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The effects of screen media content on young children's executive functioning

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ABSTRACT

Children's exposure to screen-based media has raised concerns for many reasons. One reason is that viewing particular television content has been shown to negatively affect children's executive functioning. Yet, it is unclear whether interacting with a touchscreen device affects executive functioning in the same way as the television research suggests. In the current study, 96 2- and 3-year-old children completed executive functioning measures of working memory and response inhibition and task switching before and after a brief screen intervention consisting of watching an educational television show, playing an educational app, or watching a cartoon. Children's ability to delay gratification was also assessed. Results indicate that the type of screen intervention had a significant effect on executive functioning performance. Children were more likely to delay gratification after playing an educational app than after viewing a cartoon. In particular instances, children's working memory improved after playing the educational app. These findings emphasize that, for young children's executive functioning, interactivity and content may be more important factors to consider than simply "screen time."

Introduction

The purpose of the current study was to examine how different types of screen media experiences immediately affect young children's executive functioning (EF). This work was intended to fill a

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number of important empirical gaps in the literature. Specifically, there is little work examining the effect of media exposure on the EF of children younger than 4 years old. Moreover, prior work in this area has focused on observational noninteractive video. Here, we further examined how touchscreen app use affects young children's EF.

Executive functions refer to higher order cognitive processes responsible for mediating goal-directed behavior, including self-regulation, working memory, inhibition, and attention (Beck, Schaefer, Pang, & Carlson, 2011; Garon, Bryson, & Smith, 2008; Hughes & Ensor, 2005). Researchers have distinguished between executive functions as being either "hot" or "cool." Hot executive functions are activated in emotive or heightened social situations, and are typically measured by tasks with an extrinsic reward such as delay of gratification (Beck et al., 2011). Conversely, cool executive functions are emotionally neutral cognitive skills typically assessed by more abstract tasks (Brock, Rimm-Kaufman, Nathanson, & Grimm, 2009). These abilities develop rapidly during early childhood and are related to children's social and academic school readiness (Blair, Zelazo, & Greenberg, 2005). Collectively, both hot and cool executive functions are crucial to daily functioning and are important for learning and academic success (Diamond, 2013).

Given the significance of EF in development and learning, it is important to identify factors that may affect executive function performance in children. One such factor that has been repeatedly identified is exposure to observational media (e.g., television). Particular features of television programs can have immediate effects on 4-year-old children's hot (e.g., delay of gratification) and cool (e.g., digit span, Tower of Hanoi, Heads–Knees–Toes–Shoulders) EF performance (Lillard, Drell, Richey, Boguszewski, & Smith, 2015; Lillard & Peterson, 2011; Lillard, Li, & Boguszewski, 2015) . In addition, other research has found that both television exposure time and content are related to children's concurrent EF abilities as well as their EF performance later in life (Barr, Lauricella, Zack, & Calvert, 2010; Nathanson, Aladé, Sharp, Rasmussen, & Christy, 2014). Notably, as detailed below, it is not only the duration of exposure but also the specific media experience that can affect children's EF.

The nature of television content and the amount of screen time exposure have been shown to affect children's EF. For example, in a longitudinal study exploring the effects of television exposure during infancy and the preschool years, Barr et al. (2010) found that the content and duration of television exposure at each time point were related to EF at 4 years of age. Children exposed to high levels of adult-directed television at both 12 months and 4 years had poorer EF scores at 4 years of age. In addition, high levels of household television use at age 4 were associated with poorer EF. Interestingly, exposure to child-directed programming at either time point was not associated with EF scores (Barr et al., 2010). When children view content that is designed for them (e.g., Public Broadcasting Station [PBS] and Nickelodeon preschool programs), it is less detrimental to their EF than adult-directed content. This study suggests that in addition to overall television exposure, television content also plays an influential role in young children's EF development.

More recently, children's television viewing was further teased apart. Parental records of household television use reported television duration, channels, and programs watched (Nathanson et al., 2014). Here, consistent with the aforementioned study, children who viewed more television had weaker EF scores compared with children who watched fewer hours. Both the television channel viewed and the type of content were important predictors of EF performance. Specifically, PBS viewing was positively related to children's EF skills, whereas watching educational cartoons (e.g., *Dora the Explorer*) was associated with poorer EF performance. Greater television viewing is typically related to poorer EF skills, whereas high-quality children's programming (e.g., PBS) is related to better EF.

In addition to correlational studies, experimental research has shown that particular television content can have immediate effects on children's EF. Lillard and Peterson (2011) assessed preschoolers' EF abilities directly after viewing 9 min of a fast-paced cartoon (*SpongeBob SquarePants*) or an educational television program (*Caillou*). They concluded that the fast-paced fantastical cartoon subsequently impaired preschoolers' hot (e.g., delay of gratification) and cool (e.g., backward digit span) EF performance. Interestingly, baseline EF performance was not measured, meaning that an alternative explanation of the results remains to be explored. Specifically, it is possible that the cartoon did not have negative effects on EF performance but that the educational program had positive effects on EF performance.