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Impact of Screen Time on Executive Function in Early Childhood

Ms. Rudritara Jaidev Shroff

Student

ABSTRACT

The World Health Organization (WHO) mandates no screen time for children below two years of age; and an upper limit of one hour per day for children aged 2–5 years. However, contemporary research studies present a whole new perspective - 53% of Indian children receive screen exposure before the age of 2; roughly 88% use screen media during mealtime, and 68% do so within an hour before bedtime.

The digital era makes it easy to normalize this increased exposure to screens, but we ought to be concerned about its developmental consequences on early childhood development. The ensuing study probes the relationship between screen time and executive function in children aged 3 to 6 years.

Deploying a mixed-methods approach including caregiver surveys, structured observation, and validated executive function tasks (e.g., Dimensional Change Card Sort, Stroop-like Day-Night Task), we learnt that higher daily screen exposure, particularly passive screen time (e.g., television), is associated with significantly poorer executive function performance. The findings support the aforementioned guidelines advocating limited screen use, and underline the importance of content quality and parental supervision.

KEYWORDS: Executive Function (EF), Screen Time, Early Childhood Development, Passive Media Exposure, Cognitive Flexibility, Inhibitory Control, Working Memory, Parental Mediation, Co-viewing, Digital Media, Child Development, Preschoolers, Developmental Psychology, Mixed-Methods Study, Dimensional Change Card Sort (DCCS), Day-Night Stroop Task, Cognitive Engagement, Media Content Quality, Parental Supervision, Vygotsky's Scaffolding.

INTRODUCTION

Early childhood is a critical period for brain development, during which time executive function (EF) skills gain new ground. But what exactly are executive functions? Working memory, inhibitory control, and cognitive flexibility are foundational for learning, behavior regulation, and emotional development. They become the backdrop against which goal-oriented behavior and school readiness take centre-stage. So why are educators, psychologists, and healthcare professionals growing increasingly concerned about how screen time is shaping these developmental milestones?

Let me present a scenario – Compare and contrast two children aged three years, one of whom spends his/her time solving puzzles, reading age-appropriate books, and partaking in social interaction hinging on relevant game play. Meanwhile, the other commits the same amount of time, if not more, to passive screen exposure. In the latter's case, where is the leeway for incurring spontaneous experiences that can encourage lateral thinking? Doesn't watching repetitive content snatch away the prospect of making independent decisions, essentially disallowing the developing brain to adjust or adapt? This is what we attempted to investigate by probing the association between screen exposure and executive function

development in early childhood. Our eventual aim is to contribute empirical data to inform evidence-based recommendations.

LITERATURE REVIEW

Truth be told, prior studies have shown mixed outcomes regarding screen time's impact on children. For instance, Anderson and Subrahmanyam (2017) emphasized that content matters, with educational programming potentially supporting EF development, and fast-paced or violent content impairing attention and self-regulation. However, new-age research offers more definitive and conclusive insights into the dynamic relationship between screen time and executive function (EF) development in early childhood.

A 2024 study published in Scientific Reports found that increased screen time was associated with poorer performance in tasks measuring inhibitory control and cognitive flexibility. This suggests that excessive screen exposure may hinder the development of imperative cognitive skills.

Likewise, a study published in Academic Pediatrics in 2024 drew parallels between screen time trajectories among preschoolers and their association with executive function outcomes. The findings revealed that those with consistently high screen time exhibited lower scores in inhibitory control and effortful control, exemplifying the potential long-term cognitive implications of uninhibited and uninterrupted screen exposure.

Another report published in Healio Pediatrics in December 2024 corroborated the fact that preschool children, who indulge in more than one hour of screen time every day, exhibit reduced inhibitory control and cognitive flexibility. These compilations lend credibility to the notion that rapid scene changes and passive consumption impair a child's ability to develop sustained attention or practice self-regulation skills. Factor in the displacement of developmentally enriching activities such as play, sleep, and social interaction; coupled with the lack of cognitive engagement in passive screen content; and we have fertile ground for elucidating plausible mechanisms underlying this association.

This merits a discussion on parental mediation, and whether co-viewing and engaging in discussions about content can buffer the displacement effects. The following research pre-empts the fact that the quality and context of screen interactions are likely critical factors in mitigating potential negative impacts on executive function development.

METHODOLOGY

Participants

80 children aged 3–6 years were included from urban preschools and pediatric clinics, along with their primary caregivers.

Instruments

- Parent questionnaires were handed out requesting documentation of duration, type, content, and co-viewing practices pertaining to screen time
- Executive Function Tests:
  - Dimensional Change Card Sort (DCCS) – cognitive flexibility
  - Day-Night Stroop Task – inhibitory control
  - Corsi Block-Tapping Test – visual working memory
- Observation logs during structured play sessions

Procedure

Each child participated in a 30-minute EF assessment session. Parents completed screen-time diaries for 7 consecutive days. Screen time was categorized as passive (TV, YouTube) or interactive (educational apps, games). Confounding variables like parental education, sleep patterns, and socioeconomic status were controlled during analysis.

Moreover, each child underwent a 30-minute structured EF assessment session using the Dimensional Change Card Sort and the Head-Toes-Knees-Shoulders (HTKS) tests, both widely recognized tools to measure cognitive flexibility and inhibitory control.

In order to isolate the effects of screen type and mediation, confounding variables such as parental education level, family income, average sleep duration, and the number of siblings were statistically controlled using multiple regression analysis.

Findings

- Children with >2 hours/day of screen time showed lower scores on all EF tasks when compared to those with <1 hour/day.
- Passive screen time had a stronger negative correlation with EF performance ($r = -0.45$, $p < 0.01$) than interactive screen time.
- Children with higher proportions of interactive or co-mediated screen time performed significantly better on EF tasks compared to those with higher passive screen exposure, even after accounting for socioeconomic and demographic factors.
- Co-viewing and parental discussion during screen use moderated negative effects, especially in the 4–5-year-old group.
- Gender differences were of no consequence in EF outcomes related to screen use.

DISCUSSION

The enlisted findings reinforce the hypothesis that excessive screen time—particularly in the form of passive content consumption negatively impacts executive function (EF) development in early childhood**.** When young children spend a disproportionate amount of time passively watching television and non-interactive videos, it comes at the cost of time that should have been spent in developmentally enriching activities crucial for self-regulation, learning, and adaptive behavior.

The plausible explanation for this equation is the displacement hypothesis**.** Excessive screen time ousts critical experiences such as free play, physical activity, face-to-face social interaction, and adequate sleep—all of which are pivotal for the healthy development of EF skills. Play, for example, encourages problem-solving and imaginative thinking; social interaction fosters emotional regulation and language development; and sleep consolidates learning and memory. When screens replace these experiences, opportunities for practicing and strengthening executive function processes are notably reduced.

Moreover, passive screen content often lacks the cognitive complexity needed to stimulate and challenge the impressionable child brain. Unlike interactive activities or guided storytelling, passive viewing does not demand decision-making, reflection, or problem-solving, and thus fails to engage the mental processes that support EF development. The content itself also plays a role—fast-paced or over-stimulating media may impair attention and reduce the ability to focus or transition between tasks effectively.

However, parental mediation does serve as an important moderating factor. When parents co-viewed media with their children and engaged them in active discussions about the content, the negative effects

of screen exposure were mitigated. Asking reflective questions, linking the material to real-life experiences, and encouraging children to predict outcomes or explain scenarios set the pace for higher-order thinking.

One particular child, while watching an animated cartoon story featuring a character who loses her pet rabbit, with a parent, was asked, "What do you think the character will do next?" The child responded, "I would put up posters and ask my neighbors for help."

This response illustrates several components of executive functioning in action:

- **Planning and prediction:** The child is anticipating a logical next step based on narrative cues.
- **Cognitive flexibility:** The child is drawing from personal or observed experiences.
- **Working memory:** The child is holding story details in mind to inform their prediction.
- **Inhibitory control:** The child pauses to think through a realistic possibility.

Such thoughtful co-engagement demonstrates how co-viewing with intentional questioning transforms passive screen time into an active cognitive task, directly supporting the development of executive function skills. This approach aligns with Vygotsky's theory of **scaffolding**, which asserts that children develop cognitively when adults support learning within their zone of proximal development.

This highlights an important distinction: rather than promoting screen avoidance alone**,** which isn't exactly realistic in today's digital environment, emphasis should be placed on how screens are used. Context, content, and co-engagement matter. Endorsing thoughtful media use, limiting screen time in accordance with developmental guidelines, and prioritizing quality content alongside active parental involvement can help mitigate potential harms and promote healthier developmental outcomes.

Future research should explore the long-term implications of these findings and examine how different types of digital engagement—such as educational games, interactive storytelling, or parent-guided apps—compare with passive consumption. Additionally, understanding the socio-economic and cultural factors that influence screen time habits can inform more tailored and equitable interventions.

CONCLUSION

Our study adds to the growing body of evidence suggesting that screen time in early childhood should be carefully monitored, with emphasis on quality, duration, and parental involvement. While technology can support learning when used appropriately, excessive and passive screen exposure may hinder the development of crucial executive functions. These results have implications for parents, educators, pediatricians, and policymakers in guiding healthy digital habits in young children.

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