Executive Function and Delayed Gratification and the Effects of Screen Time on Children

It doesn't take a scientist to see that more children than ever are being raised with screen-time play as a primary feature of their days; the landscape of childhood has been digitized, affecting how children play, learn, and form relationships. In addition to traditional television programming, rapidly emerging technologies, particularly portable electronic devices like ipads, provide unprecedented access to a wide range of screen-based media. Use begins in infancy and increases with age, and it was recently estimated at more than 2 hours per day in children younger than 9 years, outside of use during childcare and at school. Accompanying this rise are variables with potential risks and benefits, including access to screens (e.g., in bedrooms), frequency of use, content, and grownup-child interaction (Hutton, Dudley, Horowitz-Kraus, DeWitt, & Holland, 2020). It makes sense that this use is on the rise; busy parents often use this quick and easy technology as a means of entertainment instead of more traditional play styles which take more time, even though the American Academy of Pediatrics (AAP) recommends limits on screen-based media use, citing myriad health risks. These include a wide variety of developmental and cognitive-behavioral risks such as language delay, poor sleep, impaired executive function and general cognition, and decreased parent-child engagement, including reading together (Hutton et al., 2020).

Screen use by young children is prevalent and increasing, although its implications for brain development are unknown. As children are exposed to technology in various ways at younger ages, there are negative effects on their executive functioning, especially with their attention and learning. Delayed gratification regarding technology is influenced by parental modeling; if parents

are more attached to technology their children show difficulty with delayed gratification regarding technology.

Many adults lament about the “kids today” and their issues with self-regulation and addiction to screen media use and as a result, the effects of technology use on executive functioning in children has been studied widely. Though the above complaint has increased in recent years, Christakis, Zimmerman, DiGiuseppe, & McCarty showed in 2004 that early exposure to television was associated with subsequent attentional problems. This finding was present even while controlling for a number of potential confounding factors, including prenatal substance use and gestational age, measures of maternal psychopathology, and socioeconomic status.

Some parents may believe that an on-screen story time, watching a video of an adult reading a book, is no different from the same activity done in-person. The results of the study done by Zivan, Bar, Jing, Hutton, Farah & Horowitz-Kraus, however, show that children exposed to on-screen stories demonstrated higher functional connectivity in EEG frequencies related to attention difficulties, compared to the in-person (from a book) storytelling group (2019). Due to the passive nature of gazing at a screen without human interaction or the need to respond, an overall negative effect on the attention abilities of the screen group compared to the storytelling group was observed. Compared with the AAP guidelines, there is an association between increased screen-based media use and lower microstructural integrity of brain white matter tracts supporting language and emergent literacy skills in prekindergarten children (Hutton, et al., 2020). Increased screen to reading time ratio was also shown to be related to reduced reading and executive function abilities in children (Horowitz-Kraus, 2021).

Though many of these studies controlled for different confounding variables, such as socioeconomic status and maternal psychopathology, one study has shown that in typically

developing preschool children from low risk and well-educated families the time of exposure to various screens is not related to their executive functions. It is worth mentioning, these children were mostly using screens for a reasonable duration, usually not exceeding the AAP recommended time limits as the children in other studies were shown to (Jusienė, Rakickienė, Breidokienė, & Laurinaitytė, 2020).

One of the hallmarks of early child development is increasing self-control. This competence involves sustaining behavior towards goals in the face of obstacles, and is expressed behaviorally in various ways, including waiting for desired outcomes, resisting temptation, and perseverance when challenged. Self-control deficits are directly relevant to major childhood behavior disorders, including attention deficit and under-socialized aggressive conduct disorders and are associated with a variety of other problems of childhood adaptation, peer rejection, delinquency, substance use, and academic achievement. The ability to postpone immediate gratification voluntarily in order to obtain a delayed but preferred outcome is often viewed as a key component of children's early self- control.

Though it has been several decades since the publication of the Standard Marshmallow Experiment, the ability for children to master the ability to delay their gratification is still being studied in various ways. It has been shown that though not statistically significant, there is an interesting trend between the types of attachment these children demonstrate towards their parents and their delayed gratification skills. Children who showed success with delayed gratification in the well-supported Standard Marshmallow Experiment, were more likely to report better academic success, social competence, psychological health, and physical health later in their lives (Mischel, Shoda, & Rodriguez, 1989), so it is not a surprise that many parents want their children to be successful in this area.

Recent research, like that of Mittal, Russell, Britner, & Peake, has demonstrated that effective delay of gratification operates before the age of 4 years, the historic age point for most research on self-control (2012). This self-control depends heavily on the individual skills developed during social exchange with familiar social partners, especially primary caregivers. Securely attached children are generally interested in exploring and interacting with the parent. They like their parents to be involved and appear to have a very special relationship with the parent, with interaction that is smooth, full, warm, and positive. These trends are also supported in the delay of gratification literature: securely attached children work towards the goal of delaying by mutual involvement with their primary caregiver. On the other hand, avoidant children have the strategy of acting independent and minimizing parental involvement by creating a mental wall between themselves and others. Thus, they may be able to resist temptation to the gift using a similar approach—by moving their attention away from the gift thereby creating a more familiar psychological distance. (Mittal et al., 2012).

In 2015, a survey was conducted to determine what a fairly broad sample of American adults thought about potential changes in children's delay of gratification and self-control. The survey study affirmed that adults in the U.S. generally intuit that children today are less tolerant of delayed gratification and less self-controlled than children were 50 years ago. Furthermore, those who were parents suspected their children would not delay as long as they themselves would have as 4-year-olds, just one generation earlier. These findings held true across demographic variables (Carlson et al., 2015).

There are four primary themes related to delaying (or not delaying) gratification: fear of punishment, self-directed speech, reinforcement, and parental modeling (Ang, & Lee, 2017). These four factors are largely successful in assisting a child with their ability to delay gratification

by means of technology use; the only one that seemed to have negative effects was parental modeling. The demonstration by the primary caregiver of increased tech use was not helpful in teaching the children moderation when it comes to technology use; even if children's time was structured by the parents to have only the recommended time of screen use in it, they were more likely to fail the delayed gratification task if their parents were heavy technology users. Some children show an increased tendency to engage in technology use when their parents are often enraptured with their gadgets. Parents characteristically find themselves glued to their handheld devices, particularly young parents, an implication of this is the possibility that children would be less likely to develop the ability to delay gratification on technology use. Instead of expecting a young kid to magically self-control and to delay gratification on technology use, parents need to lead by example (Ang & Lee 2017).

As established earlier, as technology use is increased in children, their executive function skills, such as inhibition control, are lowered. Could the decreased inhibition control related to increased technology be creating a vicious cycle as it reduces the ability to delay gratification (Shoda, Mischel, & Peake, 1990)? Contrary to what the group of polled adults from 2015 reported, cohort studies show the average time that children are able to wait increased by about 2 minutes since the 1960s and 1980s (Carlson et al., 2018).

In conclusion, there are correlations between more-than-recommended screen time and decreased executive functioning in children. Children who succeed with delayed gratification are likely to show more success as adolescents and adults than those who do not; interaction with primary caregivers affects the child's success with delayed gratification tasks. There is little research on delayed gratification and technology but what is out there suggests that failure or success in the delay corresponds to how the child perceives the outcome of their actions.

There are some major limitations in this area of research, primarily due to the studies being conducted in the United States, using American children. The results are culturally biased and can therefore not be generalized to the world's entire population. In addition, delayed gratification skills have been shown to be context dependent. When a child does not not trust the experimenter to return with the larger reward, they will choose not to delay, In a low-resource and unpredictable environment, it might be irrational to delay, so it does not necessarily indicate poor self-control ability when children choose not to, and could even be considered adaptive. Additionally, the use of proxy reports in terms of screen use is an issue. This method may cause usage to be underestimated or overestimated due to recall bias, social desirability bias or the lack of parents' awareness as to how much their child is truly engaging in screen-based media. It is also important to mention that many studies do not differentiate between the types of media used during screen time, passively watching media, such as television or the aforementioned online story time, can be extremely different in terms of brain activity in comparison to educational apps and interactive screen-based media activities.

In terms of future directions, more research into the way screen use and delayed gratification interact is needed; research on the delay of gratification on technology use is in its infancy, and most findings are only suggestive. A multi-variable longitudinal study regarding both parental modeling influence on delayed gratification with technology as well as the effects of the usage of technology on the executive function of children would be beneficial to examine just how these effects play into the lives of children from early childhood through adolescence into adulthood. If possible, it would be beneficial to the body of research as a whole to take these experiments to different countries around the world, primarily the delayed gratification studies, as those findings are currently limited to population of the United States.

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