Mapping and Retention in Children Who Learn Through Physical Objects versus a Tablet

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Abstract

Children can expand their vocabulary through a variety of modes, such as face-to-face instruction and hands on teaching. Recently, technology has become a more prevalent way for young children to learn. As technology becomes more widespread, it has become more common for children to be introduced to technology at a young age. It is now a topic of debate if this technology should be used as a learning device, specifically if technology is an effective means for word learning. Our study investigates learning novel words and retention through physical objects compared to through a tablet. We hypothesized that the children who learn through a tablet will learn and retain the novel words less than the children who learn through physical objects. Independent samples t-tests were used to compare average accuracy between conditions (real objects vs. tablet) in each of the tasks. The results of this study displayed no significance difference for most of the word learning trials used in the study, the children were able to retain the new information with physical objects as well as with the tablet. However, when the objects were named in front of the child repeatedly and the child was then asked to choose the object by name later, it was found that the children that were shown the objects on the tablet retained the new information significantly better compared to the children shown the objects physically. It can be concluded from this that interactions with physical objects can be beneficial for a child's learning, but that tablet learning can also be a valuable way for a child to learn.

Introduction

When children begin the process of word learning, multiple steps are required in order for the new pair to become ingrained into the child's vocabulary. In order for a child to learn a single unfamiliar word from a single sentence the child must first parse that word away from the other words within the sentence. Following encoding of the word form, the child has to link this new word to an unfamiliar object within the scene in front of them. This fast mapping step in which a link is formed between the word and the object is believed to be followed by a period of slow mapping (Carey, 2010). Finally, the child must store the word-object pair for later use (Horst & Samuelson, 2008). This process involves many cognitive pathways throughout the brain of the child (Carey, 2010). During the slow mapping stage, the child can enhance the connection between the novel word and novel object made during fast mapping (Carey, 2010). Slow mapping therefore helps the child retain the new knowledge and use the new word for communication later.

To better understand this word learning process, researchers have conducted studies to test this mapping and retention within children in a laboratory setting (Horst & Samuelson, 2008; Kucker &Samuelson, 2012). Horst and Samuelson (2008) explored the process that occurs when the connection is made between the novel word and object, and how well this word-object mapping is retained. Within this study, 24-month-old children were given multiple novel names during a selection test, known as referent selection, with both familiar and novel objects. The retention of the children was then tested after a 5-minute delay. Horst and Samuelson (2008) determined that the children performed well during the referent selection, but performed poorly during the retention tests. With these results, they suggest that fast mapping is not the same learning process as retention. Kucker and Samuelson (2012) also examined fast mapping and retention within children. In contrast to Horst and Samuelson (2008), children were allowed time to physically interact and explore the toys. The results of this study found that the children were able to retain the unfamiliar fast mapping words after the delay when familiarized with novel objects. Retention was at chance when children were familiarized with novel words. Kucker and Samuelson (2012) allowed half of the infants performing the task to become familiarized with the novel objects and allowed to explore the objects freely. The other infants were familiarized with the novel name as the names were said aloud to the infants repeatedly. Following the referent section, the infant's retention of the new word-object pairs was assessed. Kucker and Samuelson (2012) discovered that the infants were able to retain the new pair when familiarized with the novel objects versus when familiarized with the novel word. This study concluded that while further research is needed to determine the precise mechanism of the word learning process of infants, exposure before fast mapping can influence the learning process after the link is made. The data from this study is the inspiration for our current study.

Taken together, the prior work suggests that children can learn better through hands-on, interactive methods compared to less physical methods. This suggests that the modality by which children are exposed to information may change learning. One modality that is vastly less physical is technology. Recently, technology has become an important mode for children to learn and explore using a different medium. Some recent work has begun to compare the process of learning novel words through face-to-face methods versus technological approaches, specifically when learning through video interaction. Roseberry et al. (2014) worked to determine if learning conditions influenced the child's ability to learn new words. This study tested three conditions: live interaction, video interaction, and pre-recorded interaction with children from 24- to 30-months-old. In each condition, the child would hear a phrase with a novel word. Depending on the condition, the child would either hear this phrase through a screen (video and pre-recorded) or through an experimenter (Roseberry et al., 2014). The results of this study displayed no significant difference between the live and video interaction. However, the children who watched the prerecorded video did not retain any of the unfamiliar words. Roseberry et al. (2014) concluded that these results support the idea that contingent, live interaction is necessary for learning. Krcmar, Grela and Lin (2007) investigated if children could learn vocabulary through fast mapping from television programs. The conditions tested within this study included: a presentation by an adult when the child was attending, a presentation by an adult when the child was not attending, an adult presenting through a television, and a clip from a television program (Krcmar et al., 2007). The children demonstrated the greatest retention when learning through the adult presentation. The results also demonstrated that the children were less successful when learning through the television program. Krcmar et al. (2007) concluded that the higher attention the children paid to the adult speaker increased the amount of learning yet higher attention to the television program was not as beneficial. In other words, real-life interactions are important for learning.

There are few studies that have considered the effectiveness of touch-screen devices on the learning process versus face-to-face learning. Kwok et al. (2016) investigated the rate of learning of children, ages 4 through 8, during physical instruction and during learning through an interactive device. During the first phase of this study, the Learning Phase, the children were taught novel facts about animals through either an experimenter or a pre-recorded voiced cartoon (Kwok et al., 2016). During the Testing Phase of this study, the retention of the children was tested. The results of this study suggests that using an interactive device for learning can be as effective as learning through face-to-face instruction within this age group (Kwok et al., 2016).

Frank et al. (2016) examined the efficacy of learning through three different techniques: a tablet, eye tracking, and a face-to-face storybook model. This data was collected with children ages 1 through 4. This study examined the reaction time and accuracy of the children's selection when performing simple retention tests with the three different techniques. The results displayed that for both reaction time and accuracy the tablet results were higher than the reaction time and accuracy of the other two techniques (Frank et al., 2016). Frank et al. (2016) suggest that the tablet should be considered as a method for learning. Taken together, both Kwok et al. (2016) and Frank et al. (2016) suggest that it is possible to learn through technology (i.e. without physical engagement). However, the studies by Krcmar et al (2007) and Roseberry et al. (2014) suggests learning with physical interactions are more beneficial. Thus, the results are mixed as to which modalities benefit word learning best.

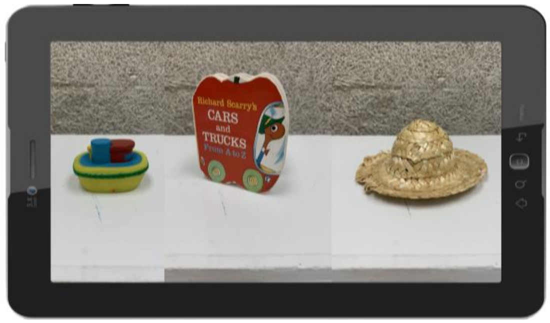
The current study aims to add to this literature and investigate learning novel words with physical objects compared to learning these novel words on a tablet. Previous research (Kucker & Samuelson, 2012) discovered that children better learn and retain novel words when given physical objects and allowed to physically engage with them. The goal of the current study is to replicate this study with a tablet, which lacks physical engagement. Based on the idea that physical interaction can enhance the word learning ability, we predict that retention and mapping will be lowered in children who learn through the tablet trials compared to the children in the prior study (Kucker & Samuelson, 2012) who learn with physical objects. We hypothesize that learning through the tablet will hinder the child's ability to retain the newly taught words. These results explore whether tablet learning is beneficial and how it relates to word learning with physical objects. Ultimately, this study may have important implications for the use of technology as a mode of learning and if it is as effective as using physical objects.

Method

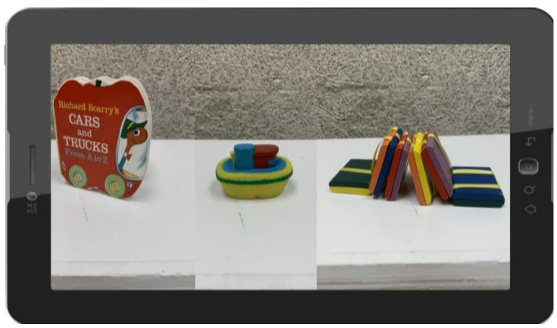
Participants

For the current study, two samples of children were recruited to participate in either a tablet condition or real-object condition. For the tablet condition, 16 children between the age of 17 to 26 months (M =22.19, SD = 3.04), participated in two separate word learning tasks via a tablet. 63% of the children were female. The data were drawn from a larger sample of children from another study (Kucker and Samuelson, 2012). Children recruited for the real-object condition were the same ages and demographics.

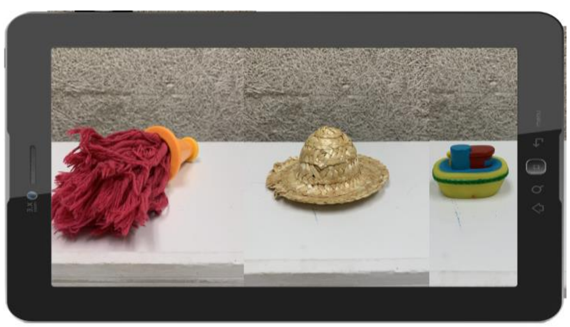
Warm up: "Can you point to the *hat*?"



Referent Section: "Can you point to the *book*?"



"Can you point to the *zup*?"



"Can you point to the *roke*?"

5 minute break

Retention: "Can you point to the *zup*?"

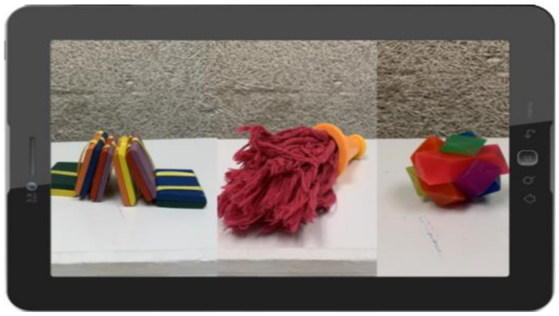


Figure 1 example of warm-up, referent section, and retention trials

Procedure

This research observes children's referent selection accuracy and retention of new words when learning through the use of the tablet. Children were tested in a calm setting in a child development lab while seated in a booster chair at a table. The data is then compared to prior work without a tablet, using real objects (Kucker & Samuelson, 2012; Kucker & Seidler, in prep), in order to determine how technology influences retention and mapping. The procedure for both conditions (tablet vs. real objects) was identical with the only difference being the modality in which the objects and trials were presented. These tasks test the child's ability to map a word and an object together, and the child's retention of those newly learned words. The first task is a referent selection with multiple known and novel objects. The second is an ostensive naming task with only single novel objects.

Stimuli

Novel and known objects were selected for each participant at random from a set of well-known known and unknown novel items. Parents identified the objects as known and recognizable by the child or as novel and unfamiliar to the child. During the trials, the child saw a total of twelve novel objects and three known objects. The words associated with each novel object were chosen at random with each session.

Referent selection

The trials began with a 1 minute familiarization period with all eight novel objects. Following was a warm-up with three known items. The three known objects are presented together across the tablet screen in a horizontal row. The order of the objects is randomized so that each object is shown in a different location for the three warm-up trials. The children are instructed to select an item by name ("Can you point to the car?"), then praised or corrected based on their answer. In the eight succeeding test trials, the child is presented with three objects in a row: two known items from warm-up and one novel item from familiarization. The child is asked to find either a novel object or a familiar object by name. The child receives no praise or correction for their choice. On half the trials, the experimenter asked the child to choose a known item ("Can you get the car?"). On the other trials, the experimenter asked the child to choose a novel item ("Can you get the cheem?"). The location of the named item was randomized across the trials. During each trial, the experimenter makes sure to not look at any one object or touch just one object so that no experimenter bias was presented. The child is given a five minute break after the test trials in which the child was allowed to play with other toys not used in experimentation.

Retention trial

The break is followed by a single warm-up trial with the same three known objects from the previous trials. Praise or correction was given to the child similar to previous warm-up trials. The four retention trials followed the warm-up selection. For each trial, the child was presented with three of the novel objects from the previous referent mapping trials. The child was asked to get the previously named object (“Can you get the cheem?”). The location of the named item was randomized for each trial.

Ostensive naming

For the ostensive naming task, the children were taught the names directly by the experimenter holding an object and labeling it with a novel name five times, and the children were able to explore the item while it was named. This occurred for each of the four new objects individually. Immediately following the training, children were tested for their retention of these new words. On each of the four retention trials, two novel items from training were present in a row. The experimenter presents the child with two of these objects and the child is asked to pick one object by name.

Results

For this study, an independent sample t-test is used to statistically analyze the data for: warm-up trials, known referent selection trials, novel referent selection trials, retention for the referent selection, and retention for the ostensive naming task. The results are summarized in Table 1 and Figure 1.

Referent Selection

No significant difference was found for the Warm-Up Selection between the two groups (P=.170). The results for this selection, however, were marginal. No significant difference was found for the Known Referent Selection between the groups of children (P=.718). No significant difference was found for the Novel Referent Selection between the two groups (P=.441). No significant difference was found for the Retention of the Referent Selection between the two groups (P=.592).

Ostensive Naming

A significant difference was found between the two groups for Retention trials of Ostensive Naming (P<.001).

Discussion

Our study investigates the impact of a tablet on the ability of a child to learn and retain information. For most of the trials within our study, when the modality of learning was manipulated, the referent selection accuracy and retention of the children was not significantly different. Within the scope of our study, the children were able to learn the new words just as well on the tablet compared to with physical objects. However, a significant difference was found when the ostensive naming trials were compared. The children who learned with the tablet retained more novel words compared to the children who learned with physical objects. This could suggest that a tablet may be a beneficial way for children to learn new words. For the ostensive naming task, in both conditions the experimenter showed the child one object while naming it five times. Our results display that the children retained the new words to a higher degree when being taught this way through a tablet. It is important to understand how tablet learning influences cognition as this is a relatively new method being introduced to children at young ages. More research is necessary to determine how this developing method helps or hinders the ability of a child to learn. Tablets provide a unique experience for children and allow them to learn in a new way. Learning through physical movement remains a vital method for a child's development. Many researchers have investigated the role that physical movement plays on learning and development.

Prior work has suggested that learning is improved when integrated with physical motion and exploration. For instance, research suggests that learning should actually be integrated into movement in order to enhance development (Sibley & Etnier, 2003). Sibley and Etnier (2003) argue that both forms of training are needed for the development of the "whole child". Scientific research displays that physical movement, such as team sports, fosters learning through improving concentration, rule following, and social skills. This occurs through numerous physiological methods such as increased blood flow, oxygenation, and neural connectivity within the brain (Mavilidi et al., 2014). When physical movement is combined with cognition, research suggests that learning can improve. Mavilidi et al. (2014) suggests that when speech is combined with gesturing, working memory load can be reduced and learning can increase. Mavilidi et al. (2014) study argues that physical and cognitive activities should be integrated together for learning to be at its highest.

Hannaford (2005) also argued that physical movement fosters learning and development of the brain, specifically with children. When children are able to move and be active, the neurons within the brain are stimulated and in turn the child's ability to take in information and learn is enhanced (Hannaford, 2005). The integral link was discovered when a pathway was traced from the cerebellum to the areas of the brain that code for memory, attention, and spatial recognition (Jenson, 2000). This part of the brain is the same region that codes for learning, and becomes heightened when children are able to physically engage in an activity (Jenson, 2000). Jenson (2000) used electrodes placed on a child's head to measure the activity within the brain. It was discovered that different areas of the brain light up with different activities. The area within the brain that lights up when the child reads or performs a math problem is the same area of the brain that lights up when the child participates in a movement activity (Jenson, 2000). These results provide insight into the relationship between cognition and physical movement. These studies amplify Kucker and Samuelson (2011) study in which interacting and playing with the novel objects allowed for retention of the novel objects and novel names. As the studies mentioned, physical movement and interaction can increase learning through physiological methods such as increasing blood flow and neural connectivity. This in turn can lead to higher intellectual and social skills (Sibley & Etnier, 2003). Physical play still proves to be an integral method for children to learn and explore. Within this study, no significant difference was found between for the referent selection trials. The children performed equality during the referent selection and retention choices with the physical objects as with the tablet. However, the children who learned through a tablet performed significantly better during the ostensive naming trials. This results of this study provides insight into how technology can be thoughtfully integrated into the learning system, and how this method impacts learning.

Limitations

The possibility of the Clever Hans effect is a potential limitation for this study. This effect is when a researcher inadvertently gives away the answer to the question during the trial through body language or tone of voice. In order to present a Clever Hans effect, the experimenter is taught to be aware of their body language by making an effort not to touch any one object or give away an object before the trial begins. The experimenter is also taught to put no emphasis on any particular word to not give away any answers to the trial. For example, when an experiment touches one of the three objects, they are trained to then touch the other objects, so that no object seems to be favored. Tone of voice could potentially pose a problem as it could lead the child to choose one object over another or give away an answer. However, the tone of voice is not focused on as much in these trials as only one object is mentioned. The objects are also set up out of view of the child and the experimenter running the child maintains eye contact with the child throughout each trial. There is also the potential of authority biases (a novel word sounding more familiar to a child than another novel word) and visual biases (a novel object looking more familiar to a child compared to other novel objects. To account for this, the novel objects and novel names were chosen from the Novel Objects and Unusual Names Database (Horst & Hout, 2016). In this database, adults were asked to give novel objects a familiarity score and only the objects that were considered very novel were chosen for the current study. This is similar to the unusual names used in this study. The objects and words are also randomized to counterbalance the chances of bias. Every child within the trials received a random group of objects. In doing this, the chance of bias is lessened. However, it is possible that a child finds an object more favorable than others.

It is important to determine if modality of learning hinders a child's ability to comprehend new information. Tablet learning can prove to be an important part of a child's learning experience. Our study concluded that for most trials, the children retained the information just as well during the tablet trials. Ultimately, determining if tablet learning works is important because this can prove to be a beneficial method for teaching. As technology continues to develop, it can prove to be a beneficial way for children to learn. Within this study, interactive learning and tablet learning proved to be equally beneficial for learning novel words and retaining the new information. It can be concluded from this study that physical and nonphysical methods can enhance retention and learning. The results from the ostensive naming tasks displayed a significantly higher average correct choices for the children who learned through the tablets compared to through physical objects. This displays that while physical movement can improve cognition, tablet training does not hinder learning and can even enhance retention and learning.

		Levene's Test for Equality of Variances		T-test for Equality of Means	
		F	Sig.	t	Sig. (2-tailed)
WU Final	Equal variances not assumed	47.325	0.000	-1.464	0.17
Known Object Selection	Equal variances not assumed	11.597	0.001	0.366	0.718
Novel Object Selection	Equal variances assumed	0.903	0.344	-0.773	0.441
Referent Selection Retention	Equal variances not assumed	6.33	0.014	-0.545	0.592
Ostensive Naming Retention	Equal variances not assumed	5.945	0.017	0.017	**0.000**

Table 1. Independent Sample T-Test Results

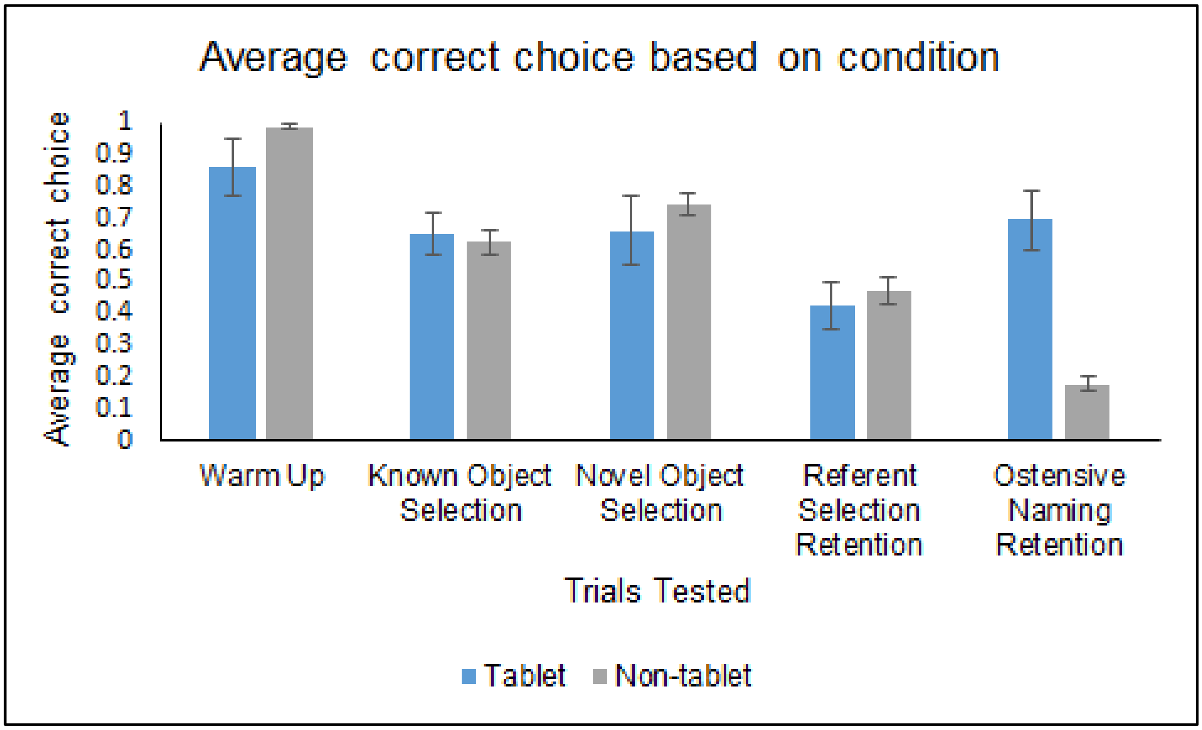


Figure 1. The average correct choice based on method of learning (tablet, non-tablet).

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