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The Origins of Reading: Using the IPad to Study 2-to 4-Year-Old's Learning of Sound/Print/Object Relations

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By Ashley Catherine Vance

Entitled
The Origins of Reading: Using the IPad to Study 2- to 4-Year-Old's Learning of
Sound/Print/Object Relations

For the degree of Master of Science

Is approved by the final examining committee:
George J. Hollich
Chair
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Approved by Major Professor(s): George J. Hollich

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Head of the Graduate Program
11/19/13
THE ORIGINS OF READING:
USING THE IPAD TO STUDY 2- TO 4-YEAR-OLD’S LEARNING OF SOUND/PRINT/OBJECT RELATIONS

A Thesis
Submitted to the Faculty
of
Purdue University
by
Ashley Vance

In Partial Fulfillment of the
Requirements for the Degree
of
Master of Science

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ABSTRACT

Vance, Ashley. M.S., Purdue University, December 2013. The Origins of Reading: Using the iPad to Study 2- to 4-Year-Old’s Learning of Sound/Print/Object Relations. Major Professor: George Hollich.

This thesis looks at the origins of reading (before the age of 5) through the lens of early language development. We used an iPad to test if children can make the connection between printed words and the spoken word or their visual referent. Using a forced choice procedure, inspired by the traditional Preferential Looking Paradigm, we tested 30 children, ages 2-4 years. Results suggest that children as young as 2 years of age can indeed make spoken word-to-print connections. Specifically, by emphasizing or exaggerating text differences, we were able to get children (2-4 years of age) to correctly tap the printed word that corresponded to a spoken request. Some children were extremely successful in the print task (getting greater than 12 out of 16 correct, with five children getting perfect scores) far exceeding chance values even at the individual level. Children were also able to correctly tap the printed word when prompted by a picture of that word. We conclude that this method represents a new avenue to test young children’s developing reading ability and a potential means to facilitate literacy learning.
INTRODUCTION

Reading is fundamental to virtually every aspect of modern life: from our jobs, to driving, and even to figuring out which bathroom to use. As a result, reading is one of the most important skills for children to learn. Greater reading skills have been linked to academic success and future career success (National Early Literacy Panel, 2009). Few things are as useful as knowing how to read. Sadly, many children struggle with this process, and by some estimates, 14.7% of Americans are functionally illiterate (NCES, 2003).

But when does learning to read begin? Before learning to map the printed word “cat” to a picture of a cat, toddlers are getting the foundations of literacy (and language) in a period that those in the reading field refer to as emergent literacy (a period that lasts up to four years of age). Emergent literacy hinges upon mastery of two skills: phonological awareness and alphabet knowledge (Bailet, Repper, Murphy, Piasta, & Zettler-Greeley, 2011). Collectively, these two skills are sometimes referred to as the “alphabetic principle” (Byrne, & Fielding-Barnsley, 1989). Research suggests that basic phonological awareness begins to develop around age two (Anthony & Lonigan, 2004) and alphabet knowledge is typically assessed around age three (Piasta, Petscher, & Justice, 2012). In addition, early reading experiences during this time seem to predict later reading skills including the early (Piasta et al., 2012) and late
elementary school years (Dickinson & Porche, 2011) and continue to predict reading skills into the middle school years (NICHD Early Childcare Research Network, 2005). Coincidentally (or perhaps not), it is around ages two to four that children begin to master *spoken* language.

How much of the reading process parallels or is connected to spoken language skills? At one level, both reading and spoken language involve connecting sight to sound: While language involves connecting object to spoken word (e.g., a picture of a cat with the spoken word “cat”), learning to read partially involves connecting word and letter shapes to their acoustic representations (e.g., the printed word “cat” with the spoken word “cat”). Learning to read also involves connecting sight with sight (e.g., the picture of a cat with the printed word “cat”). In all cases, children are learning to connect two apparently arbitrary entities. This skill is commonly referred to in the literature as associative or statistical learning (Saffran, Aslin, & Newport, 1996). Gogate and Hollich (2010) have suggested that such associative learning (which they called invariance detection) plays a crucial role throughout all of language development: segmentation, semantics, and grammar.

*Could emergent literacy be tapping into the same processes involved in associative learning and/or other processes involved in general language acquisition?*

The literature is rife with clues about the overlap between emergent literacy and spoken language. Research has shown that focusing on language development during the preschool years has a lasting effect on many aspects of reading. For example, Dickinson and Porche (2011) found a correlation of $r = .62, p < .001$ between language comprehension in kindergarten and reading comprehension in fourth grade. They also
found that focusing on semantics and syntax while teaching preschoolers more sophisticated language improved later reading comprehension. Similarly, Metsala (1999) found that increasing a child’s vocabulary improves phonemic awareness and is correlated with the mental representation of language necessary for reading. Furthermore, children who have greater phonological awareness (Hecht, Burgess, Torgesen, Wagner, & Rashotte, 2000) appear to learn to read sooner. Using Structural Equation Modeling, Silven, Poskiparta, Niemi, and Voeten (2007) found that early reading is uniquely affected by language acquisition beginning at twelve months of age. Specifically, they concluded that the ability to detect multi-phonemic units led to greater word production, which, in turn, enhanced reading ability.

All of these studies point to the importance of early language skills and early reading experiences in learning to read. Might the skill of word mapping (connecting sound with object) be related to connecting print with object? If early language is as important to successful reading as the above studies suggest, then it follows that the same kinds of things that help children learn to connect word with object (see Hollich, Hirsh-Pasek and Golinkoff, 2000) may also play a role in helping children learn to connect print with object. For example, Hollich et al. (2000) found that word learning seems to be facilitated by overlapping cues. The more distinctive the perceptual cues, the easier it is for children to learn connections. Might learning to read also work in a similar manner? Might overlapping perceptual cues (such as bright colors, size, and motion) prove just as facilitative to print learning as they are in spoken word learning?

How different is the process of learning to recognize one letter (or one word) from another as compared to the process of learning to recognize a dog from a cat? It is
likely that perceptual and categorization skills (Younger & Cohen, 1983) underly both activities. Just as infants come to discover classes of perceptual objects (such as dogs, chairs, boats, cars, etc.), they must also discover classes of letters and word shapes in learning to read (Phillips, Norris, & Anderson, 2008). More specifically, if reading uses the same skills as early language acquisition, then learning to read is analogous to trying to learn different spoken words for multiple black objects that are all the same general height, thickness, and style (abcdefg...). Perhaps exaggerating the differences between characters (and words) could make the initial process of mapping printed words with objects much easier. For example, using different fonts and colors for each key word could help maximize the distinctions, and make learning individual associations between printed words and their referents easier. Some research suggests that during shared book reading, children only focus on print .4 to 7% of of the time (Evans, Saint-Aubin, & Landry, 2009; Justice, Skibbe, Canning, & Lankford, 2005). It’s possible that the pictures typical to children’s books are far more salient than the black and white print. It could be that making the words larger than the object or somehow incorporating the object into the word would enhance print knowledge.

To test this hypothesis, we used a forced choice procedure on the iPad. This method takes advantage of two well-established methods of developmental psychology (preferential looking and forced choice) to test for reading knowledge at much earlier ages then previously possible.

The first method we used as inspiration was the Preferential Looking Paradigm (hereafter referred to as PLP). The PLP has been used to measure knowledge of early language in infants and toddlers for more than 20 years (Fagan, 1971; Spelke, 1979).
Specifically, this method is especially suited to show that even very young children can connect sounds with objects (Gogate & Hollich, 2010). In a typical study, children might see an apple on one side of a screen and a flower on the other side while one of these objects is requested (e.g. children would hear “Where’s the apple? Do you see the apple?”). If children look longer at the targeted object (in this case the apple) than the non-targeted object (the flower), then this is taken as evidence of children having made the connection between the spoken word and the picture of the object. Using a method inspired by preferential looking in this study has several advantages. First, it provides an objective way of measuring what children know and are capable of learning about print at a very young age. For instance, could a child learn the printed letter “A” (or even the printed word “Apple”) before they have been formally taught the alphabet? Second, the PLP allows researchers to look at early knowledge as opposed to advanced knowledge. Early stages of reading might bear little relation to the later, more mature, versions of the skill. Thus, the understanding of children’s earliest print knowledge (and the kinds of support necessary) aids in tracking the precise developmental processes and pathways necessary for reading.

For this study, we have modified the PLP for the iPad by making it a forced choice procedure, where participants touch or tap the correct response. The traditional forced choice procedure has been used by many researchers to test a variety of variables including pain thresholds (Satero, Klingenstierna, Karlsson, & Olausson, 2000), object labeling (Corriveau, Kinzler, & Harris, 2013; Han & Hollich, 2013) and early comprehension argument structures with novel verbs (Noble, Rowland, & Pine, 2011). Noble et al. (2011) taught children several novel verbs. For example, the
children saw images on a screen of a duck pushing a bunny’s head down. While this was occurring, a prerecorded voice said “the duck is daxing the bunny.” During the test block, children were shown the “daxing” scenario and a control scenario and asked to point to “where the duck was daxing the bunny.” These researchers referred to this as the forced choice pointing paradigm (FCPP).

There are many benefits for researchers by combining the traditional PLP and forced choice procedures. In a traditional PLP study, the results are reported in terms of differences in mean looking time between the the target and non-target object (Seidl, Hollich, & Jusczyk, 2003). These differences tend to be minute and difficult to code. With the iPad, the participant chooses between the target and non-target item and has either a correct or incorrect response. This is beneficial for researchers in many ways. First, it allows for more conclusive and accurate results; either the child touches the target item or doesn’t. Second, it allows for meaningful interpretations of results on an individual level. Instead of using only mean differences, the researcher can analyze each participant’s performance. Finally, this method is far more efficient than the traditional PLP. Instead of having parents bring children to a lab one at a time, we can take the iPad to one location and test many children. For example, in this study, data were collected at local preschools.
METHOD

The current study uses a forced choice procedure on an iPad to examine whether 2- to 4-year-olds can connect spoken word to print as easily as they can connect spoken word to visual referents, when the print is maximally distinct and motion is utilized to draw attention.

Participants

A total of 30 participants were used in this study (16 girls and 14 boys). Participants were recruited from two preschools in central Indiana. The age range was 837-1795 days or 2-4.9 years ($M = 1350$ days or approximately 3.7 years). We chose children in this age range because, as previously mentioned, this is the age of emergent literacy, when phonological awareness and alphabet knowledge is developing. We chose 30 participants because preliminary studies using this method, have shown extremely large effect sizes (Han & Hollich, 2013).

Procedure

After receiving a signed consent form from the parent, the child was taken to a research room set up in his or her preschool with a table and chairs. Here, the child sat next to the researcher with an iPad placed on the table. The researcher instructed the child that there would be times when he or she could to touch the screen (during test trials) and other times when he or she should just watch (during training trials). Next,
the child went through 56 slides of objects and/or words (see stimuli section). In the extremely rare case where the child seemed unable to make the screen advance because he or she didn’t touch the screen hard enough or due to a technical error, the researcher touched the screen for the child. The researcher only did so if the child had clearly indicated one of the objects or words. If the child looked to the researcher for encouragement or validation, the researcher simply made a neutral statement such as “You’re doing a great job.” If the child was distracted or fussy the researcher tried to reengage him or her. If at any point in the experiment the child indicated that he or she wanted to stop, the researcher ended the procedure immediately. The experiment was recorded with a Sony DCR-HC52 camcorder attached to a tripod.

**Stimuli and Design**

The stimuli for this project were created using Keynote ‘09 version 5.1. The stimuli were designed to be similar to an electronic or ebook. The children were tested across three types of test trials: *Object*, *Print*, and *Object-to-Print* (See Figure 1) with four sets of objects/words. During the *Object* trials, the children saw a visual of two objects on the screen while audio requested each in alternation. The *Object* trials were presented first because previous research suggests that this is a task that almost all of the children should be able to complete successfully (Han & Hollich, 2013). Also, by starting with an easy task, it allowed the children to become comfortable with using the iPad. Following each block of *Object* trials, there were *Training* trials where one word appeared on the screen and the object that corresponds with that word moved into the picture becoming a part of the printed word (See Figure 2). In the *Print* trials, similar to the *Object* trials, the children saw a visual of two printed words while the audio
<table>
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<tr>
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<th>Object-to-Print</th>
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<tbody>
<tr>
<td>“Apple”</td>
<td>“Apple”</td>
<td>apple  flower</td>
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</table>

*Figure 1*. Test trials.

*Figure 2*. Training trials.
alternated requests for one of those words. Again, we used distinct colors and fonts for all 8 words (See Appendix for full list). Finally, in the Object-to-Print trials, the children saw a picture on the top of the screen and two printed words on both sides of the bottom with no audio.

In order to ensure that the child touched an object/word before the next slide appeared, we set the presentation so that one of the target items had to be touched in order to advance to the next slide. This manipulation was particularly important in the Object-to-print trials, since children had a tendency to tap the object rather than to select one of the print items.

This study consisted of four main blocks. Each block included (a) two Object trials; (b) six Training trials (c) four Print trials; and (d) two Object-to-Print trials. Each block consisted of two objects and their respective printed labels.

**Coding**

Coding for this study was done by watching the captured videos from the camcorder in the computer program Final Cut Pro. The object or word touched by the child was the dependent variable and coded as either a 1 (correct) or 0 (incorrect). The underlying assumption for this method of coding is that children will touch the object or printed word when it is requested if the participant has successfully identified the object or made the printed word-object association, respectively. Thus, an overall percentage was calculated for each test trial: Object, Print, and Object-to-Print.
RESULTS

The mean percentages for each type of test trial was calculated and a series of chi square tests were run to check for a significant difference in touching target vs. non-target objects and words. For the Object trials, the mean percentage of correct responses was 71.3%, $\chi^2 = 43.35$, $p < .001$. For the Print trials, the mean percentage of correct responses was 63.3%, $\chi^2 = 34.13$, $p < .001$. For the Object-to-Print trials, the mean percentage of correct responses was 63.3%, $\chi^2 = 17.07$, $p < .001$. These results indicate that children as young as two years of age are able to use the iPad to correctly identify objects and more surprisingly, make correct associations between objects and words.

Results were also analyzed on an individual level to give us unique information about whether each child was performing statistically above chance. For example, we calculated that getting seven out of eight correct on the Object trials would be above $p = .05$. Nineteen children succeeded at this level. For the Print trials, thirteen children performed above $p = .05$, getting at least twelve out of sixteen correct. Finally, for the Object-to-Print trials, nine children performed above $p = .05$ getting at least seven out of eight correct. This suggests that some of these children are clearly succeeding at these tasks.
DISCUSSION

This study is a first step at exploring reading using the iPad with a method inspired by the PLP. The purpose of the present study was to see if we can test whether children understand the links between text and objects in the pre-reading period. As expected, the children were statistically significantly able to touch the target object during the Object trials. These Object results are similar to traditional PLP studies but are more robust (Seidl et al., 2003). The children also touched the target word at a significant level during the Print trials. This is the first study of its kind looking at children at such a young age. Children were also able successfully complete the Object-to-Print task. This was the most surprising result because this was a considerably more difficult task, especially for the younger participants. This study shows that by changing font, using intersensory redundancy, and incorporating objects as part of the word, children were able to make the correct object-word association 63% of the time.

This line of research could help us discover if principles of learning early language also apply to learning to read. Understanding this process could be central to constructing reading materials that take advantage of the way children learn and make learning to read as easy as possible. Indeed, a long-term goal of this program of research is to create a framework that can be used to test the most effective methods for
teaching early literacy to children. Empirical evidence suggesting that there are simple changes writers/educators could make to written material to draw children’s attention to print and help them learn printed words would be very beneficial to the field of emergent literacy.
FUTURE DIRECTIONS

There are several possible explanations for these results. It may be that children are actually making the object-word association; thus, taking the first steps towards reading. However, we were trying to make the print maximally distinct and in doing so we may have added cues that children are using to succeed in the task. It remains to be seen whether children would succeed if the font were in black and white. To test whether this is the case, the next step in this line of research is to include words that are all the same font and color.

It is also important to note that most data were collected from middle to upper class families in a college town which could limit the generalizability of the results. Another step in this line of research is to test children of different backgrounds and from different places. One advantage of this method is that it is very portable, and could be used across different labs and demographics, perhaps even being used in a children museum setting.

More broadly, a tantalizing possibility of this method is that it could be used to detect individual differences in reading ability. This provides both theoretical and practical benefits. Thus, we could explore theoretical questions as to why some children succeed in learning to read while others do not, and we could similarly explore practical interventions that could help individual children learn to read. In sum, we
believe that this method represents a new avenue to test young children’s developing reading ability, and a potential means to facilitate literacy learning.
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