Media Exposure and Early Child Development Workshop

January 25–26, 2018

6710B Rockledge Drive
Bethesda, Maryland

Executive Summary

The Media Exposure and Early Child Development Workshop addressed the impact of various media on early child development. This two-day workshop was hosted by the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development (NICHD) and co-sponsored by the National Institutes of Health (NIH) Office of Behavioral and Social Sciences Research (OBSSR), the National Science Foundation (NSF), Children and Screens, the Society for Research in Child Development (SRCD), and the American Psychological Association (APA).

Participants explored the influence of media exposure and use on infants and toddlers, reviewed the neuroscientific perspectives on media exposure, discussed implications for learning and language development, and explored the impact of technology on the lives of young children and parent–child interaction. The objectives of this Workshop were to identify current knowledge gaps and promising directions for future research to address these gaps. Recommendations by Workshop members touched on a range of issues that need to be addressed to move the field forward, including meaningful measurements and analyses, parent–child interactions, long-term longitudinal population studies that include diverse groups, neuroimaging research, interdisciplinary and multidisciplinary research, parent education, data sharing, collaborations and partnerships, and staying ahead of continually evolving technologies.

Contents

Participants

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Federal Sponsors

Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD)

National Institutes of Health (NIH) Office of Behavioral and Social Sciences Research (OBSSR)

National Science Foundation (NSF)

Non-Federal Sponsors

Children and Screens: Institute of Digital Media and Child Development

Society for Research in Child Development (SRCD)

American Psychological Association (APA)

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Thursday, January 25, 2018

Opening Remarks and Introductions

Ruben Alvarez, Lisa Freund, and James A. Griffin, NICHD, and
Della Hann, Director of Extramural Research, NICHD

Dr. Alvarez opened the workshop at 8:30 a.m., welcomed the participants, and introduced and thanked the sponsoring partners.

In other opening remarks, Dr. Freund said that the purpose of the workshop is not to discuss policy, but to look at what is known about the impact of media on early development and determine where to direct future research. Dr. Hann stressed the importance of the workshop for finding ways to optimize health and development and the functioning of children and families. She said that input from the participants will help to identify gap areas and clarify what is already known, what no longer needs addressing, and what to address moving forward. The emphasis is on research, not guidelines. She said that the question is no longer whether media has an effect, but rather how and when it has an effect. Multiple variables—social, individual, and biological—must come together to address these questions.

Dr. Griffin reviewed the structure of the workshop and encouraged all attendees to take part in the general discussions.

Session I: Media Exposure and Early Childhood: An Overview

Children's Technology Use and Health: A Population Studies Perspective
Paula Fomby, University of Michigan

Dr. Fomby discussed opportunities for improving the current survey data infrastructure for studying children's media use and its consequences for development. Key points included:

- A population studies perspective refers to research based on data collected from observed samples to make inferences about the distribution of attributes and behaviors within and between population subgroups and over time (historical or developmental).
- In practice, population research is based on analysis of mostly secondary data sets that are population-representative and reflect multiple data collection methods.
- Population-level research has had an important role to play in quantifying the prevalence of media exposure overall as well as in identifying disparities between population subgroups. These data can also document time trends and age-graded patterns of media use.
- Beyond prevalence indicators, population-level research allows us to document the magnitude of associations; describe population variation in impact of exposure on health; describe changes within individuals and in populations over time; use study designs, statistical methods, and quasi-experimental conditions to estimate causal effects; and

research community use of public data to build a knowledge base that supports the public interest.
- Longitudinal data also offer the opportunity to consider pre-existing characteristics that might be associated with both frequent television viewing and later child outcomes.
- Population-representative data on children's time use have been widely used to document how media use fits into children's daily lives.
- The contemporary media regime is not well-characterized by the information included in older data sources. Challenges posed by new media include:
  o New platforms and new applications
  o Time versus content and context in shaping child outcomes
  o Diffusion of media use in households
  o Media use as a "background" activity
  o Measuring salient "under-the-skin" pathways and outcomes
  o Media/technology developments outpace data collection/release/analysis
- Technology-centered research, like the Common Sense surveys and studies conducted by the Pew Research Center, is at the leading edge of collecting data on contemporary media use, usually in great depth.
- Health-centered studies include a wealth of content on general health, diagnosed conditions, and functional impairments, but relatively little content on media use as a health behavior.
- The Panel Study of Income Dynamics (PSID) Child Development Supplement collects extensive information on children's media use. The Environmental Influences on Child Health Outcomes (ECHO) study, to date, has no content developed on children's media use across cohorts, but it potentially could be a resource for collecting such information.
- Place-centered data based on administrative data from schools and public agencies offer a novel approach for documenting variation in media use and assessing its association with child outcomes.
- In conclusion, a population studies perspective offers critical insight into the implications of media use for early child development, as demonstrated by prior research on conventional media. No single population data source will be sufficient to address the expanding universe of research questions.

Discussant
Elizabeth Vandewater, University of Texas at Austin

Dr. Vandewater provided comments on Dr. Fomby's presentation. Key points included:
- Population-level study data (U.S.-represented) are exceedingly rare; longitudinal population studies are even rarer.
- Experiments are great for determining causality but not at understanding the prevalence of phenomena. Population data can help us see things in ways that smaller samples cannot.
- Large-sample studies are expensive; researchers should have access for secondary data analysis.
- Researchers can compare prevalence-of-use estimates from population data with their own data and use that information when designing their own studies.

- Adolescents who don't have computers at home use smartphones as the main way to access the Internet.
- In a world of streaming and personalized advertising, what an adult sees, is not what children see.
- The greatest need is for the development of new technologies and approaches to measure media use.

A Brief Historical Tour of Research on Media and Children's Development
Ellen Wartella, Northwestern University

Dr. Wartella reviewed a brief history of research on media and child development. Key points included:

- The introduction of each new technology during the past century—film, radio, television, computers, and digital media—has brought recurring concerns about children's use of these new technologies.
- With each new type of media, there was hope for an educational benefit, along with concerns about crime and violence.
- Between 1928 and 1934, the Payne Fund supported 12 major investigations into the effects of films on children's sleep patterns, attitudes toward violence, delinquent behaviors, and other topics. These studies established a paradigm for studying how media content influences child audiences and introduced new measurement techniques.
- In 1939, criticism about radio programming for children led the National Association of Broadcasters to adopt a set of standards for all children's programs. To avoid controversy, many radio broadcasters gradually replaced their children's programs with adult fare. By 1941, CBS had replaced almost all of its children's shows with soap operas.
- From the 1950s through 2000s, a consensus emerged that television could be a powerful influence on children, depending on its content. The 1972 Surgeon General's study concluded that for some children, under some circumstances, some television has an effect.
- In the digital media era, new issues about social media use and adolescent depression, the effects of virtual reality and augmented reality on perceptual development, and the effects of constant technology connection on children's well-being have arisen.
- In studying media effects on children, the "3 Cs" matter:
  - Child: Age, cognitive abilities, and personality traits may influence how the child is affected by media experience.
  - Content: Violent programming influences aggressive behavior; prosocial programming influences prosocial behavior; and high-quality, curriculum-based educational television can influence and support children's learning.
  - Context: When children consume media along with their parents, opportunities for interaction and parental mediation are related to how children are influenced by exposure.
- Every new technology is accompanied by a wave of both panic and excitement about potential effects, as reflected in both popular press and empirical support.

Discussant

Sandra Calvert, Georgetown University

Dr. Calvert provided comments on Dr. Wartella's presentation. Key points included:

- Mobile media use has reached 93% of households in the U.S., consistent with television. Television still "reigns supreme."
- Viewing television and video content is not a passive experience. "A still body does not mean a blank mind." The child is attending to the content, retaining information, converting information to symbols, and responding to a motivational system.
- There is power in a "story well told."
- Children have needs and desires for using media just as adults do—for gratification, entertainment, and education.
- The commercialization of childhood is still alive and well. The goal of most media companies is to make money.
- Marketers are getting more sophisticated over time, using more personalization and tracking. As a result, children's privacy is diminishing.
- Children who have strong relationships with characters (e.g., Dora the Explorer) in media learn better. Increasingly interactive media with responsive characters can revolutionize education.
- One major concern among parents is the lack of physical activity when children are using media.
- Another concern is the loss of a quiet environment; the world is "noisy 24/7."
- Children's developmental needs have not shifted. There is a need to create a "media diet," with quantity and quality that optimizes children's development.

General Discussion

- Studies done in today's context may not be relevant later.
- Are there any data available on use of things like Facebook games before the age of 5? (Dr. Graesser)
  - o Time diaries would be useful for that kind of information; data is collected about the time of day and time of device. There may be questions about game use by young children, but these have not been specific about Facebook use in children that young. (Dr. Fomby)
  - o Smartphones and iPads are now being used by children age 1 year and younger. Fathers, in particular, encourage the early use of technology, thinking this will help when the child starts school. Little is known about video game use at this age; it is usually seen among boys with their fathers. There seems to be a gender difference. Television is still the prevalent form of media use time; video content remains the major form of media used online. (Dr. Wartella)
  - o When looking at population data, it's important to be clear about the different types of media use (e.g., video games, social media, television). We tend to think all children have all of those patterns, but studies have shown that there are subgroups of users who use media in different ways. (Dr. Wartella)

- o Android-based sensing apps are in development and can yield fascinating data on the apps that children are actually using.
  - o In addition to addressing content, it is important to address how the media is being delivered. Certain patterns of technology design can manipulate children (e.g., into making purchases). (Dr. Radesky)
- Have any studies looked at the effect of media on children with intellectual disabilities?
  - o There are a few studies from the 1990s and early 2000s on television use and children with mental health issues. but this is not the same as intellectual disability. A compendium about the research was released in 2005.
- Have any studies addressed virtual reality, which is very different from television or tablet use?
  - o There are concerns about the effects of virtual and augmented reality programs on children under 12; one company has stopped developing these for young children for this reason. Sesame Workshop® has been working with companies on augmented reality and its effects but is using caution because of concerns about the technology.
  - o Young adults have experienced side effects like nausea or dizziness with virtual reality; the impact is much stronger than for observational media.
- We need real-time data on children's use of iPads. Netflix and other companies are doing more research than scientists are. In population studies, is there a way to look at iPad and Facebook use in the home?
  - o The ECHO study is in the final stages of finalizing data; adding measures to an already large questionnaire might be difficult. Yet, there is a working group on mobile health and mobile technology sensors, and ideas for passive measures that would not add significant time are welcome.
  - o Long-term longitudinal population data are needed. PBS has some data about use by children to share.
  - o Media use alone doesn't mean anything; looking at the content is important.

Session II: Influence of Media Exposure and Use on Infants and Toddlers

Learning from Media in Young Children: Constraints and Opportunities
Rachel Barr, Georgetown University

Dr. Barr discussed the content and context of early media exposure and how constraints on learning due to cognitive development, such as the transfer deficit, can be exacerbated or ameliorated. Key points included:

- Television is the most frequently used media format during early childhood.
- Background television is not benign and has been shown to interfere in children's play and learning. It has been associated with poorer parent–child interaction. In 42% of homes, television is on almost all the time.
- Studies of parental media use suggest missed opportunities for valuable social interactions with children.
- Transfer of learning is an adaptive skill that develops gradually during childhood. The ability to transfer information across content and context is important for day-to-day functioning and is central to memory theories.
- Learning from television, books, and touch screens involves transfer of learning across content and context. It is almost effortless by adulthood but is cognitively challenging during early childhood.
- Young children consistently learn less from television and touch screens than from a live demonstration, because it is difficult to understand how information from the screen relates to the real world. Transfer deficit can be overcome by considering the 3 Cs (i.e., how the child learns and the content and context of that learning).
- Transfer across dimensions (3-dimensional [3-D] to 2-dimensional [2-D], or 2-D to 3-D) is challenging for children 1 to 3 years of age, due to cognitive flexibility limitations. There are very similar patterns of learning from video and touch screens.
- Music, even if it is played in the background, is very much an active component of attention, learning, and memory retrieval during infancy. Cognitive overload happens easily. Learning from media is easily disrupted during infancy.
- Parents may mediate "looking patterns" toward television stimuli during infancy by directing their child's attention to specific content during co-viewing. If this is the case, a higher degree of parental scaffolding during television co-viewing should positively affect attention to and learning from television.
- Parental scaffolding is defined as elaborate verbal input; emotional support, warmth, and responsiveness; and structured teaching. Parental scaffolding provides a warm and receptive context in a challenging learning task and provides a set of individualized language and joint visual attention cues to connect 2-D and 3-D information for the child. The context of media exposure may contribute as much as program content does to any early learning from television.
- Cognitive processing of televised information during infancy is complex. Learning from 2-D is cognitively demanding and complex. The potential for learning is predicted by a number of different factors.

- o Child: Repetition and language cues help. There is a transfer deficit from books, television, and touch screens.
- o Content: Features can be added to enhance learning. Processing differs as a function of age.
- o Context: Scaffolding may be particularly important during early childhood.

Discussant
Heather Kirkorian, University of Wisconsin–Madison

Dr. Kirkorian provided comments on Dr. Barr's presentation. Key points included:
- It's important to think about the sources of information and the hierarchy of the different layers. Are children learning from a screen, a person, and/or an interaction? Are they distracted? How are children encoding information?
- Some current unknowns related to children's media use:
  - o Whether/what children learn from screens and what is more difficult.
  - o Whether some kinds of learning are more beneficial than others (e.g., rote learning vs. problem-solving).
  - o Which children learn better, and for how long; whether they retain the information or whether it disappears quickly.
- It's important to consider individual differences, but this is difficult to do.
- There is a need to fill gaps and find shifts across age, even within narrow age ranges.
- A better understanding of parental scaffolding is needed to fill in gaps about where and when parents should intervene.
- We are starting to move toward more sensitive measures.
- There is a need to explore transactional effects (i.e., not just how children are learning but how they experience what they learn).

A Pediatric Perspective on the Impact of Early Media Exposure
Jenny Radesky, University of Michigan Medical School

Dr. Radesky discussed pediatricians' concerns about digital media and early childhood and the relevance for clinical care. Key points included:
- Pediatricians are child advocates. A pediatrician's practice involves caring for the children within their family, social, and cultural environments. Media use interacts with each of these aspects, is entwined with health problems (e.g., sleep, obesity, mental health), and comprises a large proportion of a child's waking hours.
- Prior American Academy of Pediatrics (AAP) guidelines, which characterized media use as a risk factor, have limitations.
- A differential susceptibility model has addressed predecessors of media use based on four propositions:
  - o Media effects depend on three types of susceptibility (dispositional, developmental, and social).
  - o Three media response states (cognitive, emotional, excitatory) mediate the relationship between media use and effects.

- o The differential susceptibility variables act as predictors and moderators.
- o Media effects are transactional.
- Examples of dispositional, developmental, and social predictors of use by infants or toddlers include:
  - o Infants with more fussing or crying have a higher duration of television viewing.
  - o Infants and toddlers with regulatory problems are more likely to exceed AAP guidelines at 2 years.
  - o Toddlers with socio-emotional delays have higher odds for being given a mobile device to calm them down when upset and when a parent wants peace and quiet in the house.
- Parent characteristics that predict media use by a child include maternal mental distress and parent media practices. Possible mechanisms include media as a correlate of parent mental health, life stressors, role modeling, concept formation, relationship-based factors (i.e., withdrawal from parenting stress), and decreased reflective capacity about parent–child relationship.
- Guidelines need to address:
  - o Actionable, family-centered guidance that acknowledges the major role(s) that media plays in households.
  - o Shared media use and intentional/planned media use as a tool, which can help build digital literacy.
  - o Advocacy around marketing to help parents evaluate low-quality apps and content.
  - o Attention on disparities in quality media access.
- Gaps in knowledge include:
  - o Transactional, longitudinal associations between child characteristics and media use.
  - o Parent–child interaction around media.
  - o Identification of interventions and methods for implementing them through existing community systems (e.g., schools, child care).

Discussant
Sandra Waxman, Northwestern University

Dr. Waxman provided comments on the presentation by Dr. Radesky. Key points included:
- Babies' and children's access to media has far outpaced what we know about its impact, for better or worse.
- There is promise and peril. The promise is that we know children can learn from material on a screen. The peril is the concern about screen time.
- When developing a new research paradigm, we need to keep in mind what is known from developmental science.
  - o Learning is not a steady state. An optimal learning environment varies significantly over development, especially from birth to age 3. Each developmental step sets the stage for later development.
  - o Children learn best when socially engaged with a devoted tutor (e.g., a parent, sibling, experimenter) from ages 3 to 5; not much is known about this for children under age 3.
- Questions remain about how well children move forward on their own using technology. Once children become "fluent" in media, how do they "take it on the road" and learn more?

- In addition to exploring scaffolding from adults and others, it is important to explore the role of individual independent discovery (e.g., a child alone in a sandbox vs. alone with an iPad). Which children are able to discover things alone, and under which conditions?
- Other suggestions:
  - Bring the power of diversity into population studies. More population work is needed with focused target populations.
  - What are the goals (e.g., discovery, entertainment) of the child, the parent, and the developer of the program?
  - Examine learning conditions (e.g., quiet vs. noisy) and how they are related to how much is learned.
  - Harness the powerful work done at companies like Google and Netflix, which study how long children are on a page, when they go forward, and when they go back. Link spontaneous touch screen data to research criteria.

General Discussion

- We also need to address social cognitive development, especially when thinking about middle childhood. How is learning different when technology is less of a tool and more a part of an experience? (Dr. Smith)
- In most of the studies about learning from media, the children studied were 15 and 18 months old. Do the characteristics of the media affect children as much at younger ages (6 and 12 months old)? (Dr. Richards)
  - Babies at 6 months are an interesting group and have demonstrated that they learn easily. (Dr. Barr)
  - Babies are learning from media designed in a particular way. In studies, babies are learning from material on a screen by 3 months of age. They form categories of objects. There is evidence of object characterization, abstract rule learning, and word comprehension. Research as to whether they can use the information to learn new information is ongoing. (Dr. Waxman)
  - Learning from screens in the first 6 months is possible, but how much do we want that to happen?
- Parents need to be savvy about the types of apps designed for infants; we don't know what infants are consuming. There are concerns about displacement of verbal interactions and play experiences that are needed for development. (Dr. Radesky)
- What are babies learning from background media? What are the long-term implications of that type of distraction on the child's experience of the world? (Dr. Hurst-Della Pietra)
- Babies may learn from video, but perhaps not as efficiently as they do from a person. The fact that they learn better at a later age may involve their ability to develop concepts about the reliability of a screen and their sophistication in relating screens to reality. (Dr. Troseth)
- What types of industry data are available? Is there a willingness to share?
  - Netflix is forming its own research teams and is able to hire Ph.D. researchers. Such companies are not likely to give data away freely, but there is hope for collaboration. (Dr. Smith)

- At Northwestern Medicine, the neonatal intensive care unit (NICU) staff uses apps—delivered through the parents' mobile devices—to maintain contact with parents of pre-term babies. There are other areas where apps or links for parents could advance the child's development. (Dr. Waxman)
- Tufts University researchers are designing technology for young children, ages 4 to 7, and collecting data that the researchers are willing to share on how children use the technology. (Dr. Umaschi Bers)
- We need to know more about whether the media experience in special populations differs from that in the typical child populations studied. Also, is there an interest in using media to deliver interventions, especially for people with intellectual disabilities, rare conditions, and geographic limitations? Do we assume that the results of these interventions are the same as those delivered in person? Is the quality of the data analogous to the data acquired when interventions are delivered in person?
  - There are examples of video games being used successfully to help children with asthma and diabetes. (Dr. Wartella)
  - Children with autism are often visually savvy and more motivated to use digital media. Families are eager to have a way to communicate. Apps for social skills and recognizing emotions have been developed but not tested, and may be a good way to deliver interventions. (Dr. Radesky)
- We can increase sample sizes through a synergistic approach (i.e., by using the same assessment tools, or some aspect of the same tools, to collect data from different groups). (Dr. Barr)
- There are multiple sources of data available for sharing including:
  - The Family Life Project, which examined household chaos, poverty, and parenting as predictors of early language development.
  - Databrary, a video data library for developmental science that shares videos, audio files, and related metadata. (Dr. Griffin)

Session III: Neuroscientific Perspectives on Media Exposure and Use in Early Childhood

Media Effects on Young Children: An Attention Development Perspective
John Richards, University of South Carolina

- The ages of infants in this study were 3, 4.5, 6, 9, 12, 18, and 24 months.
- The methods involved having the children watch video programs, with or without distractions. Videos used in the study included *Sesame Street*'s "Follow that Bird," geometric patterns synchronized with music, "Blue's Clues," "Teletubbies," "Elmo's World," and Richard Scarry videos.
- The main experimental variable in these studies was the type of video stimuli: "comprehensible" (age-appropriate) and "incomprehensible" (age-inappropriate).
- The dependent variables were fixation, "attentional inertia," and heart rate measures of attention.

- In experiments with children ages 6, 12, 18, and 24 months, the children sat on their parents' lap (or in a chair) while watching video stimuli on a video monitor.
  - Video recordings of fixation were made, along with off-line observer judgments (e.g., "looking toward video monitor," "looking away from video monitor").
  - Heart rate was recorded as a measure of sustained attention.
  - Average look duration, distribution of looks, and "attentional inertia" were recorded.
  - Extended heart rate changes during "looking toward video monitor" were recorded.
- The neuroscientific model for development of attention in the first 12 months, which links the changes in infant attention to the changes in brain networks, shows:
  - Changes in the first 12 months in brain areas supporting basic attention processes.
  - Orienting, peripheral stimulus sensitivity (spatial cueing), and smooth pursuit tracking.
  - Memory, eye gaze perception and joint attention, and perceptual narrowing.
  - Extended development of sustained attention and attention engagement (and heart rate measurement).
  - Changes in particular areas of the brain that are important for social interaction that may affect video processing.
- In children ages 6, 12, 18, and 24 months:
  - Extended visual fixations are an index of attention engagement.
  - Changes in extended heart rate–defined sustained attention develop to comprehensible stimuli.
  - Extended attention engagement to organized comprehensible stimuli at 18 and 24 months.
- In conclusion, the findings showed that:
  - For infants ages 3 months to about 12 months, video programs had minor effects on extended fixations, neural development of several "core attention systems" affecting fixation and attention, and development of brain systems for attending to the environment and likely for social brain development. Synchronized audiovisual stimuli elicit the most attention.
  - For babies 18 and 24 months old, comprehensible and age-appropriate stimuli elicited extended fixations and changes in heart rate, indicating attention engagement.

Discussant
Martha Ann Bell, Virginia Tech

Dr. Bell provided comments on Dr. Richard's presentation. Key points included:
- A brain model system is critical to our understanding of media exposure and screen time in children.
- Changing patterns of fixation are associated with brain patterns.
- Attention in the first year is critically important. We are discovering that infants learn from screens before 12 months of age, but what is involved beyond looking?
- Something important happens at 12 months of age when looking patterns change with comprehensible videos. Does it involve language, song, and dance? Attention networks may change beyond basic alerting and orienting networks.

- Executive attention starts at about 10 months of age and is associated with motion and social interaction. Social interaction may be critical for the executive function setting.
- Quite a bit is known about brain development up until 12 months of age. Less is known about development in ages 12 to 24 months than at any other period in the lifespan, possibly because of more difficulty in studying that age (e.g., difficulty with electroencephalography [EEG] caps).
- A brain networks approach would help us understand the impact of screens' effects on children 12 to 24 months of age. Are these ages more vulnerable?
- The implications of a family's socioeconomic status (SES) must also be considered in studies of brain network development in relation to media use; the differential impact of poverty is not known.
- Longitudinal studies are important and should also address brain network analysis.

Language Development in the Digital Age
Linda Smith, Indiana University Bloomington

Dr. Smith presented suggestions for framing research questions and setting an agenda for research on children's digital media use. Key points included:
- The psychology of digital media use, especially for children, is not well understood.
- Individuals differ in how long they sustain attention; these differences are predictive of later outcomes.
- The influence of experience on development starts with real behaviors and the internal neural effects that they elicit.
- Sustained attention to objects plays an important role in early visual and cognitive development, as well as self-regulation. The likely drivers of that development occur in the context of actions in a 3-D and social world.
- In 3-D play, toddlers have long looks to single objects. Those long looks predict later cognitive development. In picture book reading, there is more rapid shifting between objects. Parents' book-reading with children is a positive developmental context and predictive of many long-term outcomes.
- Sustained looks to an individual object in a 3-D world predict learning, both in the task and in the future, and is supported by physically holding objects. This supports joint attention (and is supported by joint attention) with a social partner.
- Children change, and the understanding of short and long looks needs to change. Short and long looks may have different functions and different values at different points of view. If digital media promote rapid shifting among targets in the execution of motor plans and series, those media might be promoting more mature looking patterns.
- Children have a lot to learn and need many different kinds of experiences. Digital media may be good for some forms of learning and not others.
- Considerations for defining a research agenda for studying infant's and children's use of digital media and effects on development include:
  o Basic descriptors:

- How much use, what types of use, when and where used, and how use fits with other activities.
- How these change with development.
  - o Populations studies
  - o Underlying mechanisms:
    - Which mechanisms are engaged by media use and how they are changed by that use.
    - How functional networks in the brain form as a function of different kinds of tasks.
    - How these component abilities—developed potentially through many different tasks—fit together.
- Development and experience emerge in effects in real time, at scales of fractions of seconds repeated over time, and with aggregated effects on development.

Discussant
Sarah Roseberry Lytle, University of Washington

Dr. Lytle provided comments on Dr. Smith's presentation. Key points included:
- Continue to explore the role of social scaffolding and joint media engagement and their relevance when using both screens and books.
- Librarians have a bias against screen media, but the bias lessens if screens are considered in the same category as books.
- Different types of learning occur with 2-D print than with 3-D objects. More sensitive measures for the different kinds of learning are needed.
- Using neuroscientific methods and understanding the nuances of the data will be incredibly important.
- Children who have had some social scaffolding show more mature responses.
- Continue to explore the role of social scaffolding. We don't understand all the nuances of why this is important.
- More real-time neuroscientific data on language development in relation to media use is needed.

General Discussion
- Agents or avatars on a screen can serve a social function, opening up a powerful new world. (Dr. Graesser)
- In thinking about the brain systems model, short looks might be increasing with age because the child has developed a schema that does not involve continual looking. (Dr. Wartella)
- When a person is reading, there is not one long look in one direction. Neuroscience measures can distinguish between extended fixations and long looks by using heart rate and other indicators. During long extended looks, people are actually getting the most information. A really long look might be a lot of short fixations. (Dr. Richards)
- There is a lot of evidence that poverty and extreme stressors have significant long-term effects on development; not all of the time spent with parents is good time. We need to be thinking about other shocks to the system that are part of brain development and should

not assume that every minute a parent spends with a child is good for the child. It's important to think about these other contexts in a brain systems model. (Dr. Kirkorian)

- Regarding interactivity, many educational videos are designed either according to what the adult thinks a child should be doing or by using an outcome measure (e.g., increased reading). Interactive programs are? designed "millisecond by millisecond" to modify the interaction if a child's attention is waning. Not much work has been done to describe the important features of learning from interactive video and systematically designed videos. (Dr. Richards)
- A lot of data is being gathered on digital game play. PBS is studying digital games in development to determine how and when children are learning and is happy to share the data. (Ms. Rotenberg)
- The National Science Foundation funds basic research and is very interested in longitudinal studies and research into brain mechanisms from a developmental viewpoint. (Dr. David Moore)
- Researchers at NIH are starting to look at EEG responses in infants at 3, 4, and 6 months of age. There is more to be learned from looking and attention behaviors than just duration. Very fine analyses of "what is going on under the hood" can be done by manipulating the conditions under which babies are devoting these short vs. long looks in advance of brain measures.
- We shouldn't conclude that interactive learning is always better; it depends on what is being learned. Studies in adults have shown that video and television are better than interactive media for certain kinds of learning. Interactive learning might be better for acquiring new information. (Dr. Nichols)

Session IV: Media Exposure and Use in Early Childhood: Implications for Learning

Links Between Media Exposure and Language and Literacy Development
Deborah Nichols, Purdue University

Dr. Nichols discussed links between media exposure, language and literacy development, and the transfer of learning. Key points included:

- Attributes of micro-level content need to work in concert with macro-level contextual features to provide duplicative content across multiple modalities while taking into account a child's individual differences.
  - o Child factors: demographics, learning capabilities, cognitive constraints, basic cognition, prior knowledge, transfer deficit.
  - o Content attributes: form and content, macrostructure/frame, platform/affordances, instructional strategies, appeal and usability, character attributes, interactivity.
  - o Contextual features: family demographics, environmental expectations, early educators, parent–child interactions, parenting styles.
- Those with less print experience/knowledge did best in receptive vocabulary acquisition without onscreen print until they reached a threshold number of views.

- Certain formal features (across media/as currently used) attract attention away from central content and interfere with learning. Background music (on television) is problematic for infants, but the addition of sound effects paired to key content enhances learning.
- Low-SES children show larger gains from educational media–based interventions and language.
- "Transfer of learning" refers to the ability to extend what has been learned in one context to new contexts.
- Factors that matter in facilitating transfer to accelerate development using media:
  - Positive, nurturing relationships and social support.
  - A human brain in good working order.
  - Opportunities to learn.
  - Self-efficacy ("I can do it").
  - Regulation of emotion, arousal, and behavior.
  - A sense of belonging/meaning in life.
  - Involved parents.
- Evidence-based ways that media help in facilitating transfer to accelerate development:
  - A parasocial relation with onscreen characters enhances learning.
  - High-quality educational experiences provide protection. Increasing exposure to educational television is linked to stronger academic performance in both short- and long-term and better behavior.
  - There is a large body of evidence for learning across multiple domains for children 2 years and older, and a developing body of evidence for children under age 2.
  - Low-income parents interact with/around television content in the same way that middle-income parents interact around books. Parent–child interactions are similar across different media (books, screens, pictures).

Discussant
Nicole Patton Terry, Georgia State University

Dr. Patton Terry provided comments on Dr. Nichols' presentation. Key points included:
- The interaction of the 3 Cs (child, content, context) is especially important for individuals with diverse needs.
- Language is central to this research; it is critical to how well children achieve later in school. Language is much more than vocabulary and should be measured that way. Really good measures of language may be long and difficult to administer and interpret but tend to do a better job of measuring many aspects of language than measures that target vocabulary alone.
- Many children speak languages other than American English. This matters in how they develop language and literary skills, and therefore how they learn from media.
- Children ages 0 to 5 years are not buying or choosing media; adults are. We need to consider how adults, including teachers, are interacting with media. Their values, goals, and mindsets will matter if a child is to engage and learn.
- Many children spend many hours of a day with adults who are not their parents (e.g., teachers). How are these adults engaging with media?

- Language is interactive. Consider whether media is creating a barrier or is supporting language. This will depend on the context and/or the individual. For example, media may be supportive of teachers who are teaching children with disabilities or parents who are English learners of children who speak English, or low-literate parents who may have difficulty with literacy and with technology.
- Explore how we can disseminate knowledge to adults, so they can use information more easily. It is very difficult to change adult behaviors. Even professionals may need support to implement best practices with media usage with young children.
- Continue to explore underserved populations, and include those not traditionally included (e.g., individuals with disabilities, rural populations, fathers, low-literate adults). Ensure that samples are inclusive.

Understanding Children's Learning in Digital Contexts
Georgene Troseth, Vanderbilt University

Dr. Troseth provided an overview of children's learning in digital contexts. Key points included:
- Babies learn better from people than from screens; parents are the best teachers.
- Toddlers learn better from a person who is present rather than from imitating a person's novel behavior seen in a video or from learning a word uttered by a person in a video.
  - Children do not expect television to connect to reality. They distinguish between images and reality. Television images don't reliably represent reality. Video that was clearly related to reality helped children use information from the video.
  - Social cues missing from video impair learning for very young viewers. Providing those cues on video (e.g., contingent responsiveness) helped those viewers learn.
- Preschoolers (ages 3 to 5 years) have better learning with screens plus scaffolding.
  - Evidence shows enduring educational benefits (e.g., better GPAs in high school, controlled for parent involvement and education, SES, etc.) from watching *Sesame Street.*
  - Early evidence shows that co-viewing helps children learn more. Parents watching a video with their children can improve learning.
- "Interactive" digital technology can empower parents, rather than replace them.
- Dialogic questioning in an e-book gives parents the tools to engage in rich conversation around all kinds of storybooks.
- Digital media isn't good or bad for learning and family interactions. Factors that matter include age, content on the screen, and scaffolding.

Discussant
Arthur Graesser, University of Memphis

Dr. Graesser provided comments on Dr. Troseth's presentation. Key points included:
- We are working with collaborative learning and problem-solving. Media can be built to support this kind of collaboration.

- When measuring scaffolding, what are the scaffolding moves used (e.g., dialogic questioning, giving hints, challenges)? Those affordances and details need to be measured before conclusions about media are made.
- The differences between reality and media may become more blurred with virtual reality and augmented reality, in which users are participating and not just observing. There is little research comparing the influence of virtual reality and augmented reality with conventional screens.

General Discussion
- Children will, in general, prioritize understanding the story over learning words; these must be meshed together. (Dr. Calvert)
- In low-SES families, talking about media is an option, but reading books to children is not. (Ms. Rotenberg)
- How do you disseminate information to parents that translates to them? PBS has a tremendous reach to parents and would be happy to take this work and help translate it for parents and figure out how to engage them so children benefit. PBS is applying what was learned from the Ready To Learn initiative to help parents understand how they can work with media to help children learn more. Information is available on PBS KIDS Lab. (Ms. Rotenberg)
  - A lot of important work is ongoing throughout the U.S. government, which is trying to integrate all partners, including the U.S. Department of Education. (Dr. Griffin)
- For non-English speakers, print books are more expensive and may not be affordable; e-books are an important and accessible venue for promoting early language and literacy. (Dr. Griffin)
  - Smart e-books in which both the text and the prompts change are in development. For example, there may be English text with a Spanish questioner. Parents were surprised to be able to connect books to their children's lives using adaptive digital technology. (Dr. Troseth)
- In thinking about the larger effects on low-SES populations, is it possible that parents are learning from some of these activities as well? Materials sent home may help educate parents. (Dr. Smith)
  - Háblame Bebé is an app for Spanish-speaking parents to trigger talking with children. (Dr. Troseth)
  - There are many apps for parents, particularly related to newborns. The Ready To Learn initiative found that parents need education about interacting with babies. (Dr. Vandewater)
- Screens are old-fashioned technology, and we need to think about how those interfaces will be replaced in the future. Research questions should not be tied only to screens. By the time we get answers, we will be talking about the past. (Dr. Umaschi Bers)
- Research on asking questions deserves more attention. Teaching how to ask and answer questions is integral to comprehension. (Dr. McNamara)

- Language is multidimensional and can be used to study social interactions between individuals. We can discover an enormous amount about language with adults and children by using automated technologies. (Dr. McNamara)

Final Presentation of the Day

Dr. Pamela Hurst-Della Pietra, Founder and President, Children and Screens: Institute of Digital Media and Child Development; School of Health Technology and Management, Stony Brook Medicine

Dr. Hurst-Della Pietra discussed research needs and questions for participants to consider. Key points included:
- In a recent literature review of the range of research designs used to examine young children's use of digital technologies (Miller, Paciga, Danby, Beaudoin-Ryan, & Kaldor, 2017), the authors found only 10 studies that examined technology or media use in children across age groups, and none of these studies directly observed children or studied them longitudinally.
- Parental surveys give a snapshot of what parents are willing to admit but compared with direct observations survey data correlate imperfectly with reality. Sophisticated parental surveys are necessary but not sufficient.
- Research that is designed to focus on narrow populations or questions is highly limited. For example, Miller et al. (2017) report that studies of media use in "early childhood" overwhelming focus on 3- to 5-year old children, largely excluding younger children.
- Methodological limitations in the research base make it difficult to provide clinical or parental guidelines because of incomplete or insufficient data.
- The rapidity of technological advances has far surpassed methods for assessing their use. More large-scale, real-time, observational, longitudinal studies of young children's digital media exposure are needed as are more randomized double-blind controlled trials.
- Synchronized analysis of data on media exposure, parent and child behaviors, including subjects' physical states over time seem necessary to achieve the breakthroughs sought.
- Deploying comprehensive resources in future research on media exposure will require cooperation among parents, clinicians, academics and industry, and a structure that protects children's and families' privacy and safety, but the potential benefits make this worth pursuing.
- Researchers may benefit from examining virtual and augmented reality technologies, and so-called smart toys and social robots while they are less widely adopted compared to smartphones and tablets which are ubiquitous.
- Future research needs to address how exposure to or isolation from social media might affect factors such as creativity, school readiness, physical health, and propensity to violence. What other behaviors are being displaced or otherwise influenced? How does digital media influence constructive or destructive habits of mind? How do parents' digital media behaviors influence parenting?
- A structured dialogue is needed so doctors or nurses can assess and prescribe media-based interventions that are likely to achieve goals.

- Large-scale collaborations that have more potential for transformational results are needed.

Dr. Hurst-Della Pietra encouraged participants to attend her organization's 2018 National Congress on Digital Media and Developing Minds on October 15–18, 2018, at the Cold Spring Harbor Laboratory.

Identification of Gaps in Our Research Knowledge (group session)

Participants were asked to identify current gaps in research knowledge related to media exposure in children. They suggested needs for:
- A better understanding of neuroscience and the effects of media on brain development. EEG and MRI data in the second year of life are almost nonexistent. (Dr. Richards)
- More knowledge about brain development and tools from age 1 to 2 years. Children are first observed to fall off the trajectory after the first birthday and before the second. Developmental issues are often first noted in this window. (Dr. Smith)
- Inclusion of children ages 0 to 1 year. Powerful learning occurs before a baby's first words; language and cognition are being built. (Dr. Waxman)
- Exploration of existing large data sets related to media use in children. There is a need to determine who has these data sets, where they are, and how to learn from them to determine precise research questions. (Dr. Calvert)
- More longitudinal research and sequential designs. Media is changing rapidly, but developmental needs are not changing. There is a need to look in sequential ways and see how media issues are matched with points in development. (Dr. Calvert)
- A determination of the basics of how children develop and learn that can be applied to changes in devices or interfaces. Technology changes quickly, and certain formats can become less relevant. Which fundamentals of developmental science will make sense 10 to 15 years from now? (Dr. Kirkorian)
- Mechanisms to conceptualize how to publicize research and get the message out. Parents are hungry for information. (Dr. Umaschi Bers)
- An understanding of the interactions that children are having with adults regarding media. An adult in the child's environment gives the child the device. (Dr. Patton Terry)
- Tracking of "smart technology" rather than touch screens. Address "big macro systems" and new technologies entering a child's world. (Dr. Calvert)
- Methodologies to capture real-life media usage and population-based research. Address measurement issues (e.g., determining who the actual user is if a tablet is used by several family members). (Dr. Radesky)
- An understanding of how learning from media or a parent influences a child's representation of the world. What is safe? How do the heart and mind work together? What information is being taken up from the information being offered? (Dr. Calvert)
- Piggybacking on the era of Big Data and spending the next decade exploring data mining. Explore measurement issues related to emotions and language. (Dr. Graesser, Dr. McNamara)

- An understanding of the role of siblings and peers. This is an understudied area; children spend more time with them than with parents. How does their role mediate executive function and outcomes? (Dr. Nichols)
- A better understanding of the effects of technologies on parent–child interactions. (Dr. Roseberry Lytle)
- The inclusion of commercial media producers in the discussion. Data is being collected by private industries but not being shared. (Dr. Wartella)
- A better understanding of educational media. This traditionally meant "getting ready for school," but education also occurs outside of school. (Dr. Wartella)
- Large multidisciplinary research studies to understand all pieces of the puzzle. (Dr. Wartella)
- Careful work on valid measures for exposures. (Dr. Wartella)
- Efforts to connect with multiple sites collecting the same data. Video data, for example, can be coded by different researchers with different interests. The potential is greater than with individual labs looking at individual things. (Dr. Griffin)

Friday, January 26, 2018

Welcoming Remarks

Ruben Alvarez, NICHD, Catherine Spong, Deputy Director of NICHD, Dara Blachman-Demner, OBSSR, and William Riley, Director of OBSSR

Dr. Alvarez welcomed the participants and introduced Dr. Spong, who stressed the importance of addressing the discussed topics across all people affected, not just normally growing children. She encouraged inclusion and assurance that as many populations as possible, particularly those with physical and intellectual disabilities, are included in the research agenda.

Dr. Blachman-Demner introduced Dr. Riley, who also emphasized the importance of the topics discussed. He cited challenges in measuring the effects of content, context, and multiple media exposures and in assessing the relevance of SES and the impact on special populations.

Session V: The Role of Technology in Early Childhood Interventions

The Positive Impact of Digital Technologies in the Lives of Young Children
Marina Umaschi Bers, Tufts University

Dr. Umaschi Bers reviewed the role of technology in early childhood interventions.
- Three tensions are found in the literature with respect to the role of new technologies in early childhood interventions. These include:
  o Technologies as playground versus playpen.
  o Impact as literacy versus science, technology, engineering, and math (STEM).
  o Goal as development versus education.
Tension 1: playground versus playpen
  o Playground (Papert, Piaget): features constructionism, tools for thinking, a focus on learning, programming tools, engineering, and educational robotics.
    ▪ A playground focus results in the child as producer; activities are child-directed and unpredictable.
  o Playpen (Skinner): features instructionism; tools for mastering; focus on teaching, drills, games; computer-assisted instruction; intelligent tutoring systems; social robots.
    ▪ A playpen focus results in child as consumer; activities are adult-directed, safe, and predictable.
- Programming and coding can be a playground for young children. Relevant products developed at the DevTech Research Group at Tufts University and funded by the National Science Foundation include:
  o ScratchJr is a free app that allows children (ages 5 to 7 years) to program their own interactive stories and games.
  o KIBO is a robot kit for young children that allows programming without a screen, using wooden blocks and creating a sequence.
Tension 2: literacy versus STEM

- o Literacy: features a way of thinking, integrated curricula, project-based methodology, goal of expression, an empowerment agenda for all, and literacy campaigns.
    - A focus on literacy results in epistemological tools.
  - o STEM: features a skill set limited to a few disciplines, completing challenges, a goal of problem-solving, improving competitiveness, workforce pipeline, and STEM in schools.
    - A focus on STEM results in disciplinary tools.
- "Coding as a literacy" involves the ability to use a symbol system and a technological tool to comprehend, generate, communicate, and express ideas or thoughts. It empowers individuals and can promote social change.

Tension 3: development versus education
  - o Development: features the importance of play, the whole child, all dimensions of development, complex and multidimensional, developmental trajectories, and difficult assessments.
    - A focus on development results in novel interfaces in formal and informal settings.
  - o Education: features the importance of practice and repetition, focus on school readiness, emphasis on cognitive domain, linear and unidimensional, "personalized" learning, and scalable assessments.
    - A focus on education results in traditional software and school settings.
- A positive technological development framework addresses a personal development trajectory within a sociocultural context.
  - o Positive youth development includes caring, connection, contribution, competence, confidence, and character.
  - o Constructionism includes collaboration, communication, community-building, content creation, creativity, and choices of conduct.

Discussant

Danielle McNamara, Arizona State University

Dr. McNamara provided comments on Dr. Umaschi Bers' presentation. Key points included:
- Building a knowledge base from the time a child is born involves multiple senses.
- The concept of a "playground" is interesting. Playgrounds are often devised according to what adults think a child needs. This is sometimes wrong. Children often have more abilities than adults think they do.
- With the "coding" examples, the child is essentially creating rules, elements, and systems. How does that transfer to language learning, problem solving, and social interaction? How can we use those technologies to enhance child development and the interactions between child and parent?
- We have traditionally thought of behaviors as linear and have used linear statistics. However, we know that behaviors are multidimensional, complex, and interactive and involve different layers, data streams, and sources of information. We are on the brink of using analytic tools to help understand interactions.
- To advance the science in this area, it is important to consider multiple sources of information, multidimensional processes, and interdisciplinary teams.

Educational Media Exposure and Parent–Child Interactivity
Suzy Tomopoulos, Bellevue Hospital Center

Dr. Tomopoulos discussed whether parent–child interactions are enhanced by educational media that is directed at children and by media apps and technology-based interventions that are directed at parents.

- Value of educational media exposure in young children:
  - o Established benefits of media exposure in preschool and older children, related to learning vocabulary and language and to prosocial behavior.
  - o Not as well established in younger children (younger than 3 years of age).
- Possible routes for benefit of educational media include a direct impact on learning and increased cognitive stimulation via parent–child interactions.
- Characteristics of media exposure that may support or impede parent–child interactions include context (background or foreground exposure), content, and platform (e.g., mobile devices, e-books).
- Fewer interactions and language with educational media compared with play.
- Interventions aimed at enhancing relationships by promoting interactions increased the quality of parent–child interactions.
- Parents who used more scaffolding (questions, labels, descriptions) had toddlers who used more words.
- Co-viewing rates by parents vary with the age of the child and family income; it is more likely with very young children. Poorer children are at risk for language delay when exposed to few words.
- Parents who actively scaffold around child-direct content and use more language are likely to enhance the child's exposure to new words.
- Further research on educational media use in young children, the use of new emerging mobile devices and their impact on child development, and the impact of parents' attitudes, mediation, and own use on their children is needed.
- Text messaging (with parenting tips, interventions) helped engage parents in more learning activities with their children such as engaging in pretend play, telling stories, and describing to children what they were doing (Hurwitz et al., 2015).
- Multiple parent apps are available for a variety purposes. Some apps help parents choose activities that promote learning, others provide games that parents and children can play together, and some provide general learning tips for young children.
- Parent-direct, technology-based interventions focusing on parent–child interactions have multiple goals such as:
  - o Increasing parents' sense of competence and decreasing parental stress
  - o Teaching parent-child play and learning strategies
  - o Providing parent training through video feedback
  - o Promoting enhanced reading, play, talking, and teaching, and reduced screen time via parent-child interactions.
- Parent-directed media impacts interactions, with the potential to enhance them.
- Text messaging is the most established intervention aimed at parents; newer apps are not well studied yet.

- Future study of following features is needed:
  - o Tailored messages.
  - o Supplemental in-person interventions to boost use of media.
  - o Built-in interactive elements.
  - o Ability to upload videos/interactions to share or track.
  - o Involvement of social media.

Discussant
Lesli Rotenberg, Children's Media and Education, PBS

Ms. Rotenberg provided comments on Dr. Tomopoulos' presentation. Key points included:
- All media companies have different goals. PBS differs from many others in that it views itself as a learning company that helps children learn and grow.
- The media research at PBS is mainly focused on children ages 2 to 8 years, not on children under age 2. All funded research is focused on high-risk populations. Children from the lowest family income levels have made the greatest gains.
- Not all educational content is created equal. Defining content as "educational" can be a disservice. The process at PBS is rigorous and starts with frameworks from advisors in child development. It begins with goals, followed by the development of characters, stories, and games.
- Parent–child interactions are critical to learning. Research extends beyond the time the child is watching. When parents discuss the program in the real world, they are making connections and the benefit increases. The television does not have to be on. This is being studied, and more research is needed.
- Data shows that rates of co-viewing are high in all groups. PBS is gathering data on this, as well as data on game play, and is interested in sharing data and partnering with others to use media to benefit children. PBS is interested in forming partnerships and can provide assets, tools, and data for research.

General Discussion
- Understanding how to motivate parents and teachers and bridging the gap is important. The idea of videotaping the parent–child interactions with an interventionist, for example, is a good one. There is a need to build systems to motivate and engage parents and teachers as well as children. (Dr. Griffin)
- Early childhood education should not be regimented and should include a lot of discovery and learning. There is tension when early childhood education is seen as an intervention, especially for at-risk children due to poverty; there, the perspective is on school readiness gaps and is adult-driven. The challenge is to create early childhood education environments for high-risk and high-need children without negating discovery. (Dr. Patton Terry)
- We need to make sure that research also includes the facilitators (e.g., teachers, parents) who are interacting with children every day. Many are on the front lines, whether they want to be or not, and need to understand how to teach children online. (Dr. Patton Terry)

- What does learning from media (e.g., ScratchJr, robots) mean for children struggling with literacy impairments, autism, or developmental disabilities? If coding is language, what are the ramifications for children with difficulties learning language? How do we leverage that to support them? (Dr. Patton Terry)
- Are "technology" and "media" the same or different? Technology often refers to infusing STEM in a program and building that curriculum. Most teachers are not shying away from technology but do shy away from media, such as using the iPad in a classroom. They like technology but are afraid of media. (Dr. Patton Terry)
- In a study with children with autism, children were able to use language and program, but in a different way than typical children; they would create a program in a different sequence with different symmetry than other children. (Dr. Umaschi Bers)
- There is a lot of learning from media that happens outside of the actual exposure time. We are not doing an adequate job of gathering information on what happens afterward (e.g., how often the parent talks about the television program or video with the child).
(Dr. Nichols)
- Comparing "live" time with people to video time is an unfair comparison. The transfer deficit is not necessarily a function of the media. (Dr. Nichols)
- Is there enough research on adults intervening with play—or at least not disrupting it? When parents talk during a program, are they interrupting the flow? How and when does a parent or teacher "dance" with the play? (Dr. Graesser)
  - Early developers were against teachers intervening. However, studies have shown that more learning occurs when teachers orchestrate the right groups of no more than three children; two is better. More studies are needed to teach teachers how and when to intervene. (Dr. Umaschi Bers)
- How much do children get from technology and media that they cannot get from other areas? How do children use media as a tool to promote their other interests? For older children, media and technology are tools to further interests that aren't addressed in school. The idea of delayed transfer after the program is also important. (Dr. Erica Spotts)
  - It is not just about the game or the interaction but also about how children are learning, with all the triggers put together and in context—not just in school but in their whole lives. Studying one aspect in the laboratory may miss the big picture. (Ms. Rotenberg)

Future Research Directions (group session)

This session consisted of a "lightning round" brainstorming exercise, in which each participant contributed one key point related to future research directions, followed by a general group discussion.

Brainstorming Suggestions
- Explore measurement issues beyond exposure. Examine what is measured and whether it is meaningful. What are the dynamics and interactions? (Dr. Fasig Caldwell)

- Move away from simplistic models—not measuring exposure just in the moment but also over days and weeks later. Develop sensitive measures to answer questions in more sophisticated ways. Examine the impact on subpopulations of children. (Dr. Nichols)
- Use what is known from other research to explore how children connect words and images to the real world, and to understand the parent–child interaction with things that are not screens or technology toys. Consider the issue of interruptions while watching media or reading a book. (Dr. Troseth)
- Examine how to coordinate parents, teachers, peers, agents, and others with scaffolding moves to coordinate play and learning. (Dr. Graesser)
- Apply neuroimaging and brain development research in children ages 1 to 2 to the media issues discussed. When studying brain imaging, start out with small picture studies, such as looking at how 1-year-olds move their eyes from one character to another and the brain areas that control that. (Dr. Richards)
- Expand the idea of content. Explore the importance of media to understand parent–child interactions, such as including pauses where parents can jump in to comment. Explore user-based designs that allow for parent–child interactions. In a game, a parent's interruption could be intrusive. Ways to measure mediation are important. (Dr. Radesky)
- Move beyond surveys and apply real-time measures of use, not just parents' reports. Explore the impact on other activities in the home and how people really use devices, without the experimenter present (e.g., use cameras in children's hats). Observe how users switch from one moment to another and how this changes with development. (Dr. Smith)
- Consider a range of evolving technologies—not just screens—and how these support learning and discovery. Focus on the lasting moment, as well as the immediate moment. (Dr. Waxman)
- Consider the goals in children's futures and understand that stories are not obsolete. Understand whether the goals are to pick up on the language, the moral of the story, or sequencing. Interruptions can disrupt the continuity of the story and affect story comprehension. (Dr. Calvert)
- Examine the impact over time with longitudinal research—how to help children use media best to develop the habits of mind needed to be successful. Focus on content, not devices. Examine differences with different populations, as well as how adults can support learning along with the media. (Ms. Rotenberg)
- Do interdisciplinary and multidisciplinary research. Explore features of games that are effective for children, such as competitiveness. Address the control of the learning process and the tension between agency and control. (Dr. McNamara)
- Help practitioners understand what happens and what should happen when children use content. Expand the area of children making, and not just consuming, content. (Dr. Umaschi Bers)
- Focus on engagement strategies that can be used in the home. Understand how pediatricians, who have a large amount of contact in the early years, can disseminate information learned from research. Be sure to address low-SES children. (Dr. Tomopoulos)
- Focus on reliability and validity of data—not quantity. Do not increase data collection in a way that increases burden. (Dr. Fomby)

- Address multiple subgroups—such as single-parent families and Spanish-speaking families—and not just low-SES families. Expand "mediation" and explore what happens at engagement and post-engagement for parents and children. (Dr. Wartella)
- Explore the long-term implications—understand how children become happy, functioning adults. How much does media use add to other exposures that we know are important? (Dr. Vandewater)
- Explore long- and short-term transfer of learning. How do children learn from multiple sources, including their environments and parents, and how do they integrate this information and knowledge? Multiple, integrated data streams are necessary. (Dr. Barr)
- Understand the mechanisms and moderators of learning in real time, the "goodness of fit," and what the environment provides. (Dr. Kirkorian)
- Be explicit about the conceptual framework driving the work. It is critical to have a conversation about mechanisms. (Dr. Bell)
- Have longitudinal studies that are media-centered, real-scale, real-time, observational, and multidimensional. These should be inclusive enough to include parenting styles and economic resources, diverse cultural backgrounds, caregiving practices, and developmental differences. Try to understand how exposure affects social competence, executive function, language development, addiction, creativity, and school readiness. How do early coders turn out compared with those not exposed? Consider multiple factors such as physical health, weight, etc. (Dr. Fomby)
- Address the use of different technologies and screens with special populations, as well as the technologies developed specifically for these populations. Consider differential effectiveness and training of teachers. (Dr. Patton Terry)
- Address issues of social and emotional development beyond aggression and violence. (Dr. Layla Esposito)
- Consider what children get from media that they do not get from other sources and how they may use media sources to further their other interests. (Dr. Erica Spotts)
- Stay ahead of the curve and understand the impact of new technology, which is rapidly changing.
- Include children with intellectual disabilities when addressing diverse populations. They are not usually included in regular trials. Also consider the dissemination of information and how to get new information to the public. (Dr. Sujata Bardhan)
- Address dual-language learners. (Dr. Karen Lee)

General Discussion

Participants were asked for any additional ideas that were not addressed in the brainstorming round. Suggestions included:
- Address the differences in access to media when doing population studies. Acknowledge "literacy deserts," where some neighborhoods have no newspapers or other print media, and how this might influence learning and development in later years. (Dr. Graesser)
- Analyze influence of social networks on media use and how media is transferred across these networks. (Dr. Vandewater)

- Consider the international perspective and learning from research done outside the U.S.; urge coordination. (Dr. Barr)
- Consider the kinds of learning in the first year of life, as well as learning acquired from media and social scaffolding with others. The first year is an incredible time for learning language and rules. (Dr. Waxman)
- Explore how to access data created by industries and consider including them in discussions with academics around exposure and use of technologies. (Dr. Wartella)
  o Include contributors from development and address coding. Bring science and developers together and address basic questions in development. (Dr. Umaschi Bers)
  o Build relationships with industry to make sure research is well designed scientifically but is not exploited. (Dr. Radesky)
- Encourage more randomized controlled trials and double-blind experiments. (Dr. Hurst-Della Pietra)
- Address the marketing environment that children are exposed to and the loss of their privacy. (Dr. Calvert)
- Consider the family ecology and how different family members interact with systems. Build a research agenda that can partner academics with professional organizations who are good at addressing these issues. (Dr. Barr)
  o Research on development is often done in pieces (e.g., on attention, motor function, executive function) and not often put together. This gets more complex with age. How often are we drawing from what we know? (Dr. Griffin)
- Pay attention to fundamental findings (behavioral and neuroscience) that may have been missed before and may not show up in large scale. (Dr. Waxman)
- Stop treating all content equally; different content may have different effects. (Dr. Fasig Caldwell)
- Note that AAP is rethinking its advice. Babies are living in a world surrounded by media from birth; it's dangerous to ignore this based on the principle of not showing screens because we don't know their effects. (Dr. Smith)
- Focus on dissemination and implementation of verey good products; Skype, for example, is a good tool and is not just consumptive. (Dr. Radesky)
- Harness early educators as liaisons and sources of good tech ideas for families. Telling families to avoid all screens is polarizing. If teachers receive good ideas, they can share them. Pediatricians are another source and can educate parents to avoid nonsense programs that may have an "E" for education but are not real learning. (Dr. Radesky)
- Increase data sharing across multiple labs and common measures. (Dr. McNamara)
- Improve measurement with diverse samples, more complex designs, randomized controlled trials, longitudinal studies, more complex analyses, and transdisciplinary designs. Encourage partnerships and collaborations. Address the roles of family, school, and peers. (Dr. Vandewater)
- Address obstacles to measurement problems (e.g., funding, a lack of standardized systematic methods). A higher level of analysis is needed for synchronizing multiple real-time responses (e.g., heart rate with a time stamp); this is difficult to do and resources

are needed to help. Also consider that users multitask and that it is difficult to determine which activity is primary, secondary, or tertiary. (Dr. Calvert)

- Getting data directly from an Apple or android device would be useful, with screenshots showing the time of day. Note that children's device use is always changing, and it's hard to know if we're asking the right questions. Do we need a semi-structured interview to see how they are using media? (Dr. Radesky)
- Address the question of not just how but also what to measure. This is not clear in naturalistic settings. (Dr. Umaschi Bers)
- Understand that in neuroscience, measurements are made on a millisecond scale, with interactions happening over seconds, minutes, and the whole day. Obtaining precise information over a long period is complex and will continue to be an issue. (Dr. Richards)
- Take advantage of resources like Databrary that archive video data. Consider opportunities for for-profit businesses to develop tools, applications, and measurements. (Dr. Griffin)
- Note that IRB rules may prohibit sharing data from children and videos. (Dr. Calvert)
- Parents can be asked to opt in to sharing of data. (Dr. Barr)

Adjournment

Dr. Alvarez thanked the participants. He and Dr. Griffin encouraged all participants to continue to share ideas, forge connections, and establish collaborations with each other. Dr. Alvarez will send the participants an email with links for accessing the presentations. He also invited the discussants to share slides that may not have been presented.

The workshop adjourned at 11:55 a.m. on Friday, January 26, 2018.