Linguistic Cues and Attention to Competing Objects in Novel Word Learning

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Defense: April 8, 2013

Revised: April 14, 2013

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Abstract

Children use all of the sources of information available to them to acquire names for novel word referents (Markman & Wachtel, 1988; Horst, Scott, & Pollard, 2010). When children first begin learning novel words, they primarily do so through the novel-noun-nameless category (N3C) principle, where they attach a novel name to a novel object based on their unfamiliarity. However, as children age, their skills become more refined and complex, and children become capable of using their previous word learning knowledge and increased vocabulary to help them infer the meanings of novel words among other possible word referents (Zosh, Brinster, & Halberda, 2013). Children additionally learn through comparison and through the labeling of multiple novel objects that are the same, which establishes commonalities and differences among objects that highlight the specific features of a target object among other possible referents or competing objects (Graham, Namy, Genter, & Meagher 2010). This study evaluates how two different linguistic cues help direct children's attention toward novel features in the presence of competing objects. The results suggest that children are best able to learn the target features of an object, when presented in a simplistic word learning environment, if their attention is verbally guided only to the target features and not to the competing objects.

Linguistic Cues and Attention to Competing Objects

in Novel Word Learning

Children begin to learn words slowly and laboriously, yet they soon become efficient word learners, compiling a vocabulary of about 14,000 words and mastering many rules of their language by age six (Carey, 1978). Since this acquisition of words happens so rapidly, children need to be capable of picking up on certain cues from information in the environment to help them discern the referent of various expressions (Markman & Wachtel, 1988). In addition, they must learn to infer the meaning of a new word when the word referent is ambiguous or when there is more than one possible referent, both of which require children to correctly eliminate possible referents (Zosh et al., 2013; Axelsson, Churchley, & Horst, 2012). This paper will discuss a study looking at what children infer about novel word referents when presented with information about one other possible referent in two different ways. Specifically, this study looks at how the communication of different levels of information about the objects not named affects how children attend to the features of the named objects, as well as what they learn about the unnamed competing objects.

Literature Review

Children are rapid and successful word learners. This is due in part to their ability to prioritize information that has previously proved helpful when learning novel words (Markman & Wachtel, 1988). This is an unbelievable feat considering the limitations that children have regarding their developing capabilities for reasoning, information processing, and memory (Markman, 1994). However, children are able to recruit all the information that they have to constrain the possible referents for a novel label in order to try to attach the appropriate meaning to a new word (Horst et al., 2010).

One of the primary abilities that children use to learn words is a process called fast mapping, in which children make an initial guess about the meaning of a new word based on information from linguistic and nonlinguistic contexts present in a single exposure (Heibeck & Markman, 1987). This process allows children to learn many new words quickly, even when the words are introduced in ambiguous labeling situations, such as hearing a new word within a stream of speech rather than in direct instruction tasks. Research on this phenomenon has also shown that children can retain these new word mappings. In fact, studies have shown that children can maintain semantic understanding of a novel term for a week after one exposure, even when the exposure only lasted for a few seconds (Spiegel & Halberda, 2010). More impressively, the same study showed that children have the ability to retain the label of a referent for a month after the single exposure.

Children are also constantly presented with multiple cues in the presence of novel words, having to sift through all this information to help them discern the meaning of a new word. Children's ability to use all this information demonstrates how they are able to access word learning mechanisms to understand the meaning of new words in chaotic and confusing environments. In the present study, I have focused on how children use multiple cues to attach a meaning to a novel word in the presence of competing items. I did so by giving children multiple cues to attend to, while manipulating the linguistic information that I gave to them about a competing object. Based on previous research, it is evident that children can learn in the presence of competing objects; however, I wanted to get an understanding of how a child's attention can best be directed to a novel object by using different linguistic cues (Zosh et al., 2013). In order to understand how children could possibly use these cues to form word mappings, it is important to first understand the various sources of information that children use to help identify the meanings of target words.

Sources of Information in Word Learning

Children use various word learning tools to help them identify the meaning of a novel term. In order to do so, children compile information from previous contexts and the specific context in that moment to help them figure out a word referent. Some of the main word learning tools that a child uses to compile information will be introduced here and include learning through indirect exposure, through contrast, and through grammatical form.

Indirect learning. One of the main ways children pick up information is through indirect situations that require children to learn from ambiguous, nonlinguistic cues. Indirect situations offer no direct instruction to the child, rather they require children to combine overt cues as well as the less obvious social cues of eye gaze, voice, and gesture to gain knowledge (Jaswal & Markman, 2001). In fact, according to Jaswal and Markman (2001), in Western cultures direct learning through labeling, such as “kitty” or “this is a kitty,” accounts for less than 20% of what is said to children less than 36 months of age. However, these children still acquire an abundance of words through fast mapping and indirect learning skills. Through this process, children are able to identify what a certain label is referencing, as well as make appropriate hypotheses about a word’s meaning. An example of an indirect learning situation would be if a child was at the zoo and a parent asked the child, “Where’s the aardvark?” The child would have to infer which animal the aardvark was by trying to eliminate the possible referents based on their previous knowledge about the other animals present.

Indirect learning can be very beneficial because direct learning tends to lead children towards more conservative thinking, which can restrict the range of possible meanings that they will consider when guessing the meaning of a new word (Jaswal & Markman, 2001). In addition, in studies done by Hall and colleagues (2000), as cited by Jaswal and Markman (2001), children who learned from indirect labeling situations were found to pay better attention to grammatical form and more specific dimensions of an object than when they were taught in ostensive situations. Lastly, indirect learning can allow for more thorough processing of linguistic and nonlinguistic information because the child has to infer both the referent and the meaning of the referent (Jaswal & Markman, 2001). This research shows that certain overt social-pragmatic cues do not need to be present in order for children to effectively learn the abundance of new words that they do.

Contrast. Another method that children use to acquire language is the principle of contrast. This occurs if you ask a child for one unfamiliar object in reference to a familiar one (Heibeck & Markman, 1987). An example of this for the familiar word square would be, "Show me the *trapezoid* one, not the square one." The child would use the knowledge of the word square to understand the meaning of trapezoid. This shows that by contrasting a new term with a well-known one, children acquire new information about the novel term. Carey and Bartlett (1978) studied this phenomenon in their famous chromium studies in which they presented *chromium* as a new name for the color olive. They presented this new color by painting one tray olive and one tray blue. They then asked three to four year olds, "Bring me the *chromium* one, not the blue one, the *chromium* one." The results were that half of the children retained something about the term *chromium* as a new name representing the color olive one week after they were introduced to the word in a context different than the first exposure (Carey, 1978).

An additional study was done expanding on the chromium study. The results showed that children use fast mapping and contrast to generalize over various domains and different items, not just color (Heibeck & Markman, 1987). Additionally, Heibeck and Markman (1987) noted that contrast is very effective for children especially when ambiguous, nonlinguistic information is presented. These researchers gave an example of this, where children were presented with two objects that have different color and shape and were asked, "Bring me the *ecru* one, not the red one." Most children thought ecru was a shape term because the nonlinguistic information indicated a noticeably unusual shape. However, the linguistic information pointed to color because it was compared to the color red. All in all, these findings demonstrate the power of fast mapping and the principle of contrast in word learning.

Grammatical form. Another way that children are able to fast map is through the information that they gain from the grammatical introduction of a word. For example, a study by R.W. Brown (1957), as cited by Jaswal and Markman (2003), introduced new words to three and four year olds, such as a picture of hands kneading an unknown material in a container. The word was introduced as a verb ("sibbing"), a count noun ("a sib"), or a mass noun ("some sib"). Depending on which lexical form the child was told to find, they were able to correctly choose either the kneading motion of the hands, the container, or the material being kneaded. This study shows that children are capable of gathering information about the meaning of a word from the grammatical form in which it is presented. This information regarding grammatical introduction ties into children's ability to distinguish between proper and common names.

Proper names represent individual identities whereas common names are extended to other members of a similar kind (Jaswal & Markman, 2001). It has been found that children can most easily learn proper names because the meaning is more concrete, less fragile, and typically refers to animate objects, like people, which are generally more important to us (Jaswal & Markman, 2001). This context helps children narrow down possible word referents and restricts the label to one particular animate object, making proper names that refer to animate objects easier to learn (Jaswal & Markman, 2001). Children can additionally recognize proper names based on the grammatical form in which they are presented. Proper names do not possess an article, such as “a,” “the,” or “hers,” which helps children constrain the possible word referents for a novel term.

Overall, the work done by all these researchers shows that both younger and older children use fast mapping to form quick guesses about the meaning of a novel term (Heibeck & Markman, 1987). These studies demonstrate how children use various sources of information during fast mapping in order to learn words. These sources of information include prior knowledge, how the new word is communicated, which grammatical form the word is presented in, and explicit linguistic contrasting cues (Heibeck & Markman, 1987; Jaswal & Markman, 2001; Jaswal & Markman, 2003). Underlying these sources of information are key mechanisms of word learning that are central to children’s acquisition of words.

Mechanisms of Word Learning

In order to learn words, children rely on underlying mechanisms to help them limit the number of possible word referents. Some of the most important mechanisms for word learning include inferential word learning and highlighting.

Inferential word learning. One of the mechanisms involved in children’s word learning is inferential word learning biases and patterns. The ability to infer the meaning of a new word is important because children’s vocabularies are far smaller than those of adults around them, meaning that many of the words that children are hearing are unfamiliar to them. This presents a challenge for children because they must try to infer the meaning of the new word even when the word referent is not obvious. For example, if a parent points to an elk in a field and says, “Look at that elk!" a child would look into the field and would see a lot of possible referents, such as a fence, foliage, or other animals. The child would try to discern what is being referenced based on the parents' gaze or gesture; however, there would still be possible competing items present. In an attempt to figure out exactly what an elk is, the child would have to pull together all of the knowledge that they gained from previous word learning experiences, as well as the specific contextual information present in that moment (Zosh et al., 2013).

One of the specific areas that researchers study with regard to inferential learning is how the presence or absence of distractions and distractors affects word learning. In the context of word learning, a distractor refers to another specific object or feature that could be the referent for a word, whereas distraction is a general term used for anything around us, such as events or people, that could take some of our attention away from the task at hand. Intuitively, many believe that learning is improved by removing all distractions, particularly those that are irrelevant to what must be learned, regardless of what type of material you are trying to master (Zosh et al., 2013).

In the context of word learning, even when the distractors being presented are related to the material trying to be mastered (e.g. various vocabulary words being presented during one learning session), too many competing items can negatively affect word learning (Horst et al., 2010) and working memory (Zosh et al., 2013). However, there is also support for the argument that the presence of multiple exemplars helps to aid in children's category formation (Zosh et al., 2013). Additionally, children have to deal with competing objects daily when they are learning words. Therefore, although the effects of competing objects on word learning remains an unanswered question, children must possess skills to help them infer word meanings in the presence of distractors and distractions in order to be successful at language acquisition.

A study by Zosh and colleagues (2013), looked at how children might have the ability to learn new words better when one competing distractor is present rather than when children are directly instructed about the name of one target item with no competing items present. Previous research has demonstrated that children are best able to remember labels of novel objects when those words are introduced with only two competing items present, as opposed to three or four, arguing that too much competing information is detrimental to word learning (Horst et al., 2010). In addition, it has been found that children can best learn in the presence of a distractor when the target item is highlighted or the importance of the distractor is reduced (Zosh et al., 2013).

Building on prior research, Zosh and colleagues (2013), wanted to see if eliminating all competing items would elicit the best retention of the target word. They had two conditions: 1.) an inference trial with a target object and one familiar distractor (e.g. a cup), and 2.) a direct instruction trial that had no distractors present. They used 36-42 month old children because this is the age that inferential word learning becomes possible for children based on their large vocabulary size and word learning expertise (Zosh et al., 2013). The results of their first experiment were that significantly more children in the inference trials correctly identified the target object (54%) compared to those who were in the instruction trials (29%).

These findings suggest that children can use the information from one competing object to infer a word's meaning, particularly once they have compiled enough experience and vocabulary to reject familiar distractors as possible referents (Zosh et al., 2013). These results were replicated in a second study demonstrating again that children can retain words better when they learn them by inference, rather than direct instruction with no competing objects present. Therefore, it appears that as children age they can quickly use inferential word learning strategies alongside the strong vocabulary base that they have built up to help them more quickly reject competing items and hone in on a word's meaning (Zosh et al., 2013).

Research by Graham and colleagues (2010) also support the idea that one competing item helps children infer word meanings in their discussion surrounding comparison. These researchers showed that the act of comparing items helps children find commonalities and differences in objects that they would not have noticed if the target object was shown alone (Graham et al., 2010). This in turn helps children reject possible referents for words, allowing them to have confidence inferring the meaning of a word. In addition, showing objects that explicitly are given the same name increases the likelihood of children noticing specific similarities and differences among objects. In support of this, in research done by Baldwin and Markman (1989) cited by Axelsson and colleagues (2012), it has been found that children pay more attention to objects that are named and less attention to the objects that are not. This helps children retain the features of the named object so that they can best infer the meaning when it is presented in the future, while also diminishing the importance of any competing objects present.

Graham and colleagues' (2010) research cited other studies that have shown the effectiveness of comparison for creating word categories. For example, infants can more readily infer different categories when they are given two novel objects than when they are presented with these objects alone (Graham et al., 2010). Graham and colleagues (2010) did their own study looking at the role of comparison in categorizing unfamiliar objects, an area with little previous research. They found that when they presented children with two novel objects, and gave both of the objects the same label, children were more likely to look deeply into the specific commonalities or differences of the objects. For example, the children would attend to the shared feature of texture, rather than to the salient property of shape. This research suggests that comparisons, as well as common labels, help to enhance the processes of categorization for children, helping them to infer categories based on specific, non-salient features. Overall, this shows that children are able to use labels and comparison to help them infer important and specific information about a new object. This information then helps children differentiate a new object from other competing objects, while also helping them remember the meaning of a word when it is presented in different contexts (Graham et al., 2010).

Another well-known method children use to help them infer the meaning of a new word is through the use of one of the contextual clues that is also involved in fast mapping. This process is called mutual exclusivity, first described by Markman (1984). Through this process children assume that every object has only one label and that each label refers to only one object (Markman, 1984; Markman & Wachtel, 1988). This helps children eliminate guesses about word meanings so that they can appropriately place the correct meaning to a new word. This means that if a child already knows the name for something, they should know not to reassign a new label to it (Markman & Wachtel, 1988). This is helpful because children can eliminate possible word referents based on previous knowledge. A similar principle is the novel-noun-nameless category (N3C) principle, which refers to a child's tendency to map a novel name to a novel category (Horst et al., 2010). Children who are 17 months and younger, or those who have smaller vocabularies, typically use the N3C principle because they do not have the word learning skills or vocabulary built up to allow them to learn via inference (Zosh et al., 2013). Overall, children are remarkably capable of inferring the meaning of new words in the presence of a multitude of possible word referents. They are able to do so by synthesizing important information about both the target and competing objects, as well as through the use of previous word learning knowledge.

Highlighting. Another important predictor of word learning is the order in which learning situations are presented, which affects what is taken away from a new experience. In the context of word learning, previous language acquisition directs and motivates new word learning, mainly by guiding attention (Yoshida & Burling, 2012). This phenomenon is called highlighting and demonstrates how the ordinal presentation of information can influence what we pay attention to and then learn. Therefore, a child's previously acquired knowledge can help them pick up on novel information.

The previous research done on highlighting focused only on adults, through experiments created by Kruschke (1996, 2005), as cited by Yoshida and Burling (2012), that looked mainly at attention and memory. The research found that the sequential order of the information presented can shift or affect what the individual learns from the experience (Yoshida & Burling, 2012). Therefore, advanced models like this one predict that learning involves a connection between cues and outcomes, where previous knowledge affects what will be learned, along with memory capabilities that facilitate the retention of information (Yoshida & Burling, 2012). This shows the importance of the first cues that come, because they are enduring and they direct attention to novel stimuli.

Looking at highlighting specifically in word learning is of interest because previous word knowledge facilitates attention to a new word. Studies on this topic have included looking at previously learned nouns and new adjective learning. Children have a difficult time learning new adjectives in general, and often rely on previously learned nouns to help highlight the novelty of an adjective (Yoshida & Burling, 2012). In fact, children age's two to three often have a hard time placing a new adjective as a property of an object, instead mistakenly placing it as a noun. However, if the child already knows a lot of basic noun categories, they have a much easier time attaching an adjective correctly to a property. In fact, when a noun is present ("the lug car"), children are more capable of learning new adjectives than when a noun isn't present ("the lug one") for this reason (Yoshida & Burling, 2012). This demonstrates the importance of the ordinal nature of previous knowledge and how old words compete with novel ones to highlight the new word, increasing the chances of the new word being linked to the novel aspect presented.

Overall, how a child's attention is directed is an important mechanism present in word learning. This is because words guide human attention unlike any other auditory signal (Suanda & Namy, 2013). In fact, in a child's first year of life, the auditory signaling from words helps children to place objects into categories and promotes object individuation when other nonverbal tones or sounds are not able to do so (Suanda & Namy, 2013). This means that the words that are used to describe a novel term have the power to greatly aid a child's ability to learn that new term, particularly when associated with words that child already knows.

In summary, these various mechanisms help children use the information that they are presented with in order to learn new words and retain the mappings of novel terms after a delay and in a different context (Horst et al., 2010). In many cases, this context includes the presence of unfamiliar competing objects, rather than all familiar competitors and one novel object. Therefore, a child's ability to form rapid mappings for words in chaotic environments demonstrates the remarkable nature of word learning mechanisms.

The Current Study

Looking at these prior studies, it is evident that children are capable of using information from competing items to help hypothesize about the meanings of novel words. In fact, having a few competing items present has been shown to help highlight less salient commonalities or differences in novel objects (Graham et al., 2010). It is also understood that highlighting the target object, and decreasing the importance of distractors, helps children form the correct hypotheses about the referents of novel objects (Zosh et al., 2013). With this knowledge in mind, the present study focused on what children learn when they are offered different degrees of information about a competing, unnamed, object. In one experimental condition, children were directly instructed on the name of an object and did not receive any information regarding the competing item presented. It was hypothesized that this condition highlighted the target feature and focused the children's attention on the target object, while de-emphasizing the competing item. Because this condition directed attention only to the target object, leaving children to infer its relation to the competing objects, this was called the implicit information condition.

In the second experimental condition, the children were told the name of the target object and then explicitly told the competing object was not a member of the same category. The children had their attention directed to the target and the competing objects, which provided information about both objects not presented in the other condition. This clearly and overtly directed the children to both objects, so this condition was called the explicit information condition. In both conditions, children were tested to see if they successfully learned the target feature, as well as if they were distinguishing the target feature from the specific feature present in the competing objects.

Predictions

Based on previous research addressing a child's ability to learn by comparison (Graham et al., 2010) and in the presence of competing objects (Zosh et al., 2013), I predicted that children in my study would best learn the target feature, and distinguish it from the feature present in the competing objects, in the implicit information condition. Based on the knowledge that competing objects can be a beneficial learning aid (Horst et al., 2010), I was confident that the children would be able to learn the trained features in both conditions. However, in the implicit information condition, my communication of information about the target object would highlight the target feature so that the children's attention was directed toward its specific details. At the same time, when I didn't label the competing object, I hypothesized that children would infer this to mean that the competing item had little importance to the target feature I taught them, causing them to selectively attend to the target object.

In addition, based on research by Baldwin and Markman (1989), as cited by Axelsson and colleagues (2012), it has been found that labeling just the target object leads a child to attend longer to that object, therefore, allowing them to learn more information about it than competing objects, weakening the importance of the competing objects. I predicted that this diminished importance of the competing objects would make the children choose the objects with the learned target feature as the correct referent to the novel term more than the objects with the target feature and the competing objects feature in the implicit information condition. Again, this is because the importance of the competing objects would be low in the child's mind, based on the fact that I labeled only the target object. In fact, I predicted that this diminished importance could make children infer that the features of the competing objects aren't a part of the correct mapping for the novel term at all. Therefore, previous research guides my prediction that child in the implicit information condition will attend longer and associate more importance to the specific target features than to the competing objects' features, facilitating the choice of more target feature matches in this condition than in the explicit information condition.

Looking at the explicit information condition, I thought that children would be able to learn the target feature; however, I did not think that children would be able to distinguish this feature from the feature of the competing objects as well as children in the implicit information condition. This is because I offered information about both the target and the competing objects, directing the children's attention to both the objects rather than facilitating selective attention to the target objects, as seen in the implicit information condition. Additionally, by giving verbal information about both objects, I vocalized the importance of the target objects' features and the competing objects' features. Therefore, I predicted that children in this condition would infer that the competing objects have importance, making it likely that they would equally choose the test object matching both the target and competing objects' features as often as the test object matching the target feature only as the correct referents in the testing trials.

Lastly, since I am administering the Peabody Picture Vocabulary Test, Fourth Edition, Version B (Dunn & Dunn, 2007), I predicted that the better the children performed on this measure, the more easily they would be able to learn the target features that were trained. This prediction is supported by previous research that children use all of their prior knowledge and skills surrounding word learning to help come to decisions about new word meanings (Markman & Wachtel, 1988; Horst et al., 2010).

Method

Participants

This study included 31 child participants from the Boulder, Colorado area. Two additional children participated in this study; however, they were excluded from the analyses because one was tired and did not complete the task, and the other was inattentive during the task and chose all objects from left to right for every trial. The participants were recruited from the DACS Lab Database run out of the Department of Psychology and Neuroscience at CU-Boulder. Parents signed up to be contacted about studies via a letter from the Colorado State Department of Health, daycares, preschools, and based on referrals from other parents. Parents were compensated with $5 and the children were given a book and stickers. The current study included 14 boys and 17 girls ages 36-42 months. The children came into the lab when they were 39 months old (M_{age} Explicit Information = 39.03 mo, *SD* = 2.09, M_{age} Implicit Information = 39.36 mo, *SD* = 2.06, range = 36.6-42.4 mo).

Stimuli

The stimuli consisted of 60 novel objects all made in the lab. The stimuli were divided up into five sets, each containing 12 novel objects that were labeled *daxy, regli, fode, plint,* and *koodle.* Every novel object had the same shape, however, each set contained different materials and different colors. More specifically, each set had a different material that was being trained as the target feature, as well as a different color for the competing object feature. For the *daxy* set (See Figure 1), I trained the kids on a bumpy material and the competing objects' color was pink. For the *plint* set, the target material was a pipe cleaner and the competing color was yellow. Looking at the *fode* set, the target material was sand and the competing color was white. The *koodle* set had a rope target material and the competing color was navy blue. Lastly, the *regli* set had tissue paper for the target material and the competing color was green. In each of the sets, there were six objects that were solely used for the three training trials and six objects that were used for the four testing trials. No object was used in more than one set, the target materials were not used again outside of their set, and the colors used for the competing objects were not reused in any sets.

For the training trials, each set contained three material matches of differing colors, as well as three competing objects of different, novel materials but of the same assigned color. Looking at the testing trials, there were two different types: 1.) selective attention trials and 2.) control trials. In the selective attention trials, a target material match, a target material/competing color match, and a distractor was presented. These trials were intended to test whether or not children were selectively attending to the target feature, and therefore, eliminating the target material/competing color match based on the presence of the competing color. The control trials had a target material match, a competing color match, and a distractor. These trials were intended to test whether the children were learning the target feature at all. Every object in the testing trials was seen twice by the children, but in the presence of different objects in the set.

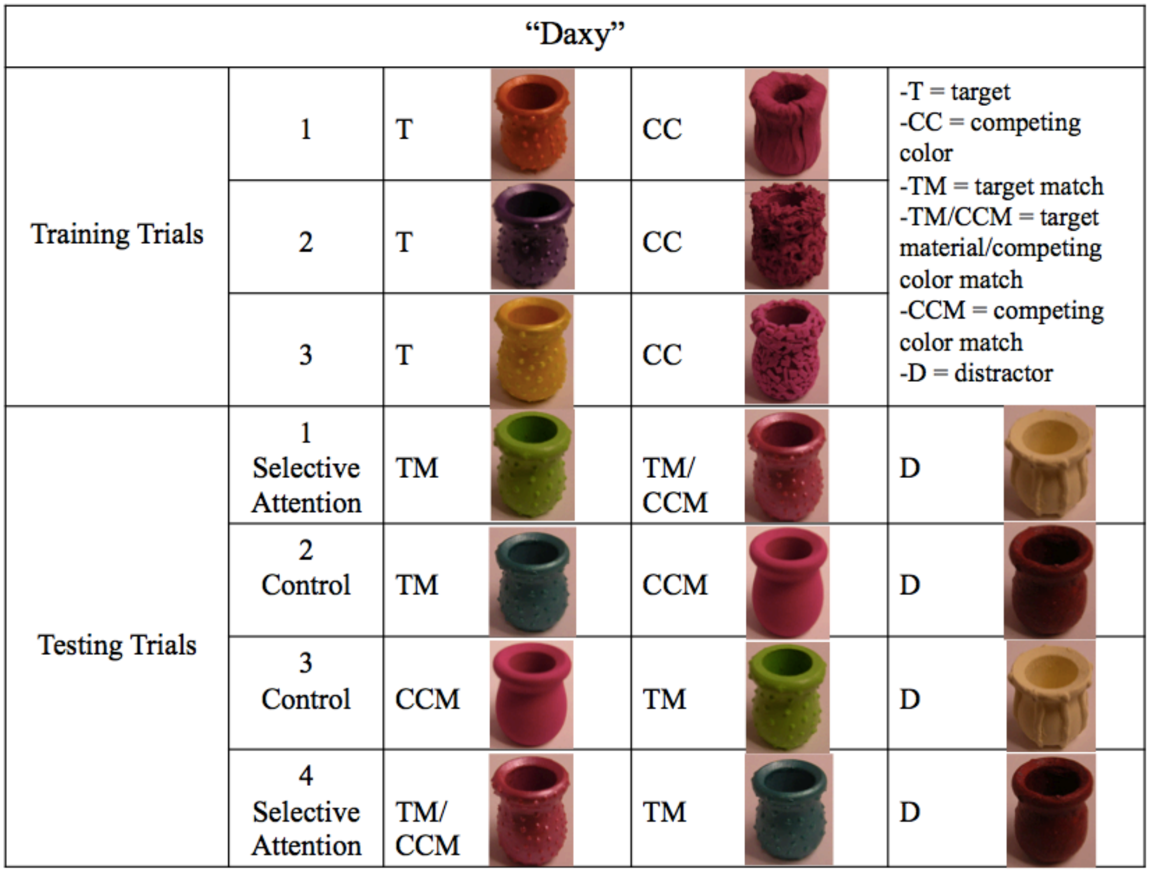

Figure 1. *Daxy* stimuli set

Procedure

The parents and children were met outside of the Muenzinger Psychology building and brought into a greeting room where the parents signed a consent form and the children got a chance to play and get comfortable in the lab environment. Once the paperwork was completed, I took the parents and children into another room in the laboratory to run the experiment and the Peabody Picture Vocabulary Test (PPVT). I was the only experimenter running this project.

Task. I ran the experiment before the PPVT for every participant included in these analyses. The children were randomly assigned to one of the two conditions and to one of two orders. In both conditions, I presented the stimuli to the children on a black tray. For the explicit information condition, I presented the children with both the target material training object and the competing color object at the same time; however, I labeled the target material object first saying, “This is a *daxy* one, see the *daxy* one?” While I was labeling the object I rotated it once in front of the child to make sure they knew which of the two objects I was referring to. I then rotated the competing object and said, “This is *not* a *daxy* one.” I repeated this same procedure for the other two training trials. I then moved to the four testing trials where children were presented with three objects simultaneously. The position of each object on the tray was random for every testing trial and for every child. Once I placed the three items on the tray I asked, “Can you show me the *daxy* one? Is there another *daxy* one here?” I then recorded which objects the children picked and in what order. I repeated this same procedure with the other four sets of novel objects. The order of the selective attention and control trials was the same for every set.

The implicit information condition looked exactly the same as the explicit information condition; however, the way that I labeled the competing objects in the training trials was different. In the training trials, I would pick up and rotate the target object and say, “This is a *daxy* one, see the *daxy* one?” I would then pick up and rotate the competing object; however, I didn’t say anything about it. For the testing trials, the procedure was the same as the explicit information condition, where I said, “Can you show me the *daxy* one? Is there another *daxy* one here?” I again recorded which objects a child chose and in what order.

PPVT. After the main task was completed, I administered the PPVT, Fourth Edition, Version B. The PPVT provides a quick, standardized measure of receptive vocabulary ability. This task has four pictures per page and you ask the child to identify one predetermined item (See Figure 2). You begin with a practice trial and then start at the page appropriate for that child's age. There are 12 items per set, and each set gets more difficult as you progress. The test ends after you complete a set where the child had at least eight errors. The information that I recorded from this task was the child's raw score, standard score, and percentile based on age. It typically took 15 minutes to administer for each child and the average percentile for 30 children was 82.5 (One child was too tired to finish so his score was not included).

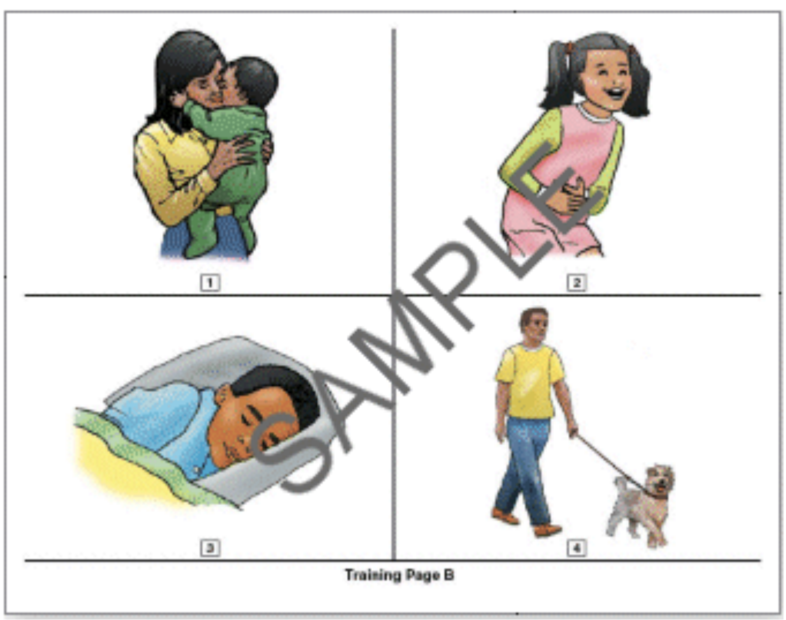

Figure 2. PPVT sample, target word = "sleeping"

Results

For this study, I predicted that children would be able to learn the target feature in both the implicit information condition and the explicit information condition. I tested this prediction by analyzing the control test trials. However, I hypothesized that children in the implicit information condition would choose more target material matches than children in the explicit information condition based on the way that my labeling of the competing objects directed the children's attention. I tested this prediction by analyzing the selective attention test trials.

Control Trials

At the beginning of the analysis I looked at the effects of age and gender. Both of these variables were found to make no significant difference in the results, so they are not included in any of the following analyses. Next, the control trials across both conditions were looked at, including any effects of the covariate PPVT. Children's item selections were submitted to a 2 (condition: explicit information or implicit information) x 3 (item type: competing color match, target material match, or distractor) ANOVA with the covariate PPVT score, and there was a significant interaction between item type and PPVT scores, $F(2, 54) = 7.68$, $p = .001$. No other effects were significant. The overall pattern in both conditions for item type choices can be seen in Figure 3.

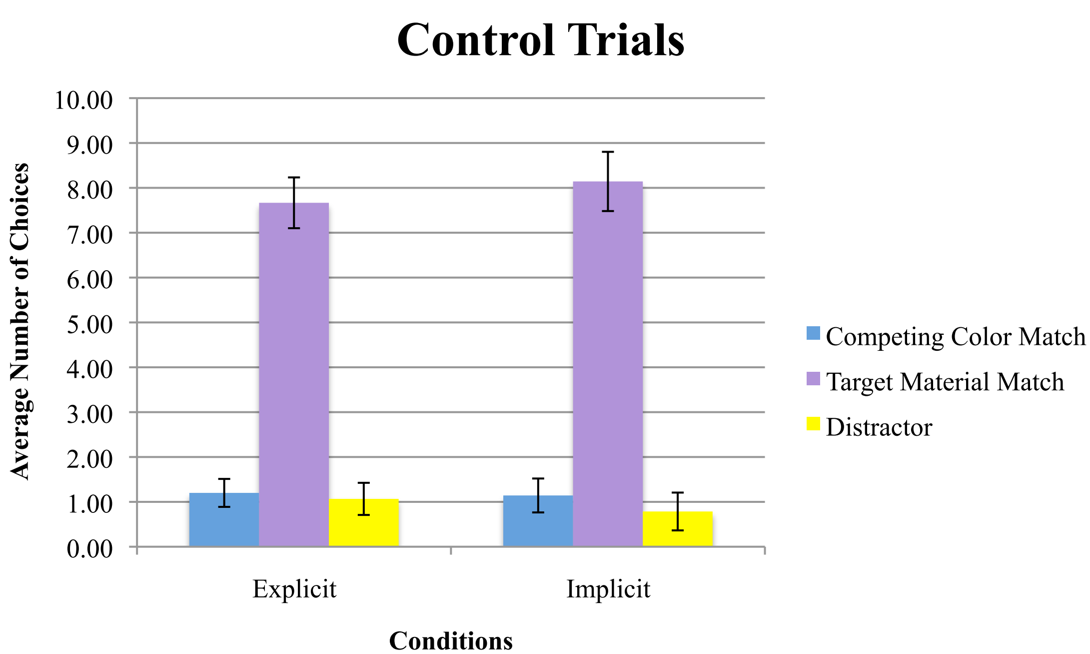

Figure 3. Average choices for each item type in each condition. Error bars represent standard errors.

Looking into this interaction more closely, the parameter estimates of the ANOVA from the three item types were looked at and it revealed that the PPVT score was a significant predictor of children's choices of distractors (b= -.05, t(28) = -3.02 p = .006) and the target material match (b = .07, t(28) = 2.94, p = .007), but not the competing color match. This interaction demonstrates that children who had a larger vocabulary were better able to reject the distractor objects as possible word referents and pick the correct target feature more often than those who had a lower vocabulary percentile.

Next, the control trials were dissected further to be sure that the children were correctly learning the target objects' materials. In order to do so, a paired samples t-test was run to compare children's choices of different item types: target material match, competing color match, and distractor. There was a significant difference between the target material match and the competing color match, where the mean selection of target material matches (M = 8.03, SD = 2.23) was significantly higher than the mean selection of competing color matches (M = 1.10, SD = 1.25), t(30)= 11.58, p < .001. Looking at the target material match and the distractor, the mean target material match choices were significantly higher than the mean distractor match choices (M = .87, SD = 1.38), t(30)= 11.41, p < .001. There was no significant difference between children's choices of the competing color match and the distractor. Overall, these results show that children were learning the target features that were taught to them in the training trials (See Figure 4).

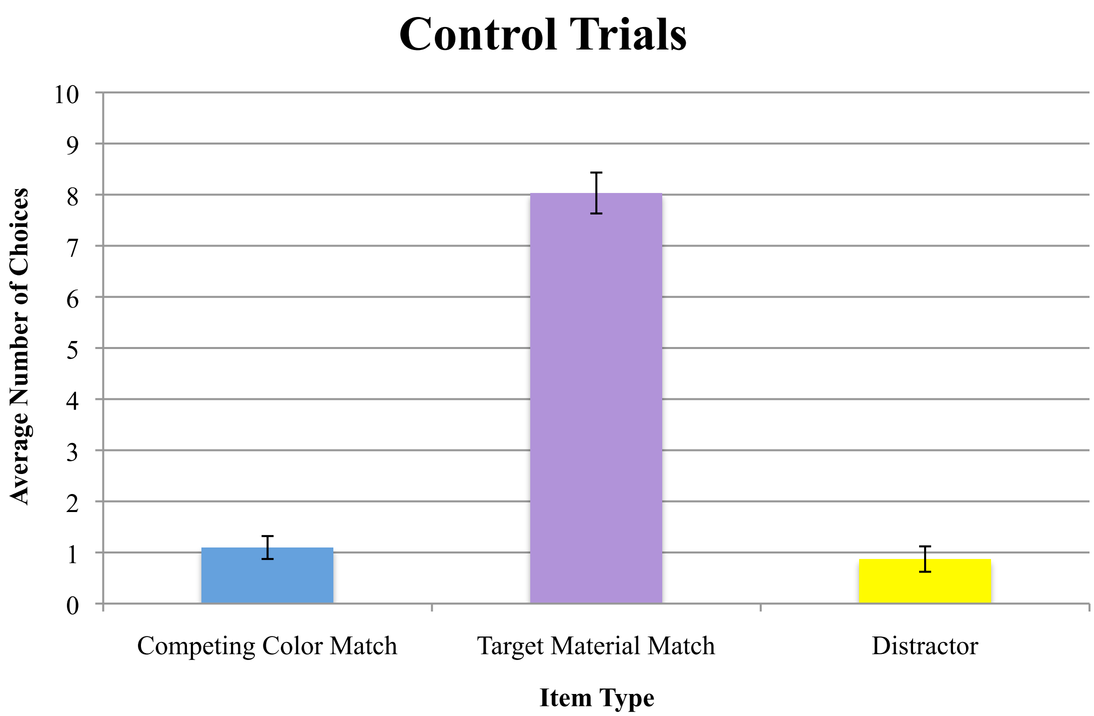

Figure 4. Average choices of each item type across conditions. Error bars represent standard error.

Selective Attention Trials

The selective attention trials were then looked at with a 2 (condition: implicit information and explicit information) x 3 (item type: target material match, target material/competing color match, distractor) ANOVA with the covariate PPVT score. There were no significant effects. However, the interaction between item type and condition approached significance F = (2, 54) = 2.40, p = .100 (See Figure 5).

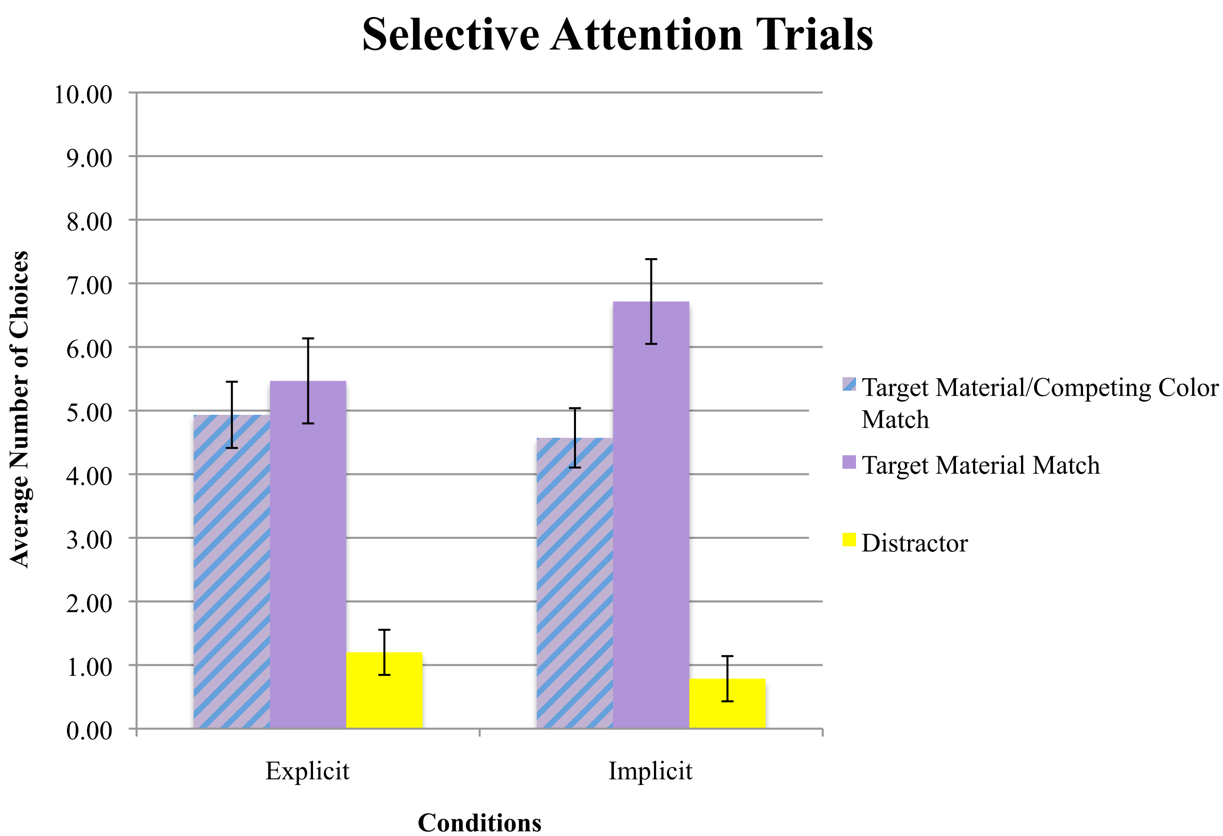

Figure 5. Average choices for each item type in each condition. Error bars represent standard errors.

To look more closely at what item types children tended to pick in the selective attention trials, a paired samples t-test between all of the selective attention item types for both conditions together was run. The mean selection of target material matches ($M = 6.23$, $SD = 2.19$) was significantly higher than the mean selection of the distractors ($M = .94$, $SD = 1.29$), $t(30) = 9.19$, $p = < .001$. In addition, the mean selection of target material/competing color matches ($M = 4.71$, $SD = 2.19$) was significantly higher than the distractor selection, $t(30) = 7.47$, $p = < .001$. Lastly, and most importantly, the mean selection of the target material matches was significantly higher than the mean selection of target material/competing color matches, $t(30) = -2.85$, $p = < .01$. This t-test shows that, not only did children choose the distractors much less than the target material matches and the target material/competing color matches, but also they chose the target material matches more than the target material/competing color matches on average across both conditions (See Figure 6).

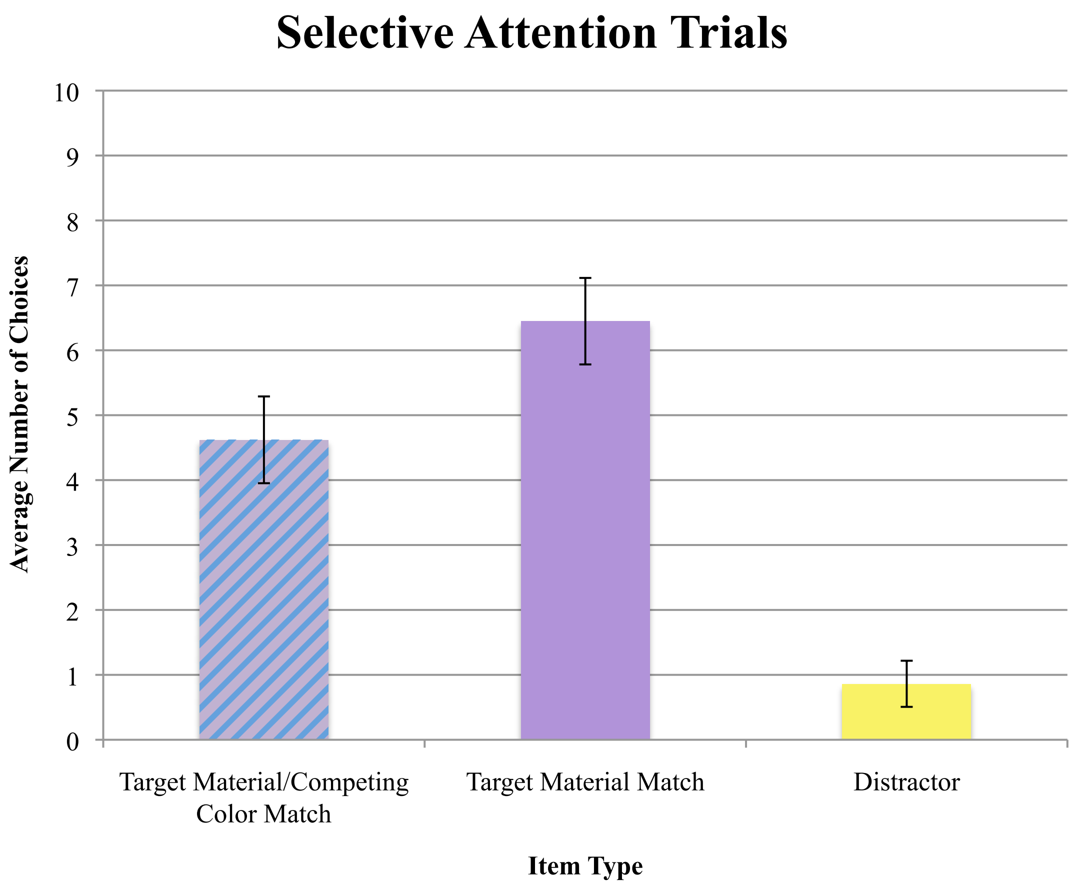

Figure 6. Average choices of each item type across conditions. Error bars represent standard error.

Based on these results, the next question was whether any effect of condition would emerge once distractors were removed. A 2 (item type: target material match and target material/competing color match) x 2 (condition: implicit information and explicit information) ANOVA with PPVT as a covariate revealed that the interaction between these two item types and condition was marginally significant, $F = (1, 27) = 3.78$, $p = .06$. Looking into this interaction further, a paired samples t-test was run first on the explicit information condition, looking at the target material match ($M = 5.47$, $SD = 1.81$) and the target material/competing color match choices ($M = 4.93$, $SD = 2.02$) and no significant differences were found. Another paired samples t-test was run for the implicit information condition, which revealed that children in this condition did pick the target material matches ($M = 6.94$, $SD = 2.32$) significantly more than the target material/competing color matches ($M = 4.50$, $SD = 2.39$), $t(15) = -3.04$, $p < .01$. This shows that children in the implicit information condition were choosing the target material matches more than the target material/competing color matches, whereas children in the explicit information condition were not (See Figure 7).

Next, an independent samples t-test was run looking at children's selections of the target material/competing color matches across conditions and there was no significant difference, showing that children chose these objects equally across conditions. Lastly, another independent samples t-test looking at the selection of target material matches across conditions was run and it revealed that numerically children in the implicit information condition chose more target material matches ($M = 6.94$, $SD = 2.32$) than children in the explicit information condition ($M = 5.47$, $SD = 1.81$). However, the difference between the two groups was only marginally significant, $t(29) = -1.96$, $p = .06$. This does show that children in the implicit information condition were able to better understand the importance of the target material matches' features over the color of the competing objects (See Figure 7).

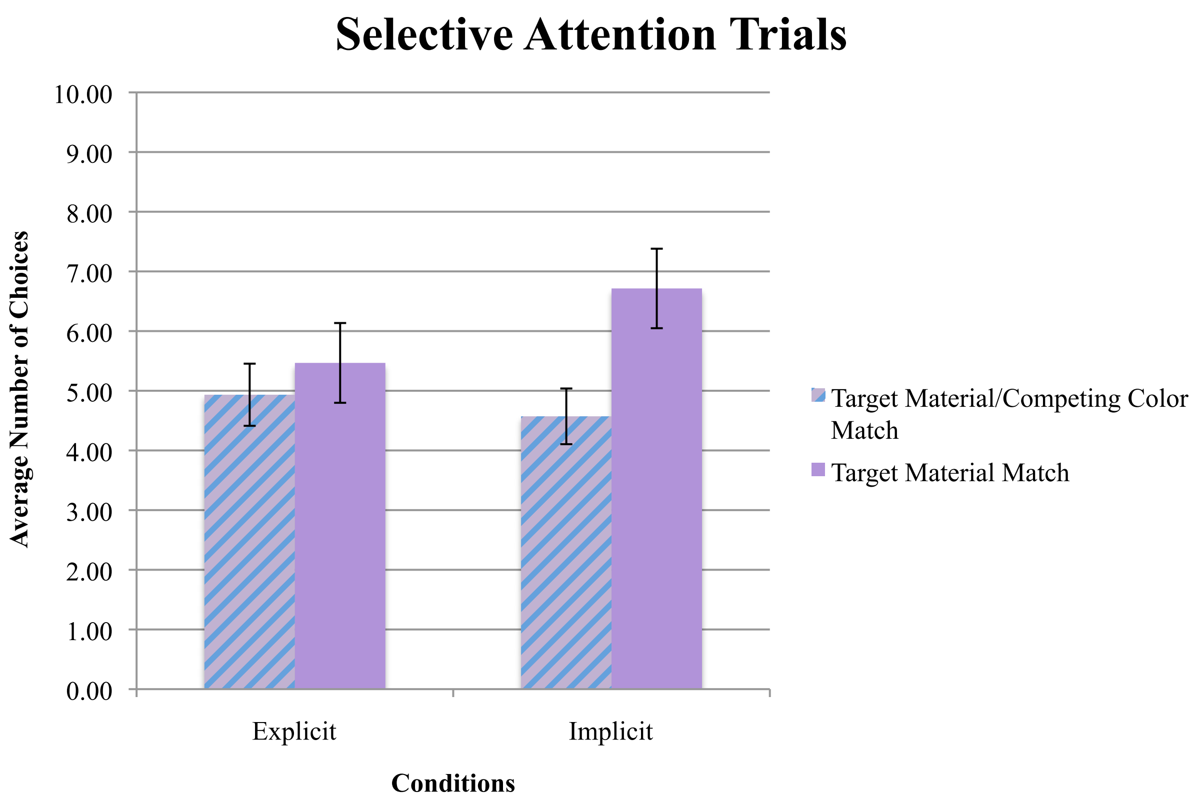

Figure 7. Average choices for item types in both conditions. Error bars represent standard error.

Discussion

This study evaluated how differences in linguistic information can alter what children attend to most, and therefore, what they end up learning about the target objects and the competing objects present. My original predictions included that children would be able to learn the target materials in both conditions based on previous research that children can learn effectively in the presence of competing objects (Horst et al., 2010; Zosh et al., 2013). Based on the results form the control trials, it is clear that children in both conditions learned the novel names for the target materials I trained them on. Additionally, in these control trials it was evident that children who performed better on the PPVT were best able to identify the target materials and reject the distractor choices. This supports previous research that children use all of their previous knowledge and skills surrounding word learning to help understand new terms and decrease the number of meanings for novel terms that they should consider (Markman & Wachtel, 1988; Horst et al., 2010).

In this study I was particularly interested to see what occurred in the selective attention trials between the two conditions. I predicted that children would best be able to learn the target materials and distinguish them from the competing objects' colors in the implicit information condition. As seen in the results, children picked the target material matches numerically more in the implicit information condition than in the explicit information condition; however, the difference between groups was only marginally significant. Once I looked at target material match choices and target material/competing color match choices in each condition separately, the results did strongly support my hypothesis. This is because there was no significant difference in children's choices of the target material matches and target material/competing color matches in the explicit information condition. However, in the implicit information condition, children did choose the target material matches significantly more than the target material/competing color matches.

This is an important result because it shows that children in the implicit information condition were more likely to diminish the importance of the competing object colors and focus on the target match features. This means that the relatively limited verbal information given about only the target objects in this condition led the children to infer that even though the target material/competing color matches had the target features, the presence of the competing color moved these objects away from being the best answers in the testing trials.

These results agree with previous research by Graham and colleagues (2010) that discussed children's abilities to learn about competing objects through comparison, which highlights differences in objects. This was seen in the implicit information condition where the labeling of only the target objects helped to command the children's attention mainly to those objects, while children were perhaps still comparing those objects to the non-labeled competing objects. Based on the lack of label for the competing objects, it appears that the children diminished the importance of those objects during comparison with the target objects, which agrees with the previous research by Axelsson and colleagues (2012). Therefore, this lowered importance of the competing objects made it less likely that children in the implicit information condition would choose objects in the testing trials that had the competing color.

This also relates to previous research by Baldwin and Markman (1989) cited by Axelsson and colleagues (2012), which showed that children selectively attend to objects that are named and pay less attention to objects that are not. In fact, the results of this study go beyond this, as seen in the explicit information condition, where even when I did not label the competing object, simply talking about it seemed to draw children's attention too much toward the competing object. Even when I offered potentially helpful information about the object by saying it was *not* the target feature they needed to focus on, the verbal input harmed children's ability to discriminate the competing objects' color from the target material. This shows that children do attend to objects that are verbally referenced, even if they aren't named. Based on this information, children in the implicit information condition likely learned that the features of the target objects were more separate from the color of the competing objects than children in the explicit information condition because more of their attention was focused on the target objects since they were the only ones verbally referenced.

Based on these results, I think that it can be helpful to have a competing object present for word learning; however, only if it is presented in a way that draws little attention to that object so that the majority of a child's attention is focused on the target object. This means that in order to support children's word learning, it is best to keep their attention on the target object and only have them minimally address the competing objects. Therefore, I believe that only a small level of children's attention should be on the competing objects in order to rule out the features of those objects; however, not enough for them to think that these features are important. Based on these results, it appears that children naturally pay enough attention to competing objects and will pay too much attention to them if they are verbally addressed. If children mistakenly attach importance to competing objects that are not the word referent, their mapping of the target features could mistakenly include features of the competing objects. It is noted that this recommendation does not pertain to all word learning situations, such as when children are trying to learn very small differences between objects from the same category, because directing attention to other possible referents may be essential for word learning in complex environments.

Limitations

There are some limitations to the design of my study. Due to time restrictions, I could only run 33 children through the study, two of which were excluded from these analyses for being tired or inattentive during the training and testing trials. As seen in the results section, some interactions were very close to significance, therefore, it would have been useful to run additional children to help clarify these results. Based on power calculations, I need to run five more children in each condition for a total of 10 more children.

Another limitation is that, although the participants were randomly selected from the DACS Lab Database, the city of Boulder is composed of many middle to upper class Caucasian families. Additionally, many of the parents that choose to participate in our studies have received higher education and volunteer to come in based on their interest in their children's development. Although it is advantageous that the sample was similar, in the sense that socioeconomic status and race could not account for any differences in the results, the results of this study cannot be generalized onto other diverse populations. However, because of the experimental design of this study, where participants were randomly assigned to conditions, I do not think that using a different population would impact the main effects of this study. With this being said, since PPVT was found to affect how well children learned the target features in the control trials, it would be interesting to look at a sample with a more diverse educational background.

Future Directions

One possible direction for this research would include running more children in each condition in order to understand more fully what children learn about the target and competing objects in both conditions. This is particularly important for my study because I had many marginally significant interactions. For these additional children, I would like to include the same age group, because three to four years of age is when inferential word learning has been found to be the most robust (Zosh et al., 2013). However, I want to use a more diverse population than what was included in my study. This is because the children who did best in the PPVT were also the best at learning the target features and rejecting distractors. This shows that children with more previous knowledge, which could be due to the amounts of energy and resources that a family had available to put toward their child's education, were better equipped to do well in this study. Therefore, I would like to include a population that is more diverse than this Boulder cohort in a future study, in order to compare their results to the current study.

I would also like to include two more conditions in future studies. The first would be a condition where both the target object and the competing object were given two different labels, for example, "This is a *daxy* one and this is a *plint* one." The children would only be asked to identify the *daxy* ones in the testing trials. It would be interesting to see whether they were able to learn the target feature with so much specific information presented at once. I would predict that they would have difficulty doing so based on the results from this study, particularly because their attention would again be divided between the target object and the competing object. However, this condition could also prove to be helpful, because if children have a label for the competing object they might be able to more easily think about these features separately from the target objects.

The second condition I would like to include would present a target object and no competing object to children. This condition would be interesting to look at, because it would be a direct instruction trial where the children would have all of their attention directed to the target object. Although children can and do learn through direct instruction, it seems that once they begin compiling a large enough vocabulary, children begin primarily using inferential word learning strategies. In addition, they would not have a competing color presented to use for comparison or to aid or hinder learning in any way. Therefore, I predict that children in this condition would learn the target feature; however, I think that they would generalize it onto all colors.

Additionally I would like to run the two conditions used in this study as well as the two new ones presented in this discussion with a retention trial run a week later. This would provide valuable information regarding how the differences in conditions affected testing choices right after training and after a delay. Lastly, I would like to run this experiment on adults in order to see what they learn about the target and competing objects in these two conditions, and how it compares to what children learn.

Conclusion

In summary, children use all of their previous word learning knowledge and experiences to help them acquire meanings of novel words in chaotic and complex environments (Markman & Wachtel, 1988; Horst et al., 2010). As children age, they are capable of utilizing more and more sources of information present in a specific context, as well as their past vocabulary and word learning expertise, in order to reject possible referents and hone in on specific features of an object to infer a word's meaning (Zosh et al., 2013).

Although children do have all of this information available to help them learn words, figuring out a word referent is still a demanding task. Therefore, the current study suggests that when teaching children new words in the presence of competing referents, one should guide children's attention to the novel object in order to help them learn the word referent. More specifically, in order to best help children learn novel words, verbally directing them only to the target object appears to help them learn the specific features of that object, as well as the importance of that object over competing objects. This is because it seems that children naturally place attention on other possible word referents, and will attend too much to them if they receive verbal input about these competing objects.

However, it is important to recognize that this recommendation is based on a specific experimental situation; therefore, this suggestion might not be applicable to complex word learning situations. For example, when teaching children very slight differences between a target object and a competing object that are from the same category, attention directed onto the competing object to facilitate comparison would be helpful and possibly necessary. Whereas, if you are teaching children about an object and a competing object from an unrelated category is also present, these comparisons are not as essential. Overall, in word learning situations that don't require a more complex understanding of similar objects, providing verbal information only about a target object helps children focus their attention on that object and de-emphasize the importance of other objects present at that moment.

Acknowledgements

Special thanks to my thesis advisor, Dr. Eliana Colunga for helping me brainstorm, design, create, and analyze this study. In addition, thank you to Dr. Richard Olson and Professor Raymond Johnson for spending their time to meet with me and for being present at my defense. I would also like to thank Dr. Clare Sims for her oversight on every aspect of this project, which would not have been possible without her. Lastly, I would like to thank all of the families who participated in my study.

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