4-2017

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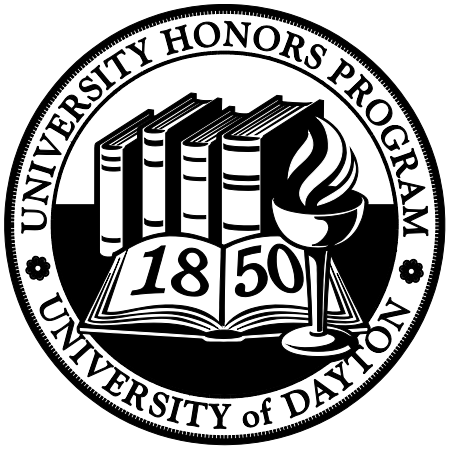

Honors Thesis

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Department: Psychology

Advisor: Mary Wagner Fuhs, Ph.D.

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Abstract

The ability to attend to relevant information and resist attention to distractors is important for children's cognitive development. Much has been written in the news about the impact of electronic media on children's development of attention skills, but little research has been done explicitly comparing children's attention to relevant information and resistance to distractions across activities that are presented as either a computerized or tactile learning game. The goal of this study is to compare levels of attention and distraction among preschool-aged children while they engage in a common childhood activity, playing a board game that is either presented in a computerized or tactile format. Children's basic comprehension of the game across conditions was also compared. Participants consisted of twelve families (N=12), each including one parent and one preschooler (Age 3-6). Participants were randomly assigned to either the computerized or tactile condition. The Linear Numbers Board Game (Siegler & Ramani, 2009), which has shown to be helpful in teaching children about the number line, was used as the task. Children's attention, distraction, and understanding were coded to determine how computerized and tactile games affect these skills. Results suggested that older children attended more to the game regardless of the condition and also made fewer errors. However, children paid more attention and were less distracted in the tactile version of the game, but also had a harder time understanding the tactile version of the game.

Dedication or Acknowledgements

Special thanks to my advisor, Dr. Mary Fuhs, for the constant guidance throughout the development of this thesis, as well as the Psychology Department and Honors Program here at the University of Dayton for providing the support and resources to make this thesis possible.

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Introduction

The millennial generation is part of the ongoing research debate about the pros and cons of learning with computers versus tactile manipulatives. The implications of this debate are crucial to discover because early childhood is a significant time for cognitive development. Cognitive abilities associated with memory, reasoning, problem solving, and thinking all grow and emerge throughout childhood (Cherry, 2016). Additionally, children's early literacy skills, consisting of oral language, phonological processing, and print knowledge, as well as early numeracy skills, such as numbering and numerical relations, all develop during this time (Purpura, Hume, Sims, & Lonigan, 2011). It is highly beneficial for these skills to develop typically, as executive function regulatory skills during preschool years are associated with cognitive and behavioral skills predictive of both school readiness and later academic achievement (Blair & Razza, 2007). Specific educational games can have benefits on these processes for preschoolers', such as how playing linear number board games improves preschoolers' numerical skills (Ramani & Siegler, 2008; Whyte & Bull, 2008).

The past several years have brought about a serious debate among parents, teachers, and psychologists on the pros and cons of electronics and media consumption, particularly in the context of child development. Computers have slowly evolved into objects of everyday use, even in the lives of children. On a typical day, 27% of 5-6 year olds spend fifty minutes on average using a computer (Vandewater et al. 2007). Even touch screen tablets seem to have infiltrated the lives of children. Over 80,000 apps in the Apple App Store are learning and education based, and the preschool and toddler categories accounts for 72% of paid apps in the Apple App Store (Apple, 2015; Shuler,

2012). Furthermore, 58% of parents in the United States have reported to downloading apps for their children to use (Common Sense Media, 2013). Over the past few years, the number of children under the age of eight who used a device at least once a day increased by more than double from 8% to 17% (Back to School 2014). While a majority of these apps are certainly not backed by research, this may be beneficial for preschoolers in some ways because certain computerized math games, such as Number Race, have been shown to improve preschoolers' and kindergarteners' number senses (Wilson, Dehaene, Dubois, & Fayol, 2009).

Negative research on electronics suggests that certain factors important for children's cognitive development, specifically the ability to attend to relevant information and resist attention to distracters, may be impacted by many types of electronic media. For instance, television shows can also have an immediate negative effect on children's executive functioning skills (Lillard & Peterson, 2011). These negative impacts are important to be aware of because young children's attention span is an important predictor of school readiness, and difficulties with attention can impede memory development and impact learning (Welsh, Nix, Blair, Bierman, & Nelson, 2010; Darby & Sloutsky, 2015). Furthermore, while the impact on younger children is less researched, other studies have been quick to document the negative effects of electronics in adolescents, such as how electronic media use is positively correlated with difficulty sleeping and negatively correlated with sleep duration, all of which can relate to depressive symptoms as adolescents are developing (Lemola, Perkinson-Gloor, Brand, Dewald-Kaufmann, & Grob, 2015).

However, while negative impacts exist for both television and computer devices, some studies suggest that computers may have some potential benefits. Specifically, a study comparing television, computer use, and reading to neurocognition found that TV watching was negatively related to neurocognition, but computer use and reading was positively related to neurocognition in younger children (Rosenqvist, Lahti-Nuuttila, Holdnack, Kemp, & Laasonen, 2016). Additionally, media use has possible benefits even outside of learning and educational aspects, such as facilitating the development of self-regulation of arousal in children and allowing them to experiment with aggression in a safe consequence-free place (Salonius-Pasternak & Gelfond, 2005). Furthermore, certain electronic applications may be beneficial in helping younger children learn literacy and vocabulary skills (Chiong & Shuler, 2010).

Little research has been done explicitly comparing children's attention to relevant information and resistance to distractions across activities that are presented in either tactile or computerized format. A study by Schmidt and Vandewater indicates that interactive websites appear to have many benefits for learning, such as improved visual spatial skills, but there is little empirical evidence to show media is more effective for learning as opposed to other types of instruction (2008). Understanding which is more effective at keeping a child's attention and which is more effective at reducing distraction is an important tool that parents and teachers alike may utilize in educational settings to promote the richest learning environment for their children as possible. Additionally, the degree to which children understand the task at hand on a computer compared to a tactile board game is equally as important because early comprehension of the social and physical world is one of the strongest predictors of later reading and science success

(Grissmer, Grimm, Aiyer, Murrah, & Steele, 2010). A study by Takacs, Swart, and Bus suggests that certain features of technology may be beneficial for learning, but not others. Multimedia aspects, such as music and sounds, were shown to be beneficial on young children's story comprehension, but interactive aspects consisting of games were not (2015).

Current Study

The goal of this study is to compare levels of attention and distraction among preschool-aged children while they engage in a common childhood activity, playing a board game, as a pilot study. It is important to know how electronics may facilitate or inhibit cognitive skills in young children. Understanding the cognitive effects of using computerized versus tactile manipulatives to learn is particularly important for preschool-aged children, as they develop many important cognitive and social skills necessary for school readiness during this time. Therefore, understanding which types of learning activities (computerized or tactile) are more effective at keeping a child's attention, and which are more effective at reducing distraction, is important because these results will inform parents and teachers alike about different ways to enhance attention in educational settings to promote the richest learning environment for their children as possible. Additionally, the degree to which children comprehend the task at hand using a computerized version compared to a tactile version is equally as important. While some research suggests that electronics have a negative effect on standard attention, it may actually improve visual attention, or the ability to process more visual cues at once (Swing, 2013). Additionally, motion seems to attract young children's attention in storybooks (Takacs & Bus, 2016). Having the animated motion of the game pieces in the

computerized version may capture more of the children's attention than in the tactile version of the board game. Therefore, I hypothesize that children's attention would be greater and distraction would be lower when they play the computerized game. Furthermore, children learn the best when they use their dominant senses, seeing, hearing and touching (Walker-Tileston, 2004 in Hall & Higgins, 2005). Using the board game pieces and the game itself may serve as an interactive way to boost understanding that the computerized version cannot provide. Therefore, I hypothesize that children would have a greater understanding of the game when it is a tactile board game.

Method

Participants

Participants were recruited by attending Preschool Story Time programs at Dayton Public Libraries. Participants consisted of 12 families, including one parent and one preschooler (*M* age= 4 years, 11 months; 7 girls, 5 boys).

Measures

Linear Numbers Board Game (Siegler & Ramani, 2009). Preschoolers were asked to play the Linear Numbers Board Game with their parent. The game was a simple number line consisting of numbers 1-10. The goal of the game was for the preschooler to have his or her token piece reach the end of the number line. They were told to spin a wheel that either landed on a number 1 or a number 2. If it landed on a number one, they moved their token piece one space on the number line. If they landed on a two, they moved their token piece two spaces on the number line. Each time they landed on a new number they had to state the number out loud, until they reached number 10. Parents were only asked to help their child once they had answered by themselves.

Procedure

Each preschooler was randomly assigned to either the tactile or the computerized version of the game. After random assignment, 7 participants were placed in the tactile condition, and 5 were placed in the computerized condition. A video camera was set up to record each of the family's game play in order to later code for attention, distraction, and comprehension. Attention was coded for by measuring how long it took each child to look away from the game, if at all. Distraction was measured by how many times each child looked away from the game. Comprehension was measured by counting the number of errors each child made stating the numbers during game play.

Results

Descriptive Statistics

Attention, distraction, and comprehension were measured across both the tactile and computerized conditions. Across both conditions, children attended on average 72.3% of the time (*SD* = 29%). On average children looked away 1.25 times per game (*SD* = 1.36). Children made about errors on about 21.4% of moves during game play (*SD* = 35%).

Correlations

Overall, older children performed better on all outcomes measured, even though only significantly in one category. Age did not correlate significantly with percent attended ($r = .152$, $p = .638$) or with the number of times looked away ($r = -.498$, $p = .099$), but did correlate significantly with percent errors ($r = -.627$, $p = .029$).

Analyses

Levels of attention, distraction, and comprehension were then compared across both conditions after controlling for age (see Table 1). Results are then represented in figure 1 and figure 2.

Table 1

Levels of Attention, Distraction, and Comprehension Across Conditions

Variables	Mean	Std. Error	95% CI
Percent Attended			
Condition 1	.752[a]	.117	.488, 1.017
Condition 2	.682[a]	.138	.369, .995
Percent of Errors			
Condition 1	.309[a]	.102	.078, .540
Condition 2	.080[a]	.121	-.193, .354
Times Looked Away			
Condition 1	.968[a]	.470	-.095, 2.032
Condition 2	1.644[a]	.556	.386, 2.902

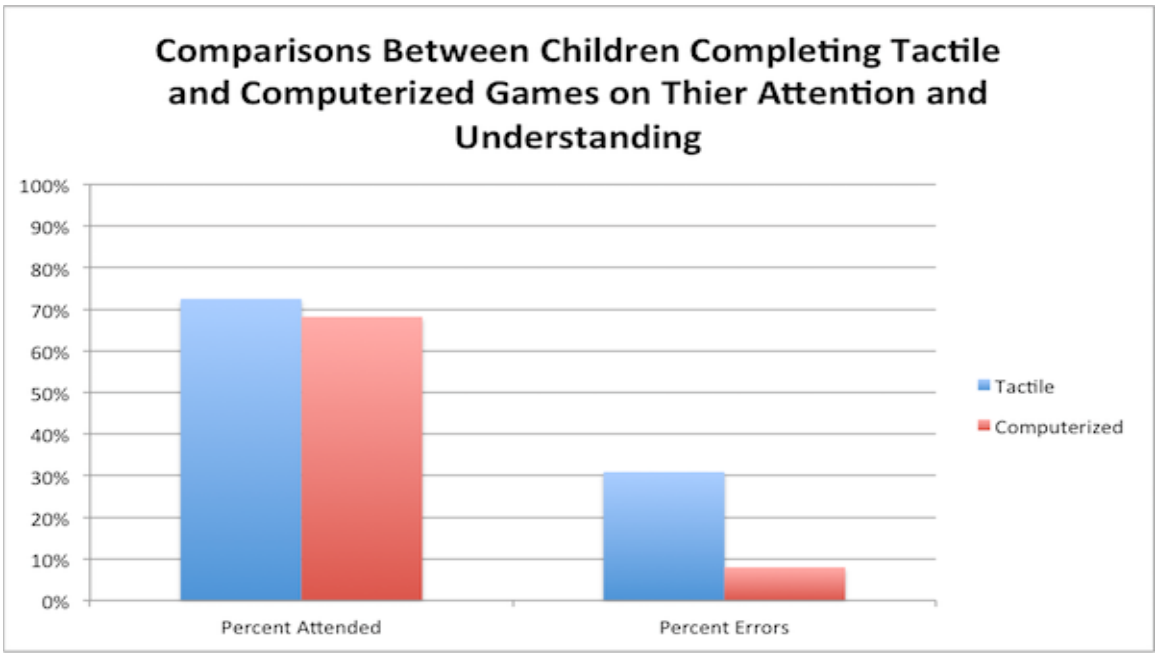

Figure 1. Attention and understanding is compared between the tactile and computerized conditions and represented as the mean percentage of attendance across conditions, and the mean percentage of errors across conditions.

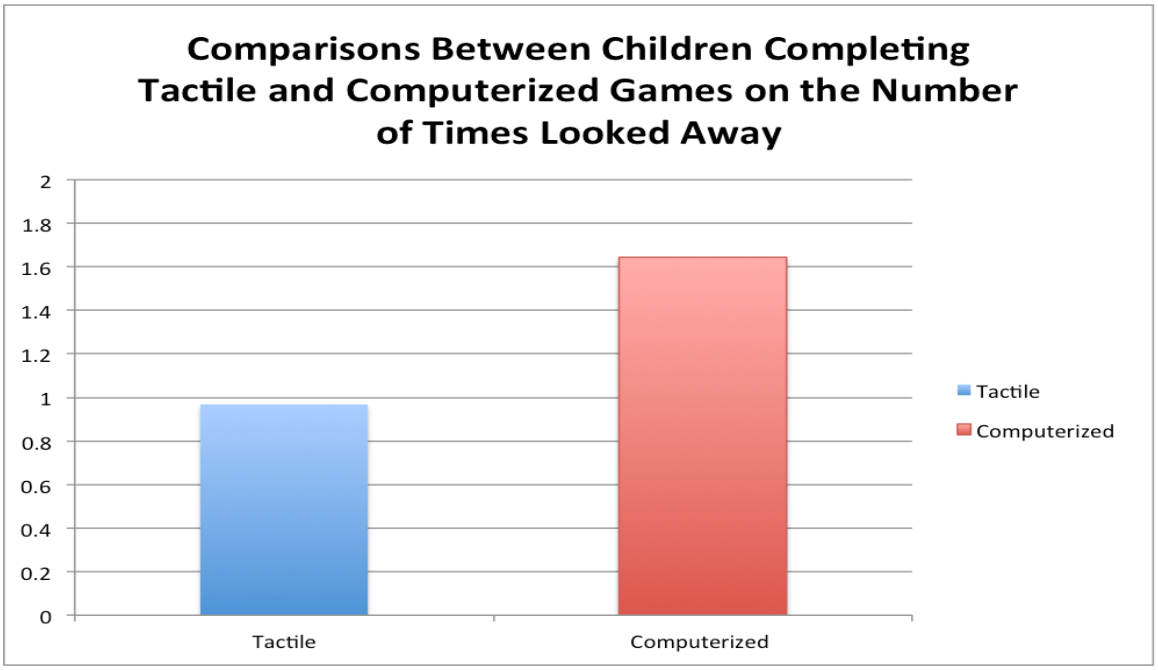

Figure 2. The mean number of times children looked away from the game is compared between the tactile and computerized conditions.

Discussion

Preschoolers' aged 3-6 were assessed based on their attention, distraction, and comprehension levels while engaged in the Linear Numbers Board Game (Siegler & Ramani, 2009). Overall, older children attended more to the game regardless of the condition and also made fewer errors, coinciding with research that suggests that certain executive functioning skills develop rapidly during early childhood, and are therefore more likely to be further developed in the group of 6 year olds compared to the younger 3 year olds (Anderson, 2002).

Concerning levels of attention and distraction, children paid more attention and were less distracted while playing the tactile version of the game compared to the computerized version of the game, while not significantly. This result was contrary to the original hypothesis in which the children's attention will be greater and distractions will be fewer while playing the computerized game. While this did not follow the original hypothesis, one potential explanation may lay in a study by Turoman, Merkley, Scerif, and Matusz (2017). These researchers focused on distractors in both children and adults and found that for all ages, when a task is difficult children and adults do not get distracted. Rather when performing an easier task, less attention is used on the task and therefore is more likely to be diverted to potential distractions. Furthermore, Vygotsky, one of the first influential psychologists in child development, suggested a theory called the "Zone of Proximal Development", that describes the distance between what a child is capable of doing on their own, and what they have the potential to do with assistance from an adult (Vygotsky, 1978). Vygotsky believed that providing assistance when a child is the ZPD will give them enough of a boost to achieve the task, and then do so

successfully by themselves (McLeod, 2012). The term for this concept is known by many in research as “scaffolding”. This may be an additional explanation for the results because it was further observed that children had a harder time comprehending the tactile version of the game compared to the computerized version of the game, even though insignificantly. Due to the fact that the preschoolers in this study seemed to comprehend the task more easily in the computerized game, there may have been more room for distractions. Additionally, perhaps while this task was challenging and left less room for distractions, it may have been too challenging and surpassed preschooler’s zone of proximal development, in that they needed more scaffolding to successfully complete the task.

This second result also contradicts the secondary hypothesis, which stated that children would have a greater comprehension and understanding of the game as a tactile board game. However, a study by Cameron et al. in 2012 may have a potential explanation for this result. Cameron et al. states that the development of executive functioning skills are linked with motor skills, in that tasks that require more complex motor skills appear to strain cognitive resources in young children (2012). The added component of physically moving the board game pieces in the tactile version of the game may have left more room for children to make errors. This hypothesis may be looked into in future studies researching similar topics.

Implications

While the results of this study were mainly non-significant, this study and future studies on similar research have many practical implications. For instance, studies demonstrate that regardless of the format, learning games help preschoolers’ develop

executive functioning skills and predict school readiness (Blair & Razza, 2007; Ramani & Siegler, 2008). This is additionally important because little attention is given to math in general during preschool, either by parents or teachers, even though these games could help children develop early numeracy skills and the other benefits listed above (Siegler and Ramani, 2009).

The results of this study suggest that preschoolers both pay more attention and are less distracted when playing the tactile board game, but also seem to have a harder time comprehending the game. Playing games that are slightly more difficult may lead to the scaffolding effect, suggesting that tactile games may in fact be more beneficial for preschoolers' learning than the computerized version of games. However, many of the implications of using learning games as tactile or computerized formats still remain uncertain.

Limitations

At least three limitations to this study must be addressed. First, the sample size for this study, despite its status as a pilot study, was very small. Had the sample size been larger, more significant results may have been observed. Additionally, a larger sample size would increase reliability and reduce the possibility of the results occurring from chance.

Secondly, this study specifically focused on attention, distraction, and comprehension, several important factors of executive functioning skills developing in preschoolers. However, this study did not address any other factors associated with executive functioning skills that would have an impact on the effectiveness of either tactile or computerized learning games. Therefore, the results presented in this study

could have been a result of other factors not taken into account in this particular experiment.

The third limitation was a result of the application of the Linear Numbers Board Game. Firstly, younger children seemed to struggle with identifying numbers as they were presented on a number line, even though most were able to count to ten by themselves. Additionally, the younger children in general seemed to have a harder time operating a laptop computer in order to play the computerized version of the game. This may be because younger children have more experience using touch-screen electronics, making the operation of the laptop more difficult. While this limitation did not skew the results significantly, it should be addressed in future studies.

Future Directions

This study leaves several directions for future research as well. More research is needed on this topic as a whole within the field, and future researchers would benefit from conducting a similar study with a larger sample size. Additionally, it would be highly beneficial to compare how tactile versus computerized manipulatives affect other skills, such as working memory, attention shifting, and emotion regulation, compared to the attention, distraction, and comprehension examined in this study. Finally, it is critical to examine how these effects impact children not only during game play, but also by analyzing the long-term effects of electronic learning versus tactile learning. The findings presented in this study call attention to these future directions in research by highlighting the need for more empirical data in this area.

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