest predictors of coviewing, and co-media use in general, is the amount of time parents spend with media overall (Bleakley, Jordan, & Hennessy, 2013; Connell et al., 2015). Thus, although there are clear benefits of coviewing television, existing research indicates that parents are not intentionally making this happen to support learning. In the remainder of this chapter we describe behavior during TV coviewing and then discuss possible consequences of such behavior, emphasizing the research on coviewing from our own research group.

11.1 TV Coviewing Behavior

11.1.1 Attention

TV coviewers influence each other's attention and reactions to the program. An early study by our research group examined the social influence of peers on 3- and 5-year-olds' viewing of *Sesame Street.* We found that peers frequently talked about the program, mutually influenced overt viewing behavior (pointing at the screen, singing along, etc.), and mutually influenced each other's looks at and looks away from the screen. This social influence had the effect of exaggerating viewer behavior: compared to solitary viewing, there was more audience participation with greater highs and lows of attention. Solitary viewers paid more visual attention but interacted with the program less. In particular, coviewing preschoolers followed each other's looks toward and away from the screen. The design of our analyses allowed us to show that these effects were not simply due to children being influenced by the same TV content and production features (known as formal features) at the same time, but was also due to a social influence. We showed this by comparing the probabilities of looking toward and away from the screen by children who viewed together as compared to same-age children who viewed the same program in a different group. While all probabilities of looking toward and away from the screen at the same time were above those expected by chance (indicating a common influence of content and formal features), the probabilities were substantially greater in children who were in the same room at the same time. By 3 years of age therefore, the second-by-second flow of TV viewing behavior is strongly socially influenced (Anderson, Lorch, Smith, Bradford, & Levin, 1981).

In a more recent study we examined whether this pattern of social influence on attention to the TV screen holds for parent and infant coviewers. Other research has shown that more noticeable parental behaviors, such as labeling and asking questions about the content onscreen, facilitate toddler attention to television (Fidler, Zack, & Barr, 2010). We were interested in whether babies would follow more subtle cues to guide their attention—specifically their parents' looks at and away from the TV screen. The data we used were collected as part of a larger study on the impact of baby videos on parent–child interactions (Pempek, Demers, Hanson, Kirkorian, & Anderson, 2011). In that study (infants were aged 12- to 15-months or 18- to 21 months), parent–infant dyads were shown episodes of *Baby Einstein,* a popular baby video series, or *Sesame Beginnings*, a series that had not yet been released. The *Sesame Beginnings* viewers were divided into two groups: one group had never previously seen the series and the other group had been given two episodes to watch at home over a 2-week period. We discuss other aspects of this study later in this chapter, but for now, we focus on parent and infant looking at the TV screen (Demers, Hanson, Kirkorian, Pempek, & Anderson, 2013).

The more one member of the dyad looked at the screen, the more the other looked. Percent looking at the screen by the parent was correlated with percent looking at the screen by the infant ($r=0.63$). Figure 1 shows a scatter plot of parent–infant percent looking combining all three conditions of the study (*Baby Einstein*, *Sesame Beginnings* familiar, and *Sesame Beginnings* unfamiliar; the scatter plots

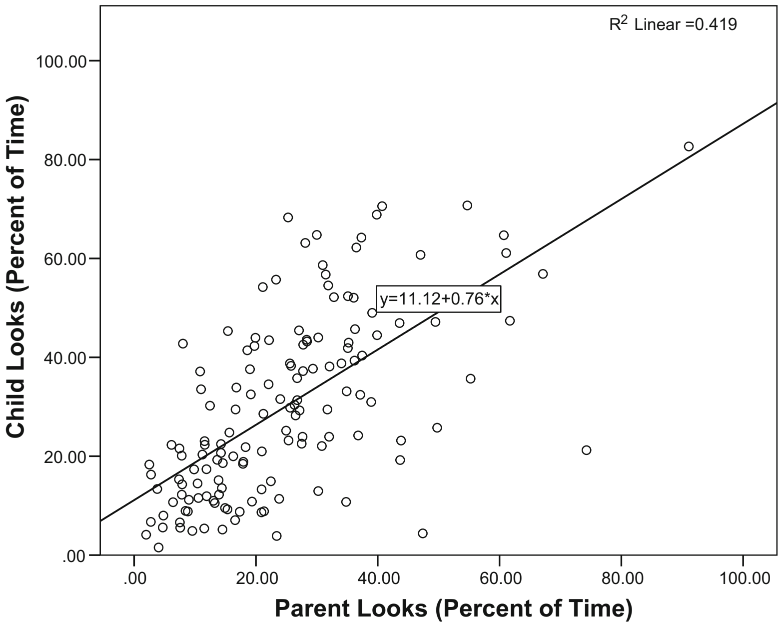

Fig. 1 Scatterplot of the percent of time spent watching a baby video by parents and their children

were very similar between these conditions). This correlation is suggestive that there could be a social influence on parent–infant dyads' looking. It is also possible that there is a shared genetic influence on interest in television as research has shown that there is a substantial heritability quotient in the amount of television viewing by separated twins (Plomin, Corley, DeFries, & Fulker, 1990). The scatter plot also shows the wide range of individual differences in the amount of looking at the screen by dyads. Some infants (and their parents) looked a great deal at the screen whereas others looked very little.

We were interested in whether the 1-year-olds followed their parents' gaze to and from the video. This seemed plausible insofar as prior research has shown that 1-year-olds follow the direction of their parents' gaze in structured experimental situations (e.g., Bakeman & Adamson, 1984). We had to take into account the possibilities that infants could appear to follow gaze onsets directed at the TV screen purely by chance, or because both parent and infant were attracted by the same feature on the video at the same time.

As in the earlier Anderson et al. (1981) study, we compared the looking patterns of each infant who was watching with his or her own parent to the patterns of a different parent who was not watching with the infant. That is, each child's pattern of looking was compared with the pattern of his or her own parent, as well as, to the looking patterns of other parents watching with their own children. If particular program features cause looks to begin and end in both adults and infants (cf, Schmitt et al., 1999), then those features would equally influence adults and infants who were not viewing together. In fact, we did find that parents and infants who did not view together had synchrony in their looking patterns at levels substantially greater than would be expected by chance. This shows that the video content and formal features did indeed simultaneously influence both adult and infant looking.

The big question was whether the synchrony in patterns of looking was greater when parents and infants watched the program together. The answer was a clear "yes" for look onsets. That is, an infant was substantially more likely to initiate looking at the screen if the parent had just initiated a look. This was true for *Baby Einstein* and for the two *Sesame Beginnings* groups. Familiarity with the *Sesame Beginnings* video did not influence this pattern. However, infants were much less likely to follow their parents' looks away from the screen, so the effect of parent behavior is primarily on infants who were not currently paying attention to the TV screen when the parent initiated a look (Demers et al., 2013). This latter result is not particularly surprising because the infants, who were looking at the screen, were probably less likely to notice that their parent had looked away.

In a further analysis we examined the lengths of infants' looks depending on whether they were spontaneously initiated by the infant, or whether they followed the parent's look onsets. Infants looked longer when their look followed the parent. From a great deal of other research, we know that longer looks are associated with improved comprehension (cf, Anderson & Hanson, 2010; Anderson & Kirkorian, 2006). Gaze-following during TV viewing, therefore, may possibly be a bootstrapping mechanism by which infants gradually come to develop strategies of attention and ultimately comprehension of what they are watching.

We next wanted to see if infants follow their parents' gaze when watching adult-directed TV, which look and sound different from child-directed programs. Preschool children are quite sensitive to these production differences and pay greater attention to programs that appear to have been produced for children even when the programs depict the same events and dialogue (Campbell, Wright, & Huston, 1987). To see whether young children would follow parent looks at adult content, we performed a secondary analysis of existing data, which were taken from a different study of parent–child dyads (Kirkorian, Pempek, Murphy, Schmidt, & Anderson, 2009). In this study, children aged 12-, 24-, or 36-months were allowed to play with toys while a television showed a parent-selected, adult-directed TV program. Parents were free to interact with their children in this study. Not surprisingly, parents paid more attention to the adult-directed TV program than did their children. However, the children did not follow parent look onsets and there was no significant relationship between parent and child looking patterns. This stands in sharp contrast to the significant relationship between adult and infant looking patterns when the content was infant-directed (Demers & Anderson, 2010).

From this analysis, we concluded that infant gaze-following is context-bound. Toddlers appear to be aware of the qualitative differences between adult- and child-directed TV content, which is probably related to the formal features characteristically used in child-directed TV programs (e.g., Schmitt et al., 1999). When they recognize that video content is child-directed, infants may consider parent attention to be informative; when they see a parent begin to pay attention to the screen, they turn their own attention to what may be interesting and comprehensible scenes. In the context of adult-directed video content, however, toddlers appear to have learned (probably from home viewing experience) that following adult looking at the TV is not rewarded in the same way.

11.1.2 Parent Engagement During TV Coviewing

We were interested in whether parents are less engaged with their toddlers when the TV is on versus when it is off, and whether the patterns of engagement differ depending on whether the content is foreground or background. Because parents pay more attention to the TV during background (adult-directed) content (Schmitt et al., 1999), it is a fairly straightforward prediction that they would engage less with their toddlers. The question is then whether the level of parent engagement is of lesser quality in the presence of TV compared to the level of engagement when in the absence of TV.

We observed parent–child interactions in a free play session in which the TV was on for half the session. The TV program was chosen by the parent from an array of adult-directed programs that did not contain violence or potentially offensive language (Kirkorian et al., 2009). Children were 1-, 2-, or 3-years-old. Sessions were videotaped and parent–child interactions were coded using a 5-level coding system applied to each 10-s interval, ranging from no interaction or attention to the child, to merely looking at the child, to active engagement. Results were clear: parents are less engaged with their children when the TV is on. Parents were actively engaged with their children during 68 % of the intervals when the TV was not on, but only 54 % of the intervals when the TV was on. Our guess is that these differences are even greater at home than in the laboratory where parents were aware that their interactions were being observed.

What about when parents coview a foreground (child-directed) program with their child? Are they similarly less engaged as when adult-directed programming is on? One might expect that parents would engage more with their children because the TV program is for the child and less distracting to the adult. Parents might also attempt to actively engage in scaffolding their child's comprehension of the program. Alternatively, parents may use the program as a means of occupying their child's attention while parents engage in their own activities. In the *Sesame Beginnings* and *Baby Einstein* study mentioned above (Pempek et al., 2011), we coded parent–child interactions during the half-hour TV session and compared it to the free play period with the TV turned off. In these sessions, we made toys available as well as magazines for parents—to see whether they would choose to play with their child or read instead. We also coded parent–child interactions during a 15-min free play session immediately after the 30-min TV viewing session. Recall that half of the *Sesame Beginnings* viewers had previously viewed the videos at home while the other half had never seen them before.

As had been found in other studies, when the TV was on, regardless of which program was shown, parents interacted less with their children than when the TV was off (Pempek et al., 2011). This finding is consistent with other studies that have found a reduction in parents interacting with their children while the TV is on with foreground content (e.g., Courage, Murphy, Goulding, & Setliff, 2010). Taken together, parents interacted less with their children during coviewing, regardless of whether the content was adult- or child-directed. Nevertheless, it was clear that parents' interactions during foreground TV viewing were richer than during background TV viewing insofar as parents and children responded to the content together. Parents did more labeling during *Baby Einstein,* and more singing during *Sesame Beginnings*, appropriate to the content of each program. As had been previously reported by Barr and her colleagues, we observed that some parents engage in substantially more scaffolding behavior focused on the child-directed content (Barr, Zack, Garcia & Muentener, 2008).

It should be pointed out that the main purpose of the study was to assess whether *Sesame Beginnings* had a positive influence on parent–child interactions. *Sesame Beginnings* was specifically designed to foster positive interactions between parents and their toddlers (although not necessarily during program coviewing). We examined the cumulative influence of watching the video series over 2 weeks as compared to groups given *Baby Einstein* videos or no videos at all. Unlike *Sesame Beginnings, Baby Einstein* videos were not specifically designed to foster parent–child interactions. We found that parents who had watched *Sesame Beginnings* at home were more likely to actively engage with their children in the laboratory during a 30-min free play session (no TV). This was *not* true for parents who watched

Baby Einstein. In line with our study, Barr and colleagues (2011) also used the *Sesame Beginnings* series in an intervention program to enhance high quality interactions between incarcerated teen fathers and their young children. They found that the videos, in conjunction with staff-led training sessions, increased the quality of fathers' interaction (e.g., turn taking, join attention, taking the child's lead) with their young child over time, likely facilitating a stronger and more positive bond (Barr, Morin, Brito, Richeda. Rodriguez, & Shauffer, 2014; see also Chap. 15, McClure & Barr, 2016). Thus, although research has shown that parent–child interactions generally decrease during foreground TV coviewing, content that is specifically designed to foster high-quality parent–child interactions can have a positive impact on the quality of parenting and the parent–child relationship.

11.1.3 Parent Language During Coviewing

It is well known that parent language directed at toddlers is exceptionally important for language development (e.g., Hart & Risley, 1995). In light of these findings, we were interested in examining the quantity and quality of parent language during coviewing as compared to situations when the TV is off. To accomplish this, we re-coded the background (Kirkorian et al., 2009) and foreground (Pempek et al., 2011) experiments, specifically looking at parent language. The prior overall analyses of parent–child interactions from these experiments clearly showed reduced parent engagement during coviewing. In the next series of studies, we examined whether reduced engagement during TV viewing influenced parent language directed at the children and in what ways. For example, although we expected that parents would talk less to their children during TV viewing, we wanted to know how big a decrease actually occurred and whether quality as well as quantity of language was affected during coviewing. We based our transcriptions on a study that had examined parent language addressed to toddlers at home (Hoff & Naigles, 2002). The investigators recorded parent utterances directed at 1½ to 2½-year-olds at home for 42 min and then assessed the children's lexicons 10 weeks later. Their analyses indicated that the best predictors of lexical development were number of words addressed to the children, number of different words, and mean length of parent utterance (all positive). Consequently, we used these measures in our transcript analyses.

First consider our findings on how parent language changed when the TV was showing adult-directed content (Pempek, Kirkorian, & Anderson, 2014). Parents were free to interact with their 12-, 24-, and 36-month-old children during a 1-hour free play session. For half the time the TV set played a program of the parents' choosing and for the other half the TV was off. The question of interest is how parent language was different when the TV was on. As compared to the same parents' language when the TV was off, there was a decrease in the number of words directed toward their children, as well as a decline in the number of different words parents used. There was, however, no difference between conditions in mean length of utterance. To give a sense of the magnitude of this effect, nearly all parents talked less to their children when the TV was on (grand average across ages of 23.9 words per minute when the TV was on versus 35.5 when the TV was off). The richness of parent language expressed as number of different words used, similarly declined (grand average of 6.3 when the TV was on versus 7.9 new words per minute when the TV was off).

To put this in a larger context, if our observations were representative of parent language at home, the cumulative effects would be substantial. Background television in the homes of toddlers is present about 5.5 h per day (Lapierre, Piotrowski, & Linebarger, 2012). If a toddler is exposed to background television for only half that time, then over the course of a week, parents would direct about 13,400 fewer words to their children compared to the TV not being on.

Now, consider foreground coviewing. Our original study of foreground viewing (Pempek et al., 2011) found that although parents engaged less with their toddlers when the TV was on, they did interact to some extent around the content of the programs (similar to findings by Barr et al., 2008; Fidler et al., 2010). They labeled objects and actions during *Baby Einstein* and sang songs along with the program during *Sesame Beginnings.* The question here concerns quantitative aspects of their language directed at their 1-year-olds during coviewing as compared to no TV (Lavigne, Hanson, & Anderson, 2015). Analyses of the transcripts again indicated that parents talked less to their children during coviewing (grand average of 27.2 words per minute when the TV was on versus 45.4 when the TV was off across the two series). The number of different words used also declined (6.5 when the TV was on versus 8.2 different words per minute when the TV was off). However, knowing that parents do tend to talk about the programs as they are coviewing, we wondered if despite fewer total utterances, they might use richer language with each utterance. This was indeed the case, with parents using an average (across both programs) of 0.86 new words per utterance during coviewing, compared to 0.63 new words per utterance during free play. So foreground coviewing has some important nuances: Parents talk less, but when they talk, their language is richer. As with background TV, we found no differences in mean length of utterances. Figure 2 is a scatterplot for parent language during foreground TV as compared to free play (no TV) for words per minute, new words per minute, new words per utterance, and mean length utterance. Any points that fall above or below the diagonal line in each plot indicate greater or lesser use of that category of speech when the TV was on versus when it was off.

There were some additional findings from our study of foreground TV. First, we found no differences in parent language as a function of parent and child familiarity with *Sesame Beginnings.* Second, there was clear evidence that part (but not all) of the reduction in parent language during foreground coviewing was due to parent attention to the TV. Parents who looked more at the screen talked less overall.

We also found effects of coviewing on parents' language during a free play session immediately following the TV session. We had parents and children engage in free-play sessions 1 week before the TV co-viewing session and also for 15 min after the TV program concluded. During this post-TV session, parents used an

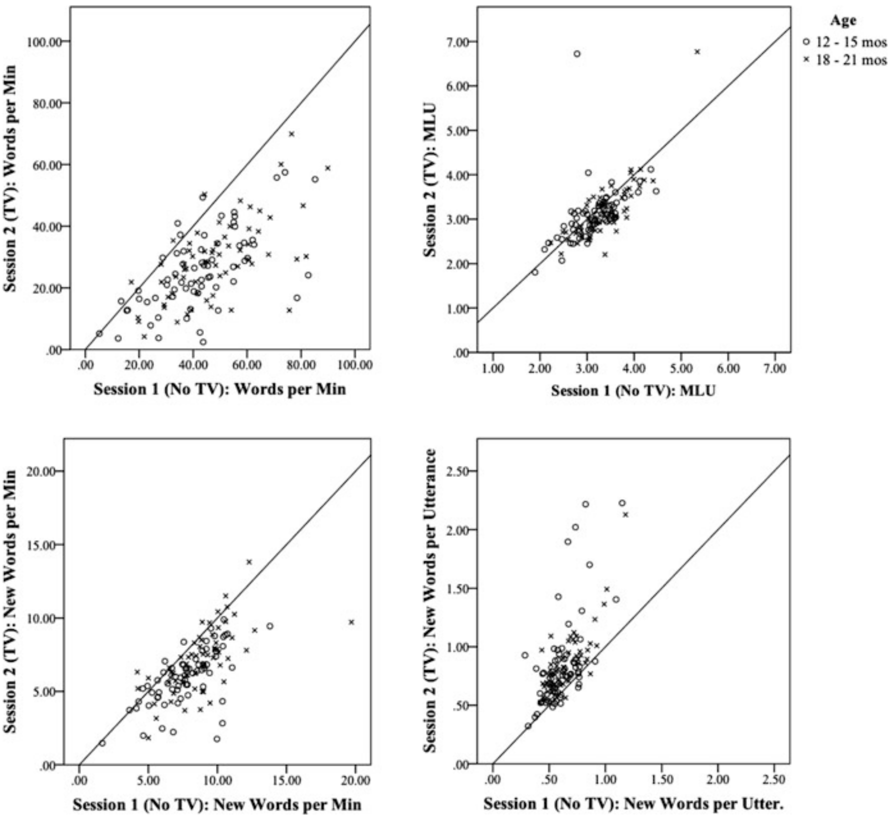

Fig. 2 Scatterplots indicating the number of parents who showed an increase (points above the diagonal) or decrease (points below the diagonal) in child-directed language from Session 1 (No TV) to Session 2 (TV)

average (across both programs) of 11.6 new words per minute as compared to 8.2 new words per minute in the free play session recorded a week previously, although total words used did not significantly differ. With respect to new words per utterance, the averages were 0.88 (for Post TV) versus 0.63 prior to TV. That is, although parents' total language directed at their children was the same as the previous week, immediately after viewing their lexicon was richer.

Finally, we were interested in whether home coviewing predicted language used in the laboratory when the television was not on. We tested this hypothesis by using the 2-week home viewing diaries to investigate whether the amount of coviewing foreground and background television reported by the parents predicted parents' language during the 30-min free play session when the TV was turned off. New words per minute was negatively related to the amount of background and foreground television in the home, while total words per minute was negatively related to foreground television coviewing. In addition, we found that the reduction in parent language in the laboratory for the TV session as compared to the no TV session was less for families who reported higher levels of background television in the home. Summarizing, the higher usage of TV at home, the less parents talked to their children in the laboratory when the TV was not on. Moreover, parents living in heavy TV households were not affected as much when the TV was on compared to parents who used television less.

Transcript analyses from the background and foreground TV experiments indicate that parents talk less to their children during coviewing in our laboratory, and that more coviewing at home predicted less parent speech during a free play session in the laboratory. This suggests that if a significant proportion of parent–child interactions at home occur in the presence of television, it is possible that parents' normally positive influence on children's lexical development could be reduced. That said, however, we found that parent language during appropriately age-directed children's programming was lexically richer, with this richness carrying over to immediate post-viewing free-play sessions. Putting all these results together, most coviewing at home probably reduces the amount and richness of parent language directed at their children. Coviewing age-appropriate programs together reduces amount of parent language but may, at the same time, enrich it. Both content of the TV program and parents themselves are likely the key to long-term effects on child language. When parents actively scaffold the child's comprehension and broader understanding of the appropriate child-directed programming, they use richer language and probably enhance the child's lexical development. When parents are not engaged with the child and the program content is not comprehensible to the child, the overall effects on the child are probably negative.

Christakis and colleagues (2009) obtained broadly similar results from a home-based observational study in which 329 2- to 48-month-old children wore a device on their clothing that recorded all audible sound, including television and parent verbalizations, for an entire day. They found that for every hour of television, parents spoke 770 fewer words, suggesting that over the course of the week, children would hear about 30,000 fewer words. In addition, for each hour of television, children's vocalization was reduced by 0.26 standard deviations. It is important to note that the TV program content, adult- or child-directed, was not assessed in this study.

Over time, reductions in parent language could have negative consequences for children's linguistic abilities. Indeed, there are a handful of studies that have found a negative relationship between early TV exposure and language development (e.g., Zimmerman, Christakis, & Meltzoff, 2007). Conversely, the increase in richness of parent language that we found in our study could have beneficial effects. Mendelsohn, Brockmeyer, Dreyer, et al. (2010) examined whether parents' verbal interactions during coviewing influences infant verbal abilities at 14 months. Results indicated that among this low-income sample, verbal interactions while viewing did mitigate any adverse affects of media exposure on infants' language abilities. In addition, verbal interactions while viewing educational content positively predicted infants' language abilities.

Taken together, our findings, combined with those from other studies, indicate that background television is probably a consistent negative influence on development during early childhood. The results concerning foreground television viewing are less dire. When children can understand age-directed educational TV programs, by about 2½ years, they can learn directly from the programs themselves. When parents are actively engaged with their children during foreground coviewing, they use richer language both during and immediately after viewing, and increase the positive impact of educational programs. Heavy television use, however, is associated with less parent language directed at very young children, even when the TV is not on.

11.2 Parent Language During Book Reading Compared to TV Coviewing

11.2.1 Traditional Paper Storybooks

In a typical day, young children spend about 30 min reading and about 90 min watching television (Common Sense Media, 2013). In contrast to the mixed findings regarding the impact of coviewing television, shared reading has been shown to facilitate parent language and in turn, children's language development (Bus, Van Ijzendoorn, & Pellegrini, 1995; Scarborough & Dobrich, 1994). Thus, differences in time that children spend with each medium could potentially lead to differences in language outcomes.

Home observation studies have revealed that parents engage in similar behaviors while coviewing television with their children as they do reading to them. Among preschoolers, Stoneman and Brody (1982) observed 14 families and found that mothers tend to turn the coviewing experiences into teachable moments, discussing the content with their children especially if the program was educational. The children, in turn, were more likely to label things on the program and recount what they had learned. Lemish and Rice (1986) examined interactions between parents and their young children around the television set from early infancy to 3 years of age. They found that parents used television similar to storybook reading, often labeling objects, asking questions, and describing content. Together, these observational studies provide qualitative evidence for the potential of coviewing TV to enhance children's linguistic abilities via parent–child interactions, which is akin to their interactions while reading books.

However, when we look at the comparison experimentally, a different story emerges. In a recent study in our laboratory, we compared coviewing television to shared storybook reading. Thirty-month-old and 15-month-old children and their parents were randomly assigned to watch either *Teletubbies* or *In the Night Garden* for 30 min. A third group of parents and children read storybooks together for 30 min. Parents chose from an array of 16 books including titles such as *Good Night Moon, Dora and the Rainy Day, Are You My Mother?, One Fish Blue Fish,* and other similar books. Transcript analyses were similar to those described above, except that we excluded parent words that were taken verbatim from reading the

Table 1 Parent language during shared reading compared to foreground TV coviewing

	Shared reading	TV coviewing
Words per min	46.77	16.02
Utterances per min	11.22	4.55
New words per min	9.67	4.51
New words per utterance	0.92	1.20
Mean length of utterances	4.15	3.38

texts of the stories aloud. Compared to book reading, there was a drastic reduction in words per minute, utterances per minute, new words per minute, and mean length of utterances while viewing TV (see Means for parent language variables in Table 1; *Teletubbies* versus *Night Garden* comparisons are not significant, but program comparisons with reading are all significant). Recall that we had similar findings when comparing coviewing foreground TV with free play. However, in that research we found that although parents talked less to their children while viewing, they used more new words in each utterance. We replicated this finding in our comparison of coviewing with book reading: Parents used more new words per utterance during coviewing as compared to shared book reading. Again, although they talked less, parents' vocabulary directed at their children was richer during coviewing, utterance by utterance. We found parallel results for parents of 15- and 30-month-olds with one exception: parents of 15-month olds used fewer new words than parents of 30-month-olds in all conditions. Again, the finding for the effects of foreground TV on parents' language suggests that the effects of TV coviewing are nuanced. Parents talk less, but when they talk, their lexicon is richer.

Our findings are consistent with a study reported by Nathanson and Rasmussen (2011). They compared parent language while watching television, reading books, and playing with toys. Their coding system for analyzing parent language differed from ours, so the results are not directly comparable, but the trends are the same. They found that mothers talked less and were less responsive while coviewing television relative to shared reading, and that they provided fewer descriptions and contingent responses compared to toy play. However, while coviewing television, parents provided more non-contingent responses (i.e., parent-initiated talk) than while reading together. Both parent responsiveness and non-contingent responses were positively related to toddlers' contemporary word production so the findings again suggest that the effects of coviewing are likely more complex than one might suppose given the overall reduction of parent language. That is, although there is a general reduction in language due to coviewing television, there are potential benefits as well.

Given that the nature of parent interactions depends on the content being viewed (Kirkorian et al., 2009; Pempek et al., 2011), the value of parent interactions during TV viewing likely depends on the particular programs watched. However, our study, combined with Nathanson and Rasmussen (2011), strongly suggests that an hour of shared book reading is more valuable in terms of parent–child interactions and language development than an hour of shared TV viewing. That said, it should be noted that reading is not necessarily a better medium in all cases; rather different media may afford different types of learning. For example, toddlers learn about action-based events as well or even better from TV compared to reading (Brito, Barr, McIntyre, & Simcock, 2012; Simcock, Garrity, & Barr, 2011).

11.2.2 E-books

With the advent of e-books, the nature of reading is changing. E-books combine elements of both traditional children's paper books with the interface of mobile technology. One question is whether shared reading experiences using e-books are similar to that of traditional books or other screen media. An observational study of seven parent–child dyads demonstrated that sharing online storybooks with choice points (allowing changes in story plots among others) elicited similar types of parent–child behaviors to that of traditional storybooks (Fisch, Shulman, Akerman, & Levin, 2002). In contrast, experimental research shows that there are significant differences between traditional books and e-books. Krcmar and Cingel (2014) found that compared to traditional storybooks, electronic books on the iPad decrease children's comprehension even when reading with their parents. This finding was most likely due to parents focusing more on the format and function of the e-book rather than on the content. Other studies support this result, demonstrating that e-books prompt more non-content related talk associated with explorations of the e-books' functional properties, thereby reducing comprehension (Chiong, Ree, Takeuchi, & Erickson, 2012).

The novelty of e-books may influence these findings. There have been no experimental studies that have examined whether this phenomenon persists once parents and children understand the mechanics of e-books. Given that very young children tend to read the same books over and over again, parents may at first focus on the form, but then after the first few times begin to focus on the content. Moreover, at this young age, it may be just as beneficial for parents and children to interact in general regardless of whether parents focus on the form versus the content of e-books. Some studies suggest that this might be the case. Parents naturally scaffold and tailor their support based on their children's actions and abilities. While engaged in a computer storybook activity, for example, parents made more references to the mechanics of using the technology if their child tended to use the mouse (Lauricella, Barr, & Calvert, 2009). However, when children did not use the mouse, parents provided support by remarking on the story content. In another study, these same researchers examined how parent language differed across different media and how this difference influenced children's narrative comprehension (Lauricella, Barr, & Calvert, 2011; Lauricella, Calvert & Barr, 2014). With their parents, 4-year-olds read a traditional storybook (*Click, Clack, Moo*), viewed a TV program (*Dora the Explorer*), or read an online storybook (*Elmo Goes to the Doctor*). Despite reduced parent language with television compared to the other media, children were able to comprehend more from television than reading stories via book or on computer. Direct comparisons between books and e-books showed that there was no difference between comprehension levels, though engagement was higher with e-books, and parents talked more about features of the e-book that were not related to the narrative and provided more vocabulary definitions with traditional books. These findings indicate that parents are sensitive to their children's cognitive abilities and needs and adjust their scaffolding behaviors appropriately. Together, these studies suggest that experience with e-books influence parents' behavior and in turn, children's story comprehension.

A recent observational study by Schmitt (2015) investigated how experience influences parent reading aloud behaviors with a Tag Jr. book. This e-book is an interactive device that can read stories out loud, ask questions, label objects, and play music. For this study, parent–child observations were made over the course of five weekly home visits. The study revealed that among parents and their 2- and 3-year-old children, parents read more to their children while reading traditional storybooks than Tag Jr. books; however, the total number of words heard by the children was the same when accounting for the Tag Jr. device reading aloud. With the Tag Jr., parents were more likely to engage in behaviors that are known to support story comprehension such as asking open-ended questions and providing simple labels relative to reading traditional books; though, no differences were found between media types in closed-ended questions and elaborations. In sum, this study shows that with experience, parents can and do engage in high quality interactions with e-books. Future studies should examine whether these interactions facilitate children's story comprehension.

11.3 New Media Are Reshaping Family Interactions

We have shown thus far that television coviewing can change the nature of parent–child interactions for better or worse, depending in part on what is measured and to what it is compared. Although television still dominates young children's media diets, *how* children watch television is changing, which has the potential to influence the nature and amount of coviewing with parents. Based on a recent nationally representative survey by Common Sense Media (2013), children aged 0–8 watch about 1.5 h of television in a typical day. This estimate captures the different ways that children can now watch television programs: via a traditional television set, on a computer, or on mobile devices. In addition, use of newer technology like smart phones and tablets is on the rise. For example, only 8 % of children in 2011 used a mobile device in a typical day, which increased to 17 % in 2013. Moreover, the amount of time that children spend with mobile devices has tripled from 5 min to 15 min per day. Given these differences in how children spend time with old and new media, it is important to understand how new media technology shapes family interactions.

Our review has shown that coviewing television changes parent behaviors, usually in the direction of less engagement; but the question of whether television and new media completely displace time spent together is another area of concern. It might be better for a parent and child to coview television rather than not interact at all as each uses separate mobile devices or TV sets, but analyses as of yet have not been conducted. A recent national survey indicates that 58 % of parents said that their children's media use does not make a difference in the amount of time they spend with each other, while 28 % said they spend less time with their children, and 12 % say they spend more time because of media use (Common Sense Media, 2013). The reasons why parents allow their young children to use media reveal a pattern of displacement. One of the main reasons parents allow their children to use mobile devices is to distract them. About 44 % of parents said they "often" or "sometimes" allow their children to use their mobile devices to occupy them while running errands (Common Sense Media, 2013). Another survey found that children's TV usage is moderately correlated with the parents' need to get chores done (Cingel & Krcmar, 2013).

In addition to considering the frequency of screen use by children, it is critically important to look at the impact of parent use of digital devices. Traditionally, when creating guidelines for a healthy media diet for young children, the focus has been on children's use of and time spent with media. For example, the American Academy of Pediatrics recommends that children under 2 years use no screen media at all and that preschoolers use screen media no more than 2 h per day, limiting the content largely to educational programming. When it comes to parents, the focus has been on how parent attitudes and mediation styles influence children's media use and outcomes. Missing from these and similar guidelines are recommendations for parent use—that make parents aware of how media influence their own behavior, which in turn has the potential to affect their children's developmental outcomes. This concern is an increasingly pressing issue because parents today are more tuned in to media than ever before, heavily relying on smart phones, tablets, computers, and the internet to stay connected with work, family, and friends, and for entertainment. In addition, parents' own media consumption is one of the most powerful predictors of their children's media use (Bleakley, Jodran, & Hennessy, 2013; Cingel & Krcmar, 2013; Field, 1987; Jago, Stamatakis, Gama et al., 2012; Lauricella, Wartella, & Rideout, 2015). Thus, media effects on child outcomes are indirectly but importantly linked to parents' own media use.

To date, there is a dearth of research examining how parents' use of new digital media influences their interactions with children. One observational field study examined parents' use of mobile devices in fast food restaurants (Radesky et al., 2014). The study found that out of the 55 families that they observed, about 30 % of the parents were completely absorbed with their mobile device at the expense of interacting with their children. When children tried to vie for their parents' attention, parents would often respond harshly. Further, in a laboratory study (Radesky et al., 2015), 225 low-income parents were asked to engage in a structured task where familiar and unfamiliar foods were presented to their children. The researchers noted whether mothers spontaneously used a mobile device during the session and, if they did, how the mobile device influenced maternal verbalizations directed at their children. Approximately 23 % of the mothers used their phone during the session. Of those who did, they spoke less and made fewer nonverbal gestures to their children (80 % of the utterances and 61 % of the nonverbal gestures compared to those who did not use phones). Notably, there was no association with maternal education level, parenting style, age, or race.

While media may distract parents and reduce their family interactions, media also have the potential to positively connect and may promote familial interactions in new ways. Video chats may be a promising avenue of communication and connection with long-distance family and friends as traditional methods, such as the telephone, are difficult for young children to use with sustained interest (Ballagas, Kaye, Ames, Go, & Raffle, 2009). Skype, for example, a software application that provides users with the ability to video chat with others, is a popular means and essential part of communication among military parents who are deployed (Chalmers, 2011). Raffle and colleagues (2010) found that the use of software like Skype and interactive online storybooks promote enhanced child engagement and interactions while communicating online with loved ones from a distance. For example, an online storybook called *Story Visits* connects children with long distance relatives using video chat and linked online e-books that allow both parties to see and hear each other and operate the pages as they read together (see also Chap. 15, McClure & Barr, 2016). These types of media-related social interactions may facilitate and strengthen connections over time. Thus, similar to coviewing television, new media technology offers both promising and potentially harmful effects on children's outcomes.

11.4 Conclusions and Needed Research

In this chapter we mainly focus on children under 3 years because a large body of research has shown that parent–child interactions during this time are particularly important for subsequent development. Our own and others' research have shown that these interactions are substantially influenced by the presence of television, either in the foreground during children's programs or in the background during adult programs. Compared to a free play situation or to shared book reading, parents interact substantially less with their children while coviewing television. Although equivalent research with digital interactive screen media is limited, the effects appear to be similarly large.

While the reductions in parent engagement have been repeatedly found in different studies and by multiple research groups, it is important to note that during coviewing of foreground TV, there are also effects that could be positive. Infants follow their parent's gaze at the TV screen as a cue to also attend. Looks at the screen last longer when they follow the parents' gaze, making it more likely that infants' comprehension of the TV content may be enhanced.

Utterance for utterance, parents use a richer vocabulary during foreground TV coviewing than they do during shared book reading or free play. Moreover, if the program content encourages positive parent–child interactions (i.e., *Sesame Beginnings*), then the more parents coview the program, the more positive their engagement is outside of the television viewing situation. Some parents provide interpretative comments, label, and engage in other behaviors that scaffold their children's comprehension of program content.

Overall, however, the fact that there is a reduction in parent engagement during TV coviewing is likely to have negative consequences. If the TV was never on in the home—foreground or background—and all that extra time was spent in shared play and reading, then parents would address roughly 28,000 more words a week to their toddlers, although on an utterance by utterance basis, they would use fewer different words. Nevertheless, the overall reduction in parent–child interactions during coviewing may well account for multiple findings that toddler television viewing is associated with poorer language development (e.g., Chonchaiya & Pruksananonda, 2008; Zimmerman et al., 2007). In fact, Zimmerman et al. (2009) argued that this negative association is entirely due to reduced parent language during coviewing.

Practically speaking, a useful outcome of the research reviewed here would be to make parents more aware of their own media use and the consequences for their children. While parents understand that media effects stem from the content of children's programs as well as the time children spend with media, they are much less likely to be aware that their own media use has an impact on their young children. Most of the research documents the negative impact of television as distracting from parent–child interactions, but the effects may be even greater with respect to parents' use of mobile screen media. Texting, game playing, email-reading are all potentially engrossing and can disrupt parent–child interaction. Although no quantitative studies have yet compared the impact of mobile screen media versus TV usage on parent behavior, our guess is that the effects of mobile screen media are even greater.

We conclude this chapter by suggesting two areas for further research. First, there is considerable need for quantitative observational research in the homes of young children along the lines of what was done with television in the 1980s (Anderson et al., 1985; Schmitt et al., 2003). We simply do not know how much and how media are used in toddlers' homes, and especially the nature of parent–child interactions with and without shared media use. This cannot be accomplished by survey methodologies alone; instead, some form of unobtrusive observation technology is essential. Second, there is a pressing need for experimental, longitudinal research on child outcomes in relation to family media use. One approach would be to have a group of parents agree to limit their use of adult-directed screen media while with their toddlers for several months and see what the consequences are for lexical or other aspects of development. Christakis and colleagues (2013) did an experiment that asked parents of young children to encourage use of educational screen media (rather than entertainment screen media). They found important positive outcomes for the children compared to controls. The same approach could well be taken with parents' own media use with an outcome focus on their children.

Media are embedded in the larger fabric of family life today. Contemporary media use is extraordinarily varied, occupying a great portion of family social time.

We simply cannot fully understand the impact of media on children if we focus only on media time and media content for children. We must also study and understand how media influence family dynamics.

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Chapter 12
Context Matters: How Co-using Screen Media Impacts Young Children—Commentary on Chapter 11

Claire Lerner

Screens or no screens—that was the question—way back when at a time when the only screen we knew was the TV. Parents were warned against any television use for young children, especially those under 2, because the long-term effects were unknown, and research showed potential for adverse shorter-term impacts on language and cognitive development, as well as on obesity and sleep. So the safest advice from experts was "No TV." But we know more now about the actual impact of screen use on young children, and especially the role of co-viewing on children's learning, thanks to the work of researchers Daniel Anderson and Kate Hanson. This commentary reviews their key findings on co-viewing and what it means for parents and other caregivers of young children.

But despite this counsel, study after study started revealing that millions of parents of young children were exposing their little ones, as young as 6 months, to TV. Thankfully, a number of researchers were taking a closer look, trying to understand under what conditions TV use could not only do no harm, but actually be used as a tool for learning. What their studies have shown is that the picture is not so cut and dry. In short, when children are exposed to content that is specifically designed for their age-group, and parents make screen use a shared experience, talking with children about what they are viewing and extending the learning from the screen to the child's real world, the potential negative effects of screen use can be mitigated and the benefits enhanced.

Daniel Anderson and Katherine Hanson make a major contribution in helping us understand the impact of context by looking at parent and toddler co-viewing from almost every angle imaginable. We know that watching TV alone has relatively few benefits for very young children, and is linked to poorer developmental outcomes. When viewing alone, without parental support, children's ability to learn from the concepts that are illustrated in the program is limited. It is important to note that

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this is also true of any 2D experience, such as book-reading, or playing games on touchscreens—that without parental scaffolding, limited learning takes place. Consequently, child development experts have long encouraged parents who allow their children to watch TV, and more recently use mobile devices, to co-view (or co-use). Anderson and Hanson's paper now takes a deeper dive into understanding how much parents are actually co-viewing with their babies and toddlers, what is happening when they co-view, what it is exactly about co-viewing that is beneficial to children's learning and development, and the limitations of co-viewing. They also consider the overall impact of young children's media use and parents' media use on the parent-child relationship.

12.1 Key Findings

12.1.1 Co-viewing Is Not an Intentional Strategy

Anderson and Hanson (Chap. 11, 2016) report that the strongest predictor of co-viewing, and co-media use in general, is the amount of time parents spend with media overall (Bleakley, Jordan, & Hennessy, 2013; Connell et al., 2015). This suggests that parents are not necessarily intentionally co-viewing as a strategy to help their children learn, it is just that the more the TV is on, the more likely they are to co-view. This could either mean that parents do not understand or appreciate the value of co-viewing; or, that they are aware of the benefits of co-viewing but are choosing to allow their children to use screens independently. Rare is the parent who never relies on a screen to divert a child at a time when he or she needs to accomplish a task or get a well-deserved break. So it is important for parents to understand the limitations of independent viewing among infants and toddlers, and the benefits of co-viewing, so they can be more intentional, and mindful, about TV usage.

12.1.2 TV Co-viewers Influence Each Other's Attention and Reactions to the Program

Anderson found that when 3- and 5-year-olds co-view during television watching, their viewing experience is influenced by their peers. They not only talk about the program, gesture at the screen to communicate to their friend about what they are seeing, and sing along, they mutually influence each other's looks at and looks away from the screen: "Compared to solitary viewing, there is more audience participation with greater highs and lows of attention." Since we know that more engagement generally leads to greater learning, and that peer interaction is very important for social development, this finding suggests that sharing the screen experience will have greater benefits for young children than watching solo. However, what we do not know is how peers co-viewing a program together compares with their engaging in another play activity, such as running around on the playground or building a village for their stuffed animals with blocks. So in the case that young children are watching, it seems it would be a more enriching experience to share it with a friend. But it is important to consider what kind of interaction or activity the viewing is replacing.

Anderson and Hanson's research also revealed this phenomenon of co-viewers influencing the screen experience with parents and toddlers. The more one member of a parent–toddler dyad looked at the screen, the more the other looked; and toddlers looked longer when following their parent's looks toward the screen than when children looked spontaneously. The researchers concluded that since other studies consistently show that longer looks are associated with improved comprehension, gaze-following during TV viewing may ultimately increase toddler's comprehension of what they are watching.

This finding suggests that parents may indirectly help children learn more from the TV viewing experience by simply looking at the screen. The more they look at the screen, the more likely their child is to attend to it. However, this should not be in lieu of interacting during viewing, taking about the program and expanding on the learning, just like they would when jointly attending to a toy they are playing with together. The parent looks at the screen, the child then looks at the screen, sensing that there is something interesting that the parent is guiding them to pay attention to. That is step one. Step 2 is to talk about what they are seeing on the screen to build language and comprehension, and to make it a rich, social experience.

12.1.3 Parents Engage Less with Their Children When the TV is on, Even When Co-viewing Child-Directed Content

Even taking into consideration times when parents are co-viewing, Anderson found overall that parents were less engaged with their children when the TV was on than when it was off. This is not surprising, and does have important implications. First, the TV should be off when no one is watching. Exposure to adult-directed, background TV has multiple negative effects on young children's play and learning, and takes time away from parent–child interaction.

When parents are co-viewing, it is important to be sure they are actively involved, not just passively watching together. They should make it an interactive, language-rich social experience, just as they do when engaged in "3D" play. The TV or other screen should be seen as a tool for engagement and learning. At the same time, it is important that parents balance their participation so as not to overwhelm their young child who is working hard to comprehend the content on the screen. For example, instead of speaking over the program, parents can pause the show, or summarize the program and ask questions at the end, just like they typically do with picture books.

12.1.4 Content Can Influence Parent Behavior

So what about the influence of TV viewing on parents' learning and behavior? Interestingly, Anderson and his colleagues found that viewing programming that models positive parent–child interactions can lead to parents emulating this behavior when engaging with their own children. Particularly promising is the work Barr and her colleagues have done on this front with incarcerated fathers, which illustrates that showing, in addition to "telling", can be a powerful tool in promoting active, positive, attuned engagement between parents and their children. This also introduces another nuance, as Anderson and Hanson explain: "Although research has shown that parent-child interactions generally decrease during foreground TV co-viewing, content that is specifically designed to foster high-quality parent-child interactions can have a positive impact on the quality of parenting and the parent-child relationship." In short, content matters.

12.1.5 Media Has the Potential to Limit, But also Enhance Language Development

Language development starts at birth and is nurtured through the back-and-forth interactions between babies and their caregivers—first with sounds, facial expressions and gestures, and then words. The strongest predictor of children's vocabulary development is the amount of language that is addressed to them. So it is a significant finding that nearly all parents talked less to their children when the TV was on. This is especially concerning given that the authors calculate that toddlers who are exposed to even half the average amount of background television would hear about 13,400 fewer words per week compared to the number of words they would hear if the TV was not on at all. This provides further evidence for the need to avoid background TV; and when co-viewing, to use lots of language to label, narrate, and engage in back-and-forth dialogue about the content being watched.

However, this research has revealed a surprising and interesting twist. While parents use fewer words when the TV is on, the vocabulary they use is more complex, both during co-viewing and during free-play that takes place after viewing. This may be due to the fact that the programs introduce new concepts, and therefore language, that parents pick up on and then incorporate into their interactions with their children. This points to a positive aspect of sharing media with young children—the potential to introduce new vocabulary and ideas for parents and children to explore together—and means parents should be on the lookout for these opportunities to enhance language and cognitive development.

Further evidence of the benefits of co-viewing is provided in the study by Mendelsohn et al. (2010), which showed that amongst parents who chose to show their young children educational content, those who interacted while co-viewing had a positive influence on their babies' verbal skills. Taken together, these studies reinforce the importance of looking for high-quality content that is designed for the developmental stage the child is at, and that presents concepts in ways that are relatable to young children.

12.1.6 Books Compared to TV

It turns out that while parents use significantly less language when co-viewing TV as compared to book-reading (excluding the reading of the book's written text), parents use more *new* words when watching a program together versus when reading a book. Interesting is that in this study, the results were consistent between the two age groups they tested, 15- and 30-month-olds, with one difference: parents used fewer new words with 15-month-olds compared to 30-month-olds. This may in part be due to the fact that we use simpler language with babies which would explain the fact that parents used fewer new words with them. But it is also a reminder that it is very important to talk with babies and toddlers, even though they are "preverbal" and may be communicating and responding largely with sounds and gestures, not words.

Anderson and Hanson conclude in this section on language that an hour of shared book reading is more valuable than an hour of shared TV viewing. But there is new research that shows that the picture may be more nuanced depending on the content of each medium. Simcock, Garrity, and Barr (2011) and Brito, McIntyre, and Barr (2012) showed that toddlers aquire more action-based information from a video demonstration than from a book, and are more likely to recall action-based information from television than from books. So while traditional books might be a good vehicle for vocabulary acquisition and story comprehension, television might be a better vehicle for action-based information; for example, for learning how to put something together or to do a certain movement or play a game. The implication would be that parents should choose content based on the goal. Although the jury is still out, to learn about how objects work, video might be better; to learn concepts and language, books might be better.

12.1.7 Learning from E-books

The use of e-books is rapidly expanding and can be a great resource, especially for families with low incomes, as there are thousands of e-books available for free through local libraries. But the research comparing print versus e-books has yielded some conflicting results. Some studies (Chiong, Ree, Takeuchi, & Erickson, 2012; Krcmar & Cingel, 2014) have shown that children's story comprehension is decreased when reading e-books versus print books due to parents' guiding children's attention to the various bells and whistles—all the extra features included on the screen—which distracts the child from the story.

Other studies (Fisch, Shulman, Akerman, & Levin, 2002; Schmitt, 2015) showed that parents' increased interaction while reading e-books versus print books did not decrease comprehension, and that parents also used more new vocabulary than when reading traditional books.

Given these conflicting findings, it seems the best advice to parents is to tune in to their child's unique abilities and learning style and adjust how they use the e-book to maximize the benefit for their individual child. Children are not a monolithic group and process information in different ways. For some children, exploring the different features of an e-book may not interfere in comprehension. For others, it is important to stay focused on the story and save the fun features for after the story is done. It is hard work for young children to make sense of stories—it requires intense concentration—so we do not want to do anything that distracts them from understanding the plot.

It is also important to avoid using e-books that actually read the book to the child. Children need contingent responses to learn about the back-and-forth—the reciprocity—of communication; to experience that their utterance has a specific impact on the listener and causes a related response back. Just as with other 2D experiences, parents need to provide scaffolding to make it more contingent by asking open-ended questions about the story, pointing to pictures and then talking about the story together after it is done.

Anderson and Hanson (2016, Chap. 11) raise an important question for future research—the impact of children's experience with e-books on comprehension. The hypothesis is that once children have explored the enticing features, they will no longer hold the same appeal and may focus more on the story.

12.2 Impact of Media Use on Parenting and the Parent–Child Relationship

We know that parent–child interaction is the most important factor in a child's overall long-term development. And we know that the use of screens—by parents and children—reduces time spent together. So the advent of digital media and the host of mobile devices that are now ubiquitous have introduced a major new variable into the already complex job of parenting. Limit-setting is hard enough for most parents. Now they have to add limiting screen use—thier own and their child's.

The research shows, not surprisingly, that the most common reason parents provide children with mobile devices is to distract them. Anyone who spends any time in public has seen parents hand over their phone or tablet in a restaurant when their toddler is having a hard time waiting for her food; or their 2-year-old falls to the ground in despair when told it is time to leave the playground. Finding a way to distract a child is nothing new. It is the tool that has changed. It used to be a coloring book; now it is a coloring app. The problem is that when children are handed a device repeatedly in these situations, it becomes a coping mechanism that they come to rely on. This tends to lead to meltdowns when children do not get the device, with parents throwing their hands up and giving in, eroding their authority and ability to set and enforce important limits. It also means missed opportunities for children to learn that they can survive the upset without needing a device to be soothed. Imagine this: Toddler throws himself to the ground, kicking and screaming. Mom calmly picks him up, puts him in the car seat, acknowledges how mad he is to leave the park, and assures him that he will be okay. As they drive off she ignores his shouts and puts on his favorite music and starts to sing. He eventually calms. He does not need to play with an app or watch a show to make it all better. Music and singing can do the trick.

I do live in the real world and know that occasional use of the screen to distract is not going to be the end of the world, provided it is very time-limited and the content is developmentally appropriate. What's most important is for parents to be mindful and intentional about the choices they are making about media use; to be clear on what the goal is and what the impact on their child will be. That is, parents are pivotal in setting up a healthy media diet early in childhood.

12.3 The Impact of Parents Own Media Use

Anderson and Hanson rightly emphasize the critical importance of understanding and helping parents become aware of the influence their own media use has on their young children. There is so much that parents feel is out of their control when it comes to the factors that influence their children's development. Media is one variable they can and should control; and one of the most effective ways to do that is to limit their own use, at least while with their children, as research shows that one of the most powerful predictors of children's use of media is their parent's use.

One study of parental usage—observational by design—found that more than 25 % of parents were absorbed with their digital devices while eating at a fast-food restaurant. The more time that parents interacted with mobile devices, the more likely their children were to act out, trying to get the parents' attention, which often led to angry reactions by the parents, including shouting and, in one case, kicking a child's foot. Although this was an observational study, it suggests that many parents may be missing opportunities for valuable social interaction with their children during mealtimes, and that parental preoccupation with their mobile devices can result in an increase in negative child behaviors and angry, punitive responses from parents. Just as children need to learn healthy media habits, so do parents.

No parent sets out to behave this way. We see a work email with a pressing matter or get a text from a friend, and the compulsion to respond takes over. Nothing can wait anymore. There seems to be some unspoken contract that one must reply within minutes or we are perceived as irresponsible or unresponsive. This phenomenon seems pretty pervasive—I for one am totally guilty. At the same time, parents today are keenly aware of the significant impact their interactions with their children have on their long-term development. So the more they are aware of how their device usage can have a negative impact on interactions with their children, the more likely they will be to set and enforce limits, not just on their children but on themselves. A good start might be committing to turning phones off or putting them on the "do not disturb" mode for periods each day in order to enjoy uninterrupted time to focus on their little ones.

12.3.1 Ways New Media Forges Connections

Finally, Anderson and Hanson address the powerful, positive impact media can have on staying connected with family and friends via tools like Skype and FaceTime (see Chap. 15, McClure & Barr, 2016; Chap. 16, Truglio & Kotler, 2016). I love the idea that parents who are separated from their children can share online storybooks, providing a tool for learning and bonding from a distance. Connections are the foundation of healthy early development, so when media is used as a tool for engagement, it can be a powerful positive. It is when it reduces interaction and connection that it is a problem.

12.4 Conclusions: Use Media Mindfully

- Limit viewing as less interaction and talking takes place when the TV is on. Also, the more parents use media, the more their children tend to use media.
- If using media to occupy your child, be mindful of the goal of the media use in order to set healthy media diets, and to avoid creating a dependency on digital devices to cope with life's challenges.
- When co-viewing, engage in lots of back and forth interaction; pick up on new concepts and words and use them with children during and after the show. Initiate discussion in addition to responding to your child's prompts.
- Talk with preverbal children while viewing. Even though they do not have a lot of words, they benefit greatly from hearing lots of language. So as not to overwhelm your toddler who is working hard to understand the content, consider pausing the program or waiting to talk about it at the end of the segment.
- Choose developmentally appropriate and educational content.
- Beware not to get distracted by the bells and whistles of e-books. Stay focused on the story. Engage in lots of back-and-forth discussion around the e-book, especially if using a talking book that does the reading itself.
- Limit your own media use when with your child.

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Chapter 13
The Parental Media Mediation Context of Young Children's Media Use

Jessica Taylor Piotrowski

13.1 The Parental Media Mediation Context of Young Children's Media Use

For most young children today, media play a key role in their daily home life. Whether watching television, playing video games, using apps, or even streaming YouTube videos, media are inextricably linked to the lives of most youngsters. Researchers have long contended that how children spend their time has a substantial influence on their development of skills, relationships, attitudes, and behavior patterns (Huston, Wright, Marquis, & Green, 1999). Just as adult's time use is considered a form of human capital (Juster & Stafford, 1991), children's investments of time can be viewed similarly, as these investments provide opportunities for learning, social activities, and other outcomes (Huston et al., 1999; Larson & Verman, 1999). Given that children's time use is an important determinant for development, it is not surprising that researchers are frequently in search of updated estimates on the amount of the time that youngsters spend with media. While these estimates are certainly valuable as researchers try to understand the types of socialization and developmental opportunities that youngsters are experiencing, they are often incomplete as they typically omit the crucial role of context.

Defined as the circumstances through which media use occurs, context can be conceptualized in many different ways. Ecological systems theory, for example, posits that media use can be examined through micro-level contexts (e.g., role of parents, peers), meso-level contexts (e.g., institutional influences), and macro-level contexts (e.g., influence of cultural norms and values) (Bronfenbrenner & Morris, 1998). Just as parents can restrict access to certain media content, norms and values

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in a given society may similarly discourage access to specific media (Valkenburg & Peter, 2013). Moreover, these contexts not only can influence whether or not media content is consumed, but they can also influence the experience and subsequent effects of such media content (Valkenburg & Peter, 2013). As such, understanding children's media use through the contextual contours of their daily life can provide crucial information not only on the media children are using, but potentially how they experience and are affected by it.

Despite the valuable information that context provides, research on the role of context in children's media use tends to be scattered and inconsistent. While some scholars treat context as core variables in theoretical models, the majority have either disregarded the role of context entirely or opted to statistically control for context rather than formally evaluating its relationship with media (Piotrowski & Valkenburg, 2015). As a result, researchers have recently called for more systematic theorizing and investigations on the role of context in media research (Valkenburg & Peter, 2013). To that end, the aim of this research is to contribute to our understanding of young children's time spent with media by investigating their media use within the contours of one particularly relevant context—parental media mediation.

13.1.1 Social Context and Media Use

When looking across the media effects literature, there are a host of theories that explicitly posit that the process of media selection, processing, and subsequent effects is likely to be influenced by contextual variables. Most notably, Valkenburg and Peter (2013), in their presentation of the Differential Susceptibility to Media effects Model, argue that context can influence media use both deliberately, whereby particular individuals or institutions have specific rules about media use, or less intentionally whereby prevailing norms may influence the selection process. These researchers further argue that contexts can also amplify or dampen how users experience media content. Described as the context-convergence hypothesis, Valkenburg and Peter (2013) explain that media effects can be amplified if the messages converge with the opinions, values, and norms of the social context of the user (see also resonance in cultivation theory, Gerbner, Gross, Morgan, Signorielli, & Shanahan, 2002). Similarly, when media content diverges with the social context of the user, this is thought to result in dissonance (Festinger, 1957) and, in most cases, leads to a weaker effect of the media content on the user. Given the powerful role of context both in media use and media experience, it is somewhat surprising that the literature on media use—including children's media use—inconsistently includes contextual variables. While some studies formally include contextual variables in their work (e.g., Fikkers, Piotrowski, Weeda, Vossen, & Valkenburg, 2013), the great majority tend to either omit context, treat context as noise that is randomly distributed across experimental conditions, or treat context as control variables in survey and longitudinal models (Piotrowski & Valkenburg, 2015).

While there are often statistical or methodological explanations for how context is treated in research studies, the mismatch between theoretical propositions and empirical practice is problematic. By averaging out differences across contexts, rather than formally investigating them, not only are we likely to miss potentially valuable differences in the process of media selection and effects, but we are likely to make erroneous conclusions about the size of these effects. For example, in a recent study by Fikkers, Piotrowski, Lugtig, and Valkenburg (2015), the researchers were interested in understanding how teens' perceived peer norms may mediate the relationship between media violence and subsequent aggression. At the omnibus mediation level, there was no evidence of a relationship between media violence and aggression. However, a more detailed moderated-mediation model revealed that the process differed for different youth. On the one hand, for teens who believed their peer environment was particularly aggressive, media violence exposure predicted increased aggression via peer approval of aggression. On the other hand, for teens who did not feel that their peer environment was particularly violent, media violence exposure predicted decreased aggression via peer approval of aggression. In other words, the peer context influenced how media violence affected these teens. For media violence researchers, these results offer valuable nuance to an area of study wrought with inconsistencies, and more broadly, this work reminds us what our theories already tell us—that is, that media effects are not that simple and indeed are best understood through their contextual contours.

13.1.2 Parental Media Mediation

When it comes to young children's media use, one particularly relevant contextual variable is parental media mediation. Conceptualized as the practices that parents engage in to manage and regulate their children's experience with media (Clark, 2011; Valkenburg, Krcmar, Peeters, & Marseille, 1999), parental media mediation is typically thought to reflect one of three types of behaviors: active mediation, restrictive mediation, and co-viewing/co-use. Although evidence for the effects of co-viewing has not been convincingly demonstrated in the literature (Nathanson, 1999; Nathanson, 2001a), research does suggest that whether parents rely on active or restrictive mediation strategies influences children's use and experience with media content in different ways. Early studies, for example, have shown that active mediation—defined as parents' efforts to explain media content to their children and convey their opinion about the content—can increase desirable media effects (e.g., learning from educational television, Huston & Wright, 1994) or reduce undesirable ones (e.g., effects of media violence on aggression, Nathanson, 2004). On the other hand, restrictive mediation—defined as parents' efforts to restrict the amount of time that their children spend with media or the content they are exposed to—has been linked with a forbidden fruit effect whereby youth (particularly teens) are more likely to consume the content which parents deem as restricted (Nathanson, 2001b). As a result of these and other findings, researchers suggest that active mediation is a preferred to restrictive mediation (Fujioka & Austin, 2003).

In recent years, research on parental media mediation has received renewed attention with more researchers recognizing that it is vital for processing both traditional media and new media (Clark, 2011; Nikken & Jansz, 2006). Considering the dramatic growth of children's media use over the past decade, combined with the increasing opportunities and concerns associated with media use, the increasing attention to parental media mediation is unsurprising. Yet, despite this increasing interest, we still lack descriptive information about the frequency of parental mediation behaviors. Not only is it unclear whether and the extent to which parents of young children engage in parental media mediation, it is equally unclear as to whether these behaviors are associated with media use in the current media climate. The majority of the existing work on parental media mediation was conducted more than a decade ago—in other words, before digital media was a fixture in our everyday lives. If we hope to truly understand how parental media mediation may influence how children experience and are affected by media, we need to first understand the parental media mediation climate that young children are growing up in today. To that end, using cross-sectional data from a large sample of parents of children aged 3–8, the current study is designed to provide updated information on parental media mediation in the digital age. In particular, the study is designed to evaluate the extent to which parents engage in restrictive and active mediation with their young children (RQ1), as well as the relationship of this mediation to young children's media exposure (RQ2).

13.2 Method

13.2.1 Sample and Procedure

For this study, survey data from Dutch parents of children aged 3–8 were analyzed. After receiving approval from the sponsoring institution's Institutional Review Board, a private research company (TNS-NIPO/Veldkamp) collected the data between September and December 2012. Families were recruited through the research company's existing panel of approximately 60,000 households that is representative of the Netherlands. Because this study is part of a larger research design in which the inclusion of sibling data was necessary, the research company recruited 467 families with at least two children between 3 and 8 years old from their panel members. Two children from each family participated in the study, resulting in a total of 934 children (52 % female, $M_{age} = 5.41$ years, 95 % CI [5.32, 5.50], Min/Max = 2.83–7.83 years). All data in this study are parent report data.

13.2.2 Measures

13.2.2.1 Parental Media Mediation

To measure parental media mediation, parents completed a 12-item parent report scale. Updated from the original parental mediation scale developed by Valkenburg et al. (1999), this scale measured the frequency with which parents reported engaging in both restrictive and active mediation. Given the inconsistency in the literature on co-viewing, this revised scale omitted co-viewing and instead expanded the active mediation items to better represent the encouragement of positive media content (four items, $\alpha = .85$) and discouragement of negative media content (four items, $\alpha = .83$). An example of an item that measures stimulation of positive media content is "How often do you encourage your child to play an educational computer game?" while an example of an item that discourages negative content is "How often do you tell your child that certain things in a TV-program or movie are wrong?" For restrictive mediation, a total of four-items were used ($\alpha = .85$). An example of an item that measures restrictive mediation is "How often do you forbid your child to watch TV-programs or movies that contain violence?" All twelve items were measured on a five-point Likert scale ranging from never (=1) to often (=4).

13.2.2.2 Media Use

Because parental mediation has been associated with both overall media use as well as content-specific media use, for these analyses, a total of six media use variables were created. Two variables were created to represent average time spent watching television and playing video/computer games per week, two variables were created to represent average time spent watching violent television and playing violent games per week, and lastly, two variables were created to represent average time spent with educational television or educational games per week. All items were created using direct estimates, an approach that has been shown to be valid for assessing media content exposure (Fikkers, Piotrowski, & Valkenburg, 2015).

For overall television and game use, parents were asked "how often does your child watch TV [play games]?" and "on the days that your child watches TV [plays games], how much time does s/he spend?" Parents were told that games include "games played on the computer, via internet, on the Xbox, Playstation, Wii, a portable gaming device, an iPad, or on a mobile phone." For violent television and game use, parents completed a similar set of questions except items focused specifically on violent content—"how often does your child watch TV [play games] that contain violence? By violence, we mean all violence (e.g., fighting, shooting) that living beings (e.g., people, monsters—including cartoon and animation) do to each other" followed by "on the days that your child watches violent TV [plays games that contain violence], how much time does s/he spend?" Lastly, to capture educational TV and educational game play, parents were again asked a similar set of questions. Specifically, they were asked "how often does your child watch educational television shows [play games]? By educational, we mean shows [games] with a goal to teach children (e.g., Dora the Explorer, Sesame Street, or Youth News; [Comfyland, Ambrasoft, or Big Brain Academy games]) followed by "on the days your child watches educational TV [plays educational games], how much time does s/he spend?"

For all frequency ("how often") items, responses ranged from 0 (never) to 7 (days per week). The follow-up ("how much") items were open-ended questions in which parents answered by filling in hours and minutes. The two items for each medium and content type were multiplied to calculate the number of hours per week of television

Table 13.1 Descriptive statistics of study variables

Variable	Mean Untrimmed variable	95 % CI Untrimmed variable	Number of cases trimmed	Mean Trimmed variable	95 % CI Trimmed variable
Television use	8.86	[8.24, 9.48]	5	8.69	[8.17, 9.22]
Game play	1.96	[1.71, 2.22]	18	1.85	[1.64, 2.05]
Violent TV	0.25	[0.18, 0.32]	26	0.21	[0.16, 0.26]
Violent games	0.09	[0.05, 0.12]	14	0.06	[0.04, 0.08]
Educational TV	3.23	[2.91, 3.56]	17	3.14	[2.84, 3.43]
Educational games	0.55	[0.42, 0.67]	9	0.48	[0.41, 0.56]
PM: Restrictive	2.09	[2.03, 2.16]	0	–	–
PM: Discourage negative	2.54	[2.48, 2.61]	0	–	–
PM: Encourage positive	2.73	[2.66, 2.79]	0	–	–
Child age	5.41	[5.31, 5.50]	0	–	–
Child gender	48 % boys	–	0	–	–

Note: Media variables represent hours per week; parent media mediation (PM) was scored on scale of 0 (never) to 4 (often); age is in years

use, video game use, violent TV use, violent game use, educational TV use, and educational game use. Descriptive statistics for all items can be found in Table 13.1.

13.2.3 Analytic Approach

Analyses were conducted in STATA 12.1. Descriptive statistics were used to examine the frequency of parental mediation strategies, as well as, media use estimates. Since the media use measures were calculated, in part, based on open-ended questions, there were some extreme values which can increase the likelihood of making Type 1 errors. These extreme values were defined as values exceeding the mean ± 3 times the standard deviation. These values were trimmed by recoding the value of the observation closest to the threshold of the mean ± 3 times the standard deviation. In Table 13.1, the original mean and standard deviation as well as the trimmed means and standard deviations are reported.

Following this, bivariate correlations and ordinary least squares regression models were used to examine the relationship between parental mediation strategies and media use. To evaluate the bivariate relationship between model variables, Kendall's tau-a was calculated. This statistic is preferred to Pearson's correlation coefficient because it does not assume variable normality nor does it require independent observations when used with the clustering option in Stata 12 (i.e., this data is based on sibling pairs). Stata 12 enables a conversion of Kendall's tau into an approximation of Pearson's *r* using Greiner's relation (Newson, 2002). This converted Pearson's *r* is presented in Table 13.2.

Table 13.2 Zero-order correlations for model variables

Variable	1	2	3	4	5	6	7	8	9	10	11
1. Television use	**1.0**	.23*	.09*	.03	.52*	.09*	−.04	.14*	.17*	.04	−.02
2. Game play	.23*	**1.0**	.19*	.15*	.05	.48*	.18*	.21*	.21*	.42*	−.16*
3. Violent TV	.09*	.19*	**1.0**	.17*	.00	.09*	.15*	.14*	−.01	.20*	−.13*
4. Violent games	.03	.15*	.17*	**1.0**	−.03	.05*	.10*	.07*	.01	.11*	−.09*
5. Educational TV	.52*	.05	.00	−.03	**1.0**	.14*	−.03	.13*	.25*	−.06	.03
6. Educational games	.09*	.48*	.09*	.05*	.14*	**1.0**	.10*	.16*	.32*	.23*	−.02
7. Restrictive mediation	−.04	.18*	.15*	.10*	−.03	.10*	**1.0**	.43*	.23*	.29*	−.17*
8. Discourage negative	.14*	.21*	.14*	.07*	.13*	.16*	.43*	**1.0**	.46*	.15*	−.15*
9. Encourage positive	.17*	.21*	−.01*	.01	.25*	.32*	.23*	.46*	**1.0**	.10*	−.01
10. Child age	.04	.42*	.20*	.11*	−.06	.23*	.29*	.15*	.10*	**1.0**	−.01
11. Child gender	−.02	−.16*	−.13*	−.09*	.03	−.02	−.17*	−.15*	−.01	−.01	**1.0**

Note: Table depicts Pearson's *r* correlations, which were converted from Kendall's tau-a correlations using Greiner's relation in Stata 12. All analyses used trimmed media variables. Gender is coded as boys=1, girls=2

*$p<.05$

Table 13.3 Regression predicting media use from parental mediation, controlling for age and gender

	1: Television			2: Games		
	B	95 % CI	*β*	*B*	95 % CI	*β*
Restrictive	−1.09*	[−1.73, −0.46]	−0.18	−0.19	[−0.42, 0.04]	−0.06
Discourage negative	0.87*	[0.1, 1.63]	0.14	0.11	[−0.19, 0.41]	0.03
Encourage positive	1.24*	[0.53, 1.95]	0.21	0.40*	[0.14, 0.66]	0.12
Child age	0.12	[−0.15, 0.39]	.02	0.55*	[0.44, 0.65]	0.30
Child gender	−0.63	[−1.48, 0.22]	−0.10	−0.98*	[−1.32, −0.65]	−0.19
$F(5,466)$	6.67*			26.46*		
R^2	.05			.14		

	3. Violent TV			4. Violent Games		
	B	95 % CI	*β*	*B*	95 % CI	*β*
Restrictive	−0.01	[−0.05, 0.03]	−0.01	0.02	[−.001, 0.04]	0.06
Discourage negative	0.14*	[0.07, 0.2]	0.18	0.02*	[.001, 0.04]	0.07
Encourage positive	−0.08*	[−0.14, −0.03]	−0.11	−0.02*	[−0.04, 0]	−0.07
Child age	0.08*	[0.05, 0.11]	0.19	0.02*	[0.01, 0.03]	0.11
Child gender	−0.12*	[−0.19, −0.04]	−0.10	−0.07*	[−0.11, −0.03]	−0.13
$F(5,466)$	10.73*			5.99*		
R^2	.08			.05		

	5. Educational TV			6. Educational Games		
	B	95 % CI	*β*	*B*	95 % CI	*β*
Restrictive	−0.39*	[−0.73, −0.06]	−0.09	−0.05	[−0.14, 0.03]	−0.05
Discourage negative	0.16	[−0.24, 0.55]	0.03	−0.01	[−0.13, 0.1]	−0.01
Encourage positive	1.07*	[0.66, 1.49]	0.23	0.36*	[0.24, 0.47]	0.28
Child age	−0.22*	[−0.38, −0.06]	−0.09	0.11*	[0.06, 0.15]	0.15
Child gender	0.09	[−0.36, 0.55]	0.01	−0.02	[−0.15, 0.11]	−0.01
$F(5,466)$	8.61*			13.70*		
R^2	.07			.10		

Note. All regression models use robust clustered standard errors and bootstrapping (1000 bootstrap samples) to correct for clustering in sample (sibling pairs) and residual skewness. Media use variables are trimmed and represent hours per week. Age is measured in years. Gender is coded as boys = 1, girls = 2

*$p < .05$

Although the bivariate relationships provide information on the relationship between mediation strategies and media use, regression models were used to better understand the independent contribution of each mediation strategy.[1] Specifically,

[1] Preliminary models also examined potential interactions with age to identify whether the relationship between parental mediation and media use may vary as a function by age. Although some

six regression models predicting different forms of media use (television, games, violent television, violent games, educational television, and educational games) were conducted. Regression models were examined for residual normality and multivariate outliers. Although Mahalanobis distance indicated no problems with outliers, residual normality was somewhat skewed. To account for this skewness (an artifact of our media use variables), all regression models used bootstrapping (bias-corrected and accelerated 95 % confidence intervals, 1000 bootstrap samples). Finally, in order to ensure that standard errors were not biased as a result of clustering (sibling pairs), robust clustering was used. All models include controls for child gender and child age. For parsimony, only significant findings are discussed in the text. Complete accounting of all regression analyses can be found in Table 13.3.

13.3 Results

13.3.1 Parental Media Mediation Descriptive Statistics

Research question 1 asks the extent to which parents of children 3–8 years old engage in restrictive and active mediation. To address this research question, descriptive statistics were used. Overall, results indicate that encouraging positive media content is the most common mediation strategy that parents of young children use at home. Nearly 80 % of parents, on average, report encouraging positive media content "sometimes" (Mean = 2.73; Median = 3.0). Following this, the second most common mediation strategy is discouraging negative media content (Mean = 2.54, Median = 2.50). Here were see that roughly 70 % of parents report using this strategy "sometimes." Lastly, restrictive mediation was the least common among this sample of parents (Mean = 2.09; Median = 2.0) with slightly more than half of all parents reporting that they "almost never" use this mediation style at home.

13.3.2 Relationship between Parental Media Mediation and Media Use

Research question 2 asks about the relationship between parental mediation approaches (restrictive and active mediation) and young children's media use. Bivariate analyses, presented in Table 13.2, indicated that parental media mediation strategies are indeed associated with media use in diverse ways. To ascertain the independent relationship between each mediation approach and media use, six regression models (predicting each of the forms of media use) were analyzed.

interactions were significant, no meaningful differences emerged. For model parsimony and to aid interpretation, age was treated as a covariate in final analytic models.

In model 1 (television), results indicate that all forms of parental mediation are significant correlates of time spent viewing television. While restrictive mediation is associated with less television ($b=-1.09$, $\beta=-.18$), both forms of active mediation (encouraging positive content, $b=1.24$, $\beta=.21$; discouraging negative content, $b=.87$, $\beta=.14$) are associated with increased time spent viewing television. On the other hand, parental mediation was not as robust of a correlate with game play. While encouraging positive media content is associated with increased time spent playing games ($b=.40$, $\beta=.12$), restriction and discouraging negative content are unassociated with time spent playing games.

Models 3 and 4 looked specifically at violent media content. In these models, we see that parental mediation is associated with both violent television viewing and violent game play in the same manner. Specifically, while discouraging negative media content is associated with increased time spent with violent television ($b=.14$, $\beta=.18$) and video games ($b=.02$, $\beta=.07$), encouraging positive media content is associated with less time spent viewing violent television ($b=-.08$, $\beta=-.11$) and playing violent games ($b=-.02$, $\beta=-.07$). Restriction mediation was unassociated with both violent television viewing and violent game playing.

Lastly, models 5 and 6 looked at the relationship between parental media mediation strategies and educational media content. Results indicate that discouraging negative media content is unassociated with viewing educational television or playing educational games. However, encouraging positive media content is strongly related with both educational television viewing ($b=1.07$, $\beta=.23$) and educational game play ($b=.36$, $\beta=.28$). Although restriction is unassociated with educational game play, restrictive mediation is associated with less educational television viewing ($b=-.39$).

13.4 Discussion

Researchers widely agree that how children spend their time is an important predictor of the development of their skills, relationships, attitudes, and behavior patterns (Huston et al., 1999). For the majority of children growing up in today's digital society, media is a mainstay of their daily life. In our sample of children aged 3–8 years old, for example, we see that they are reportedly viewing nearly 9 h of television per week and playing nearly 2 h of games per week. In other words, children are spending approximately 90 min every day using screen media at home. Considering the potential for media to influence children's development, it is not surprising that many researchers are interested in understanding children's daily media exposure. However, media use estimates in the absence of context present an incomplete picture. Not only can the context of media use influence whether or not media is consumed, but context can also influence the experience and subsequent effects of such media content (Valkenburg & Peter, 2013). Despite the critical importance of media context, it is inconsistently investigated in studies estimating children's media use. To address this gap, this study evaluated young children's media use through the contours of one particularly relevant context variable—parental media mediation.

Overall, results of this study support Valkenburg and Peter's (2013) argument that the context of media use matters. Specifically, the results show that different parental mediation strategies are correlated with media use in different ways. Not only are restrictive mediation strategies associated in different ways with media when compared to active mediation strategies, but even the manner of active mediation (discouraging negative content, encouraging positive content) is differentially associated with media use. Such findings have important implications for future research as well as for the messages that we share with parents about how to successfully manage media at home.

13.4.1 Restrictive Mediation

Restrictive mediation was the least common mediation style found in this sample. Nearly half of the parents in the sample reported "almost never" using restriction as a way of managing their child's media use. However, for children growing up in homes with parents who tend to rely on restrictive mediation strategies, results indicate that these children are likely to be watching less television—specifically less educational television. Interestingly, however, restrictive mediation does not seem to translate to differences in time spent with games nor does it seem to be associated with violent media content exposure. This lack of a consistent pattern for restriction is somewhat surprising. Restrictive mediation reflects parents' efforts to restrict the amount of time or specific content that their children engage with. Based on the goals of this mediation strategy, it would have been reasonable to see a negative relationship between restrictive mediation and overall media use (television and games) as well as a negative relationship with violent media content. Instead, not only was restrictive mediation not associated with game play, it was negatively associated with educational television content—a type of content one would presume parents would be less likely to restrict. It is possible that parents view television content, in general, as more concerning that game content. Early research, for example, suggests that parents perceive digital content as having greater positive consequences while television content is perceived as having greater negative consequences (Sneed & Runco, 1992). It may be that parents in our sample are more likely to restrict television content whereas they are not employing similar rules for game content because they believe that digital (game) content can be beneficial for their children. A follow-up investigation as to what restriction looks like for these families, as well as why they engage in these behaviors, would provide important insight into the findings presented here.

13.4.2 Active Mediation

While restrictive mediation was largely an unpopular form of media management for the families in this study, active mediation strategies were much more popular with the majority of families using active mediation at least "sometimes." Although previous studies had not delineated the different ways that parents can actively mediate their children's media content, in this study we looked at parents' efforts to both encourage positive media content, as well as, discourage negative media content. Interestingly, results reveal a different pattern of results for these different forms of active mediation. On the one hand, for children growing up in homes with parents who tend to discourage negative media content exposure (a form of active mediation), we see that they are *more* likely to be viewing greater amounts of television, particularly violent television, and are *more* likely to be playing violent games. Yet, on the other hand, for children who are growing up in homes with parents who prefer to encourage positive media content exposure (another form of active mediation), we again see a greater amount of television and game content, yet this content is more likely to be educational in nature.

The significant discrepancy between active mediation approaches is quite interesting. While both seem to be associated with increased media exposure, the type of media exposure that they are linked with differs dramatically. The positive relationship between discouraging negative content exposure and media violent is particularly puzzling. It may be that, for children who show a preference for violent media content, parents are more likely to actively work to discourage this form of content exposure and the effects associated with it. Alternatively, it may be that efforts to discourage negative media content consumption and, relatedly, learning from negative content—particularly violent media content—may lead to reactance among young children and create the so-called forbidden fruit effect that is often associated with restrictive mediation. In other words, by talking with children about why this content is problematic and by discouraging its use, parents may be making this content seem more attractive. Although the cross-sectional design of this study makes it impossible to identify the direction of effect, it seems somewhat more likely that parents are responding to their children's preference for negative media content since reactance (and the forbidden fruit effect) is more commonly associated with adolescence (Smetana, 1995). However, follow-up longitudinal work would provide valuable insight into the direction of this effect.

Just as longitudinal analyses would be particularly helpful in untangling the direction of effect between discouraging negative content and media use, such analyses would also be valuable for better understanding the process of encouraging positive content. The positive relationship between encouraging positive media content and time spent with educational television and games suggests that this form of mediation may be an effective way of encouraging a healthy media diet among children. However, it is also possible that—as with negative media content—there are certain children who prefer educational media content and, as such, parents respond to this by encouraging more of this behavior. And, of course, it may also be a cyclical relationship whereby parents encourage positive media, children watch and enjoy this media, and parents' mediation behavior is subsequently reinforced. Longitudinal analyses that attempt to identify direction of effect, as well as potential cyclical relationships, would be a fruitful avenue for further investigation.

13.4.3 Implications, Future Directions, and Concluding Thoughts

In all, the findings from this research offer important theoretical, methodological, and practical implications. Theoretically, this work confirms what many of our theories already tell us—that our relationship with media cannot be fully understood without appreciating the role of context. The results presented here highlight that how children's media use varies by the contextual contours of parental mediation. As such, continued efforts to acknowledge and accommodate the role of context in youth and media research is certainly justified. In particular, it is crucial that researchers move away from treating context as a variable to be adjusted for and instead establish a priori more nuanced hypotheses about the interconnected relationship between children, media, and context.

Second, methodologically, this study makes the important point that *how* parents mediate content may be as important—if not more important—than whether they mediate content. For example, here we see that different approaches to active mediation (encouraging positive versus discouraging negative) are both positively associated with overall media use but hold distinctly different relationships with specific media content. Recently, in other work, my colleagues and I have argued that parental media mediation during adolescence should be considered within the lens of parenting styles (Valkenburg, Piotrowski, Hermanns, & de Leeuw, 2013). Specifically, we argue that some of the inconsistencies in the literature as to the effectiveness of parental mediation may reflect that *how* mediation is enacted is just as important as whether it is enacted. In particular, whether restrictive and active mediation are done in a manner which supports a teen's autonomy versus in a manner which is more coercive or inconsistent is likely to influence whether a teen consumes particular media content as well as how s/he experiences it. For example, teens may be less likely to react against restriction messages that are done in an autonomy-supportive way compared to restriction messages that are coercive in nature. Based on this argumentation, we developed a revised scale for measuring parental media mediation that takes into account the manner of mediation—the Perceived Parental Media Mediation Scale (PPMMS, Valkenburg et al., 2013). Given the differences found in this study, a more nuanced methodological approach to measuring parental media mediation during early childhood also seems warranted.

In addition to a more nuanced methodological approach to measuring parental media mediation in early childhood, it is also important to consider the value of methodological replication with varied samples. At present, the majority of parental media mediation literature consists of research from the Netherlands (including this study) and the USA. While both of these countries are highly developed countries with similar media use among children and adolescents, recently, scholars have suggested that parental media mediation may work differently in these (and other) countries (Krcmar & Cingel, 2015). Specifically, Krcmar and Cingel (2015) found that predictors of parental media mediation differed significantly between Dutch and American parents. Interestingly, while worries about media and parental demographics primarily explained variance in Dutch parents' parental media mediation practices, attitude and subjective norms primarily explained variance in American parents' parental media mediation behaviors. This suggests that culture may play an important role in determining how parents mediate media, and as such, may also influence the effectiveness of such mediation. Future work which not only seeks to replicate these findings in different cultures, but also conducts cross-cultural comparisons can go a long way towards helping us better understand the role of culture in predicting parental media mediation and explaining its effects and effectiveness.

Finally, this study also lends itself to practical implications. While this correlational design does not permit evaluating which form of mediation is most effective, the findings for encouraging positive media content are particularly notable. Not only were children more likely to consume greater amounts of educational media content when their parents encouraged such content (as well as consume less violent content), but the effect size of these relationships was the largest among all of the relationships discovered in this study. Moreover, preliminary analyses with age suggest that this relationship remains present throughout early childhood (3–8 years old). Although longitudinal data is necessary to assess whether there are positive cumulative effects over time, this suggests that early adoption and continuous use of this strategy may be effective across early childhood and beyond. From the perspective of home media management then, efforts to help parents identify what positive media content looks like as well as clear tips on how to encourage this use are worthwhile. As this study shows, encouraging positive media content is already the most popular form of mediation amongst parents of young children. If we can move this behavior from being a "sometimes" behavior to an "always" behavior, we can play an important role in ensuring that young children have a healthy media diet that effectively balances quantity and quality.

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Chapter 14
Parental Mediation in an Evolving Media Landscape—Commonalities, Contrasts, and Implications for Design: Commentary on Chapter 13

Shalom M. Fisch

As the chapter by Piotrowski (2016, Chap. 13) demonstrates—and as many parents can attest—parents play important roles as gatekeepers, facilitators, and moderators of their children's use of media. Studies of parental mediation of children's media use frequently center on counteracting potential effects of negative media content, such as ameliorating the impact of violent media or overcoming gender stereotypes (e.g., Nathanson, 2004, 2014). However, parental mediation can be equally valuable in facilitating or enhancing positive effects of media as well. Perhaps the most extensive body of evidence in this area can be found in the decades of research that have documented benefits of joint parent–child book reading in contributing to children's language and literacy development (e.g., Bus, Van Ijzendoorn, & Pellegrini, 1995; Trivette, Dunst, & Gorman, 2010). Yet, these effects are not limited to print. In the case of educational television, parental mediation can result in children's exhibiting greater comprehension of the particular educational content presented on the screen or in broader, less program-specific benefits for children's language development, which arise through interactions between parent and child as they discuss material shown in the program. Similarly, positive interactions have also been found to occur during joint use of e-books and digital games. (See, for example, Takeuchi & Stevens, 2011 for a review). This commentary discusses several issues related to parental mediation that enhances the value of educational media: the nature of such mediation, how it compares across different types of media, and how media can best be designed to promote such mediation.

As reflected in Piotrowski's survey measure, parental mediation can take various forms, such as encouraging children to play an educational game, telling children that the negative behavior seen in a TV program is wrong, and so on. This variety is understandable since the form that parental mediation takes may differ as a function of whether the media content is positive or negative, and whether the mediation

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Table 14.1 Some forms of parental mediation of positive and negative media content

		Nature of media content	
		Positive (e.g., educational TV/games)	Negative (e.g., violent TV/games, stereotyped portrayals)
Timing of mediation	Before use	• Encourage use • Introduce or preview subject matter	• Discourage or prevent use • Inoculate against objectionable content
	During joint use	• Guide attention to screen and/or key elements • Provide comments or questions to facilitate comprehension and/or learning • Expand upon the presented subject matter	• Provide comments or questions to counter objectionable content • Encourage children's critical and evaluative thinking
	After use	• Engage in follow-up discussions to reinforce and/or expand upon lessons learned • Extend learning via follow-up activities	• Engage in follow-up discussions to counter objectionable content

occurs before use of a particular piece of media content, during use, or after use. To illustrate this point, Table 14.1 presents examples of some of the different kinds of mediation that can occur at each of these stages, in the context of positive or negative media content. Prior to use, parents can encourage use of positive media content or discourage use of negative content. In addition, if parents are aware of the subject matter of a particular piece of media, they can prepare children by introducing the subject matter (in the case of positive content) or "inoculating" them against negative content (e.g., by alerting children in advance to the presence of objectionable content and explaining why it is inconsistent with their family's values). During joint use of positive media, parents can draw children's attention to key aspects of the educational content, elaborate on (or spur children to elaborate on) the presented content, or draw connections between the presented content and children's own lives. Conversely, for negative media, parents can supply comments or questions to counter objectionable content, or encourage children to evaluate and think critically about the appropriateness of the content (known as *evaluative mediation* [e.g., Nathanson, 2004]). After using a media product, parents can conduct follow-up discussions to expand on positive content or counter negative content. Additionally, parents can engage children in hands-on activities to extend learning beyond the screen, such as following an educational digital game about animals with a live visit to a zoo.

To a substantial degree, all of these forms of mediation occur naturally, although the precise rate at which parents engage in such mediation varies across types of media and across specific media products. In Piotrowski's data, approximately 80 % of participating parents reported sometimes encouraging use of positive media content, and 70 % sometimes discourage use of negative media. Piotrowski's survey did not assess joint use of media (e.g., a parent and child coviewing a television program or playing a video game together), but other existing literature has demonstrated that substantial numbers of families engage in joint use as well. Approximately 90 % of families with children 5 years old or younger engage in joint book reading at least once per week (YouGov, 2015). Joint use of television and digital games is not as ubiquitous as it is for books, perhaps because young children typically cannot read books by themselves. However, significant amounts of joint use occur for these media as well: One survey of more than 1300 families found that approximately 1/3 to ½ of third through fifth graders "always" or "often" watch television with a parent (Gentile, Nathanson, Rasmussen, Reimer, & Walsh, 2012). Rideout and Hamel (2006) found coviewing to be even more prevalent among families with younger children, between the ages of 6 months and 6 years; 40 % of these children coview with their parents "all of the time" and 28 % "most of the time." Similarly, 50 % of the same families reported joint use of computers "all" or "most" of the time, and 38 % reported playing video games together "all" or "most" of the time (Rideout & Hamel, 2006). More recently, research by the Entertainment Software Association (2015) found that 59 % of parents whose children are gamers play digital games with their children at least once per week.

Of course, simply using media together does not guarantee that parents and children will engage in interactions that yield benefits beyond those of children's unaided use.[1] Rather, parents must take advantage of these opportunities to engage children in interactions (or children must engage parents in interactions) that enhance learning. Spontaneous interactions during joint media use can enhance children's comprehension and learning of the educational content in a television program (e.g., Reiser, Tessmer, & Phelps, 1984; Reiser, Williamson, & Suzuki, 1988) and/or contribute toward more general language and literacy development while viewing a television program or reading an e-book (e.g., Chiong, Ree, Takeuchi, & Erickson, 2012; Fisch, Shulman, Akerman, & Levin, 2002; Lemish & Rice, 1986).

Indeed, media can be designed intentionally to incorporate production features that promote parent–child interaction during joint use. For example, Fisch et al. (2008) found that adding a line of parent-directed, on-screen text to a television program successfully prompted parents to engage their children in content-related interactions during coviewing. Brooks, Fenwick-Naditch, and Branch-Ridley (2011) found that, to best elicit parent–child collaboration during a game designed for intergenerational play, it was necessary to build features into the game that clarified the parent's role, structured the point system to reward joint play and highlight each player's contribution, and provided instructional support to scaffold play. Drawing on research and experiences from numerous projects, Takeuchi and Stevens (2011) identified several design principles for the creation of digital media that promote joint parent–child engagement effectively:

[1] In fact, in the absence of appropriate interaction, joint media use can send unintended messages that may be the opposite of the parent's intent. For example, in the case of negative media, when parents watch negative television content without reacting, children may take the parent's silence as tacit approval of the on-screen behavior (Nathanson, 2001).

centering on child-driven experiences, incorporating appeal on two levels to attract and engage both parents and children, assigning distinct but collaborative roles to parents and children, scaffolding parents' involvement as well as children's, building upon past experiences and existing curiosities, providing opportunities for cocreation, and tailoring the media to fit the constraints of families' schedules and logistical considerations. At the same time, though, it is equally important not to overdesign such media; Chiong et al. (2012) found that basic e-books promoted content-related interactions that were comparable to traditional print books, but enhanced e-books were less successful because users were distracted by numerous extraneous bits of interactivity that did not tie directly into the story or literacy-based activities.

As can be seen from the examples throughout this commentary, comparing joint use across media platforms reveals both similarities and differences. For example, many of the same kinds of interactions have been found to occur while experiencing a story, regardless of whether that story is presented in a book, e-book, or television screen: drawing children's attention to key content on the screen, making inferences and elaborating on on-screen events to support comprehension, connecting on-screen objects or events to similar real-life events in children's own lives, and so on. Yet each medium also presents its own affordances and constraints, which influence the interactions that occur during use, such as the inability of young, preliterate children to read text by themselves, which probably contributes to the higher rate of joint use of books vs. other media (as supported by the fact that joint book reading declines as children grow older; YouGov, 2015). Conversely, during joint use of digital media, usability issues often give rise to interactions such as parents' showing children where to click or how to use an interface, whereas parallel interactions are less likely to appear in joint use of television or books.

The growth of online videoconferencing technology and multiplayer games brings opportunities for new types of parent–child interaction as well. Children and their parents (or even grandparents) no longer even need to be in the same physical location to share a story or game (e.g., Raffle et al., 2011). Interactions that have traditionally taken place in front of a screen can now occur through a screen, allowing for shared experiences that bridge vast geographic distances. To what degree does the nature of such interaction resemble or differ from the interactions that occur when parents and children are in the same room? How do parents facilitate the use of positive media from a distance? Can parents effectively prevent use of negative media when they are not co-located with their children? Future research will be needed to explore the nature of "remote mediation" in the context of these emerging media (see Chap. 15, McClure & Barr, 2016).

Indeed, the constantly evolving media landscape makes it difficult to predict what other new forms of media will emerge in the coming years, and what affordances or constraints they may present. Still, no matter what new media arise, the consistent interactions observed during joint use of books, television, and digital media suggest that parents will continue to play an important role in mediating their children's use of a wide range of media platforms.

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Chapter 15
Building Family Relationships from a Distance: Supporting Connections with Babies and Toddlers Using Video and Video Chat

Elisabeth McClure and Rachel Barr

Modern living conditions, including labor mobility, military deployment, divorce, and parental incarceration, have led to the need for many families to maintain relationships with one another at a distance. When families—especially those with very young children under 2 years—are geographically separated, forming warm family relationships can be a challenge. Many circumstances can lead to this outcome. For example, as many as ten million children in the United States experienced at least one military deployment of a loved one between 2003 and 2013; and 37 % of children with a deployed parent are under the age of 6 (American Academy of Pediatrics, 2013a; Dayton, Walsh, Muzik, Erwin, & Rosenblum, 2014). Furthermore, as of 2007, 1.7 million children in the USA had an incarcerated parent (American Academy of Pediatrics, 2013b); 92 % of incarcerated parents were fathers and 22 % of their children were under the age of five (National Resource Center on Children and Families of the Incarcerated, 2007). Additionally, more than one million children per year experience the divorce of their parents (American Academy of Pediatrics, 2002) and one third of children born in the US are born outside marriage. Of those fathers who are unmarried at the time of birth, approximately two thirds of them no longer live with their children at age 5 and their parenting involvement varies widely, with approximately three quarters of fathers having infrequent or no contact with their children (Carlson, McLanahan, & Brooks-Gunn, 2008).

Close family relationships are known to be of critical importance for child development, especially for children under the age of three (Cassidy & Shaver, 2008),

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so these familial separations are important to consider. Parent–infant relationships are especially significant; in fact, mother–infant interaction, on which most parent–infant research has been conducted, has been called “the cradle of social understanding” (Rochat & Striano, 1999), and it supports the development of attachment, communication and language acquisition, and emotion regulation (Bornstein & Tamis-LeMonda, 2001). Thus, the physical or emotional absence of a parent during the early years of a child’s life puts these infants at risk for a number of negative outcomes, including an insecure attachment to the absent parent (Tomlin, Pickholtz, Green, & Rumble, 2012).

Moreover, the number of families living in multigenerational family households in the USA has decreased since the 1940s from 25 % to 16 % in 2008 (PEW, 2010). Circumstances like labor mobility, the change in location of workers across different jobs and geographical areas (Long & Ferrie, 2003), can lead these extended families to live far apart from one another. According to the Pew Research Center (2008), those Americans who move away from their hometowns most often cite economic opportunity as their reason for doing so; and those who choose not to move most often cite family connections as their reason for staying (Pew Research Center, 2008). Grandparents and other extended family members are considered very important for young children and are drawn upon extensively in many cultures. Indeed, shifting demographics suggest that grandparents may play an increasing role in childrearing (Dunifon, 2013). The effects of nonresidential grandparents on child outcomes have been mixed, but geographical distance is a significant predictor of the association between grandparents and child outcomes, with less geographical distance associated with stronger effects on child outcomes (Dunifon, 2013).

What can be done to promote the development of warm attachment relationships between these very young children and their remote parents and relatives? Fortunately, rapid developments in communication technology are transforming our ability to interact at a distance. In the present chapter we explore the role that technology can play in facilitating communication between very young children and their distant family members. We will focus on how technology both old and new has been co-opted into this service. Formal interventions that use older technologies like video recordings, as well as informal opportunities to use newer technologies like video chat, are allowing these families to form and maintain bonds at a distance like never before. First we will discuss how unidirectional video technology has been used in parenting interventions and to facilitate shared book reading experiences. We will then discuss how families use newer video mediated communication (“video chat,” e.g., Skype, FaceTime, Google Hangouts), which is now readily and widely available, to interact remotely. Because of the novelty of this technology, there is very little research on the frequency of video chat usage among young children, especially among infants and toddlers, and no specific recommendations or policies exist for families and very young children regarding video chat use. Families should be mindful of this, while also using the existing information to make informed decisions for their own circumstances.

15.1 Media Interventions

15.1.1 Noncontingent Unidirectional Video Interventions

Formal interventions that use video recordings, like *The Just Beginning "Baby Elmo" Program* and the *United through Reading* program, have been shown to be effective at improving the remote relationships of parents and their very young children. A number of other very effective programs have also been developed for at-risk groups of children and delivered via outreach services within the media industry. Truglio and Kotler (Chap. 16) will describe these effective approaches in more detail.

The *Just Beginning* (aka "*Baby Elmo*") *Program* is a research-based parenting and structured visitation program for incarcerated teen parents, most often teen fathers, which targets the parent–child relationship and aims to enhance the quality of interactions, foster secure attachments, and maintain strong bonds during the period of incarceration and remote parenting (Barr et al., 2014). The program is inexpensive and easy to implement, and it can be integrated into other mental health and education programs within the facilities. The curriculum is written simply, so that no technical background is needed to put it into service. Adopting a strengths-based approach, media was incorporated into the intervention to maximize its utility for incarcerated teens, who typically have low literacy rates but a high affinity for and proficiency with digital media. As most incarcerated teens read at a fourth-grade level, the bulk of instruction is conveyed through videos, produced by *Sesame Street*'s Early Childhood Education Department, that give clear, visual examples of the parenting skill to be taught. Youth and families are already comfortable with media and the Sesame Street characters. High-quality play during a parent–child interaction is an essential component of quality parenting interventions and is central to developing a lasting positive and warm relationship. The *Sesame Street* videos are able to clearly depict positive, warm parent–child interactions, which can otherwise be difficult to describe. This is particularly important for incarcerated parents who do not have daily opportunities to interact with their children and often do not have a positive model of interactional quality. On the basis of extensive pilot testing, the program now includes five unique sessions, each centered on how to improve upon a different aspect of the father–child relationship. The sessions are composed of a teaching portion followed by a contact visit where the youth is able to practice the skills learned during instruction.

The five-session curriculum is delivered once a week. In the initial session youth learn the basics of attachment theory and stranger anxiety, and the remaining four sessions expand upon the initial interactions with the baby. Session 2 introduces the idea of following the baby's lead to help encourage synchrony, and the father learns to engage with the child in activities that the child chooses. In Session 3, the father learns how to incorporate language in playtime by labeling objects with which the baby is playing. In Session 4, the father learns to encourage his child to show his affection. In Session 5, the father reviews and practices all the skills that he has learned. Each visit lasts approximately 45 min. Participants are encouraged to incorporate into the visit those skills that they have learned in the instructional component. The visits take place in a room designed by the facility and the young fathers to be baby friendly: There are *Sesame Street* characters painted on the walls, and there are floor mats, fire trucks, mirrors, and other toys meant for the dyad's use. Activities range from "tummy time" with infants to "tag" with older toddlers.

The evaluation results indicate improvements in quality interactions and communication; this improvement in the interactional quality of the relationship increases the likelihood that the dyad will form and maintain a positive relationship with one another (Barr et al., 2011, 2014). Structured interviews showed that during the course of the program, fathers developed more specific and positive knowledge of their children's personalities and a greater understanding of their impact on the children's futures (Richeda et al., 2015). Facilities also became more "father friendly" after the introduction of the program. Some facilities have invited families to graduation celebrations and holiday family gatherings. Finally, fathers' negative behavior in facilities decreased upon program entry and the positive change was sustained after program completion for the time that they remained incarcerated, providing preliminary evidence that the intervention participation was associated with improvements in fathers' behavior beyond the parent–child relationship. Taken together, evaluations of the *Just Beginning "Baby Elmo" Program* have shown positive changes in the quality of father–child interactions for children from 3 to 36 months old (Barr et al., 2011, 2014), an overall reduction in fathers' misconduct, and increases in fathers' acceptance and awareness of their influence on their children (Richeda et al., 2015).

United Through Reading is another parenting program that uses unidirectional video recordings to help maintain bonds between remote parents and their very young children (Yeary, Zoll, & Reschke, 2012). This program was founded in the late 1980s to allow deployed parents to create video recordings of themselves reading a children's book aloud. These videos are then sent to the service members' children at home, who can watch them as often as they like—83 % are watched nearly every day or more—to help maintain a sense of presence of the absent parent in the home. According to a recent report from the organization (United Through Reading, 2014), families who have participated in the program have a remarkably positive response to it: 81 % of participants say it helped their children have less anxiety about deployment and 88 % say it helped them feel more connected to the deployed parent. This intervention has been very successful in using a simple technology to help over a million separated families maintain connections at a distance (Yeary et al., 2012).

Both *Just Beginning* and *United Through Reading* are interventions that utilize noncontingent video technologies. In other words, parents and children are not able to interact and respond to one another in real time. Prerecorded videos restrict communication to simple one-way interactions, so while they may be successful on some fronts, they are limited in their ability to support complex reciprocal interactions.

15.1.2 Evaluating Video Chat as a Novel Approach

Today, newer technologies are allowing more interactive communication to take place at a distance. Families with school-aged children have reported using video chat to help their children develop and maintain relationships with parents who are separated from them by work (Yarosh & Abowd, 2011), divorce (Yarosh, Chieh, & Abowd, 2009), or immigration (Madianou & Miller, 2012), as well as with remote grandparents (Ames, Go, Kaye, & Spasojevic, 2010). For example, a deployed parent can now access video chat technologies to interact and play visually and in real time with his or her child at home. In fact, a significant proportion of military families now use some form of computer mediated communication technology to keep in touch during deployment. According to Blue Star Families (2010), 88 % of the military family members surveyed reported using some type of social media, and 50 % of these used it regularly for communication and connection during a deployment. Of these, 43 % reported using Skype with a deployed family member. Other sources report that some military families are using video chat services like Skype and FaceTime to allow deployed service members to witness and participate in the birth of their children; some to initiate relationships and familiarity with their infants, whom they have never met; and some to maintain existing relationships with their young children (Yeary et al., 2012).

Because video chat offers the ability to interact contingently in real time, it promises to be a more effective intervention than videos for parenting at a distance. However, video chat is often used informally by families who have existing access to free software, like Skype or FaceTime, rather than as part of a formal intervention program. Some applications—like Kindoma's *Storytime* app—are designed to help support structured video chat activities like reading books aloud; however, they are still used informally and without specific programmatic support by families with access to them at home. For this reason, these resources do not easily lend themselves to quantitative program evaluations like those conducted on *Just Beginning* and *United Through Reading*, and thus, few studies have evaluated their effectiveness for parenting at a distance. We do know that the prevalence of smartphone ownership among families with young children has grown in the past 5 years—75 % of families with children between 0 and 8 years of age own smartphones or some other mobile touchscreen device (Rideout, 2013)—suggesting that video chat has become more accessible. One recent survey on video chat usage patterns was conducted in Washington, DC, a location with high levels of labor mobility. Under these conditions, parents reported that 85 % of 6- to 24-month-olds had used video chat at some point, that nearly 60 % used it several times a month or more, and 37 % used it regularly at least once a week. The majority of these calls were to geographically remote grandparents, and 91 % of families reported using it most of the time to communicate with people who live far away (McClure, Chentsova-Dutton, Barr, Holochwost, & Parrott, 2015).

While relatively little is currently known about the effectiveness of video chat for supporting relationships between infants and remote family members, preliminary studies have shown that toddlers remain content for longer when they have access to a parent via video chat than when they are completely alone (Tarasuik, Galligan, & Kaufman, 2011) or when they have access to a parent via audio-only telephone (Tarasuik, Galligan, & Kaufman, 2013). There is also evidence, however, that two-dimensional media can be difficult to process for toddlers (for review see Barr, 2013; Chap. 3, Hipp et al., 2016), which may suggest that video chat technologies would make little difference to such young children.

Video chat appears to be a promising approach for parents and grandparents attempting to maintain connections with infants at a distance; however, with little existing research to support the practice, it is necessary to estimate its effectiveness using indirect evidence from the existing literature on infant development and on human–computer interaction. The evaluation of screen exposure in the early years has often been broken down into categories following "the three C's"—Content, Context, and the individual Child (Guernsey, 2012, see also Chap. 2, Guernsey, 2016)—and this practice can be utilized here as well. Specifically, the content and context of video chat can be compared to other communication technologies and to interactions that take place face-to-face, areas in which extensive research already exists, thus providing some insight into what may be expected from video chat.

15.2 The Content and Context of Video Chat

The content of video chat can be considered in two ways: It can be compared to other communication technologies like audio-only phone calls and prerecorded videos; and it can be compared to the rich social interactions that take place face-to-face. Fortunately, research on these comparison scenarios is more abundant than that on video chat itself and can help direct our expectations for video chat.

Exploring the content of these communication forms alone, however, would be a mistake. The context in which babies and toddlers use media can make a critical difference in the way they experience the content. For this reason, the potential consequences of both the content and context of these communication media will be examined together throughout this section.

15.2.1 Comparing Video Chat to Other Forms of Technology

First, how might the content of video chat interactions between relatives and very young children compare to those on audio-only telephone? Both media allow contingent, real-time interaction between the involved parties, which is a substantial benefit; however, video chat has an additional visual element. This visual dimension allows the parties to communicate using nonverbal cues, including facial expressions and gestures, and to witness the surrounding physical context of the conversation. Given the restricted content of audio-only telephones, it is not surprising that children up to 7 years of age tend to have difficulty using this medium to communicate successfully (Ballagas, Kaye, Ames, Go, & Raffle, 2009). Furthermore, because the use of audio-only telephones requires verbal and cognitive skills that they have not yet acquired, infants and toddlers under three are especially unlikely to be able to use such media effectively. Ballagas et al. (2009) suggest a visual medium like video chat as a developmentally appropriate alternative to traditional telephone use for young children. As a contingent visual medium that does not rely exclusively on verbal ability, video chat is a promising mode of communication for children under three when compared to simple audio-only telephone calls.

How might video chat compare to prerecorded videos, like those used by *United Through Reading*? While video is a visual medium and can thus afford many of the same benefits as video chat—exchanging rich nonverbal communication and sharing the visual context of the interaction—it is not a socially contingent one. For children under three, this is especially important due to the existence of the *transfer deficit*, previously known as the *video deficit* (Anderson & Pempek, 2005), a deficit in transferring information from two-dimensional (2D) to three-dimensional (3D) real world contexts (see Barr, 2013 for review; Chap. 3, Hipp et al., 2016). Some researchers have argued that the lack of social contingency in video content dramatically reduces the social relevance of information presented on screens for very young children, thus limiting their learning (Troseth, 2010). The context of children's exposure to video does play an important role in moderating young children's learning, however (see Chap. 11, Anderson & Hanson, 2016; Chap. 13, Piotrowski, 2016). Furthermore, when contingency can be reintroduced via video chat, learning dramatically improves. For example, Roseberry, Hirsh-Pasek, and Golinkoff (2014) compared 3-year-olds on their ability to learn new verbs, a task that is both difficult and important for young children. Children were exposed to the new verbs via either face-to-face interactions, prerecorded video, or video chat. Although children did not learn the verbs via prerecorded video, they were able to learn equally well from video chat and face-to-face interaction (see also Troseth, Saylor, & Archer, 2006; Chap. 17, Zosh, Roseberry Lytle, Golinkoff, & Hirsh-Pasek, 2016). Recent evidence, however, suggests that there are some limitations to the ability of video chat to overcome the transfer deficit, particularly in the domain of person recognition (Kondrad, Soska, Keen, & DeLoache, submitted for publication). It is also important to note, though, that it may be possible to mediate some of the remaining transfer challenges via the *context* of video chat interactions (see Sect. 15.2.2). For a number of reasons, then, video chat remains a promising approach for maintaining remote relationships between babies and adults.

15.2.2 Comparing Video Chat to Face-to-Face Interactions

Despite the increased contingency of video chat interactions relative to prerecorded videos, they are still limited by a number of factors relative to face-to-face interactions. Human–computer interaction research on both adults and older children has identified that the loss of physical contact, the misalignment of gaze, and delays in social contingency contribute to poorer social interactions during video chat (Parkinson & Lea, 2011; Ballagas et al., 2009). Other factors include the limitation of movement and the restriction of users to a head-on orientation toward one another; a limited range of sight; the loss of olfactory signals; the reduction in dimensional space from three dimensions to two; and the fact that the size of depicted objects on screen tends to be larger or smaller than the actual objects (Parkinson & Lea, 2011). One cannot assume that the effects of these differences are the same for adults and young children, but consideration of the probable effects of *all* the aforementioned factors on infants is beyond the scope of this chapter. While developmental constraints may contribute to the processing of any of these, three of the most striking differences between video mediated and face-to-face interactions—physical contact; eye contact (and, by extension, all joint visual attention); and contingency and reciprocity—are considered below.

Of course, many of the limitations of video chat may be less critical than expected when one considers the *context* of adult–infant video chat: Children under two are too young to intentionally establish a video call on their own, so they will always be in the company of a physically present caregiver during the interaction. Investigating video chat in this context may alter our analysis of its risks and benefits. Unlike audio-only phone calls, in which physically present caregivers can often only hear one side of the conversation and are thus incapable of participating in the child's exchange, video chat allows a caregiver to see and hear both sides of the interaction. This affords the caregiver the opportunity to participate and support the ongoing video-mediated interaction.

The potential for physically present caregivers to scaffold successful adult–infant video chat is supported by evidence from recent observations of naturally occurring video chat interactions between 6- to 24-month-old babies and remote relatives (McClure, Chentsova-Dutton, Holochwost, Parrott, & Barr, in revision). As predicted, physically present caregivers play a major role in mitigating the developmental constraints babies encounter when using video chat, providing creative solutions to counteract the loss of physical contact, the misalignment of eye contact and JVA, and delays in social contingency. The content limitations of video chat (relative to face-to-face interactions) for infants and toddlers, as well as the contextual scaffolds provided by the present adults in such circumstances, will be discussed below.

15.2.2.1 Physical Contact

The typical physical contact that would normally take place between adults and young children in a face-to-face interaction (Stack, 2001) is most certainly compromised in video mediated interactions. Physical contact is a very important part of adult–baby interactions. For example, physical contact helps maintain higher levels of smiling and attention in babies as young as 3 months old compared to no physical contact (Stack & Muir, 1990). Physical contact is also important among nonhuman primates. In his historic research, Harlow demonstrated that the proximity-seeking behaviors of infant monkeys to their mothers were not due exclusively, or even primarily, to the mother's ability to provide food to her infant; instead, infants appeared to seek out their mothers more for the physical contact comfort she could provide (Harlow, 1958).

What might happen when parental physical contact is unavailable? Nonhuman primates in such cases will seek out, and even work for, *visual* contact with their mothers. When Harlow's (1958) infant monkeys were placed in a box with a covered window that provided visual access to their surrogate mother, they repeatedly uncovered the window for hours on end, for no other reward than visual access to the mother. In a separate study, Levine and Wiener (1988) found that the cortisol levels induced in infant monkeys by physical isolation from their mothers were reduced by visual access to them. These studies suggest that infant monkeys can receive some relief from the stress of maternal separation by accessing their mothers visually.

Might this be true of humans as well? Tarasuik et al. (2011) used an adaptation of the Strange Situation Protocol (Ainsworth & Wittig, 1969) to investigate the emotional security that could be afforded to young children through access to their mothers via live video link. As mentioned previously, they found that children left alone in a room with a live video link to their mothers were content for longer and played for a greater percentage of the time than when they were left alone in the room with no access to their mother at all. This study suggests the promise of video chat, but, as many controlled lab experiments do, it also fails to consider the context of the phenomenon: Due to the technical sophistication required to start and maintain a video call, an infant will never be alone during such calls and thus is likely to have some degree of physical contact with a different, physically present adult during a video call. Furthermore, the comparison group for an infant having visual access to an absent adult is very unlikely to be an infant alone in a room; it will instead be the infant having both visual and physical access to a present caregiver. Considering this context is critical to understanding infant interactions in video chat.

McClure et al. (in revision) investigated this context, and their research suggests that families find creative ways to simulate physical contact through the screen in meaningful ways. For example, infants and toddlers are regularly encouraged to kiss and hug their virtual partners *by proxy* by kissing or hugging the screen. The children in this study also often pretended to exchange physical objects with their screen partners. For example, they often offered toys or food through the screen to their virtual partners, who pretended to accept these physical objects and interact with them on the other side of the screen. In such exchanges, the virtual adult frequently offered an appropriate object back through the screen to the child. For example, many children offered the virtual adult a snack item through the screen, which the adult would then "eat" (see Fig. 15.1).

These pretend physical interactions sometimes took the form of activities as well. In one remarkable case, a grandmother began singing a dance song and extended her arm above the camera, pretending to hold the 15-month-old child's

Fig. 15.1 Sequence: Baby offering raisin through the screen. *Left panel* is of the child; *middle panel* is the child offering toward the remote adult; *right panel* is of the remote adult pretending to eat the raisin

hand over his head; the child did likewise, pretending to take her hand, and he began to spin in circles under his arm as though his grandmother was twirling him in a dance. Physically present caregivers can also play an important role in these simulated physical activities. For example, one grandmother recited the "This Little Piggy Went to Market" nursery rhyme, while the physically present mother pinched each of the 20-month-old child's toes in coordination with the song and tickled the child at the appropriate time, all as a proxy for the grandma. The mother did not make any sounds of her own or even place herself directly in the child's visual field, to maintain the illusion that the grandma was the one providing the physical contact.

While physical contact with the virtual adult may be impossible, families appear to be finding creative ways around this limitation. Remote adults and children can simply pretend to touch one another or share physical items, and physically present adults can also offer themselves as proxies for physical contact between them. The present adult is also available to interpret any confusion or missed cues that arise during these pretend interactions. In this way, remote relatives may still be able to maintain the child's attention and encourage positive emotional responses (like smiles) from the child by simulating the physical contact they would otherwise offer in person. It is not currently known whether these simulations are as effective as their face-to-face counterparts.

15.2.2.2 Visual Cues

Direct eye contact and joint visual attention (JVA; including pointing as a communicative gesture) are also compromised in video mediated interactions. This is especially important for preverbal infants, who rely heavily on nonverbal behaviors, including gaze cues and joint attention gestures, to communicate with others. Given that JVA is a key ingredient in successful communication and develops rapidly during the first 2 years of life, it is important to consider how this deficit will impact interactions between children under 2 and adults interacting with them both on the screen.

Eye contact. Eye contact is a critical part of successful social interactions for all age groups, beginning during early infancy. For example, infants as young as 3 months of age react less socially when eye contact is absent in social exchanges, smiling 50 % less than when eye contact is present (Hains & Muir, 1996b). Very young infants also use eye contact information to form preferences for others. For example, infants as young as 2–3 months old exhibit a visual preference for a stranger who previously fed them while making eye contact, while this preference is not exhibited toward a stranger who looked at their foreheads while feeding them (Blass & Camp, 2001).

Unfortunately, direct eye contact is compromised in video chat. Consider that preinstalled or manually attached web cameras tend to be located above the computer monitor, where faces are displayed during video chat. When a user attempts to make eye contact with a partner's face as it is presented on the screen, the user is directing his or her gaze several inches below the camera's aperture. The image that is transmitted to the user's partner is that of the user gazing several inches below the receiver's eye level (Grayson & Monk, 2003). Given the importance of direct eye contact for infants, it may be that this misalignment of eye contact will lead to less social behavior on the part of an infant in video mediated interactions, including less smiling and a lower likelihood of preference for the mediated social partner in future interactions.

As before though, one must consider the context of these interactions, including the presence of a caregiver with the child. Physically present caregivers play a critical role in diminishing the potential negative effects of misaligned eye contact and JVA in video chat. Even though the intended eye contact of the remote adults may be quite misaligned initially, the physically present caregiver can intervene to limit the degree of this misalignment, for example by providing verbal instructions for how to remedy it. In the observational study by McClure and colleagues (in revision), one mother instructed the remote grandparents throughout their call on how to more effectively make it appear that they were making eye contact with their 6-month-old grandson. At the end of the call she gave instructions to the grandmother when she leaned in toward the camera and her face went off the screen:

Grandpa : (to Baby) Good bye!
Grandma : (to Baby) I love you! {leans in and goes off screen}
Mother : (to Grandma) Mom, you can stare straight into the screen, cuz then…
{Grandma adjusts}…yeah, I can see you straight on now. Otherwise, it uh…
Grandma : (to Mother) I'm taking up too much…?
Mother : (to Grandma) Yeah. And then you remind me of his great grandma. {laughter}
(to Baby) That's how Great Grandma Skype's with you, right? {laughter}

Figure 15.2a and b demonstrate the effectiveness of this instruction. Not only did the correction allow for better eye contact, it remedied the more severe problem of the grandmother's near-complete disappearance from view.

Without the participation of the physically present caregiver, the misalignment of eye contact would seem to be an insurmountable limitation of video chat as an effective communication medium between infants and remote relatives. When one considers the context of these calls, however, it becomes clear that this problem can

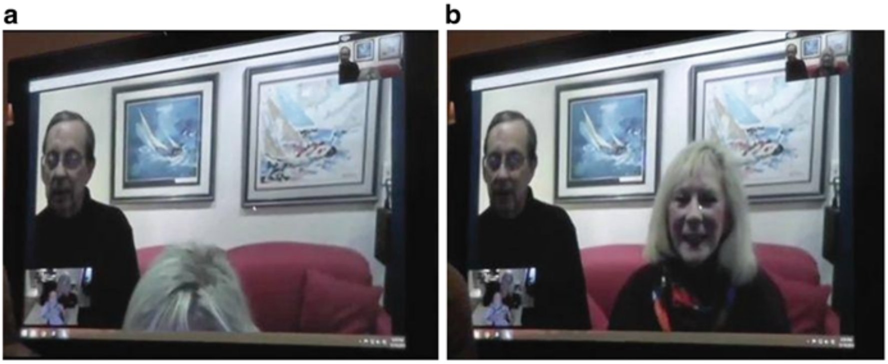

Fig. 15.2 (**a**) Before instructions. (**b**) After instructions

at least be ameliorated by the feedback of the caregiver assisting the child. However, given the high degree of sensitivity infants have to eye contact—the difference between looking in their eyes or at their foreheads was enough to lead to different preference-formation in 2- to 3-month-olds (Blass & Camp, 2001)—it is not clear whether these kinds of corrections are effective enough to simulate the kind of eye contact required to produce typical levels of infant responsiveness during social interactions (Hains & Muir, 1996b).

Joint visual attention. Infant sensitivity to changes in gaze direction is crucial for the development of "joint visual attention" (JVA), a phenomenon that has been said to form "a bedrock for shared social realities" (Butterworth, 2004, p. 213). JVA is simply "looking where someone else is looking," or more subtly, "following the direction of attention of another person to the object of their attention" (Butterworth, 2004, p. 213). Before 9 months, parents support JVA by adjusting their own gaze to the attention of the infant (Bakeman & Adamson, 1984). Starting around 9 months, the infant begins to more frequently initiate the exchange of attention, to reference third-party objects, and to follow the adult's gaze (Bakeman & Adamson, 1984). Both of these types of JVA exchanges may be disrupted in video chat simply due to the aforementioned eye gaze misalignment.

Furthermore, it is not until 18 months that babies begin to search for objects behind them when an adult's visual attention is directed there (Butterworth & Cochran, 1980). Given the close proximity of the infant participant to the webcam in video chat, if screen partners reference something in the infant's environment the object is likely to be *behind* the infant. For this reason, video mediated JVA initiated by the screen participant is likely to be limited for children under 18 months, as least without the scaffolding of another adult.

Moreover, once infants do begin to consider the area beyond their peripheral vision as valid space for JVA, their *own* initiations of JVA may become difficult to understand for their screen partners. If a child points, for example, to an object within his own environment but beyond the view of the webcam, his screen partner will not understand the reference. In fact, pointing, which by 14 months makes up

Fig. 15.3 Baby points off-screen

55 % of infant gestures (Franco & Butterworth, 1996), may be compromised in video chat in other ways as well. First, if the child points to something in the environment of his screen partner, then the pointing gesture, like gaze direction, will be misaligned from the perspective of his partner due to the relative position of the camera: all pointing gestures will appear to reference objects below the eye line of the receiver. Second, due to the close proximity of the pointer to the camera, there will be little angular distinction in the direction of a sender's pointing gesture, making it difficult for their partner to interpret which specific object is being referenced. Whether an infant is the sender or receiver of a pointing gesture during video chat, successful JVA may be challenging.

Here, too, the physically present adult can play an important role, verbally interpreting or otherwise scaffolding JVA when confusion arises (McClure et al., in revision). For example, when one party looks beyond the visual field of the screen, it is difficult for the remote partner to understand what is being referenced. The adults in such scenarios can benefit by verbally communicating the intent of these looks and gestures. For example, a physically present mother can interpret a baby's pointing gesture for his remote grandparents, as in the following case:

Mother : (to Grandma & Grandpa) His new favorite thing is to watch the garbage truck in the morning.
Baby : {points to the front window, which is out of the visual field of the screen}
Mother : (to Baby) Yeah, that's where you see the trucks, isn't it? Outside the window, yeah!

While the mother in this case directed her words toward the 18-month-old baby, she was simultaneously providing information to the remote grandparents, who would otherwise not know toward what the child was pointing (see Fig. 15.3). This strategy allowed them to maintain a natural conversation style without referencing the limitations of the medium.

Caregivers are also able to verbally instruct older toddlers on how to properly initiate JVA through the screen. For example, they can describe to the child the importance of bringing objects to the screen and putting them in front of the camera so that the remote relative is able to see them. In the following case, a mother instructed her 23-month-old toddler on how to show his remote grandmother his toy airplane.

It required more than one attempt, but ultimately they were successful. This scenario begins with the baby holding an iPhone in one hand and his toy airplane in the other:

Baby : *Hi Yaya!*
Grandma : *Hi [Baby]! What are you doing?*
Baby : *Airplane! {starts poking the screen with the airplane}*
Grandma : *{appears confused} You want to see the puppy?*
Mother : *(to Grandma) He wants to show you his airplane.*
(to Baby) Come here, hold it here. {shows him where to hold the airplane in front of the screen}
Grandma : *(to Baby) Ohh, let me see! Hold it here.*
Baby : *{puts the airplane on the floor}*
…
Mother : *(to Baby) What's this? {off screen, picks up airplane from the floor}*
Baby : *(to Mother) Airplane!*
Mother : *(to Baby) Show Yaya your airplane.*
Grandma : *(to Baby) Where's your airplane?*
Baby : *{turns iPhone screen toward the airplane, which is still held by Mother}*
Mother : *(to Baby) There it is!*

Here, the mother not only interpreted the baby's failed attempt to initiate JVA the first time (poking the screen with the airplane) by verbally informing the grandmother, but she also instructed the child in how to successfully initiate JVA in the future ("Hold it here."). While her instructions did not produce a successful instance of JVA immediately, she continued to encourage the attempt and ultimately supported a successful interaction involving the airplane later in the conversation.

The misalignment of eye contact and JVA is a significant limitation of video chat for children under 3 years of age, since much of their communicative ability relies on these nonverbal cues. Despite the disruptions to eye contact and JVA, these examples illustrate the potential for a positive outcome, as both physically present and video mediated adults can be employed to aid in the success of the interaction. Physically present adults can scaffold their infants' video mediated interactions by verbally interpreting the JVA cues (including pointing and gaze direction, e.g., the truck out the front window) of both the infant and mediated adult parties for one another. It is also possible that infants may be able to *independently* and successfully follow the gaze or point of a video mediated partner if the partner's attention is directed toward an object or event within the partner's own environment (Hood, Willen, & Driver, 1998)—for example, when a grandmother brings a toy to the screen to show the baby. While the caregiver's feedback, clarifications, and instructions may not remedy the problem entirely—i.e. eye contact will never be fully aligned given the location of the camera relative to the screen—adaptations to this novel situation can occur. This is an encouraging possibility, and one that provides the potential for successful triadic child–adult–object play across the medium.

15.2.2.3 Social Contingency and Reciprocity

The social contingency and/or reciprocity of adult–infant interactions may also be impaired in video mediated interactions. Social contingency is defined as "an interaction in which a sequentially dependent, close temporal relationship exists between the infant's social behavior and the adult's reply" (Dunham & Dunham, 1995). Reciprocity occurs when an adult both acknowledges and responds appropriately to the infant's preceding behavior (Dunham & Dunham, 1995).

The social contingency and reciprocity of interactions can be compromised in video chat in at least two ways. First, the adult's ability to respond in a timely and appropriate manner to the infant's JVA cues can be compromised by visual misalignment, as described previously. Second, it is typical for users of video chat to experience some degree of noticeable delay in their connections (and, therefore, in their interactions) due to limited bandwidth or other connectivity disruptions. In fact, the average delay in a video chat conversation is between 290 ms (Google Plus) and 788 ms (Skype) (Xu, Yu, Li, & Liu, 2012). Some studies have shown that a delay of less than 150 ms is optimal for communication (Roberts, Duckworth, Moore, Wolff, & O'Hare, 2009), and the mutual attunement of adults can be sensitive within a timeframe of 50 ms (Condon, 1982)—well below the frame-rate of most popular video chat software. Furthermore, while large, noticeable delays tend to cause somewhat obvious disruptions in the conversation, even minor, unnoticed delays of 200 ms in adult interactions can lead to a sense of greater communication difficulty (Parkinson & Lea, 2011). Bandwidth delays can also lead to lost frames in the video transmission, resulting in a jerky image and a possible loss in the discrimination of brief but important facial expressions (Parkinson & Lea, 2011).

Babies can distinguish between contingent and noncontingent stimuli starting very early in infancy (Gergely & Watson, 1999). For example, at as early as 6 to 12 weeks of age infants exhibit negative facial expressions in the absence of social contingency in both still-face procedures (Fogel, Diamond, Langhorst, & Demos, 1982) and in the video playback of prerecorded interactions (Nadel, Carchon, Kervella, Marcelli, & Réserbat-Plantey, 1999), suggesting that they expect contingent responses from others. Contingency also plays an important role in maintaining infants' attention during social interactions, again starting at a very young age. For example, Hains and Muir (1996a) found that 5-month-olds were more visually attentive to both live video link and face-to-face interactions with strangers, than to a video replay (i.e., noncontingent) version of the stranger interaction. While these infants had an equal level of visual attention to both the face-to-face and the live video link interactions, infants smiled earlier and more often in the face-to-face interaction, suggesting that babies are able to detect very subtle differences between video chat and face-to-face interactions starting early in life.

A young infant's preference for contingency may also have lasting effects on the child's response to their social partner if contingency is compromised. For example, 4- to 5-month-olds have been shown to prefer individuals with whom they have had contingent interactions in the past over those whose interactions were noncontingent (a video replay from a previous interaction), even 6 days later (Bigelow & Birch, 1999). In the context of video chat, if an infant experiences a contingency delay during a video mediated interaction, the infant may be less likely to prefer attending to that social partner—at least on screen—in the future. This could result in a cascading effect on the infant's motivation to develop a strong relationship with that social partner, at least when using video chat exclusively.

According to Braarud and Stormark (2008), mothers are similarly quite sensitive to the social contingency of their 2- and 4-month-old infants. Mothers in this study were told to interact with their babies on screen via video chat, but, unbeknownst to them, segments of the screen presentation were actually video replays of their earlier interactions. These mothers expressed significantly less infant-directed speech during video replay segments of their infants than during the video chat segments of the interaction. Moreover, once they returned to fully contingent video chat interactions, mothers' infant directed speech required some recovery time to return to original levels after their exposure to the replay segments.

When one considers the content of video chat, isolated from the context of its use, it might appear that losses in contingency during video chat pose a great risk for remote relationship development. Observational data, however, suggest that parents are able to successfully navigate these disruptions in connectivity. Delays in social contingency caused by human error or by technological difficulties may be unavoidable, but physically present adults attempt to ameliorate and explain such disruptions (McClure et al., in revision). In the following example, a 23-month-old was interacting with his grandmother, showing her a house he had built out of blocks by pointing an iPhone toward the house. His sophisticated attempt at JVA was interrupted by a technical error on the grandmother's side:

Grandma : It's so beauti-- {her image on the screen freezes}
Mother : (to Grandma) So what are you up to today Yaya? …Mom?
(to Baby) Did you hang up on Yaya?
{takes phone from Baby, sees blank screen, which now has the word "Reconnecting" on it}
Ohp! Reconnectiiiing!
{Props phone up on some blocks} Here, let's put this here so she can see you. …We have to wait… We have to wait…
Father : (to Baby) Say, "Yaya, where did you go?"
Mother : …Yeah, Yaya's wireless is a little spotty…
Baby : {gets up close to the screen} Yayaaa?
Mother : (to Baby) Where'd she go?
Baby : Oh no!
Mother : (to Baby) Where's Yaya?!
{B touches the screen and hangs up the call, apparently by accident}
Ohp! Call back…
Baby : Call back!!

Mother : Call back…
Baby : Bye bye…
{phone rings, Grandmother's image appears}
Mother : Oh, there she is!
Baby : There she is!

In total, 45 s of the interaction was lost to this technical problem. It ought to seem strange that Yaya would suddenly freeze mid-sentence, then disappear entirely; such things certainly would never happen face-to-face. However, the baby was relatively unperturbed by the bizarre experience. It might be that he was used to such errors occurring during video chat interactions (the mother seemed unsurprised at Yaya's "spotty" wireless connection) and, thus, did not respond with shock. It is also notable, though, that the parents scaffolded his carefree response by responding that way themselves. Both parents treated Yaya's sudden disappearance like a game of hide-and-seek, encouraging the baby to look for Yaya in the screen. Instead of being disturbed by Yaya's absence, then, the baby waited in anticipation for Yaya's reappearance, as though it was intended from the start. For this reason, it appears that the baby responded to this incident not as a moment of disrupted contingency but as a moment of highly suspenseful, highly contingent play. Furthermore, the mother verbally removed any blame for even the *appearance* of noncontingency from Yaya herself, blaming it instead on her spotty wireless. While it is likely that the baby did not fully understand the meaning of this sentence, it is remarkable that the mother felt inclined to mention it. The degree to which this strategy is effective at avoiding the negative outcomes associated with noncontingent social interactions is unknown, and will likely depend at least in part on the child's ability to understand these verbal explanations.

Although in this instance the error was technological, oftentimes there is human error involved. Specifically, in calls that took place via a touchscreen device, children sometimes spontaneously ended the calls by touching the screen. Furthermore, parents often actively encouraged children to touch the screen (e.g. to pretend to make physical contact like kissing the image) but they also discouraged it out of fear of accidental hang-ups. Finally, it is notable that families persisted through slow connections and human errors, rarely giving up. Instead, as illustrated above, parents often engage in "tech talk," in which the interaction centers on dialogue about the technology itself. It is unknown whether such "tech talk" provides an additional risk to these interactions by taking away time the family might usually spend interacting more successfully, or whether it provides an opportunity to contextualize the technological errors and delays that occur. During other forms of mediated interactions, contextual talk is commonplace. For example, during book reading, parents orient children to print, the directionality of print, and to the orientation of the book itself (DeLoache, Uttal, & Pierroutsakos, 2000). During e-book readings, parents orient children to the use of the interface to move the narrative forward or to explore the additional embedded content. Further exploration of "tech talk" and its implications in the context of video chat is warranted.

15.3 Conclusion

Overall, the use of media-based interventions and video chat provide exciting new opportunities for families who are separated due to migration, incarceration, deployment, and divorce. This chapter also illustrates some key advantages and constraints in the content and context in which video chat can be effectively deployed. Consideration of these developmental constraints on communication can ameliorate limitations inherent in the medium and maximize the positive benefits of interactions, thus mitigating any unexpected negative consequences of video chat on relationships. Specifically, the development of the dyadic relationship between the remote relative and the young child is heavily dependent upon the primary caregivers in the child's everyday environment. As such, the triadic relationship between the caregiver, the child, and the remote relative needs to be considered. Young children, and sometimes remote relatives as well, need support in bridging the gap between the real world and the virtual world.

It is also important to consider the broader implications of familial separation and the insufficiencies of the medium to meet certain unique needs. For example, the relationship between the caregiver and remote relative may be under strain due to deployment, incarceration, or the dissolution of the parents' romantic relationship, which may make it difficult for the caregiver to participate in and scaffold the interaction. Under conditions of parental incarceration, specifically, video chat should not replace face-to-face visits between parents and their infants. In some jurisdictions, there is a move to build video chat into visitor centers and to stop face-to-face visits altogether. Although this approach may significantly reduce security costs, it is not recommended when visitors include young children, due to the noticeable psychological differences between video chat and face-to-face interactions. In fact, video chat may be worse than non-contact glass-separated visits because it places constraints on contingency and JVA as well as physical contact. It is important, therefore, to consider interventions such as the *Just Beginning "Baby Elmo" Program* in this context in order to build relationship skills between the incarcerated parent and the child. In some cases, however, when visits are interrupted due to inclement weather or prohibited by cost, video chat may supplement parent–child face-to-face visits and is definitely a better alternative than traditional phone calls.

Overall, is it crucial for caregivers to recognize that there are limitations to video chat and that they understand the critical role they play in brokering early relationships with their children. Whenever possible, it is also necessary to have face-to-face interactions as well as video chat, and to note that video chat is unlikely to be a replacement for the richness and complexity of face-to-face interactions. Humans are exquisitely sensitive to social contingency beginning very early in development. Furthermore, face-to-face interactions uniquely strengthen triadic interactions, which in turn are necessary for successful video chat. Unfortunately, research on video chat use with young children is sparse and there are a number of outstanding questions about the emotional quality of video chat relative to face-to-face interactions. Furthermore, the potential long-term consequences of this mode of communication for relationship quality are unknown.

Technology is advancing rapidly and provides a promising method of decreasing psychological distance as well as building and maintaining connections within immediate and extended family networks. Video interventions to support remote parenting and studies on the use of video chat at home with babies and toddlers have thus far shown encouraging results. It is possible that the conflict between local family connections and distant opportunities may be reduced over time as modern communication technologies like video chat become more easily accessible to families and promise to help maintain connections at a distance.

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Chapter 16
Smarter, Stronger, Kinder—Developing Effective Media-Based Tools for At-Risk Populations: Commentary on Chapter 15

Rosemarie T. Truglio and Jennifer Kotler

We approach our commentary of McClure and Barr's chapter not only as research scientists, but also as educators involved in creating educational media experiences. We spend our days entrenched in developing content across media platforms to address specific educational needs of children spanning the ages of 2–8, creating curriculum documents to guide content creation, and conducting applied research at Sesame Workshop, the producers of *Sesame Street*. The mission of Sesame Workshop is to harness the power of media to help children grow smarter (academic skills and executive function skills), stronger (physical health and resiliency skills), and kinder (building empathy, compassion, and other prosocial behavior). Since its inception, content produced by Sesame Workshop is curriculum driven to address an educational, health, or societal issue, informed by content experts, and guided by basic and formative research with children, parents, caregivers, and educators. As such, we ensure that the media content that is created is of high quality and developmentally appropriate. Much of our experiences at Sesame Workshop, however, have been focused on unidirectional video interventions or interactive technologies for colocated parents and children ages 2 and older.

Today's young parents (Millennials) grew up in a media saturated environment. As a result, they are very comfortable using new technologies, digital applications, and a range of media distribution platforms as media consumers and creators. They use these digital devices as part of their daily lives to communicate, gather information, and be entertained. This generation of parents is also comfortable using a range of applications with their young children. While there are limitations of these technologies as McClure and Barr's review suggests particularly with infants and toddlers, it is quite remarkable how video chat has been and can be used in creative ways to bring families together.

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Video chat provides an opportunity for increasing quality time spent with families who are not physically together. McClure and Barr (2016, Chap. 15) describe a variety of studies designed to assess how to improve the quality of the interactions between adults and children. However, hardly any commercially available products have been developed which are designed specifically to increase such positive interactions. Given that we look to academic research to inform industry practice, the chapter encourages us to think more deeply about how to implement their findings in guiding content creation across interactive digital media experiences for maximum impact to children and families' well-being.

Hirsh-Pasek et al. (2015) indicate that children learn best when they are (1) active, (2) engaged, (3) immersed in meaningful content, and (4) socially interactive. Indeed children need hands-on experiences and opportunities to actively explore their environment and their relationships with others. These quality adult–child interactions within a safe, loving, and stimulating environment are critical to brain development and they foster the intellectual, socioemotional, and physical development of children (National Scientific Council on the Developing Child, 2004, 2010; Shonkoff & Phillips, 2000).

While media content can never be a supplement for a present and engaged adult, there is much research suggesting positive effects from media as seen throughout this book. Media can have differential effects (positive and negative) depending upon the type of content, characteristics of the child, and the context of the experience (Guernsey, 2012). For instance, watching age appropriate educational content is associated with learning gains (Fisch, 2004; Kirkorian, Wartella, & Anderson, 2008). Furthermore, having a parasocial relationship with a television character such as Elmo from *Sesame Street* also helps children to learn from noncontingent unidirectional video content (Lauricella, Gola, & Calvert, 2011). Richard and Calvert's Chap. 9 in this book discusses this in more detail.

We see the power of *Sesame Street* in teaching children a range of academic, social–emotional, and health skills and concepts throughout our work with children, as well as the adults in their lives (Kolter, Truglio, & Betancourt, 2016). While many parents can and do provide those nurturing hands-on environments for their children, many do not necessarily have access to knowledge, services, and social support necessary to promote positive parenting behaviors. We have evidence from many different initiatives using *Sesame Street* content that videos and accompanying resources do indeed help parents support their children's growth in academic skills, health, and social–emotional skills (Andrews & Buettner, 2011; Cohen, Betancourt, Kotler, & Truglio, 2012; Cozza, Ortiz, Schmidt, & Fullerton, 2011; Field Research Corporation, 2011).

We have embarked on a variety of specific initiatives to support parents broadly and to address parenting at a distance due to incarceration, divorce, and military service. For example, we developed Sesame Beginnings, a collection of DVDs for parents to use with infants and toddlers; created community engagement materials to help parents build resiliency skills when children experience separation from a parent; and experimented with newer digital technologies to engage children in guided playful learning experiences. McClure and Barr's review has encouraged us to think about how several of our initiatives could be enhanced to incorporate video chat as an additional component for enriching the experience. The research that McClure and Barr cite, particularly around social contingency and joint visual attention, in video chat situations are important for all content providers whether we are creating such media for unidirectional video or for video chat experiences.

16.1 Sesame Beginnings

Parents are often told to engage in quality stimulating activities with their children, but often not shown *what* these behaviors look like or *how* to integrate these interactions or activities during everyday moments to enhance learning across all content domains. Home visiting programs from organizations such as Home Instruction for Parents of Preschool Youngsters (HIPPY) or Parents as Teachers (PAT) are excellent in providing such specific information to parents and there is much evidence that such programs are effective. However, they are very expensive to implement on a mass scale. Media and technology-based interventions would be particularly useful as a supplement to these types of programs to extend reach and scale.

Sesame Beginnings DVDs modeled high quality parent–infant/toddler interaction styles. These DVDs were created in response to parents reporting their infants and toddlers "watching" *Sesame Street*, when the show was designed for children ages 2–5. With Sesame Beginnings, we provided parents and caregivers of children under two with content designed to be used together (i.e., joint visual attention while modeling useful parent–child interactions for parents to expand upon after viewing the video). Research conducted by Pempek, Demers, Hanson, Kirkorian, und Anderson (2011) study comparing Sesame Beginnings (SB) to Baby Einstein (BE) videos (plus a control group that had no videos at home) showed that parents who viewed Sesame Beginnings more often at home during the 2 weeks were more likely to interact (singing, making music, chatting) with their children when they first came into the lab compared to those who frequently viewed Baby Einstein. Those who viewed Sesame Beginnings while in the lab also engaged more with their children after viewing compared to those who viewed Baby Einstein in the lab (see also Chap. 11, Anderson and Hanson, 2016).

The Just Beginning (a.k.a. Baby Elmo) program, a formal interventional parenting program, is an excellent example of how incarcerated parents can benefit from seeing what quality interactions look like across a range of scenarios and why these interactions are critical for the healthy development of their young children. The trainings incorporated video content from Sesame Beginnings that featured four different dyads: (Elmo (13 months) with his dad, Cookie Monster (16 months) with his grandmother, Big Bird (19 months) with his aunt, and Prairie Dawn (24 months) with her mother). Through themes such as making music, exploring using one's senses, and movement, both Muppet and real parents with their children portrayed a range of adult–child playful moments with joint focused attention as they use everyday objects, toys, and books as a basis for interaction and dialog; engage in dialogic reading when reading a book to their child; and navigate emotional transition times (e.g., naps, meals, travel, diaper change). The Muppet characters were carefully chosen for their ages and temperament. As Brito, Barr and colleagues (2012) report, teenage fathers who were part of the intervention increased in their emotional responsiveness toward their infants and toddlers.

The Just Beginning intervention was an in-person intervention, but the findings could have implications for video chat content as well. According to a new report by the Prison Policy Initiative (Wagner & Rabuy, 2015), many jails have begun implementing programs incorporating video chat visitation between inmates and their families. If these kinds of visits become more common place (either as a substitution or addition to face-to-face interaction) then incorporating video content as a joint engagement experience during a video chat conversation is something we need to think carefully about as a future possibility.

Furthermore, while the broader Sesame Beginnings initiative was not designed to be used at a distance or through video chat, much of the content could be used to support parents in engaging with their children through video chat. With supports, it is possible that the content included in the video could be edited such that it could provide instructions to parents who are not colocated as to how to engage with children from afar. One could also imagine reediting some of the content together specifically for parents who are not colocated with their children to do activities that are feasible regardless of the distance between parent and child.

16.2 Little Children, Big Challenges

The use of our Muppet characters along with real-life families has been an effective strategy for reaching parents in meaningful and nonthreatening ways to address a range of issues facing parents. The Community Engagement staff at Sesame Workshop has a long history of creating multiple media (linear and interactive) digital resources for parents and caregivers to help their children cope with difficult situations in their lives as a result of a parent's separation from a child because of incarceration, divorce, or military service. These resources can be found on our website as well as mobile apps in the Apple store, Google Play, and Amazon App Store. As McClure and Barr discussed, it is important for children to develop and maintain quality interactions with their parents, but parents need resources to help them have a better understanding of how to help their children in these situations. Parents often do not have the language to explain what is happening nor the strategies to help the family cope with the parental separation.

Little Children, Big Challenges: *Incarceration* was developed to help children (between the ages of 3 and 8) cope with the absence, confusion, and possible shame of an incarcerated parent and could be used to support the families in *The Just*

Beginning parenting program. These digital resources include: a tip book with age-appropriate language to talk honestly with children, as well as strategies to help children build resiliency skills; videos featuring real families and *Sesame Street* Muppets; and an interactive storybook and photo activity for caregivers to use with children. Additional resources are included and can be found online at sesamestreet.org/incarceration.

An experimental evaluation of the Incarceration toolkit among 93 parents who were caring for a child with an incarcerated parent found that those using the toolkit reported that they had significantly more appropriate language to better discuss incarceration with their child and that their child's behavior had improved at home. When compared to the control group from pre- to posttest, caregivers using the incarceration toolkit were more likely to: agree with statements related to being able to answer their child's questions about the incarceration, report an increase in the child's expression of his or her feelings, prepare their child on what to expect while visiting the incarcerated parent, and report increased comfort in answering questions from other adults about the incarceration. In general, the incarceration toolkit increased parent communication about the incarceration with children and extended friends and family (Oades-Ses & Lau, 2015b).

Little Children, Big Challenges: *Divorce* is another example that provides parents and caregivers with tools to help children ages 3–8 cope with the many transitions as a result of martial divorce or separation. It features *Sesame Street* characters, in particular Abby Caddaby whose parents are divorced, and real-life families talking about their thoughts and feelings. The key messages were to reassure children that both parents love them very much and they had nothing to do with their parents' marital situation. Interactive art tools are also able to help children communicate thoughts and feelings with a parent. Online material such as articles with tips and strategies and conversation starters providing age-appropriate language can found at sesamestreet.org/divorce.

An experimental evaluation on the Divorce toolkit ($N=100$) showed that 73.5 % of parents said that they felt more comfortable helping their child cope after using the toolkit compared to half of the parents in the control group. There were also parent observed effects on children. About half of the parents said that their children were better able to cope after use of the toolkit. Moreover, the intervention group showed a significant decline in negative emotions and behaviors (based on parental report), while the control group showed no significant changes from pretest to posttest (Oades-Ses & Lau, 2015a).

Since 2011 Sesame Workshop has been working with military families to help our nation's children build much needed resilience and self-expression skills to cope with: deployments, homecomings, and the changes to the parent both mentally and physically; and grief of the loss of a parent. All of these digital resources developed over a multiyear initiative are available at the website: sesamestreetformilitaryfamilies.org. We also have a Military Families App with the resources from the website. While these initiatives generally focus on the unidirectional nature of video, and noncommunicative uses of digital application, we also developed a safe social networking tool to help children stay in contact with a deployed parent. Digital tools were designed for children's self-expression through video and audio messages and text-based messages. There have been several evaluations of the military families' initiatives and they all indicate that the information, tips, and resources were extremely helpful in helping children cope with various aspects of military life, including deployment, homecoming, as well as loss and were effective in increasing communications between families and decreasing stress (Cohen, Betancourt, & Kotler, 2014).

The McClure and Barr chapter (Chap. 15) suggests that we could have taken these initiatives further by providing additional strategies about using the materials at a distance. For example, we could design the content with specific tips and suggestions as to how to start conversations, come up with a fun greeting song, and a concluding song that caregivers and children can sing to each other when they are on video chat, as well as a few routines that can be developed that are specific to having a video chat conversation. Just as there are conventions in television that become familiar to children, we could help develop these kinds of conventions for those who are going through challenging times and are not physically together with loved ones.

16.3 Emerging Technologies as Parenting Tools

While there are some new and novel ways that media producers have used technology for communication between young children and adults who live far away from each other, currently those efforts are few and far between. One example is Kindoma, a company which produced an app called "Storytime." Although this content was not developed by Sesame Workshop, our colleagues at the Joan Ganz Cooney Center (an independent policy and research center housed within Sesame Workshop) were part of the research team that investigated Storytime's effectiveness. Storytime blends story-reading with video chat, allowing a child to "*coread*" a story with a loved one far away. In early formative research of a version of Storytime, parents and other relatives (who were often the adult who was reading with the child at a distant) found the Storytime interactions more engaging than traditional video chats. Furthermore, they spent more time engaging with each other compared to traditional video chats (Raffle et al., 2011). By providing specific roles and instructions, rich interactions were possible that may not be as engaging as if the distant relative had to initiate and improvise a conversation with a young child. To adapt for families with children under 2, a picture book with a simple story would be a more developmentally appropriate experience to coengage via a video chat.

Another example of the use of emerging technologies is a prototype we experimented with through a partnership with Qualcomm. We used their technology (Vuforia) to test how technology might enhance traditional block play and model for parents the concept of guided play to facilitate learning during these parent–child activities (see Chap. 17, Zosh and colleagues, 2016 for more information on guided play). Children learn from block play, especially if an adult is present to play with them and comment on their actions, suggest activities, and respond to their play patterns (Christakis, Zimmerman, & Garrison, 2007). Research has found that interaction with blocks naturally elicits higher levels of spatial language (through language like "under" and "next to") especially through the context of guided play (Ferrara, Hirsh-Pasek, Newcombe, Golinkoff, & Lam, 2011). Block play is also associated with imaginative play, particularly make-believe, which includes rich opportunity to use language, especially math-rich language (Cohen & Uhry, 2007).

Hirsh-Pasek and Golinkoff (2011) demonstrated that guided play that is facilitated and scaffolded by an adult is best associated with learning outcomes compared to completely open-ended free play or closed-ended structured play. However, many adults do not have the understanding of how to engage in such play without possibly co-opting the child's play. This technology gave us an opportunity to test how Grover on a screen can respond to a child's natural play pattern in a personal and adaptive way as an intelligent agent. Through personalized feedback and encouragement, Grover commented on the child's block play by saying "you are building a very high tower" or "you are building a very long wall, just like the Great Wall of China." In the case of the last example, the child would see a short video of the Great Wall to gain knowledge of what this structure is in China. In addition to including language and math concepts, Grover's commentary helped foster executive function skills such as: focused attention, shifting attention, task persistence, listening, and following directions.

If we had developed this experience in a way that it was to be designed for families who were not colocated, perhaps we would use Grover's commentary in an entirely different way. Instead of Grover speaking solely to the child, Grover could speak to the adult and facilitate conversation between the child and the adult. Grover, in his own humorous way, could give tips to the parents about the commentary he provided. *Sesame Street* characters are particularly suited to talking to children and parents given that much of the content, which is developed by excellent comedic writers, contains "winks" and "nods" to the parents.

In conclusion, technological advances will constantly provide innovative tools that could be used to provide content experiences and relationship supports. As Joan Ganz Cooney, Co-Founder of *Sesame Street*, challenged the status quo of children's programming in the late 1960s and experimented with the idea to use a popular and engaging medium to teach young children and better prepare them for Kindergarten, we must continue to take on this challenge with all new technologies. With a variety of content producers examining the possibilities of voice recognition, augmented reality and wearables for children and parents, we will certainly think about how these tools can be best served to promote positive interaction whether or not parents and children are physically in the same space.

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Chapter 17
Putting the Education Back in Educational Apps: How Content and Context Interact to Promote Learning

Jennifer M. Zosh, Sarah Roseberry Lytle, Roberta Michnick Golinkoff, and Kathy Hirsh-Pasek

A digital revolution is changing the lives of today's children. On the one hand, this dramatic "culture change" of childhood is worrisome because science simply does not have the resources to evaluate these apps quickly enough in a rapidly changing market. With over 170,000 educational apps available world-wide in the Apple App Store (Apple, 2016) alone, researchers cannot test every app before it is offered to parents with an assurance that the app actually has proven educational value and parents often do not know where to start when it comes to selecting apps. Further, most (but not all) apps are created by developers who are not experts in cognitive development. The sheer volume of apps developed for the preschool market, however, offers an unbridled opportunity, if there were an easy and accessible way to evaluate the educational value of apps. Harnessing the potential of educational apps might be particularly useful for children in families of low socioeconomic status (SES). Reports indicate that at least 65 % of low SES families have tablets or smartphones (Common Sense Media, 2013). By capitalizing on the educational power of

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apps on devices that are **already in the homes of children from across different socioeconomic groups,** we are on the verge of an educational revolution.

In a recent article for *Psychological Science and the Public Interest*, Kathy Hirsh-Pasek and Jennifer Zosh with colleagues who study media from different perspectives (Roberta Golinkoff, Michael Robb, James Gray, and Jordy Kaufman [2015]) proposed that the relatively new, multidisciplinary field dubbed the *Science of Learning* has identified key "pillars" that support learning across any platform—whether it be in the classroom, in the living room, or the screen. Learning scientists have distilled decades of research to suggest that optimal learning occurs most when children (or adults!) are **active** (minds-on), **engaged** (not distracted), are learning **meaningful** information (applicable or relatable to their lives) in a **socially interactive** environment (using our most powerful resource—social partners). Further, this learning should occur within a context of a supported learning goal. In other words, when a learning environment (in real life or digital) has a particular educational goal and the context is structured with playful learning in mind, educational value is maximized. Here, we review how these evidence-based principles generated by the Science of Learning can be directly applied to the evaluation and creation of educational apps. Our approach is not to evaluate every app on the market or even at this time to offer guiding principles for any particular content area be it reading or mathematics; instead, we propose a framework that will allow parents and early learning professionals to make individual-level app decisions based on the Science of Learning. Using this approach unlocks a world of truly "educational" apps, helps parents evaluate educational value from among the 170,000 available apps and helps developers better understand how to infuse apps with real educational value.

17.1 The Context of the 170,000 App Problem and a Potential Solution

What created the marketplace for over 170,000 apps? Many believe that the digital revolution can fill the gap left by an ailing education system. Parents are bombarded with the fact that we are falling behind in international testing scores. The recent release of the 2012 international test Program for International Student Assessment (PISA), for example, examines the scores of 15-year-olds in many countries around the globe (Organisation for Economic Co-operation and Development [OECD], 2012). The USA performed below average in mathematics (27th, behind such countries as Slovenia, Liechtenstein, and Estonia) and only average in both science (ranked 20th), and reading (ranked 17th). Despite the fact that playtime is decreasing in an effort to compensate for these scores, we are not seeing dramatic gains in performance. Perhaps digital technology will offer the magic sauce that allows true educational practice to jump the school walls in ways that will make our children smarter and later increase these scores.

On December 10, 2006, *Time Magazine* suggested that if Rip Van Winkle woke up today the one familiar setting he would recognize would be the American school, with the only change being the color of the chalkboards—black to white (Walls & Steptoe, 2006). Rip would see children sitting passively, receiving information spoon-fed by teachers who are preparing them for the proscribed exam. These images were reinforced by the No Child Left Behind (NCLB) Act, which was originally enacted in 2001 continued until 2015. Although NCLB aimed to provide quality education to all children regardless of age, race, SES, and location, the implementation of NCLB has resulted in a system that emphasizes teaching to a high-stakes test and drilling students on "facts" that are rapidly changing (Darling-Hammond & Adamson, 2014; Ravitch, 2010). Indeed, the PISA scores discussed above were from the cohort of students whose entire educational career had been under NCLB. Though testing has surely increased under NCLB, this national education reform policy did little to close the achievement gap (Dillon, 2009). Critics worry that despite efforts to remedy the situation, the context of a test-focused education system will reward teaching-to-the test, resulting in less learning overall (Roediger, 2014).

It is in this context that the educational app revolution has occurred with haste. Parents want academic success for their children and may be turning to "educational" apps because of what they are seeing—and not seeing—in schools. We are in the midst of a time where we are seeing below average test scores, yet apps not only allow for more educational practice, but they also offer the promise of individualized instruction in ways that were not possible before. Much of this knowledge comes from a growing body of data in the newly amalgamated field of the Science of Learning.

Since the creation of the *Journal of Learning Science* in the early 1990s, the term "Science of Learning" has appeared at the forefront of cognitive and developmental psychology. In the 1999 publication of *How People Learn*, a report from the National Research Council (Bransford, Brown, & Cocking, 1999), the authors wrote, "… the new Science of Learning is beginning to provide knowledge to improve significantly people's abilities to become active learners who seek to understand complex subject matter and are better prepared to transfer what they have learned to new problems and settings" (p. 13). One key aspect of the Science of Learning is that its multidisciplinary approach brings together findings from psychology, linguistics, computer science, animal behavior, machine learning, brain imaging, neurobiology, among others. A second key aspect of this field is the nature of the questions it asks. Instead of solely asking what we should teach children—that is, what **content** children need to know—it also asks *how* children learn best. That is, if learning is to occur and "stick," what **contexts** enable children to learn flexibly and generatively so that they can apply what they have learned (e.g., Benassi, Overson, & Hakala, 2014; Golinkoff & Hirsh-Pasek, 2016; Pellegrino, 2012; Pellegrino & Hilton, 2013; Sawyer, 2006).

In this piece, we review what the Science of Learning has taught us about how children learn. A few tenets have emerged as pillars for learning across any context (e.g., in real life or in digital apps). When children are **active** (minds-on), **engaged** (not distracted), thinking about **meaningful** information, and in **socially interactive** situations, learning is maximized. Here, we apply these pillars of learning to educational apps. As we apply each of the pillars, we consider the *content*, or what children need to know and *context*, or how they can best learn what they need to know (Guernsey, 2014). By uniting what we know about learning—both in terms of content and context—with the technology that is already in the homes of today's children, we are in the position to equip families and developers with the knowledge to solve the 170,000 app problem.

17.2 Pillars of Learning

17.2.1 Active—Learning Is Maximized When Children Are "Minds-on"

At first glance, apps appear to have an inherent benefit over other forms of screen media such as television or video because children usually have to tap and swipe rather than just sit passively. While any type of physical action may benefit learning (Chi, 2009), the Science of Learning suggests that simply tapping and swiping is not enough. The Science of Learning repeatedly finds that when humans are "minds-on" and **mentally** active, learning is maximized. This minds-on perspective can be supported via both content and context.

17.2.1.1 Content

Imagine watching a child swiping from left to right. In one scenario, he may be mindlessly cutting a piece of fruit that flies up in the air. In another case, he may be playing with angles to create a slingshot for a piece of fruit to enter a goal. These are two very different situations: one requires relatively little minds-on thinking and one engages a child in playing with concepts from physics.

In some ways, it is easiest to embrace the content aspect of minds-on learning. The Science of Learning has repeatedly found that children learn best when the task requires just a little more of children than they could otherwise do on their own. Identifying this sweet spot—akin to Vygotsky's zone of proximal development—helps children to attend and stay on task (Wright & Huston, 1983). Pushing children out of their comfort zones little by little contrasts with strategies that advocate "hot housing" children to go beyond developmental norms, that have been found to stifle creativity and increase anxiety (Sigel, 1987). It is important that the app content is not too easy or too hard, but just right. The Goldilocks approach suggests a number of age- and developmentally appropriate guidelines for learning. Common Core standards, while sometimes viewed as controversial, really represent a massive effort to quantify what children should aspire to at a particular grade level. These guidelines can then be utilized by parents and app developers to determine the content supported by apps. If material is too easy, children can easily adopt a more minds-off approach (as any adult who plays a game designed for preschoolers has experienced). Similarly, if material is too difficult, children may simply stop trying. Knowing what content is developmentally appropriate is especially important as parents are not always an accurate judge of the benefit—or lack thereof—of their own child's progress when using products specifically aimed at teaching young babies advanced skills such as reading (DeLoache et al., 2010; Neuman, Kaefer, Pinkham, & Strouse, 2014). The more challenging, and likely more important, aspect of learning that apps may struggle with is the context that they set for learning.

17.2.1.2 Context

A key factor for promoting a minds-on context is what the app asks children to do. Apps can set up a "mental workspace" within the context of an app. The data is clear that minds-on thinking is optimal for learning—even beginning in early infancy. In a study of 3-month-old infants, Sommerville, Woodward, and Needham (2005) find that when outfitted with Velcro-equipped mittens that allow them to reach out and "stick" to objects, infants learn about goal-directed reaching. With the sticky mittens, infants are also more apt to interpret others' reaching as goal-directed and are more likely to perform these goal-directed reaches themselves (Libertus & Needham, 2010).

Similar benefits of active, minds-on learning appear throughout childhood. When preschoolers with low expressive vocabularies experience "dialogic reading," in which adults involve children in the story by active techniques such as prompting, asking questions, and talking about the content of the story, they showed greater vocabulary gains than children who listened silently to stories (Hargrave & Sénéchal, 2000). Another study showed that children are more likely to comprehend novel words in a story if they ask questions and label objects while reading compared to children who engage in more passive listening (Sénéchal, Thomas, & Monker, 1995). In a direct comparison of active versus more passive vocabulary learning, Zosh, Brinster, and Halberda (2013) find that when 3-year-old children use the process of active elimination of a wrong answer to determine the referent of a novel object, they show better retention of that label compared to children who are told the novel object's label. This effect holds despite the fact that children who learned the label in the more active condition actually spent less time looking at the target object. Their "minds on" approach to learning was more powerful than passive viewing.

Benefits of active learning are evident even in later childhood. When middle school students were asked to draw chemical reactions, they showed better comprehension of the chemical mechanisms underlying those reactions compared to those who were asked to explore them with dynamic visualization (Zhang & Linn, 2011). Similar effects were seen with ninth grade students—students who only read about chemical processes showed inferior learning compared to those who actively generated their own drawings (Schwamborn, Mayer, Thillmann, Leopold, & Leutner, 2010). In more informal contexts such as in science museums, superior learning happens for children actively involved in the experience. For example, when children question, comment, and discuss what they see, they learn more than children who do not engage in these behaviors (Borun, Chambers, & Cleghorn, 1996; see Haden, 2002 for a review). This benefit might not be limited to learning outcomes. High school chemistry students involved in active learning lessons had fewer misconceptions and a more positive attitude about chemistry than those in more traditional classes (Sesen & Tarhan, 2010).

The evidence is strong: learning in an active, minds-on context is better than sitting back and receiving information. This effect is apparent across the lifespan. Thus, while content may be similar in "educational" apps, the context in which the information is presented may differ. Consider two apps with the same goal of teaching preschoolers the shape and sounds of letters of the alphabet. On one extreme lies an app that simply shows a letter and makes a sound. The app goes from one letter to the next and children can simply watch the "show." The design of the app is bright and the sounds are child-directed. Imagine a child watching this app from A-to-Z, probably many times over the course of a week—or even a day. Compare this example to an alternative app that not only shows children what each letter looks like, but also asks the child to trace the outline of each letter and once it is completed, the child is rewarded with the sound the letter makes and 1–2 examples of words that start with that letter. As the child gets faster at tracing the letter, the app might ask children to point to the picture of an animal whose name starts with that letter. Both of these apps show children what the letter looks like and plays audio to show them what it sounds like. But in the latter example, children exhibit more minds-on thinking by tracing the letters and, eventually, being asked to use their knowledge to decide between two or more choices. In this way, this app promotes increased minds-on thinking. Indeed, preliminary evidence suggests that learning is increased when parents use an app alongside their children that promotes this type of minds-on thinking (Schmitt, 2015).

17.2.2 Engaged: Learning Is Maximized When Distractions Are Limited

Learning occurs best when adults (or children) are engaged—meaning that they stay on-task and are not distracted. In the arena of classroom engagement, Fredricks, Blumenfeld, and Paris (2004) distinguish between *behavioral* engagement (e.g., following the rules and participating), *emotional* engagement (e.g., emotional reactions to content) and *cognitive* engagement (e.g., motivation to learn and effort to gain deeper understanding). Each type of engagement has a common theme—staying on-task. A key pillar highlighted by the Science of Learning is how focused engagement—or staying on-task and being present in the learning context—is central for learning.

Anyone who has ever tried to talk to a child playing with an app likely has experienced the "zone out"—the child does not respond, or, if he or she does respond, it is likely with a mumbled "what?" In this sense, apps (or television) appear to maximize children's attention and prevent them from being distracted (even from the questions or commands of their parents). However, research teaches us that this "zone out" is not sufficient for learning. Instead, the high-quality, active learning that children exhibit when playing with apps can be maximized when the child stays "on-task" and is not distracted by competing or nonessential content. Adding social interactions to media use is another way to combat the effects of "zone out." Strouse, O'Doherty, and Troseth (2013) found that when parents were trained to use dialogic reading questioning techniques (e.g., pausing, asking questions, and encouraging story-telling) when watching educational television with their 3-year-old children, story comprehension and story-related vocabulary was increased relative to a condition where parents directed children's attention to the show but did not use questions.

By managing the context of the child's experience (with screens of any type), adults can help promote minds-on, engaged learning.

When thinking about how apps might promote this engagement, one must consider how the content of the material and also the learning context an app inspires—either helps children to stay on task or encourages distraction.

17.2.2.1 Content

When it comes to learning content, it is tempting to espouse the "more is better" model. To take the earlier example of an alphabet app, parents might be attracted to an app that simply does not have tracing but also includes multiple examples of that letter using different fonts, words displaying on the screen that start with that letter, and an animal game where the child matches the sounds of animals whose name starts with that letter to the animal name. It is easy to buy into the idea that more learning will occur if the app goes beyond letters. However, it is crucial to determine what information is necessary and supportive to a learning goal (avoiding overload). In the above example, an app that moves children through those features as the child demonstrates increased understanding will be better for learning compared to one in which the child is overloaded with too many features at one time. Another consideration is to determine what information may be extraneous and distracting to the goal or learning objectives. An example comes from an investigation of parent-child interaction with electronic toys. Zosh et al. (2015) found that when parents and children interacted with a traditional, non-electronic shape sorter, children heard higher quality and more on-topic language than children who played with an electronic version of the same toy. Instead of hearing about shapes, children in the electronic condition heard unrelated songs and much of the conversation was about the toy rather than conceptual information about shape. Indeed, Mayer (2014) notes that when the amount of extraneous material is limited, deeper learning occurs. Mayer calls this concept the "coherence" principle.

Apps need to give just enough extra detail to help keep children engaged and on-task, but not provide so many "extras" that the actual meaningful information is hidden or lost.

17.2.2.2 Context

While many adults do not hesitate to check email, talk on the phone, and text while driving, recent data suggests that children are beginning to multitask with media sources, too. Among children under the age of 8, 16 % of children report using more than one type of screen media "most" or "some" of the time (Rideout, Foehr, & Roberts, 2010). Just as research demonstrates that only about 2 % of adults are "super taskers" who are capable of true multitasking (Watson & Strayer, 2010), studies with children have shown that they are particularly susceptible to the effects of distraction. Something as simple and seemingly noninvasive as a television playing in the background is related to lower attention in children and less engagement with the toys they are playing with—even if they are only distracted for a few seconds (Schmidt, Pempek, Kirkorian, Lund, & Anderson, 2008).

When it comes to apps, it is important to think about the ways the app itself may provide distractions that take away from the learning objectives. Research about a previous technological advancement—electronic books—has shown that the additional features they contain distracts children instead of increasing their engagement. This is an important finding considering that books, toys, and apps, commonly add, rather than subtract, proverbial "bells and whistles" in the form of extra buttons and sound effects. Even "pop-up" books, whose pages open up to create three-dimensional displays, can impede rather than support children's vocabulary learning and story comprehension, as compared to traditional books (Tare, Chiong, Ganea, & DeLoache, 2010). Similar effects have been seen with electronically enhanced books relative to traditional books. Parish-Morris, Mahajan, Hirsh-Pasek, Golinkoff, and Collins (2013) found that 3-year-olds (but not 5-year-olds) showed better comprehension and memory for a story that was a traditional book rather than an electronically enhanced version of the same story. Similarly, Krcmar and Cingel (2014) found preschoolers' comprehension of story details was increased when parents read the traditional version of a book relative to the electronic version and follow-up analyses suggested that this was due to an increase in distraction talk. However, Lauricella, Barr, and Calvert (2014) do not find a cost of electronic books per se but do find that interaction is key: "For both types of storybooks, child attention, child language, and parent engagement were significant predictors of story comprehension. Our results suggest that a storybook is a storybook, whether the story is presented on paper or electronically, although the ways in which parents and children engage with the storybooks may differ as a function of the platform." (p. 17). Together, these results suggest that the *context* promoted by electronic books or apps is likely what causes either costs or benefits to learning.

The distraction caused by the additional attributes is not limited to seemingly extraneous features. Children stay engaged and tend to learn more when additional features are not present, even when they were created to support a specific learning goal as in the case of pop-up books (Chiong & DeLoache, 2012). Finally, background music can also result in distraction. Barr, Shuck, Salerno, Atkinson, and Linebarger (2010) found that even simple instrumental music added to a video demonstration can serve as a distraction and prevent or limit infants' abilities to learn a new action. Further, the addition of mismatched sound effects to a demonstration of an action by either a live model disrupts imitation performance during the first 2 years of life relative to the same demonstration without sound effects (Barr, Wyss, & Somanader, 2009).

While apparent throughout the lifespan, the susceptibility to distraction appears to be strongest for the youngest learners. Kannass and Colombo (2007) examined how different types of distractions—ranging from no distractors, to intermittent, to continuous distractions—impacted 3.5- and 4-year-olds' task performance. Although the youngest children showed impaired task performance with any type of distraction, older children began to recover from distraction and only showed evidence of impaired performance when the distraction was continuous. This has important implications for setting the context for learning in childhood, a time when children are less able to regulate their attention and more likely to become distracted. Kindergarteners whose classrooms are highly decorated tend to show more time off-task and less learning compared to those in a less decorated and less distracting context (Fisher, Godwin, & Seltman, 2014). Not surprisingly, individual children differ in their susceptibility to distraction (Choudhury & Gorman, 2000; Dixon, Salley, & Clements, 2006), but in general, sustained attention abilities at 5 years (i.e., lack of impulsivity, focused attention) are related to later attention abilities at age 9 (Martin, Razza, & Brooks-Gunn, 2012). Distraction remains an issue for students throughout their education. Students who text during class are outperformed by those who do not (Dietz & Henrich, 2014) and college students who multitask during a lecture not only risk lowering their own performance but also that of the students sitting around them (Sana, Weston, & Cepeda, 2013).

A significant finding, then, is that staying on-task is a key pillar of learning. App "enhancements" should be rather limited, especially those designed for the youngest children. However, distraction is malleable for both children and adults (Kannass, Colombo, & Wyss, 2010; Neville et al., 2013) and varies not only with age (Kannass & Colombo, 2007) but across individuals (Martin et al., 2012). Together, these findings stress that the context of learning is crucial and that it is important to limit the distracting information in apps while keeping in mind that some children will be more susceptible than others.

17.2.3 Meaningful: Learning Is Maximized When the Material Links to Children's Lives

It is a relatively common occurrence for a parent to exclaim that their 2-year-old child can count to 20. However, when that same child is asked to give a caregiver four items, the child acts as if he or she has no actual concept of numbers. Clearly, children must move beyond rote memorization to achieve meaningful learning. In fact, Brown, Roediger, and McDaniel (2014) state, "People who learn to extract the key ideas from new material and organize them into a mental model and connect that model to prior knowledge show an advantage in learning complex mastery" (p. 6). Research affirms these ideas. Bransford et al. (1999) stress that competence is not simply the acquisition of facts but the ability to conceptualize those facts into a larger framework. Meaningful learning in apps can be achieved by being mindful of the content of the information we are sharing and the way we ask children to incorporate this information into their understanding.

17.2.3.1 Content

Findings in the Science of Learning suggest that, across the lifespan, humans show better learning for material that is meaningful to them and that can be linked to what they already know. Ausubel (1968) theorized that for learning to occur, we must make connections between the material we are trying to learn and our existing knowledge. The critical distinction here is between "meaningful" and "rote" learning. Rote learning is the equivalent of learning the names of all the numbers but having no real conceptual understanding of numerosity. Meaningful learning, on the other hand, is when new knowledge can "hook" onto existing information and more complex and complete conceptual understanding occurs. When a child can not only recite the count list to 20 but can also respond that 15 is more than 11 and that if you add 4 to 15, the result is 19, we would say that the child has a meaningful understanding of number. These same sentiments are echoed by Shuell (1990) and Chi (2009). Meaningful learning must connect to what is already known and the new information must be incorporated within a mental model to lead to true conceptual understanding (Novak, 2002).

Just like experience outside of the digital world, apps can contain meaningful or rote content. One can imagine an app that makes a game of tracing the numbers from 1–10 with your finger. While children may be able to trace the outline of each number, if they cannot later tell you how many cookies they have in front of them or do not understand that 5 is more than 2 and it is equally distant from 8, their learning is shallow at best. Thus, it is crucial for the material presented in apps to have meaning and move beyond this rote level.

While content in educational apps should be meaningful, this does not rule out a role for fantasy. Children can learn more effectively with fantasy than realistic materials in stories (Weisberg et al., 2015). Many apps present children with the opportunity to pretend or to engage in dramatic play. Pretend play helps children to develop creative thinking skills and promotes executive function (see Weisberg, 2015 for a review). As long as the content promotes drawing meaningful connections between their actual lives and the pretend context, it may be more effective than disembodied content that does not link to children's prior learning. For example, the app Alien Assignment asks children to help a family of green aliens who are visiting the planet to become oriented to life here by taking pictures of various objects. While the story line may not be directly related to real life, the premise of helping someone and thinking about what they might know and do not know is very meaningful to young children. However, given that research is mixed regarding the benefit of reality over fantasy or pretense (Richert, Shawber, Hoffman, & Taylor, 2009; but see Hopkins, Dore, & Lillard, 2015; Weisberg et al., 2015) one should keep in mind that depending on the age of the child, he or she may need more support to draw the conclusions between fantasy/pretend and real life.

17.2.3.2 Context

Beyond content, it is important for children to learn within a meaningful context and to extend this meaning into their everyday lives. Apps must go beyond the flash-card model to promote meaningful learning. In fact, recent work suggests that children begin to prefer meaningful contexts as early as infancy. Before their second birthday, infants are more successful at a categorization task when they learn about the function of the objects to be categorized. In other words, they learn more when they understand how an object works and this meaningful information is even more useful than the name of that object for younger (14 month old) infants (Booth & Waxman, 2002). Later in childhood, this same benefit of meaningfulness is evident with children learning more vocabulary words when those words are embedded in a meaningful narrative or expository text relative to when words were not exposed in a meaningful text (Nagy, Herman, & Anderson, 1985). Crucially, learning was equivalent when children were exposed either to the narrative or the expository text suggesting that children were able to learn just as much from context that is not explicitly attempting to teach them (the narrative text) than when it is (the expository text). Children used contextual meaning to learn. When adults provide extended instruction about vocabulary that is embedded within a story, children learn and retain even more (Coyne, McCoach, & Kapp, 2007). Helping children find meaning results in better learning.

One way to inspire meaningful learning is to provide contexts that help children to see the connection between what they are learning about and their everyday lives. For instance, children ages 4–7 years are more likely to remember story events when they hear a familiar narrative versus a more novel narrative (Hudson & Nelson, 1983). Given the fact that children can and do learn from pretense (Hopkins et al., 2015), it is likely that this benefit may not necessarily be about familiarity but about drawing meaningful connections, which is admittedly easier in reality or in familiar contexts. This type of meaningful learning actually appears to help children stay engaged (not distracted) and active in the learning process. Perhaps it makes what is new stand out, thereby making it easier for children to focus on what is to be learned. Recent work has found that when children were "rewarded" with meaningful information (such as how an object worked), they were more likely to continue on-task than when meaningful information was not offered or children were given a sticker (Alvarez & Booth, 2014).

Not surprisingly, meaningful contexts benefit adults' learning as well. One area that has recently begun to adopt this approach is healthcare (Hinyard & Kreuter, 2007). Recent work suggests that when doctors hear a narrative about a patient, they are better able to remember guidelines for prescribing opioids compared to doctors who are simply instructed about these guidelines. Despite the transparency of this explicit instruction, when guidelines are embedded within a meaningful context, even adults show better learning and more appropriate application (Kilaru et al., 2014).

When thinking about designing educational apps, it is important to consider whether the context created by the app allows children to make meaningful connections to their lives *outside* of the app. For instance, helping children to see that the triangle shapes that they are identifying within an app are just like the triangles they see when a parent cuts a sandwich or serves them a slice of pizza will result in true learning.

17.2.4 *Socially Interactive: Learning Is Maximized When Supported by Social Relationships (Either in-Person or Virtual)*

The final pillar that emerges from the Science of Learning is social interaction. Decades of evidence suggest that children learn best when working with others on joint tasks. At first glance, this appears to be the pillar that is the least easily applicable to the app environment as children often sit alone when engaging with apps. In fact, apps on most devices are designed for single-person viewing. However, some principles of social interaction may be attainable and even promoted via the use of apps.

17.2.4.1 Content

Although research on apps is so new that the existing literature is not yet abundant, research with another type of screen media, television, has uncovered ways to promote social interaction through content—even when children are the sole user of the app. Research on children's learning from television suggests that the characters themselves are important. Children have a tendency to form "parasocial" relationships with familiar characters on the screen. These relationships contain a strong emotional bond on the child's part, and children perceive themselves as interacting meaningfully with the character (Strommen, 2000; see Calvert & Richards, 2014; Chap. 9, Richards and Calvert, 2016; Chap. 10, Simensky, 2016 for a review).

Importantly, when children view content presented by familiar characters, they tend to learn more. Research from Lauricella, Gola, and Calvert (2011) presented identical math content to all children, but manipulated whether children learned from Elmo or DoDo (a character popular in Taiwan but not in the USA). Toddlers who saw Elmo on the screen learned to seriate nesting cups, but children who saw DoDo did not. Similar effects of familiar characters have also been associated with improved expressive vocabulary (Linebarger & Walker, 2005), literacy skills (Piotrowski, Linebarger, & Jennings, 2009) and healthier food choices (Kotler, Schiffman, & Hanson, 2012). While parents should be aware of the concerns about consumerism and marketing to children via apps (Common Sense Media, 2013), it may be that at least some familiarity with characters may serve an important role in helping children learn.

17.2.4.2 Context

Apps do have an advantage over television in that they provide a natural context for interaction and contingency. Research shows that social contingency, in which there is a back-and-forth reciprocity between speakers, is a powerful tool for children's learning (Goldstein & Schwade, 2008; Reed, Hirsh-Pasek, & Golinkoff, submitted for publication; Tamis-LeMonda, Bornstein, & Baumwell, 2001; Tamis-LeMonda, Bornstein, Kahana-Kalman, Baumwell, & Cyphers, 1998; Tamis-LeMonda, Kuchirko, & Song, 2014). Investigations of children's ability to learn from television have long suggested that learning language from the screen is limited during children's first 3 years of life (Wyss, 2008; DeLoache et al., 2010; Krcmar, Grela, & Lin, 2007; Kuhl, Tsao, & Liu, 2003; Scofield & Williams, 2009), termed the "transfer deficit" (Anderson & Pempek, 2005; Barr, 2010). Additionally, research is clear that live human interactions trump electronic "interaction" when it comes to children's language learning (Krcmar et al., 2007; Kuhl et al., 2003; Reiser, Tessmer, & Phelps, 1984; Roseberry, Hirsh-Pasek, Parish-Morris, & Golinkoff, 2009). Yet recent work suggests that if screen media were able to incorporate the natural back and forth that happens in face-to-face interaction, as is the case in Skype or other video chatting programs, children can learn new words. In work by Roseberry and colleagues, toddlers learned new words through video chats just as they did in live interactions with the experimenter, but the children who viewed traditional video showed no evidence of learning (Roseberry, Hirsh-Pasek, & Golinkoff, 2014). When it comes to language development of young children, this reciprocity appears to be especially important (Dunst, Gorman, & Hamby, 2010; Goldstein & Schwade, 2008; Gros-Louis, West, & King, 2014; Tamis-LeMonda et al., 2014; see also Chap. 15, McClure & Barr, 2016).

One technique that children's television shows have used successfully to increase social interaction and learning is for a character to pose questions to the unseen audience, wait for an answer, and then respond (Anderson et al., 2000; Fisch & McCann, 1993). For example, a character on the show might look into the camera and say, "What else is orange?", pause for a few seconds, and then say, "That's right! The carrot is orange!" (see also Chap. 7, Linebarger, Brey, Fenstermacher & Barr, 2016). This contingency is a powerful tool and can result in increased learning (Troseth, Saylor, & Archer, 2006).

Apps allow for a remarkable degree of contingency that was never available in television. While television programs might have a character ask a question and then insert some "blank" time meant for children to respond, these responses are only contingent in that they are time-locked to allow for a child's response. The character responded the same whether the child remarks that apples or carrots are orange. Apps have the increased ability and flexibility to respond contingently and immediately to a child's response. If the app asks the child to point to another object that is orange, and the child taps on the apple, the app can then respond by saying "Try again! Apples are red!" This represents another degree of meaningful contingency that was unavailable without a real-life social partner within the medium of television. However, apps are not yet at the point where they are as flexibily contingent as a real-life social partner.

One can easily imagine an app that is designed to teach children about numerosity. In this app, children are tasked with finding items on a grocery list. When the child taps on different foods, the item flies off of the shelf and into the cart. The child gets immediate responses that are linked to her taps and can get positive feedback once she completes the shopping list. However, apps are not yet at the point where they can hear her talk about the apple she ate at the grocery store yesterday or how she felt when she dropped her cookie on the ground while she was waiting in line. While some new apps (e.g., Words by Osmo) utilize reflective artificial intelligence and respond to items children manipulate in the real word, apps still are not able to mimic the second-by-second, complex, and ever-changing reciprocity of a human partner.

Again we return to the issue of within app- versus environmental-context. An additional lesson from the screen media literature is that although television (or really any activity) may not be inherently social, it has the potential to become a social activity when a social partner joins in on the experience. For television, this is termed **coviewing** and while it can involve anyone, most research has concentrated on parents coviewing television with children. While research applying this concept to apps has not yet been conducted, the results from research on coviewing with television are mixed. Parents' eye gaze, for example, has been shown to impact the likelihood that infants will gaze at a television and for longer periods of time (Demers, Hanson, Kirkorian, Pempek, & Anderson, 2013; see also Chap. 11, Anderson & Hanson, 2016). While some early research found positive results when parents coview with children (Reiser et al., 1984; Reiser, Williamson, & Suzuki, 1988; Rice, Huston, Truglio, & Wright, 1990), other more recent research finds no benefit of coviewing when it comes to learning vocabulary (DeLoache et al., 2010). It is important to keep in mind that the potential benefit of coviewing or joint media engagement when considering all forms of media, is likely highly dependent on the content being delivered, the age of the child, and his or her current conceptual understanding. In many ways, effective joint media engagement is very similar to the classic techniques of dialogic reading and as such, is likely highly dependent on the skill of the social partner. When a parent or other social partner uses techniques like dialogic reading, such as asking children to recall events in a story after viewing, or asking open-ended questions, children showed better story comprehension and increased vocabulary knowledge (Strouse et al., 2013).

Apps open up a world of possibilities with regard to utilizing what the Science of Learning has taught us about the benefits of social interaction for children's learning. From the use of parasocial relationships to engaging multiple players in a live game to the availability of social partners within the app itself, the potential of apps to harness this social interaction is unlike anything we have seen in television or video games. Further, the ability to have live experiences that parallel the social contingency and responsivity of live interactions via apps like Skype or FaceTime, children again are given the opportunity to interact with social partners from around the world.

Taken together, research in the Science of Learning suggests that children learn best in environments where they are **active** (minds-on) and **engaged** (not distracted), when the material is **meaningful**, and when they are learning in a **socially interactive** context. However, there is one important aspect of content and context that cuts across these four pillars of learning. This is whether the app has a learning goal. If it does, and if learning is supported in a flexible context in which children are scaffolded towards that learning goal in a playful, exploratory way, learning is maximized (Hirsh-Pasek, Golinkoff, Berk, & Singer, 2009).

17.3 Scaffolded Exploration Towards a Learning Goal

> "… children can learn anything if it is properly arranged; that appropriate structuring of the very young child's learning environment with accompanying, properly calibrated materials will enable that child to learn to read, to acquire an advanced vocabulary, and to do arithmetic calculations." (Sigel, 1987, p. 212)

Sigel (1987) believed that the optimal early learning environment allows children the opportunity to learn through self-directed play and exploration but highlighted that how children's environments are structured is key. The question about how to best instruct children is not new. For decades, there has been a debate about how we can set children up for academic success (e.g., Hirsh-Pasek & Golinkoff, 2011). On one end of the spectrum are those who advocate free play in which the learning context is unstructured and not designed purposefully (Gray, 2013). At the other end of the spectrum lies proponents of direct instruction in which adults or other more knowledgeable individuals (e.g., teachers or parents) tell children what they need to know (Klahr & Nigam, 2004). A meta-analysis of 164 studies found that direct instruction works better than free play (Alfieri, Brooks, Aldrich, & Tenenbaum, 2011). However, this analysis also found that another hybrid instructional method was superior to both. The researchers noted that "assisted discovery" methods in which the learning context is designed in a purposeful way with an adult following a child's lead while supporting learning, worked best of all. Another term for this type of learning context is 'guided play' (Fisher, Hirsh-Pasek, Newcombe, & Golinkoff, 2013; Hirsh-Pasek et al., 2009; Zosh, Hirsh-Pasek, & Golinkoff, 2016).

The benefits of guided play have been shown across educational domains. In the case of mathematical learning, Ramani and Siegler (2008) designed a game-based intervention in which children played a linear board game designed to help them understand the relation between numbers and develop more linear mental representations of the number line. They found that when low-income preschool children played the numerical version of the board game for a total of about 1 h (four 15-minute sessions over two weeks), they showed increases in mathematical thinking and that this effect held for 9 weeks. It was not just playing a game that helped them to learn. When the same game with the same rule was played with a game board that used colors instead of numbers, no benefit remained. Furthermore, children appear to benefit when the board is organized as linear and not circular (Siegler & Ramani, 2009) as to mimic the number line. It was critical that the adults set up and designed the play situation but then allowed children the chance to play and explore.

In a study of geometric knowledge, Fisher et al. (2013) directly compared learning through free play (no guidance or assistance), guided play (a more knowledgeable play partner followed the child's lead and scaffolded their understanding through playful instruction), and direct instruction (children were directly told the key concepts). They found that those children in the guided play condition not only showed increased knowledge over the course of that play session but also demonstrated retention of these concepts a week later.

The benefits of guided play extend beyond number and shape to include language and literacy outcomes (Weisberg, Hirsh-Pasek, & Golinkoff, 2013; Zosh, Reed, Golinkoff, & Hirsh-Pasek, 2014 for a review). Han and colleagues examined reading outcomes for at-risk preschoolers and found that when instruction is paired with guided play, children show increased gains in literacy compared to those children who only received direct instruction (Han, Moore, Vukelich, & Buell, 2010). Similarly, early evidence in a large-scale, in-progress intervention-based study with preschoolers in Head Start again finds that a focused, guided play context (either child-led or adult-led) is superior to free play (Dickinson, Hirsh-Pasek, Golinkoff, Nicolopoulou, & Collins, 2013).

Unsurprising to anyone who remembers memorizing multiplication tables or chemical reactions, direct instruction can result in learning. In fact, work by Klahr and colleagues on children's understanding of experimental confounds suggests that in some cases, direct instruction can be particularly effective (Klahr & Nigam, 2004; Strand-Cary & Klahr, 2008) over both short-term and long-term timescales. It is important to note, however, that the direct instruction condition of Klahr's work has commonalities with guided play conditions (see Chi, 2009).

Why is guided play so effective? One recent explanation suggests that guided play sets the stage, or the 'mise en place,' for learning (Weisberg, Hirsh-Pasek, Golinkoff, & McCandliss, 2014). In this account, children adopt a different mindset when they are engaged in playful learning. Unlike free play and direct instruction, the adults' role in guided play is to follow a child's lead, offering him or her the right "ingredients." The child then figures out how the ingredients go together, adopting a minds-on approach. Further, it helps children to see the meaning in what they are learning while also engaging with others socially. A closer inspection of free play and direct instruction shows that these types of pedagogy do not fully engage these four pillars of learning.

Another possible mechanism by which guided play may be more effective is in promoting discovery. Bonawitz and colleagues suggests that there is a 'double-edged sword' with direct instruction. While it gives children the appropriate information, it actually decreases exploration and discovery (Bonawitz et al., 2011). When children were directly instructed about one of four functions of a novel toy, they were much less likely to discover the other functions when given the chance to play with the toy. Children who were not directly instructed about the hidden function were more likely to discover the other functions.

It appears that one way to maximize learning is to couple exploration and guided play with direct instruction. For instance, when second to fourth grade children were given the opportunity to explore potential solutions for math problems before they were directly instructed, they had better conceptual understanding of those math concepts than those were directly instructed and then given the chance to practice (DeCaro & Rittle-Johnson, 2012).

Across all of these instances, guided play helps to focus children on the dimensions that are important for solving a particular problem. It does so, however, in a context in which children are the agents of their own learning—by either setting up the environment in which children explore, or by allowing them to explore an area with adults who then extend and augment their learning by asking open-ended questions.

When applied to apps, adopting the principle of this scaffolded exploration through guided play can be embraced in a number of ways including allowing children the opportunity to explore a problem or concept before providing a demonstration of the correct answer, creating a context that promotes active exploration and discovery, and engages children in creative thinking. One can easily imagine an app designed to teach children about the mathematical concept of addition by allowing children to drag products into a picnic basket with a target number in mind for a picnic lunch. One app might show the child an example problem where the number 7 is displayed and the app automatically shows the child four items in the basket and three additional items are added. When the problem is solved correctly, the child is shown the items on a picnic blanket and two happy children sit down for lunch. When it is the child's turn, he or she knows what to do. If the child does not correctly answer the problem, the app might play a 'buzzer' sound and then show the child the correct answer. This app demonstrates the way to play with the app and how to solve the problem. A related app might not demonstrate the "correct" way to solve the problem but instead first let children put items into a picnic basket and when the target number is reached, they hear a "ding ding ding" and a picnic party begins. In this case, children are tasked with determining what makes the bell go off. When children respond incorrectly to this app, the game might respond to an incorrect answer by demonstrating that the extra items fall off of a picnic blanket and are eaten by ants. When children are given the opportunity to explore the content and arrive at new conceptual understanding through their own exploration, learning will be maximized.

Apps represent a unique opportunity for scaffolded exploration and guided play by offering an interesting possibility. Is it perhaps possible for apps that engage children in scaffolded exploration and guided play to replace an actual, real life human? The jury is still out and this is a question ripe for investigation. Given the current limitations of even the most impressive app (e.g., even the best possible educational app is powerless when a child states he wants apple sauce for a snack!), we would hypothesize that an actual social partner would still reign supreme. However, since more experienced play partners are simply not available every second of the day—whether it is because a parent needs to make dinner or because a teacher has to share his attention with 20 students, apps represent brand new territory. It is up to researchers to find out what benefits and limitations this type of hybrid social interaction affords. It is critical that app developers keeps these pillars in mind and create contexts in which children are allowed to explore but are guided by the app towards a learning goal. Apps can be truly educational and represent a powerful learning tool that is already in many homes.

17.4 Final Thoughts

Parents are confronted with tens of thousands of apps marketed as educational. At first glance, determining which of these actually have real educational value appears to be an insurmountable challenge. By harnessing research that has been conducted under the umbrella of the Science of Learning and by abstracting four commonly agreed upon learning pillars that promote high-quality education within a context of scaffolded exploration and guided play, we developed a framework by which parents, educators, researchers and even app developers have the tools to determine what how to put the education back in the "educational" app.

Indeed, this is a first step in an as yet uncomfortable marriage between science and app developers. There is much to gain, however, by making this marriage work. A collaboration between app developers and learning scientists might herald a *second wave* of app development where apps are based on secure learning principles, here defined as the four pillars. In the first wave, the marketplace succeeded in convincing parents that content is all children need to succeed in school. Golinkoff and Hirsh-Pasek (2016) have referred to this misguided belief as the "learning illusion." Given the demands of the twenty-first century, and findings from the Science of Learning, five areas beyond ***content*** are required as well for children's success: (1) **collaboration**, or the ability to work alongside others while recognizing their differences and similarities with us; (2) **communication**, whether speaking writing or listening we must take the perspective of the other for communication to work; (3) **critical thinking**, selecting and integrating from the vast amounts of information now available that which is needed to solve the problem at hand; (4) **creative innovation**, and (5) **confidence**—the ability to persist and to take intellectual risks. In other words, ***contexts*** that are collaborative and communicative while promoting critical thinking, creative innovation, and confidence result in truly educational experiences for children. When the majority of apps no longer simply reproduce children's workbooks but create innovative approaches to facilitating children's acquisition of these 6Cs, they will be reaching their potential as instructional agents.

The power of truly educational apps is great. Utilizing what we now know about learning and applying that to a technology readily available to children across SES, we are now in a position to help level the playing field of early learning. As the Mayor of New York suggested, technology might well prove an important tool for narrowing the achievement gap (City of New York & Office of the Mayor, 2014). Preliminary evidence is promising. For example, a recent study exposed children from low-income families to a vocabulary-focused app for 2 weeks and found an increase in vocabulary of up to 31 % (Corporation for Public Broadcasting, 2011). These kinds of findings, while admittedly preliminary, show the potential impact apps may when the marriage between developer and researcher works.

Considering the four pillars within a learning context can help parents, developers and educators ride the second wave as it washes ashore. The Science of Learning has much to offer developers as we move forward. To put the education back in "educational apps" we need active, engaged, meaningful and socially interactive learning with an eye towards scaffolded exploration through guided play and a clear learning goal.

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Chapter 18
Supporting Children to Find Their Own Agency in Learning: Commentary on Chapter 17

Jeremy Boyle and Melissa Butler

Draw a circle and place the word learning inside it. Then, draw an overlapping circle with the word education inside it. This Venn Diagram will look different depending on the person doing the thinking, with some people finding lots of depth in the overlap and others finding great separation between the two ideas.

There is a need for more such Venn Diagram conversations in contexts embodied by stakeholders who are interested in supporting meaningful learning for children, both in and out of schools. The chapter by Zosh and colleagues (Chap. 17), with a focus on children's opportunities for learning with "educational" apps, contributes to this conversation. We agree that it is important to advocate for children's learning inside all contexts intended (or named) as "educational."

> "*There is no scientific or technological advance that is either good or bad itself. Just because we hear sad news over the telephone doesn't mean that the telephone was a bad thing. It's only as we human beings give meaning to science or technology that they will have a positive or negative thrust. A good friend of mine is using the splitting of the atom for medical diagnosis. Others we know have used it for destruction.*"—Fred Rogers
>
> Fred Rogers, undated, "Communicating with Children," Fred Rogers Archive at Fred Rogers Center for Early Learning and Children's Media, Box EU60.

These words from Fred Rogers point to a need to look beyond the *thing* of technology in order to think about potential to support thinking and learning in positive ways. Whether it be with a telephone, a pencil, a bicycle, a 3D printer, a screw, a pulley system or an app, the technology itself is not what creates the learning.

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There is no inherent value to technology. And as Zosh and colleagues suggest, there is no inherent value in an app that is simply labeled “educational.”

Just as many people incorrectly assume that technology itself will allow for learning or innovation, others embrace content in a similar way. Many current conversations about learning innovation are framed inside an assumption of the importance of content first. For example, the number of learning initiatives in formal and informal environments focusing on STEM (Science, Technology, Engineering and Math) or STEAM (Science, Technology, Engineering, Arts, and Math) dominates the current educational landscape. The focus is rarely on depth or quality of learning, and such initiatives and programs often assume that any learning in STEM or STEAM domains will be of quality; that the methodologies of exploration, creativity, inquiry, problem solving, etc., are all inherently part of the content defined as STEM or STEAM. In these content examples, just as in “educational” apps, the importance of developing the context for learning needs to remain primary if we are to create opportunities for deep and meaningful learning for all children.

Since 2010, we’ve developed the *Children’s Innovation Project* where we work primarily within the context of interdisciplinary classroom learning within formal preK-5 classrooms. At its heart, our work is learning about learning. And inside this, we find content is most meaningful when its purpose is as a vehicle for learning about learning. There will be content outcomes, but the most significant work of learning is in the less tangible experiences within the processes of learning. Learning that happens inside these spaces is transferrable to other content areas and other contexts. We find that careful consideration of the relationship between content and context is necessary to more fully realize potential learning opportunities. With *Children’s Innovation Project*, children explore and learn about electricity and simple circuits through hands-on engagement with Circuit Blocks and other raw materials, developing habits of mind to notice, wonder, and persist. Children make connections to objects in their world—specifically through imagining about the insides of electronic toys, opening them to notice carefully, identifying components, and then repurposing and reconfiguring their internal components into new circuits and new ideas (Fig. 18.1).

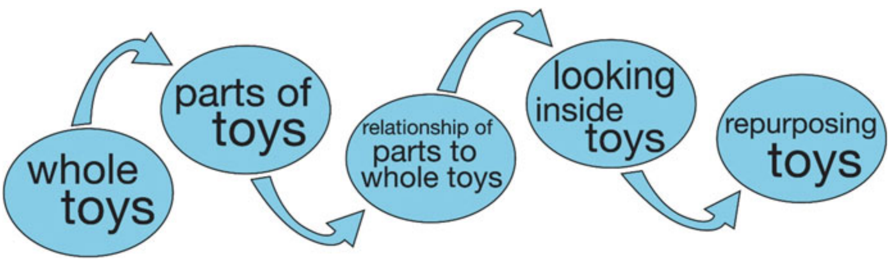


Fig. 18.1 Progression with material of electronic toys

18.1 Reframing Innovation and Technology

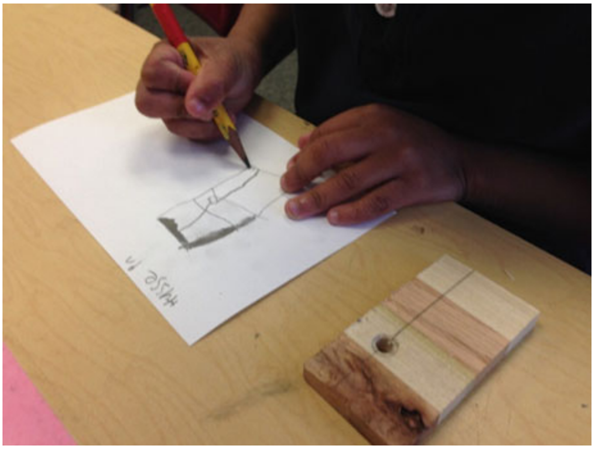
Within *Children's Innovation Project*, we embrace two primary theoretical reframings that support how children, educators, and families might understand the content of technology in order to open opportunities within the context of how children learn, understand, explore, imagine, and innovate with technology.

Reframe 1: Innovation—finding something new inside something known. This definition supports a shift in thinking about what it means for children to engage in innovation. Our approach moves away from a focus on children making some *thing* and allows a space for children to find small discoveries as they think about themselves in relation to the materials they explore. Specifically, when speaking about the context of a young child, this definition honors children's small authentic discoveries as innovation and supports children's confidence in becoming innovators.

Often when people look for innovative practice in classrooms, they look for an innovative product or technology to be introduced into the learning environment. The engagement or learning might look impressive at a surface level, but typically it is the material or tool that is more impressive than the learning. If the focus is instead on explorations, small discoveries and growing curiosities with raw materials, we might be able to see more actual innovation and learning. A teacher might engage students in developing language to describe sensorial experiences (touch, smell, taste, sound), explore physical attributes (rough, smooth, soft, hard, flexible), and support depth of children's growing logic (cause–effect, same–different, part–whole) in an open inquiry for digging deeper into unknowns.

Reframe 2: Technology—an approach with it as raw material. Most often when we think about technology within the context of learning, we think about it as a tool—for interaction, communication, delivery, efficiency, expression, etc. While these can be important in the framework of learning, we are interested in what might become possible if we also think about technology as a raw material. We define the raw material of technology in two primary categories: (1) the material components we can touch, such as LEDs, wires, screws, springs, batteries, resistors, switches, integrated circuits, and so forth, and (2) the logic systems upon which our technology systems work. It is within this second category of technology material that we are able to focus on children's access to the thinking of technology, not only the stuff (or things) of technology. If we wish for children to grow an empowered and critical relationship with technology, one in which they can imagine their own purposes and forms, it is important for children to develop a sensibility that technology is developed and created with purpose and that they also have the agency to determine purposes and forms. Without these experiences, children will likely develop a relationship with technology as passive consumers, more inclined to participate within fixed narratives and with limited opportunities for finding their own deep connections.

Exploration with raw materials such as clay, paper, paint, or wood is common and most educators and parents can see opportunities for children's learning with such materials. We are interested in how we might think about technology in that same framework. What might it mean to move toward the grain of technology and what might be the learning opportunities? As we work with children, teachers, parents, informal educators, administrators, and others, we find wood to be a good analogy to communicate this idea and wood is a material we directly explore in many teaching and learning contexts. Exploring at the grain of wood is something we can do in many ways. We can look closely at pieces of wood, some might be cut into blocks, some might be slices from a branch. Some might have a side with bark still on it, while others might have all sides with clean cuts. The grain can guide us in our explorations. It can be a focus for us when we look closely and practice observational drawing. We can look at the grain and connect it to the growth rings of a tree to better understand the piece of wood in relation to the whole tree. We can sand the wood with sandpaper. We can notice how different grits of sandpaper work. We can notice what happens when we sand with and against the grain. All of these are explorations of the grain of wood. In *Children's Innovation Project* we are interested in using this idea to guide our work in a similar way to what we consider the grain of technology; to explore both the raw component materials that we can touch, hold, and see as well as the logic systems upon which all technology is constructed. Through explorations of the grain of technology, children are able to make connections between what they see/don't see and find new ways to talk about and deepen their understandings of systems. We have designed language-logic constructs such as *Same and Different, Do → Happen, Parts and Whole, Known/Unknown* that young children use to engage in this thinking.



Exploration with the raw material of technology happens with our youngest children as they play with sets of keys, open and close doors, stack blocks, and watch them fall. Access to the thinking of technology, too, can happen when children are very young, as they are first finding language to describe how things are the same and how they are different, first trying to understand the cause of the effect they see or feel, first wondering about the things they can see and the things they can't see. Young children's experience with technology as a tool for passive engagement does not lead automatically to children's access to technology's logic then or in the future. In fact, we believe

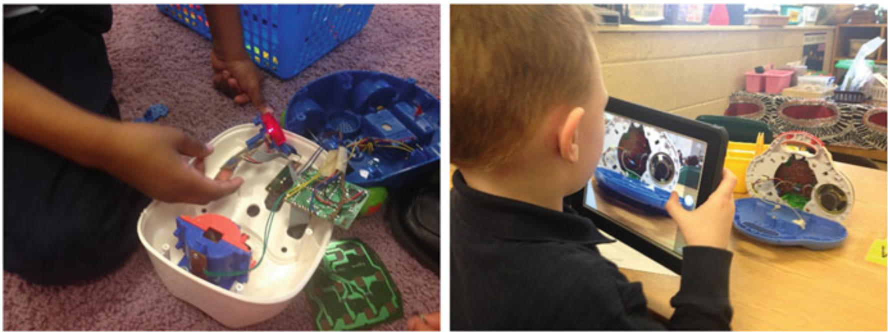


Fig. 18.2 Looking inside an electronic toy and using Message From Me to share learning

that without access to the material of technology and its language-logic early on in children's development, they are more likely to not wonder about the insides of things or have language to explain how things might or might not be working.

In *Children's Innovation Project*, we find that opportunities for exploration with technology as raw material and as tool can happen side by side, even with the youngest children. For example, in preK and Kindergarten classrooms, children explore simple circuits learning to make a pathway for electricity to travel from a set of batteries, through a wire, to a light, and back to the batteries. They add a knife switch to their circuit and develop cause-and-effect language to describe what they are doing, "I closed the switch and the light went on." This builds from explorations with electronic toys where children imagine what might be inside the toys and wonder about the connections of components, how they work together in a system. Alongside these explorations, children are using Message From Me in their classrooms, a technology developed by Carnegie Mellon University's CREATE Lab and supported by PAEYC (Pittsburgh Association for the Education of Young Children) in preK and kindergarten classrooms throughout Southwestern Pennsylvania. This iPad app allows children to take a photograph of what they are doing, record a short voice message and then send the message (via email or text message) to their family, supporting connections and communication between the learning in the classroom and the home environment. http://www.messagefromme.org/. No matter the context—"educational" apps or *Children's Innovation Project*—it is important for all children to actively engage in meaningful, socially interactive learning (Fig. 18.2).

18.2 Tools Are Not Inherently Educational: How to Foster Active Meaningful Engagement

What does it mean for children to be meaningfully engaged in learning? What supports opportunities for children to reflect on their learning in order to embrace their own agency to create learning for themselves? A focus on socially interactive environments, the fourth pillar from Zosh and colleagues, needs to extend beyond interaction with apps or any technology. In order for children to extend meanings to their lives and make connections beyond their direct time interacting with apps, children need opportunities for social relationships alongside and within such experiences. This sentiment is echoed in the joint position statement from the National Association for the Education of Young Children and Fred Rogers Center for Early Learning and Children's Media at Saint Vincent College. In this statement, they define interactive media as "digital and analog materials, including software programs, applications (apps), broadcast and streaming media, some children's television programming, e-books, the Internet, and other forms of content designed to facilitate active and creative use by young children and to encourage social engagement with other children and adults." In this definition and throughout the position statement, the role of social engagement is critical for children's active and creative use of technology.

Years before this position statement was written, Fred Rogers was thinking about the role of technology and media in children's lives:

> "*I have long believed that the best use of television happens when the program is over, and people integrate what has been presented. TV may be the only appliance that is more useful after it is turned off.*" "What Did Fred Rogers Say? Reminders for …". 2015. Fred Rogers Archive at Fred Rogers Center for Early Learning and Children's Media.

This could be read as a statement assigning negative value to television and media, but this would be a misreading. Fred Rogers' position is that the most important learning that television media can foster is learning that continues once the broadcast is over (television is turned off), when the child and/or adult continues learning in the space of real-world interactions.

Fred Rogers also cautions us on the limits of technology and the importance to know what it does well and what can be done better in different ways. He spoke about this directly:

> "*No matter how helpful they are as tools (and, of course, they can be very helpful tools), computers don't begin to compare in significance to the teacher-child relationship which is human and mutual. A computer can help you learn to spell "hug," but it can never know the risk or the joy of actually giving or receiving one.*" Fred Rogers. "*The past and present is now.*" Speech to National Association for the Education of Young Children, Atlanta, 1983. Fred Rogers Archive at Fred Rogers Center for Early Learning and Children's Media.

These two statements together reflect the complexity of what children need in their engagement as learners. Just as Zosh and colleagues speak about the importance of guided play in children's active and meaningful engagement in learning, Fred Rogers, too, spoke consistently about the need for human interactions to nurture and facilitate the space and time of children's play.

And perhaps one of the most significant aspects of human interaction is how these experiences support children to notice their own thinking, develop a concept of perspective, and reflect more deeply about how they approach and feel about their own learning. Through *Children's Innovation Project,* we focus on children's development of habits of mind to notice, wonder, and persist, and we find these habits to be significant for children's development of their own intrinsic desire to be learners.

18.3 The Goldilocks Effect

Within *Children's Innovation Project* classroom contexts, children learn a process of slowing down to look closely, that even in the smallest things there will always be more to see, find, and imagine. A common assumption is made that children need things to be flashy and fast paced to hold their attention, that otherwise they will become bored. With the space to slow down we can support their wonderings: I wonder why, what, how, when, where. This curiosity to wonder is the foundation for inquiry. If we focus on process, children learn to love and embrace a sensibility for inquiry, where one question leads to another and another and another.

Fred Rogers spoke of this too, of the importance for children to have sustained time and space for themselves, for their thinking:

> "*Sustained attention to things tends to foster deliberate thought. Readiness to develop the capacity for deliberate thought begins very early as children engage in their own kind of thinking-daydreaming, fantasizing, and making up all kinds of activities that we call play.*"
> Fred Rogers, "You Are Special" pg. 91, 1994, Viking Penguin Publisher.

In this self-reflective space children might learn how to notice, name, navigate, and have agency over their own learning, and learn persistence. The importance for children to practice staying with their struggles has become a central focus for *Children's Innovation Project*. Children need to learn that failure is part of learning and growing.

Zosh and colleagues point out "the Science of Learning has repeatedly found that children learn best when the task requires just a little more of children than what they can do on their own" in order to maximize their active or "minds-on" engagement in learning. They liken this with a Goldilocks analogy, where learning is not too difficult or too easy. They advocate for pushing children out of their comfort zone little by little in contrast to strategies of "hot housing" children to go beyond developmental norms, which has been found to stifle creativity and increase anxiety.

Aligned with this thinking is the current focus on personalized learning as an approach that utilizes the flexible nature of digital content delivery to be able to assess, identify, and deliver content specific to each child's "sweet spot" of challenge. While this is an important aspect to consider in both content design and delivery, we worry that without a deep focus on meaningful engagement and learning, one that extends beyond content and into the areas Zosh and colleagues identify, such as collaboration, communication, critical thinking, creative innovation, and confidence, many children may not develop the agency to find and seek their own learning pathways. In order for children to grow as learners who seek depth and complexity, it is important for them to be able to internalize what struggle feels like and to develop a desire to find and create their own challenges. When children play an active role in problem solving and are encouraged to reflect on how they feel about the process, they are more likely to develop agency for their own "minds-on" learning.

In order to be effective, learning environments need to empower children to engage with their feelings along an easy ↔ hard continuum. As a framework in learning design, whether for classrooms, after school programs or "educational" apps, we propose this should be a primary consideration as a learning goal. If the identity of the "sweet spot" is known as a fluid location in constant flux, the challenge can be to engage each child in a process of continually shifting this "sweet spot" as the child gains mastery rather than relying on its perfectly differentiated delivery to them.

Children need to learn more about how they are learning in order to grow their own intrinsic desire for challenge and growth. This might be the most central component in the design of a learning context to support all children's learning. And this means that as educators, parents, and caregivers, we need to also be engaged in the learning process to notice, listen, nudge, and connect *with* children to support "minds-on" engagement. There are learning potentials present in new media-related technologies, but in order to access and leverage these, it is important to recognize that this will not happen through a technology interaction alone, just as it will not happen in a content focus alone; human interaction remains critical to support children's growth and development as learners.

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Chapter 19
Conclusions: Making Screens Make Sense for Young Children

Deborah Nichols Linebarger and Rachel Barr

This collection of research chapters and commentaries was organized around the myriad and intersecting roles that child factors, content attributes, and contextual features play in determining which, whether, and why young children are affected by media exposure. By considering the young child as embedded in and interacting with particular contexts (e.g., home, school, parents, siblings) while simultaneously engaging with diverse media content, a more complex and nuanced view of the impact of media in their lives begins to emerge. Although developmental scientists have argued for models that avoid "piecemeal analysis, fixed in time and space, of isolated aspects" (p. 75, Bronfenbrenner, 1944), much of the early research investigating media effects did just this. Scholars spent a great deal of time studying simple cause → effect relations (i.e., exposure → outcomes) in the absence of content at least through the first few decades of media research. In 2001, Anderson and colleagues presented a longitudinal study where specific content effects were hypothesized and tested across a variety of outcomes. Despite this advance in attending to content, other contextual influences were incorporated as covariates, a trend that continues to dominate media research today. More recently, a number of researchers have argued for more contextually sensitive models to examine who is affected by what content under which circumstances (e.g., Jordan, 2004; Linebarger & Vaala, 2010; Valkenburg & Peter, 2013; Vandewater, 2013). When such contextually sensitive models have been used, researchers have found larger effect sizes for children who were most susceptible to these contexts (e.g., Linebarger, 2015a; Linebarger, Barr, Lapierre, & Piotrowski, 2014).

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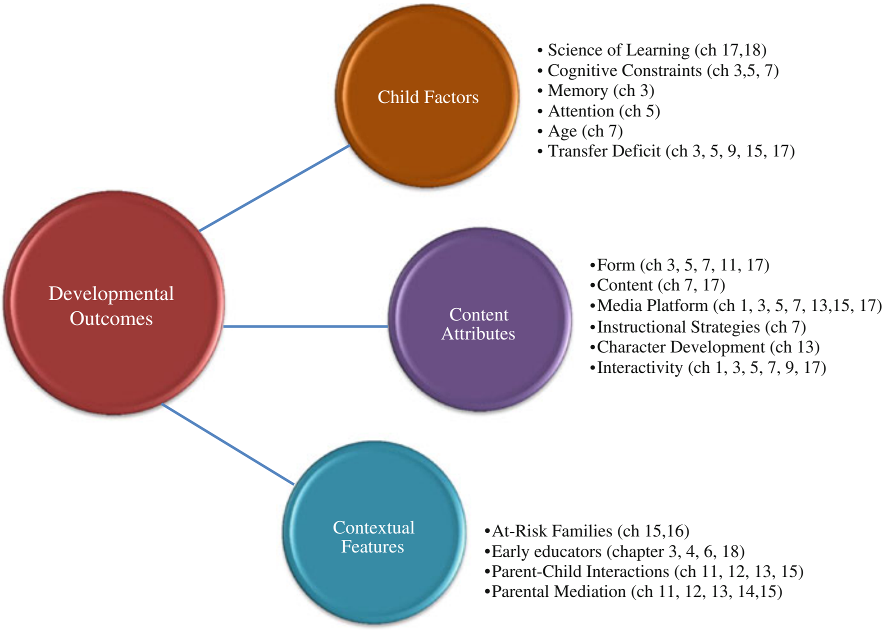

Fig. 19.1 Interrelationships among child factors, content attributes, and contextual features

The book was conceived to progress the field of infant media research by asking scholars who authored chapters to explicitly consider these three factors: child factors, content attributes, and contextual features as each related to their own research programs. Figure 19.1 incorporates the multiple and diverse variables examined across the nine scholarly chapters and nine commentaries that put the research into practice.

Child Factors. Child factors comprise a number of developmental factors that moderate the ways in which children perceive, encode, store, and retrieve media content. Specifically during a time of rapid social (self-regulation, theory of mind, emotion recognition), linguistic (comprehension and production), cognitive (memory and executive functioning), and neural development, constraints on how infants and toddlers encode and process media must be carefully considered. This is important for researchers investigating media but also for producers who are developing content and parents and early educators who are co-using media with young children. Additional factors include gender, age, birth order, disability status, ethnicity/race, and infant temperament.

Content Attributes. Content attributes encompass both content and form. Content refers to the message or storyline and form refers to the vehicle in which content is presented. Researchers investigating content attributes examine how both interact with a child's developmental competencies and the environmental contexts to which the child is exposed. Form serves to organize and structure the delivery of content and can support or inhibit content processing.

Contextual Features. Contextual features reflect broader ecological categories such as settings, economic resources, parent availability, parental scaffolding and interactional style, parent education, and other cultural and linguistic factors that surround where and how children experience media. Contexts can simultaneously limit and facilitate performance, depending upon the nature of the context.

To further move this research area forward, we also asked those responsible for creating content, developing child and family policies, and informing parents and educators about evidence-based best practices to comment on the implications of the presented research. This volume, therefore, represents an integration of research and practice in an effort to communicate what we know, what we do not know, and what we are not sure about the effects of media on young children. Consequently, it is our intent that this volume serves as both a foundational source of high-quality and rigorous developmental science research as well as a resource that parents, educators, and policy-makers can use to make informed decisions about media access and use for young children.

In addition to serving as a knowledge resource for researchers and the general public, we would also highlight the varied and creative methods presented throughout this volume. We know from the extant developmental research that very young children know and can do much more than previously thought. As developmental scientists, our challenge is to devise innovative, reliable, and valid ways to ascertain what they can understand and do. Kirkorian et al. (Chap. 5) and Hipp et al. (Chap. 3) offer new ways to evaluate young children's learning from media thereby advancing the field in important and sophisticated ways. As developmental scientists, we must continually push against the notion that infants experience a blooming, buzzing confusion by asking what we can do to better document their competencies. When we do find true inability, working with media industry leaders like Angela Santomero (Chap. 8) and Linda Simensky (Chap. 10) can help to create content that is capable of scaffolding learning more effectively. Lauricella and colleagues (Chap. 1) and Zosh et al. (Chap. 17) have extended our understanding of traditional media effects to new technologies by providing a framework for evaluating their effectiveness and Jeremy Boyle and Melissa Butler (Chap. 18) describe a project that does scaffold inability by using technology to help young children learn about their own learning.

19.1 Where Do We Go From Here?

Moving forward, we propose that researchers continue to incorporate multiple developmental processes and contextual features into their research programs. Jessica Piotrowski (Chap. 13) describes differential susceptibility as it relates to child factors (Valkenburg & Peter, 2013) and its role in determining who is more or less likely to be affected by parental mediation. This research is an excellent example of disentangling individual child differences rather than controlling for them. Susceptibility is not a single quality; rather a variety of child and family factors may make children more or less susceptible. Several recent studies evaluated susceptibility as poverty status (Linebarger, 2015b), gender (Anderson, Huston, Schmitt, Linebarger, & Wright, 2001), and parenting skills and sociodemographic risk (Linebarger et al., 2014). From a practical perspective, Rosemarie Truglio and Jennifer Kotler from *Sesame Workshop* (Chap. 16) discuss how to design for diverse populations to meet the needs of these individual populations including incarcerated adolescent fathers, deployed military personnel, and children and families coping with divorce.

Analyzing content attributes will also continue to play a vital role in media effects research. Deborah Nichols Linebarger and colleagues' analysis of preschool content attributes (Chap. 7) offers a systematic template for how to approach content evaluation while Melissa Richards and Sandra Calvert's research (Chap. 9) on characters and the relationships young children form with these characters offers a different way to conceptualize the importance of content attributes on young children's learning. Both chapters broaden the definition of content beyond key messages and delivery of those messages to include a focus on the role of character–viewer relationships. The extant literature on learning in early childhood underscores the crucial role that relationships play in young children's lives. Kara Garrity Liebeskind and Alison Bryant's commentary (Chap. 4) encourages researchers and practitioners alike to consider how these issues translate into the development of educational apps.

The contexts in which young children engage with media are quite diverse including Elizabeth McClure and Rachel Barr's chapter on video chat (Chap. 15) for maintenance of long-distance relationships and Daniel Anderson and Katherine Hanson's chapter (Chap. 11) on parent–child interactions during screen media and non-screen-media activities. Lisa Guernsey's commentary (Chap. 2) discusses the importance of deepening our understanding of context particularly as it relates to the maintenance of relationships through the use of technology. This perspective is a complement to the viewer–character relationships previously discussed by Richards and Calvert. The portrayals of caring and sensitive onscreen characters along with the use of technology to facilitate supportive and engaged relationships with caregivers in everyday life emphasize the multifaceted ways in which technology can play an important and positive role in young children's lives. Michael Robb (Chap. 6) extends these relationships to include early childhood educators who can model the constructive use of technology in their classrooms and help parents understand beneficial uses of technology in their own homes. Shalom Fisch's commentary (Chap. 14) then connects content attributes to context by presenting multiple ways that the judicious use of production techniques can promote joint media engagement between a child and caregiver. Claire Lerner's commentary (Chap. 12) shifts the debate in another direction by proposing guidelines for using media mindfully that include parental media use behavior outside of the parent–child relationship, arguing that one's own media use is a powerful model for how children come to use and engage with media.

19.2 Method and Measurement Challenges

Beyond child, content, and context, two other aspects of media effects research warrant greater attention. First, as suggested by Vandewater (2013), media research would benefit from thinking "deeply and comprehensively about how best to incorporate and test the ebb and flow of developmental processes" (p. 51). In this field, there have been only a handful of longitudinal studies to follow children over time with the specific goal of delineating the effects of media across childhood (e.g., Anderson et al., 2001; Barr, Lauricella, Zack, & Calvert, 2010; Linebarger & Walker, 2005; Wright et al., 2001). It is essential for sensitive and robust measures of media usage in the home be incorporated into comprehensive and prospective longitudinal studies similar to the NICHD Study of Early Child Care Experiences to more systematically examine child factors, content attributes, and contextual features as they unfold over early childhood and beyond. This would allow us to better gauge how media is impacting multiple facets of early child development.

Second, a major challenge in this field involves the measurement of media exposure. Labs use widely varying methods to measure media, even for more traditional forms like TV (e.g., recall based on a "typical" day vs. diary methods; Vandewater & Lee, 2009), making it difficult to compare across studies. Most methods for estimating amount of exposure rely on one or several questions asking parents to "estimate the amount of TV viewed in a 'typical' day," calling into question the strong conclusions drawn from such weak methods. The vast majority of research in this area focuses more on a global estimate of time spent (Vandewater & Lee, 2009), ignoring content despite robust evidence that content is a critical moderator of media effects (e.g., Anderson et al., 2001). Other family member's media habits are also typically ignored, which is becoming an issue as each family member is likely to have his/her own device. Researchers have yet to establish reliable methods for measuring use of newer media, especially on mobile devices where exposure occurs in small bursts. In previous research, Burns and Anderson (1993) found that shorter bursts of attention to television (versus longer looks) are much less likely to be remembered, making retrospective assessments particularly problematic for this kind of media use. In October 2015 after attending the Digital Media and Developing Minds conference (organized by the National Academy of Sciences), a number of child media researchers formed the CAFÉ consortium (CAFÉ = Comprehensive Assessment of Family Exposure) to tackle these issues. Specifically, the group is working to systematize and standardize how media exposure is measured in the context of children's everyday experiences.

19.3 Final Thoughts

From the first discussions of this project in Rachel's garden to the completed product, we have made strong progress toward understanding the "new blooming, buzzing confusion" in the context of early child development. We know that a number of factors govern early sociocognitive development in the digital age. It is incumbent upon researchers to consider the complexity of this learning environment on child development. As highlighted throughout this book, we need to consider developmental constraints on child learning, the content of the media exposure, and the context in which media are being used. Media use and co-use by all members of the household and by early education providers needs to be considered as part of this environment. The rapid pace of technology proliferation cannot be a reason for researchers to shy away from accurate measurement or even consideration of the media factors that are impacting early development. Similarly, it is incumbent upon media producers and child advocates to continue to dialog with researchers to translate research into practice.

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