COMMENTARY

Improving Learning From Screens for Toddlers and Preschoolers

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Barr and Kirkorian (2023) describe difficulties that toddlers and some preschoolers have with learning from screens, such as not being able to replicate a video demonstration with real objects. In this essay, I examine eight evidence-based principles for designing multimedia lessons based on 40 years of research with adults and adolescents that could be adapted and tested for improving onscreen learning by toddlers and preschoolers (Mayer, 2021). Specifically, I offer techniques for guiding attention based on the signaling principle and the coherence principle; techniques for managing cognitive load based on the segmenting principle and the pretraining principle; techniques for promoting productive engagement through activity based on the generative activity principle; and techniques for promoting productive engagement through social cues based on the embodiment principle, personalization principle, and positivity principle. Empirical testing is needed to determine how these principles based on the cognitive theory of multimedia learning apply to onscreen learning by toddlers and preschoolers.

Keywords: transfer deficit, video demonstration, multimedia learning, toddlers, preschoolers

Digital technology is ubiquitous in children's lives, including experience with tablets, but work is needed to determine the educational value of onscreen learning experiences. For example, consider a scenario in which a toddler views a video demonstration on a tablet in which an adult shows how to carry out a sequence of three actions such as removing an object from a box, opening it, and placing the contents into another box. Then, we seat the toddler at a table with the real objects that were depicted in the video and ask the toddler to imitate what they just saw. Children below the age of 3 years (and sometimes even preschoolers) tend to have difficulty in transferring what they have seen in the video demonstration to the real-world context involving the same objects. This situation can be called a *transfer deficit*. Transfer deficits highlight the challenge of how to design screen-based learning experiences for young children that are educationally effective.

Barr and Kirkorian (2023) present a thoughtful, evidence-based discussion of this problem and offer a useful theoretical framework. They focus on how to help toddlers and preschoolers learn from onscreen instructional messages such as video demonstrations and eBooks. In this article, I approach this problem by examining how we can take what my colleagues and I have learned over the past 40 years about effective design of onscreen multimedia instructional messages

for adolescents and adults and leverage it for making to-be-tested suggestions for improving toddlers' and preschoolers' learning from screens. In the following sections, I examine examples of evidence-based multimedia design principles that could apply to the transfer deficit: techniques for guiding attention such as the signaling principle and coherence principle; techniques for managing cognitive load such as the segmenting principle and the pretraining principle; techniques for promoting productive engagement through activity, such as the generative activity principle; and techniques for promoting productive engagement through social cues such as the embodiment principle, personalization principle, and positivity principle. These evidence-based principles are summarized in Table 1.

Techniques for Guiding Attention

Barr and Kirkorian (2023) note that watching an instructional video on a tablet can be distracting for young learners, so they may need help in guiding their attention. In the cognitive theory of multimedia learning, we offer the *signaling principle*, which states that people learn better from multimedia lessons when the important material is highlighted (Mayer, 2021; van Gog, 2022). For example, signaling can be accomplished by pointing to relevant elements on a screen while talking about them, by spotlighting relevant elements on a screen (and graying out everything else) while talking about them, or by changing the color of relevant elements while talking about them. Signaling is intended to guide the cognitive process of selecting—that is, attending to certain aspects on the incoming information and representing it in working memory for further processing.

The cognitive theory of multimedia learning also suggests another technique for guiding attention, namely, the *coherence principle*, which holds that people learn better when extraneous images and words are eliminated from a multimedia lesson (Fiorella & Mayer, 2022a; Mayer, 2021). For example, the coherence principle suggests

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Table 1
Some Evidence-Based Design Principles for Multimedia Lessons

Principle	Mechanism	Description
Signaling	Guides attention	Highlight important material (e.g., by pointing).
Coherence	Guides attention	Reduce unneeded material.
Segmenting	Manages load	Break lesson into segments paced by the learner.
Pretraining	Manages load	Provide names and characteristics of key elements before the lesson.
Generative activity	Promotes engagement	Ask the learner to interact with the screen or discuss the content during learning.
Embodiment	Promotes engagement	Show instructor with appropriate gesture, facial expression, body movement, and eye contact.
Personalization	Promotes engagement	Have instructor use conversational language that directly addresses the learner.
Positivity	Promotes engagement	Show instructor who displays positive emotion through gesture and voice.

that video presentations should be as simple as possible, restricted to the key objects and actions. Signaling and coherence may be particularly helpful techniques in light of Barr and Kirkorian's (2023) suggestion that young children may experience impoverished perception of elements presented on two-dimensional screens.

Techniques for Managing Cognitive Load

Barr and Kirkorian (2023) argue that cognitive load can protract the transfer deficit, such that it is worse when the tasks are more difficult and therefore more likely to overload the learner's processing capacity. This issue of lessons that create cognitive overload is addressed in the cognitive theory of multimedia learning by suggesting evidence-based techniques for managing cognitive load, such as the *segmenting principle* and the *pretraining principle* (Mayer, 2021; Mayer & Fiorella, 2022). The segmenting principle states that people learn better when a complex multimedia lesson is broken into manageable segments that can be paced by the learner. For example, a video demonstration can stop after each step, and continue when the learner clicks on a continue button.

The pretraining principle states that people learn better if they receive pretraining concerning the names and characteristics of key elements before they view a complex multimedia lesson. For example, before seeing a video lesson, the learner could see, handle, and name the key objects that are manipulated in the lesson. Pretraining with concrete objects can help learners make connections between two-dimensional objects in the video lesson and their corresponding three objects in the real world, which Barr and Kirkorian (2023) highlight as a challenge for toddlers. According to the cognitive theory of multimedia learning, these two techniques reduce the learner's cognitive load while watching the video lesson and thereby allow the learner to have capacity to engage in deeper processing of the content. This deeper processing involves mentally organizing the material and relating it with relevant prior knowledge.

Techniques for Promoting Productive Engagement Through Activity

Barr and Kirkorian (2023) note that young learners may not engage productively with an instructional video presented on a tablet, so they may need targeted help in relating what they see on the screen with their relevant prior knowledge. This is why they suggest greater touchscreen interactivity for young learners or asking children to actively discuss what is happening in the video. Specifically, Barr and Kirkorian call for joint media engagement, which includes actively discussing content and interacting with media with other learners. In the cognitive theory of multimedia learning, we offer the *generative activity principle*, which holds that people learn better from multimedia lessons when they engage in generative learning activities during the lesson (Fiorella & Mayer, 2022b; Mayer, 2021). For example, some generative learning activities that have been shown to effective with adult learners include enacting (i.e., making movements that imitate the content of the lesson), explaining (i.e., generating explanations of the lesson for oneself), and teaching (i.e., generating explanations of the lesson for others).

Engaging in generative activities is intended to help learners organize the material and relate it to their relevant prior knowledge (Fiorella & Mayer, 2015, 2016). For example, prompts in eBooks to engage in more embodied activities can foster productive engagement that leads to deeper processing of the material. Generative activities such as enacting, explaining, and teaching may be particularly helpful techniques for younger learners in light of Barr and Kirkorian's (2023) suggestion that young children may not understand that a two-dimensional object on the screen stands for a three-dimensional object in the real world and therefore do not reason about them systematically.

Techniques for Promoting Engagement Through Social Cues

Barr and Kirkorian (2023) assert that young learners may learn better and like instructors more when there is social interaction between the instructor and the learner, such as with video chat rather than recorded lectures. This idea meshes with evidence-based design principles of cognitive theory of multimedia learning based on social cues, such as the *embodiment principle* and the *personalization principle* (Fiorella, 2022; Fiorella & Mayer, 2022c; Mayer, 2021). The embodiment principle states that people learn better from multimedia lessons when there is an onscreen instructor who displays appropriate gesture, facial expression, body movement, and eye contact. The personalization principle states that people learn better from multimedia lessons when the instructor uses conversational language in directly addressing the learner. Furthermore, the emotional tone of the social interaction in video chats can come into play. For example, the *positivity principle* states that people learn

better from multimedia lessons when instructors display positive emotional cues through gesture and voice (Lawson & Mayer, 2022, 2023). Overall, these kinds of social cues are expected to prime a social response in the learner, which results in a feeling of social partnership with the instructor that prompts the learner to try harder to make sense of what the instructor is saying.

Conclusion

Barr and Kirkorian (2023) describe some challenges in designing onscreen lessons for toddlers and preschoolers and offer a theoretical framework for understanding them. In this essay, I have summarized some evidence-based principles of multimedia instructional design that my colleagues and I have proposed based on more than 200 experiments carried out over 4 decades mainly with adult and adolescent learners. My hope is that some of these design principles can be adapted to help toddlers and preschoolers learn more effectively from onscreen multimedia lessons. I will consider this essay to be a success if it encourages further empirical testing of the efficacy of our design principles for supporting onscreen learning for toddlers and preschoolers.

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