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Young Children's Fine Motor iPad Gestures When Performed Alone and in Dyads

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YOUNG CHILDREN'S FINE MOTOR iPAD GESTURES WHEN PERFORMED ALONE AND IN DYADS

by

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ABSTRACT

Since the release of the first iPad in 2010, over 200 million have been sold worldwide. In the short time since the iPad's release, the devices have become popular in classrooms. The purpose of this study was twofold: 1) to document the fine motor iPad gestures of 2-, 3-, and 4-year-old children who used iPads by themselves and in dyads and 2) to conduct international comparisons regarding such observed fine motor iPad gestures. In this study, I examined seven iPad gestures: (a) tap, (b) drag/slide, (c) free rotate, (d) drag and drop, (e) pinch, (f) spread, and (g) flick. This study had five components. The first component involved observations of the iPad gestures of a sample of Orlando, Florida, children operating iPads by themselves. The first component was a partial replication of the 2013 and 2014 studies conducted by Aziz et al. The second component of this study involved observations of the iPad gestures of the Orlando children operating iPads in dyads. In the third component of this study, I compared the iPad gestures of the Orlando children with the gestures of a sample of 2-, 3-, and 4-year-old children from London. In the fourth component of this study, I compared the iPad gestures of the Orlando children with the gestures of a sample of 2-, 3-, and 4-year-old children from Malaysia. In the fifth component, I compared the iPad gestures of the Orlando sample when the children were paired with classmates and asked to play with the iPads in dyads, rather than operating iPads by themselves. Biographical information was collected, including (a) child's age, (b) household income, (c) child's gender, (d) child's ethnic origin, (e) types of mobile devices in the household, (f) daily usage of mobile devices, (g) people with whom the child used mobile devices, (h) earliest age of device usage, and (i) the primary language spoken at home.

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CHAPTER ONE: INTRODUCTION

Introduction

Mobile devices (smart phones and tablets) are becoming more accessible to young children. For example, some researchers have found classrooms have one iPad per child (Vatalaro & Nguyen, 2014). These mobile devices have a touch interface that is easier for children to manipulate, compared to the traditional keyboard and mouse personal computers and laptops use. Young children are often curious and want to explore new things. This curiosity makes the touch screen technology popular among young children. With just a touch of a finger, children can interact with mobile devices such as smart phones and tablets.

In Chapter 1, I provide an overview of the research study. I describe a partial replication from two previous studies conducted by Aziz et al. (2013, 2014) and discuss the iPad gestures of a sample of young children operating iPads in dyads. In the chapter, I explain the history and background of iPads, provide a problem statement, state the purposes of this research study, and state the research questions.

Background of the Study

In recent years, the use of technology has increased in early childhood classrooms (Fallows, 2004), contributing to young children's increased use of interactive technologies such as iPads (Glaubke, 2007). iPads were first released in 2010 (Statista, 2015) and have grown in popularity. Further, children are often being exposed to technology such as iPads in their daily lives. Recent studies have used iPads as an educational tool in early childhood classrooms (Aziz

et al., 2013, 2014; Beschorner & Hutchison, 2013). Descriptive studies like this study can help educators and researchers understand the phenomenon of young children's use of iPads. The findings from this research study could help identify more effective ways to use iPads and other mobile devices as tools for learning.

The Problem Statement

Researchers have suggested that young children with better motor abilities, compared to their peers, may find it easier to be physically active and may be more likely to engage in physical activity (Wrotniak, Epstein, Dorn, Jones, & Kondilis, 2006). Media research studies have many times pointed out that children have more and more access to smart devices at home. According to Common Sense Media (2013) 72% of all children under 8 years old in the United States have used a mobile device for various purposes, and 38% of children under 2 years old have used mobile devices for entertainment. Interactive mobile devices, such as the iPad increasingly used by young children (Glaubke, 2007), require fine motor gestures to interact with the screen. In this study, I call these gestures *iPad gestures*.

Mobile devices are relatively new. The iPad was first released in 2010 and has grown in popularity—200 million have been sold worldwide (Statista, 2015). Documenting these fine motor gestures and the way that children use the mobile devices is important because, in my research, I have found little research on the long-term effects of using the in early childhood settings. However, studying an educational phenomenon requires researchers to generate an accurate description of the phenomenon. According to Gall, Gall, and Borg (2007), new educational research should start with exploratory studies before experimental studies involving

cause-and-effect relationships are employed to test new instructional methods and programs. In this study, the phenomenon studied was the use of iPads in small-group early childhood settings. The phenomenon was studied as it existed in a natural setting, which could help future educators design clear and appropriate learning interventions (Gall, Gall, & Borg, 2007).

To understand the learning potential of iPads fully, researchers should conduct quasi-experimental and experimental studies. However, one must first start by conducting exploratory studies in order to understand the phenomenon of interest (Gall et al., 2007). Therefore, this research study was intended to measure iPad gestures of children engaged with iPads. Data collected and reported from this research study could be useful in designing future technology and applications specifically targeted toward the development of young children. A first step in understanding the use of mobile devices is to examine the ways in which children engage with them. For this research study, iPads were selected to represent the category of mobile devices. The iPad facilitated the investigation of children's fine motor iPad gestures when interacting with a variety of educational applications.

Purpose of the Research Study

Without a doubt, technology in the form of mobile devices such as iPads is being integrated into classroom settings. The purpose of this research study was twofold: 1) to describe the fine motor iPad gestures of 2-, 3-, and 4-year-old children and 2) to conduct international comparisons regarding such observed fine motor iPad gestures. The comparison sample included two sets of participants in two different international studies. The first study was conducted in London (Aziz et al., 2013) and the second one was conducted in Malaysia (Aziz et al., 2014).

The foci of this research study was to 1) observe the use of iPads by 2-, 3-, and 4-year-old children working by themselves and in dyads and 2) to compare observational findings in three different countries.

As a first step to gain preliminary information, which included the use of mobile devices internationally. Next, I needed to understand how technology is used by children. To this end, I observed children during visits to a kindergarten classroom (Vatalaro & Nguyen, 2014). The kindergarten classroom that I visited was piloting a digital curriculum. I observed that the teacher was using iPads as an educational component in most of the lesson plans. Other technologies available in the classroom were two personal desktop computers and a television with a DVD player. All the classroom technology was available for children to use but none of these other technologies had a similar ratio per child as did the iPad. The iPad was the most abundant technology in the classroom, with one iPad per child (Vatalaro & Nguyen, 2014). During my visit to the classroom, I asked 12 kindergarten-aged students questions. The results are shown in Figures 1 and 2.

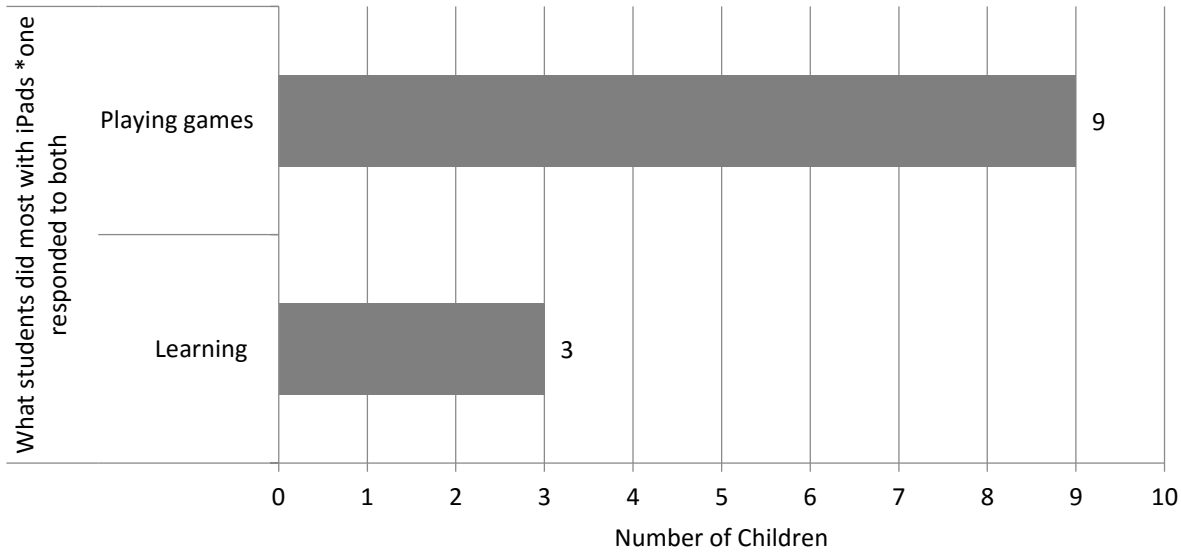

Figure 1. Kindergarten-aged students' use of iPads.
Note: Adapted from "iPad use in a kindergarten classroom," by A. Vatalaro & L. Nguyen2014. Orlando, Florida. (N = 12)

I asked the children what they used iPads for. I categorized the responses of the nine kindergarten-aged children as "playing games" and the responses of three of the children as "learning."

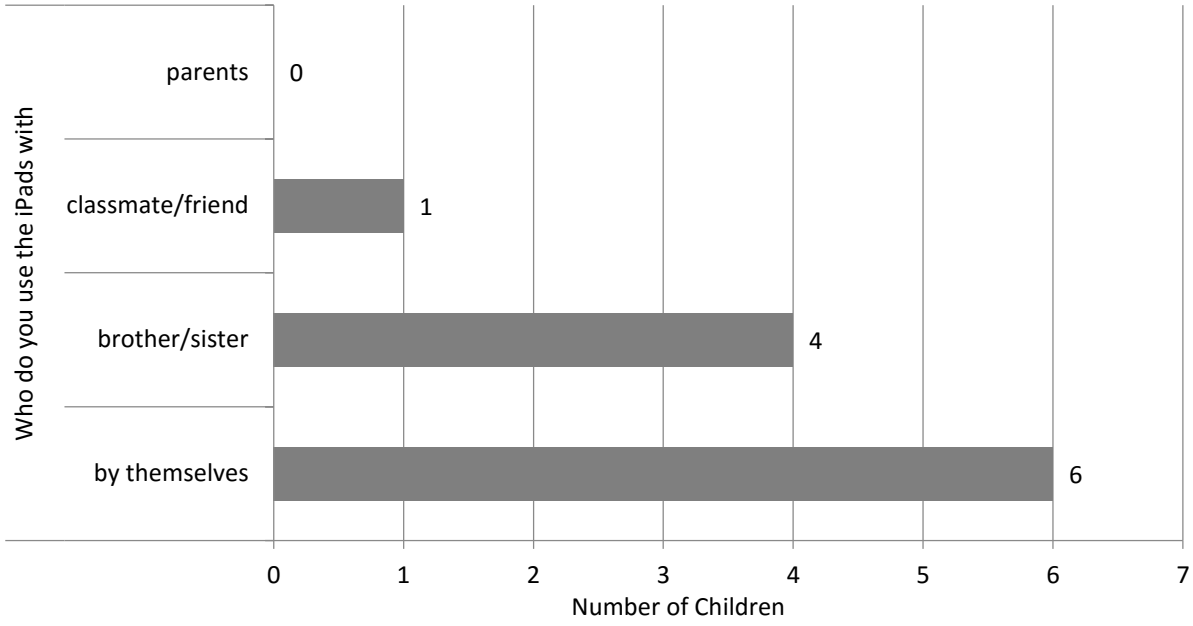

Figure 2. Students' time spent operating iPads with others.
Note: Adapted from "iPad use in a kindergarten classroom," by A. Vatalaro & L. Nguyen, 2014. Orlando, Florida. (N = 11)

When I asked the children with whom they spent the most time using the iPad, the majority of their responses were categorized as "by themselves." None of the children responded that he or she used the iPads with "parents."

I identified a need for research to describe the fine motor behavior displayed by children when operating iPads. This research study took place at a daycare facility located in downtown Orlando, Florida. At the time of this study, the daycare facility historically served a low socioeconomic status (SES) population. Researchers have found that children from higher SES backgrounds experience different language learning environments compared to children from

lower SES backgrounds (Culp, Osofsky, & O'Brien, 1996). Additionally, parents from higher SES backgrounds talk more to their children, sustain conversational topics longer, use richer vocabulary, ask more questions, give fewer directives, respond more to their children's speech, and elicit more talk (Culp, Osofsky, & O'Brien, 1996; Hart & Risley, 1995; Hoff-Ginsberg, 1998). In addition, Timler, Vogler-Elias, and McGill (2007) argued that in order to understand the natural interaction of children, researchers should study the contexts in which peer interactions naturally occur. Thus, a need for research into the iPad gestures of children from low socioeconomic backgrounds was clear.

Research Questions

Five research questions guided this study. RQ1 is a partial replication of two previous studies involving iPad gestures (Aziz et al., 2013, 2014). The iPad gestures were (a) tap, (b) drag/slide, (c) free rotate, (d) drag and drop, (e) pinch, (f) spread, and (g) flick, coded from video recordings using the iPad Gestures Checklist (Appendix B).

1. What are the percentages of 2-, 3-, and 4-year-old children who performed seven iPad gestures in a free play session in which the children operated iPads by themselves?
2. What are the percentages of 2-, 3-, and 4-year-old children who performed seven iPad gestures in a free play session in which the children operated iPads in dyads?
3. What are the percentage differences in iPad gestures performed by a sample of 2-, 3-, and 4-year-old Orlando children who operated iPads by themselves in a free play session, compared to the iPad gestures of a sample of London children (Aziz et al., 2013)?

4. What are the percentage differences in iPad gestures performed by a sample of 2-, 3-, and 4-year-old Orlando children who operated iPads by themselves in a free play session, compared to the iPad gestures of a sample of Malaysian children (Aziz et al., 2014)?
5. What are the percentage differences in iPad gestures performed by a sample of 2-, 3-, and 4-year-old Orlando children who operated iPads by themselves in a free play session, compared to when the children operated the iPads in dyads?

Limitations and Delimitations

This research study had several limitations. The first limitation involved the sample. The sample for this research study was small ($N = 41$). In addition, the sample was generated by a convenience sampling method, and all the sample participants were drawn from only one site. These factors contribute to the limited generalizability of the findings. In addition, data collection recording sessions did not occur in the classroom. Even though the children were familiar with everyone in the daycare facility, not recording in their natural setting could limit generalizability.

Another limitation of this research study was the Biographical Information and Mobile Device Use Questionnaire (Appendix C). The questionnaire was created only in English. Families whose primary language at home was not English may have had difficulty filling out the questionnaire.

An additional limitation involved the pairing of children. I asked the teacher to pair each child with a classmate with whom he or she interacted well in the classroom. However,

sometimes children in nonclassroom paired settings do not interact the way they interact when they are in their classroom (Cochran-Smith & Lytle, 1993). The behavioral differences between settings might be especially problematic with dyads of 2-year-old children.

Finally, permissions from the Institutional Review Board (IRB) (Appendix A), from the data collection site (Appendix D), and from the children's parents were obtained prior to the start of this research study. Collecting data from only the children whose parents or guardians had given permission limited the sample.

Assumptions

Several assumptions were made prior to the start of this research study. First, the children in this study are living in a historically low-income area may and not have daily access to mobile devices like the iPad and may not be familiar with how to operate, engage with, and use these devices. Second, I assumed the university undergraduate students who had been trained in previous coursework, who had participated in reliability training, and whom I supervised were qualified to record the data collection sessions and code behaviors from recordings.

Operational Definitions

Applications: Software that runs on iPads, also referred to as *apps*.

Descriptive study research design: A study that has no intervention and involves making detailed reports of the phenomenon being studied (Gall et al., 2007).

Early childhood education: Early learning programs serving children from birth through 8 years of age (Radich, 2013).

Institutional Review Board (IRB): A committee established to review and approve research involving human subjects.

iPad: A small hand-held mobile device introduced in 2010, weighing 1.44 pounds and measuring 9.5 inches × 7.31 inches × .37 inches, also referred to as a tablet. The iPad uses a touch screen to interface with applications (apps).

iPad gesture: Any fine motor physical movement made by a child that a digital system can sense and respond to without the aid of a traditional pointing device such as a mouse or stylus (Saffer, 2009). In this research study, the term was defined as fine motor skills.

Low-income: The U.S. Department of Health and Human Services (2015) defined poverty as an income of less than $11,770 a year, plus $4,160 for each additional household member.

Mobile device: A hand-held device such as an iPhone, Galaxy, Droid, iPad, Kindle FIRE, Microsoft Surface, Galaxy Tab, LeapPad, Nabi, or VTech InnoTab.

Nonexperimental research design: A research design that has no random assignment of groups and no comparison group (Gall et al., 2007).

Orlando Day Nursery (ODN): Daycare facility data collection site, located in the downtown Orlando, Florida, area, serving low-income families for over 90 years (Orlando Day Nursery, 2015). ODN students range in age from 6 weeks to 36 months.

Percentage difference: The change between the two percentages, calculated by the following formula: (new value − old value) / old value × 100.

Summary and Organization of the Research Study

This research study is described in the following chapters. Chapter 2 contains a review of the literature. Additionally, in Chapter 2, I explain children's motor development, children in dyads, iPads, applications, and my theoretical framework. I provide a critical review of previous studies connected to this research study. Chapter 3 contains this research study's methodology. Additionally, in Chapter 3, I describe the research design, demographic information about the participants, and data collection procedures, Institutional Review Board (IRB) procedures, and instrumentation. In Chapter 4, I report the study's findings. Additionally, in Chapter 4, I report the demographic information about the participants gathered from the Biographical Information and Mobile Device Use Questionnaire (Appendix C). In Chapter 4, I report and compare data collected from the iPad Gestures Checklist with two previous studies (Aziz et al., 2013, 2014). I also describe the data analysis procedures used to answer the research questions. Finally, in Chapter 5, I discuss the findings regarding the percentage differences, as well as the limitations, implications, and recommendations for future research.

CHAPTER TWO: REVIEW OF LITERATURE

Introduction

In this chapter, I explain several topics, including motor development, children in a dyadic setting, the iPad device, applications, the theoretical framework and its connection to this research study, and previous research. In this chapter, I also examine the rise in popularity of the iPad and the number of apps that have been downloaded from the Apple Apps Store. Previous research regarding iPads and apps as educational tools is also discussed. The theories of interest are those developed by Gallahue and Ozumun (1998), Vygotsky (1978), Gibson (2014) and Bandura & Walters (1963). The rationale is presented for conducting this research study documenting children's iPad gestures.

The iPad

The first iPad was released in 2010; as of June 2014, over 200 million have been sold worldwide (Statista, 2015). In a relatively short time, schools have gone from one computer per classroom to a ratio of one iPad per child (Vatalaro & Nguyen, 2014). Figure 3 shows iPad sales, as an indicator of the popularity of the iPad.

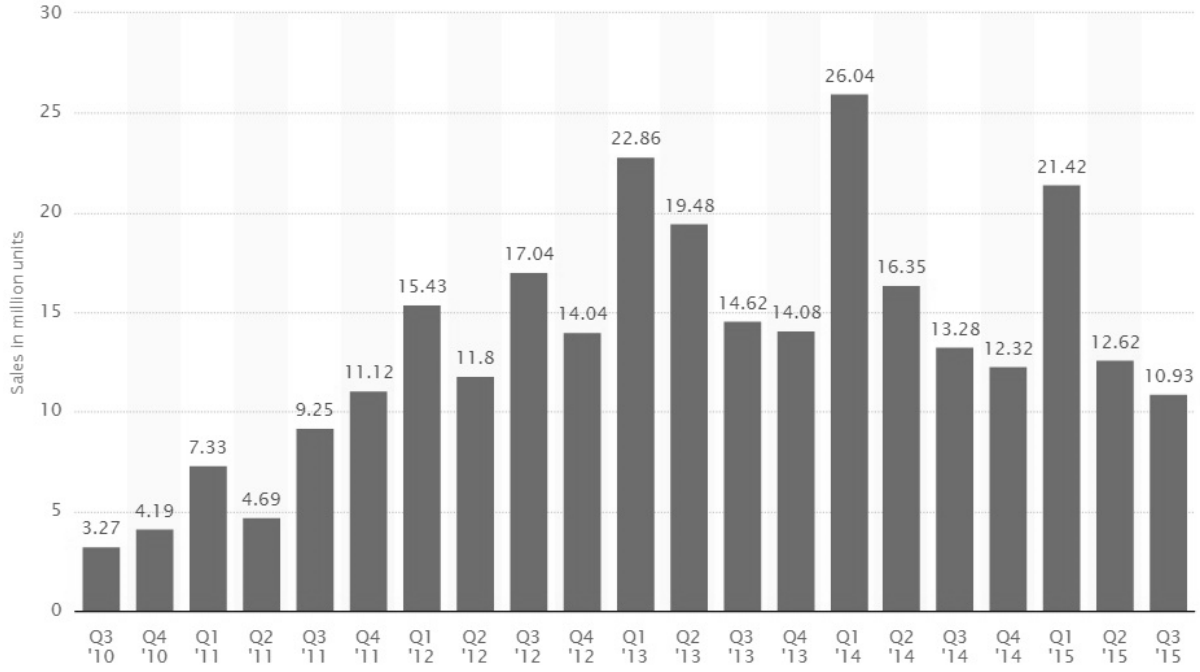

Figure 3. Global Apple iPad sales from 3rd quarter 2010 to 3rd quarter 2015.

Source: Statista (2015). Retrieved from http://www.statista.com/statistics/269915/global-apple-ipad-sales-since-q3-2010/

Figure 3 shows that iPad sales increased from 3.27 million in the third quarter of 2010 to about 10.93 million in the third quarter of 2015, peaking in the first quarter of 2014 when 26.04 million iPads were sold (Statista, 2015). The iPad was chosen for use in this research study because of its popularity and for several other characteristics, including its unique interface, its portability, its touch screen, and the number of iPad applications available. The iPad's low weight of about a pound and a half makes it portable and easily transportable, compared to

laptops and desktop computers. Additionally, the touch screen on the iPad makes it easier for children to interact with software, as opposed to the mouse and keyboard required for some other devices. Finally, the iPad was selected for this research study because over 1.5 million applications (apps) are available in the Apple App store for use on the iPad (Statista, 2015). The term *app* will be used throughout the document to mean *applications*. As the popular saying goes, "There's an app for that," meaning that there is an application for virtually any type of activity, including math, games, literacy, news, art, and science. App developers are pioneers in the electronic category of mobile devices. This category of electronics existed before the iPad's invention; however, mobile devices' popularity did not take off until 2010 with the introduction of the iPad (Statista, 2015). This point is further discussed in Chapter 2. Since the release of the iPad other mobile devices currently on the market have been modeled after the touch pad of the iPad. Given these facts, the iPad was the logical choice of device for this research study.

Mobile Devices Internationally

In a report by the GSM Association (GSMA) and the Mobile Society Research Institute (MSRI) compared the mobile device behavior of 4,500 pairs of children across five countries – Japan, India, Indonesia, Egypt, and Chile. According to the report (GSMA & MSRI, 2013):

- Japan 57% of children own a mobile phone
- India 35% of children own a mobile phone
- Indonesia 67% of children own a mobile phone
- Egypt 91% of children own a mobile phone
- Chile 79% of children own a phone

Additionally, the report states that Internationally the use of tables is relatively low with 18% children using in Egypt and Chile, 7% in Indonesia and between 507% in Japan and India (GSMA & MSRI, 2013).

Applications

Applications (apps) are software for the iPad. Apps were designed to work on Apple's mobile device operating system (iOS). A review of the iPads' hardware is further discussed in the Equipment section of this chapter. Applications allow the user to use the touch screen to perform unique gestures, known in this research study as *iPad gestures*. Figures 3 and 4 show the total number of applications downloaded and the most popular categories of applications.

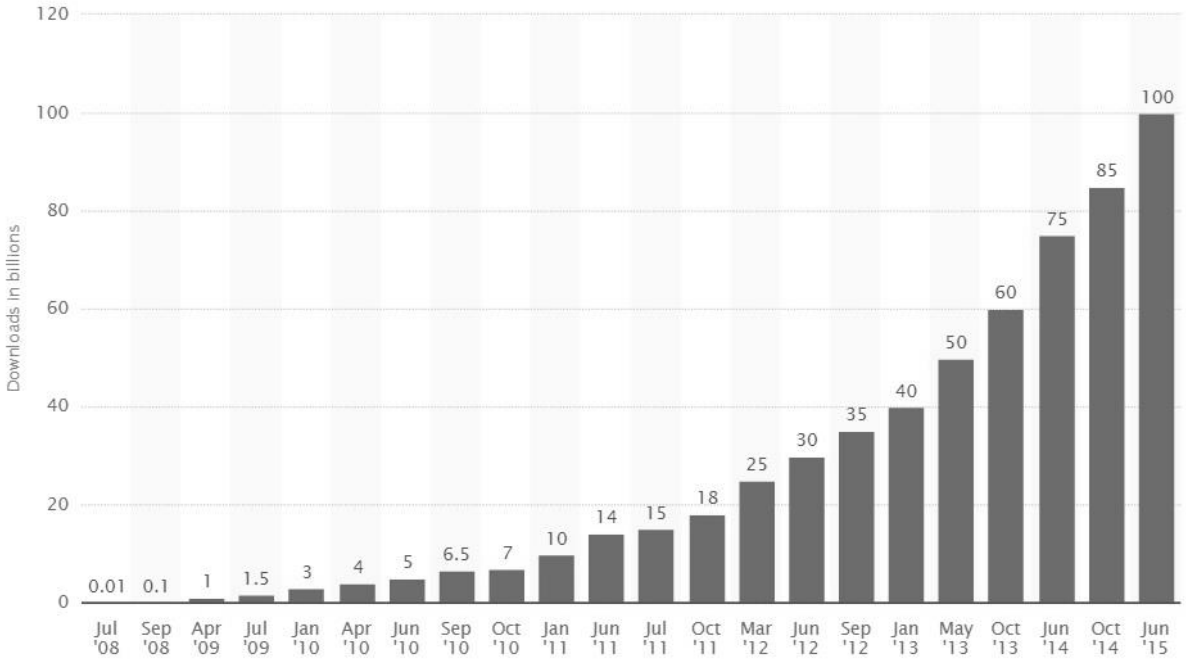

Figure 4. Number of Apple App Store app downloads, July 2008 to June 2015. (Statista, 2015). Retrieved from http://www.statista.com/statistics/269915/global-apple-ipad-sales-since-q3-2010/

Figure 4 shows the number of applications download in October 2010 was 7 billion, the year when the iPad was first introduced to the public (Statista, 2015). Since then, there has been a steady increase in the number of applications downloaded. The total number of applications downloaded as of June 2015 reached over 100 billion applications downloaded from Apple's App Store (Statista, 2015). Figure 4 shows that from 2010 to June 2015, application downloads have increased 1300%.

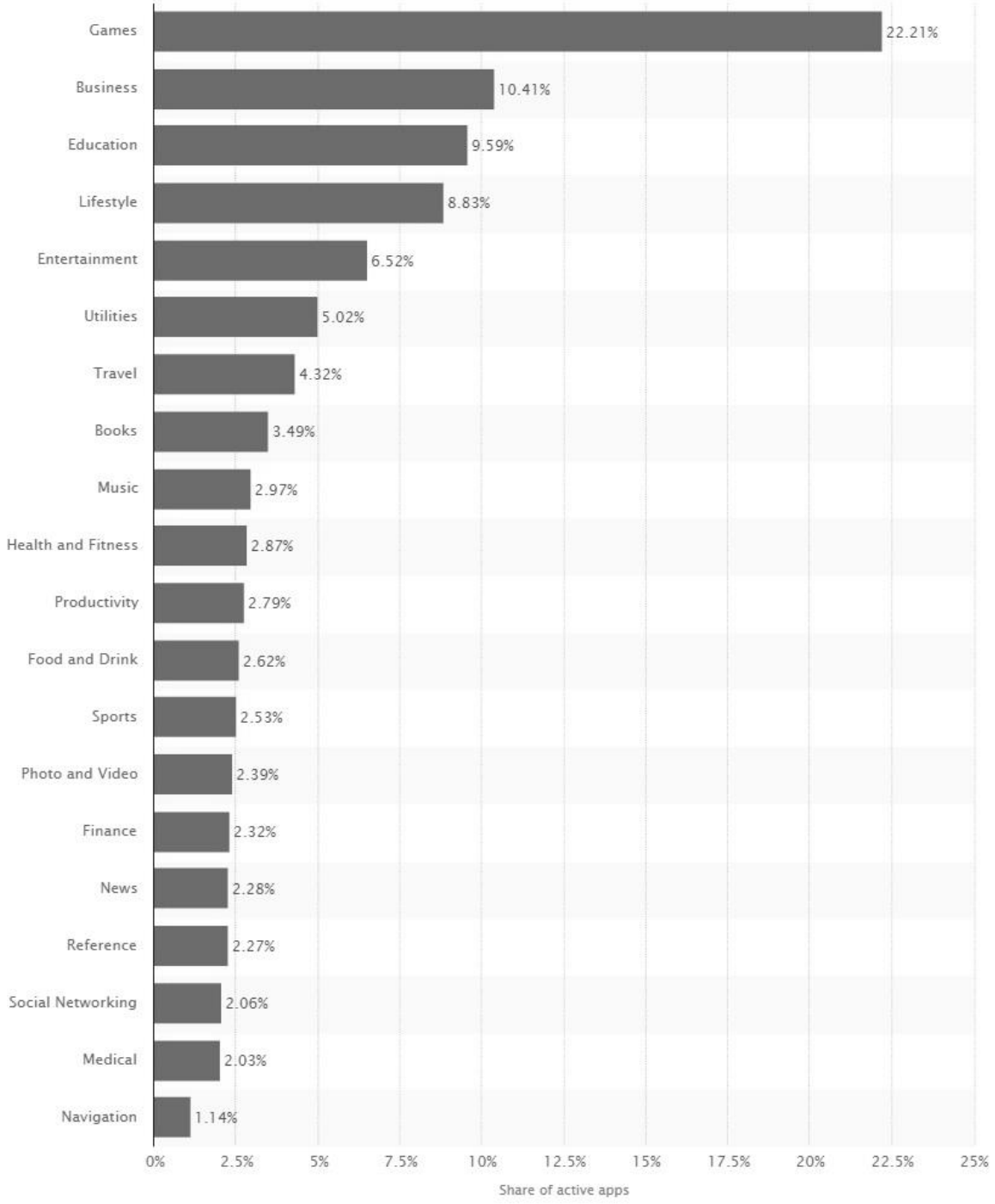
Games
22.21%
Business
10.41%
Education
9.59%
Lifestyle
8.83%
Entertainment
6.52%
Utilities
5.02%
Travel
4.32%
Books
3.49%
Music
2.97%
Health and Fitness
2.87%
Productivity
2.79%
Food and Drink
2.62%
Sports
2.53%
Photo and Video
2.39%
Finance
2.32%
News
2.28%
Reference
2.27%
Social Networking
2.06%
Medical
2.03%
Navigation
1.14%
0%
2.5%
5%
7.5%
10%
12.5%
15%
17.5%
20%
22.5%
25%
Share of active apps

Figure 5. Most popular active Apple App Store categories in September 2015.

Source: (Statista, 2015). Retrieved from http://www.statista.com/statistics/269915/global-apple-ipad-sales-since-q3-2010/

Figure 5 shows the most popular Apple App Store app downloads by share of active app, as of September 2015 (Statista, 2015). An active application is an application that is opened by the user. The application stays open until closed completely by the user. Users can see their active applications by pressing the home button twice on their iPads. Figure 5 shows data on those applications that are opened and kept open by the user (Statista, 2015). The most popular applications category as of September 2015 was gaming (22.21%), followed by business (10.41%; Statista, 2015). Third was the category of educational applications (9.59%; Statista, 2015). In the first quarter of 2015, 1.4 million applications were added to Apple's App Store (Statista, 2015). In addition, 100 billion total applications were downloaded as of June 2015 (Statista, 2015). Because applications are an important component of the iPad, the growth in total number of downloaded applications can be an indicator of the popularity of the iPad.

In a content analysis of the Apple App Store, Shuler (2009) found that 47% of the 100 best-selling applications were designed for preschool- or elementary-aged children, with foreign language and literacy the most popular applications categories. Watlington (2011) conducted a similar study in 2010, classifying the types of free apps available for the iPod Touch and iPad via the Apple App Store. Haugland as cited in Watlintgon (2011) Developmental Software Scale to rate the free iPad applications' developmental appropriateness and found that only 48% of the

108 applications analyzed could be classified as developmentally appropriate and recommended for educational use.

Theoretical Framework

Four theories formed the theoretical framework of this research study. The theories were selected according to the following criteria: (a) the theory related to the age group of this study, (b) the theory has been used to explain how iPads can be used, and (c) the theory has been used to explain children's motor development. The following theories were used in this research study: Gallahue and Ozmun's motor development, Vygotsky's Zone of Proximal Development (1998), Gibson's ecological approach of affordances (2014) and Bandura and Walter's social learning theory (1963).

Motor Development

Children undergo many physiological, cognitive, and physical changes as they grow up, which can help develop in their ability to understand and interact with the environment. As children grow up, their body anatomy evolves into more dexterous fingers and stronger arms that help children achieve fine levels of motor control which, combined with physiological, cognitive, and physical development, lead to achievement of more complex motor movement and learning skills (Vatavu, Cramariuc, & Schipor, 2015). There are two classifications of movement skills. The first is gross motor movement, which involves the movement of large muscles of the body, and the second is fine motor movement, which involves limited motion of parts of the body for the performance of precise movements (Gallahue & Ozmun, 1998). In the

theory developed by Gallahue and Ozmun (1998), motor developments are broken into age-related phases because motor development emerges primarily through changes in movement behavior within the age ranges (p. 1188). Motor development is thus divided into six phases. The six phases are (a) reflexive movement phase, (b) rudimentary movement phase, (c) reflex inhibition phase, (d) precontrol phase, (e) fundamental movement phase, and (f) specialized movement phase (p. 1188). Three phases are relevant to this research study.

Reflexive Movement Phase

Gallahue and Ozmun (1998) theorized that all movements the fetus makes in this stage are reflexive. Gallahue and Ozmun defined *reflexes* as involuntary, subcortically controlled movements. Through reflexes triggered by touch, light, sounds, and even changes in pressure, infants begin to explore and gain information about their environments (Gallahue & Ozmun, 1998). Within this phase, two types of reflexes are present. The first, primitive reflexes, are for information gathering, nourishment seeking, and protection (Gallahue & Ozmun, 1998). The second, postural reflexes, serve as testing time for locomotor, manipulative, and stability movements for infants in later phases (Gallahue & Ozmun, 1998).

Rudimentary Movement Phase

Gallahue and Ozmun (1998) found in this phase, the first forms of voluntary movements occur and are evident between birth and 2 years old. Further, an infant's rudimentary movement abilities represent the basic forms of survival involving stability movements such as gaining

control of the head, neck, and trunk muscles, along with manipulative tasks of reaching, grasping, and releasing (Gallahue & Ozmun, 1998). Within this phase, three substages represent higher orders of movement control (p. 1188).

Reflex Inhibition Phase

Gallahue and Ozmun (1998) theorized that at birth, reflexes dominate a child's movement; the developing cortex increasingly influences the child's movement from then on. The development of the child's cortex represses several reflexes and eventually is replaced by voluntary movement. However, at this level, voluntary movement is poorly differentiated or integrated, and movements may appear uncoordinated and unrefined (Gallahue & Ozmun, 1998).

Precontrol Phase

The precontrol phase occurs around 3 to 4 years of age. A child in this phase has improved precision and movement control (Gallahue & Ozmun, 1998). This stage is characterized by the rapid development of the child's higher cognitive and motor processes, causing rapid gains in rudimentary movement abilities (Gallahue & Ozmun, 1998). Children learn to gain and maintain their equilibrium, manipulate objects with more control, and move (crawl or sometimes walk) through their environments with a better degree of proficiency and control ((Gallahue & Ozmun, 1998).

Fundamental Movement Phase

This phase starts at about 2 to 7 years old. Children outgrow the rudimentary movement phase and are actively involved in exploring and experimenting with their bodies' movement capabilities (Gallahue and Ozmun (1998). Additionally, this is the time for children to practice movement (running and walking), stability (standing and balancing), and manipulation (throwing and catching), first by themselves and then in combination with others.

Specialized Movement Phase

Gallahue and Ozmun (1998) stated that children in this phase do not learn to move for the sake of moving but rather movement becomes a tool to be used in a variety of specialized movement activities. Fundamental movements like hopping can now be joined with rope-jumping activities. Gallahue and Ozmun (1998) found that the onset of development for these complex skills depended on a variety of cognitive, affective, and psychomotor factors, such as (a) reaction time, (b) movement speed, (c) body type, (d) height, and (e) weight. This phase ranged from 7 to 14 years old.

Gallahue and Ozmun's (1998) theorized phases of motor development connected to the topic of this research study in the sense that it is important to understand the motor and fine motor development of 2-, 3-, and 4-year-old children. I observed clear operational definitions of the constructs proposed by Gallahue and Ozmun. The population for this research study consisted of 2-, 3-, and 4-year-olds in downtown Orlando. According to Gallahue and Ozmun (1998), children in this age range learn how to perform movement (running and walking),

stability (standing and balancing), and manipulation motions (throwing and catching). In this research study, I documented children's iPad gestures as they interacted with iPads. I theorized elements of the initial and elementary stages of the fundamental movement phase described by Gallahue and Ozmun (1998). Children in this research study were expected to show the movement abilities described by Gallahue and Ozmun (1998).

Recent Studies in Motor Development and Touch Screens

In a recent study (Vatavu et al., 2015) of touch screen interaction of children 3 to 6 years old, researchers found correlations with children's touch performances and age. These results suggest that there are relationships between children's level of motor skills and their performance when interacting with touch-screen devices. Other studies (McKnight & Cassidy, 2012) of touch screen interaction of 7 to 10 years old found that children prefer using their finger rather than the stylus when interacting with the touch-screen devices.

Children in a Dyad

Vygotsky (1978) defined the Zone of Proximal Development (ZPD) as the distance between children's development levels. The ZPD is determined by children's ability to solve a problem independently using critical thinking. According to the ZPD theory, children can reach a higher level of potential development on their own. However, it is more helpful if children have adult guidance or work in collaboration with more capable peers (Vygotsky, 1978).

Psychologists and educators have used the ZPD as a tool through which the internal course of development can be understood (Miller, 2010).

Vygotsky (1978) discussed a new approach for the theory. In this new approach, three theoretical assumptions were rejected. First, the rejected assumption was that learning is a purely external process that does not actively involve the learner; this idea assumed learning only utilizes achievements rather than providing motivation to modify learning (p. 31). The second rejected assumption was that learning is development. The third rejected assumption was that the relationship between learning and development extremes can be overcome by having them work together (p.31).

According to Vygotsky (1978), children can move from where they are currently to where they want to be with the help or guidance of knowledgeable adults or peers, a process Vygotsky called *scaffolding*. Miller (2010) found that children accomplish scaffolding through a variety of means, including receiving prompts and clues, viewing model behavior, receiving explanations, asking questions, discussing, participating jointly with peers, receiving encouragement, and having teachers control children's attention. Vygotsky (1978) further explained that learning awakens a variety of internal development processes that can operate only when children interact with people in their environments and in cooperation with their peers. During this interaction, the more skillful peers or adults build upon abilities that the learner already has (p.35). The child is then presented with activities, which helps support levels of competence slightly beyond the child's current level (Miller, 2011). In relation to my topic,

iPads were given to children to interact with twice, the first time by themselves and the second in dyads.

I predicted that children in this study would, what I refer to as "leap frog," a process in which children learn about the iPad from each other. I theorize that if an adult does not negatively interfere, children will learn among themselves. Additionally, children in this research study had some verbal guidance in using the iPads from an adult, in accordance with the data collection protocols of the previous studies (Aziz et al., 2013, 2014).

In the context of the Zone of Proximal Development (Vygotsky, 1978), knowledgeable peers can help children move from where they are currently to where they want to be. The applications that accompany iPads often give navigation prompts and clues and often are entertaining, engaging a child's attention (Miller, 2010). If a child did not know how to operate the iPad or the app, I theorized that a peer would help that child; thus, the partner becomes the knowledgeable peer. In those situations, to help the child understand the task, teachers or peers may provide explanations, offer leading questions, discuss the iPad tasks, participate jointly, and even provide encouragement as they complete tasks (Miller, 2010).

Ecological Approach of Affordances

J. J. Gibson (2014) introduced the theory of affordances, and his wife, E. J. Gibson (1982), further developed the theory. *Affordances* are what an environment offers or provides for an organism; they are opportunities for action, growth, exploration, development, and even learning (E. J. Gibson, 1982; J. J. Gibson, 2014). In the context of early childhood, the

environment “affords” surfaces children can use for support to walk or crawl on, objects to be manipulated, tubes to crawl though, and even obstacles that prevent forward movement (p. 127). Miller (2010) noted that even the social environment offers affordances. For example, in a classroom setting, if a teacher displays a smiling or angry face to children, the teacher is affording positive or negative connections with that interaction. Gibson (1982) noted affordances are even present when there are no perceived stimuli, retinal images, or sensations. Additionally, a person can perceive things they can eat, write with, sit down on, or talk to (p. 128). Devices like the iPad are a part of children’s environments; however, children do not identify the iPad as an object with a touch screen, a battery, and many little electronics that make it function. Rather, they tend to recognize it as a whole entity (p. 128). Children have been observed manipulating iPads and even talking to the devices (Vatalaro & Nguyen, 2014). Further, as children acquire new motor skills during development, they discover new affordances (Gibson, 1982).

This idea directly correlated to this research study in which I recorded and documented the children’s iPad gestures. Children’s evolutionary backgrounds provide the perceptual equipment and motivation to perceive, or to learn to perceive, particular objects, events, and spatial layouts they need in a setting (Miller, 2011). Further, children explore and learn to play with affordances of objects, events, and surfaces (Miller, 2011), which they use to further develop their skills. The iPad is part of children’s environments that affords them the opportunity to develop further. With the constant manipulation of the iPads, children can develop their fine motor skills, such as swiping, pinching of the screen, double tapping, shaking of the iPad, and using their fingers to type. Paired with interactive apps to stimulate the children’s attention, I

theorized that over time with iPads, the children's fine motor skills develop because of constant manipulation in the routine use of the iPads. Additionally, I theorized that once children mastered the fine motor skills required to operate iPads, they acquired new motor skills and then discovered new affordances, as noted by E. J. Gibson (1982).

Social Learning Theory

The early days of social learning focused on socialization, wherein members of society attempt to teach children to behave like ideal adults of that society (Bandura & Walters, 1963). According to Miller (2010), early social learning theorists proposed the existence of important learned drives, such as aggression and dependency, derived from primary biological drives. Children also tend to imitate models who are part of their lives, including parents, siblings, or even extended family members who spend a lot of time with the children (Bandura & Walters, 1963).

Bandura's most famous contribution was social learning theory (Bandura & Walters, 1963). Bandura wrote, "Learning may occur through observation of the behavior of others even when the observer does not reproduce the model's responses" (p. 4). In a famous experiment using Bobo dolls (Bandura, Ross, & Ross, 1963), Bandura showed that children who watched an adult act out aggressive or violent behavior modeled that behavior. According to Bandura and Walters (1963), aggression is considered the natural dominant response to frustration, and "a nonaggressive response is likely to occur only if aggressive response had previously met with non-reward or punishment" (p. 110). Although my study did not deal with aggression like

Bandura's Bobo doll study, I used the basic concept of the social learning theory: that children tend to imitate models such as parents, teachers, siblings, or class peers around them.

The iPads and applications can stimulate children through sounds and colors and reward children after they complete objectives. If the applications are too difficult for the children or do not stimulate, the apps would not create a positive experience for children, and therefore the children would likely no longer be excited to interact with the iPad. I theorized that social learning theory (Bandura & Walters, 1963) was also present when children watched their peers use the iPads. In that setting, children can model simple behaviors such as pointing or dragging their fingers across the screen. Over time, children combine these simple behaviors to create more complex behaviors, such as swiping or pinching, double tapping, shaking, or typing on the iPads.

In relation to social learning theory (Bandura & Walters, 1963), I theorized that a child who sees a peer having positive or fun interactions with the devices will be encouraged to do the same. Seeing a peer interact with the iPad may foster a positive learning experience, which could motivate children to want to use the iPad more, potentially developing their motor skills further. Bandura and Walters (1963) further advanced the notion of modeling by demonstrating that children can acquire new behaviors simply by watching a model (vicarious reinforcement) and biological variables that influence social learning. If children see peers having fun and laughing while using the iPad, the children would likely see the iPad as something positive and would likely interact with it. On the other hand, if children see their peers having negative experiences, the children would be less likely to use the iPads.

Bandura and Walters's (1963) social learning theory was an important advance over traditional learning theory. Prior to the social learning theory, traditional learning theories such as operant conditioning were used to explain how children gradually produced relatively new behaviors through stimuli (Bandura & Walters, 1963). However, traditional learning theories could not show how complex new behaviors emerged suddenly after children watched their peers play a new game (Miller, 2010). Social learning theory was used to show that after children acquired new behaviors by observing various models or their peers, children could combine these behaviors to form complex behaviors (Bandura & Walters, 1963). For example, when introducing the iPad to children who may not have regular access to the devices, children might find it difficult to navigate the iPad at first. However, over time, children watch their peers operate the applications on the iPad and begin to model the behavior. Children eventually combine these behaviors to form complex movements with the devices (Miller, 2010). With continuous use of the devices, children's motor skills can further develop, enabling them to complete tasks on the iPads that require complex motor skills movement.

Previous Studies

Previous studies have focused on children's motor skills as they interact with the technology of their era. Thus, these studies were deemed relevant to this research study. An important study related to this research was conducted by Aziz et al. (2013) and replicated by Aziz et al. (2014). The first study was conducted in London (Aziz et al., 2013) and replicated in Malaysia (Aziz et al., 2014). The authors of these two studies examined the following iPad gestures: (a) tap, (b) drag/slide, (c) free rotate, (d) drag and drop, (e) pinch, (f) spread, and

(g) flick. The 2-, 3-, and 4-year-olds interacted with the iPad using four apps (Aziz et al., 2013, 2014). The authors determined that 2-, 3-, and 4-year-olds in London and Malaysia were able to perform these fine motor gestures while using iPads.

In a previous study that investigated interactivity using pointing devices but not touch screens or iPad gestures, Donker and Reitsma (2007) found children in kindergarten and first grade had not yet fully developed their motor skills and were more likely to click incorrect targets. Results of this study showed that the accuracy of children's mouse clicks is related to the size of the targets (Donker & Reitsma, 2007). Donker and Reitsma studied 5- and 6-year-old school-aged children who were in the age group mentioned in Gallahue and Ozmun's (1998) phases of motor development. Additionally, Donker and Reitsma (2007) used a mouse to interface with the computer. Fine motor control is required to operate a mouse, and children scored lower as the objects became smaller (Donker & Reitsma, 2007). Devices like iPads give children control of a touch screen to interface with the apps, without requiring the motor skills needed to operate a mouse. The use of the touch screen allowed me to include 2-, 3-, and 4-year-old children in this research study.

A study initiated by the Michael Cohen Group (MCG) explored the perceptions of children and their caregivers regarding the use of iPads and apps (Cohen, Hadley, & Frank, 2011). The authors found:

1. Children as young as 2 years old could play with touch screen devices and learn to target, to press, to drag hard and slowly, and to tap or swipe.

2. Children aged 4 to 5 years old used gestures in a more directed and intentional way; first presses or drags quickly evolved to taps and swipes with trial and error.
3. Children aged 6 to 8 years old quickly figured out the moves that worked; children sometimes pressed too hard initially but soon tapped and targeted with better control. (Cohen et al., 2011, p. 10)

Further, Cohen et al. (2011) suggested that apps need to be age appropriate. The effective app interface design is also critical in apps for children. Cohen et al. suggested that apps are user-friendly and support the player's capabilities. For this research study, 2-, 3-, and 4-year-olds interacted with four age-appropriate iPad apps. These apps were Toca Kitchen Monsters, Toca Hair Salon, AlphaBaby Free, and Montessori Crossword. A review of the operation of these apps is further discussed in the Applications section of this chapter.

Aziz et al. (2013, 2014) conducted two relevant studies. The first study was conducted in London (Aziz et al., 2013) and the second study was replicated in Malaysia (Aziz et al., 2014). In selecting the apps to be used in Aziz et al. (2013), the researchers analyzed 100 apps using three search categories: books, kids, and entertainment. The results of this search are summarized in below. Table 1 shows the iPad gestures and the number of apps that used them.

Table 1

Gestures and the Percentage of Apps That Used Each

Gestures	The Percentage of Apps
Tap	86%
Drag/Slide	56%
Free Rotate	40%
Drag & Drop	22%
Pinch	14%
Spread	11%
Flick	9 %

Note: Adapted from "Selection of touch gestures for children's applications," by N. A. A. Aziz, F. Batmaz, R. Stone, & P. W. H. Chung, 2013. Paper presented at the Science and Information Conference, London, UK, p. 2.

The seven iPad gestures in Table 1 shows: (a) tap was 86%, (b) drag/slide 56%, (c) free rotate 40%, (d) drag and drop 22%, (e) pinch 14%, (f) spread 11%, and (g) flick 9% of the top 100 apps the those search category. Aziz et al. (2013, 2014) investigated the abilities of 2-, 3-, and 4-year-olds in London and Malaysia to perform these iPad gestures. The 2-, 3-, and 4-year-olds interacted with the iPad using four apps. Aziz et al. (2013, 2014) recorded the iPad gestures of children as they played on each app for 4 to 5 minutes. The researchers, with the parent or teacher, guided the children to play with each app at least once. Aziz et al. (2013, 2014) reported the percentages of children who demonstrated the iPad gestures, shown in Table 2.

Table 2

London and Malaysia iPad Gesture Results

Gestures	Age: 2 (n=11) London	Age: 2 (n=10) Malaysia	Age: 3 (n=11) London	Age: 3 (n=14) Malaysia	Age: 4 (n=15) London	Age: 4 (n=16) Malaysia
Tap	100%	100%	100%	100%	100%	100%
Drag/Slide	100%	100%	100%	100%	100%	100%
Free Rotate	55%	40%	91%	100%	100%	100%
Drag & Drop	36%	30%	100%	100%	100%	100%
Pinch	55%	30%	82%	71%	100%	100%
Spread	11%	10%	36%	64%	100%	100%
Flick	36%	80%	73%	100%	100%	100%

Note: Adapted from "Selection of touch gestures for children's applications," by N. A. A. Aziz, F. Batmaz, R. Stone, & P. W. H. Chung, 2013. Paper presented at the Science and Information Conference, London, UK, p. 99; and "Selection of touch gestures for children's applications: Repeated experiment to increase reliability," by N. A. A. Aziz, N. S. M. Sin, F. Batmaz, R. Stone, & P. W. H. Chung, (2014). *International Journal of Advanced Computer Science and Applications, 5*(4), p. 6.

Table 2 shows that fewer than 50% of the 2-year-olds performed some of the iPad gestures. Fewer than half (36%) of the London 2-year-olds performed drag and drop and flick. Thirty percent of the 2-year-old children in the Malaysian sample performed the drag and drop gesture during the research session. The 2-year-olds used the spread gesture the least (11% of the London sample and 10% of the Malaysian sample). Table 2 also shows that 100% of the London 2-year-olds performed tap and drag/slide, and 55% of the London 2-year-olds performed free rotate and pinch.

In the Malaysian sample, 100% of the children used tap and drag/slide; however, 40% used free rotate and 30% used pinch. The majority (between 71% to 100%) of the Malaysian 3-year-olds could perform most of the iPad gestures. One hundred percent of the 3-year-olds in both the London and Malaysian samples used tap, drag/slide, and drag and drop. In the London sample, 91% of the 3-year-olds and 100% of the Malaysia sample used free rotate. Thirty-six percent of the London 3-year-olds and 64% of the Malaysian 3-year-olds performed the spread gesture. All of the 4-year-old children in the study were able to perform all seven iPad gestures.

The current research study is a partial replication of the two previous studies described (Aziz et al., 2013, 2014). In this research study, I investigated the iPad gestures of 41 2-, 3-, and 4-years-old children who used iPads by themselves and in dyads. Additionally, biographical information was collected, including (a) child's age, (b) household income, (c) child's gender, (d) child's ethnic background, (e) types of devices used, (f) daily iPad usage, (g) people with whom the child used the iPad, (h) earliest age of iPad usage, and (i) the primary language spoken at home. The biographical results are reported in Chapter 4.

Summary

The presence of iPads in classrooms is evident. As discussed, iPads can be considered educational tools that can be used in conjunction with the early learning theories of Gallahue and Ozmun (1998), Vygotsky (1978), E. J. Gibson (1982), , and Bandura and Walters (1963). iPads run user-friendly apps. Operating an iPad has become so easy even a child can use it. The many new applications in the Apple Apps Store and the ease of the user interface make the iPad a potentially valuable educational tool.

CHAPTER THREE: METHODOLOGY

Introduction

In this chapter, I describe the participant population employed in this research study. Next, I explain the research design, which consisted of three data collection phases. In addition, I describe the iPad applications and instruments used in this research study. After restating the research questions used to guide this study, I discuss the data analyses used in this study. Finally, I address ethical considerations.

Participants

The participant population of this research study consisted of a set of 2-, 3-, and 4-year-old children (N = 41) who attended school at Orlando Day Nursery, a daycare facility located in downtown Orlando. For over 90 years, this location has served a low-income community (Orlando Day Nursery, 2015). The research participants were divided into three age groups consisting of 2-year-olds, 3-year-olds, and 4-year-olds. The targeted age groups were selected for this research study in order to replicate the ages of the participant populations used in previous studies (Aziz et al., 2013, 2014).

Three- and 4-year-olds are in the fundamental movement phase theorized by Gallahue and Ozmun (1998). Children in the fundamental movement phase have greater control and better rhythmical coordination of fundamental movements than do younger children (Gallahue & Ozmun, 1998). This means 3- and 4-year-old children should have the necessary motor skills to operate an iPad effectively. In order to closely replicate the two previous studies (Aziz et al.,

2013, 2014), I included a group of 2-year-old children in this research study. I selected the sample size of this research study to match the sample size used in the Aziz et al. (2013) and Aziz et al. (2014) studies. In addition, the age distribution within the sample for this research study was matched, as closely as possible, to the age distributions of Aziz et al. (2013) and Aziz et al. (2014). Information about the samples of the Aziz et al. (2013) study, the Aziz et al. (2014) study, and the current study is shown in Table 3. The information on Table 3 is limited to age of the children due to the sparse amount of information about the samples employed in Aziz et al. (2013) and Aziz et al. (20140. My goal was to keep the age distribution close to the distributions reported in the previous studies. The information on Table 3 is limited to age of the children due to the sparse amount of information about the samples employed in Aziz et al. (2013) and Aziz et al. (2014).

Table 3

Samples of Aziz at. (2013), Aziz et al. (2014), and the Current Study

Age	Sample of Aziz et al. (2013) London	Sample of Aziz et al. (2014) Malaysia	Sample for Current Study (2015) Orlando
2-years-old	10	11	12
3-years-old	14	11	15
4-years-old	16	15	14
Total	40	37	41

Note: Adapted from "Selection of touch gestures for children's applications," by N. A. A. Aziz, F. Batmaz, R. Stone, & P. W. H. Chung, 2013. Paper presented at the Science and Information Conference, London, UK, p. 2; and "Selection of touch gestures for children's applications: Repeated experiment to increase reliability," by N. A. A. Aziz, N. S. M. Sin, F. Batmaz, R. Stone, & P. W. H. Chung, (2014). *International Journal of Advanced Computer Science and Applications, 5*(4), p. 6.

The participant sample was divided into three groups of children based on age of the child in all three of the studies. The three groups are (a) 2-year-old children, (b) three-year-old children and (c) four-year-old children. A review of Table 3 shows the samples used in this research study, the Aziz et al. (2013) study and the Aziz et al. (2014) study. The total sample size of the London sample (Aziz et al., 2013) consisted of 40 children, Malaysia sample (Aziz et al.

(2014) consisted of 47 children, and the Orlando sample for this research study consisted of 41 children. The sample sizes of the 2-year-old children for the London study was 10, for the Malaysian study was 11, and for this research study was 12. The sample sizes of the 3-year-olds for London study was 14, for the Malaysian study was 11, and this research study was 15. The sample sizes of the 4-year-old children for the London study was 16, for the Malaysian study was 15, and for this research study was 14.

Orientation to Research Design

During the first 2 weeks of this research study, the pre-data collection phase, the children were introduced to the iPad and the applications. I collected permission slips from the parent or guardian of each child. Data collection for this study consisted of two phases. During data collection phase I, data were collected to address the first research question. The data collected consisted of the iPad gestures of 2-, 3-, and 4-year-old children while the children engaged with the iPad by themselves. Data collection phase I was a partial replication of the Aziz et al. (2013) and Aziz et al. (2014) studies. The Aziz et al. (2013) study was conducted in London, and the Aziz et al. (2014) study was conducted in Malaysia. In data collection phase II, the data collected consisted of the iPad gestures of 2-, 3-, and 4-year-old children while the children engaged with the iPad in situations involving two children (dyads). I then compared the iPad gesture data collected during data collection phase II to the iPad gesture data collected during data collection phase I.

Applications

Children had verbal guidance from an adult while using the iPads, following the data collection protocol of the previous studies (Aziz et al., 2013, 2014). Four iPad applications were used in this research study: Toca Kitchen Monsters, Toca Hair Salon, AlphaBaby Free, and Montessori Crossword. These specific applications were selected for this study because they were used in the Aziz et al. (2013) study and the Aziz et al. (2014) study. A description and examples of the specific iPad gestures needed to operate the iPad application appear in Appendix E. A list and descriptions of the applications used in this research study were included in the permission slips sent home for the parents. Table 4 shows the iPad gestures needed to operate each application.

Table 4

Application Gestures Reported by Aziz et al. (2013) and Aziz et al. (2014)

	Tap	Drag/ Slide	Free Rotate	Drag & Drop	Pinch	Flick	Spread
Toca Kitchen Monsters	Yes	Yes	Yes	Yes	No	Yes	No
Toca Hair Salon	Yes	Yes	Yes	Yes	No	Yes	No
AlphaBaby Free	Yes	Yes	Yes	No	Yes	Yes	Yes
Montessori Crossword	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: Adapted from "Selection of touch gestures for children's applications," by N. A. A. Aziz, F. Batmaz, R. Stone, & P. W. H. Chung, 2013. Paper presented at the Science and Information Conference, London, UK, p. 3; and "Selection of touch gestures for children's applications: Repeated experiment to increase reliability," by N. A. A. Aziz, N. S. M. Sin, F. Batmaz, R. Stone, & P. W. H. Chung, (2014). *International Journal of Advanced Computer Science and Applications, 5*(4), p. 6.

A review of Table 4 shows the four applications used in this research study along with the iPad gesture needed to operate each application as reported by Aziz et al. (2013) and Aziz et al. (2014).

For this research study, I created a description of each of the applications, Toca Kitchen Monsters, Toca Hair Salon, AlphaBaby Free, and Montessori Crossword. I describe the applications in the following paragraphs.

Toca Kitchen Monsters

In Toca Kitchen Monsters, children tap to select which character "monster" they would like to feed (see Appendix E). The child can select from eight foods: mushroom, tomato, broccoli, lemon, carrot, hot dog, steak, or a spikey fruit. The food is selected by using the tap gesture.

After selecting a food, the child selects a virtual kitchen implement to use to prepare the food. The virtual cooking implements include a cutting board, which children use by flicking across the food to cut it; a blender, which children use by tapping a button to turn on the blender or by holding their finger on the screen to keep the blender on; a pot of water, which children use by dragging and dropping the food into the pot of water to boil the food and drag/sliding their finger on the screen to stir the food; a frying pan, which children use by dragging and dropping the food into the pan and then dragging their finger across the screen to stir the food; and a microwave, which children use by dragging and dropping the food into the microwave oven. Next, they press a button to turn on the microwave, and after 10 seconds, hear a series of beeps like a real microwave.

After children have used the virtual implements to prepare the food, they can place the food back on the plate and add salt and pepper to the food. Adding salt and pepper is

accomplished by placing a finger on the salt or pepper and sliding it up and down on top of the food. On the screen, black and white dots appear, which represent the salt or pepper falling on the food.

At any time during this application, children can drag the food item over to the monster and feed it to the monster or "throw" the food into the air. This is done by dragging and dropping the food item over the mouth of the monster or by flicking the food upward on the screen. The iPad gestures used to operate this application are tap, drag/slide, drag and drop, and flick.

Toca Hair Salon

In Toca Hair Salon (see Appendix E), children select from six characters. Each character has unique hair styles, color styles, and sounds. Children select a character by tapping on the character. After characters are selected, children can slide or flick their finger across the bottom row to scroll across six sections. The sections present children with different choices of elements to add to the character. The first section has three hair elements: a comb, which children use by sliding their finger across the hair of the character; a pair of hair-cutting scissors, which children use by tapping on the hair or dragging their finger across the screen; and a hair-growing brush, which children use by tapping or dragging their finger across the screen.

The second section shows three hair elements: a blow dryer, which children use by tapping their finger on the screen or holding their finger on the screen; a camera, which children use by tapping the camera and then tapping anywhere on the screen to take a picture of the character; and a pair of hair clippers, which children use the same way they use the scissors.

The third and fourth sections can be used in a similar fashion to change the hair color of the characters by tapping on the character's hair or by dragging a finger across the iPad screen. Children can choose white, orange, dark orange, brown, black, gray, red, green, pink, purple, yellow, or baby blue. The fifth section has three elements: a towel, which children use the same way they use the scissors; shampoo, which children use the same way they use the colors; and a shower, which children use the same way they use the camera. The sixth and last section offers a selection of accessories children can add to the characters' hair. Children add these accessories by dragging and dropping the accessory to the hair. The accessories include bow ties, hair clips, feathers, flowers, hair ties, and hair pins. The iPad gestures used to operate this application are tap, drag/slide, drag and drop, and flick.

AlphaBaby Free

In AlphaBaby Free (see Appendix E), children open the application to a blank screen. The screen stays blank until children touch it. When children tap the screen, a set of random objects appears on the screen. The objects include shapes, numbers, and letters. These objects appear on the screen in random configurations (e.g., a blue triangle, a pink "3," or a red "R"). A maximum of six shapes, numbers, or letters can appear on the screen, and there are never shape duplicates (e.g., a purple triangle and a yellow triangle cannot appear on the same screen). Tapping on the screen creates new random shapes, numbers, or letters, replacing the old ones.

To use this application effectively, the children must perform all seven iPad gestures. Children can perform each iPad gesture by tapping the screen to bring up new random shapes,

numbers, or letters. Once the object is on the screen, children can select which one they want to interact with by placing their finger on the object. When their finger is on the object, children can take a variety of actions. For example, they can move objects across the screen by dragging or sliding to move that object across the screen. Children can turn the object using free rotate by placing two fingers (two fingers from one hand or one finger from each hand) on the screen and rotating clockwise or counterclockwise on the screen. Children can move objects to a specific location and interact with another object by dragging and dropping the object anywhere on the screen, removing their finger off the screen, and tapping a new object. Children can make objects smaller using a pinch by placing two fingers (two fingers from one hand or one finger from each hand) on the screen and bringing the fingers together. Children can make objects larger using spread by placing two fingers (two fingers from one hand or one finger from each hand) on the screen and moving them apart. Finally, children can "throw" the object across the screen, making it "bounce" around on the screen by flicking the object across the screen. The iPad gestures used to operate this application are tap, drag/slide, free rotate, drag and drop, pinch, spread, and flick.

Montessori Crossword

The fourth and final application is Montessori Crossword (see Appendix D). In this application, children are required to spell a three-letter word by using the iPad drag-and-drop gesture. On the screen, children are given a picture of the word, as well as three empty boxes for each letter of the word and the 26 letters of the alphabet, arranged along the bottom of the screen. Children can hear the word by tapping the picture, hear the phonetic sound of the letter by

tapping on the empty box, or hear the phonetic sound of any letter by tapping on any of the 26 letters of the alphabet on the bottom of the screen (the letters used in the word are highlighted; consonants are red, and vowels are blue). Children can spell the word by tapping the letter and dragging and dropping the letters into the box. Putting the correct letters in the correct boxes creates a "ding" sound, giving children an audio cue that their action is correct. Putting incorrect letters in the box sends the selected letter back to the bottom of the screen and creates a "swhoop" sound, giving the children an audio cue that their action was incorrect. After children place the letters in the correct boxes, they can move to the next screen by tapping a highlighted box. This creates a new screen on which children can watch some animation and interact with the screen. The animations have random shapes, themes, movements, and colors. Children interact with all of the animation by tapping to make new objects appear or sliding a finger across the screen to make the animation follow the movement across the screen. The iPad gestures used to operate this application are tap, drag/slide, drag and drop, and flick.

iPad Gestures

All four of the applications require iPad gestures to operate them on the iPad. I investigated seven iPad gestures, defined as follows:

1. Tap is a light strike of one finger with a quick motion on the screen.
2. Drag/slide is placing one finger on the screen and moving it to another location on the screen without removing the finger off the screen.
3. Free rotate is placing two fingers on the screen and twisting them without removing the finger off the screen.
4. Drag and drop is placing one finger on the screen and moving it to another location on the screen and removing finger off the screen, generally after completing a task or after moving an object to a designated location or having an objective.
5. Pinch is placing two fingers on the screen and moving them closer together.
6. Spread is placing two fingers on the screen and moving them apart.
7. Flick, also known as "swipe," is placing a finger on the screen to brush the surface.

An expanded definition of each iPad gesture is provided in Appendix E; examples of each gesture are given.

Data Collection Procedures

In this section, I discuss the three phases of the data collection process. Table 5 shows the data collected in this research study.

Pre-Data Collection Phase

In the pre-data collection phase, I introduced the devices to the children in the four Orlando Day Nursery classrooms. The participant pool was selected from these four classrooms. I presented an introduction session to the research study that lasted between 5 to 10 minutes during circle time when I addressed all of the children in each classroom as a group. During this introduction session, I explained my intentions in the classrooms, described how I would use the collected data, discussed proper iPad etiquette, explained the basic use of the iPad, and showed the basic use of each application.

In addition, during the classroom introductory session, I introduced the research assistants and distributed the permission slips, the Biographical Information and Mobile Device Use Questionnaire (Appendix C), and an informational flyer (Appendix G). I explained that the permission slips were to be signed by the children's parents and guardians and were required to allow the children to be part of this research study. I explained that the questionnaires were to be filled out by the parents and guardians and returned to Orlando Day Nursery. The informational flyer provided the parents and guardians of the children with a description of the study. These steps constituted the pre-data collection phase.

Table 5

Data Collected

Data	When	Why	How
(a) age (b) household income (c) gender (d) ethnic background (e) types of devices (f) daily usage (g) with whom child uses iPad (h) earliest age of iPad usage (i) primary language	Weeks 1 and 2	To gather biographical information about children and their use of mobile devices	Biographical Information and Mobile Device Use Questionnaire
(a) tap (b) drag/slide (c) free rotate (d) drag and drop (e) pinch	Weeks 3 to 7	To replicate studies on 2-, 3-, and 4-year-old iPad gestures	iPad Gestures Checklist

Data	When	Why	How
(f) spread (g) flick			
(a) tap (b) drag/slide (c) free rotate (d) drag and drop (e) pinch (f) spread (g) flick	Weeks 8 to 11	To replicate studies on 2-, 3-, and 4-year-old iPad gestures while in dyads	iPad Gestures Checklist

Over the 2 weeks of the pre-data collection phase, to reinforce how to handle iPads, I reviewed the information from the introduction session with the classes at the end of each week. During these sessions, I focused on the basic etiquette of iPad handling and usage with the children. Mishandling the iPad can damage the screen. As an additional layer of protection for the screens, I added shock- and drop-proof cases on the iPads used for this research study.

Throughout the pre-data collection phase, I visited the four participating classrooms during the times the children were being dropped off and picked up from ODN by parents and guardians. During these visits, I picked up permission slips and the Biographical Information and Mobile Device Use Questionnaires. During these visits, I contacted the parents who had not

returned permission slips and asked them to read the information packets. Table 6 shows the schedule used to collect permission slips and questionnaires. I conducted no recordings in this phase.

Table 6

Pre-Data Collection Phase Timeline

Pre-Data Collection Phase	Monday	Tuesday	Wednesday	Thursday	Friday
Week 1	Introduction of study to children in classrooms **1 & 2**, hand out permission slips	Introduction of study to children in classrooms **3 & 4**, hand out permission slips	Hand out Biographical Information & Mobile Device Use Questionnaire	Return of permission slips classrooms **1, 2, 3, or 4**	Return of permission slips classrooms **1, 2, 3, or 4**
Week 2	Return of permission slips classrooms **1 & 2**	Return of permission slips classrooms **3 & 4**	Collect Biographical Information & Mobile Device Use Questionnaire classrooms **1, 2, 3, & 4**	Return of permission slips classrooms **1, 2, 3, or 4**	Return to collect all documents in classrooms **1, 2, 3, or 4**

Data Collection Phase I

In weeks 3 through 7, I started the data collection. In this phase, children were recorded operating the iPad by themselves. Data collection phase I comprised five goals: (a) to show children how to perform all seven of the iPad gestures, (b) to allow children to operate all four applications that were involved in the research study, (c) to record children for at least 4 minutes as they operated the applications, and (d) to code the data from the recordings. Table 7 shows the timeline for data collection phase I.

Table 7

Data Collection Phase 1 Timeline

Data Collection Phase I	Monday	Tuesday	Wednesday	Thursday
Week 3	Record children **1-3**	Record children **3-6**	Record children **7-9**	Code, analyze, and write up data
Week 4	Record children **1-12**	Record children **13-15**	Record children **16-18**	Code, analyze, and write up data
Week 5	Record children **19-21**	Record children **22-24**	Record children **23-25**	Code, analyze, and write up data
Week 6	Record children **26-28**	Record children **29-31**	Record children **32-35**	Code, analyze, and write up data
Week 7	Record children **36-38**	Record children **39-41**		Code, analyze, and write up data

As Table 7 shows, in data collection phase I, I partially replicated two previous gesture studies (Aziz et al., 2013, 2014). The procedures for these two studies were identical (Aziz et al., 2013, 2014). The procedures included a session prior to the recording of the session, in which

each participant child was brought to a designated recording area one at a time and given time to familiarize himself or herself with the four applications (Aziz et al., 2013, 2014). Then, children were given an opportunity to demonstrate each iPad gesture 3 to 5 times, with the assistance of the researcher or teacher (Aziz et al., 2013, 2014). Following this demonstration, the recording sessions took place. In Aziz et al. (2013, 2014), the children's participation consisted of one session of approximately 15 to 20 minutes. During the recorded part of the session, the children were allowed to play with all four applications for 4 to 5 minutes each and given verbal guidance (Aziz et al., 2013, 2014). The researchers in these two studies coded the iPad gestures from the recordings (Aziz et al., 2013, 2014).

For this research study, I created the iPad Gestures Checklist (Appendix B), which included the seven gestures used in Aziz et al. (2013) and Aziz et al. (2014). The iPad Gestures Checklist was used to code every time a child performed an iPad gesture while operating the iPad. Aziz et al. (2013); Aziz et al. (2014) did not include a script on how to perform each iPad gesture. For this research study, I developed and used the following script to instruct children in the classrooms on how to perform the iPad gestures.

- *(Me at classroom):* Hi, my name is Lap. Would you like to play some games on an iPad today? Would it be okay for me to record you playing on the iPad?
- <Wait for child to consent>
- *Me*: Great and thank you! Now let's go play with some games on the iPad!
- <Walk toward the cafeteria (designated recording area)>
- *Me:* This is how you tap on the iPad.

- <Tap the screen for child to see>
- *Me:* This is how you drag and slide on the iPad.
- <Drag/slide the object across the screen>
- *Me:* This is how you do free rotate on the iPad.
- <Place two fingers on the screen and rotate the object>
- *Me:* This is how you drag and drop on the iPad.
- <Drag the object on the screen and drop it at a designated location>
- *Me:* This is how you pinch on the iPad.
- <Place two fingers (of the same hand) on the screen and bringing them closer together>
- *Me:* Or, you can do this to pinch.
- <Place two fingers (from different hands) on the screen and bring them closer together>
- *Me:* This is how you spread on the iPad.
- <Place two fingers (of the same hand) on the screen and pushing them further apart>
- *Me:* Or, you can do this to spread.
- <Place two fingers (from different hands) on the screen and pushing them further apart >
- *Me:* This is how you flick on the iPad.
- <Place one finger on the screen and brush the surface of the screen>
- <Allow child to imitate all the gestures for the remaining 20 minutes>

- *Me:* Now we are going to play with all four games, okay?
- <Record child playing with each application for 4 minutes>

Data Collection Phase II

During data collection phase II, each child was paired with a classmate, forming a dyad. The dyads were escorted to the designated research area and recorded as they operated a shared iPad. The dyads were recorded for at least 4 minutes as the children operated the applications on the iPad. The resulting recordings were coded.

In data collection phase II, I enlisted the help of the classroom teacher to pair the children into dyads. To obtain a higher likelihood of getting higher interaction between the children, I asked the teacher to pair children who regularly interacted with one another in the classroom. With the help of a research assistant, the dyads were escorted from their classrooms to the designated research area where all the recordings took place. Table 8 shows the timeline for data collection phase II.

Table 8

Data Collection Phase II Timeline

Data Collection Phase II	Monday	Tuesday	Wednesday	Thursday
Week 8	Record Dyad 1-3	Record Dyad 4-6	Record Dyad 7-9	Code, analyze, and write up data
Week 9	Record Dyad 10-12	Record Dyad 13-15	Record Dyad 16-18	Code, analyze, and write up data
Week 10	Record Dyad 19-20	Collect missing data	Collect missing data	Code, analyze, and write up data
Week 11	Code	Code	Code	Code, analyze, and write up data

Children in data collection phase II were familiar with the iPad gestures, the iPad, and the four applications because they had participated in the pre-data collection phase and in data collection phase I. Data collection phase II was completed in 4 weeks by recording 45 minutes a day, taking no longer than 15 minutes to record each dyad of children. The dyads were recorded for 3 minutes prior to the free play session as a "warm up." This gave the children time to reacquaint themselves with the iPad and the research assistants time to set up the applications on

the iPad. Below is a general script that I used as I picked the children up from their classrooms in data collection phase II:

- *(Me at classroom):* Hi, my name is Lap. Would you like to play with iPads again today?
- <Wait for children to consent>
- *Me:* Great and thank you! Now follow my friend [research assistant's name] and let's go this way!
- <Walk toward the cafeteria (designated research area)>
- <Once everyone is at the study table>
- *Me*: Here's the iPad; what game would you two like to play first?
- *Me*: Remember to share with your friend.
- <Place camera to record the children>
- <Record 4 to 5 minutes>
- *Me*: Thank you for your help, we are going back to the classroom now.
- <With the help of the research assistant, escort the children back to the classroom>

Instrumentation

The instruments used in this study were the iPad Gestures Checklist (Appendix B) and the Biographical Information and Mobile Device Use Questionnaire (Appendix C). Both of these instruments were developed specifically for this research study.

iPad Gestures Checklist

For this research study, I developed and used the iPad Gestures Checklist (Appendix B) to track the seven iPad gestures previously presented in Chapter 2. Children were recorded as they operated an iPad. Using these recordings, the research assistants coded an observation as "yes" if children were observed making one of the iPad gestures and "no" if they were not observed making one of the iPad gestures. This coding scheme resulted in a code of "yes" or "no" for each of the iPad gestures for each of the four applications. Coders were trained on the definitions of each of the iPad gestures and the coding procedures prior to coding the recordings. The iPad gestures were clearly defined for the research assistants (Appendix E).

Biographical Information and Mobile Device Use Questionnaire

I designed the Biographical Information and Mobile Device Use Questionnaire (Appendix C) to gather demographic information about the children in this research study. The information included (a) the child's age, (b) household income, (c) the child's gender, (d) the child's ethnic origin, (e) the types of mobile devices in the child's home, (f) the child's daily usage of mobile devices, (g) people with whom the child used mobile devices, (h) the child's earliest age of device usage, and (i) the primary language spoken at home. The results of the questionnaire are reported in Chapter 4. The household income question consisted of three income categories created by ODN: household income less than $25,000, household income of $25,000 to $50,000, and household income of $50,000 to $100,000. ODN classified children from households with income below $25,000 as low-income.

Equipment

Three pieces of equipment were used in this study: an iPad, a hand-held video camera, and a set of child-sized table and chairs.

A fourth-generation iPad retina display was used for this research study. The older generation iPads did not have the computing power to run the updated versions of the applications used in the study. The iPad was selected because of the following reasons, as previously discussed in Chapter 2:

1. Popularity – Over 200 million have been sold as of 2014 (Statista, 2015).
2. Portability – Unlike laptops and personal computers, the iPad 2 is compact, weighing 1.44 pounds and measuring 9.5 inches × 7.31 inches × .37 inches.
3. Screen – The iPad uses a touch screen rather than the keyboard and mouse commonly used by laptops and computers.
4. Application – There are over 1, 500,000 applications (Statista, 2015) to choose from in the online Apple Apps store.

The second piece of equipment used for this research study was a Sony hand-held video camera. This hand-held camera was selected for its ability to record in high definition and its high storage capacity. I recorded all sessions in 720 pixel resolution, creating 296 files totaling 215 gigabytes (GB). The final piece of equipment was a set of child-sized table and chairs, provided by ODN.

Research Questions

Five research questions guided this study. RQ1 was a partial replication of two previous studies (Aziz et al., 2013, 2014). The iPad gestures were (a) tap, (b) drag/slide, (c) free rotate, (d) drag and drop, (e) pinch, (f) spread, and (g) flick, coded from video recordings using the iPad Gestures Checklist (Appendix B).

1. What are the percentages of 2-, 3-, and 4-year-old children who performed seven iPad gestures in a free play session in which the children operated iPads by themselves?
2. What are the percentages of 2-, 3-, and 4-year-old children who performed seven iPad gestures in a free play session in which the children operated iPads in dyads?
3. What are the percentage differences in iPad gestures performed by a sample of 2-, 3-, and 4-year-old Orlando children who operated iPads by themselves in a free play session, compared to the iPad gestures of a sample of London children (Aziz et al., 2013)?
4. What are the percentage differences in iPad gestures performed by a sample of 2-, 3-, and 4-year-old Orlando children who operated iPads by themselves in a free play session, compared to the iPad gestures of a sample of Malaysian children (Aziz et al., 2014)?
5. What are the percentage differences in iPad gestures performed by a sample of 2-, 3-, and 4-year-old Orlando children who operated iPads by themselves in a free play session, compared to when the children operated the iPads in dyads?

Data Analysis Procedures

Data collected in this research study were entered into Statistical Package for the Social Sciences (SPSS) version 22. Microsoft Excel was used to create the graphics for the tables and figures. The research questions were answered by coding the recorded sessions in data collection phases I and II using the iPad Gestures Checklist. The results of data collection phases I and II were compared with the results of two previous studies (Aziz et al., 2013, 2014). The percentage difference of children who performed the iPad gestures are reported in Chapter 4. The percentage difference was calculated by first subtracting the old value from the new value, dividing that number by the old value, and finally, multiplying the result by 100 (Gall et al., 2007).

$$(\text{new value} - \text{old value}) / \text{old value} \times 100$$

Data collected from the Biographical Data and Mobile Device Use Questionnaire were analyzed with SPSS. The data reported from the questionnaire consisted of (a) the child's age, (b) household income, (c) the child's gender, (d) the child's ethnic origin, (e) the types of mobile devices in the child's home, (f) the child's daily usage of mobile devices, (g) people with whom the child used mobile devices, (h) the child's earliest age of device usage, and (i) the primary language spoken at home.

Ethical Considerations

After this research study was approved by the dissertation committee, I requested approval from the Institutional Review Board (IRB) to conduct the research study. I then contacted the director of ODN, the data collection site, to get approval to conduct this research

study at ODN. Once written approval was given from IRB (Appendix A) and from ODN (Appendix D), data collection commenced. Ethical considerations are discussed in the next section.

IRB Procedures

Because my research study involved human subjects, I secured the Institutional Review Board's (IRB) approval to conduct the research study and to collect biographical information about children in the research study. The biographical information consisted of (a) the child's age, (b) household income, (c) the child's gender, (d) the child's ethnic origin, (e) the types of mobile devices in the child's home, (f) the child's daily usage of mobile devices, (g) people with whom the child used mobile devices, (h) the child's earliest age of device usage, and (i) the primary language spoken at home. These data were collected using a questionnaire (Appendix C) filled out by the parents or guardians of the children, along with consent to allow their children to participate in this research study.

A multistep procedure was used to gain permission for the children's participation. First, I secured permission to collect data at the site from the director of ODN. Second, I secured permission from the parents and guardians of the children to record the children's iPad gestures. Third, I secured consent from the children participating in the research study.

Participation in this research study was voluntary. For this research study, children were recorded as they used the apps on the iPad. The recordings of the children's iPad gestures were coded. Children whose parents did not sign the consent form were not recorded. To further

reduce the risk of accidentally recording children who were not part of research study, recordings took place outside of the classrooms. Instead, the recordings took place in a space outside the cafeteria, set aside for this research study. Parents also knew that participation in the research study was voluntary and that they could withdraw their children at any time.

Children participating in this research study were identifiable because they were recorded. Steps were taken to keep the identities of the children confidential. All children participating in the research study were given a three-digit number (code) so their real names were never used. This code was used to label the recordings and all paper documents in this research study. Because children were asked to return in data collection phase II, a master list showing children's number and names was maintained. I was the only one to handle and have access to hard drives that contained recordings, hard-copy files of children in this research study, and the master list of names and identification numbers. Only one back-up of the recordings collected in this research study was maintained. The back-up of the recordings was stored on a separate hard drive and, as an additional step to maintain the confidentiality of the children's data, never stored in the same location as were the hard-copy files. None of the recordings was stored online or posted on social media outlets. The method of data storage was approved by the IRB of the University of Central Florida. Data for this research study were always kept within a locked file cabinet inside a locked room in the research laboratory on campus at the University of Central Florida.

Research Assistants

The recordings were coded by a team of research assistants. I trained the research assistants on how to code the recordings. At least 20% of the recordings were coded independently by two research assistants to enhance reliability. The research assistants had access only to the recordings they were assigned to code. None of the recordings left the designated research laboratory located on the campus at the University of Central Florida. Research assistants were screened through an interview process and trained before they were allowed access to the data and recordings. Training of the research assistants took 7 weeks, meeting once a week. Training sessions (Appendix F) included (a) confidentiality training, (b) introduction to this research study, (c) introduction to iPad gestures, (d) coding, and (e) reliability. All the research assistants were undergraduates, and their assistance in this research study was voluntary.

Nonparticipants Protocol

Children whose parents did not wish to have them participate in the study were not excluded from normal classroom activities. In order to minimize accidental video recording of children not in this research study, the following steps were taken:

1. Recordings did not take place in the classroom; therefore, only children who had parental permission were recorded.
2. Children who were not part of this research study were not asked to leave the classroom or to enter the area where recording took place.

3. If there was an “accidental” recording of a child not in this research study, the audio and video recordings were destroyed. The recordings were not used or coded.

If a parent changed his or her mind and allowed a child to participate after the research study had started, their participation was granted on a case-by-case basis. Parents who wished to withdraw their children from this research study were allowed to do so without negative consequences, and none of their data were used.

Summary

In this chapter, I described the framework of the methodology of this research study. The selection of the sample of 2-, 3-, and 4-year-old Orlando children participants was discussed. The data collection phases were explained. In this chapter, I further explained the apps and instruments used in this study. Additionally, I restated the five research questions. Finally, ethical considerations were discussed as outlined by the University of Central Florida, and IRB protocols were presented.

CHAPTER FOUR: RESULTS

Introduction

This chapter is divided into seven sections. In section 1, I report and discuss missing data. In section 2, I report the results from the Biographical Information and Mobile Device Use Questionnaire. There were five research questions in this study, which are discussed in sections 3 through 7. In section 3, I report the results from the data collected in data collection phase I, which addressed Research Question 1. In section 4, I report the results from the data collected in data collection phase II, which addressed Research Question 2. In section 5, I report the results of the analyses related to Research Question 3. In section 6, I report the results of the analyses related to Research Question 4. In section 7, I report the results of analyses related to Research Question 5. The chapter closes with a summary.

Response Rate and Missing Data

Forty-one of 58 of the parents in the selected classrooms signed permissions slips and provided data, producing a response rate of 70.7%. The Biographical Information and Mobile Device Use Questionnaires (Appendix C) were sent home and filled out by the parent and guardians of the children in the study. Of the 41 questionnaires sent home, 41 of 41 (100%) were returned. However, some parents did not fill out all of the questions on the Biographical Information and Mobile Device Use Questionnaire, resulting in missing data for some questions. Table 9 shows a summary of the missing data on the Biographical Information and Mobile Device Use Questionnaire.

Table 9

Missing Data

		Child code	Age	Income	Gender	Ethnic	Smart phone	Tablet	Ed game player	How often daily use	Who plays with child	Earliest age with device	Language spoken at home
N	Valid	41	41	41	41	41	40	40	40	40	40	40	39
	Missing	0	0	1	0	0	1	1	1	1	1	1	2

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Table 9 shows no missing data for the questions related to the child's age, the child's gender, and the child's ethic origin. However, data were missing for questions related to household income, child's access to various types of mobile devices, child's daily usage of mobile devices, people with whom child used mobile device, and the earliest age of mobile device usage. One parent/guardian did not provide responses to these questions. The question related to the primary language in the home showed the highest frequency of missing data. Two parents/guardians did not provide responses to this question.

Biographical Information and Mobile Device Use

In this section, I report data collected from the Biographical Information and Mobile Device Use Questionnaire. The data consisted of the following: (a) the child's age, (b) household income, (c) the child's gender, (d) the child's ethnic origin, (e) the types of mobile devices in the child's home, (f) the child's daily usage of mobile devices, (g) people with whom the child used mobile devices, (h) the child's earliest age of device usage, and (i) the primary language spoken at home.

As shown in Table 2, children in this research study encompassed three age groups: 2-, 3-, and 4-year-olds. Additional data were collected in this research study that were not collected in the two previous studies (Aziz et al., 2013, 2014). The sparse information about the samples in Aziz et al., 2013, 2014) did not allow for comparisons for demographic characteristics among the three studies except for age of the children.

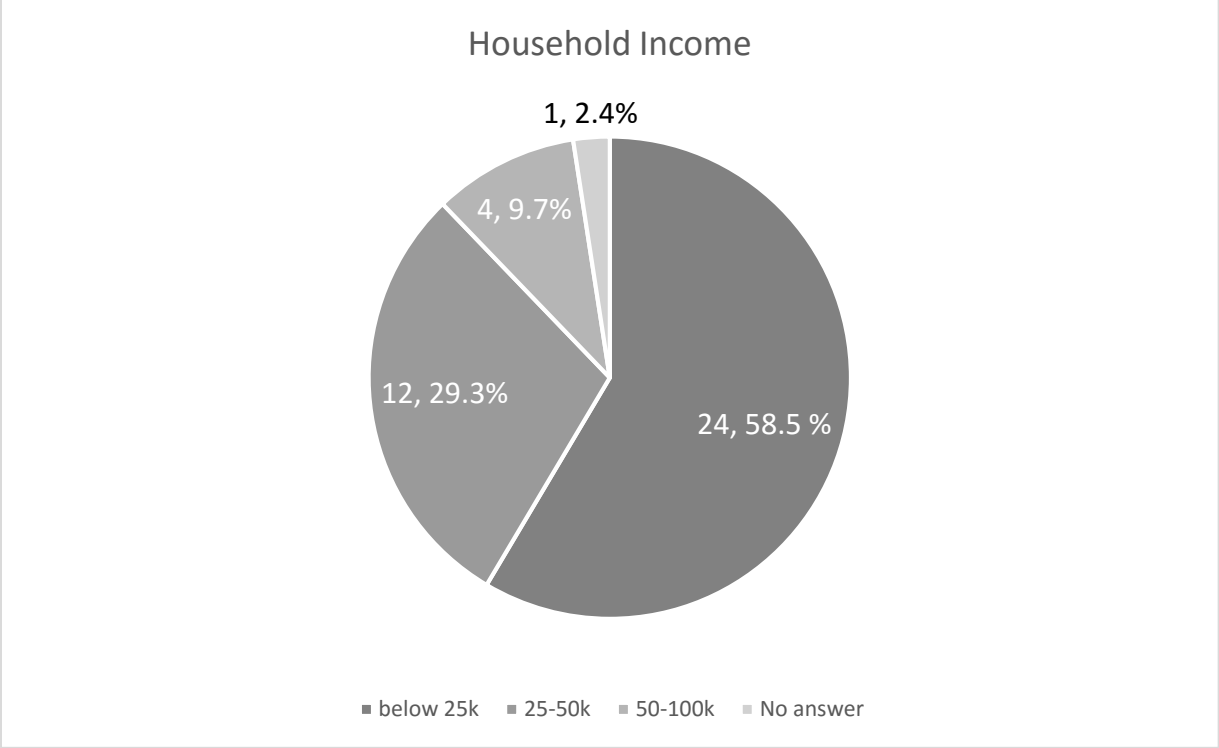


Figure 6. Household income.
(N = 41)

Figure 6 shows household income reported by parents. As previously mentioned, three income categories were created by ODN, classifying children who had household income below $25,000 as low-income. Twenty-four of 41 children (59.5%) had household incomes below $25,000, 12 of 41 (28%) had household income of $25,000 to $50,000, and 4 of 41 (10%) had household income of $50,000 to $100,000. One parent declined to answer the question.

Table 10

Child's Age Group and Gender

		Child's Gender		
		Male	Female	Total
Age Group	2-year-old children	6	6	12
	3-year-old children	7	8	15
	4-year-old children	4	10	14
Total		17	24	41

Table 10 shows there were 12 2-year-olds (30%). Six were boys and six were girls. Fifteen 3-year-olds (37%) participated; 7 were boys and 8 were girls. Fourteen 4-year-olds (33%) participated; 4 were boys and 10 were girls.

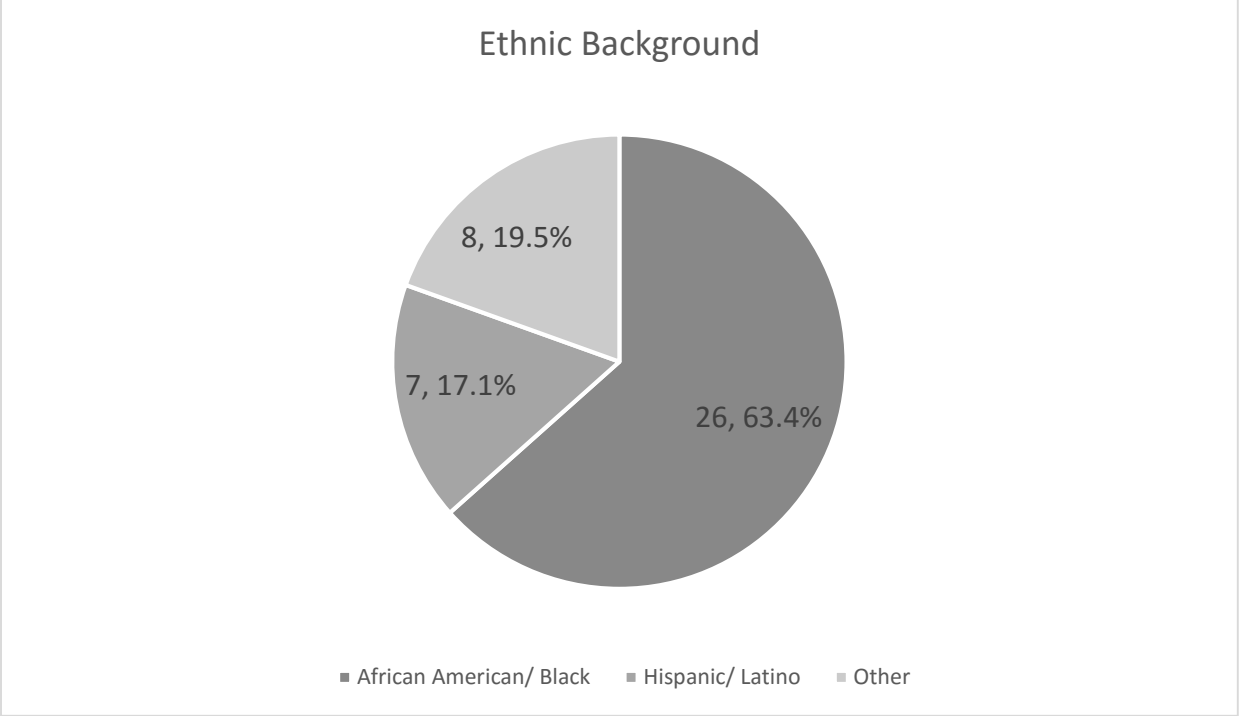


Figure 7. Child's ethnic background.
(N = 41)

Figure 7 shows the children's ethnic backgrounds as reported by their parents. Figure 7 shows 26 of 41 children (63.4%) were African American/Black, 7 of 41 (17.1%) were Hispanic/Latino, and 8 of 41 children (19.5%) were categorized as "other." This sample was reflective of the community surrounding the data collection site.

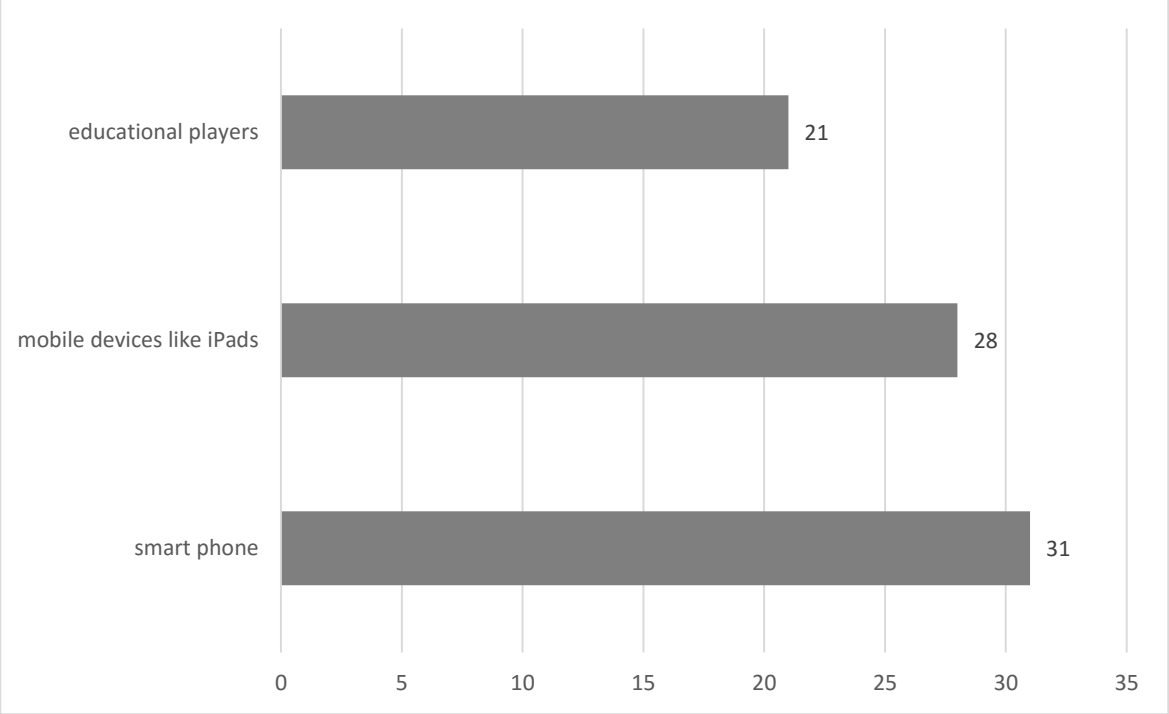


Figure 8. Type of mobile devices the children access on a daily basis. (*N* = 41; multiple responses allowed)

Figure 8 shows the types of mobile devices the children had access to on a daily basis. The children could have had access to more than one type of mobile device. Thirty-one of 41 (75.6%) had access to a smart phone, 28 of 41 (68.3%) had access to mobile devices like an iPad, Kindle FIRE, Microsoft Surface, or Galaxy tablet, and 21 of 41 (51.2%) had educational game players. Thirteen of 41 children (31.7%) had access to all three types of mobile devices. Fifteen of 41 children (36.5%) had access to two of the types of mobile devices.

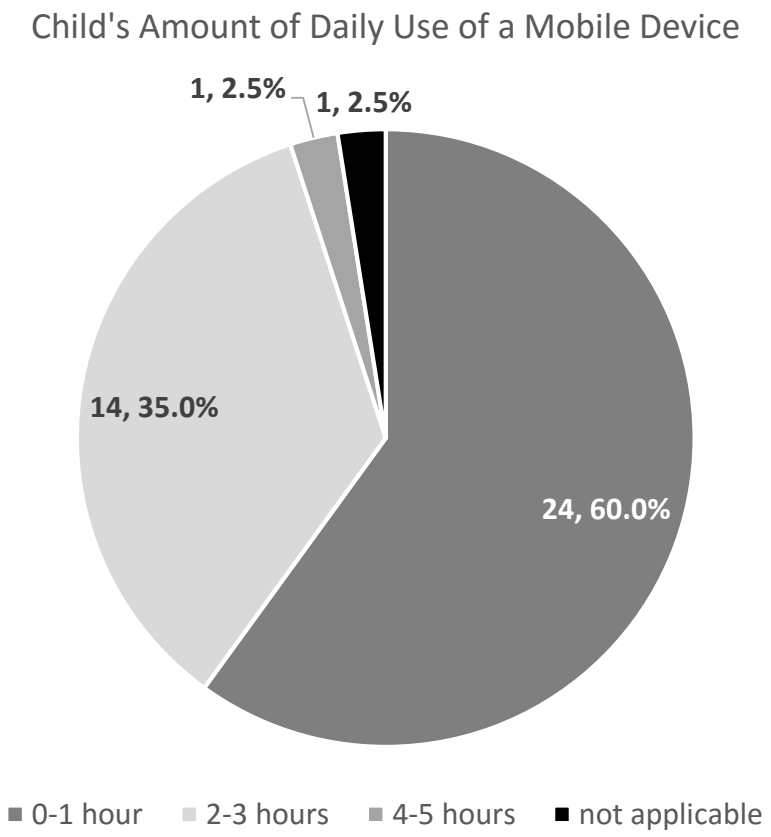


Figure 9. Child's daily use of mobile devices.
(N = 40)

Figure 9 shows the children's daily use of mobile devices, as reported by their parents. Twenty-four of 40 children (60%) used mobile devices 0 to 1 hours a day, 14 out of 40 children (35%) used mobile devices 2 to 3 hours a day, 1 of 40 children (2.5%) used mobile devices 4 to 5 hours a day, and 1 child of 41 children (2.5%) did not have access to mobile devices so the parent answered with "not applicable" on the questionnaire. The parent of one child did not complete this question.

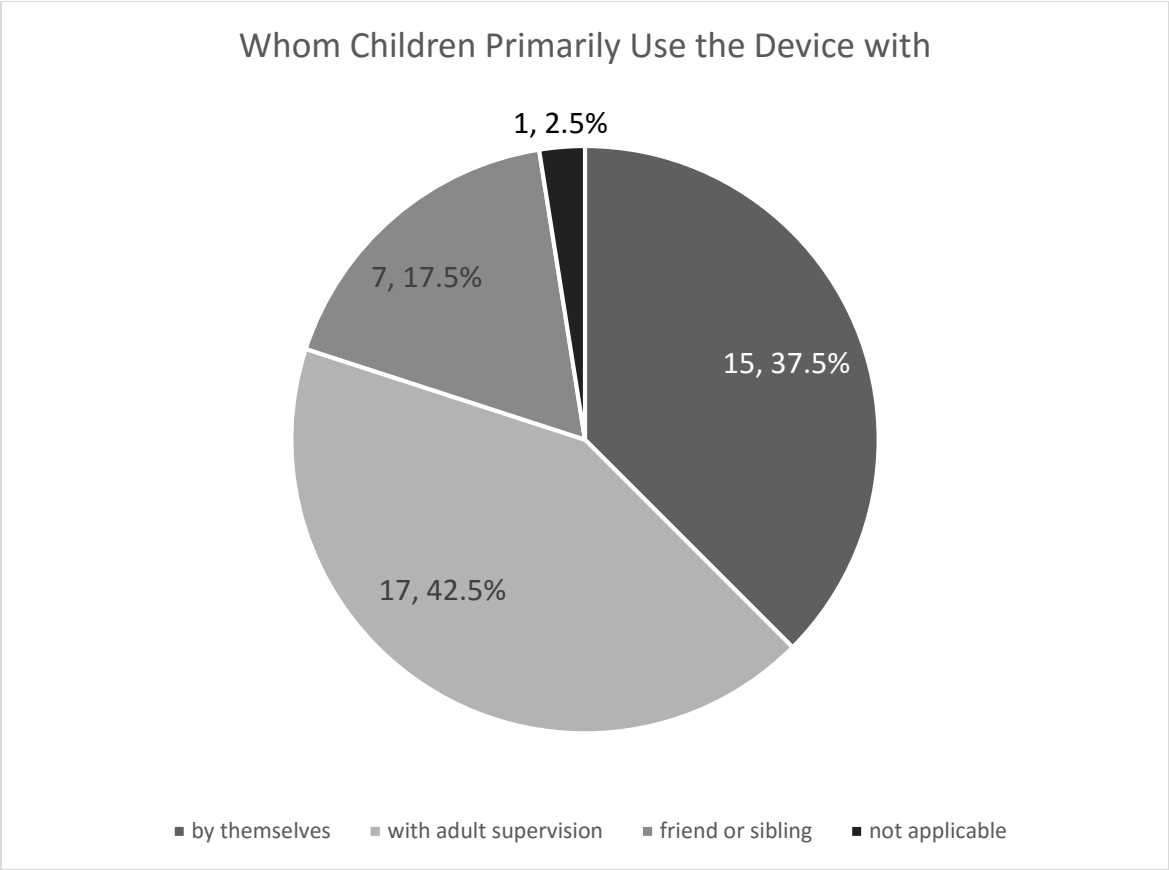


Figure 10. People with whom children primarily used the device. (N = 40)

Figure 10 shows the people with whom the children used mobile devices. Fifteen of 40 children (37.5%) used a mobile device by themselves, 17 of 40 children (42.5%) used a mobile device with adult supervision, 7 of 40 children (17.5%) used a mobile device with a friend or sibling, and 1 of 41 children (2.5%) did not have access to mobile devices so the parent answered with "not applicable." The parent of one child did not complete this question.

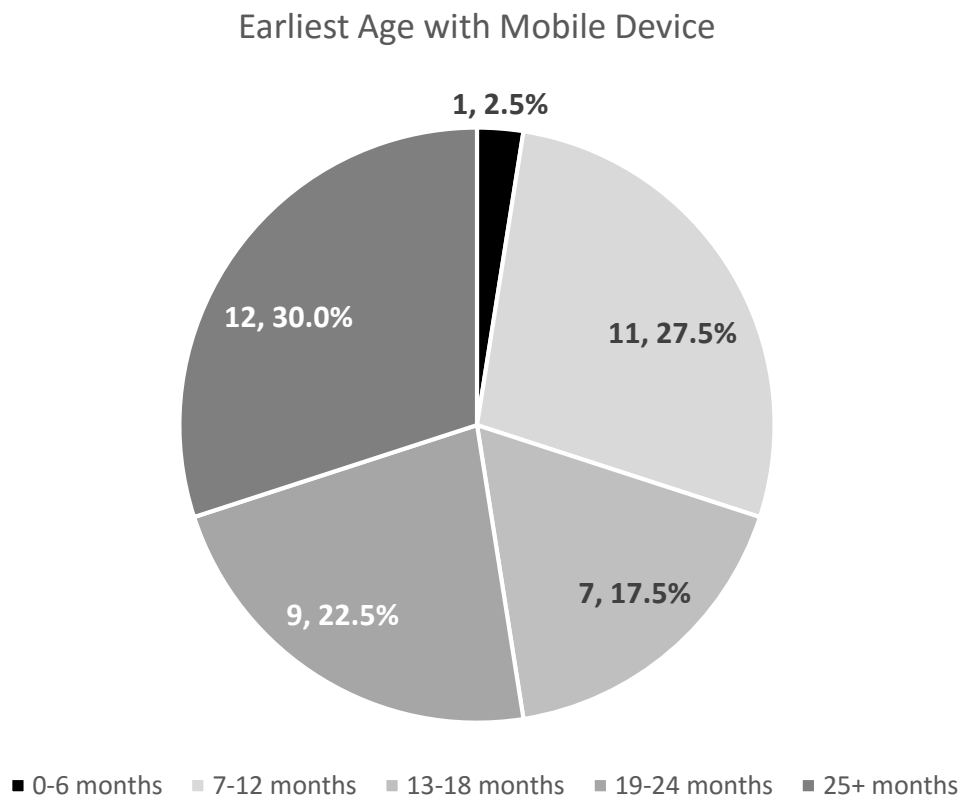


Figure 11. Earliest age child played with any mobile device. (N = 40)

Figure 11 shows the earliest age the children started to play with mobile devices. One child of 40 (2.5%) started playing with a mobile device between 0 and 6, 11 of 40 children (27.5%) started playing with mobile devices between 7 and 12 months, 7 of 40 children (17.5%) started playing with mobile devices between 13 and 18 months, 9 of 40 children (22.5%) started playing with mobile devices between 19 and 24 months, and 12 of 40 children (30.0%) started playing with mobile devices at 25 months or older. The parent of one child did not complete this question.

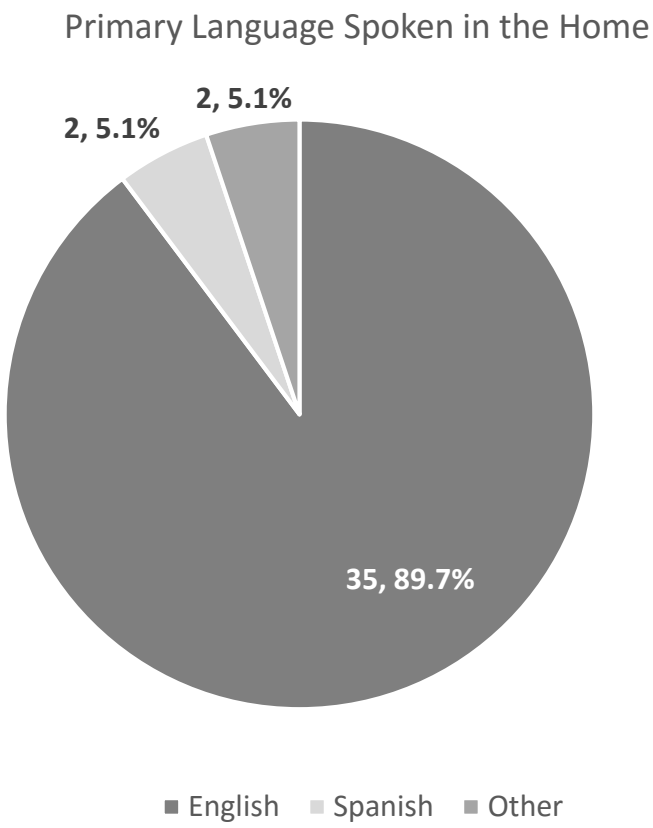


Figure 12. Primary language spoken in the home.
(N = 39)

Figure 12 shows the primary language spoken in the home of the children in this study. Thirty-five of 39 children (89.8%) spoke English as their primary language at home, 2 of 39 children (5.1%) spoke Spanish as their primary language at home, and 2 of 39 children (5.1%) spoke a language other than English or Spanish as their primary language at home. The parents of two children did not complete this question.

Research Questions

Five research questions guided this study.

1. What are the percentages of 2-, 3-, and 4-year-old children who performed seven iPad gestures in a free play session in which the children operated iPads by themselves?
2. What are the percentages of 2-, 3-, and 4-year-old children who performed seven iPad gestures in a free play session in which the children operated iPads in dyads?
3. What are the percentage differences in iPad gestures performed by a sample of 2-, 3-, and 4-year-old Orlando children who operated iPads by themselves in a free play session, compared to the iPad gestures of a sample of London children (Aziz et al., 2013)?
4. What are the percent differences in iPad gestures performed by a sample of 2-, 3-, and 4-year-old Orlando children who operated iPads by themselves in a free play session, compared to the iPad gestures of a sample of Malaysian children (Aziz et al., 2014)?
5. What are the percent differences in iPad gestures performed by a sample of 2-, 3-, and 4-year-old Orlando children who operated iPads by themselves in a free play session, compared to when the children operated the iPads in dyads?

Research Question 1

To answer Research Question 1, I calculated the total percentages of the Orlando sample of 2-, 3-, and 4-year-old children observed performing the iPad gestures. The iPad gestures were coded from recorded session from children operating the iPad by themselves in data collection phase I. The percentages were calculated using the following equation:

number of "yes" codes of children in the age group/

by the total number of children in that age group

The coded iPad gestures were (a) tap, (b) drag/slide, (c) free rotate, (d) drag and drop, (e) pinch, (f) spread, and (g) flick. Table 11 shows the Orlando sample results from data collection phase I.

Table 11

iPad Gestures from Data Collection Phase I – Orlando Sample

	Age 2 (*n* = 12)	Age 3 (*n* = 15)	Age 4 (*n* = 14)
Tap	95%	95%	95%
Drag/Slide	85%	96%	96%
Free rotate (only in AlphaBaby)	8%	60%	92%
Drag and Drop	75%	78%	83%
Pinch (only in AlphaBaby)	42%	80%	100%
Spread (only in AlphaBaby)	33%	73%	100%
Flick	50%	61%	54%

Table 11 shows the percentages of children who performed the iPad gestures. I answered RQ1 with data reported in data collection phase I. Of the 2-year-old children in this research study for Data Collection Phase I: 95% perform tap, 85% performed drag/slide, 8% performed free rotate, 75% performed drag and drop, 42% performed pinch, 33% performed spread, and 50% performed flick. Of the 3-year-old children in this research study for Data Collection Phase I: 95% performed tap, 96% performed drag/slide, 60% performed free rotate, 78% performed drag and drop, 80% performed pinch, 73% performed spread, and 61% performed flick. Finally, of

the 4-year-olds in this research study for Phase I: 95% performed tap, 96% performed drag/slide, 96% performed free rotate, 92% performed drag and drop, 100% performed pinch, 100% performed spread, and 54% performed flick.

Research Question 2

To answer Research Question 2, I calculated the total percentages of the Orlando sample of 2-, 3-, and 4-year-old children observed in this study who performed the iPad gestures. The iPad gestures were coded from recorded sessions of children operating the iPad in dyads during data collection phase II. The percentages were calculated using the following equation:

number of "yes" codes of children in the age group/

by the total number of children in that age group

The coded iPad gestures were (a) tap, (b) drag/slide, (c) free rotate, (d) drag and drop, (e) pinch, (f) spread, and (g) flick. Table 12 shows the Orlando sample results from data collection phase II.

Table 12

iPad Gestures from Data Collection Phase II – Orlando Sample

	Age 2 (*n* = 12)	Age 3 (*n* = 15)	Age 4 (*n* = 14)
Tap	100%	100%	100%
Drag/Slide	87%	81%	100%
Free rotate (only in AlphaBaby)	25%	27%	100%
Drag and Drop	52%	61%	88%
Pinch (only in AlphaBaby)	58%	53%	100%
Spread (only in AlphaBaby)	41%	40%	100%
Flick	71%	68%	86%

Research Question 3

To answer Research Question 3, I compared the percentages found in a previous study (Aziz et al., 2013), as reported in Table 2, to the observations found in this research study and report the percentile differences. Table 13 shows the percentage differences in iPad gestures performed by a sample of 2-, 3-, and 4-year-old Orlando children who operated iPads by

themselves in a free play session, compared to the iPad gestures of a sample of London children (Aziz et al. 2013).

Table 13

Percentages of Orlando Sample and London Sample iPad Gestures

	2-year-olds		3-year-olds		4-year-olds	
	London	Orlando	London	Orlando	London	Orlando
Tap	100%	95%	100%	95%	100%	95%
Drag/Slide	100%	85%	100%	96%	100%	96%
Free rotate (only in AlphaBaby)	55%	8%	91%	60%	100%	92%
Drag and Drop	36%	75%	100%	78%	100%	83%
Pinch (only in AlphaBaby)	55%	42%	82%	80%	100%	100%
Spread (only in AlphaBaby)	11%	33%	36%	73%	100%	100%
Flick	36%	50%	73%	61%	100%	54%

Table 13 shows for the children who were 2-year-old : 95% Orlando sample and 100% London sample performed tap, 85% Orlando sample and 100% London sample performed

drag/slide, 8% Orlando sample and 55% London sample performed free rotate, 75% Orlando sample and 36% London sample performed drag and drop, 42% Orlando sample and 55% London sample performed pinch, 33% Orlando sample and 11% London sample performed spread, and 50% Orlando sample and 36% London sample performed flick.

For the children who were 3-year-old: 95% Orlando sample and 100% London sample could perform tap, 96% Orlando sample and 100% London sample performed drag/slide, 60% Orlando sample and 91% London sample performed free rotate, 78% Orlando sample and 100% London sample performed drag and drop, 80% Orlando sample and 82% London sample performed pinch, 73% Orlando sample and 36% London sample performed spread, and 61% Orlando sample and 73% London sample performed flick.

Finally, for the children who were 4-year-old: 95% Orlando sample and 100% London sample performed tap, 96% Orlando sample and 100% London sample performed drag/slide, 92% Orlando sample and 100% London sample performed free rotate, 82% Orlando sample and 100% London sample performed drag and drop, 100% Orlando sample and 100% London sample performed pinch, 100% Orlando sample and 100% London sample performed spread, and 54% Orlando sample and 100% London sample performed flick.

In addition to showing the percentages of children who performed the various iPad gestures, I calculated a difference score to describe the differences between the two samples. The difference score was calculated using the following formula:

$$(A - B) / A \times 100$$

where

- A = Percent of children who performed each gesture in the London sample
- B = Percent of children who performed each gesture in the Orlando sample

A positive difference score indicates that a higher percentage of the children in the Orlando sample performed the particular iPad gesture compared to the percentage of children in the London sample. A negative difference score indicates that a lower percentage of the children in the Orlando sample performed the particular iPad gesture compared to the percentage of the children in the London sample. A zero difference score indicates that the performance percentages of children in the Orlando and London samples were the same. Table 14 shows the percentage differences when the results of the Orlando sample were compared to the results of the London sample (Aziz et al., 2013).

Table 14

Percentage Differences in iPad Gestures between Orlando and London Samples

	2-Year-Olds Percentage Difference	3-Year-Olds Percentage Difference	4-Year-Olds Percentage Difference
Tap	–5%	–5%	–5%
Drag/Slide	–15%	–4%	–4%
Free rotate (only in AlphaBaby)	–26%	28%	–8%
Drag and Drop	14%	–22%	–17%
Pinch (only in AlphaBaby)	–7%	2%	0%
Spread (only in AlphaBaby)	2%	13%	0%
Flick	5%	–9%	–46%

Note: Adapted from "Selection of touch gestures for children's applications," by N. A. A. Aziz, F. Batmaz, R. Stone, & P. W. H. Chung, 2013. Paper presented at the Science and Information Conference, London, UK, p. 3. ($N = 37$)

Table 14 shows the percent differences when the results of Orlando sample are compared to the London sample (Aziz et al., 2013).

In comparisons of the iPad gestures of the group of 2-year-old children from the Orlando sample and the group of 2-year old children from the London sample, there was a -5% difference on tap with tap lower for the Orlando sample, -15% difference on drag/slide with drag/slide lower for the Orlando sample -26% on free rotate with rotate lower for the Orlando sample, 14% difference on drag and drop with drag and drop higher for the Orlando sample, -7% difference on pinch with pinch lower for the Orlando sample, 2% difference on spread with

spread higher for the Orlando sample, and 5% difference on flick with flick higher for the Orlando sample.

In comparisons of the iPad gestures for the group of 3-year-old children of the Orlando sample and the group of 3-year old children from the London sample there was a -5% difference on tap with tap lower for the Orlando sample, -4% difference on drag/slide with drag/slide lower for the Orlando sample, 28% difference on free rotate with free rotate higher for the Orlando sample, -22% difference on drag and drop with drag and drop lower for the Orlando sample, 2% difference on pinch with pinch higher for the Orlando sample, 13% difference on spread with spread higher for the Orlando sample, and -9% difference on flick with flick lower for the Orlando sample.

Finally, in the comparison of the group of 4-year –old children of the Orlando sample and the group of 4-year old children from London sample there was -5% difference on tap with tap lower for the Orlando sample, -4% difference on drag/slide with drag/slide lower for the Orlando sample, -8% difference on free rotate with free rotate lower for the Orlando sample, -17% difference on drag and drop with drag and drop lower for the Orlando sample, there was no difference on pinch or spread between the Orlando sample and the London sample, and -46% difference on flick with flick lower for the Orlando sample than for the London sample.

Research Question 4

To answer Research Question 4 (RQ4), I compared the percentages found in a previous study (Aziz et al., 2014) to the results of this research study and report the percent differences. Table 13 shows the percentage differences in iPad gestures performed by a sample of 2-, 3-, and

4-year-old Orlando children who operated iPads by themselves in a free play session, compared to the iPad gestures of a sample of Malaysian children (Aziz et al. 2014).

Table 15

Comparisons of iPad Gestures for Orlando and Malaysia Samples

	2-Year-Olds		3-Year-Olds		4-Year-Olds	
	Malaysia	Orlando	Malaysia	Orlando	Malaysia	Orlando
Tap	100%	95%	100%	95%	100%	95%
Drag/Slide	100%	85%	100%	96%	100%	96%
Free rotate (only in AlphaBaby)	40%	8%	100%	60%	100%	82%
Drag and Drop	30%	75%	100%	78%	100%	83%
Pinch (only in AlphaBaby)	30%	42%	71%	80%	100%	100%
Spread (only in AlphaBaby)	10%	33%	64%	73%	100%	100%
Flick	80%	50%	100%	61%	100%	54%

Note: Adapted from "Selection of touch gestures for children's applications: Repeated experiment to increase reliability," by N. A. A. Aziz, N. S. M. Sin, F. Batmaz, R. Stone, & P. W. H. Chung, (2014). *International Journal of Advanced Computer Science and Applications, 5*(4), p. 6. (*N*= 40)

A review of Table 15 shows for the children who were 2-year-old : 95% Orlando sample and 100% Malaysia sample performed tap, 85% Orlando sample and 100%

Malaysia sample performed drag/slide, 8% Orlando sample and 40% Malaysia sample performed free rotate, 75% Orlando sample and 30% Malaysia sample performed drag and drop, 42% Orlando sample and 30% Malaysia sample performed pinch, 33% Orlando sample and 10% Malaysia sample performed spread, and 50% Orlando sample and 80% Malaysia sample performed flick.

For the children who were 3-year-old: 95% Orlando sample and 100% Malaysia sample performed tap, 96% Orlando sample and 100% Malaysia sample performed drag/slide, 60% Orlando sample and 100% Malaysia sample performed free rotate, 78% Orlando sample and 100% Malaysia sample performed drag and drop, 80% Orlando sample and 71% Malaysia sample performed pinch, 73% Orlando sample and 64% Malaysia sample performed spread, and 61% Orlando sample and 100% Malaysia sample performed flick.

Finally, for the children who were 4-year-old: 95% Orlando sample and 100% Malaysia sample performed tap, 96% Orlando sample and 100% Malaysia sample performed drag/slide, 92% Orlando sample and 100% Malaysia sample performed free rotate, 82% Orlando sample and 100% Malaysia sample performed drag and drop, 100% Orlando sample and 100% Malaysia sample performed pinch, 100% Orlando sample and 100% Malaysia sample performed spread, and 54% Orlando sample and 100% Malaysia sample performed flick.

In addition to showing the percentages of children who performed the various iPad gestures, I calculated a difference score to describe the differences between the two samples. The difference score was calculated using the following formula:

$$(A - B) / A \times 100$$

where

- A = Percent of children who performed each gesture in the Malaysia sample
- B = Percent of children who performed each gesture in the Orlando sample

A positive difference score indicates that a higher percentage of the children in the Orlando sample performed the particular iPad gesture compared to the percentage for the children in the Malaysia sample. A negative difference score indicates that a lower percentage of the children in the Orlando sample performed the particular iPad gestures compared to percentage for the children in the Malaysia sample. A zero difference score indicates that the performance percentages of children in the Orlando sample and Malaysia sample were the same. Table 16 shows the percentage differences when the results of Orlando sample were compared to the results of the Malaysia sample (Aziz et al., 2014).

Table 16

Percentage Differences between the Orlando and Malaysia Samples

	2-Year-Olds Percentage Difference	3-Year-Olds Percentage Difference	4-Year-Olds Percentage Difference
Tap	–5%	–5%	–5%
Drag/Slide	–15%	–4%	–4%
Free rotate (only in AlphaBaby)	–13%	–40%	–8%
Drag and Drop	14%	–22%	–17%
Pinch (only in AlphaBaby)	4%	6%	0%
Spread (only in AlphaBaby)	2%	6%	0%
Flick	–24%	–39%	–46%

Table 16 shows the percent differences when the results of Orlando sample (N = 41) are compared to the Malaysia sample (N = 40) (Aziz et al., 2014).

In comparisons of the iPad gestures of the group of 2-year-old children from the Orlando sample and the group of 2-year old children from the Malaysia sample, there was a -5%

difference on tap with tap lower for the Orlando sample, -15% difference on drag/slide with drag/slide lower for the Orlando sample -13% on free rotate with rotate lower for the Orlando sample, 14% difference on drag and drop with drag and drop higher for the Orlando sample, 4% difference on pinch with pinch higher for the Orlando sample, 2% difference on spread with spread higher for the Orlando sample, and -24% difference on flick with flick the lower for the Orlando sample.

In comparisons of the iPad gestures for the group of 3-year-old children of the Orlando sample and the group of 3-year old children from the Malaysia sample there was a -5% difference on tap with tap lower for the Orlando sample, -4% difference on drag/slide with drag/slide lower for the Orlando sample, -40% difference on free rotate with free rotate the lower for the Orlando sample, -22% difference on drag and drop with drag and drop lower for the Orlando sample, 6% difference on pinch with pinch higher for the Orlando sample, 6% difference on spread with spread higher for the Orlando sample, and -39% difference on flick with flick lower for the Orlando sample.

Finally in the comparison of the group of 4-year –old children of the Orlando sample and the group of 4-year old children from Malaysia sample there was -5% difference on tap with tap lower for the Orlando sample, -4% difference on drag/slide with drag/slide lower for the Orlando sample, -8% difference on free rotate with free rotate lower for the Orlando sample, -17% difference on drag and drop with drag and drop lower for the Orlando sample, there was no difference on pinch or spread between the Orlando sample and the Malaysian sample, and -46% difference on flick with flick lower for the Orlando sample than for the Malaysian sample.

Research Question 5

To answer Research Question 5, I calculated the percentage differences between the performance scores of 2-, 3-, and 4-year-old Orlando children in a free play session when the children operated iPads by themselves and when the children operated iPads in dyads. I calculated a difference score to describe the differences between data collection phase I and data collection phase II. The difference score was calculated using the following formula:

$$(A - B) / A \times 100$$

where

- A = Percentage of children who performed each gesture in the Orlando sample in data collection phase I
- B = Percentage of children who performed each gesture in the Orlando sample in data collection phase II

A positive difference score indicates that a higher percentage of the Orlando children in data collection phase II performed the particular iPad gesture compared to the percentage for the Orlando children in data collection phase I. A negative difference score indicates that a lower percentage of the children in the Orlando sample in data collection phase II performed the particular iPad gesture, compared to the performance percentage of the children in the Orlando sample in data collection phase I. A zero difference score indicates that the performance percentages of children in the Orlando sample in data collection phase I and Orlando sample in data collection phase II were the same. Table 17 shows the percentage differences for the Orlando sample in data collection phase I and Orlando sample in data collection phase II.

Table 17

Comparison of Percentage Differences between Orlando Children for Data Collection Phase I and Data Collection Phase II

	2-Year-Olds Percentage Difference	3-Year-Olds Percentage Difference	4-Year-Olds Percentage Difference
Tap	5%	5%	5%
Drag/Slide	2%	–15%	4%
Free rotate (only in AlphaBaby)	17%	–33%	8%
Drag and Drop	–23%	–17%	5%
Pinch (only in AlphaBaby)	16%	–27%	0%
Spread (only in AlphaBaby)	8%	–33%	0%
Flick	21%	7%	32%

In comparisons of the iPad gestures of the group of 2-year-old children from the Orlando sample in data collection phase I (N = 41) and Orlando sample in data collection phase II (N = 41), there was a 5% difference on tap with tap higher in data collection phase II, 2% difference

on drag/slide with drag/slide lower in data collection phase II, 17% on free rotate with rotate higher for the data collection phase II, -23% difference on drag and drop with drag and drop higher for the data collection phase II, 16% difference on pinch with pinch higher for the data collection phase II, 8% difference on spread with spread higher for the data collection phase II, and 21% difference on flick with flick the higher for the data collection phase II.

In comparisons of the iPad gestures for the group of 3-year-old children of the Orlando sample in data collection phase I and Orlando sample in data collection phase II there was a 5% difference on tap with tap higher for data collection phase II, -15% difference on drag/slide with drag/slide lower for data collection phase II, -33% difference on free rotate with free rotate the lower for data collection phase II, -17% difference on drag and drop with drag and drop lower for data collection phase II, -27% difference on pinch with pinch lower for data collection phase II, -33% difference on spread with spread higher for the phase II, and 7% difference on flick with flick higher for the data collection phase II.

Finally in the comparison of the group of 4-year –old children of the Orlando sample in data collection phase I and Orlando sample in data collection phase II there was 5% difference on tap with tap higher for data collection phase II, 4% difference on drag/slide with drag/slide higher for data collection phase II, 8% difference on free rotate with free rotate higher for data collection phase II, 5% difference on drag and drop with drag and drop higher for data collection phase II, there was no difference on pinch or spread between the in data collection phase I and data collection phase II, and 32% difference on flick with flick higher for the data collection phase II.

Summary

In this chapter, I presented the results of this research study. In section 1, I discussed the response rate and missing data. In section 2, I presented the data collected with the Biographical Information and Mobile Device Use Questionnaire. In section 3, I answered Research Question 1 by presenting data collected in data collection phase I. In section 4, I answered Research Question 2 by presenting data collected in data collection phase II. In section 5, I answered Research Question 3 by calculating the percentage differences in iPad gesture performance between London children and Orlando children. In section 6, I answered Research Question 4 by calculating the percentage differences in iPad gesture performance between Malaysian children and Orlando children. Finally, in section 7, I answered Research Question 5 by presenting the percentage differences in Orlando children's iPad gesture performance between data collection phase I and data collection phase II.

CHAPTER FIVE: DISCUSSION

Introduction

The purpose of this research study was twofold: 1) to describe the fine motor iPad gestures of 2-, 3-, and 4-year-old children and 2) to conduct international comparisons regarding such observed fine motor iPad gestures. The comparison sample included two sets of participants in two different international studies. The first study was conducted in London (Aziz et al., 2013) and the second one was conducted in Malaysia (Aziz et al., 2014). The foci of this research study was to 1) observe the use of iPads by 2-, 3-, and 4-year-old children working by themselves and in dyads and 2) to compare observational findings in three different countries. In this research study, I looked at seven iPad gestures. The iPad gestures were (a) tap, (b) drag/slide, (c) free rotate, (d) drag and drop, (e) pinch, (f) spread, and (g) flick. I collected data from 41 2-, 3-, and 4-year-old children who lived in Orlando, Florida. Additionally, biographical information and mobile devices use data were collected and reported. The variables included (a) child's age, (b) household income, (c) child's gender, (d) child's ethnic background, (e) types of mobile devices in the home (f) daily usage of mobile devices, (g) people with whom the child used mobile devices, (h) child's earliest age of device usage, and (i) the primary language spoken at home.

This research study was guided by five research questions encompassing five components. The first component of this study involved the iPad gestures of a sample of Orlando children operating iPads by themselves. This component was a partial replication of two previous studies conducted by Aziz et al. (2013, 2014). The second component of the study focused on the

iPad gestures of the Orlando children operating iPads in dyads. In the third component of this study, I compared the iPad gestures of the Orlando sample with the gestures of a sample of 2-, 3-, and 4-year-old children from London (Aziz et al., 2013). In the fourth component of this study, I compared the iPad gestures of the Orlando sample with the gestures of a sample of 2-, 3-, and 4-year-old children from Malaysia (Aziz et al., 2014). The fifth component involved examining the iPad gestures of a sample of Orlando children who were paired with classmates and asked to play with the iPads in dyads, compared to the gestures of children operating iPads by themselves.

Discussion of the Findings

Research Question 1

What are the percentages of 2-, 3-, and 4-year-old children who performed seven iPad gestures in a free play session in which the children operated iPads by themselves?

Research Question 1 was a partial replication of two previous studies (Aziz et al., 2013, 2014). One of the major findings of Research Question 1 involved the iPad gesture of free rotate. This iPad gesture is defined as placing two fingers on the screen and rotating them in the same direction without removing the fingers off the screen. This iPad gestures performed by the Orlando sample aligned with the precontrol phase as theorized by Gallahue and Ozemun (1998). According to Gallahue and Ozemun (1998), a rapid development of children's higher cognitive and motor processes causes rapid gains in rudimentary movement abilities, occurring in 3- and 4-year-old children but not in 2-year-old children. As previously stated in Chapter 2, Cohen et al. (2011) explored the perceptions of children and their caregivers regarding the use of iPads and

apps. Cohen et al. found that children as young as 2 years old could play and learn with touch screen devices. Children at this age learned to target, press, and drag hard, and slowly learned to tap or swipe (Cohen et al., 2011).

However, iPad gestures like free rotate, pinch, and spread require two points of contact and deliberate movements on the touch screen to perform. Thus, these iPad gestures require higher cognitive and motor processes to perform than do the iPad gestures of tap, drag/slide, drag and drop, and flick. As shown in Table 11, the 2-year-old children in the Orlando sample had the lowest percentage of free rotate performance. Only 8% of the 2-year-old children in the Orlando sample performed free rotate; in contrast, 60% of the 3-year-old children in the Orlando sample performed free rotate, and 92% of the 4-year-old children performed free rotate.

Another finding of Research Question 1 involved the iPad gesture of flick. This iPad gesture, also known as "swipe," is defined as placing a finger on the screen to brush the surface. Flick was one of the four iPad gestures present in all four of the applications used in this research study. As shown in Table 11, 50% of the 2-year-old children in the Orlando sample performed flick; in contrast, 61% of the 3-year-old children in the Orlando sample performed flick. For the 3-year-old children in the Orlando sample, flick was the second lowest performance percentage at 61% (free rotate was lowest at 60%).

For the Orlando 4-year-olds, flick was the lowest percentage at 54%. This finding does not align with the Gallahue and Ozmun's (1998) fundamental movement phase. According to Gallahue and Ozmun, this phase ranges from 2 to 7 years old. Children outgrow the rudimentary movement phase and are actively involved in exploring and experimenting with the movement capabilities of their bodies (Gallahue & Ozemun, 1998). Additionally, this is the time when

children discover how to perform a variety of movements (running and walking), demonstrate stability (standing and balancing), and perform manipulation motions (throwing and catching), first in isolation and then in combinations.

Research Question 2

What are the percentages of 2-, 3-, and 4-year-old children who performed seven iPad gestures in a free play session in which the children operated iPads in dyads?

One of the major findings of Research Question 2 involved the iPad gesture of free rotate. In Chapter 2, I discussed the context of the Zone of Proximal Development (Vygotsky, 1978). In those situations, children can often use explanation, ask leading questions, talk about the tasks in the iPads, and offer joint participation and encouragement as students complete tasks to help them learn (Miller, 2010). However, as shown in Table 12, of the seven iPad gestures in this research study, free rotate was the gesture least performed by the 2-year-old Orlando children (25%). In addition, free rotate was the gesture least performed by the 3-year-old Orlando children (27%). All the 4-year-old children in the Orlando sample performed free rotate. I previously theorized that in a dyadic setting, one of the children would serve as the knowledgeable peer guiding his or her partner to perform the iPad gestures in order to navigate the application. The results shown in Table 12 did not align with my theory.

Research Question 3

What are the percentage differences in iPad gestures performed by a sample of 2-, 3-, and 4-year-old Orlando children who operated iPads by themselves in a free play session, compared to the iPad gestures of a sample of London children (Aziz et al., 2013)?

The major finding of Research Question 3 involved the 2-year-old children in the London sample. The iPad gesture with the lowest percentage was spread (11%). Additionally, of the 2-year-old children in the Orlando sample, the iPad gesture with the lowest percentage was free rotate (8%). As mentioned, iPad gestures like free rotate, pinch, and spread require two points of contact and deliberate movements on the touch screen to perform. Thus, these movements require higher cognitive and motor processes to perform, aligning with the precontrol phase (Gallahue & Ozemun, 1998). As theorized by Gallahue and Ozemun (1998), a rapid development of children's higher cognitive and motor processes causes rapid gains in rudimentary movement abilities. As shown in Table 14, the largest percentage difference between the 2-year-old children in the London and Orlando samples was drag and drop (14%).

The lowest percentage difference between the 2-year-olds in the London and Orlando samples was free rotate (–26%). Additionally, the highest percentage difference between the 3-year-olds in the London and Orlando samples was for free rotate (28%). The lowest percentage difference between the 3-year-olds in the London and Orlando samples was drag and drop (–22%). Finally, the lowest percent difference between the 4-year-olds in the London and Orlando samples was for drag/slide (–46%).

Research Question 4

What are the percentage differences in iPad gestures performed by a sample of 2-, 3-, and 4-year-old Orlando children who operated iPads by themselves in a free play session, compared to the iPad gestures of a sample of Malaysian children (Aziz et al., 2014)?

The major finding of Research Question 4 involved the 2-year-old children in the Malaysian sample. The iPad gesture with the lowest percentage was spread (10%). Additionally, of the 2-year-old children in the Orlando sample, the iPad gesture with the lowest percentage was free rotate (8 %). As mentioned, iPad gestures like free rotate, pinch, and spread require two points of contact and deliberate movements on the touch screen to perform. Thus, these movements require higher cognitive and motor processes to perform, aligning with the precontrol phase (Gallahue & Ozemun, 1998). According to Gallahue and Ozemun (1998), a rapid development of children's higher cognitive and motor processes causes rapid gains in rudimentary movement abilities.

As shown in Table 16, the largest increase of percentage difference between the 2-year-old children in the Malaysian and Orlando samples was for the iPad gesture drag and drop (14%). The lowest percentage difference between the 2-year-olds in the Malaysian and Orlando samples was flick (–24%). As previously mentioned in Chapter 3, the four iPad gestures used across the four applications were tap, drag/slide, drag and drop, and flick. Additionally, the largest increase of percentage difference was between the 3-year-old children in the London and Orlando samples in both pinch and spread (6%). The lowest percentage difference between the 3-year-old children in the Malaysian and Orlando samples was drag/slide (–40%). Finally, the

lowest percentage difference between the 4-year-old children in the Malaysian and Orlando samples was drag/slide (–46%).

Research Question 5

What are the percentage differences in iPad gestures performed by a sample of 2-, 3-, and 4-year-old Orlando children who operated iPads by themselves in a free play session, compared to when the children operated the iPads in dyads?

Research Question 5 involved comparing the 2-year-old Orlando children in data collection phase I and in data collection phase II. The major finding was that the only iPad gesture with a negative difference was drag and drop (–23%). Comparing the Orlando 3-year-olds between data collection phase I and data collection phase II showed only tap and flick had positive differences (5% and 7%, respectively). Drag/drop, free rotate, drag and drop, pinch, and spread showed percentage differences greater than –15%. Comparing the Orlando 4-year-olds between data collection phase I and data collection phase II showed all the iPad gestures had positive differences, and flick had the largest increase (32%).

Contributing factors to this difference could include the fact that the iPad was part of the children's environment in both data collection phases. The constant manipulation of the iPads helped develop their fine motor skills to perform gestures they could not perform in data collection phase I, as discussed in *Ecological approach: Affordances* (E. J. Gibson, 1982; J. J. Gibson, 2014). Another factor could be that children can learn in group settings by getting prompts and cues, viewing modeled behavior, explaining and discussing material with peers, and encouraging peers (Miller, 2010). The iPad could have been serving in the role as knowledgeable

peer through the applications that gave children audio and visual cues for correct and incorrect answers.

This process relates to the theory of the Zone of Proximal Development (Vygotsky, 1978). Data from the 2-year-old and 4-year-old groups aligned with this theory in terms of the positive percentage differences. However, the performance of the children in the 3-year-old group did not align with this theory, instead showing a negative percentage difference. This negative difference implies there was a decrease in the total percentage of 3-year-old children in this study who could perform iPad gestures.

Limitations

This research study was limited in a few ways. In the following section, I discuss limitations related to population characteristics, to the iPad gestures, and to the applications used. Additionally, I analyze the applications used in the study.

First, the population characteristics limited generalizability. The sample of 2-, 3-, and 4-year-old children employed in this research study was small and drawn from one site. The chronological age of the children was used to categorize the children into groups, and because all the data were collected from one location, a convenience sampling method was used. The 2-, 3-, and 4-year-old children in this research study attended four classrooms at the Orlando Day Nursery. Additionally, the sample was reduced because of parents declining to participate. The response rate was 41 out of 58 (70.7%). Using random sampling of the entire population of 2-, 3-, and 4-year-old children in daycare classrooms would increase generalizability.

Second, the limitations related to the iPad gestures used had an impact on the results. Not all of the iPad gestures were used across all four applications. The iPad gestures in this research

study were selected because they were used in previous studies (Aziz et al., 2013, 2014). After careful review of the applications, I found that only four iPad gestures were used across all the applications (tap, drag/slide, drag and drop, and flick), which did not support the data shown in There was insufficient information to determine whether the same version of the various applications was used in Aziz et al. (2013), and Aziz et al. (2014) and the present study. Changes the apps may have impacted the children's ability to use the iPad gestures. Different versions of the applications could have used all iPad gestures but the versions that I had access to the older versions of the applications. Table 4, were the previous studies listed all seven iPad gestures were used. The application AlphaBaby was the only application that allowed the use of all seven iPad gestures. This limited the amount of data that could be collected on all seven of the iPad gestures used in this research study.

Another limitation was not having all that data from the original studies. I was unable to gather biographical information about the participants in the original studies and did not have access to the coding protocols.

Finally, only four applications were used for this research study. The applications were Toca Kitchen Monsters, Toca Hair Salon, AlphaBaby Free, and Montessori Crossword. These specific applications were selected for this research study because they had been used in the Aziz et al. (2013, 2014) studies. In the next section, I present my analysis on the applications used in this research study.

Toca Kitchen Monsters

Toca Kitchen Monsters was one of the applications that did not use of all seven iPad gestures. There were only four iPad gestures used: tap, drag/slide, drag and drop, and flick. Toca Kitchen Monsters was very interactive and was favored by all age groups in this research study. The children hesitated and sometimes resisted when it was time to move on to the next application. Toca Kitchen Monsters allowed children to interact with the virtual food, select a monster, and use a virtual kitchen implement. Toca Kitchen Monsters did not limit how many times the children could feed the monster or how children could use the virtual kitchen implements. Children could select many different ways to feed their monsters. Examples of the some of the choices were:

- Selecting a mushroom and using the virtual cutting board
- Selecting a mushroom and using the virtual microwave
- Selecting a mushroom and using the virtual cutting board and then using the virtual microwave

Additionally, Toca Kitchen Monsters allowed children to return to the main screen and select a different monster at any time. This let children reset their characters and start over again. However, Toca Kitchen Monsters did not include the use of free rotate, pinch, or spread, which limited the data collected from this application.

Toca Hair Salon

Toca Hair Salon was one of the applications that did not use of all seven iPad gestures; only tap, drag/slide, drag and drop, and flick were used. This application was very interactive

and favored by all age groups in this study. Children were able to interact with the selected character and the hair elements. Toca Hair Salon did not limit how many times the children could use each element or limit the hairstyle design the children wanted on their selected characters. Children could select many different ways to cut the characters' hair. Examples of the some of the choices were:

- Using scissors to cut hair
- Using a comb to brush hair
- Using scissors to cut hair and then a comb to brush hair

Additionally, Toca Hair Salon allowed children to return to the main screen and select a different character at any time. This let children reset their characters and start over again. However, Toca Hair Salon did not include the use of free rotate, pinch, or spread, which limited the data collected from this application.

AlphaBaby

AlphaBaby was the only application that used all seven iPad gestures. However this application was redundant and thus did not always keep the interest or attention of all the age groups in the study. Children were limited to six objects on the screen at a time, and the background in this application never changed. The redundant screen, audio sounds, and lack of choices in interacting with objects in AlphaBaby made it the least favored application by all the children in this research study.

Montessori Crossword

Montessori Crossword was one of the applications that did not use all seven iPad gestures, using only tap, drag/slide, drag and drop, and flick. Montessori Crossword was not as interactive as Toca Kitchen Monsters and Toca Hair Salon, and did not keep the interest or attention of all the age groups in the study. Children were given a word and required to spell the word in order to move to the next screen or select a new word to spell. To spell the word, children tapped the letter and then dragged and dropped the letter to the correct box. When the incorrect letter was put in the box, the letter returned to the bottom of the screen. Children were limited in the choices available in this application. Because of the strict objective to move to the next screen, this application did not keep the children's interest. The redundant screen, audio sounds, and lack of choices in Montessori Crossword made it the one of the least favored applications by all the children in this study.

Implications for Practice

This research study provided insight into the iPad gestures of 2-, 3-, and 4-year-old children. As previously stated in Chapter 1, the findings from this study could help identify more effective ways to use iPads and other mobile devices as tools for learning. One of the recommendations for practice that emerged from this research study is to select applications that include all seven iPad gestures and advance features when selecting applications for educational settings. Incorporating all seven iPad gestures could help children practice the seven iPad gestures and eventually develop the gestures into complex movements. Another recommendation that emerged from the study is to select applications that are engaging to 2-, 3-, and 4-year-old children. Applications should not be too difficult, redundant, or limited.

Recommendations for Further Research

I offer several recommendations for further research. The recommendations are related to the limitations of this research study. Recommendations for further research relate to questions that would require a nondescriptive research design.

First, the generalizability of my findings was affected by the sample I employed. As mentioned, in this descriptive research study, I collected data from children in one location that had a relatively homogenous population. Future research could employ random sampling from the entire population of 2-, 3-, and 4-year-old children attending different daycare sites in the downtown Orlando area. Selecting randomly from a larger population set would increase the generalizability of the findings.

Second, in this research study, not all the iPad gestures were used across all four applications. As previously mentioned, iPad gestures selected for this research study were selected because they were used in previous studies (Aziz et al., 2013, 2014). Future research could include applications that use all seven iPad gestures in order to measure more accurately the percentages of 2-, 3-, and 4-year-old children who performed the iPad gestures. Collecting data on iPad gestures across all the applications could be used to identify trends in groups of 2-, 3-, and 4-year-old children.

Third, four applications were used for this research study. The applications were Toca Kitchen Monsters, Toca Hair Salon, AlphaBaby Free, and Montessori Crossword. As previously mentioned, these specific applications were selected for this research study because they had been used in the Aziz et al. (2013, 2014) studies. Future research could include applications that are interactive and do not limit children's choices. Interactive applications keep the interest of

the children and allow many possible choices within the application, thus giving children many ways to interact with the application. In addition to selecting applications that include all of the iPad gestures future studies should include the frequency in which children use iPad gestures. In my observations in this research study I noticed that children were using the tap gesture substantially more than the other gestures. Future studies should factor in applications with equal frequency distribution between all iPad gestures.

Fourth, this research study was a cross-sectional study completed in 11 weeks. A longitudinal design could show potential increases or decreases in total performance percentages of 2-, 3-, and 4-year-old children who performed iPad gestures over time. Additionally, a longitudinal design could allow multiple points of data collected over time, which could not be done in a cross-sectional study such as this research study.

Finally, this research study was a descriptive study and as such, did not provide cause-and-effect answers. A quasi-experimental research design would facilitate the manipulation of a variable related to measuring changes in children's use of iPad gestures. This proposed quasi-experimental research design would have a control group and an experimental group. The control group would receive regular instructions on how to use the iPads. The experimental group would receive no regular instructions on how to use the iPads. Having two groups would show if having regular instructions would help increase the performance percentages of 2-, 3-, and 4-year-old children who performed iPad gestures.

Summary

Over 200 million iPads have been sold worldwide since its release in 2010 (Statista, 2015). iPads can be a useful tool in early childhood settings. In this research study, I observed

the iPad gestures of 2-, 3-, and 4-year-old children from Orlando Day Nursery, a daycare located in downtown Orlando that has been serving low-income families for over 90 years (Orlando Day Nursery, 2015). The purpose of this study was to document the fine motor iPad gestures of 2-, 3-, and 4-year-olds who used iPads by themselves and in dyads. In this study, I examined seven iPad gestures: (a) tap, (b) drag/slide, (c) free rotate, (d) drag and drop, (e) pinch, (f) spread, and (g) flick.

Five research questions guided this study. The first research question involved observations of the iPad gestures of a sample of Orlando children operating iPads by themselves. The first question involved a partial replication of the 2013 and 2014 studies conducted by Aziz et al. When children were operating with the iPads by themselves they were observed many times talking to the characters in the applications. As stated theory of affordances (E. J. Gibson, 1982; J. J. Gibson, 2014), devices like the iPad are a part of children's environments; however, children do not identify the iPad as an object with a touch screen, a battery, and many little electronics that make it function. Rather, they tend to recognize it as a whole entity (p. 128). The second research question involved observations of the iPad gestures of the Orlando sample operating iPads in dyads. To answer the third research question, I compared the iPad gestures of the Orlando sample with the gestures of a sample of 2-, 3-, and 4-year-old children from London. To answer the fourth research question, I compared the iPad gestures of the Orlando sample with the gestures of a sample of 2-, 3-, and 4-year-old children from Malaysia. To answer the fifth research question, I compared the iPad gestures of the Orlando sample when the children were paired with classmates and asked to play with the iPads in dyads, rather than operating iPads by themselves. In addition to the observations, biographical information was collected, including (a)

child's age, (b) household income, (c) child's gender, (d) child's ethnic origin, (e) types of mobile devices in the household, (f) daily usage of mobile devices, (g) people with whom the child used mobile devices, (h) earliest age of device usage, and (i) the primary language spoken at home. Overall I was unable to observe any aspects of the social learning theory (Bandura & Walters, 1963) previously listed in the literature review. I previously theorized that a child who sees a peer having positive or fun interactions with the devices will be encouraged to do the same, however during the study there were no negative interactions. All of the children who were part of the study did not seem uncomfortable around iPads or mobile devices.

APPENDIX A: IRB APPROVAL LETTER

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Lap Nguyen**

Date: **May 19, 2015**

Dear Researcher:

On 05/19/2015, the IRB approved the following human participant research until 05/18/2016 inclusive:

Type of Review:	UCF Initial Review Submission Form
Project Title:	YOUNG CHILDREN'S FINE MOTOR GESTURES WHEN USING IPADS.
Investigator:	Lap Nguyen
IRB Number:	SBE-15-11317
Funding Agency:	
Grant Title:	
Research ID:	n/a

The scientific merit of the research was considered during the IRB review. The Continuing Review Application must be submitted 30days prior to the expiration date for studies that were previously expedited, and 60 days prior to the expiration date for research that was previously reviewed at a convened meeting. Do not make changes to the study (i.e., protocol, methodology, consent form, personnel, site, etc.) before obtaining IRB approval. A Modification Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at https://iris.research.ucf.edu .

If continuing review approval is not granted before the expiration date of 05/18/2016, approval of this research expires on that date. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

Use of the approved, stamped consent document(s) is required. The new form supersedes all previous versions, which are now invalid for further use. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Participants or their representatives must receive a copy of the consent form(s).

All data, including signed consent forms if applicable, must be retained and secured per protocol for a minimum of five years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained and secured per protocol. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 05/19/2015 01:05:28 PM EDT

IRB manager

APPENDIX B: IPAD FINE GESTURES CHECKLIST

The following iPad Gesture Checklist was used to code the children's gestures:

Child Code: _____ / Video Clip # _____

Date: _____

Coder: _____

	Toca Kitchen Monsters	Toca Hair Salon	AlphaBaby Free	Montessori Crossword
Tap				
Drag/Slide				
Free Rotate				
Drag & Drop				
Pinch				
Spread				
Flick				

*Place a Yes or No on the gestures that child uses while playing with these applications.

APPENDIX C: BIOGRAPHCIAL INFORMATION AND MOBILE DEVICE USE QUESTIONAIRE

Biographical Information and Mobile Device Use Questionnaire

Child Code:
Age: ☐ 12-24 months ☐ 25-36 months ☐ 37-48 months
Household income: ☐ 0-$12,000 ☐ $13,000-$18,000 ☐ $19,000 +
Gender: ☐ Male ☐ Female
Ethnic Origin: (check one) ☐ Asian ☐ African American/Black ☐ Hispanic/Latino ☐ American Indian ☐ White/Caucasian ☐ Other
Which of the following mobile devices does your child own or has access to outside of school? (mark all that apply) • ☐ A smart phone (like an iPhone, Galaxy, or Droid) • ☐ A tablet device (like an iPad, Kindle FIRE, Microsoft Surface, or Galaxy Tab) • ☐ An educational game player (like LeapPad, Nabi, or VTech InnoTab)
How often does your child use the mobile devices daily? (check one) ☐ 0-1 hour ☐ 2-3 hours ☐ 4-5 hours ☐ 6+
When your child uses a mobile device, how does your child primarily use the device? (check one)

By him/herself With adult supervision With friends or siblings
Earliest age your child played with a mobile device?: (check one) 0-6 months 7-12 months 13-18 months 19-24 months 25+ months
Primary language spoken at home?: (check one) English Spanish Other:

APPENDIX D: ODN APPROVAL LETTER

ODN
ORLANDO DAY NURSERY
Founded 1921

"In Support of Families"

626 Lake Dot Circle, Orlando, FL 32801 ◆ www.OrlandoDayNursery.org
Phone: 407.422.5291 ◆ Fax: 407.422.4068 ◆ License # C09OR0158

May 13, 2015

To Whom It May Concern:

Lap Nguyen M.S., a doctoral student at the University of Central Florida under the supervision of Dr. Rex Culp, has the permission of Orlando Day Nursery to conduct his research for his dissertation at our childcare facility. The families of the children included in this project have been contacted and given their permission as well.

Should you have any questions, you may contact me at 407-422-5291 or by email: director@orlandodaynursery.org.

Sincerely,

Mata Dennis
Executive Director

APPENDIX E: IPAD FINE MOTOR GESTURES DEFINED

Coders coded each gesture as:

YES - If the children perform the gesture during the recording while using the iPad.

No – If the observed children are not doing the gesture during recording while using the iPad.

Tap

This gesture was defined as light strike of one finger with a quick motion on the screen.

Examples:

- Pressing the home button - were coded.

Drag/ Slide

This gesture was defined as placing one finger on the screen and moving it to another location on the screen without removing the finger off the screen.

Examples:

- If children pick up a saltshaker and does “up and down” drag to “shake” salt on item - were coded.
- Children creating a circle on the screen - were coded.

Free Rotate

This gesture was defined as placing two fingers on the screen and twist them without removing finger off the screen.

Examples:

- Children rotating the screen or iPad – were not coded.

Drag and Drop

This gesture was defined as placing one finger on the screen and moving it to another location on the screen and removing finger off the screen, generally after completing a task or after moving it to a designated location or having an objective.

Examples:

- Children move a piece of fruit on the screen and drops it in characters mouth – were coded.

Pinch

This gesture is defined as placing two fingers on the screen and moving them closer together.

Examples:

- Placing once finger form each hand and bringing them together –were coded.

Spread

This gesture is defined as placing two fingers on the screen and moving them apart.

Examples:

- Placing once finger form each hand and bringing them together – were coded.

Flick

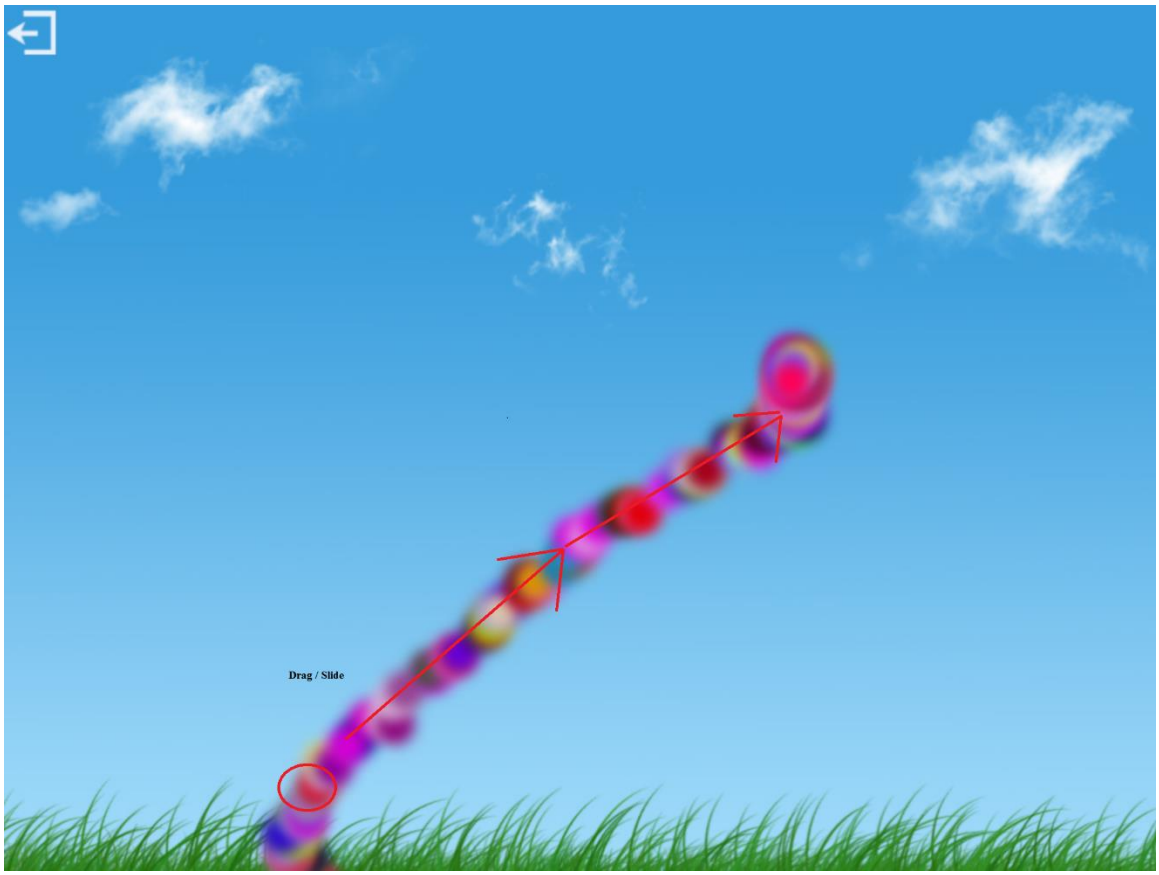
This gesture (also known as "swipe") will be defined as placing once finger on the screen to brush the surface.

- Children move a piece of fruit and flicks it across the screen – were coded.

Application: Montessori Crossword

Tap: during the spelling phase child can tap the letters, or taps the screen after the open screen (where child is awarded after spelling the word) phase

Drag/Side: can only be done during the open screen phase



Free Rotate: cannot be done on application

Drag & Drop: can only be done during the spelling phase where child drag and drops letters into the box.

Pinch: cannot be done on application

Spread: cannot be done on application

Flick: can only be done during the open screen phase

Application: Toca Kitchen Monsters

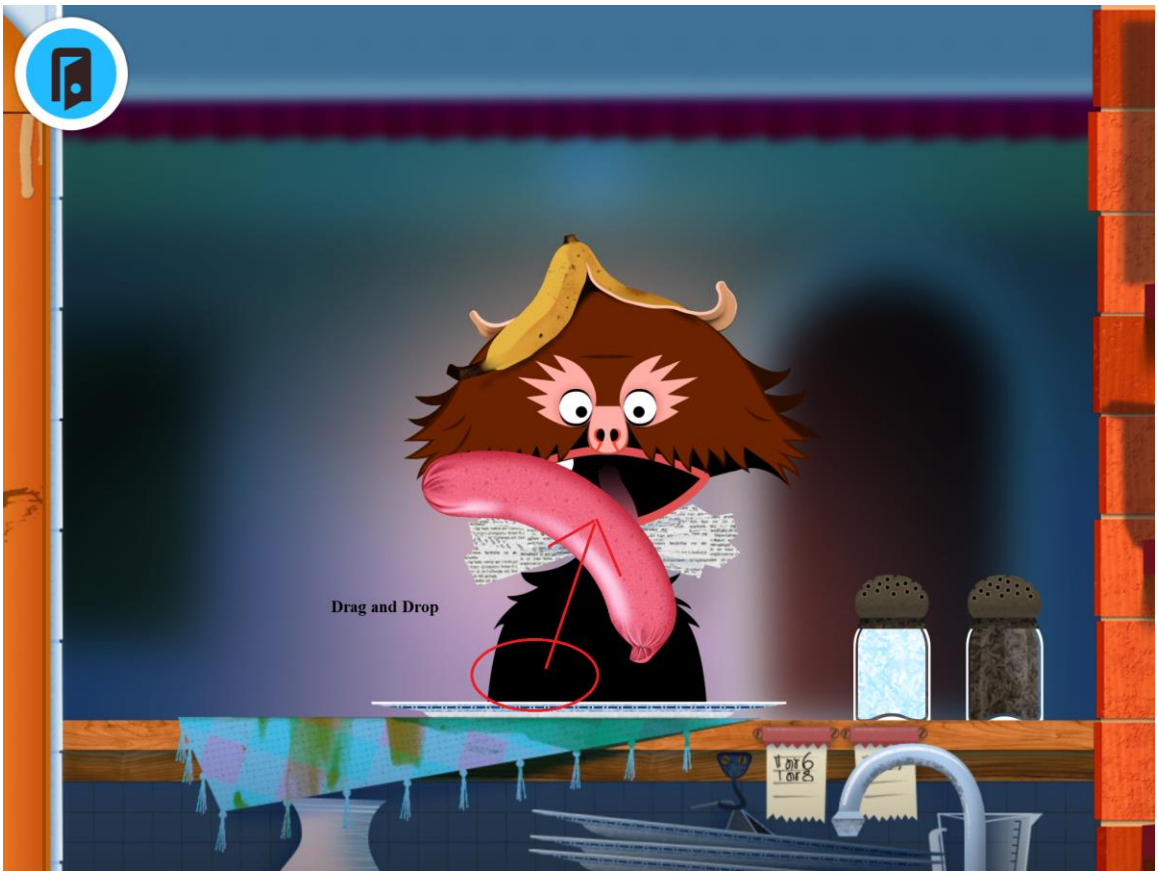

FOR PARENTS
TOCA
KITCHEN
MONSTERS
Free Update!
Update

Tap: child can tap at the beginning screen to start the game, select monsters, food, and cooking the food

Drag/Side: child can drag/slide food onto the plate, opening of the sides (the refrigerator and cooking stations), uses the salt and pepper, or when cooking of the food

Free Rotate: cannot be done on application

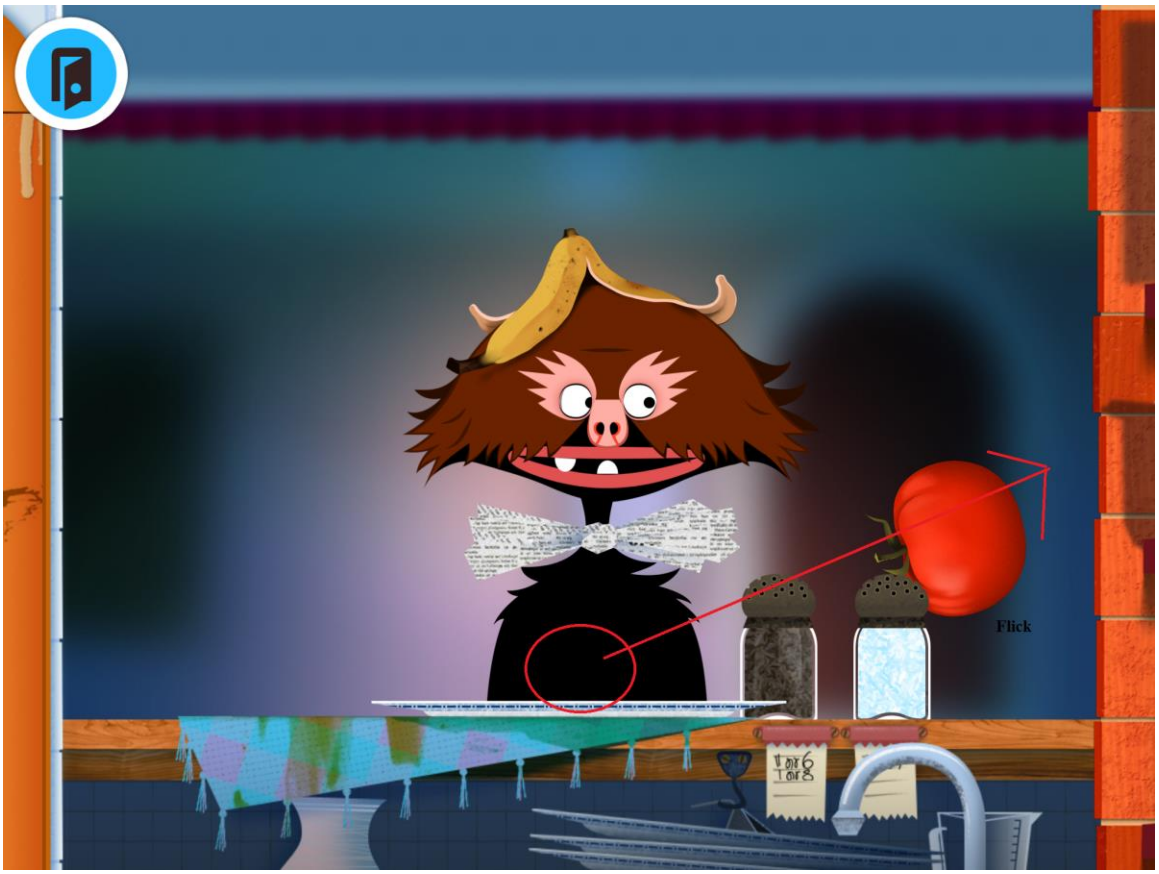
Drag & Drop: can only be done when child feeds the monsters food



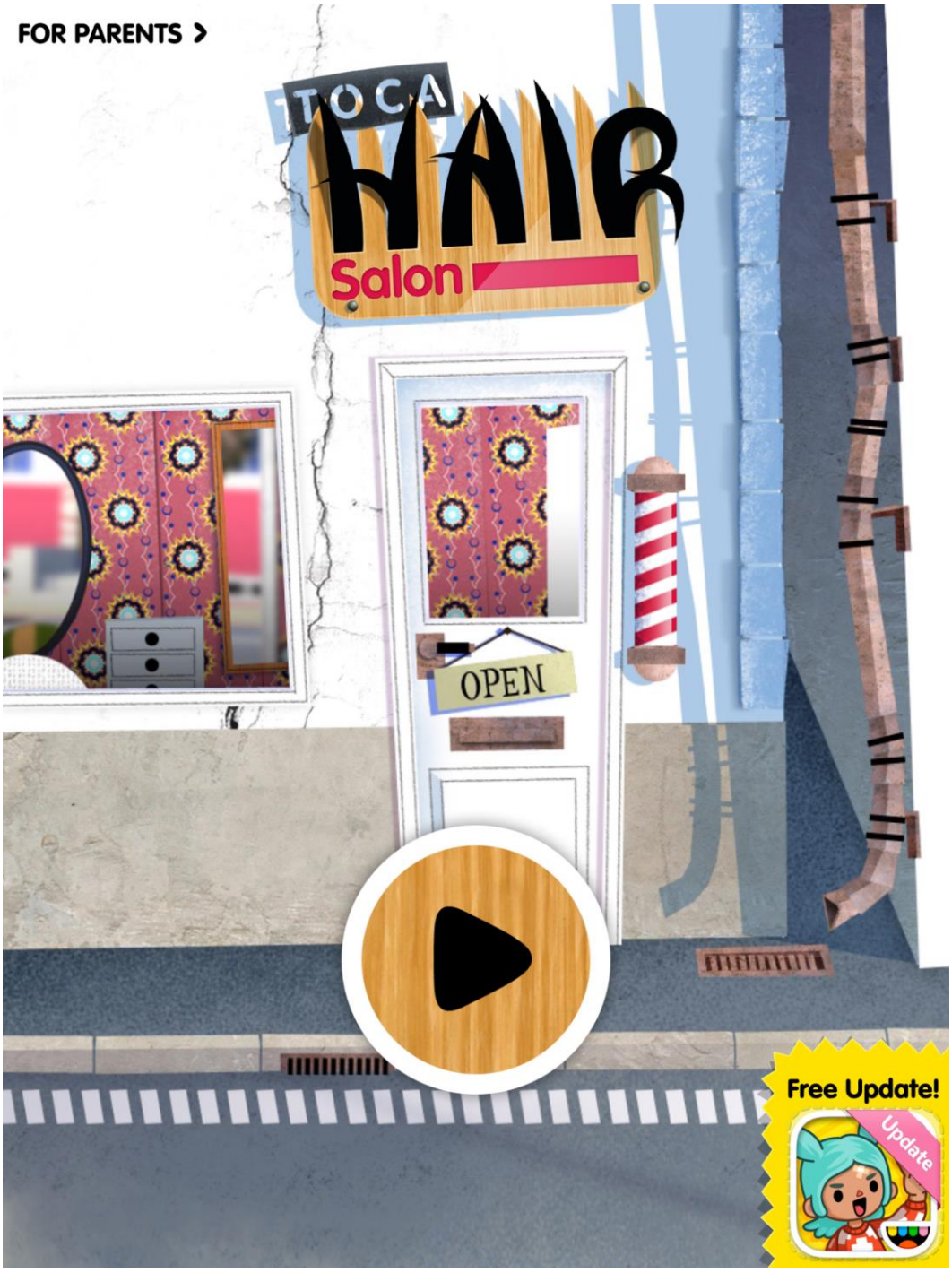
Pinch: cannot be done on application

Spread: cannot be done on application

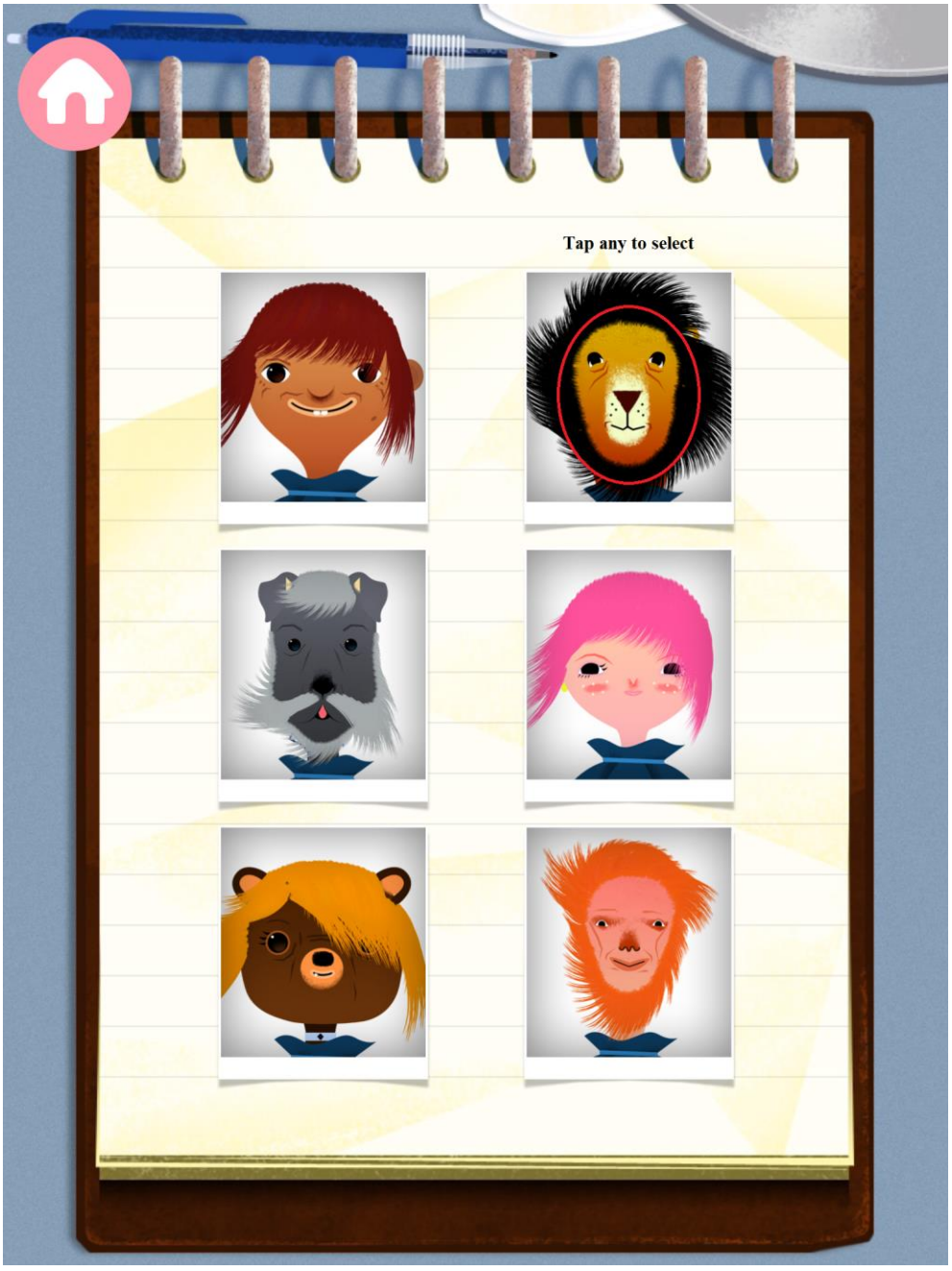
Flick: can be done when child quickly opens the sides, throws the food on the main screen or in the cutting station



Application: Toca Hair Salon



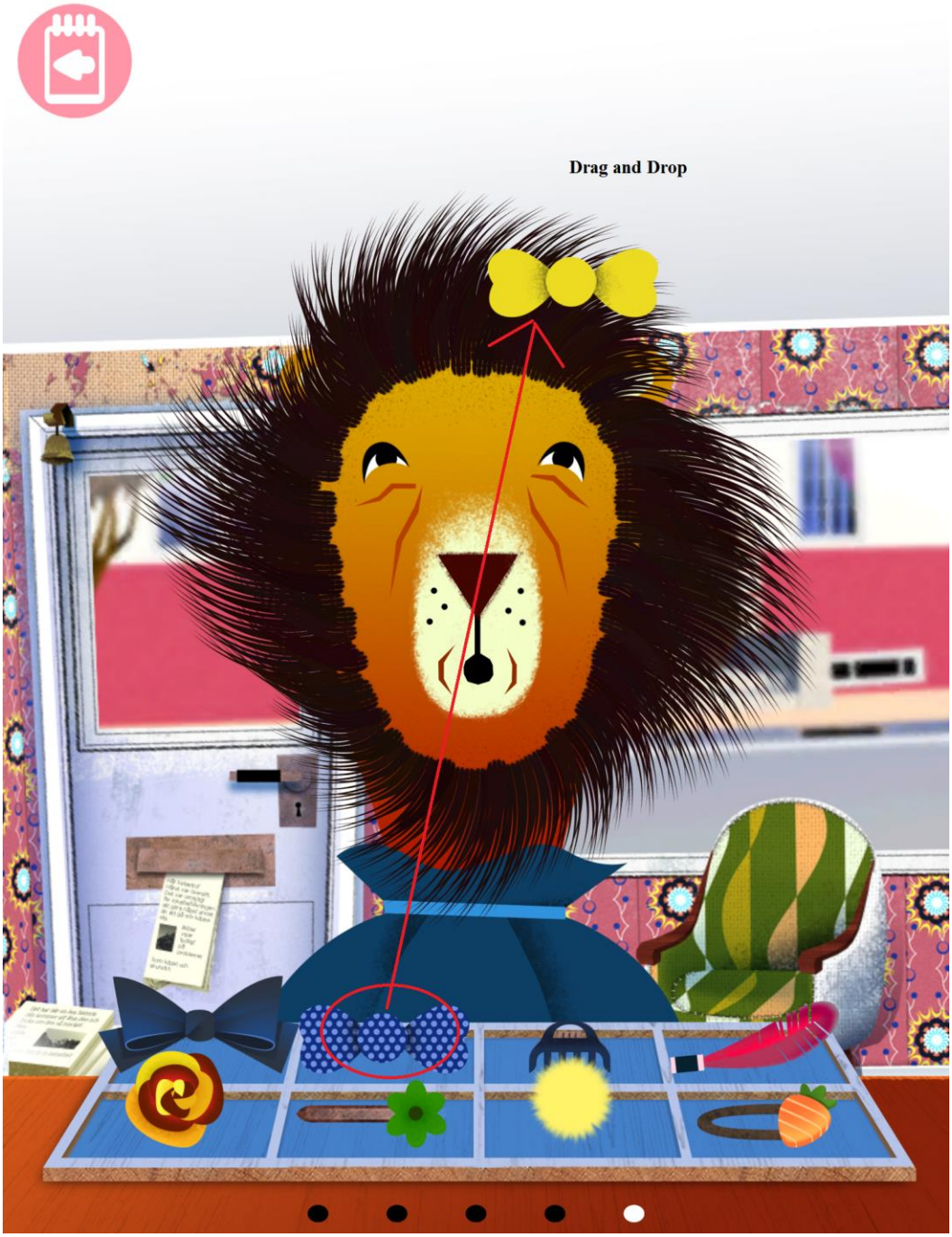
Tap: child can tap at the beginning screen to start the game, select characters, cutting, changing colors, applying shampoo, selecting items on the bottom of the screen, taking a picture



Drag/Side: child can drag/slide to cut their hair with scissors or clippers, apply shampoo or hair growth, comb the hair, or color hair

Free Rotate: cannot be done on application

Drag & Drop: can only be done when child drags and drops items into the characters hair on the very last station of items that has the hair decorations



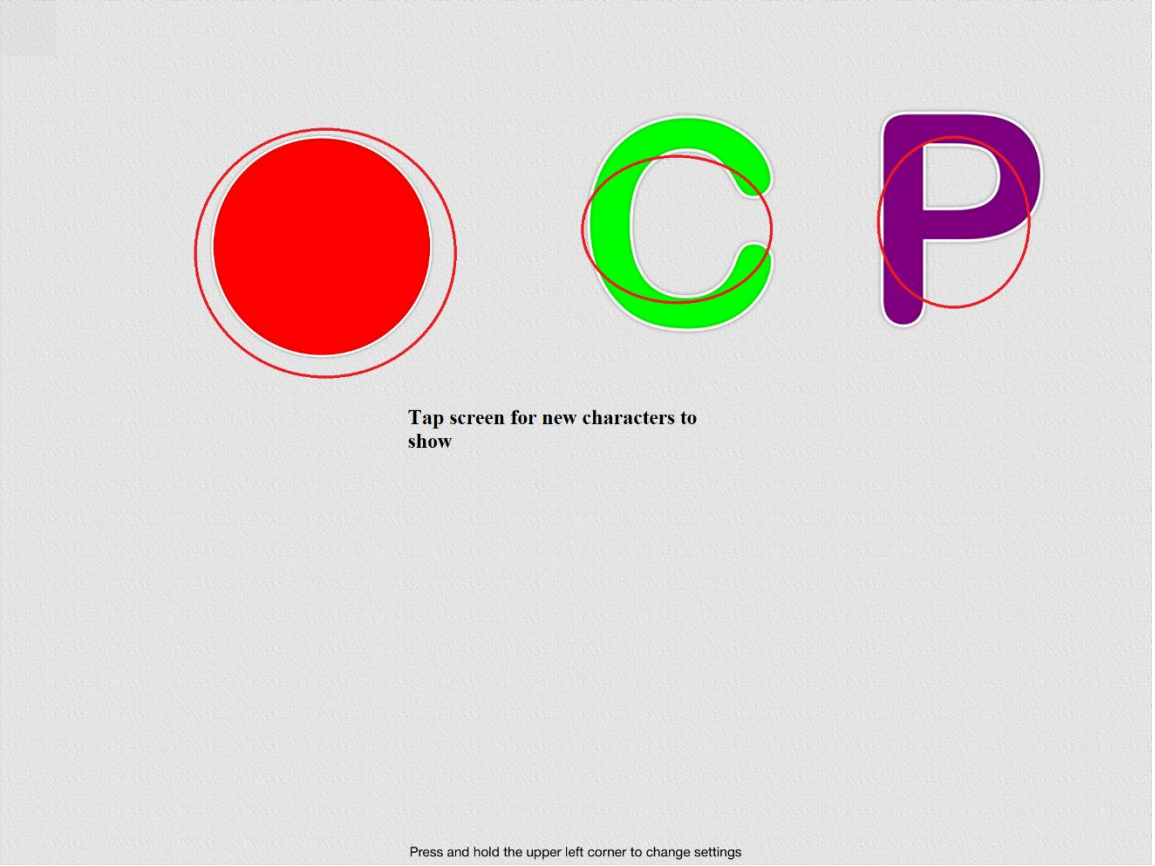
Pinch: cannot be done on application

Spread: cannot be done on application

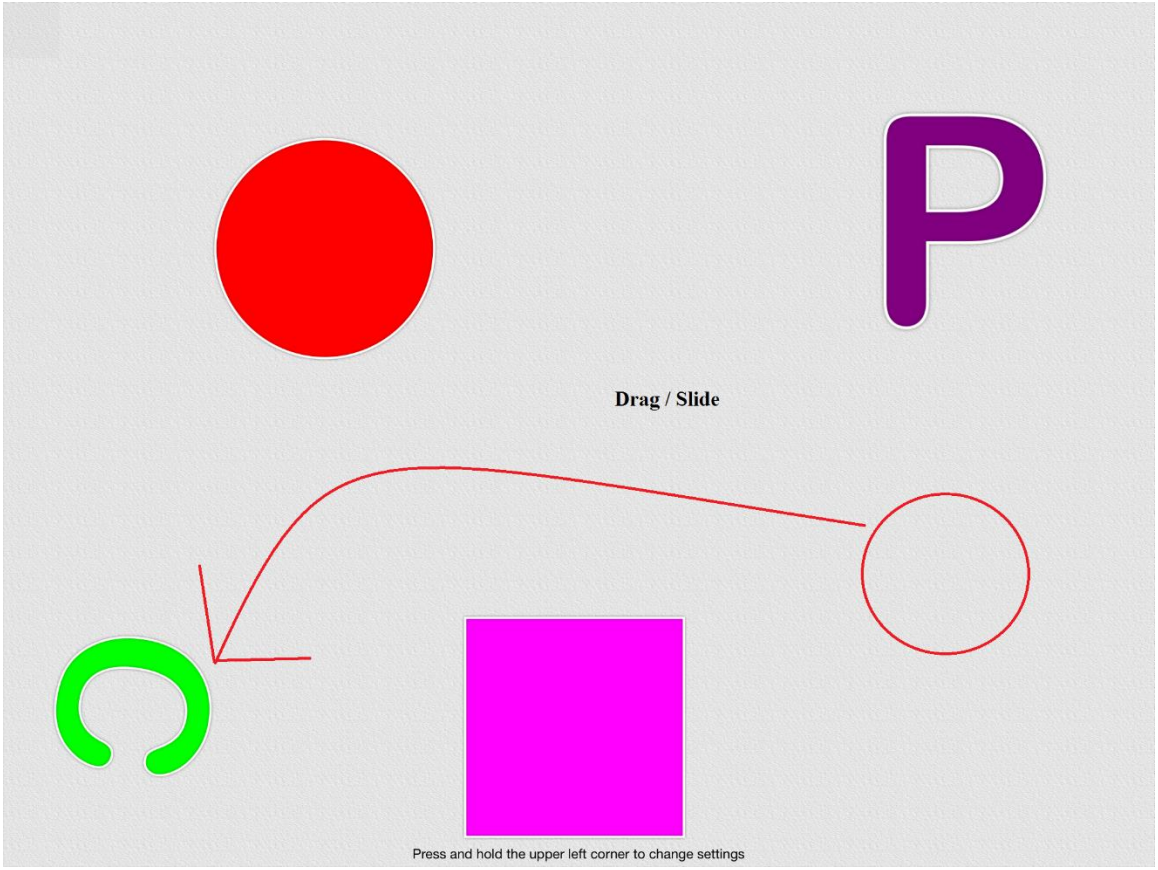
Flick: can be done when child quickly moves the bottom of the screen to the next hair stations

Application: AlphaBaby Free

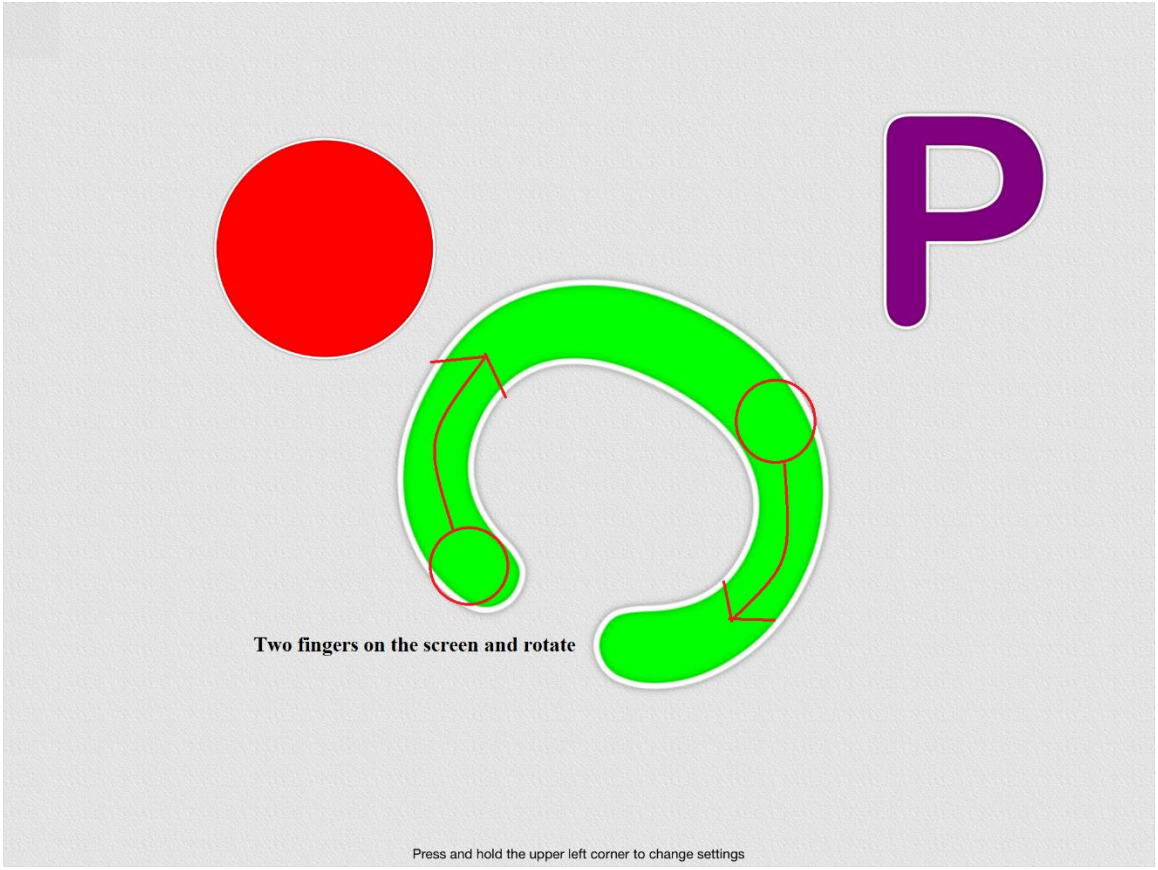
Tap: child can tap anywhere on the screen to have a new item appear on the screen, or tap existing item to move it or change the size of it



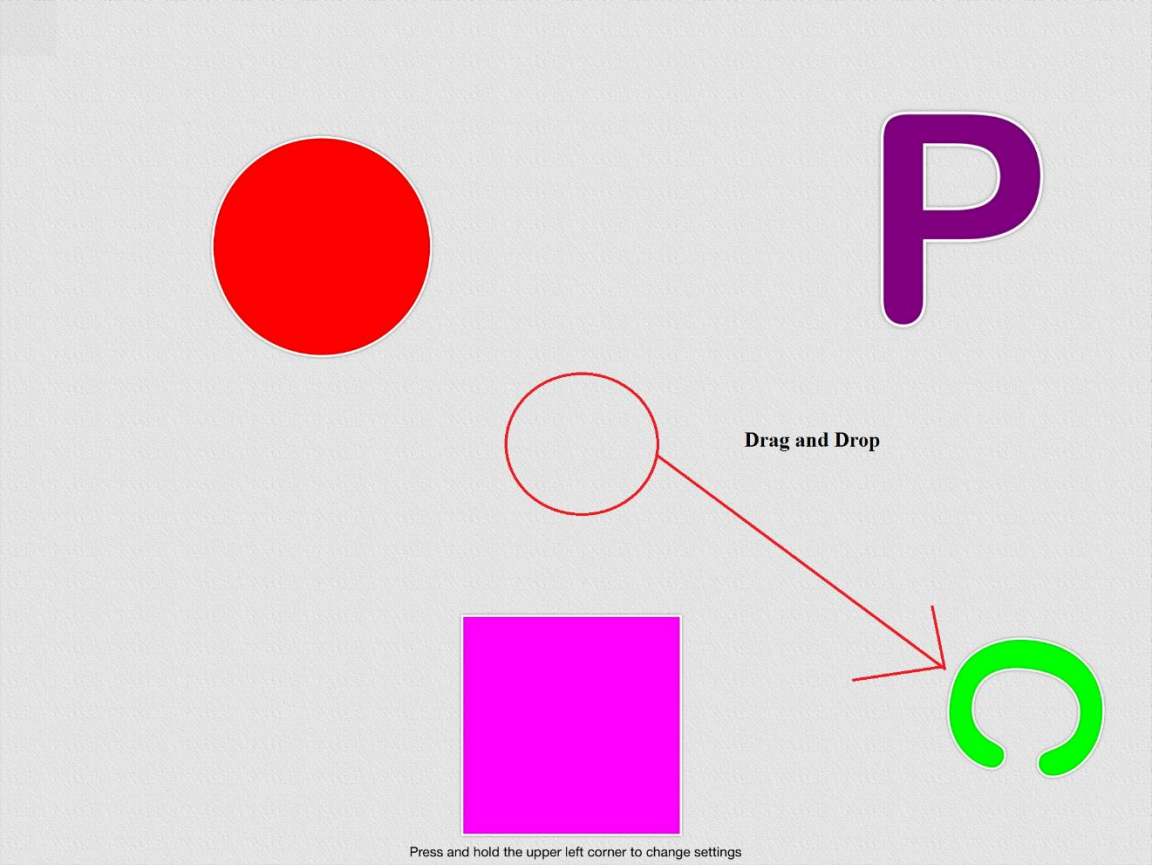
Drag/Side: child can drag/slide to move items on the screen around



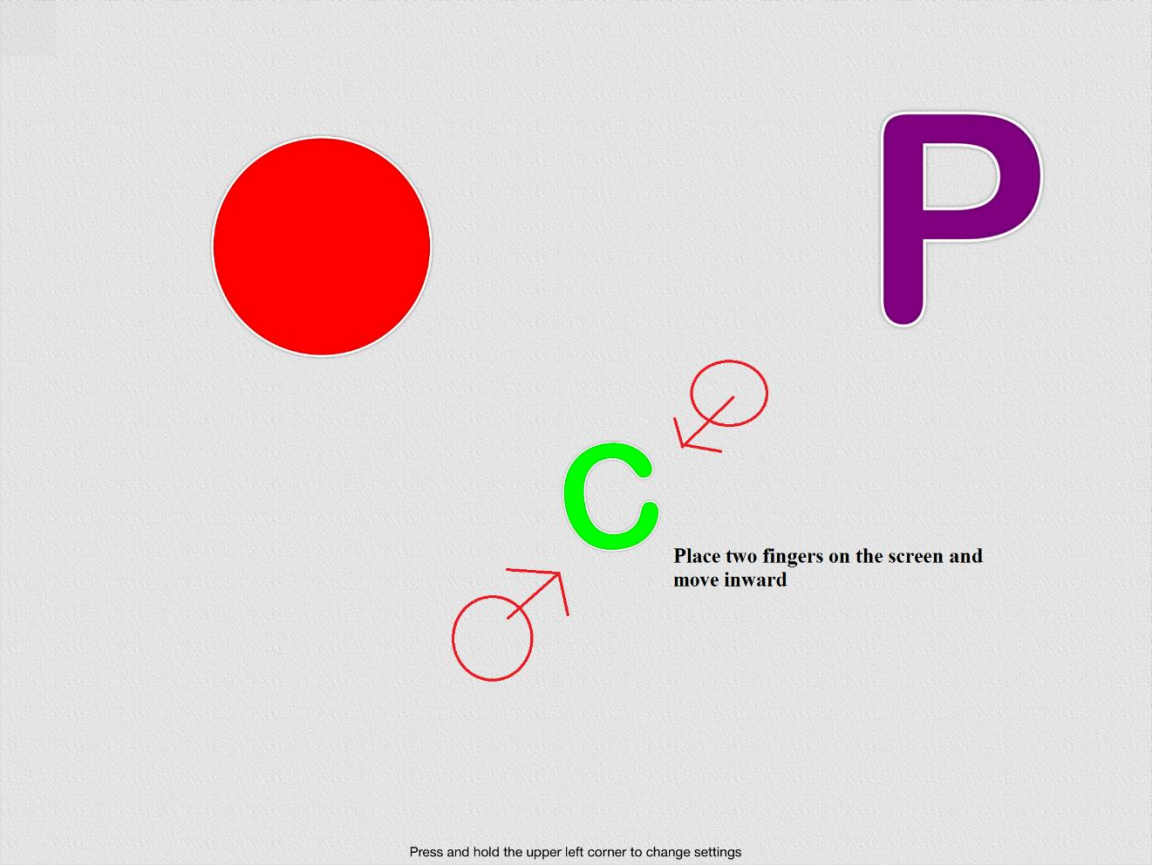
Free Rotate: child can use one hand or both hands to rotate the item on the screen



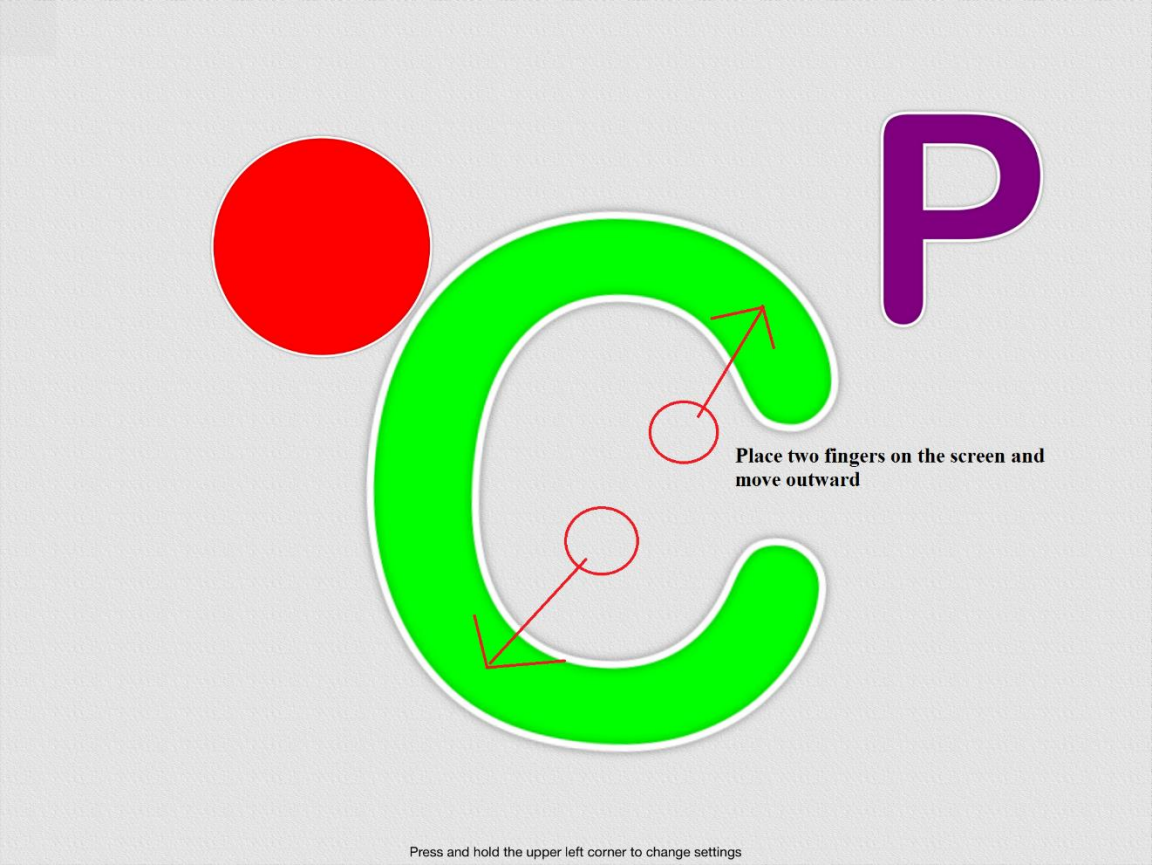
Drag & Drop: can only be done when child drags and drops items to a specific desired location without it moving further. (ex: child moves all the items into a straight line, or into the corner)



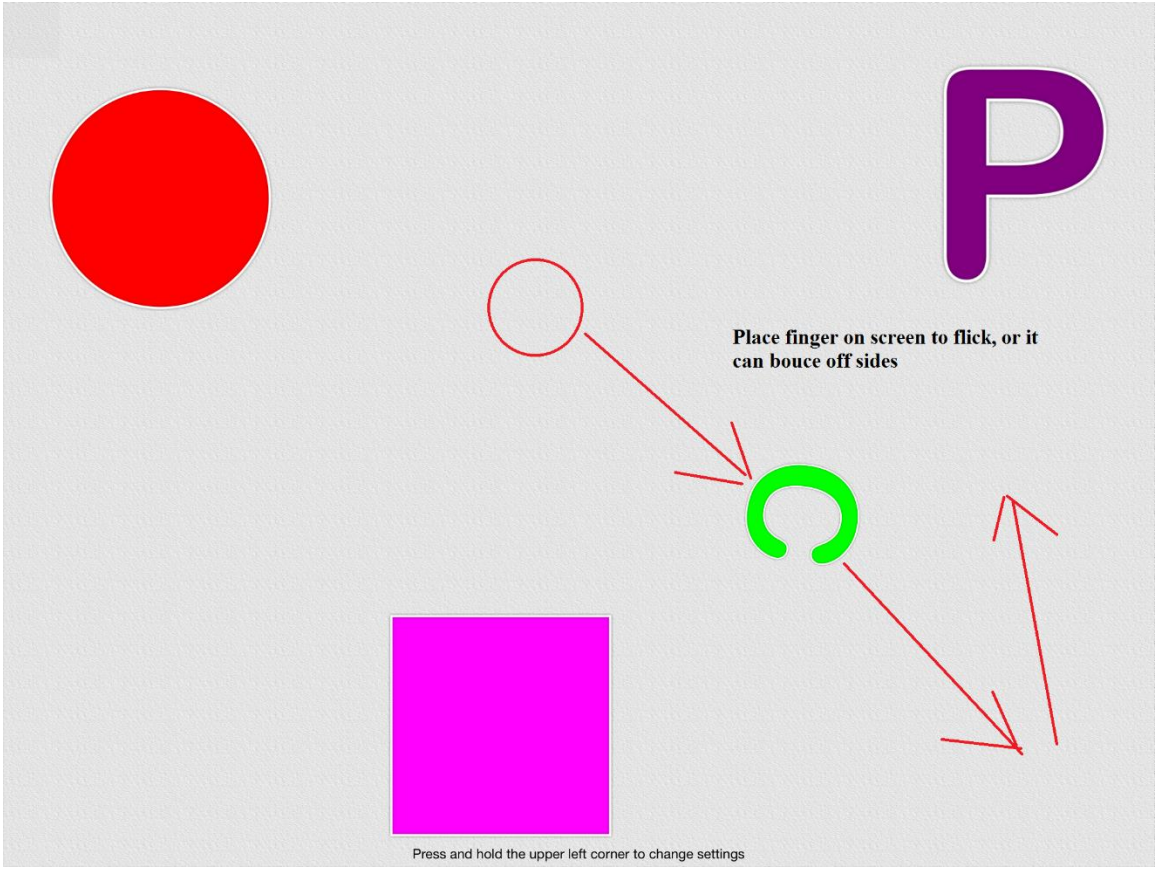
Pinch: child can use one hand or both hands to pinch the item on the screen (double tapping to make the item smaller does not count)



Spread: child can use one hand or both hands to spread the item on the screen (double tapping to make the item smaller does not count)



Flick: child can flick and item across the screen, or it can even bounce off the sides



APPENDIX F: RESEARCH ASSISTANT TRAINING

Research Assistant Training

Week	Topic	Rational
1	Confidentiality	To train the RA on steps to maintain the confidentiality of the children in this research study. No recordings are to leave to designated research lab, no real names are used, no disclosure of data collection site.
2	Introduction to Study	In this week, I showed the RA's the pilot study videos to get them orientated to this research study and answered any questions they had.
3	Introduction to iPad gestures	In this week, I introduced RA's the iPad gestures that are involved in this research study. I also introduced them to the iPad Gestures Checklist.

4	Training on Coding iPad gestures	RA's were assigned pilot videos to code with the iPad Gestures Checklist. Video 1 had 3 children, video 2 had 2 children, and video 3 had 3 children.
5	iPad gestures	Reliability was introduced and explained to the RA's
6	iPad gestures	RA's were given this week to code all 3 videos individually
7	Training Reliability	Training Reliability was collected and calculated

APPENDIX G: INFORMATIONAL FLYER

Young Children's iPad Gestures When Using iPads Informational Flyer

What is the purpose of this research study?

The purpose of this research study is to learn more about the gestures that children use when playing with the iPad.

What will my child be asked to do?

Your child will play on an iPad using at least four apps (Montessori Alphabet, Alpha Baby, Toca Hair Salon & Toca Kitchen Monsters). To use the apps, several gestures (tapping, dragging, flicking, sliding, rotating, pinching, and spreading) are involved. Your child will be video recorded while playing with the iPad.

How long will it take?

Your child will be out of the classroom for no longer than 20 minutes on two separate occasions. Your child will go to a space just outside the cafeteria at ODN. In the first session, your child will play with the iPads for 15 to 20 minutes. In the second session, your child will be paired up with a classmate and they will play with the iPad for 15 to 20 minutes.

How can my child take part?

After you have read this information, if you would like for your child to take part in this study, please sign the Informed Consent form. However if at any time, before, during, or after the sessions you wish to withdraw from this research study you are free to do so. Whether you allow your child to take part or not is up to you. If you decide to not take part in this research study, it will not be held against you or your child.

What will happen to the results of this research study?

The results of this research study will help me understand what hand gestures children use when playing on the iPad. The results of this research study will be used in publications about iPad usage. Your child's name will not be used in the publications. The video recordings may be used in future educational research, or be shown during scientific meetings or used for educational purposes.

Who is doing this research?

Lap Nguyen M.S. a doctoral student at the University of Central Florida under the supervision of Dr. Rex Culp.

Phone: (407) 242-1004

Email: Lap@knights.ucf.edu

LIST OF REFERENCES

Aziz, N. A. A., Batmaz, F., Stone, R., & Chung, P. W. H. (2013). *Selection of touch gestures for children's applications*. Paper presented at the Science and Information Conference, London, UK.

Aziz, N. A. A., Sin, N. S. M., Batmaz, F., Stone, R., & Chung, P. W. H. (2014). Selection of touch gestures for children's applications: Repeated experiment to increase reliability. *International Journal of Advanced Computer Science and Applications, 5*(4), 6.

Bandura, A., & Walters, R. H. (1963). *Social learning and personality development*. New York, NY: Holt, Rinehart, & Winston.

Bandura, A., Ross, D., & Ross, S. A. (1963). Imitation of film-mediated aggressive models. *The Journal of Abnormal and Social Psychology, 66*(1), 3.

Beschorner, B., & Hutchison, A. (2013). iPads as a literacy teaching tool in early childhood. *International Journal of Education in Mathematics, Science and Technology, 1*(1), 16-24.

Cochran-Smith, M., & Lytle, S. L. (Eds.). (1993). *Inside/outside:* Teacher research and knowledge. Teachers College Press.

Cohen, M., Hadley, M., & Frank, M. (2011). *Young Children, Apps & iPad*. *Michael Cohen Group*. Retrieved from http://mcgroup.wpengine.com/wp-content/uploads/2015/03/ipad-study-cover-page-report-mcg-info_new-online.pdf

Common Sense Media. (2013). *ZerotoEight: Childrens Media Use in America 2013*. Retrieved from http://www.commonsensemedia.org/research/zero-to-eight-childrens-media-use-in-america-2013

Culp, A. M., Osofsky, J. D., & O'Brien, M. (1996). Language patterns of adolescent and older mothers and their one-year-old children: A comparison study. *First Language*, *16*(46), 61-75.

Donker, A., & Reitsma, P. (2007). Aiming and clicking in young children's use of the computer mouse. *Computers in Human Behavior, 23*(6), 2863-2874. doi:10.1016/j.chb.2006.06.002

Fallows, D. (2004). The Internet and daily life: Many Americans use the Internet in everyday activities, but traditional offline habits still dominate. *Pew Internet & American Life Project.* Retrieved from http://www.pewinternet.org/2004 /08/11/the-internet-and-daily-life/

Gall, M., Gall, J., & Borg, W. (2007). Collecting research data with questionnaires and interviews. *Educational research: An introduction* (8th ed.). Upper Saddle River, NJ: Pearson Higher Ed.

Gallahue, D. L., & Ozmun, J. C. (1998). *Understanding motor development: Infants, children, adolescents, adults* (4th ed.). Boston, MA: McGraw-Hill Humanities, Social Sciences & World Languages.

Gibson, E. J. (1982). The concept of affordances in development: The renascence of functionalism (1st ed.). In W. A. Collins (Ed.), *The Concept of Development: The Minnesota Symposia on Child Psychology* (Vol. 15, pp. 51-81). Hillsdale, NJ: Lawrence Erlbaum Associates.

Gibson, J. J. (2014). *The ecological approach to visual perception*. Abingdon, UK: Psychology Press and Routledge Classic Editions (Taylor & Francis).

Glaubke, C. R. (2007). *The effects of interactive media on preschoolers' learning: A review of the research and recommendations for the future.* Oakland, CA: Children Now.

Hart, B., & Risley, T. R. (1995). *Meaningful differences in the everyday experience of young American children*. Baltimore, MD: Paul H Brookes Publishing.

Haugland, S. (1998). The best developmental software for young children. *Early Childhood Education Journal, 25(*4), 247-254.

Hoff-Ginsberg, E. (1998). The relation of birth order and socioeconomic status to children's language experience and language development. *Applied Psycholinguists, 19*(4), 603-629.

McKnight, L., & Cassidy, B. (2012). Children's interaction with mobile touch-screen devices: experiences and guidelines for design. *Social and Organizational Impacts of Emerging Mobile Devices: Evaluating Use: Evaluating Use*, 72.

Miller, P. H. (2010). Theories of developmental psychology. London, UK: Macmillan.

Orlando Day Nursery. (2015). *History*. Retrieved from http://orlandodayschool.org /history.html

Radich, J. (2013). Technology and interactive media as tools in early childhood programs serving children from birth through age 8. *Every Child, 19*(4), 18-19.

Saffer, D. (2009). Designing for interaction: creating innovative applications and devices (2nd ed.). San Francisco, CA: New Riders (Peachpit Press/Pearson).

Shuler, C. (2009). *Pockets of potential: Using mobile technologies to promote children's learning.* New York, NY: Joan Ganz Cooney Center. Retrieved from http://www.joanganzcooneycenter.org/wp-content/uploads/2010/03/pockets_of_potential_1_.pdf

Statista. (2015). Apple iPad global sales 2010-2015, by quarter. Retrieved from http://www.statista.com/statistics/269915/global-apple-ipad-sales-since-q3-2010/

Timler, G. R., Vogler-Elias, D., & McGill, K. F. (2007). Strategies for promoting generalization of social communication skills in preschoolers and school-aged children. *Topics in Language Disorders, 27*(2), 167-181.

U.S. Department of Health and Human Services. (2015). *2015 Poverty Guidelines.* Retrieved from http://aspe.hhs.gov/2015-poverty-guidelines

Vatalaro, A., & Nguyen, L. (2014). *iPad use in a kindergarten classroom*. Unpublished assessment. Orlando, Florida.

Vatavu, R. D., Cramariuc, G., & Schipor, D. M. (2015). Touch interaction for children aged 3 to 6 years: Experimental findings and relationship to motor skills. *International Journal of Human-Computer Studies, 74*, 54-76.

Vygotsky, L. (1978). Interaction between learning and development. In M. Gauvain, *Readings on the development of children* (pp. 29-36), New York, NY: W. H. Freeman and Company. Retrieved from http://www.psy.cmu.edu/~siegler/vygotsky78.pdf

Watlington, D. (2011). Using iPod Touch and iPad Educational Apps in the Classroom. In M. Koehler & P. Mishra (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference 2011* (pp. 3112-3114). Chesapeake, VA: Association for the Advancement of Computing in Education (AACE).

Wrotniak, B. H., Epstein, L. H., Dorn, J. M., Jones, K. E., & Kondilis, V. A. (2006). The relationship between motor proficiency and physical activity in children. *Pediatrics, 118*(6), 1758-1765.