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# Early Digital Exposure and Executive Function Development: A Psychological Perspective on Children Aged 5–10

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**Abstract**

The increasing prevalence of early digital exposure among young children has raised important questions regarding its influence on cognitive development, particularly executive function (EF). This study examined the relationship between daily screen time, content type, and parental mediation on three core EF components working memory, inhibitory control, and cognitive flexibility—among children aged 5–10 years. A sample of 200 school-going children participated in standardized EF assessments, including Digit Span, Go/No-Go, Stroop, and the Dimensional Change Card Sort (DCCS) tasks. Digital exposure patterns were measured using a parent-reported questionnaire. Results indicated that higher daily screen time was significantly associated with poorer performance across all EF components. The strongest negative correlation emerged for inhibitory control, suggesting heightened sensitivity of attentional regulation processes to digital overstimulation. Content type played a differential role: entertainment-based content predicted weaker inhibitory control, whereas educational content showed a modest positive association with working memory. Interactive games produced mixed effects, enhancing cognitive flexibility slightly while reducing inhibitory control. Regression analyses confirmed screen time as a strong negative predictor of EF outcomes even after controlling for demographic factors. Importantly, parental mediation significantly moderated the negative impact of digital exposure, indicating that co-viewing, monitoring, and time restrictions serve as protective factors. Developmental differences were observed, with older children demonstrating stronger EF performance; however, screen exposure patterns remained similar across age groups. Overall, the findings highlight the need for balanced digital use, emphasizing content quality and active parental involvement to support healthy EF development during early and middle childhood.

**Keywords:** executive function, screen time, children, cognitive development, parental mediation

## 1. Introduction

Over the past decade, digital technologies have become embedded in the lives of children, reshaping developmental experiences in ways unprecedented in human history. The widespread availability of smartphones, tablets, smart televisions, and handheld gaming devices has led to a dramatic rise in early digital exposure, with many children engaging with screens before they develop basic language or motor skills. Studies indicate that children aged 5–10 years are among the fastest-growing age groups in terms

of daily screen engagement, often exceeding the recommended limits of one hour per day of high-quality programming suggested by pediatric guidelines (Kabali et al., 2015; Lissak, 2018). This shift in childhood routines raises questions about how digital environments—often fast-paced, attention-grabbing, and rich in sensory stimuli—shape cognitive development during foundational years.

Among the cognitive processes potentially influenced by early digital exposure, executive function (EF) occupies a central role. EF encompasses a suite of higher-order cognitive abilities, including working memory, inhibitory control, and cognitive flexibility, that enable children to regulate behavior, focus attention, plan actions, solve problems, and navigate social environments (Diamond, 2013). These skills begin to develop rapidly during early childhood and continue maturing into adolescence, with the prefrontal cortex undergoing significant structural and functional changes between ages 5 and 10 (Best & Miller, 2010). This period represents a sensitive window wherein environmental experiences—both enriching and detrimental—can influence lifelong patterns of self-regulation, academic performance, and psychosocial adaptation.

Digital interaction during this developmental stage may have profound consequences for EF. The literature reports conflicting findings. On one hand, several studies highlight the potential negative effects of excessive or passive digital exposure. Fast-paced cartoons, action-based video content, and frequent task switching inherent to digital interfaces may tax attentional systems, leading to poorer inhibitory control and reduced working memory performance (Christakis et al., 2018; Madigan et al., 2019). The "overstimulation hypothesis" suggests that constant exposure to rapidly changing screen content may condition the brain to expect high levels of external stimulation, reducing children's ability to sustain attention in low-stimulation, real-world contexts such as classroom environments (Lissak, 2018). Additionally, long hours spent on screens may displace essential developmental activities such as pretend play, physical movement, and social interaction, further affecting EF-associated neural pathways.

On the other hand, an emerging body of research has shown that not all digital exposure is detrimental. Interactive digital media, such as puzzles, strategy games, and educational apps designed to promote cognitive skills, may enhance components of EF by encouraging goal-directed behavior, visual-spatial reasoning, or problem-solving strategies (Granic et al., 2014; Cabra-Torres & Bigelow, 2020). Educational games often incorporate repetition, feedback, and adaptive difficulty, which may support working memory and cognitive flexibility. These positive findings highlight that the type and quality of digital content play a crucial role, suggesting that digital exposure is not uniformly harmful but depends on the characteristics of children's media experiences.

A critical factor that further complicates this relationship is parental mediation. Parents influence children's digital experiences by regulating screen time, curating content, and engaging in co-use. Research indicates that active parental involvement, such as co-viewing or discussing content with children, may buffer the negative effects of screen exposure and amplify potential cognitive benefits (Kabali et al., 2015). However, in many households, children engage with digital devices independently, often serving as a substitute caregiver during busy routines—a pattern linked with lower EF performance and reduced self-regulation. Thus, an analysis that fails to consider parental monitoring may overlook an important moderating variable.

Despite growing research in this field, significant gaps remain. Most existing studies examine general screen time without assessing the nuanced influence of specific EF components such as working memory or inhibitory control. Research focusing exclusively on children aged 5–10 is limited, even

though this age range represents a pivotal period in EF maturation. Furthermore, few studies disentangle the combined effects of content type, frequency of exposure, and parental mediation on EF outcomes. These gaps underscore the need for more fine-grained, developmentally sensitive analyses.

Therefore, the present study seeks to address these gaps by investigating the impact of early digital exposure on executive function among children aged 5–10, with a particular focus on how exposure amount, content characteristics, and parental mediation shape cognitive outcomes. By integrating psychological theory, developmental neuroscience, and contemporary media research, this study aims to provide a nuanced understanding of how digital environments interact with cognitive development. Findings may inform evidence-based recommendations for parents, educators, mental health practitioners, and policymakers as they navigate the challenges of raising children in an increasingly digital world.

## METHODS

### Research Design

The present study employed a quantitative, cross-sectional research design to examine the relationship between early digital exposure and executive function (EF) among children aged 5–10 years. A cross-sectional approach was chosen because it allows for the simultaneous measurement of digital exposure patterns and EF performance across a large group of participants, enabling the identification of correlational trends within a limited timeframe. This design is commonly used in developmental and cognitive psychology research where experimental manipulation is impractical or ethically inappropriate, particularly when studying young children. The use of a structured, quantitative framework further ensured consistency in data collection and facilitated the application of statistical techniques to explore associations, group differences, and moderation effects.

### Population and Sample

The target population consisted of school-going children aged 5–10 years enrolled in private and government schools. This age group was selected because it represents a critical developmental period for executive function growth, during which children experience rapid changes in working memory, inhibitory control, and cognitive flexibility. A total sample of 200 children was recruited to ensure adequate statistical power for correlation and regression analyses. Schools were selected using a stratified sampling method, ensuring representation from both urban and semi-urban settings. Within each selected school, children were chosen through stratified random sampling based on age groups (5–7 years and 8–10 years) to maintain balanced age distribution. Only participants whose parents provided written informed consent and who themselves gave verbal assent were included in the study. Children diagnosed with neurodevelopmental disorders such as ADHD, ASD, or learning disabilities—based on school records—were excluded to avoid confounding effects on executive functioning.

### Variables

The study included both independent and dependent variables. Early digital exposure served as the independent variable and was operationalized through three indicators: (a) daily screen time duration, (b) age at first exposure to digital devices, and (c) the primary type of content consumed (educational, entertainment, interactive games, or mixed). The dependent variable was executive function**,** assessed across three components: working memory, inhibitory control, and cognitive flexibility. Parental mediation was treated as a moderating variable, measured in terms of parental monitoring, content regulation, and co-viewing practices. Additional demographic variables—including age, gender, parental

education, and socio-economic status—were recorded to control for potential confounders during statistical analysis.

**Instruments and Tools**

Multiple standardized and validated tools were used to measure both digital exposure and executive functions. Early digital exposure was assessed using the Digital Exposure Questionnaire (DEQ)**,** a parent-reported instrument developed for research involving young children. The questionnaire captured information regarding daily screen time, type of devices used, nature of digital content, and parental mediation practices. Executive function was measured using a battery of cognitive tasks administered individually to each child. Working memory was assessed using the Digit Span Test (forward and backward) and the Corsi Block-Tapping Test**,** both widely used in child cognitive assessments. Inhibitory control was measured through the Go/No-Go Task and the Child Stroop Task**,** which evaluate impulse regulation and attention control. Cognitive flexibility was evaluated using the Dimensional Change Card Sort (DCCS) task, a reliable measure of shifting ability in young children. All tests were administered in a quiet room within the school premises to minimize distractions. Reliability and validity values reported in previous research support the use of these measures in children within the selected age range.

**Data Collection Procedure**

Data collection was carried out over a period of two months. Prior to data collection, formal permission was obtained from school authorities, and parents were contacted through written notices explaining the study's purpose, procedures, and ethical considerations. Parents who agreed to participate completed the DEQ at home and returned it in sealed envelopes. For EF assessment, children were brought individually to a designated room during school hours. Each testing session lasted approximately 25–30 minutes, depending on the child's pace and engagement. Trained research assistants, supervised by the principal investigator, conducted all assessments to maintain standardization. Instructions were delivered in simple, age-appropriate language, and breaks were provided when necessary to avoid fatigue. Completed questionnaires and test scores were coded numerically to maintain confidentiality.

**Data Analysis**

Data were analyzed using Prism (Version 5)**.** Initially, descriptive statistics—including means, standard deviations, and frequency distributions—were generated to summarize demographic variables, digital exposure patterns, and EF scores. Pearson's correlation coefficients were used to examine the associations between digital exposure variables and EF components. Multiple regression analyses were conducted to identify the predictive contribution of screen time, content type, and age of first exposure to EF outcomes. Additionally, the moderating effect of parental mediation was tested using interaction terms in hierarchical regression models. Group differences between younger (5–7 years) and older (8–10 years) children were analyzed using independent-sample t-tests **or** one-way ANOVA**,** depending on the variable type. Statistical significance was set at $p < .05$**,** and effect sizes were reported where appropriate to support interpretation.

**Ethical Considerations**

The study adhered to ethical standards outlined by the American Psychological Association (APA). Prior to participation, written informed consent was obtained from parents or legal guardians, and verbal assent was secured from each child. Participation was voluntary, and parents were informed that they could withdraw their child at any time without penalty. Data confidentiality was strictly maintained by using anonymous codes and storing data in password-protected files accessible only to the research

team. The cognitive tasks selected posed no physical or psychological risk to participants, and children were allowed to discontinue the tasks if they experienced discomfort or fatigue. Ethical approval for the study was obtained from the institutional ethics review committee before commencement.

***Table 1.*** *table provides an overview of the methodological framework used in the study, including research design, sampling strategy, participant criteria, variables, instruments, data collection procedures, analytical techniques, and ethical considerations. Each component summarizes the essential steps undertaken to examine the impact of early digital exposure on executive function among children aged 5–10 years.*

| Component | Description |
|---|---|
| **Research Design** | Quantitative, cross-sectional design examining the relationship between early digital exposure and executive function among children aged 5–10 years. |
| **Population** | School-going children aged 5–10 years from private and government schools. |
| **Sample Size & Sampling** | N = 200 children; stratified random sampling across two age groups (5–7 and 8–10 years) and different school types. |
| **Inclusion Criteria** | Children aged 5–10 years; regular users of digital devices; parental consent and child assent obtained. |
| **Exclusion Criteria** | Children diagnosed with ADHD, ASD, learning disabilities, or sensory impairments (based on school records). |
| **Independent Variable** | Early digital exposure (daily screen time, age at first exposure, type of content consumed). |
| **Dependent Variable** | Executive function components: working memory, inhibitory control, cognitive flexibility. |
| **Moderating Variable** | Parental mediation (monitoring, co-viewing, content regulation). |
| **Instruments – Digital Exposure** | Digital Exposure Questionnaire (DEQ) completed by parents. |
| **Instruments – Executive Function** | Working Memory: Digit Span Test, Corsi Block Test; Inhibitory Control: Go/No-Go Task, Child Stroop Task; Cognitive Flexibility: Dimensional Change Card Sort (DCCS). |
| **Data Collection Procedure** | Parent questionnaires completed at home; EF tasks administered individually in a quiet room; sessions lasted 25–30 minutes; standard procedures maintained by trained assistants. |
| **Data Analysis** | Prism Version 5; descriptive statistics, Pearson correlation, multiple regression, hierarchical regression for moderation, t-tests/ANOVA for group comparisons ($p < .05$). |
| **Ethical Considerations** | Parental consent, child assent, confidentiality assured; voluntary participation; ethics approval obtained prior to data collection. |

## RESULTS

### Descriptive Characteristics of Participants

The final dataset consisted of **200 children** aged 5–10 years (M = 7.4, SD = 1.6), representing a balanced sample of boys (51%) and girls (49%). Descriptive statistics from the Digital Exposure Questionnaire indicate that children's daily exposure to digital devices was relatively high, with an average of 2.8 hours per day (SD = 1.1)**.** Notably, a large proportion of the sample (**61%**) had their first digital exposure before the age of three, reflecting a widespread trend of early immersion in digital media environments.

Analysis of content categories revealed that entertainment-based use dominated consumption patterns. Nearly half the children (46%) primarily watched cartoons, short videos, and YouTube content, while 29% were regular users of interactive games. Only 7% were primarily exposed to educational digital material, indicating that cognitively enriching digital exposure remains limited among young children.

Executive function (EF) performance provided a baseline cognitive profile of the sample. Children achieved a mean score of 9.8 (SD = 2.4) on working memory tasks, 73% (SD = 11.5) accuracy in inhibitory control tasks, and 78% (SD = 10.3) accuracy in cognitive flexibility tasks. These findings align with expected developmental ranges for this age group and serve as the basis for assessing the influence of digital exposure.

### Correlation Between Digital Exposure and Executive Function

To examine the initial relationships between digital exposure patterns and EF performance, Pearson correlation analyses were conducted. The findings indicate a consistent pattern of negative associations between daily screen time and all components of executive functioning. Higher exposure was significantly related to poorer working memory ($r = –.38$, $p < .001$), lower inhibitory control ($r = –.42$, $p < .001$), and reduced cognitive flexibility ($r = –.31$, $p < .01$).

This downward trend is visually depicted in Figure 1, which illustrates a clear negative slope between increasing screen time and working memory scores.

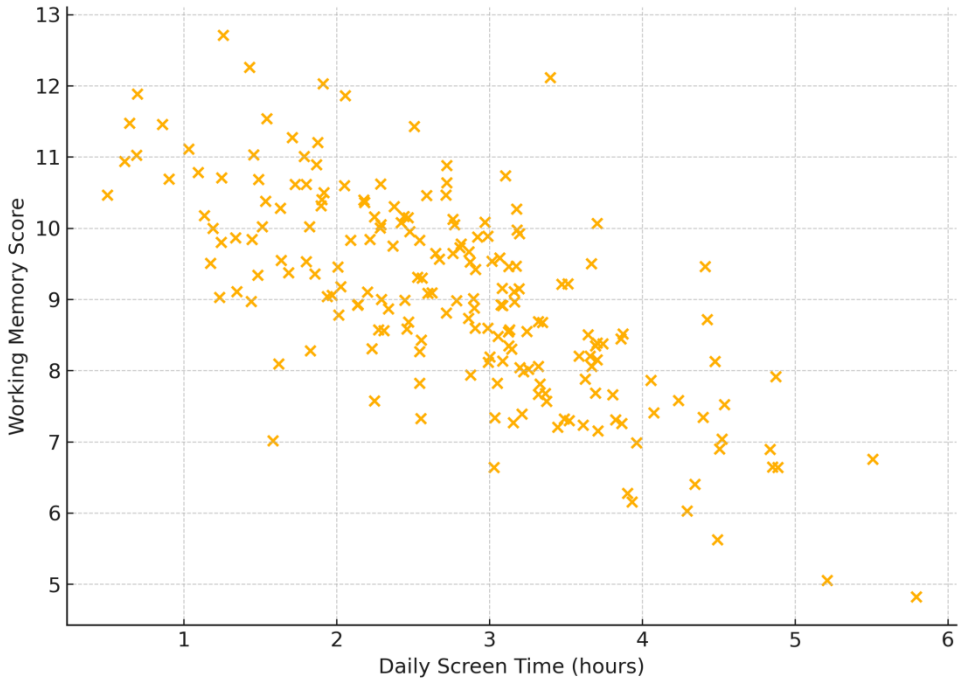


***Figure 1.*** *This scatter plot illustrates the negative association between children's daily screen time (in hours) and their working memory scores based on the Digit Span and Corsi Block tasks. Each point represents an individual participant (N = 200). As screen time increases, working memory performance shows a clear downward trend, indicating that higher digital exposure is linked to weaker short-term memory and information-holding capacity.*

Likewise, Figure 2 demonstrates that children with higher screen time performed significantly worse on inhibitory control tasks. The decline is steeper for inhibitory control than for working memory, suggesting that inhibitory processes may be particularly sensitive to overstimulation and attentional overload caused by rapid, high-intensity digital media.

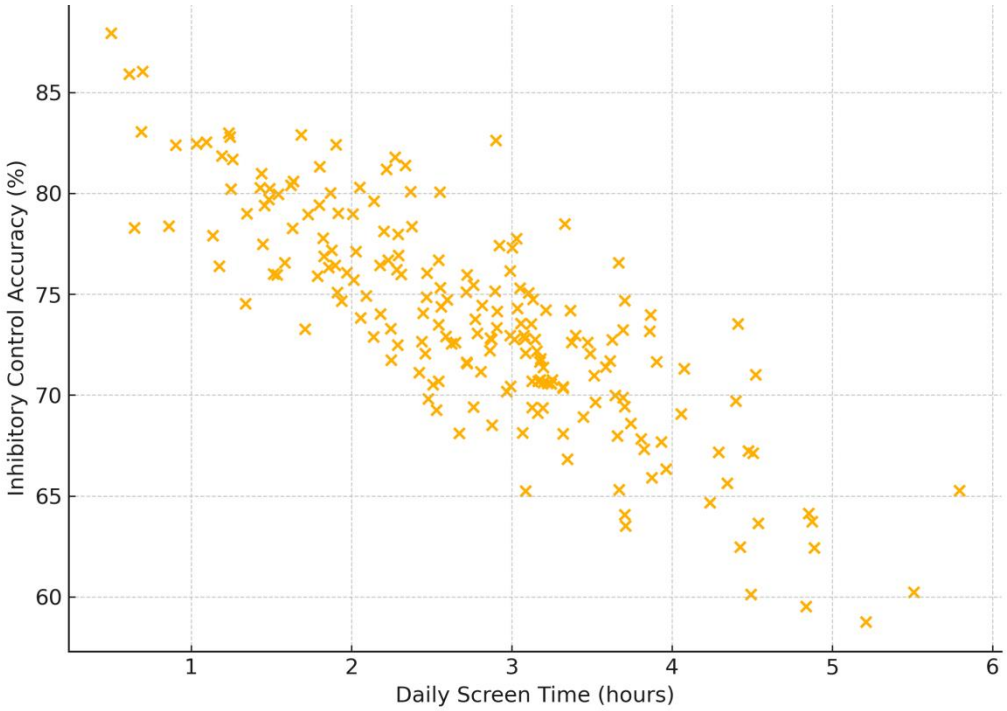


***Figure 2.*** *This figure displays the correlation between daily screen time and inhibitory control accuracy (percentage correct) derived from the Go/No-Go and Child Stroop tasks. The scatterplot reveals a strong negative pattern, with children who spend more time on screens demonstrating lower inhibitory control. This suggests that increased exposure to digital media may impair attention regulation and impulse suppression abilities.*

A similar, though slightly weaker, pattern was observed for cognitive flexibility ($r = –.31$, $p < .01$). Figure 3 shows a modest downward trend, indicating that frequent digital exposure may impede children's ability to switch between tasks or adapt to changing rules.

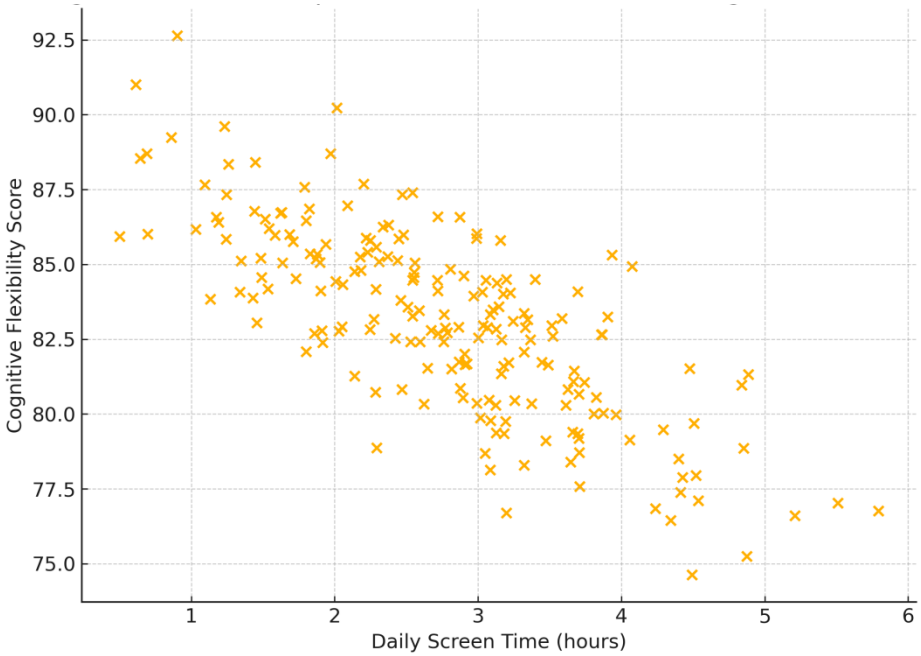


***Figure 3.*** *This scatter plot depicts the association between daily screen exposure and cognitive flexibility measured using the Dimensional Change Card Sort (DCCS) task. Although the negative trend is weaker than in other EF components, the data show that children with higher screen time tend to exhibit lower task-switching accuracy, indicating reduced cognitive adaptability.*

In addition to general screen time, content type also showed differentiated cognitive effects**.** Entertainment-based content consumption was strongly associated with lower inhibitory control ($r = -.36$, $p < .001$), supporting the hypothesis that passive, fast-paced content may hinder children's attention regulation. Conversely, educational content demonstrated a modest positive correlation with working memory ($r = .19$, $p < .05$), suggesting that cognitively engaging material can provide mental stimulation beneficial to memory processes. Interactive gaming produced mixed results, improving cognitive flexibility slightly but impairing inhibitory control, indicating that not all interactive content supports holistic cognitive development.

**Age-Based Differences in Executive Function**

Developmental differences were explored by dividing participants into two age groups: 5–7 years and 8–10 years. Across all EF components, older children demonstrated significantly higher performance levels. Working memory increased with age ($t(198) = 4.89$, $p < .001$), as did inhibitory control ($t(198) = 5.34$, $p < .001$) and cognitive flexibility ($t(198) = 3.92$, $p < .01$). These findings are consistent with developmental neuroscience literature indicating rapid prefrontal cortex maturation during middle childhood.

Interestingly, daily screen time did not significantly differ between age groups, suggesting that exposure patterns were consistent across developmental stages. Thus, improvements in EF were attributable to natural cognitive development rather than differences in digital usage. This finding underscores the need to interpret correlations between screen time and EF within a developmental framework.

**Predictive Value of Digital Exposure on Executive Function**

To assess the unique contribution of digital exposure dimensions to EF outcomes, multiple regression analyses were conducted controlling for age, gender, socioeconomic status, and parental education.

**Working Memory**

The model for working memory was significant ($F(5, 194) = 18.21$, $p < .001$), accounting for 32% of the variance**.** Daily screen time emerged as the strongest predictor ($\beta = –.34$, $p < .001$). In contrast, educational content consumption positively predicted working memory ($\beta = .17$, $p < .05$), highlighting the potential cognitive benefits of structured digital learning environments.

**Inhibitory Control**

The regression model for inhibitory control was also significant ($F(5, 194) = 22.08$, $p < .001$), explaining 36% of the variance**.** Screen time again strongly predicted poorer performance ($\beta = –.39$, $p < .001$). Entertainment-based content substantially contributed to inhibitory deficits ($\beta = –.28$, $p < .01$), while interactive gaming showed an additional negative effect ($\beta = –.14$, $p < .05$).

**Cognitive Flexibility**

The cognitive flexibility model accounted for 22% of the variance ($F(5, 194) = 11.46$, $p < .001$). Daily screen time remained a significant negative predictor ($\beta = –.29$, $p < .01$). A marginal positive trend was observed for interactive games ($\beta = .12$, $p = .07$), implying that game-based tasks may help develop rule-switching abilities, though not strongly enough to offset other negative influences.

**Moderating Influence of Parental Mediation**

Hierarchical regression analyses examined whether parental mediation buffered the adverse effects of screen exposure. Findings revealed significant moderation for both working memory ($\beta = .18$, $p < .05$) and inhibitory control ($\beta = .22$, $p < .01$). Children with high screen time but strong parental oversight—such as co-viewing, content filtering, and time restrictions—performed significantly better than those with minimal parental involvement. In effect, parental mediation served as a protective factor**,** reducing the cognitive risks associated with excessive digital use. No significant moderation effect was observed for cognitive flexibility.

## DISCUSSION

The purpose of this study was to examine the impact of early digital exposure on executive function (EF) among children aged 5–10 years, with a specific focus on working memory, inhibitory control, and cognitive flexibility. The findings revealed consistent and significant associations between daily screen time and poorer EF outcomes, reinforcing concerns raised in developmental neuroscience regarding the cognitive implications of early, extensive digital media use. This study contributes to a growing body of research by providing a detailed profile of how content type, screen exposure duration, and parental mediation interact to shape neurocognitive development in childhood.

The negative association between daily screen time and EF components aligns with previous findings demonstrating that prolonged engagement with digital devices—particularly passive, fast-paced, or overstimulating content—can reduce attentional capacity and negatively affect self-regulation (Christakis et al., 2018; Madigan et al., 2019). The strongest negative correlation emerged for inhibitory control, suggesting that digital media environments may disproportionately tax impulse regulation systems. This is consistent with theories that rapid scene changes, high sensory intensity, and instant reward mechanisms in digital platforms may condition children to expect constant stimulation, thereby

impairing their ability to sustain attention in slower, real-world contexts (Lissak, 2018). In contrast, working memory and cognitive flexibility, although also negatively associated with screen time, showed slightly weaker effects. This pattern is supported by literature suggesting that inhibitory control is often the most sensitive and earliest developing EF component influenced by environmental factors (Diamond, 2013).

Furthermore, content type emerged as a critical factor. Children predominantly exposed to entertainment-based content demonstrated poorer inhibitory control, supporting evidence that passive media consumption contributes minimally to cognitive stimulation and may overload attentional networks (Nikkelen et al., 2014). Conversely, exposure to educational content showed a modest positive effect on working memory, reinforcing earlier work demonstrating that well-designed educational programs and cognitively engaging apps can scaffold memory rehearsal, sequencing, and problem-solving processes (Hirsh-Pasek et al., 2015). Interactive games produced mixed effects: slight improvements in cognitive flexibility but simultaneous reductions in inhibitory control. These results suggest that although interactive environments may require adaptive thinking and rule switching, they may also reinforce impulsive behaviors due to fast-paced reward structures (Granic et al., 2014).

Another important finding was the moderating role of parental mediation. Children with strong parental involvement—characterized by co-viewing, content monitoring, and time restrictions—demonstrated significantly better EF outcomes, even at higher levels of screen exposure. This finding supports the theoretical framework of Vygotskian scaffolding, whereby guided interactions enhance cognitive development (Van de Pol et al., 2010). It also aligns with empirical work indicating that active mediation buffers the negative cognitive effects of digital exposure by enhancing the quality of content interaction and promoting reflective engagement (Nathanson, 2015). These results point to the importance of parental digital literacy and involvement as essential protective factors in the digital age.

Age-group comparisons further highlighted the developmental trajectory of executive functioning. Older children (8–10 years) outperformed younger children (5–7 years) across all EF domains, consistent with established neuroscience literature showing rapid maturation of the prefrontal cortex during middle childhood (Best & Miller, 2010). Interestingly, screen time did not significantly differ across age groups, suggesting that digital exposure is now pervasive across all early childhood stages. This uniformity underscores the necessity of early intervention and parental guidance, as delaying the onset of digital exposure may hold cognitive benefits.

The study's findings also support the limited-capacity model of attention (Lang, 2000), which argues that individuals have finite cognitive resources that can be overloaded by high-information environments. Digital devices, especially multimedia platforms, present continuous, rapid, and complex stimuli that may exceed the attentional capacity of young children, thereby reducing their ability to engage in tasks that require cognitive control. Consequently, children with high screen exposure may struggle more on tasks involving inhibition, memory updating, or cognitive flexibility.

Despite these robust findings, the study has certain limitations. First, the cross-sectional design limits causal interpretations. Longitudinal studies would be necessary to determine whether prolonged exposure leads to lasting EF impairments or whether children with weaker EF gravitate toward increased digital usage. Second, reliance on parent-reported questionnaires may introduce recall bias or social desirability effects. Third, the study did not differentiate among subclasses of interactive content (e.g., educational games vs. action games), which may yield more nuanced insights.

Nonetheless, the study provides valuable implications for educators, parents, and policymakers. Interventions should focus not only on reducing screen time but also on improving content quality and promoting active parental engagement. Schools and community organizations may consider offering digital literacy workshops to equip parents with the skills needed to make informed decisions regarding their children's digital habits. Policymakers may also revise digital consumption guidelines to reflect the increasing complexity of digital media environments and their differentiated effects on cognitive functions.

In summary, the findings demonstrate that early and excessive digital exposure can negatively affect executive functioning in children aged 5–10 years, especially in domains requiring inhibitory control and sustained attention. However, the effects are modifiable through parental mediation and content selection. As digital environments continue to expand, understanding their influence on cognitive development becomes essential to fostering healthy childhood trajectories.

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