The potential impacts of preschoolers' use of touchscreen devices on learning and growth

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Content

Introduction

Nowadays, the universalization of technology in childhood is unprecedented. Children use electronic screens at ever younger ages (Nikken & Schols, 2015). Even babies under 2 log an average of half hour of mobile devices per day (Chen & Adler, 2019). Children would rather play with mobile devices than with toy cars and building blocks (Cohen, 2014). In this high-tech age, children obviously have different childhood compared with the previous generation. They can be called screen generation.

Children of this generation are immersed in a digital environment. Their experience naturally changes along with the environment. "Experience in childhood has relatively more impact on the developing child than experiences later in life," says Dr. Bruce D. Perry (Perry, 2000). Many researches have pointed out the side effects of overuse of traditional media on young children, such as television. However, more investigation are needed in terms of the influence of digital media, such as tablets and smartphones, on the young generation.

American Academy of Pediatrics (AAP) recommends that infants and toddlers younger than 24 months should avoid digital media (Pediatrics, 2018). The research on television shows that for babies, television is seem like a magic window and young children around age three appear to believe all television is real (Buckingham, 2013). During the preschool years, the ability to distinguish reality from fantasy develops significantly (Corriveau, Kim, Schwalen, & Harris, 2009). The changes of children from 3 to 6 years old are profound and they develop rapidly. At this age, they may be habit-forming, and early habits may affect future life. Little work has been conducted to examine the influence of the use of digital media on young children. The potential benefits and risks of screen media in early learning environment deserve serious attention and research. My research question is: what are the potential impacts of touchscreen devices on young children's learning and growth? I will

discuss the problem in the area of motor and sensory development, learning and attention. Moreover, in the present paper, I will focus more on psychological perspective, while socio-cultural perspective will be just briefly mentioned.

Theory

Piaget's theory of cognitive development

In Piaget's theory of cognitive development, the concept of schema, assimilation and accommodation are described (Piaget, 1976). Jean Piaget was a Swiss psychologist, who made a systematic study of cognitive development. He studied how a child construct a mental model of the world. According to Piaget's theory, there are four stages of children's cognitive development: the sensorimotor stage (birth to age 2), the preoperational stage (ages 2 to 7), the concrete-operational stage (ages 7 to 11) and the formal-operational stage (ages 11 and above). Piaget claimed that cognitive development is a process which relevant to biological maturation and interaction with the environment. Piaget's study was based on detailed observation of young children and adolescents in natural setting and clinical interviews of adolescents, opposed to the laboratory experiments of the behaviorists. Piaget proposed that learning and cognitive development occurs through two processes: assimilation and accommodation.

Before explain assimilation and accommodation, Piaget's concept of schema need to be described. Schemas are the basic components of cognitive models and enable individual to form behavior and organize the mental representation of the world. In simple terms, schemas are basic building blocks of intelligent behavior. Piaget regarded schemas as mental structure, which organize past experience and provide a way of understanding future experiences (Gross & Kinnison, 2013). Schemas are adjusted and integrated with

experience over time. For Piaget, mental processes develop refers to schemas become more numerous and complex. Assimilation refers to the process of organizing new information and adding it into an existing schema. Learners assimilate new experiences by relating them to things they already know. While when new information conflicts with one's existing way of thinking, learners does not simply reject it but modify the existing schemas. Through this process of accommodation, learners accept new knowledge or experience and create new schemas. For example, children exploring connecting schema may show an interest in joining things together or tying things up, e.g. connecting Lego. When they play with Lego to build. From previous experience the child will know which pieces to pick up first. The process is assimilation. When they are given train track pieces or puzzle, the way of connection is different from Lego. So the child learns to modify his/her existing thoughts and constructs a new schema, i.e. there are many ways to connect things. The process is accommodation. The 'connecting' schema can also lead to disconnecting, e.g. taking or pulling things apart. For digital learners, the process of learning also include these processes. In this paper, I will apply Piaget's theory in the discussion of learning on touchscreen.

Vygotsky's socio-cultural theory

Despite this paper focuses more on psychological perspective, socio-cultural perspective should be mentioned as well. Vygotsky, a Russian cognitive psychologist, believed that children's cognitive development are greatly influenced by social and cultural factor, especially by parents, teachers and peers in children's social environment. Different from Piaget who focused on individual discovery, Vygotsky focused on social and cultural influence on learning and their role in knowledge construction. Vygotsky propose the concept of Zone of Proximal Development (ZPD) (Vygotsky, 1997), which refer to a learner cannot master the task, independently, but can complete the task when their full

potential is enhanced through the support given by a more skilled person. The skilled person, called More Knowledgeable Other (MKO).

Sensory Processing/ Sensory Integration

Another theory that will be used is called Sensory Processing/ Sensory Integration (A Jean Ayres, 1972).The seven senses include sight, touch, smell, hearing, taste, vestibular and proprioception. Sensory Processing –or Integration is the process that receives, interprets and organizes information through these seven senses, and responses it in a meaningful manner. It refers to the learning process in which the brain and body coordinate with each other. In the process, one combines not only all the existing information to make it a meaningful whole, but also the past experience and memories with the immediate stimuli to have a clearer understanding of existing stimulus. And this is the basis for understanding, learning and knowing a particular action or reaction, which is essential in the physical, social-emotional, communication, and cognitive development of a child (PlayCore, n.d.) and determines the child's attention, reaction speed, speed of movement, responsiveness, emotional stability, hand-eye coordination, etc. Anna Jean Ayres initially identified the term 'Sensory Integration' in 1972. In 2006, Lucy Miller used term 'Sensory Processing', which was worked based on Ayres' theory. Nowadays, these two terms are used interchangeably. In this paper, I will apply this theory in the discussion of sensory development of children.

Methodology

In this section, I will describe the methodology. Different research methods from available literature are described and the corresponding limitations and strengths are outlined. My research question is: what are the potential impacts of young children's use of touchscreen

devices on learning and growth? In order to answer the question, a detailed literature study/review is performed, together with available data from books, research articles and papers. The following are some of the methodologies used in my reference. First is naturalistic observarion (Buckingham, 2013), which means researchers observe children how they use the media in the natural setting or environment. Second is self-report questionnaires, such as online survey (Bedford et al., 2016; Rideout, 2011, 2017). Third is structured observations, for example, testing children in the lab (Verhallen, Bus, & de Jong, 2006) and videotaping in the lab (Munzer, Miller, Weeks, Kaciroti, & Radesky, 2019). Self-report questionnaires may in some cases provide unreliable data of the target behavior (Baumgartner, Lemmens, Weeda, & Huizinga, 2017). Mc Quail (McQuail, 2010) distinguished the history of media effects research into four phases: "all-power media", "theory of powerful media put to the test", "powerful media rediscovered" and "negotiated media influence." The fourth phase, negotiated media influence, the methodology is changed from quantitative survey methods to qualitative and ethnographic research methods.

In the early years of life, children develop rapidly. Ninety percent of brain development happens by the age of 5 (Sousa, 2015). Many parents are concerning about the effects of digital devices on their child's development. Given the American Academy of Pediatrics and World Health Organization recommendation to limit young children's screen time, it is critical to find out the scientific evidence behind it. However, there still exist many limitations in this field of research. First, there probably exist ethical and methodological challenges in child research. It is difficult to find volunteers for child research and it is even more difficult for parents to cooperate. Second, long term consequences in child research can be hard to measure. Third, iPad has been around for about a decade, children who grew up around iPads and such are not yet old enough for researchers to evaluate their developmental growth and broadly generalizable longitudinal evidence is in lack. Fourth,

technology changes rapidly, the speed of research may be unable to follow the speed of technology change. Due to these limitations, further researches are needed. Despite many limitations, scientists and pediatricians are looking closely at the effect of interactive media on children, and many new researches and discoveries are published in 2019 and they suggest preliminary guidance for families. Therefore, in this paper, a brief summary of existing research and literature are given and a detailed discussion on the mentioned question is provided, depending on available theoretical framework and empirical evidence. In the following sections, I will discuss recent research in the field of motor and sensory development, learning and attention.

Literature Review and Discussion

Among young children, the use of smartphones and tablet devices has increased significantly. According to report by the nonprofit organization Common Sense Media, in 2011, 52% of children under the age of 8 had access to a mobile device (although only 38% had ever used one), while in 2017, almost all (98%) of children with this age had access to mobile devices (Rideout, 2017). The report also showed that children under 8 spend a third of all screen time on mobile devices with time spent per day varying from 5 minutes in 2011 to 48 minutes in 2017 (Rideout, 2017). About 42% children of this age have their own tablet device in 2017 (Rideout, 2017).

Mobile devices are quickly becoming the preferred media choice for children because of their mobility, broad content and interactivity (Radesky, Schumacher, & Zuckerman, 2015). For young children, the mobile device is more than a learning tool sometimes. A study has shown that parents reward or punish children's behavior by giving or taking away the mobile devices (Wartella, Rideout, Lauricella, & Connell, 2013). However, whether the digital devices will have positive or negative influences on children's development need

further consideration. A recent study published in JAMA Pediatrics found that for young children between age of 2-5, the greater screen time did predict poorer performance and impinged on children's ability to develop optimally (Madigan, Browne, Racine, Mori, & Tough, 2019). The researchers identified developmental progress in 5 domains: communication, gross motor, fine motor, problem solving, and personal-social. Nevertheless, the above research did not discuss the five domains separately in detail. In this paper, I will focus on the aspects of motor development, sensory development and cognitive development.

Socio-cultural perspective

Before I review and discuss on the psychological perspective, socio-cultural will be briefly mentioned here. For children, using digital devices seemed to be a social activity, because it often occurs in a social context, for instance, in the presence of parents or peer. Based on Vygotsky's sociocultural theory, children learn through cultural experiences and social interaction with the support of more skilled individuals. The skilled person, called More Knowledgeable Other, may be parent, a teacher or a peer, provides children "scaffolding" to learn. When children are using digital devices, they communicate and share the knowledge with peers, which can influence learning. The digital knowledge spread rapidly in the group, through the interaction with peers, children acquire and master the tools quickly. Therefore, children learn from their interaction with the environment.

The effects on motor development and sensory development

Motor skills are movements of the different muscles. Fine motor skills are smaller action

that require precisely control the small muscles, such as those in the hand and wrist. Gross motor skills are lager movements, which use the large muscles in the body such as walking and jumping.

One research has shown that tablet has many benefits in children's early year (Crescenzi, Jewitt, & Price, 2014). For example, children use wider range of types of touch such as press, circular, stroke and tap, which include more complex sequences of touch. Furthermore, due to the limitless in length and size of iPad, children create more and longer continuous touch sequences (Crescenzi et al., 2014). This is important in the development of children's mark making in the generating of higher quantity and quality of pre-drawing behavior. (Dunst & Gorman, 2009) Generally, iPad promotes more touch skills on screen interaction. On the touchscreen, children pointing and moving by fingers, to fit different type of pieces. The study published in Frontiers in Psychology has shown that touchscreen is beneficial in developing fine motor control in toddlers (Bedford et al., 2016). Dr Tim J Smith of Birkbeck University of London, gathered data from 715 families with children from 6 to 36 months, showing that child first actively scrolling a touchscreen was positively correlates with the age that they were first able to stack blocks, a measure of fine motor control (Bedford et al., 2016). The research was not for preschoolers, but it is speculated that this situation would also apply to preschoolers. However, when using iPad, the quantity and range of fingers used is restricted and the range of qualities of touch used, for example differences in pressure, is limited (Crescenzi et al., 2014) In addition, due to too much manipulation on the screen, several sensory features of touch are lost. If children play without touchscreen, they could have more experience with tactility, texture, shape and weight of different things.

But despite the potential benefit on fine motor skill by using touch screen devices, children may miss opportunities to explore the world around them and practice gross motor skills- such as walking, running and climbing (Madigan et al., 2019). World Health Organization

(WHO) has issued new guidelines that children under 5 must have more active play instead of watching screens if they want to grow up healthy (WHO, 2019). Preschoolers should engage in physical activity at least 60 minutes per day (Gunner, Atkinson, Nichols, & Eissa, 2005). There are some activity-based apps, such as Pokémon Go, encouraging children to go outside and increase movement so to develop gross motor skills. And there are also more exercise-related apps, such as NFL Play 60, Big Cat Race and my little yoga which encourage children to run, jump and play with the whole body movement.

Screens provide a very limited sensory experience, thus, some essential sensory development will be deprived. Vestibular sensation, proprioceptive sensation, and tactile sensation are called the "power sensations" and they are the foundation for sensory integration and sensory processing skills (Voss, n.d.).The sensory deprivation leads to poor development and problems with sensory integration (A Jean Ayres & Robbins, 2005). Sensory integration is essential for young children's learning, as children recognize and know about the world by senses. Their senses receive stimuli and establish connections between neurons in the brain. The more sensory stimulation children have, the stronger the neural connection to be used. With the stronger neuron connection, children will have better learning capabilities in the future. Sensory development and motor development are inseparable and affect each other. For example, a child who is lack of vestibular sensation will have poor motor skills and easy to lose his/her balance, while adequate gross motor training can strengthen balance ability and develop vestibular sensation. Therefore, it is important to balance the time in touchscreen play and sensory play. It is possible to enhance children's sensory experiences through sensory-rich outdoor play environment that combining the seven senses as an integrated system into the whole environment can also provide more opportunities for children to seek sensory input (PlayCore, n.d.) and develop motor skills.

The effect on cognitive development

When children use touchscreen devices, they use different cognitive skills, including attention, memory, comprehension, spatial cognition, etc. (Lerner, Liben, & Mueller, 2015). Here I focus my review primarily on the influence of touchscreen devices on young children's learning and attention.

Learning on touchscreen

It is an important issue that new digital devices may affect children's learning and influence patterns of parent-child interactions. According to Piaget's theory, children's cognitive development is through two processes: assimilation and accommodation. Children would modify or add existing schemas as new information or experiences occur. On the iPad, children mostly build experience with the game, while life experiences are difficult to be obtained from the electronic products. For example, a primitive child in the cave saw the fire and felt fun, then he reached out, as a result, he burnt his finger and he cried. He may impress with the red-hot thing in his life and will not touch it again. The modern child pokes the flame on iPad and a word "hot" pops out, and the child thinks it is fun. It seems that children learn new knowledge, but actually, it does not help children learn about the concept of fire. In this example, lack of sensation of heat leads to incomplete schema construction and cognitive development might be delay. Young children, especially babies, can not transfer what they learn from the iPad to the real world (Chassiakos, Radesky, Christakis, Moreno, & Cross, 2016). For example, if a child build virtual blocks on an app, and then put real blocks in front of them, they start all over. On the other side, good context is also critical. Quality apps or games foster children's cognitive skills. For example, Angry Bird trains children on their hand-eye coordination and Where's My Water teach them complex physics. Children's imagination, creativity are inspired by good apps and games.

Digital screens can also disturb interactions with caregivers by limiting opportunities for verbal and nonverbal social exchanges (Madigan et al., 2019), which are important for

young children's growth and development. It is normal to use iPad to tell stories to children. For young children, books on iPad are more attractive, due to interactive feature of electronic books help young children more engaged with reading (Chiong, Ree, Takeuchi, & Erickson, 2012) and animation tied to storyline is beneficial for children who struggle with language and reading comprehension (Verhallen et al., 2006). A research has also suggested that stories on multimedia with animated illustrations, background music and sound effects provide similar scaffolding as an adult for children's literacy experiences (Takacs, Swart, & Bus, 2014). But when children watch or listen to stories alone, they miss interaction with parents. Parents can integrate digital devices into family time, for example, read with children together on digital media. And then children have chance to interact with parents and have more motivation to imagine the complete pictures and follow the story line. While a new study recommends print books over electronic books due to children have less questions and comments when reading electronic books and some parents had to focus more on the technology problems such as reminding children not to push buttons (Munzer et al., 2019). Additionally, based on Piaget's theory, we know that learners construct new knowledge by making connection between new knowledge or experience and existing knowledge, and Piaget called these process assimilation and accommodation. Along the way, since today's young children grow up in a digital environment, with the sustained exposure to digital devices, they have more experience and schema with technology and their brains are reorganizing to handle the digital environment more effectively (Kelly, McCain, & Jukes, 2008). These technologies affect the way they think and sometimes they think differently with adults (Kelly et al., 2008). For example, they prefer processing sounds, pictures and videos before text (Kelly et al., 2008). Thus, reading with iPad seems appropriate for young children. As Dr. Dimitri Christakis points out that parents use apps with children create an opportunity for "joint attention"-- the interaction between a child and a caregiver, which is important to brain development (STAFF, 2014). Thus, from my point of view, iPad can be used as a learning tool that connect the

relationship between children and parents.

Over-stimulation and ADHD

Digital technology becomes more prevalent, faster and stimulating and provide high frequency information stimulation accessible all day (Ra et al., 2018). The child's brain may be accustomed to high-intensity visual and auditory stimulation, which causes over-stimulation (Napier, 2014). Thus, over-stimulation could easily be triggered by prolonged using of touch screen devices. Over-stimulate the young child's developing brain, making them hard to adapt to the slow pace of the real world, and the child may find the realities of the world underwhelming and under-stimulating (Klass, 2011). Ultimately, without the equal or higher intensity of stimulations, the children cannot concentrate and easy to distract. Their brains are getting harder and harder to be satisfied and expect higher levels of stimulation and input. As a result, children are likely unable to adapt to low stimulation things and calm environment, such as reading a book quietly or having a peaceful sleep. When this happens, from my point of view, parents should create quiet and calm environment and encourage children to do the low stimulation things in order to slow down their brain activity.

There is a concern that mobile technology leads to the attentional difficulties, most specifically Attention Deficit Hyperactivity Disorder (ADHD). Attention Deficit Hyperactivity Disorder is a mental disorder that makes it difficult for people to pay attention on one thing for even small period and control impulsive behaviors. According to a new research, for teens, excessive screen time on digital media is a risk factor to ADHD symptoms in the future (Ra et al., 2018). This conclusion is not for young children. While too much screen time may cause symptoms that are similar to ADHD, even though they cannot cause ADHD itself, says Michael Manos, Ph.D., Head of the ADHD Center for Evaluation & Treatment at Cleveland Clinic (Healthessentials, 2018). He explains that

ADHD has genetic characteristics and children with ADHD are hyperactive and have impulsive behaviors involving physical changes in the brain. The problem is not digital media in itself, but that it requires over demanded on a one's attention. The symptoms for ADHD and digital overload are quite similar which leads us to believe that digital overload may be one of the reasons for increased hyperactivity (Agrawal, Sahana, & De, 2017). Dr. Dimitri Christakis commented on the above research that even without a clinical diagnosis of ADHD, shorter attention span is bad and is a cardinal feature of ADHD (Howard, 2018). With the constant digital media use, the habit of seeking more interesting and more stimulating things is created due to they are always available and that causes distractibility, he said, "The biggest problem children with ADHD have is, they're easily distracted (Howard, 2018)." Therefore, in my opinion, digital overload may cause over-stimultaion and may be also a potential threat to young childre's attention.

Multitasking and attention

People often multitask with multi-windows or different touchscreen in daily life and digital distraction often happens. The phenomenon that performing more than one task at the same time is common, which is referred to as multitasking. Digital kids prefer parallel processing and multitasking (Kelly et al., 2008). Even infants and toddlers interrupt their play with frequent glances to a background television program as elements of the content draw their attention. About 23% of children aged 5 to 8 often or usually engage in media multitasking (Rideout, 2011), which means using more than one media technology simultaneously, often via a smartphone (Wilmer, Sherman, & Chein, 2017). For adults, multitasking often happens in the modern workplace. Multitasking is sometimes important, for example, one is proficient at two tasks and shift attention quickly between the tasks while at work, but many researchers suggest that those who multitask frequently perform poorly (Ophir, Nass, & Wagner, 2009). Can young children multitask and what impacts does multitasking have on them?

Effective multitasking need enough cognitive resources, such as the ability to control and deploy attention, especially executive functions such as working memory, response inhibition, flexible task and metacognition. (Courage, Bakhtiar, Fitzpatrick, Kenny, & Brandeau, 2015) However, multitasking is seen to be at risk for young children, whose cognitive skills and executive functions are immature (Courage et al., 2015). In fact, researchers at Cornell claimed that when children perform many tasks at once, their brains tend to respond to stimuli and make quick decisions so that they have fewer mental resources for comprehension and memory (Walsh, 2011).

On the other hand, multitasking skills is said to be another characteristic of the digital learners (Prensky, 2001). Digital natives try to perform many tasks at one time and are used to receiving information really quickly (Prensky, 2001). A 20-year study by Jay Giedd, has shown that younger people are better at multi-tasking than older people (Snyderman & Williams, 2011), and they are more creative, though such kind of study on preschoolers is lack. In fact, the brain is constantly switching between different tasks. Multitasking can even seem effortless, such as walking and chewing gum, because one of the behaviors do not require special attention. While during the past few decades, the multitasking phenomenon increased considerably due to the exposure of new digital technology. Both adults and children are easily immersed in digital world. Adults are easily distracted by digital devices, such as checking email or message frequently, not to mention the implication on children. Habitual multitasking may decrease child's ability and will to maintain concentration on one task (Wallis, 2006) and slow down or interrupt what they are doing. For instance, a large number of sound and light stimulation on the digital screen easily draw on child's attention, he/ she may put down what they are currently doing, but play tablet, this is called self-interruption. Self-interruption is removing one's attention from what you are currently doing and putting it somewhere

else. and self-interruption is a driver of multitasking behavior (Dabbish, Mark, & González, 2011). Young child's ability of self-control are not fully developed yet, and needs to be cultivated, while the child's habitual self-interruption will hinder the development of self-control and insufficient self-control leads to self-interruption, which form a vicious cycle. Today's generation of children are developing increasingly shorter attention spans because of their excessive contact with smartphone technology, and beginning at younger ages (Nikken & Schols, 2015). In addition, younger children are not equally capable of handling multiple tasks as older children. Attention is a limited mental resource that fuels cognitive activity, for young children, multitask demands exceed their mental resource. Thus, the ability to handle several tasks simultaneously is not necessary for the child. Comparing to the digital screen, young children can concentrate better on books.

Besides that, the inclusion of advertisements in the children's apps will also lead to distraction. Jenny Radesky, expert from University of Michigan found that the apps were regularly interrupted by popup video ads and overt banner ads, which could distract, mislead and be inappropriate for younger children (Piazza, 2019). Alerts, notifications and advertisements draw on children's attention immediately, leading to children's weaker ability to control attention.

Conclusion

Above reviews and discussions show that, touchscreen devices have potential impacts on young children's development. One is direct impact, for example, fine motor skills can be practiced, learning pattern is changing, over-stimulation and multitasking may result in poor concentrate. The other is missed opportunities, for example, when children spend more time on touch screen, the gross motor development and sensory experience are in

lack and interaction between parent and children may be disrupted. Most of the impacts occur by excessive screen time, thus, moderation is the key. Most recently, the World Health Organization suggests that children under one year old screen time is not recommended, children aged under 2 screen time should be very rarely, and for children under 5 years old, sedentary screen time should be less than 1 hour per day (WHO, 2019). Besides time limits, the content and accompany of the caregivers are also critically important. In my view, children can expand their knowledge and enhance their cognitive abilities by apps with age-appropriate and educationally valuable content and parent can explore the digital world with their children and allow children to participate other development-friendly activities.

Today's young children are adapting rapidly to this new technology and these children look set to use these devices throughout their lives. It is impractical to isolated children from screen. To discourage all screen use is almost a way of 'parent shaming' (LEE, 2015). Piaget propose that "The principle goal of education is to create men and women who are capable of doing new things, not simply of repeating what other generations have done. (Duckworth, 1964)" We need to admit that the world as seen by digital generation today is different from that older generation grew up in. Young children need caregivers' guidance to establish healthy childhood media habits from early childhood and try to find a balance between the touchscreen use and real world interaction and activities.

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