University of South Dakota

USD RED

School of Education Faculty Publications School of Education

12-2023

In modeling digital learning, remember pictorial competence.

Georgene Troseth
Vanderbilt University

Gabrielle Strouse
University of South Dakota, gabrielle.strouse@usd.edu

Follow this and additional works at: https://red.library.usd.edu/se-fp

Part of the Developmental Psychology Commons

Recommended Citation

Troseth, G. L. & Strouse, G. A. (2023). In modeling digital learning, remember pictorial competence. Journal of Applied Research in Memory and Cognition, 12(4), 491-496. https://doi.org/10.1037/mac0000150

This Article is brought to you for free and open access by the School of Education at USD RED. It has been accepted for inclusion in School of Education Faculty Publications by an authorized administrator of USD RED. For more information, please contact dloftus@usd.edu.

© 2023, American Psychological Association. This paper is not the copy of record and may not exactly replicate the final, authoritative version of the article. Please do not copy or cite without authors' permission. The final article will be available, upon publication, via its DOI:

https://doi.org/10.1037/mac0000150

In Modeling Digital Learning, Remember Pictorial Competence

Georgene L. Troseth[1] & Gabrielle A. Strouse[2]

[1]Department of Psychology and Human Development, Vanderbilt University, United States, https://orcid.org/0000-0002-0333-1732

[2]Division of Counseling and Psychology in Education, University of South Dakota, United States, https://orcid.org/0000-0002-6955-4955

Correspondence concerning this article should be addressed to Georgene Troseth, Department of Psychology and Human Development, Vanderbilt University, 230 Appleton Place, Nashville, TN 37203-5721, United States. Email: georgene.troseth@vanderbilt.edu

Abstract

Barr and Kirkorian summarize decades of research about young children's learning and transfer from screen media, offer a new theoretical model of factors involved in early multimedia learning, and suggest a future research agenda to study learning from commercial media products "in the wild" of everyday family life outside the lab. In this commentary, the authors offer background on the development of symbolic understanding and "pictorial competence" for young children's learning from screen media and attempt to deepen the discussion of cognitive factors and individual differences that affect early learning.

Key words: Symbolic development, dual representation, pictorial competence, video, touchscreen, multimedia

In Modeling Digital Learning, Remember Pictorial Competence

Barr and Kirkorian (2023) provide a summary of decades of research about very young children's learning and transfer from screen media and survey theoretical accounts of the pattern of results. They offer a new theoretical model that includes both measurable features of media design that impact memory and cognition and individual differences in the child and context as factors contributing to transfer of learned information from digital media. Barr and Kirkorian suggest a future research agenda to study young children's digital learning and transfer outside the lab using the kinds of commercial products that families download from app stores. For parents and educators, they offer practical recommendations to maximize learning and mitigate negative effects of digital media.

We begin with additional thoughts about the development of symbolic understanding, including the role of "dual representation" (DeLoache, 1995; Troseth & DeLoache, 1998) for young children's understanding and use of screen media. In this discussion, a symbol is defined as any entity that someone intends to stand for or represent something other than itself (DeLoache, 1995). We then attempt to deepen the discussion of factors that are relevant to very young children's learning and transfer from digital media by comparing the new model to established theoretical perspectives on symbolic development (DeLoache, 1995; Troseth et al., 2019).

The Challenge of Pictorial Competence and Dual Representation

In the prior cognitive models of multimedia learning (Mayer, 2005, 2014; Fisch, 2000, 2017), pictorial competence, or mentally representing the connection between images on a screen and what they stand for, is assumed for school-aged children and adult learners based on their extensive past experience with all kinds of still and moving digital and analog pictures (e.g., in books, game apps, videos). In contrast, Barr and Kirkorian's model includes symbolic development because infants and young children only gradually learn about pictures.

What is so difficult about understanding pictures? James Gibson (1979) pointed out that a picture is both a surface with particular qualities and a “display of information about something else. [It] always requires two kinds of apprehension that go on at the same time” (pp. 282-283). A picture has physical qualities, whether it is printed on paper and put in a frame or a storybook, painted on canvas and hung in a museum, or appears on a phone or tablet touchscreen. Thus, a digital image includes information about the object surface – qualities of the screen itself and the surrounding device – as well as perceptual indications of two-dimensionality (lack of motion parallax and binocular disparity, etc.) from the image itself. At the same time, the image conveys information about whatever is depicted. Experience with pictures enables an individual to focus on the surface features of an image (e.g., noticing the brush strokes in a painting) or zero in on its content, and this ability depends on mentally representing both aspects of a picture (DeLoache, 1995).

Some pictorial abilities develop quite early. In their first months, infants perceive the flatness cues of a picture and during the first year, they see both similarities and differences between real people and objects and those depicted in pictures (DeLoache et al., 1979; Dirks & Gibson, 1977; Rose, 1977). However, infants do not initially know the meaning of 2-dimensionality for guiding their behavior toward pictures. Nine-month-olds direct the same manual behaviors toward pictured objects as they do to the objects themselves, attempting to grasp toys depicted in pictures (DeLoache, 1995) and video (Pierroutsakos & Troseth, 2003). In one famous instance of a “media error” (Rosengren et al., 2021), an empathetic Japanese toddler used a tissue to try to wipe the tears of a disgraced, crying politician on the TV screen (Miller, 2015). In such cases, young children appear not to notice the 2D picture surface and respond only to the depicted contents (Ittelson, 1996). Barr and Kirkorian (2023) suggest that, paradoxically, babies may learn from a screen more easily than somewhat older children because they notice only the picture contents without paying attention to the surface.

Through experience and adult support, infants gradually learn to adopt, in the words of Werner and Kaplan (1963), a contemplative stance, rather than an action stance toward pictures. Twelve-month-olds either manipulated a picture or looked at it, depending on which an adult modeled (Callaghan et al., 2004). By 19 months, grasping at depicted objects has largely disappeared (DeLoache, 1995; Pierroutsakos & Troseth, 2003). Around the same time, reading interactions in which parents label the familiar contents of pictures ("Look, here's a *dog*!") help children learn that both words and pictures refer to an outside *referent* (Callaghan et al., 2011; Ganea et al., 2009; Walker et al., 2013). In other words, children learn to treat pictures as objects with the role of representation (Tomasello, 2000). In experimental paradigms similar to the picture-labeling that parents practice with children, 18- and 24-month-old toddlers appear to recognize that pictures refer to objects, realizing that when an adult labels a pictured object as "a whisk," they are talking about an actual 3D object, not just the picture (Allen Preissler & Carey, 2004).

Toddlers find novel referential situations more challenging. For instance, in what Barr and Kirkorian call "spatial recall tasks," children are asked to use a picture or video as information about a hidden toy's location. First, children are familiarized with furniture in a lab room (couch, armchair, table, basket) and see the same items in photographs or on a television screen (through a live video feed). A researcher points out the correspondence ("Here's the couch, and here's the couch on TV. Look, they're the same!"). In the video studies, children also briefly see the toy to be hidden, themselves, and their parent on the TV screen. Then they all move to an adjoining control room where the researcher tells the child to watch on the TV while she hides the toy in the room. An assistant with the child narrates the action on the screen, "Look, Kathy is hiding Snoopy right there!" Then the researcher returns and asks the child to find the toy in the room, offering help until they do. At 30 months, most children were successful (79% errorless retrievals across 4 trials), but at 24 months, they were significantly less successful (44% –Troseth & DeLoache, 1998). The same age difference was found for children's use of pictures (DeLoache & Burns, 1994). DeLoache (1987, 1989) noted that one reason for the older children's success was advances in their cognitive flexibility, enabling them to represent the symbolic object (video or picture) not just as a flat image but as standing for something else.

Success on the search task requires "dual representation": children must mentally represent both an event on video and what it depicts (the hiding event happening behind the closed door to the room) and then act on that information rather than on a memory of what happened the last time they were in the room. Across a number of follow-up studies, we probed what would help 2-year-olds to succeed at the task. One possibility was that they could not update their memories for hiding locations across trials or hold themselves back from repeating a previous search (a problem of inhibition). To check this explanation, we asked 2-year-olds to watch the same kinds of hiding events directly through a TV-sized window from the control room. Every child was correct across all 4 trials, with no perseveration (Troseth & DeLoache, 1998). Across the two studies, children showed what Barr and Kirkorian refer to as a transfer deficit. That is, when no transfer was required (they saw the hiding events directly) children were more successful at finding the objects than when transfer from video to the real room was required.

We then reasoned that children might be logically discounting information on TV as irrelevant to the finding game because of their prior experience with televisions, which often show unrealistic events (such as animals talking and driving cars). We tested this interpretation in two ways. First, the TV was moved so that children never saw the body of the TV; it was aligned behind the window between the rooms, with only the screen visible to the children. The procedure was the same as with video, except these children were told to "watch through the window" while the researcher hid the toy. The intent was for children to believe they were watching the event directly rather than on a TV screen. In this condition, 9 of 16 children were successful across the 4 trials, compared to 3 of 16 children who saw the TV and knew they were watching a video. In other words, when 2-year-olds did not need to represent both the surface "TV" context and the depicted information (i.e., to achieve dual representation), many of them succeeded at the search task (Troseth & DeLoache, 1998). This showed that differences in perceptual details between the source video and 3D referents were not an obstacle for at least some of the children. Instead, something related to the conceptual challenge of dual representation was likely at play in the failure of those who knew they were watching a video. For example, the two separate representations may have caused cognitive overload as children progressed through the steps of Mayer's (2014) model – selecting, organizing, and integrating information. Or, as Barr and Kirkorian modeled, a still-developing symbolic understanding may have impacted children's ability to retrieve or apply the stored representations of the video content in the way that finding the hidden object required.

What Contributes to Children's Symbolic Success?

Adult support for understanding digital images is important to help children develop symbolic understanding due to the many ways pictures and video can relate to the real world. For instance, they can represent real events (family photos) or imaginary ones (often in picture books and children's television) and current events (video chat) or past ones (in a home video). Pictures also can represent specific or generic entities: a baby giraffe in an alphabet book represents a general category of animals, whereas a baby giraffe on the nightly news may represent a specific animal just born in the local zoo. Figuring out which representational relation is appropriate requires a certain degree of cognitive flexibility, along with experience with different kinds of images (Troseth et al., 2004).

We gave a group of 2-year-olds a new kind of experience to demonstrate to them that video could show real events. We attached video cameras to their home TV sets, enabling children to view live video of themselves as they played with bubbles and Slinkys. Two weeks later, the children with the live video experience (but not a control group) used the information from the video in the lab to find the hidden toy (Troseth, 2003). Their success depended on going beyond the video image of an event in a room to mentally represent the real situation depicted in the image, which gave them information to solve the finding game. Having viewed the outcome of their own actions on live video, children now appeared to recognize that the video in the lab was real, current, and relevant. Something had changed in the way children created, stored, retrieved, or applied their dual representations of the video and its referential content, highlighting the effect of prior experience with a symbolic medium in changing how children process and apply information from that medium, an example of what (DeLoache, 1995) called “representational insight.”

In another study, we asked parents to give their children direct instructions about the relation between a video image and its real-world referent. Twenty-four-month-olds watched a video of a researcher labeling a novel object, during which parents held the real object in front of the television and emphasized to their child that it was “the same” as the one on TV. Toddlers who received this direct instruction reliably transferred the label from the video to the real objects, whereas toddlers who simply played with the objects during the video did not (Strouse & Troseth, 2014). The same type of instruction supported 30-month-olds in a similar study, but 36-month-olds did not seem to need the scaffold (Strouse & Ganea, 2021). Other types of adult scaffolding to support children in connecting on-screen information to the real world have also been successful, such as when a co-viewer with the child modeled responding to an on-screen researcher who requested participation over closed circuit video (Myers et al., 2018; Strouse et al., 2018).

New technical innovations add to the representational complexity a child might encounter in a digital image: augmented reality combines real, current video with imaginary elements, such as a Snapchat filter superimposing a cat’s whiskers and ears on live video of a child’s face. Realistic-looking computer-generated imaginary creatures can appear to lunge at viewers out of a 3D movie screen. For young children with limited knowledge, support of adult co-viewers and experience with the different ways digital images relate to the real world is crucial for children to develop symbolic understanding that will enable them to learn and transfer information from digital media (Troseth et al., 2019).

Modeling Symbol Understanding and Use

DeLoache (1995) offered a formal model of symbolic development that was distinct from general cognitive development, although she acknowledged the contribution of cognitive factors including representational flexibility, inhibitory control, and the working memory capacity to hold two active representations of the same thing (DeLoache, 2000; Zelazo & Frye, 1997). In her model, *dual representation* and *representational insight* – the central cognitive processes – depend on *symbolization experience* and *instruction* by adults. The *iconicity* of a symbolic object (resemblance to what it stands for) can help children detect the “stands for” relation, but the object’s *salience* (how much it captures children’s attention as an object) may interfere with representing the symbolic relation to its referent. An updated model (Troseth et al., 2019) incorporated factors related to interactive media. *Responsiveness* of a person on the screen (e.g., on video chat) might help children realize that the image represents a real person and an event that is happening now. On the other hand, the responsiveness of a picture to a user’s touch might make the picture itself more salient as an object, focusing the child’s attention on touching the screen rather than on what is represented. Another factor that may heighten the salience of the object is a child’s *prior experience with that kind of object*. For example, children’s experience playing with touchscreen apps and watching streaming videos on their parent’s phone may build up expectations of what images on screens are for, making it more difficult for them to detect a novel symbolic relation that an adult designs for their learning. In the terms of Mayer’s (2014) model, prior experience might affect what children select to bring into working memory from sensory memory and how they organize and integrate it with what they retrieve from long-term memory.

The parallels between the core predictors in these models and in Barr and Kirkorian’s (2023) model suggest additional relations that could be explored. First, several child factors appear across models. Inhibitory control, working memory, and representational flexibility influence representational insight (DeLoache, 1995; Troseth et al., 2019). In Barr and Kirkorian's model, inhibitory control and working memory capacity influence cognitive load and representational flexibility influences memory storage and retrieval. If these child factors do predict multiple outcomes, we suggest that additional relationships between factors could be explored, such as whether symbolic understanding fully or partially mediates relations between child factors and transfer of media information, or whether child factors and symbolic understanding interact to predict differences in learning and transfer.

Several contextual and design factors also appear across models. Troseth and colleagues (2019) describe physical interactivity (responsiveness of the medium), social contingency (responsiveness of a person on screen), and joint media engagement (adult instruction before/during media use; also in DeLoache's 1995 model) as factors influencing representational insight in the context of interactive media. These aspects of the design and context also predict cognitive load in Barr and Kirkorian's model. We suggest that additional relationships such as mediations and interactions between these contextual factors and symbolic understanding could also be explored.

One benefit to examining these additional complexities may be to allow the new model to make a priori predictions in complex situations, such as when physical contingencies from a touchscreen sometimes support younger learners (Choi & Kirkorian, 2016; Kirkorian et al., 2016) and other times support not younger but older learners (Choi et al., 2021; Kirkorian et al., 2022), or when social contingencies from the screen at times support learning (Nielsen et al., 2008; Roseberry et al., 2014; Troseth et al., 2006), whereas at other times, additional support from a co-viewer is needed (Myers et al., 2018; Strouse et al., 2018; Troseth et al., 2018).

Finally, when considering symbolic understanding itself as a predictor of learning and transfer from media, Barr and Kirkorian discuss it primarily impacting children's storage and retrieval of information. For example, they explain that children who lack awareness of video's relation to the real world may store a separate representation of video events that competes with representations formed from real-world experiences, and that children may fail to retrieve video representations they deem irrelevant to real-world tasks. We suggest also exploring predictive pathways between symbolic understanding (and relatedly, representational insight) and cognitive load. Dual representation involves holding two representations in mind instead of one – children must represent both the symbolic information itself and its "stands for" relation as they organize and integrate those two representations with information retrieved from long-term memory. With symbolic development, children may more fluently look for and notice symbolic relations, making them better able to select relevant information to process, and they may more automatically match symbols and their referents, reducing organizational demands in working memory.

Models of Multimedia Learning at Different Ages

One highlight of Barr and Kirkorian's theoretical model is that their discussion of cognitive load considers the complexity of the media materials relative to the prior knowledge of and contextualized processes employed by individual learners. Prior models of multimedia learning in school age children and adults (Fisch, 2000, 2017; Mayer, 2005, 2014) instead focus on the intricacies of how information is presented to reduce processing demands. A future direction could be testing parallel effects at that more specific level in young learners. For example, according to the spatial contiguity principle, when words and pictures need to be integrated within working memory, better learning occurs when they are presented near rather than far from each other on the screen (Mayer & Fiorella, 2014). Young children do not read on-screen text, so a version of this principle for them could focus on aligning other visual information that young learners need to integrate, such as pictures of a story narrative, and could provide additional actionable recommendations for media design.

Another way in which Barr and Kirkorian's model diverges from prior models is their focus on transfer rather than learning. Their review and discussion centers on the *transfer* *deficit,* which they define as young children being less likely to transfer information from one context to another than within the same context, akin to Barnett and Ceci's (2002) model predicting that transfer across (versus within) modality would be more difficult. Research with young children in the 1990s and early 2000s involved figuring out why they at times failed to learn from videos. Anderson and Pempek (Anderson & Pempek, 2005) reviewed these studies and described a pattern they called the *video deficit,* young children learning less from video presentations than from equivalent real-life presentations. The video deficit as originally defined did not require transfer as a demonstration of learning, but most early studies reviewed by Anderson and Pempek did require transfer from video to the real world. These studies often included comparison conditions where information was presented directly and did not require transfer. Later researchers realized that the need to transfer was one way in which the conditions differed, and showed that transferring information in the opposite direction (from direct demonstrations to digital formats) was also difficult for children, indicating that the additional need to transfer was one mechanism that likely contributed to the observed video deficit pattern (Barr, 2010; Zack et al., 2009). Others have argued there is evidence that attributes of video (such as limited perceptual and social cues) also contribute to poor learning and would apply even when transfer is not required (e.g., Strouse & Samson, 2021). A helpful future direction could be to distinguish between factors that differentially impact learning and transfer, as learning goals such as following the narrative plot of a story may not require transfer.

We end with a final thought regarding future directions for research. The video deficit and transfer deficit terminology might suggest some "deficit" in young learners. However, the relative difference in children's learning or transfer from multimedia versus direct experience may reflect an intelligent strategy, as children may have prior experience that has taught them that videos and touchscreen games are not realistic. To improve children's learning and transfer from multimedia, focusing the discussion on development of the skills needed to become a successful learner from multimedia (rather than comparing learning from media versus direct experience) may be most relevant going forward. It may also simplify Barr and Kirkorian's (2023) future research agenda of studying multimedia "in the wild" because comparison conditions showing "amelioration" of the deficit would not be required.

References

Allen Preissler, M., & Carey, S. (2004). Do both pictures and words function as symbols for 18- and 24-month-old children? *Journal of Cognition and Development*, *5*(2), 185–212. https://doi.org/10.1207/s15327647jcd0502_2

Anderson, D. R., & Pempek, T. A. (2005). Television and very young children. *American Behavioral Scientist*, *48*(5), 505–522. https://doi.org/10.1177/0002764204271506

Barnett, S. M., & Ceci, S. J. (2002). When and where do we apply what we learn?: A taxonomy for far transfer. *Psychological Bulletin*, *128*(4), 612–637. https://doi.org/10.1037/0033-2909.128.4.612

Barr, R. (2010). Transfer of learning between 2D and 3D sources during infancy: Informing theory and practice. *Developmental Review*, *30*(2), 128–154. https://doi.org/10.1016/j.dr.2010.03.001

Barr, R., & Kirkorian, H. (2023). Reexamining models of early learning in the digital age: Applications for learning in the wild. *Journal of Applied Research in Memory and Cognition*. https://doi.org/10.1037/mac0000132

Callaghan, T. C., Moll, H., Rakoczy, H., Warneken, F., Liszkowski, U., Behne, T., & Tomasello, M. (2011). Early social cognition in three contexts. *Monographs of the Society for Research in Child Development*, *76*. https://doi.org/10.1111/j.1540-5834.2011.00603.x

Callaghan, T. C., Rochat, P., MacGillivray, T., & MacLellan, C. (2004). Modeling referential actions in 6- to 18-month-old infants: A precursor to symbolic understanding. *Child Development*, *75*(6), 1733–1744. https://doi.org/10.1111/j.1467-8624.2004.00813.x

Choi, K., & Kirkorian, H. L. (2016). Touch or Watch to Learn? Toddlers' Object Retrieval Using Contingent and Noncontingent Video. *Psychological Science*, *27*(5), 726–736. https://doi.org/10.1177/0956797616636110

Choi, K., Kirkorian, H. L., & Pempek, T. A. (2021). Touchscreens for Whom? Working Memory and Age Moderate the Impact of Contingency on Toddlers' Transfer From Video. *Frontiers in Psychology*, *12*, 621372. https://doi.org/10.3389/fpsyg.2021.621372

DeLoache, J. S. (1987). Rapid change in the symbolic functioning of very young children. *Science*, *238*(4833), 1556–1557. https://doi.org/10.1126/science.2446392

DeLoache, J. S. (1989). The development of representation in young children. In *Advances in Child Development and Behavior* (Vol. 22, pp. 1–39). Elsevier. https://doi.org/10.1016/S0065-2407(08)60411-5

DeLoache, J. S. (1995). Early understanding and use of symbols: The Model Model. *Current Directions in Psychological Science*, *4*(4), 109–113. https://doi.org/10.1111/1467-8721.ep10772408

DeLoache, J. S. (2000). Dual representation and young children's use of scale models. *Child Development*, *71*(2), 329–338. https://doi.org/10.1111/1467-8624.00148

DeLoache, J. S., & Burns, N. M. (1994). Early understanding of the representational function of pictures. *Cognition*, *52*(2), 83–110. https://doi.org/10.1016/0010-0277(94)90063-9

DeLoache, J. S., Pierroutsakos, S. L., & Troseth, G. L. (1996). *The three R's of pictorial competence* (R. Vasta, Ed.; Vol. 12, pp. 1–48). Jessica Kingsley.

DeLoache, J. S., Strauss, M. S., & Maynard, J. (1979). Picture perception in infancy. *Infant Behavior and Development*, *2*, 77–89. https://doi.org/10.1016/S0163-6383(79)80010-7

Dirks, J., & Gibson, E. (1977). Infants' perception of similarity between live people and their photographs. *Child Development*, *48*(1), 124. https://doi.org/10.2307/1128890

Fisch, S. M. (2000). A capacity model of children's comprehension of educational content on television. *Media Psychology*, *2*(1), 63–91. https://doi.org/10.1207/S1532785XMEP0201_4

Fisch, S. M. (2017). Bridging theory and practice: Applying cognitive and educational theory to the design of educational media. In *Cognitive Development in Digital Contexts* (pp. 217–234). Elsevier. https://doi.org/10.1016/B978-0-12-809481-5.00011-0

Ganea, P. A., Allen, M. L., Butler, L., Carey, S., & DeLoache, J. S. (2009). Toddlers' referential understanding of pictures. *Journal of Experimental Child Psychology*, *104*(3), 283–295. https://doi.org/10.1016/j.jecp.2009.05.008

Gibson, J. J. (1979). *The ecological approach to visual perception.* Houghton Mifflin.

Ittelson, W. H. (1996). Visual perception of markings. *Psychonomic Bulletin & Review*, *3*(2), 171–187. https://doi.org/10.3758/BF03212416

Kirkorian, H. L., Choi, K., & Pempek, T. A. (2016). Toddlers' Word Learning From Contingent and Noncontingent Video on Touch Screens. *Child Development*, *87*(2), 405–413. https://doi.org/10.1111/cdev.12508

Kirkorian, H. L., Choi, K., Yoo, S. H., & Etta, R. A. (2022). The impact of touchscreen interactivity on U.S. toddlers' selective attention and learning from digital media. *Journal of Children and Media*, *16*(2), 188–204. https://doi.org/10.1080/17482798.2021.1944888

Mayer, R. E. (2005). Cognitive theory of multimedia learning. In R. Mayer (Ed.), *The Cambridge Handbook of Multimedia Learning* (1st ed., pp. 31–48). Cambridge University Press. https://doi.org/10.1017/CBO9780511816819.004

Mayer, R. E. (2014). Cognitive theory of multimedia learning. In R. E. Mayer (Ed.), *The Cambridge Handbook of Multimedia Learning* (2nd ed., pp. 43–71). Cambridge University Press. https://doi.org/10.1017/CBO9781139547369.005

Mayer, R. E., & Fiorella, L. (2014). Principles for reducing extraneous processing in multimedia learning: Coherence, signaling, redundancy, spatial contiguity, and temporal contiguity principles. In R. E. Mayer (Ed.), *The Cambridge Handbook of Multimedia Learning* (2nd ed., pp. 279–315). Cambridge University Press. https://doi.org/10.1017/CBO9781139547369.015

Miller, K. K. (2015, November 29). Innocent child's reaction to seeing the bawling politician fills us with "d'awws." *Sora News 24*. https://soranews24.com/2015/11/29/innocent-childs-reaction-to-seeing-the-bawling-politician-fills-us-with-dawws/&sa=D&source=docs&ust=1697031411760890&usg=AOvVaw1iTwpP_2F05_gRALaofU8U

Myers, L. J., Crawford, E., Murphy, C., Aka-Ezoua, E., & Felix, C. (2018). Eyes in the room trump eyes on the screen: Effects of a responsive co-viewer on toddlers' responses to and learning from video chat. *Journal of Children and Media*, *12*(3), 275–294. https://doi.org/10.1080/17482798.2018.1425889

Nielsen, M., Simcock, G., & Jenkins, L. (2008). The effect of social engagement on 24-month-olds' imitation from live and televised models. *Developmental Science*, *11*(5), 722–731. https://doi.org/10.1111/j.1467-7687.2008.00722.x

Pierroutsakos, S. L., & Troseth, G. L. (2003). Video verité: Infants' manual investigation of objects on video. *Infant Behavior and Development*, *26*(2), 183–199. https://doi.org/10.1016/S0163-6383(03)00016-X

Rose, S. A. (1977). Infants' transfer of response between two-dimensional and three-dimensional stimuli. *Child Development*, *48*(3), 1086. https://doi.org/10.2307/1128366

Roseberry, S., Hirsh-Pasek, K., & Golinkoff, R. M. (2014). Skype me! Socially contingent interactions help toddlers learn language. *Child Development*, *85*(3), 956–970. https://doi.org/10.1111/cdev.12166

Rosengren, K. S., Kirkorian, H., Choi, K., Jiang, M. J., Raimer, C., Tolkin, E., & Sartin-Tarm, A. (2021). Attempting to break the fourth wall: Young children's action errors with screen media. *Human Behavior and Emerging Technologies*, *3*(4), 468–483. https://doi.org/10.1002/hbe2.273

Strouse, G. A., & Ganea, P. A. (2021). Learning to learn from video? 30-month-olds benefit from continued use of supportive scaffolding. *Infant Behavior and Development*, *64*, 101574. https://doi.org/10.1016/j.infbeh.2021.101574

Strouse, G. A., & Samson, J. E. (2021). Learning from video: A meta-analysis of the video deficit in children ages 0 to 6 years. *Child Development*, *92*(1), e20–e38. https://doi.org/10.1111/cdev.13429

Strouse, G. A., & Troseth, G. L. (2014). Supporting toddlers' transfer of word learning from video. *Cognitive Development*, *30*, 47–64. https://doi.org/10.1016/j.cogdev.2014.01.002

Strouse, G. A., Troseth, G. L., O'Doherty, K. D., & Saylor, M. M. (2018). Co-viewing supports toddlers' word learning from contingent and noncontingent video. *Journal of Experimental Child Psychology*, *166*, 310–326. https://doi.org/10.1016/j.jecp.2017.09.005

Tomasello, M. (2000). *The cultural origins of human cognition*. Harvard University Press. https://doi.org/10.4159/9780674044371

Troseth, G. L. (2003). TV guide: Two-year-old children learn to use video as a source of information. *Developmental Psychology*, *39*(1), 140–150. https://doi.org/10.1037/0012-1649.39.1.140

Troseth, G. L., & DeLoache, J. S. (1998). The medium can obscure the message: Young children's understanding of video. *Child Development*, *69*(4), 950–965. https://doi.org/10.1111/j.1467-8624.1998.tb06153.x

Troseth, G. L., Flores, I., & Stuckelman, Z. D. (2019). When representation becomes reality: Interactive digital media and symbolic development. In *Advances in Child Development and Behavior* (Vol. 56, pp. 65–108). Elsevier. https://doi.org/10.1016/bs.acdb.2018.12.001

Troseth, G. L., Pierroutsakos, S. L., & DeLoache, J. S. (2004). From the innocent to the intelligent eye: The early development of pictorial competence. In *Advances in Child*

Development and Behavior (Vol. 32, pp. 1–35). Elsevier. https://doi.org/10.1016/S0065-2407(04)80003-X

Troseth, G. L., Saylor, M. M., & Archer, A. H. (2006). Young children's use of video as a source of socially relevant information. *Child Development*, *77*(3), 786–799. https://doi.org/10.1111/j.1467-8624.2006.00903.x

Troseth, G. L., Strouse, G. A., Verdine, B. N., & Saylor, M. M. (2018). Let's chat: On-screen social responsiveness is not sufficient to support toddlers' word learning from video. *Frontiers in Psychology*, *9*, 2195. https://doi.org/10.3389/fpsyg.2018.02195

Walker, C. M., Walker, L. B., & Ganea, P. A. (2013). The role of symbol-based experience in early learning and transfer from pictures: Evidence from Tanzania. *Developmental Psychology*, *49*(7), 1315–1324. https://doi.org/10.1037/a0029483

Werner, H., & Kaplan, B. (1963). *Symbol formation: An organismic-developmental approach to language and the expression of thought.* Wiley.

Zack, E., Barr, R., Gerhardstein, P., Dickerson, K., & Meltzoff, A. N. (2009). Infant imitation from television using novel touch screen technology. *British Journal of Developmental Psychology*, *27*(1), 13–26. https://doi.org/10.1348/026151008X334700

Zelazo, P. D., & Frye, D. (1997). Cognitive complexity and control: A theory of the development of deliberate reasoning and intentional action. In M. I. Stamenov (Ed.), *Advances in Consciousness Research* (Vol. 12, pp. 113–153). John Benjamins Publishing Company. https://doi.org/10.1075/aicr.12.07zel