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Bilingual and Monolingual Children Attend to Object Properties Differently in a Word Learning Task

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1. Introduction

Learning language is a continuous natural process that starts early in life. Children say their first word by around twelve months of age and their language ability only grows exponentially from there (Fenson et al., 1993). Because of the ease with which children acquire language, it is easy to assume that children have certain capacities that are present at birth to help them learn language. However, a large area of literature shows that children's environment can influence how children learn language. Children's attention to linguistically-relevant cues provided by their environment depends on the specific experience that children have with language (e.g. Smith, Jones, Landau, Gershkoff-Stowe, & Samuelson, 2002).

Research shows that children attend to many different types of information including pragmatic cues, social cues, and cues about the properties of objects themselves as ways to help them learn language. Children have been shown to attend to changing contexts (e.g. the presence or absence of a speaker) when learning a new word (e.g. Akhtar, Carpenter, & Tomasello, 1996; Diesendruck, 2005), to attend to the properties of objects (e.g. shape, color, texture) to extend a word to other objects (e.g. Colunga & Smith, 2005), and to attend flexibly to the linguistic context depending on whether an interlocutor is looking or pointing at an object when naming it (e.g. Baldwin, 1993; Grassmann & Tomasello, 2010).

Yet, the question still remains. To what extent is the capacity to flexibly attend to different linguistic cues influenced by experience and to what extent is this capacity unchanging from birth? Recent research suggests that the linguistic environment that children are exposed to may influence what children attend to as they learn language (Smith, et al., 2002). For example, children who are trained to attend to shape as a cue to a word's meaning are more likely to attend to shape in the future and to significantly increase their word knowledge for shape-based words over children who did not receive the same training.

Therefore, it is likely that attention to different types of linguistically-relevant information is influenced by experience. In this paper, we investigate

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the impact that environment has on attention to linguistically-relevant information. We ask to what extent this capacity is influenced by experience or whether this capacity is relatively impervious to experience. In order to ask this question, we take the naturally occurring case of the monolingual versus bilingual environment and ask whether the bilingual environment is related to the way that children attend to information in a language learning task. In particular, we focused on the degree to which children attend to pragmatic and object property cues to help them learn the meaning of a novel word.

1.1. Monolingual versus Bilingual Word Learning

Monolingual and bilingual children's word learning environments differ in many ways. Despite the obvious difference in the number of words to learn and the degree of exposure to each language, bilingual children are also faced with the additional task of discovering from which language each word comes. Some research suggests that bilingual children might afford pragmatic information a special place among information providing cues to the meaning of a word. For example, bilingual children can use information about whether an interlocutor knows both languages or not or whether a speaker was present in a room when a word was first introduced or not to help them determine the meaning of a word (Diesendruck, 2005). Bilingual children are also likely to mention that an item has a particular name because someone told them that it had that name (i.e. pragmatic cue) rather than because of how it looked (i.e. property cue) (Rosenblum & Pinker, 1983).

On top of determining the language of each object name, there are also inherent differences in the ways that objects are named for bilingual children. One such difference that has been given a lot of attention recently is the use of multiple names for the same object. This is the subject for Experiment 1 of the current study. The argument has been that bilingual children are more likely than monolingual children to hear objects given two names because the two names come from different languages. Because of this difference, they are more likely to learn multiple names for the same object (Houston-Price, Caloghiris, & Raviglione, 2010). Indeed, bilingual children have been shown in several tasks to be more likely to learn multiple names for an object than monolingual children (Au & Glusman, 1990; Davidson, Jergovic, Imami, & Theodos, 1997; Houston-Price, et al., 2010).

In order to make the difference in word learning experience between monolingual and bilingual children more concrete, consider the following situation. Imagine I present you with a small ball and tell you that it is my *dax*. You might, as a monolingual child would, assume that *dax* is a name for the bumpy texture or the yellowish-color. You might think I mean a special type of ball, something like "golf ball". You are not likely to expect *dax* to be a second name for this object's shape, in addition to *ball*. That is, unless you are bilingual, in which case you might expect the new word *dax* to be a word from a different language. In this way, the bilingual experience with multiple names

for words is quite different from the monolingual experience – they have an extra interpretation open to them that is not available to the monolingual learner. In experiment 1, we test the prediction that monolingual children will attend to some aspect of the object to determine the meaning of a new word for an already familiar object, whereas bilingual children will be less likely to do so.

1.2. Overview

All children flexibly attend to linguistically-relevant information as they learn new words, whether that information is pragmatic in nature or related to properties of the to-be-named objects. The question for this study is how attention is devoted to these cues *relative* to one another depending on previous experience with those cues. In order to test the influence of experience on the relative weighting of attention to these types of cues, in two experiments, we explore to what extent bilingual children attend to object property cues and pragmatic cues when learning a new word and how this compares to monolingual children. Across both experiments, we expect bilingual children to afford pragmatic cues more attention than object property cues relative to monolingual children.

2. Experiment 1

2.1. Method

2.1.1. Participants

Sixteen bilingual and sixteen monolingual children participated in the study. Bilingual children spoke English and at least one other language. A variety of second languages were spoken. Seven children spoke Spanish, four spoke Japanese, and one child each spoke French, Russian, German, Hungarian, and Swedish. Parents were also asked to report the degree to which their children understood each of their two languages on a scale from one to five with five meaning understood the language "perfectly". Parents reported overall that their children knew both English (*M*=3.86, *SD*=1.61) and their second language (*M*=3.93, *SD*=1.07). On average, parents reported that the difference in understanding the two languages was low (*M*=3.93, *SD*=1.21). These data, in addition to informal discussion with parents, ensured that children were balanced bilinguals.

2.1.2. Materials

Four sets of objects were constructed to test children's acceptance of multiple names. Each set consisted of eight objects, four training objects and four testing objects (see Figure 1). The four training objects in each set were designed so that children could be taught a new name for a category of objects, and then taught a second name for an object that could belong to that same category. For example, all four of the training objects had the same shape but were made out

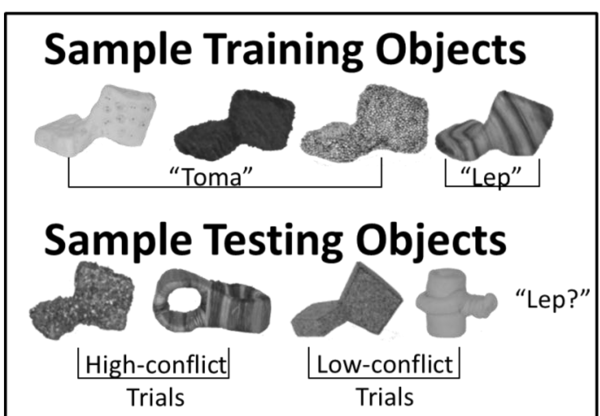

Figure 1. Sample object set for Experiment 1.

of different material. The first three training objects were all given the same novel name (e.g. *toma*). The fourth object was given a second novel name (e.g. *lep*). The testing objects in each set consisted of 1) two objects that matched the original category in shape, but not material, 2) an object that matched the fourth training object (i.e. "the *lep*") in material, but not shape, and 3) an object that did not match any of the other object in any dimension (see Figure 1).

Four additional object sets were created such that the training objects were all alike in material, but not shape. The dimensions of these sets were, thus, exactly opposite to the dimensions of the first four sets. However, initial analyses showed that there was no difference in children's responses using these alternative material-based sets versus the original shape-based sets, nor were there any interactions between set type and language group or trial type, all p's>.05. Because the set type did not alter the results, this factor was not included in further analyses.

2.1.3. Procedure

The experiment consisted of both a training phase and a testing phase. In the training phase children were taught a new category of objects. Objects in the category were all the same on one dimension (e.g. shape), but all different on another (e.g. material, color). Children were shown each of the four training objects, one at a time. The experimenter labeled each object with a name novel to the child (e.g. "See the *toma*."). The first three training objects were each given the same novel name (e.g. *toma*). The fourth object was given a second novel name (e.g. *lep*). In this way, the experimenter created for the child a category of shape-based objects that all had the same shape but a different material, and then gave the child a second name for an object that was also part of that same category.

In the testing phase, children were tested in a two-alternative forced-choice task on their acceptance of the second name given to the fourth training object. Two types of trials were included in testing (see Figure 1). In both types of trials, children were asked to “choose the *lep*”. The first type of trial (high-conflict trial) was included to test whether children interpreted the second novel name (i.e. *lep*) for the fourth training object as another name for the shape of the object (in addition to the first name *toma*) or whether they interpreted it as a name for the material of the object. Children may have interpreted the second name as a material name because they already have a name for the shape of the object (i.e. *toma*). Specifically, they were given the choice between an object matching the training category in shape and an object matching the fourth training object in material. Thus, in the high-conflict trials children could interpret the name in one of two conflicting ways, either as a second name for the shape or as a name for the material.

No such conflict was present in the other trial type (low-conflict trial). Children were given the choice between an object matching the training category in shape and an object that did not match any of the other objects in shape or material. In this way, the only good alternative was to choose the object that matched in shape; children should accept multiple names for the shape of the fourth training object given the pragmatic context.

This entire procedure, including both the training and testing phases, was completed a total of four times, once for each object set in a counterbalanced order. Both training and testing phases were completed before children were shown the next object set. Two of the object sets included high-conflict trials (two each). The other two object sets included low-conflict trials (two each). The order of the two testing trials for each set was presented randomly. The side of the table on which each object was placed (i.e. right and left of the child) was also determined randomly.

2.2. Results and Discussion

A mixed-factorial 2 (language group: monolingual, bilingual) x 2 (trial type: high-conflict, low-conflict) ANOVA was conducted on the number of times children chose the shape match object (i.e. accepted multiple names for the shape of an object). Results showed that children were marginally more likely to choose the shape match object in the low-conflict than high-conflict trials, $F(1,30)=3.54$, $\eta^2=.11$, $p=.07$. This effect was further mediated by a significant interaction between trial type and language group, $F(1,30)=4.48$, $\eta^2=.13$, $p<.05$, such that monolingual children, but not bilingual, chose the shape match more in the low-conflict than high-conflict condition (mean difference for monolingual group was 1.06 and mean difference for bilingual group was .06). However, neither planned comparison was significant, all p’s<.05. There was no

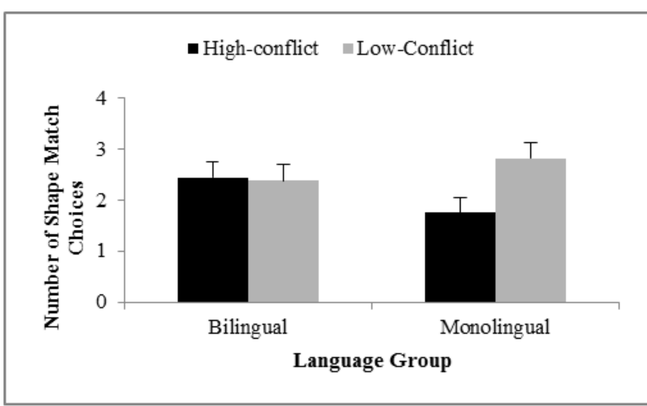

Figure 2. Results for Experiment 1. Error bars show the SEM.

significant overall difference in the amount that monolingual and bilingual children chose the shape match, $F(1,30)=.14$, $\eta^2=.01$, *n.s.*

These results suggest that monolingual children were more sensitive to the type of distractor object in the testing trials. When the distractor object provided children with another alternative interpretation of the second novel name (i.e. material), only monolingual children were less likely to attach both novel names to the shape of the object. They accepted the alternative material interpretation, whereas bilingual children did not. Monolingual children were clearly sensitive to the conflicting property information, whereas bilingual children were not.

In Experiment 2, we tested the trade-off in attention to pragmatic and object property cues more directly. In particular, we tested whether the amount of attention monolingual and bilingual children devoted to pragmatic and object property cues would differ when the cues were incongruent. In order to test this tradeoff explicitly, we needed to test children's attention to both pragmatic and object property cues simultaneously. In Experiment 2, monolingual and bilingual children were asked to identify named objects that were grouped in a specific way so as to cue children to the relevant dimension (i.e. shape). The experimenter also looked at these objects or away from the objects, thus providing a congruent or incongruent pragmatic cue. Additionally, because an alternative explanation for the result that bilingual children pay more attention to pragmatic cues in Experiment 1 is that bilingual children had a more difficult time understanding the task, causing them to perform at chance, Experiment 2 was designed to predict a difference when children *were* attending to the cues and on-task.

3. Experiment 2

3.1. Method

3.1.1. Participants

Sixteen monolingual (7 males, 9 females) and sixteen bilingual (7 males, 9 females) children participated in this experiment. The monolingual participants (M_{age}=30.26 months) were age-matched to the bilingual participants (M_{age}=29.87 months), and the ages ranged from 24 months to 36 months. Bilingual children spoke English and at least one other language. Children spoke a variety of different languages including German, French, Hindi, Farci, Russian, Spanish, Bambara, Afrikaans and Portuguese. Parents were also asked to report the degree to which their children understood each of their two languages on a scale from one to five with five meaning understood the language "perfectly". On average, parents reported that the difference in understanding the two languages was low (*M*=1.27, *SD*=1.16). These data, in addition to informal discussion with parents, ensured that children were balanced bilinguals.

3.1.2. Materials

An initial training set was used to allow the children to get a sense of the task. Three dogs made of three different materials were used (fluffy, rubber and plastic), as well as a toy bird, a truck and a seahorse.

A total of thirty-six novel items were created for this experiment, including four sets of nine objects each (see Figure 3 for a sample set). In each set of nine, there was a target object with a novel name (e.g. "zuly"), four objects that matched the target in shape and four objects that did not match the target in shape. For the four shape-match objects, one also matched the target in color and one also matched this object in texture. The four non-shape-matches only matched the target object in other dimensions, such as color, texture, or color and texture, but differed from the target in shape. Overall four objects matched the target in shape, four objects matched in color, and four objects matched in texture.

3.1.3. Procedure

This study consisted of two phases, a training phase and a testing phase. In the training phase, children were shown the three dogs, the bird, the truck, and the seahorse on a tray. They were then asked to "find a dog". Children received feedback during this phase; they were told that they were correct if they chose a dog and not if they chose another object. This procedure was repeated until all three dogs had been chosen and the child either indicated that there were no more dogs or the child had been corrected at least once. The purpose of this phase was to show children that more than one object, but not all of the objects, on the tray were included in the requested category.

The testing phase consisted of four trials, one for each of four conditions, including two conditions of interest and two control conditions. Across all four conditions, the experimenter named the target object with a name novel to the child (e.g. "See the *zuly*."). The target object was then removed, and the eight matching objects from that set were presented to the child on a tray. The

participant was then asked "is there a(nother) zuly here?" until they had chosen all eight objects or responded no.

Target Object	Shape-match Objects		Non-shape-match Objects	
	Shape Color		Color Texture	
	Shape Texture		Color Texture	
	Shape		Texture	
	Shape		Color	

Figure 3. Sample object set used in Experiment 1.

The four trials/conditions differed according to two variables, how the objects on the tray were grouped (object property cue) and where the experimenter was looking (pragmatic cue). In the two conditions of interest, the congruent and incongruent conditions, all four objects matching in shape were place on one side of the tray, while the other non-shape-matching objects were placed on the other side of the tray. This highlighted shape as an important object property. In the congruent condition, the experimenter also looked at these shape-match objects when asking for the "*zuly*". In the incongruent condition, the experimenter looked at the non-shape-match objects instead, creating incongruent pragmatic and object property cues. It was expected that on average, monolingual children would choose objects congruent with shape in both conditions, while bilingual children would choose objects congruent with the experimenter's eye gaze (i.e. choose the non-shape-match objects when the experimenter looked at these objects rather than choosing the shape-match objects).

In the control conditions only one of the two cues was present at a time. In the Pragmatic Cue Only condition, the objects were placed on the tray so that the same number of shape-, color-, and texture-matches were on each side of the tray. This eliminated the object property cue. The experimenter would then look to one of the two sides when asking for the "*zuly*". In the Object Cue Only condition, the objects were again grouped by shape, but the experimenter looked straight at the child when requesting the "*zuly*". This was done to eliminate the pragmatic cue.

Throughout the experiment, the side of the tray on which objects was placed (i.e. the right and left of tray) was random. The trials/conditions were always run in the same order to prevent carry-over effects from one condition to the next. Conditions were run in the following order: Pragmatic Cue Only, Congruent, Incongruent, Object Cue Only.

3.2. Results and Discussion

Children's choices of objects on both the left and right side of the table were scored such that the number of shape objects chosen was subtracted from the number of non-shape objects chosen. In order to take into account order effects, only the first four objects were included in this measure even if children chose more than four of the eight objects. Children's score on this measure could range from -4 (chose all four non-shape objects first) to 4 (chose all four shape objects first). This measure was subjected to a 2 (language group: monolingual, bilingual) x 2 (trial type: congruent, incongruent) mixed-factorial ANOVA. Results showed that overall children chose the shape-match objects equally often in the congruent and incongruent trials $F(1,30)=.36$, $\eta^2=.01$, n.s. However, this effect interacted with language group, $F(1,30)=4.08$, $\eta^2=.12$, $p=.05$, such that bilingual children chose the shape-match objects marginally more in the congruent trials than incongruent trials, $t(15)=1.73$, $p=.10$. Monolingual children showed no difference across the two types of trials, $t(15)=1.09$, n.s. Overall, monolingual children chose the shape-match objects more than the bilingual children, $F(1,30)=4.26$, $\eta^2=.13$, $p<.05$ (see Figure 4).

The critical comparison was in the incongruent trials. We asked what children would do when they could attend either to the pragmatic cues or the object property cues. Clearly, monolingual children paid relatively more attention to the object property cues than the bilingual children. This result was supported with a planned comparison independent t-test, $t(30)=3.07$, $p<.01$. There was no difference in children's choices of the shape match objects when the two types of cues were congruent, $t(30)=.27$, n.s.

The addition of two control conditions allowed us to ask what children would do when only one of the two cues was available (see Figure 5). When only the object property cue was available (i.e. objects grouped by shape but

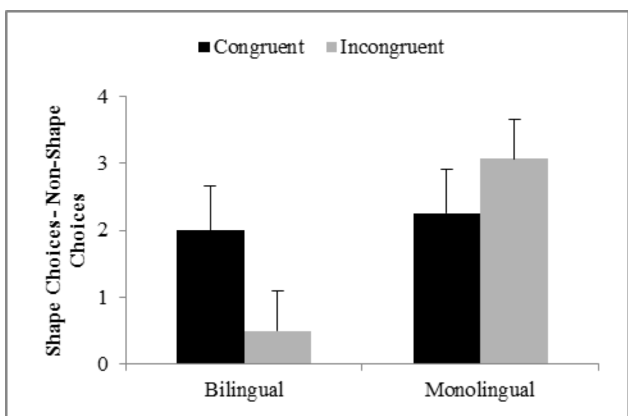

Figure 4. Results for congruent and incongruent trials in Experiment 2.

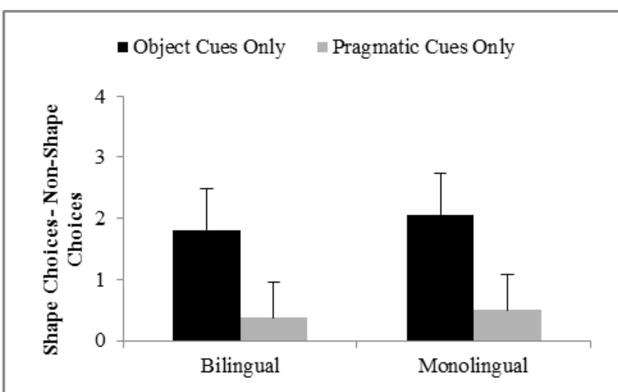

Figure 5. Results for control trials in Experiment 2.

experimenter looks at the child), the children performed similar to the congruent condition, suggesting that both groups could easily make use of the object property cue. Monolingual and bilingual children did not differ in the degree to which they chose the shape-match objects in the Pragmatic Cue Only condition, $t(30)=.27$, n.s., nor did this condition differ from either the congruent or incongruent conditions, all *p*'s>.05. When only the pragmatic cue was available, both monolingual and bilingual children chose the objects at chance levels, *p*'s>.05, suggesting that neither group attended overwhelmingly to the pragmatic cues.

In sum, both the monolingual and bilingual children easily attended the object property cue when it alone was available. However, when both object property and pragmatic cues were available, bilingual children failed to attend to the object property cue, whereas monolingual children did not. Together, these results suggest that bilingual children are more likely to attend to pragmatic cues than monolingual children *when the two cues are incongruent*.

4. General Discussion

Together these two studies suggest that bilingual children attend to pragmatic and object property cues to a different degree relative to monolingual children. Whereas monolingual children may attend more to conflicting object property cues than bilingual children (Experiment 1), bilingual children attend to pragmatic information over object property information when it is available (Experiment 2). Overall, bilingual children afford more attention to pragmatic information than monolingual children as evidenced by their tendency to follow the experimenter's gaze in experiment 2 rather than choosing shape – the object cue that was most prominent in the grouping of the objects.

It is unlikely that these results are due simply to the fact that bilingual children did not understand the task. While this argument might explain results

from Experiment 1 in which bilingual children were at chance performance in both conditions, this argument does not hold for Experiment 2. In experiment 2, bilingual children showed clear differences in performance when pragmatic cues were incongruent than when they were congruent with object property cues. Additionally, bilingual children performed above chance in both the congruent condition and the object cue only control condition, suggesting that they could easily follow the directions of the task.

It is as of yet unclear exactly why bilingual children show a trade-off as compared to monolingual children in the cues that they attend to in a word learning task. What aspect of the bilingual experience is responsible for bilingual children's tendency to both attend less to object property cues and more to pragmatic cues? One possibility is that this a general language effect in which bilingual children learn to attend to pragmatic information more simply because they must attend to which language people are using in general (Grassmann & Tomasello, 2010). If this is the case, similar trade-off effects would need to be found for other aspects of language learning. However, a second possibility is that this effect is specific to word learning. It may be that bilingual children only attend to pragmatic information more when faced with word learning tasks in particular because multiple names for objects are used to contrast words at the language level (i.e. which language each language is from). A similar, though opposite, argument has been made for monolingual children's attention to object property cues when learning multiple names for objects (Callanan & Sabbagh, 2004).

One final possibility is that children attend to different information because bilingual children are lagging in their language skills in each language separately. Because bilingual children necessarily have less exposure to each of their two languages than monolingual children do to their one language, bilingual children may be delayed in their biases to attend to certain types of cues. There is some evidence present in the current study to suggest this may be the case. In general, by two- to three-years-old, children attend to shape more heavily than other object dimensions (e.g. color, texture) (Landau, Smith, & Jones, 1988). However, in the present two experiments, bilingual children of the same ages are showing relatively less attention to shape than their monolingual counterparts, suggesting that they may not have developed this bias yet or at least as strongly. To make up for this delay, bilingual children may rely more on pragmatic information instead to help them disambiguate the name of an object.

This study provides an important first step to understanding how attention is deployed during language acquisition. It seems as though attention is deployed differently based on experience with attending to different types of linguistically-relevant cues, such as pragmatic and object property cues. The cues that are more heavily attended for any given task will to some degree be influenced by the larger monolingual or bilingual linguistic context. Follow-up studies that measure on-line attention to these difference types of cues in

monolingual and bilingual children will be important to further define the role of experience in shaping children's attention in word learning tasks.

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