Effect of Learning Environment on Parent-Child Interaction and Word Learning

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Effect of Learning Environment on Parent-Child Interaction and Word Learning

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Undergraduate Honors Thesis

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Abstract

Children learn language through immersion and interaction in particular linguistic environments. Interactions between parent and child, in particular, can alter language learning significantly. Current research favors storybook reading as the primary method to encourage language learning, as parent interactions with children while using storybooks allowed the child to learn language three times more effectively than without storybook reading (Sénéchal, 1997); however, other work suggests that the use of physical, three-dimensional objects is just as significant (Lee, 1993; Kwon, Bingham, Lewsader, Jeon & Elicker, 2013; Baki, Kosa & Guven, 2011). This study tests the effect of parent and child interaction with two-dimensional (2-D) and three-dimensional (3-D) stimulus on child language learning. In this study, the 2-D stimulus is a storybook, and the 3-D stimulus is a 3-D puzzle. Results of this study indicate that while parent and child interactions differ distinctly when using 2-D versus 3-D stimuli, child language learning is similar across conditions. These results support the theoretical results that 3-D stimulus and object use with parent interaction can be a useful tool in word learning, comparable to interactive storybook learning.
Effect of Learning Environment on Parent-Child Interaction and Word Learning

Specific Aim and Hypothesis

The Present Study

The present study aims to understand how parental interactions differ in their language use in two distinct learning environments, storybook reading and 3-D puzzle play, and the subsequent effect of these interactions on word learning. We are interested in learning how different learning environments impact parent-child interactions and child language development. The experiment consisted of an interaction period between the parent and child in which parent and child either read the storybook or played with the 3-D puzzle, followed by a testing period to assess how well children learned a set of target words. This study aims to demonstrate that there are a variety of effective methods for enhancing word learning beyond storybook reading by providing evidence of enhanced word learning with the use of 3D objects. This project is one of many working toward improving methods to bolster children’s vocabulary acquisition before the age of three.

An initial pilot of this project was completed in March of 2015, with 30 child participants aged 36 to 48 months old. The results of the pilot study showed that parents interacted with their children differently when asked to teach children specific words using either a 2-D storybook, or a 3-D puzzle. Specifically, parents who read the storybook named the target objects almost twice as much as parents who used the 3-D puzzle. However, children who played with the 3-D puzzle learned words marginally better than children in the storybook condition. These results have to be interpreted with caution, however, as children in the pilot study knew a majority of the target words, about 66.66% of the words on average, prior to participating in the experiment. Due to this, the current study aims to understand how parent-child interactions and word learning differ
in the same context with younger children, aged 30 to 36 months old, who are less likely to know
the majority of target words prior to the experiment.

**Hypotheses**

This study aims to answer two questions of theoretical interest in understanding the acquisition of language in young children. First, we attempt to replicate and better understand the differences in parent-child interactions using the 2-D and 3-D stimuli. Specifically, we are interested in the different usage rates of target words across the two conditions. Second, we attempt to offer a clear challenge to the previous assumptions in the literature that storybook reading is the most effective way to teach children language. Specifically, we are interested in whether children would learn words at similar rates across these two conditions. These patterns of learning may indicate that language learning in children aged 30 to 36 month olds benefit equally from both learning environments using storybooks or 3-D puzzles.

**Introduction**

**Parent – Child Interactions**

Vocabulary and word learning in young children is inherently a social process, especially aided by interactions between parent and child during the first two years of life (Hoff & Naigles, 2002). In general, interactions between parent and child, particularly mother and child, have a strong impact on which words children learn, how many words they learn, and the rate at which they learn new words (Hoff & Naigles, 2002; Paavola, Kunnari, Moilanen, & Lehtihalms, 2005). Research indicated that more advanced vocabularies in young children are linked to better reading comprehension, (Elleman, Lindo, Morphy, & Compton, 2009) and reading proficiency, (Catts, Fey, Tomblin, & Zhang, 2001). Here we explore the role of parent-child interactions with use of 2-D or 3-D stimuli and its subsequent effect on child language learning.
Study of the interactions between parent and child, defined as one-on-one attention shared between parent and child, and its effect on language learning has been ongoing for over 50 years. Collectively, the results provide an ample amount of evidence that indicates a strong connection between parent and child interaction and language learning in young children (Snow, 2014). In particular, the vocabulary of the parent has a strong effect on the vocabulary of the child. Brent and Siskind (2001) concluded that words and categories used by parents tend to be used similarly by their children. van Veen, Evers-Vermeul, Sanders, and van den Bergh (2009) found that the frequency parents use particular words directly affects the frequency that their children use those words. Furthermore, Callanan (1985) demonstrated that parents provide support to children through interaction and object labeling for learning more difficult or complex words throughout development. Huttenlocker, Vasilyeva, Cymerman, and Levine (2002) and Tamis-LeMonda, Baumwell, and Cristofaro (2012) determined that there is an interaction between parent word use and child word use, and concluded that language development occurs at a greater level when children are exposed to syntactically complex speech from an adult.

The current study focuses on child-parent interaction during play. One reason that the vocabularies of parent and child share similarities is due to interactions during play. Weisberg, Zosh, Hirsh-Pasek, & Golinkoff (2013) provide an extensive review indicating a strong link between play and language development. Tamis-LeMonda et al. (2012) found distinct similarities between parent and child conversation in respect to communication style and word type usage during play, concluding a strong connection between parent interaction and speech development. Additionally, Singer (1998) documented a link between play and complex language development.
2-D Stimulus - Storybook Reading

The effect of storybook reading on child language development has an abundance of literature dating back half a century. Dickinson, Griffith, Golinkoff, and Hirsh-Pasek (2011) discuss the relationship between the reading of books to children and long-term language development. In their review of over 100 studies, they found strong evidence supporting the use of storybook reading to encourage language development. Research indicates that the parental interactions during storybook reading encourage increased use of complex vocabulary between parent and child. Additionally, the interactions foster curiosity, leading to questions and discussions with the child. Overall, storybook reading appears to enhance language development in young children (Dickinson et al., 2011; Spencer, Goldstein & Kaminski, 2012). Storybooks were chosen for this study due to the regard of book reading as one of the best methods to promote child language development.

3-D Stimulus

In comparison to storybook research, there are few studies on the effect of interactions using 3-D objects on language development. Some scholars suggest that interactions using 3-D objects are just as important and effective as storybooks in childhood language development. Among children with mental disorders, handicaps, or delays, studies have shown that playing with toys increases linguistic behavior and use (Lee, 1993; Kwon, Bingham, Lewsader, Jeon & Elicker, 2013). In mathematics, research indicates that 3-D objects, manipulatives in particular, increase achievement and understanding of mathematical concepts (Baki et al., 2011). Our main contribution is to extend the significance of using 3-D objects in mathematics to suggest that 3-D objects may also offer a rich environment for learning words.
Methods

Participants

Subjects in the experimental condition include 32 children, 18 girls and 14 boys, between 30 months and 36 months of age (mean age = 33.54 months; SD = 1.97 months). Subjects in the control condition include 6 children, 3 girls and 3 boys, between 30 months and 36 months of age (mean age = 32.17 months; SD = 1.15 months). Children were accompanied by one parent for the experiment. Children were recruited through the University of Colorado Cognitive Development Center Database, which is collected on a voluntary basis. Participants were compensated $5 for travel expenses, and the child was given a book as a prize.

Stimuli

Using target words chosen through analysis of common vocabulary at three years of age, a 2-D storybook and a 3-D puzzle were created. The 3-D puzzle was created using a 3-D printer. Target words were selected using various normed vocabulary tests (MacArthur-Bates Communicative Development Inventory III, Peabody Picture Vocabulary Test-4 (PPVT-4), and Expressive Vocabulary Test-2 (EVT-2)), to select words that were unlikely to be known by the average three-year-old. After that, words were narrowed down by the ability to create concrete 3-D stimulus demonstrating the target word. The target words used in this project can be seen in Table 1. After selection of the target words, a 2-D storybook and 3-D puzzle were created with visualizations representing the twelve words (see Appendix A and Appendix B for pictures of the 2-D and 3-D stimuli).

Vocabulary Measures

Parents were asked to report their knowledge of their child’s vocabulary two times. The parent was asked to fill out the MacArthur-Bates Communicative Development Inventory III
(CDI III) in order to establish the child’s vocabulary size and percentile. Parents also indicated whether or not they thought the child knew the target words of this study, and were asked to report how certain they were. For example, if the parent thought their child knew the word ‘octopus’ but wasn’t completely sure, they may indicate that the child knows the word, but they are only 75% certain.

**Interaction Period**

The first phase of this project consisted of an interaction period in which parent and child were asked to interact in a room together with one of the two stimuli. Participants were randomly assigned into either the 2-D storybook or the 3-D puzzle condition, both created using the target words of the project. Parents were told to teach their child the target words and to interact as they would normally if they were at home. The typical instruction from the researcher was as follows:

<table>
<thead>
<tr>
<th>Target Words</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binoculars</td>
</tr>
<tr>
<td>Feather</td>
</tr>
<tr>
<td>Palm Tree</td>
</tr>
<tr>
<td>Pelican</td>
</tr>
<tr>
<td>Rake</td>
</tr>
<tr>
<td>Walrus</td>
</tr>
</tbody>
</table>

Table 1. Target Words for testing. Words were selected using MacArthur-Bates Communicative Development Inventory III, PPVT-4, and EVT-2.
“We would like you to play with the (book/puzzle) with your child as you would normally, as if you were at home, for 8 minutes and we would like to record your play to see how the two contexts might differ. Afterward, I’ll take you both to another room and I will play some games with your child to see how they learned from the experience.”

A researcher observed the interactions, and they were video recorded with permission for later use. During the interaction period, the researcher noted the amount of times the parent or child used each target word, but did not interfere during this period of time. The researcher recorded the context in which the child or parent used the target words as well, classifying it as used in a question or statement. After completion of the eight minutes, the stimulus was removed and the participant and parent were moved to a separate room for the testing phase of this project.

**Testing Period**

In the testing phase of the project, participants were asked to perform three tasks which we label as 1) the 2-D pictures task, 2) the 3-D objects task, and 3) the production task. The 2-D pictures task consisted of black-and-white line drawings of the target words, whereas the 3-D objects task consisted of 12 colorful, 3-D representations of the target words. The 3-D representations were used for the production task as well (see Appendix C and Appendix D for pictures of the drawings and 3-D objects used for the tasks).

During the first two tasks, participants were presented with a set of three 3-D objects, or a set of three 2-D pictures, and prompted by the researcher with: “show me the <target word>”. Each target word was tested twice, once as 2-D drawing and once as a 3-D object. The order of the tasks was counterbalanced across participants. Children were scored with a correct answer when they identified the correct object or picture that corresponded with the requested word. If
the child picked an incorrect item, they were scored with an incorrect answer. Children were not informed if they had answered correctly or incorrectly. Words were tested in these two modalities so that there was a 2-D to 3-D transfer cost to both the puzzle and the storybook conditions.

After completion of the first two tasks, children participated in the production task. Children were again shown the 3-D objects from the 3-D object task one at a time in a random order. The researcher asked the child: “Can you tell me what this is called?” Correct answers were recorded when the child could say the name of the object out loud without assistance. Clear pronunciation of the target word was not required as children in this age group often have trouble with producing certain sounds. Incorrect answers were recorded if children called the object a different name than the target word, or if their parent assisted them.

During the testing period, parents were asked to observe the participant and only assist in the case of confusion or language barrier.

Control Group

The control group did not participate in the interaction period of the study. They only participated in the testing period of the study. This was done in order to control for the effect of the interaction period on language learning in the study.

Results

Interaction Period

For the interaction period, the amount of times parents and children used target words was compared (Figure 1 and Figure 2). In both conditions, there was a main effect of the speaker, $F(1,1) = 12.595, p = .001$. Parents used target words significantly more than children in
Figure 1. Target word uses during the interaction period separated by parent and child, and question and statement.

Figure 2. Total target word uses during the interaction period separated by parent and child.
both conditions, \( t(62) = 4.73, p < .001 \). Between conditions, parents used significantly more target words in the storybook condition than in the puzzle condition \( F(1,1) = 7.78, p = .009 \).

There was also a main effect of word use context, \( F(1,1) = 8.19, p = .008 \), both within and between conditions. In the storybook condition, parents used target words phrased in questions significantly more than they used them phrased in statements, \( t(30) = 2.46, p = .01 \). However, there was no significant interaction for children and word use context, \( t(30) = 1.28, p = .21 \). It is important to note that there was an extreme outlier in the storybook condition; one child asked twice as many questions than the rest of the children in the condition. This could have skewed these results. In the 3-D puzzle condition, parents used target words phrased in statements significantly more, \( t(30) = 2.65, p < .01 \). Children also used target words phrased in statements significantly more in the 3-D puzzle condition, \( t(30) = 5.25, p < .001 \).

Between conditions, parents use significantly more questions in the storybook condition when compared to question use in the 3-D puzzle condition, \( t(30) = 5.79, p < .001 \).

There was a marginally significant effect of the amount of words a child uses and how many words they produce during the production task. The effect between how many questions a child uses, and how many they produce during the production task is significant, \( t(30) = 2.27, p = .031 \). The effect between how many statements a child uses, and how many words they produce during the production task is moderately significant, \( t(30) = 1.73, p = .089 \).

A positive correlation was found between the amount of statements a parent uses and the amount of statements a child uses \( r(30) = .848, p < .001 \). No correlations were found between the amount of questions a parent uses and the amount of questions a child uses, \( r(30) = .073, p = .689 \).
Testing Period

For the testing period, we found no main effect of condition on the testing measures (Figure 3). Specifically, children tested similarly on the 2-D pictures task, the 3-D object task, and the production task regardless of condition. We also found no difference between the learning of words between the 2-D storybook and 3-D puzzle conditions when compared to the control in testing. In general, children did not perform as well on the production task as they do on the 2-D pictures task and 3-D object task testing measures in all conditions (Table 2).

There was an effect of marginal significance of vocabulary size affecting how accurately the child performed on the test, regardless of condition, F(1,2) = 3.10, p = .058. Vocabulary size was measured using the amount of words parents indicated the child knew on the CDI.
Table 2. The mean scores of children on the testing instruments across conditions. There is no statistical difference between child scores on the 2-D and 3-D testing measures, but scores on the production tasks are significantly lower than scores on the testing measurements. This is most likely be due to the difficulty of the production task as compared to the 2-D and 3-D testing measures.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>2-D Testing Measure</th>
<th>3-D Testing Measure</th>
<th>Production Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>10.25</td>
<td>10.16</td>
<td>6.33</td>
</tr>
<tr>
<td>2-D Storybook Condition</td>
<td>10.19</td>
<td>10.57</td>
<td>6.06</td>
</tr>
<tr>
<td>3-D Puzzle Condition</td>
<td>10.31</td>
<td>10.56</td>
<td>6.6</td>
</tr>
</tbody>
</table>

This effect indicates that the size of the vocabulary impacted how the accurately the child tested regardless of conditions, including control. Similarly, there was a main effect of the amount of target words a parent reported the child knew with 100% accuracy and the accuracy of the child’s score on the testing measures, regardless of condition, $F(1,2) = 11.143, p = .002$. Children who knew more words initially, performed with higher accuracy on the testing portion of the experiment.

There was a marginal main effect of the order of testing measures on the accuracy of the child in identification of target words, $F(1,1) = 4.055, p = .054$. Children who were tested with the 3-D stimulus first did marginally better on all tasks than children who were tested with 2-D stimulus first, regardless of condition. This result held even for the control group.

There were a number of significant and marginally significant correlations. There were significant correlations between children’s scores on all tasks, indicating consistency of the tasks. The correlation between the 2-D pictures task and the 3-D object task was $r(30) = .728, p < .001$, between the 2-D pictures task and production task was $r(30) = .725, p < .001$, and between the 3-D object task and the production task was $r(30) = .737, p < .001$. There was also a significant
Figure 4. Correlation between 2-D and 3-D tasks. This indicates consistency between the two tasks in the testing portion of the experiment.

Figure 5. Correlation between 2-D and Production tasks. This indicates consistency between the two tasks in the testing portion of the experiment.
Figure 6. Correlation between 3-D and Production tasks. This indicates consistency between the two tasks in the testing portion of the experiment.

correlation between the number of statements used by the child during the interaction period, and their accuracy during production, \( r(30) = .393, p = .026 \).

**Discussion**

The first research question of this study proposed that parents and children would act differently during the interaction period in each learning environment. These data presented here indicates that parent and child did interact distinctly differently during the interaction period in each condition. Unsurprisingly, in each condition the parent used the target words more than their child. This is likely due to the nature of the task, requiring parents to teach their children words. Additionally, the children have limited vocabularies and are likely to talk less than their parent in most situations.
Furthermore, summary of the interaction periods between and within conditions had distinctly different patterns. The results show clear differences between the contexts parents and children used target words. In the storybook condition, parents used target words significantly more in context of a question than in context of a statement, but children did not mimic the effect. This result was consistent in comparison to the 3-D puzzle condition. However, it is important to consider the scripted phrasing of the storybook. Each target word in the storybook is scripted as a question, increasing the rate at which parents will use target words in the context of a question. However, regardless of the formatting of the book there was a large difference between parent question use in the storybook condition (M = 18.625, SD = 9.71), compared to the 3-D puzzle condition (M = 2.82, SD = 4.23), as indicated in Figure 1. Additionally, parents and children in the 3-D puzzle condition were significantly more likely to use statements rather than questions. This could also be due to the scripted nature of the storybook causing a difference in the amount of questions used in the storybook condition. The differences between parent and child question and statement use may indicate a difference in the way in which parents and children interact while using 2-D and 3-D objects.

Results of the current study also indicate a correlation between how many statements a parent uses and how many statements their child uses. This result could indicate a pattern of interaction between the parent and the child: i.e. if the parent talks often to the child, the child is more likely to talk in response, if the parent talks less with the child, the child will have less opportunities to respond than a child with a talkative parent.

In total, parents in the storybook condition used more target words than parents in the 3-D puzzle condition. It is clear from the current study that parents use more target words while reading the storybook. However, the results do not suggest the same effect for children. These
results indicate an important difference in the use of target words by parents that is not reflected in use of target words by children. There is a clear difference between how parents interact in the two learning environments, which may suggest that parents alter how they teach their children based on the object they are using.

The second research question this study proposed was that children in each condition would perform similarly during testing. Although parents and children in the conditions interacted differently between and within the two conditions, with significantly more target words being said in the storybook condition, there was no statistically significant difference between word learning across the two conditions. Children performed similarly on all three of the training tasks across conditions, including the control condition. However, it is important to note that comparison to the control condition may not be accurate due to the small size of the control (n=6). The significance of this null finding tells us that the process of language learning is complex. It also suggests that there may be no clear advantage of storybook learning, especially when compared to 3-D interactive play.

Across all conditions, children performed more poorly on the production task than on the other two tasks. This is a common result and likely due to the difficulty of the task. While these children may be able to identify words, producing them may be more difficult. This could be due to the difficulty of forming sounds or the fact that recall is more difficult than recognition (Borges, Stepnowsky & Holt, 1977). It is also possible that children in the other two tasks were using context clues to identify words; in the production task, context clues are limited. This difference in performance allows both production and comprehension tasks to be of use when understanding the complexity of early language learning.
Although order of testing method was randomized, when 3-D object task was tested first, children did marginally better on all tasks. Research on 2-D to 3-D object transfer effects indicates that children aged 24 months old are capable of generalizing words they had learned using 2-D objects (Simcock & Dooley, 2007; Barr, 2010), so it is unlikely that this result is due to this effect. It is possible that this result could be due to the color cues involved in the 3-D objects task. The 3-D objects in the task are more colorful and can provide subtle but potentially useful coloring information about the objects, allowing the children to recall words at a faster and significantly more accurate rate than children that start with the 2-D pictures task.

When vocabulary size and previous word knowledge were controlled for, main effects for child accuracy are revealed. This indicates that vocabulary and word knowledge impacts how accurate the child is in identifying and producing the target words. This may also indicate that children with larger vocabularies learn more quickly and thus perform better on both production and comprehension tests. This result shows consistency of child word knowledge with accuracy on the testing measures, indicating that word knowledge is necessary for performance on the tasks.

The correlation between the amount of child target word uses during the interaction period and their score on the production task indicates a positive relationship. Children who used more target words during the interaction period produced more correct word labels, and children who used fewer target words produced fewer correct word labels. This could provide further evidence of the connection between word use and word learning.

The results throughout the paper, when taken together, suggest that while interactions in the two learning environments differ, language learning is constant. These results provide compelling evidence that using 3-D objects to teach children language is an equally effective
method as using storybooks. This result strongly challenges the assumption that storybook reading is the best way to encourage language development in children.

**Limitations**

While the initial results of this current study are promising, it is important to consider limitations of the research.

The analysis of this study was conducted under the assumption that these stimuli simulated an environment similar to one that parents and children would experience naturally in their home settings. However, the stimuli in this study may not have accurately simulated this environment, and instead forced different types of interactions not normally seen between the parent and child. For example, the storybook used included only one picture per page, and repeated a very similar sentence about each target word. This may not accurately simulate the interactions between parent and child in the at-home environment, where they would have books with more pictures and a more developed storyline. It is important to consider this limitation as this could have significantly affected the results of this study.

Another important thing to consider is the size of the control and experimental groups for this study. The experimental group was imbalanced by gender, and too small to generalize these results. Additionally, the control group for this study was only six children. In order to provide a more accurate comparison to control conditions and generalize these results to the population, a larger sample would be needed to guarantee accurate results.

Additionally, this study observed a very small subset of children that is not as representative of the general population as we might desire, and therefore results can only be generalized to an extent. The sample size of this project was very small, perhaps not large enough to generalize to the population. Additionally, the majority of children studied came were
of middle socioeconomic status, and most had at least one parent with a college degree. This limits the generalizability of the sample as socioeconomic and education status of the parent can affect word learning (Tamis-LeMonda et al., 2012).

Selection of words for this project was limited by the ability to locate 3-D stimulus associated with the word. Creation of our 3-D stimulus required the use of a 3-D printer, which significantly limited the words we could choose for this project. The constrained selection of target words limits how representative the words are of the vocabulary of the children in this age group.

Additionally, the results of this study could be influenced by a potential ceiling effect. Children in both conditions performed with high accuracy on the 2-D and 3-D tasks, with a mean accuracy for the 2-D task of 85.4%, and a mean accuracy for the 3-D task of 84.6%. It is possible that main effects of interaction on child word learning were concealed by a ceiling effect.

**Conclusions and Future Study**

The current study’s results indicate that interactions between parent and child differ when interacting with 2-D or 3-D stimuli, but rates of word learning do not differ significantly. However, this study has a number of extensions that could to be addressed to further our understanding in this area. Future directions of this study could include addressing a younger age group. A small pilot of 24 – 30 month old children was conducted after completion of this study, and preliminary results indicate that children are performing within normative range, suggesting that this age group may be more suited for this experiment.

Future research should be conducted on the effects of parent and child interaction and interaction with 2-D and 3-D objects. Considering different versions of both 2-D and 3-D stimuli we can further test the hypothesis that 3-D stimulus encourage language learning at an equal rate
as storybook reading. The current literature lacks research on this subject, specifically in younger language learners like those we consider here.

In future projects, we are hoping to find similar effects supporting the hypothesis that 3-D objects are equally as effective in encouraging word learning as 2-D objects, such as storybooks. This would provide compelling evidence that language learning is more complex than previously thought. We are hopeful that this effect will persist among future studies and we can further challenge the popular thought that storybooks are the most effective method of teaching language to young children.
References


Appendix A: Example Pages of the 2-D Stimulus (Storybook)

1. Example of ‘Walrus’ Page in the Storybook:

   Where can piggy take a nap?  
   OINK!
   
   On a walrus?
   
   No...that's silly.

2. Example of ‘Rake’ Page in the Storybook:

   Where can piggy take a nap?  
   OINK!
   
   On a rake?
   
   No...that's silly.
Appendix B: Picture of the 3-D Stimulus (Puzzle)
Appendix C: Pictures Used in 2-D Pictures Task
Appendix D: 3-D Objects Used in 3-D Objects Task and Production Task