HOW INFANTS RESPOND TO FAMILIAR AND NOVEL WORDS: COMPARING BILINGUALS AND MONOLINGUALS

by

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Abstract

Infants growing up bilingual provide a unique window into how the language environment interacts with word learning and word comprehension mechanisms. The present studies used a preferential looking paradigm to investigate monolingual and bilingual 18-month-old infants' responses to familiar and novel words. Monolinguals and bilinguals both responded to familiar words with increased attention to the target object. Both groups also showed the mutual exclusivity effect in response to a novel word, by increasing attention to an unfamiliar object. However, while monolinguals showed a linear pattern of increasing attention to the unfamiliar object over time, bilingual infants initially increased attention to the distracter and only later increased attention to the unfamiliar object. These results suggest that monolingual and bilinguals infants use a different processing strategy in demonstrating the mutual exclusivity effect, which may arise from differences in lexical knowledge and organization. The results support the view that differences in early linguistic experience can affect emerging word learning constraints.

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1. Introduction

Learning a new word is a multi-faceted challenge, which includes extracting the word from the speech signal, inferring the meaning of the word, and figuring out the semantic and social nuances associated with using the word. Research over the past few years has clarified some aspects of how word learning and word use gets underway in infants. Copious evidence exists that constraints (either of lexical or social origin) may guide infants as they begin building a lexicon, by narrowing the possibilities of the referent of a new word. Once words are learned, infants can demonstrate their knowledge of these words by looking towards a matching referent. These patterns of lexical development – both in terms of response to familiar and to novel words- are often thought to be universal characteristics of human language development.

Yet, the universality of this developmental pattern remains to be tested. Most studies of familiar word comprehension and word learning constraints have been conducted with children learning a single language- in most cases English. Many children in the word grow up with an extra challenge- that of learning words in two languages. Bilingual babies- referring to those that grow up with two languages from birth- are immersed in a very different linguistic environment from their monolingual peers. They must learn two sets of sounds, two sets of words, and two grammars. When the two languages are taken together, bilingual infants have equal months of language exposure to monolinguals. Yet, when each language is examined separately, a bilingual may only have half as much exposure to a particular language as a monolingual. Especially relevant is that, unlike monolinguals, bilinguals frequently encounter translational equivalents- words that mean the same but are in different languages. Thus, while the bilingual and monolingual experiences have parallels, there are also important differences that could have developmental implications.

The study of bilinguals thus provides the unique opportunity for exploring the universality of the human word learning and word comprehension systems and their development. On the one hand, bilinguals and monolinguals face the same general end goal: to become proficient language users. On the other hand, monolingual infants will become proficient users of a single language, while bilingual infants will become proficient users of two languages. Given that these two groups of infants start with the same innate abilities, and both receive similar amounts of linguistic input, the same biases and processes may develop similarly in both groups. On the other hand, differences in input and end state may alter how infants respond to familiar words and learn new ones.

The current study will expand our understanding of normative linguistic development, by extending questions that have been most frequently explored in monolingual infants to a bilingual population. The study will use looking-time methods to examine how 18-month-old bilinguals process familiar words, and respond to novel to-be-learned words. The results will have implications for the role of specific linguistic input for word learning and comprehension.

1.1 Familiar word comprehension

To understand the meaning of an utterance, a language user must first understand the words that make up that utterance. Across the world's languages, nouns and other content words often refer to things in the real world. Thus, for the language learner, one important ability is to recognize a familiar word and then to search for its referent, which together form a process that will here be called familiar word comprehension.

The comprehension of a few familiar words like "mommy" and "daddy" starts as early as 6 months (Tincoff & Jusczyk, 1999), and infants become more proficient as they advance in language development. A number of studies have investigated the processing of familiar words in monolingual infants, by measuring eye movements and fixations of infants looking at pictures while hearing speech that names one of those pictures. Infants as young as 15 months can rapidly fixate on a picture that matches a spoken word, and the speed and accuracy of their fixations improve from 15 to 24 months of age. At age 15 months, it takes infants only 800-1000ms to make a correct change in fixation, and this improves to about 700-800ms in 18-month-olds (Fernald, Perfors, & Marchman, 2006; Fernald, Pinto, Swingley, Weinberg, & McRoberts, 1998). While 15-month-olds initiate a shift in gaze only after a complete word is spoken, 18 to 24-month-olds can shift to the correct picture before the end of the spoken word, or when only part-words are used (Fernald, Swingley, & Pinto, 2001). Correct shifts away from the distracter to the target object also improve during the second year.

Such looking-while-listening studies have also suggested an important link between online word comprehension and vocabulary. At 18 and 21 months, infants with higher vocabularies respond more quickly and accurately to the referent of a familiar word than infants with lower vocabularies (Fernald et al., 2001). In a longitudinal study, children who had shown faster and more accelerated growth across the second year of life were also faster and more accurate at identifying the referent of a spoken word (Fernald et al., 2006). Similar advantages for infants with high vocabularies have been found in word learning studies (Werker, Fennell, Corcoran, & Stager, 2002).

Online comprehension of familiar words in infants growing up bilingual has rarely been studied. Yet, bilinguals offer a unique opportunity for probing how the comprehension of familiar words is affected by linguistic development, vocabulary size, and lexical structure. Many outcomes in bilingual development parallel monolingual outcomes, thus one might suspect that these groups can demonstrate similar abilities in responding to familiar words. Bilingual infants learn words from both of their languages early in development (Johnson & Lancaster, 1998; Pearson, Fernández & Oller, 1995; Quay, 1995), and reach language milestones such as the onset of productive language on a similar timeframe as monolinguals (de Houwer, 1995; Oller, Eilers, Urbano & Corbo-Lewis, 1997; Pearson & Fernandez, 1994; Petitto et al., 2001). When words from both languages are taken into account, vocabulary sizes of monolinguals and bilinguals are comparable (Pearson & Fernandez, 1994; Pearson, Fernández & Oller, 1993; Petitto et al., 2001).

Yet, although bilinguals' total productive vocabulary is comparable to that of monolinguals, their vocabulary in each language is on average half that of monolinguals'. Bilinguals also get less exposure to a given language than monolinguals, and thus may get less exposure to a given lexical item. If infants' abilities to comprehend familiar words are tied to experience with those specific lexical items, then bilingual infants may show a different developmental time course for the comprehension of familiar words. However, if it is experience with language and words in general that accounts for monolinguals' improvement in familiar word processing across the second year of life, then bilinguals should show the same abilities as monolinguals to respond to familiar words.

It is also possible that the very nature of the words learned by bilinguals may alter how they respond to these words. Early vocabularies of bilinguals contain large numbers of translational equivalents (Pearson et al., 1993, 1995). In lexical decision and naming tasks, adults react more slowly to words with a familiar synonym than to words without a familiar synonym (Hino, Lupker, & Pexman, 2002; Pecher, 2001). Thus, if translational equivalents act as synonyms for young bilinguals, bilinguals may react more slowly to familiar words than monolinguals do.

Few studies to date have investigated word comprehension in bilingual infants (although see Conboy & Mills, 2006, for work using electrophysiological measures), but some studies have been conducted investigating word learning. These studies have produced mixed results, in some cases suggesting that minimal-pair word learning may be more challenging for bilinguals than for monolinguals (Fennell, Byers-Heinlein, & Werker, 2006), while other studies found a bilingual advantage (Mattock, Polka, & Rvachew, 2006). Studies of word comprehension with bilinguals may help clarify these results, while adding to our knowledge of normative bilingual development.

1.2 Learning new words: strategies

Successful word comprehension, by definition, involves responding to an already-known word. However, for young word learners, no matter their linguistic environment, many words are unfamiliar. These words constitute the to-be-learned words that will eventually become part of the child's vocabulary. How does the child move a word from novel to known? In the case of nouns, the child must somehow decide, amongst the many possibilities, what the referent of the word could be.

Studies of young word learners have shown that children may use systematic strategies for inferring the meaning of a novel noun (Markman & Wachtel, 1988). As early as 17-18 months, children seem to avoid mapping a new word to an object whose category already has a label (Halberda 2003; Markman, Wasow, & Hansen, 2003). Instead of giving a second label to an object, children will often choose to attach a new word to a salient part or property of the object, or seek an altogether different referent for the word (Markman & Wachtel, 1998). This one-to-one mapping bias might help children to make an educated guess about the meaning of a word.

Several proposals have been made that account for the basis of such behavior: mutual exclusivity, novel-name-nameless category principle (N3C), and the principle of contrast. The mutual exclusivity principle states that object terms are mutually exclusive (Markman & Wachtel, 1988). That is, each object should only have one basic level label. Other proposals to account for this principle include the novel name-nameless category principle (Mervis & Bertrand, 1994), which accounts for this phenomenon via a positive motivation to find a name for each object, and the principle of contrast, which originates from a pragmatic understanding that different words stem from different underlying intentions (Clark, 1987; Diesendruck & Markson, 2001). Each of these principles account for the one-to-one naming phenomenon via a different mechanism. However, the primary purpose of this paper is not to test the accounts of the phenomenon but to investigate the phenomenon itself. As mutual exclusivity has been the most common term used to describe the phenomenon, this paper will refer to the phenomenon as the mutual exclusivity effect, to emphasize that it is the behavior that is of particular interest here.

Just as familiar word comprehension could be characterized in terms of infants' online reactions to familiar words in the presence of a target object and a distracter, the mutual exclusivity effect might be studied in a similar way, in terms of infants' online reactions to a novel word in the presence of an unfamiliar target object, and a distracter (a familiar object with a known label). The mutual exclusivity effect in infants has thus far never been studied in terms of online processing (but see Halberda, 2003, for some work with preschoolers). However, Swingley & Fernald (2002) have tested 24-month-old infants with a novel word in the presence of two objects for which the infants already knew a word. Although this study could not directly examine the mutual exclusivity effect, as there was no unfamiliar candidate object, the study does allow the examination of infants' responses to a novel word. On these trials, infants responded more slowly than on familiar word trials, taking around 1000ms to initiate an eye gaze shift. Infants were also less likely to shift their gaze on these trials than on trials when they heard a familiar word. If infants' response in a mutual exclusivity situation is driven primarily by the novel word, infants should show similar behavior no matter what types of referents are present. However, it is also possible that the presence of an unfamiliar referent may alter infants' reactions.

It is also important to consider how children growing up bilingual might respond to a novel word- how might they show the mutual exclusivity effect? A bilingual child faces a more complex situation than a monolingual child in constructing a lexicon, and by extension, in showing the mutual exclusivity effect. In some cases, like the monolingual, the bilingual may not know any word to name a given object. However, a bilingual child may know how to name an object in one language, but not the other- a situation that is never encountered by a monolingual. One way that a bilingual could show the mutual exclusivity effect is within a language- for example, rejecting a new English word for an object when an English label is already known for that object. A bilingual could also show the mutual exclusivity effect across or between languages- for example rejecting a new English word for an object when a French label is already known for that object. A within-language mutual exclusivity effect is adaptive for bilingual word learners in the same way that the mutual exclusivity effect is adaptive for monolingual word learners. That is, it allows a child to avoid an unlikely referent for a new word. However, a mutual exclusivity effect between languages is not adaptive- a child might avoid a correct referent for an object simply because she already knows a word for the object in the other language. Using such a strategy would make it difficult for the child to learn translational equivalents, and could lead to substantial errors.

Studies that have investigated the mutual exclusivity effect have suggested that bilinguals between 2 and 3 years sometimes mistakenly show the mutual exclusivity effect between languages (Frank & Poulin-Dubois, 2002), while older bilinguals correctly suspend the constraint in this situation (Au & Glusman, 1990). However, the ability of bilinguals to avoid such a maladaptive mutual exclusivity effect rests on their ability to differentiate their two languages. Thus far, there has been little consensus as to when bilinguals might tell their languages apart, and even less is known about when they might be able to apply such knowledge in the service of word learning (for a review, see Paradis, 2001). As showing the mutual exclusivity effect within a language is the only situation in which mutual exclusivity would prove adaptive to a bilingual word learner, the current study will focus on this situation.

Disambiguation tasks have been the most common way to study mutual exclusivity (e.g. Merriman & Bowman, 1989). In these tasks, children are typically shown a number of objects, one of which does not have a known label, and given a novel label that might name one of the objects. The mutual exclusivity effect is evident if the child chooses the previously unlabeled object as the referent of the new word.

In a study of disambiguation with 2 and 3 year olds, bilinguals did not differ from monolinguals in their demonstration of the mutual exclusivity effect in a pointing task (Frank & Poulin-Dubois, 2002). It should be noted, though, that younger children showed the mutual exclusivity effect less than half the time, and older children showed it just over half the time. In a study of slightly older preschoolers, participants at two ages (younger: 3-4 years, and older: 4-6 years) were shown a familiar and an unfamiliar object, and were told to point to the referent of an unfamiliar word (Davidson, Jergovic, Imami, & Theodos, 1997; Davidson & Tell, 2005). Both monolingual and bilingual children reliably pointed to the unfamiliar object. However, older monolingual children chose the unfamiliar object as the referent for the new word almost all the time, while older bilinguals and younger children in both language groups only pointed to the unfamiliar object 60-70% of the time.

Thus, in pointing tasks, monolingual and bilingual 2-4 year olds demonstrate the mutual exclusivity effect to the same extent. As the children approach 5 and 6 years old, monolingual children become more consistent in their demonstration of mutual exclusivity, while bilingual children appear to change little.

Although the mutual exclusivity effect has been shown in monolingual infants by 18 months, there have been to date no studies of bilinguals this young. Studying bilinguals of this age could provide an important perspective on the mutual exclusivity effect. If the mutual exclusivity effect is a highly robust phenomenon that emerges from general cognitive and linguistic development, then it can be expected to emerge at the same time and in the same way in monolinguals and bilinguals. However, if the development of the mutual exclusivity effect is driven solely by linguistic input, translational equivalents in bilinguals' lexicons may provide evidence against a principle that might drive this effect, such that 18-months-old bilinguals may not show the mutual exclusivity effect at all. Finally, the mutual exclusivity effect could take something of a middle path- emerging around the same age in all normally developing infants, but with differences in its implementation between monolingual and bilingual infants.

1.3 Goals and methods of the present research

The current study will use a preferential looking paradigm (Golinkoff, Hirsch-Pasek, Cauley, & Gordon, 1987) to examine 18-month-old monolingual and bilingual infants' response to familiar words in the presence of their referents (Fernald et al., 1998), and their response to novel words in the presence of a novel referent (Halberda, 2003). Preferential looking tasks are more sensitive for infants of this age than pointing and labeling tasks, as they do not require children to make an overt response, and can be analyzed in terms of looking time, which is a continuous rather than a dichotomous correct/incorrect measure. Moreover, infants' automatic responses can be recorded continuously, giving a measure of online linguistic processing (Halberda, 2003; Tanenhaus, Magnusen, Dahan, & Chambers, 2000).

The use of the preferential looking paradigm will address two sorts of questions. The first concerns the abilities that 18-month-old infants can demonstrate. Past research has shown that monolingual infants can show comprehension of familiar words by looking towards a labeled object, and they can show the mutual exclusivity effect by looking at an unfamiliar object in response to a novel word. Do bilingual infants also demonstrate similar abilities at 18 months? The second type of question concerns the implementation of these abilities. If bilinguals can perform these functions at 18 months, do they implement them in the same way? An analogy may be made to the world of operating systems: a Macintosh and a PC computer might be able to perform the same functions: word processing, e-mail, saving files and retrieving them. However, the way that these functions are implemented depends on the structure of the system. If linguistic experience changes the structure of the familiar word and novel word processing systems, then there should be differences either between the abilities shown by monolinguals and bilinguals, or differences in their implementation of these abilities. However, if novel and familiar word processing systems follow a universal pattern of development unrelated to the specific language or languages of exposure, then there should be no difference between the two groups.

For familiar word comprehension, it is expected that monolinguals and bilinguals will show the same functional ability. Both groups must learn to respond to familiar words in order to become communicators. Thus, the hypothesis is that both monolingual and bilingual infants will be able to respond to familiar labels by shifting and maintaining attention to the labeled object above their baseline tendencies to shift and attend to that object. However, there is reason to expect that there may be some implementation differences between the two groups. Namely, because translational equivalents may act as synonyms for bilinguals, these infants may react somewhat more slowly than monolinguals.

Linguistic experience is also predicted to influence the mutual exclusivity effect, either on the level of functional ability or implementation. The ability of bilinguals to show the mutual exclusivity effect may be diminished, as these infants constantly encounter translational equivalents, which may act as evidence against a principle such as mutual exclusivity. On the other hand, monolinguals and bilinguals learn new words at similar rates, and this may be evidence that both groups take advantage of such word learning principles to build their lexicons (Pearson & Fernández 1994; Pearson, Fernández & Oller, 1993; Petitto et al., 2001). If both groups do show the mutual exclusivity effect, there are several reasons to expect that they will show differences in its implementation. First, fast-mapping constraints like mutual exclusivity have been linked with vocabulary development (Mervis & Bertrand, 1994). As bilinguals' vocabularies are split between two languages, their vocabulary in a given language differs greatly from same-age monolinguals, and this may alter when and how the mutual exclusivity effect emerges in these infants. Second, bilinguals must store words from two languages in their lexicons. It is possible that, in the application of a principle such as mutual exclusivity, bilinguals must access more lexical items than their monolingual peers.

2. Experiment 1

2.1 Method

2.1.1 Participants

The participants in Experiment 1 were sixteen full term infants (8 male, 8 female), with a mean age of 17 months 28 days (range: 17 months 13 days to 18 months 12 days). Infants were contacted through the database at the Infant Studies Centre. Infants in the database were recruited by talking to new parents at a local maternity hospital, through posters and flyers at community centers and libraries, and through referrals by other parents who had participated in studies at the centre. All of the infants came from English-speaking homes, and all parents reported that their infants had not received any significant or systematic exposure to a non-English language. Five additional infants were tested but not included in the final sample because of restlessness.

2.1.2 Stimuli

The visual stimuli consisted of four brightly colored objects, three familiar (ball, car, shoe), and one novel. Ball, car, and shoe were chosen as the familiar objects as they are among the first words learned by infants in a number of languages. The novel object was a version the phototube object from the TarrLab Object DataBank (1996), which had been digitally morphed using a graphics program, as some pilot subjects had thought that the phototube was a bottle. The objects were presented in pairs on a black background, such that the ball and car always appeared together, and the shoe and phototube object always appeared together. To ensure infant attention to the stimuli, the objects appeared in different colours on different trials throughout the study.

Auditory stimuli were recorded by a native English speaker who spoke in an infant-directed manner. The stimuli consisted of three labels that named the familiar objects- “ball”, “car, “shoe”, and one label which named the novel phototube object – “nil”. Each token was recorded in isolation, and with three carrier phrases, “Look at the ____”, “Find the ___”, and “Where is the ___”. For each trial, the label was presented once embedded in a carrier phrase, and again in isolation after a pause of 2 seconds, (e.g.

"Look at the ball! Ball!"). The different carrier phrases were presented quasi-randomly throughout the study.

2.1.3 Apparatus

Data were collected using a Tobii 1750 eye tracking system that had the following components: a monitor that both presented the stimuli and recorded infant eye gaze, and a PC computer running the Tobii Clearview software program that controlled the stimulus presentation and collected the data generated by the eye tracker. Infrared light-emitting diodes built into the monitor generated invisible infrared light, which shined on the infant's face. A high-resolution camera built into the monitor collected eye gaze data based on the light reflection off the infant's cornea relative to the pupil. Infants were not required to wear any special equipment during testing, as the camera had a wide angle of view that could tolerate moderate movement. Most infants stayed in the field of view throughout the study. If an infant did happen to shift position outside the field of view, the experimenter discretely re-centered the screen between trials.

2.1.4 Procedure

The study was conducted in a dimly lit, sound-attenuated room. Infants sat on their caregiver's lap, approximately 60 centimeters away from the eye tracking monitor. The eye tracking monitor was attached to an adjustable arm, so that the monitor could be centered relative to the infant's eyes. Loudspeakers were located on either side of the monitor, hidden from view by a black cardboard panel that sat behind the monitor. To avoid external influence during the study, caregivers wore a blindfold or simply closed their eyes if the presence of the blindfold was distressing to the infant. Prior to the beginning of the study, the eye tracker was calibrated to each infant, using a five-point infant calibration routine. The experimenter controlled the study from a computer and a closed circuit TV monitor, which were located in a screened-off area of the room, out of sight of the infant.

Each session started with a warm-up trial, during which a brightly colored spinning waterwheel appeared first on the right side of the monitor, and then on the left side. This was to familiarize the infants to the monitor, and to show them that objects would appear on both sides of the screen.

Following the warm-up, infants were presented with experimental trials. On each trial, the pair of objects first appeared in silence on the screen for 3 seconds, so that infants' baseline preference for each object could be measured. The test phase of the trial began immediately following the baseline phase, when an auditory stimulus was played that named one of the objects (e.g. "Look at the ball! Ball!). The objects then remained in silence on the screen for the infant to observe, such that the total length of the trial was 9.5 seconds. After the test phase was completed, the unlabeled object disappeared, while the labeled object moved around on the screen for 2 seconds with accompanying music. This was done in order to create a pragmatically natural task for the infants, as if to provide a reason to look at the correct object. The results of the current and past studies have found no evidence that this reinforcement helps infants' performance (see Sections 2.3.2 and 3.3.2; Halberda, 2003).

Infants were presented with 24 test trials, in four blocks of six trials per block. The first and third blocks consisted of known vs. known trials (ball-car), while the second and fourth blocks consisted of known vs. novel trials (shoe-nil). Each object was labeled on half of the trials in which it appeared, thus a total of six times. Each infant saw the objects in a consistent configuration throughout all the trials (e.g. ball on left, car on right). Eight stimulus orders were created that counterbalanced side and order of presentation across infants. A bright circular pattern was presented in the centre of the screen between trials, to ensure that the infant was fixating in the centre of the screen at the beginning of every trial. The total duration of the study was approximately 7 minutes.

Infant eye gaze data were collected by the eye tracker, which measured the infant's gaze at 20ms intervals. Areas of interest were defined around each object such that the data could be coded based on which object the infant was looking at. Each time interval was classified according the following scheme: looking at the left side object, looking at the right side object, a gaze measurement elsewhere on the screen (for example between the two objects), and no gaze data (no measurement could be made, most often because the infant was looking away from the screen or occasionally because the infant's hand was between the infant's eyes and the camera). Data were normalized to the onset of each label for each trial, so that the data could be collapsed across trial type in order to measure the infant's success at orienting to the labeled object.

Following the study, parents were asked to complete the MacArthur-Bates Communicative Development Inventory (CDI; Fenson et al., 1993). Although the Words and Sentences form is normally used for infants of 18 months, the current study used the Words and Gestures form, which is normally used only up to 16 months. Unlike the form for older children, the Words and Gestures form collects information on both receptive and productive vocabulary, which were both of interest in this study. CDI data was not available for one infant, because the parent failed to completely fill out the form.

2.2 Analyses

Three measures were used to assess infant performance: *target fixation proportion, shift proportion, and reaction time.*

All measures were examined in a window that began 360ms after the onset of the target word and ended 2000ms after word onset. A number of other studies investigating word comprehension in infants and adults have used a similar initial time point as a plausible minimum time required to respond to a word, due to the time to both process the word and to initiate an eye movement (e.g. Dahan, Swingley, Tanenhaus, & Magnusun, 2000; Fernald et al., 2006; Swingley & Fernald, 2002). Eye movements initiated after 2000ms post word onset are unlikely to be responses to the word itself. Only trials with sufficient attention during the first two seconds post word onset, those with at least 500ms of looking to the two objects, were included.

The primary measure of infant performance was *target fixation proportion*, which was defined at the time the infant fixated on the target, divided by the time the infant fixated to either the target or the distracter. Target fixation was computed in the silent baseline period as a measure of an infant's individual preference for looking at an object. This was compared to the infant's preference to look at the object after the label was used, during the labeled period. If infants can respond systematically to a label, they should increase their proportion looking to the labeled object above baseline.

At word onset, an infant could be fixated at the target object, the distracter object, or looking at neither object. *Shift proportion* is defined as the proportion of trials on which an infant shifts from one picture to the other within the time window of interest, and it is measured both for distracter-initial and for target-initial trials.

Reaction time was calculated only for those trials for which the infant is fixated on the distracter. It is defined as the time it takes for the infant to correctly shift from the distracter to the target.

A measure of effect size, Cohen's d (Cohen, 1988), is reported for statistical tests that compared two means.

2.3 Results

To provide an overview of the results, a time course line was graphed for the infants. At each 20ms measurement interval, the total number of trials infants were fixated on target relative to the number of trials infants were fixated on either object was graphed. Familiar label trials are graphed in Figure 1, while novel label trials are graphed in Figure 2. Overall, there is a pattern for infants to increase their looking to the target object for both familiar labels and novel labels. However, while the curve for familiar labels shows a steep initial increase in attention, and a subsequent decline, the curve for novel labels shows a steep but steady increase throughout almost all of the first two seconds of the trial.

To more accurately describe these two curves, a curve estimation procedure was carried out using the SPSS software package, to determine how linear and quadratic models described the curves. Time points between 360 and 2000ms were used for the curve estimation, although the results were similar if time points before 360ms were included. For the familiar label trials, a quadratic curve best explained the distribution of the data points, $R^2 = .909$, while a simple line did not describe the data well, $R^2 =.030$. The coefficient value for the quadratic term was negative, confirming that infant attention first increased and later decreased (see Figure 1). For novel label trials, a linear account of the data provided a parsimonious description ($R^2 =.706$), while adding a quadratic factor did not describe the curve much better ($R^2 =.808$). The linear coefficient for this line was positive, indicating that monolingual infants continuously increased their attention to the unfamiliar object (see Figure 2).

2.3.1 CDI data

Monolingual infants had an average receptive vocabulary of 260 words (*SD*=66, range: 156-374), and an average productive vocabulary of 76 words (*SD*=84, range: 7-285). Receptive and productive vocabulary had a marginally significant correlation $r(14)=.523$, $p=.055$. Individual items on the CDI that corresponded to the objects and words used in this study were examined. Parental reports indicated that 93% infants with completed CDIs understood each of the words ball, car and shoe. Production rates for these items were respectively 80%, 67%, and 60%.

2.3.2 Target fixation proportion

For each infant, a baseline preference for each object was computed, calculated as the percentage of time the infant looked at a given object during the baseline period, divided by the total time the infant spent looking at either object. A score was calculated for each infant, averaged across all the trials that the object had appeared on the screen. Trials in which the infant looked for less than one second during the baseline were not included.

Target fixation proportion was then calculated for the labeled period, in the window of 360-2000ms after word onset. Only trials with at least 500ms of looking at the two objects during the first two seconds after word onset were included. A preliminary ANOVA was performed comparing the three familiar objects. There was no significant interaction of time with object $F(2,30)=.62$, $p=.545$, suggesting that infants performed similarly across all familiar objects. Thus, scores were averaged across the three familiar objects for subsequent analyses.

A 2(target: familiar, novel) by 2(time period: baseline, labeled) mixed ANOVA was performed to investigate whether infants increased their looking to the labeled objects above baseline. There was a main effect of object type, $F(1,15)=158.93$, $p<.009$. Overall, infants preferred looking at the familiar objects to looking at the novel object. Critically, there was also a main effect of time period, $F(1,15)=19.78$, $p<.0005$, indicating that infants heard a label, they increased their looking to the target object above their looking during the baseline period. There was no interaction of time period and target, suggesting that the effect was not significantly different for the familiar and the novel objects, $F(1,15)=.001$, $p=.971$. The mean difference between proportion looking during baseline and during the labeled period for each of the target objects is displayed in Figure 3.

To confirm that the effect of time period held both for the familiar words and for the novel "nil" word, one-tailed t-tests were performed comparing baseline and named time periods for the two trial types. The mean fixation proportion for the familiar objects was .54 (SD =.06) during baseline and .66 (SD=.10) during the labeled period, while for novel objects fixation proportion was .38 (SD=.18) during baseline and .50 (SD=.19) during the labeled period. A significant effect of time period was indeed found for familiar $t(15)=5.97$, $p<.0005$, $d=1.49$, and novel objects $t(15)=2.63$, $p=.01$, $d=.66$. To confirm this finding, a difference score was calculated for each infant for the novel trials, by subtracting the baseline proportion looking to the target object from the proportion looking during the labeled period. Thirteen out of sixteen infants had a positive difference score, $p=.02$ two-tailed by the binomial test.

To examine whether infants improved across the six novel object test trials, a linear contrast was computed. There was no evidence of improved performance across the six trials, $F(1)=1.86$, $p=.245$. An examination of the means showed that infants increased their looking to the unfamiliar object on each of the first through fifth test trials. Only eight infants attended to the sixth trial sufficiently for the trial to be included, and on this trial these infants did not show a preference above baseline.

2.3.3 Shift proportion

For each infant, the mean proportion of shifts from distracter to target, and from target to distracter was calculated. For familiar label trials, infants correctly shifted from distracter to target over 85% of the time (M=.88, SD=.14), but shifted away from the target to the distracter somewhat less, only about 75% of the time (M=.74, SD=.27). A repeated measures t-test revealed that shifting was marginally more likely when the infants were distracter-fixated than when they were target-fixated, $t(13)=2.12$, $p=.054$, $d=.56$.

For novel label trials, infants tended to shift about 65% of the time, and they were just as likely to shift whether fixated on the distracter object (M= .66, SD= .35), as when fixated on the target object (M=.63, SD=.42), $t(9)=1.26$, $p=.240$, $d=.40$.

2.3.4 Reaction time

Data were collapsed across the two types of trials: familiar label trials (ball, car, shoe), and novel label trials (nil). Only trials where the infant was initially fixated on the distracter were included in the calculation of reaction time.

For the familiar label trials, infants rapidly shifted away from the distracter to target (*M*=904ms, *SD*=154ms). For the novel label trials, infants shifted their gaze from distracter to target somewhat slower, (*M*=1082ms, *SD*=326ms). However, there was no significant difference between these two means, $t(11)=1.43$, $p=.183$, $d=.41$.

2.3.5 Correlations amongst measures

Correlations were examined between the three measures, *target fixation proportion, shift proportion,* and *reaction time* to examine whether each measure tapped into a similar underlying ability. For the target fixation proportion measure, a difference score was derived for each infant for both the familiar and novel label trials, by subtracting the baseline preference from the preference during the labeled period. To create a single measure for shift proportion, a difference score was calculated by subtracting the shift proportion for target-initial trials from the shift-proportion to distracter-initial trials for each infant. Again, reaction time was calculated only for distracter-initial trials, and was defined as the time required for the infant to shift from the distracter to the target.

For familiar label trials, the three measures had the expected pattern of correlation. Infants who increased attention to the labeled object were also more likely to increase shifting behavior when distracter-fixated $r(14)=.541$, $p=.046$. They also tended to have a smaller reaction time, although this difference was not statistically significant, $r(15)= -.189$, $p=.5$.

For the novel label trials, there was a different pattern of correlation. Infants who most increased their attention to the nil object tended to have marginally faster reaction times on these trials $r(12)=-.534, p=.073$. However, they were also more likely to decrease shifting behavior $r(10)=-.675, p=.032$.

Correlations were also examined between CDI comprehension scores and target fixation proportion measures. A marginally significant negative correlation was found between comprehension and target fixation proportion for familiar items, $r(14)=.-.486$, $p=.078$. The correlation between CDI comprehension scores and target fixation proportion for novel label trials did not approach significance, $r(14)=-.187, p=.521$. There were no significant correlations between CDI production scores and performance on either novel label or familiar label trials.

2.4 Discussion

For monolinguals, familiar label trials appeared to present a straightforward task. When hearing a familiar word in the presence of its referent, monolingual infants significantly increased their attention to the named object above their baseline preference. On these trials, they were also more likely to shift their gaze from one object to the other when initially fixated on the distracter (a mismatch) than when initially fixated on the target (a match). Their reaction time was on average around 900ms, which is similar to what other studies have found for monolingual infants of this age (Fernald et al., 1998, 2006). Further, the three measures of performance showed internal consistency, with monolingual infants' performance correlated across measures. Curve estimation techniques showed a quadratic pattern of attention, and suggested that interest in the target object increased in the earlier part of the time window examined, and decreased later in the time window.

There was an inverse relationship between vocabulary size and proportion looking to target for familiar label trials. That is, infants with larger vocabularies tended to have smaller increases in attention to the labelled object relative to baseline. Previous research showed a positive relationship between vocabulary size and accuracy at shifting to a labelled object. A possible explanation is that the words used in this study were extremely easy for the more advanced infants. They may have been less engaged in the task, and thus shown a weaker performance than infants with smaller vocabularies for whom the task was at a more appropriate level.

On novel label trials, monolinguals also tended to increase their attention to an unfamiliar object. There was no evidence that the experimental procedure, in which the named object danced on the screen, drove this result, as infants showed this pattern from the first test trial, and there was no linear trend across the trials (see Halberda, 2003, for similar findings). These results suggest that monolingual infants of 18 months show the mutual exclusivity effect in locating the referent of a novel word. Infants who increased their attention to the unfamiliar object also tended to respond more quickly to this word than those who increased their attention less, but they were also less likely to initiate a shift in gaze within 2 seconds of hearing the novel word. Thus, infants with the strongest mutual exclusivity effect showed less overall shifting, but when shifts did occur the reaction time was relatively small.

For novel label trials, monolingual infants showed no difference in their tendency to shift on target-fixated trials than on distracter-fixated trials, and overall tended to shift less when hearing a novel label than when hearing a familiar label. A decreased tendency to shift replicates results in previous work that has used nonce words without a plausible referent, suggesting that the presence of such a referent may not affect infants' propensity to shift (Swingley & Fernald, 2002). Monolinguals' reaction time was somewhat slower to novel labels compared to their reaction time to familiar labels, almost 1100ms, which is similar to reaction times found to nonce words in other studies (Swingley & Fernald). Curve estimation techniques suggested a linearly increasing pattern of attention, suggesting increased fixation on the unfamiliar target over the course of the trial.

3. Experiment 2

3.1 Method

3.1.1 Participants

The participants in Experiment 2 were 16 full term bilingual infants, with a mean age of 17 months 29 days (range: 17 months 14 days to 18months 16 days). The participants were recruited in the same manner as Experiment 1. All of the infants in this study had been exposed to English as well as another language in the home since birth. The other languages of the infants included French (3), Japanese (3), Gujrati (2), Spanish (2), Croatian (1), German (1), Hebrew (1), Portuguese (1), Punjabi (1), and Vietnamese (1). Percent exposure to each language was measured by an English version of the Language Exposure Questionnaire, which has been used to assess language exposure in previous studies with bilingual infants (Bosch & Sebastián-Gallés, 1997). The questionnaire asks detailed questions about the languages spoken by all caregivers since the infant's birth, as well as asking parents for a global estimate of the infant's language exposure. A minimum of 25% exposure to each language was set as a criterion for inclusion in the study (Pearson, Fernández, Lewedeg, and Oller, 1997). Infants in the final bilingual sample heard a mean of 48.2% English (range: 27.1 to 70.9), and 51.8% of another language (range: 29.1 to 72.9). Four additional infants were tested but not included in the final sample due to restlessness (2), crying (1), and parental report of poor vision (1).

3.1.2 Apparatus and procedure

The apparatus and procedure were identical to those used in Experiment 1. All interactions and stimuli used with the infants were in English. Caregivers of infants in this study were also asked to complete the CDI Words and Gestures form, with respect to only their child's English vocabulary, and all but one parent returned the form. CDI data could not be collected on each infant's non-English language due to an unavailability of versions of the CDI for many of the languages represented.

3.2 Analyses

Analyses were identical to those performed in Experiment 1.

3.3 Results

As in Experiment 1, a time course was graphed for the infants. Familiar label trials are graphed in Figure 1, while novel label trials are graphed in Figure 2. The infants appeared to show a different pattern for familiar label and novel label trials. For the familiar label trials, infants showed a rapid increase in attention to the target object, followed by a subsequent decline in attention within the first 2000ms. For novel label trials, infants appeared to show a slight initial decrease in attention to the target object, followed by an increase in attention.

An SPSS curve estimation routine was used to examine the general shape of these curves. For the familiar label trials, a quadratic equation (R^2=.879) provided a substantially better fit than a linear equation (R^2=.397). The estimated quadratic coefficient was negative, suggesting that attention during these trials showed a pattern of first increasing to the target object, and later decreasing (see Figure 1). For the novel label trials, a quadratic equation (R^2=.804) fit the data better than a linear equation (R^2=.467). The estimated quadratic coefficient was positive, suggesting that infants initially decreased attention to the target object, and later increased attention (see Figure 2).

3.3.1 CDI data

Bilingual infants had an average English receptive vocabulary of 156 words (*SD*=72, range: 32-313). They had an average English productive vocabulary of 34 words (*SD*=29, range: 1-109). A significant correlation was found between the infants' percentage exposure to English and their receptive vocabulary, $r(14)=.6$, $p=.023$, however no correlation was found between percentage exposure to English and productive vocabulary, $r(15)=-.115$, $p=.684$. Productive vocabulary and receptive vocabulary were also not correlated, $r(15)=.012$, $p=.966$. Comprehension rates of the lexical items used in the current experiment were calculated, and were 93% for ball, 93%

for car, and 80% for shoe. Production rates of these words were lower, at 53%, 33%, and 27% respectively.

3.3.2 Target fixation proportion

For each infant, a baseline preference for each object was computed, calculated as the percentage of time the infant looked at a given object, divided by the total time the infant spent looking at either object during the silent baseline period. A score was calculated for each infant, averaged across all the trials that the object had appeared on the screen. Trials in which the infant looked for less than one second during the baseline were not included in the calculation.

Trials were examined during the labeled period, in the window of 360-2000ms after word onset. Only trials with at least 500ms of looking at the two objects during the first two seconds after word onset were included. A preliminary ANOVA was performed comparing the three familiar objects. There was no significant interaction of time with object $F(2,30)=1.52$, $p=.234$, suggesting that infants performed similarly across the familiar objects. Thus, scores were averaged across the three familiar objects for all subsequent analyses.

A 2(target: familiar, novel) by 2(time period: baseline, labeled) mixed ANOVA was performed to investigate whether infants increased their looking to the named objects above baseline. There was a main effect of object type, $F(1,15)=9.07$, $p<.009$. Overall, infants preferred looking at the familiar objects to looking at the novel object. Critically, there was also a main effect of time period, $F(1,15)=13.64$, $p<.002$, indicating that infants increased their looking to the target object when they heard the corresponding word, above their baseline preference. There was no interaction of time period and target, suggesting that the effect was not significantly different for the familiar and the novel objects, $F(1,15)=.05$, $p=.835$. The mean difference between proportion looking during baseline and during the labeled period for each of the four target objects is displayed in Figure 3.

To confirm that the effect of time period held both for the familiar words and for the novel "nil" word, one-tailed t-tests were performed comparing baseline and named time periods for each of the familiar and novel objects. The mean fixation proportion for the familiar objects was .54 (*SD* =.04) during baseline and .60 (*SD*=.13) during the labeled period, while for novel objects fixation proportion was .39 (*SD*=.13) during baseline and .47 (*SD*=.19) during the labeled period. A significant effect of time period was found for familiar objects $t(15)=1.96$, $p=.035$, $d=.49$, and a near-significant effect was found for novel object $t(15)=1.69$, $p=.055$, $d=.42$. For the novel object, ten out of sixteen infants showed a positive difference score between preference during the labeled period and baseline preference, but this is not significant by the binomial test, $p=.45$, two-tailed.

To examine whether infants improved across the six novel object test trials, a linear contrast was computed. There was no evidence of a linear trend across the trials, $F(1)=.08$, $p=.802$. An examination of the means trial by trial showed that infants increased their attention to the unfamiliar object on all six of the test trials. However, only 3 infants on the sixth test trial attended sufficiently to the visual stimuli to be included in the analysis of this trial.

3.3.3 Shift proportion

For each infant, the mean proportion of shifts from distracter to target, and from target to distracter was calculated. For familiar label trials, infants correctly shifted from distracter to target over 75% of the time (*M*=.76, *SD*=.20), but shifted away from the target to the distracter less, only about 65% of the time (*M*=.64, *SD*=.29). However, this difference was not statistically robust, $t(15)=.13$, $p=.227$, $d=.32$.

For novel label trials, infants tended to shift about 65% of the time, and were just as likely to shift whether fixated on the distracter object (*M*=.63, *SD*=.35) as when fixated on the target object (*M*=.67, *SD*=.36), $t(11)=1.26$, $p=.567$, $d=.17$.

3.3.4 Reaction time

For the familiar label trials, infants had an average reaction time of 1122ms (*SD*=291ms). For novel label trials, there was a similar reaction time (*M*=1173.33ms, *SD*=441ms). The reaction times for familiar and novel label trials did not differ, $t(11)=.29$, $p=.776$, $d=.08$.

3.3.5 Correlations amongst measures

Correlations were examined amongst the three measures to examine whether each measure tapped into a similar underlying ability. As in Experiment 1, difference scores were computed for the target fixation proportion measure and for the shift proportion measure to correct for infants' baseline tendencies.

For familiar label trials, the three measures had the expected pattern of correlation. Infants who increased attention to the labeled object were also somewhat more likely to increase shifting behavior when distracter-fixated compared to when target-fixated $r(14)=.441, p=.087$. They also had a smaller reaction time $r(15)=-.636$, $p=.008$.

For the novel label trials, there was a mixed pattern of correlation. Infants who increased their attention to the nil object tended to have faster reaction times on these trials, $r(12) = -.520, p=.083$. However, they were less likely to increase shifting behavior, $r(16)=-.342, p=.195$, although not significantly so.

Correlations were computed between CDI comprehension scores and target fixation proportion scores. For familiar label trials, there was a non-significant negative correlation, $r(15)=-.412, p=.127$. However, for novel label trials, there was a significant positive correlation, $r(15)=.623, p=.013$. CDI production scores did not correlate with performance for either type of trial.

3.4 Discussion

CDI data revealed differences between monolinguals and bilinguals in terms of lexical development. Bilingual infants understood and produced only half as many English words as their same-age monolingual peers. There was an extremely robust correlation between the number of English words that bilinguals could understand, and how much English exposure they received. Unsurprisingly, infants with the most English exposure could understand the most English words. Unlike in most monolingual samples, no correlation was found for bilinguals' between CDI production and comprehension scores. The lack of correlation may suggest that different factors affect the development of bilingual infants' productive and receptive vocabularies. Another possibility is that the CDI is a less appropriate measure of productive vocabulary in bilinguals than in monolinguals, possibly due to the difficulty for parents to determine whether a young bilingual is speaking English or another language.

In response to a familiar label, bilingual infants showed increased attention to the labelled object. They were more likely to shift their gaze when distracter-fixated than when target-fixated, suggesting a systematic search for the referent of the familiar word. Three measures of performance on familiar label trials were significantly correlated, suggesting that these three measures may tap into the same ability. However, unlike monolingual infants, bilingual infants did not show differences in reaction time when target-fixated than when distracter-fixated. Both latencies were longer than that of monolinguals, over 1100ms, suggesting that it may take bilinguals more time to respond to familiar words. Also, bilinguals appeared to show variability amongst familiar words, responding reliably to some but less reliably to others. This may be because they are less proficient users of English words, or it may because their lexicon is structured differently from that of monolinguals, having two entries per concept that must be sorted through.

On novel label trials, bilinguals increased attention to the unfamiliar object, indicating that these infants show the mutual exclusivity effect. The quadratic curve that best described their pattern of attention suggested a slight initial decreased attention to the unfamiliar object (thus increased attention to the distracter) followed by an increase in attention to the unfamiliar object. Infants who increased their looking the most to the unfamiliar object also had the fastest reaction time. Further, a positive correlation between proportion increase to target and CDI scores suggest that bilinguals with higher English proficiency are also more likely to show a robust mutual exclusivity effect.

4. General discussion

One important yet relatively unexplored area of infant language research is the impact of a particular linguistic environment, in this case a bilingual environment, on the processing and comprehension of both novel and familiar words.

In this study, bilingual 18-month-old infants demonstrated the same abilities for responding to familiar and novel words as monolingual infants. They responded not with confusion, but with a consistent and adaptive response. Both monolingual and bilingual infants responded to familiar words by looking towards the referent of that word. Both groups responded to novel words by showing the mutual exclusivity effect of looking towards an unfamiliar object. However, a closer examination of the data reveals that there may be differences in the implementation of these abilities. As the infants in the two studies were of the same chronological age, these differences must be attributable to differences in language environment.

The linguistic experience of monolinguals and bilinguals differs in several important ways. First, learning two languages impacts the amount of language exposure a bilingual receives in each language. Although bilinguals receive as much total language input as monolinguals, and have the same total vocabulary size, it is split between two languages. On average, a bilingual has half as much English exposure and vocabulary as a monolingual. Second, young bilinguals are in the process of building a dual lexicon that must accommodate words from both of their languages, while monolinguals only learn words from a single language. Third, bilinguals in this study received significant exposure to a non-English language. To the extent that the characteristics of different languages necessitate unique linguistic processing, these differences may influence the way bilinguals process English. Alone, any of the three factors mentioned could change the implementation of shared linguistic abilities. However, there is the possibility that these differences work in concert as well. The following section will discuss the differences in implementation found between monolingual and bilinguals, and will suggest how these differences might be accounted for by differences in linguistic environment.

4.1 Responding to familiar words

Both bilingual and monolingual infants showed a pattern of reasonably fast response to familiar labels, by shifting their attention to the labelled object. Both groups showed a quadratic - increasing then decreasing - pattern of attention to the target object. However, reaction time was very different between monolinguals and bilinguals. Monolingual infants responded to familiar words in 900ms on average, while bilinguals took over 1100ms. In monolingual infants, 15-month-olds can respond to familiar words in under 1000ms (Fernald et al., 1998, 2006). Further, bilingual infants showed more variability than monolinguals, responding more robustly to some words than to others. Time course analyses also suggested that bilinguals did not respond as strongly to familiar words as monolinguals did.

Bilinguals' less robust performance for familiar words cannot be attributed to a lack of familiarity with these words, as parental reports indicated that almost all of the infants understood the words. However, bilingual infants had lower overall CDI comprehension scores than monolinguals, and fewer bilinguals than monolinguals produced the target words. In monolingual infants, 15-month-olds also have slower reaction times to familiar words than more linguistically advanced 18-month-olds (Fernald et al., 1998, 2006). One characterization of familiar word processing is that reaction time depends on vocabulary size- after all, the 18-month-old bilinguals had similar CDI scores to these 15-month-olds. Yet, when reaction times are examined, 15-month-olds responded within 1000ms, which is still 100ms faster than the bilingual group. Thus, English vocabulary size alone does not seem to account for reaction time differences between monolinguals and bilinguals.

The current study is not the first to show differences between monolingual and bilingual infants in terms of response latencies. In a study of native language recognition in 4-month-olds, monolingual and bilingual infants both showed the ability to discriminate a native from a non-native language (Bosch & Sebastián-Gallés, 1997). However, while monolinguals showed their discrimination by a shorter latency to orient to the native language, bilinguals showed discrimination via a longer latency.

In the current study, the structure of the bilingual lexicon may have contributed to the bilingual infants' slower reaction time. The words used in this study referred to everyday objects, and are likely to be known by the bilingual infants in both of their languages. Bialystok & Martin (2004) have suggested that young bilinguals must constantly inhibit one of their languages to prevent "on-going intrusions". In the current task, a visual image of familiar objects may have activated lexical items in both English and in the other language. Bilinguals may have actively been inhibiting lexical items from their non-English language, which may have produced their longer reaction time, and less reliable responding to these words.

4.2 Responding to novel words

Bilingual and monolinguals both show evidence of using a one-to-one mapping principle such as mutual exclusivity at 18 months. Thus, it is not the case that the bilingual experience of hearing translation equivalents prevents the development of such a principle. Upon hearing a novel label, both monolingual and bilingual infants increased their attention to an unfamiliar object. Monolinguals had a more robust response than bilinguals, showing a higher increase in attention above baseline. Yet, beyond the magnitude of the response, there were important qualitative differences.

One difference between the two groups is apparent in the time course of their response to novel words. Monolingual infants showed a monotonic increase in attention to the unfamiliar object from the onset of the novel word. However, bilingual infants showed a slight initial decrease in attention to the unfamiliar object (thus increase in attention to the distracter) followed only later by an increase in attention to the unfamiliar object.

Developmental studies of monolingual infants have shown that a strategy for responding to novel words may develop between 15 and 18 months (Halberda, 2003). Upon hearing a novel label, 15-month-old infants actually increase looking to a familiar object, rather than to an unfamiliar object. The developmental trajectory between these two ages has been taken as evidence of disjunctive syllogism, a sort of process-of-elimination computational strategy that may underlie mutual exclusivity (Halberda). By this hypothesis, younger infants consider the familiar object as referent for the novel word, but are unable to complete the disjunctive syllogism and look at the novel object.

At 18 months, monolingual infants are able to rule out the familiar item as referent for the novel word, and choose the unfamiliar object as the more likely referent.

As bilinguals have less exposure to English and lower English vocabularies than same-age monolinguals, they may be characterized as more similar to younger monolinguals. Bilinguals may simply take more processing time to complete the disjunctive syllogism than their monolingual peers. However, if bilinguals require extra time to complete the disjunctive syllogism, this could also be due to differences in their lexical structure. To eliminate the distracter as a possible referent for the novel word, bilinguals may have to access the lexical items for the distracter in both English and in their other language, and may even consider that this novel word could name the distracter in a third unknown language. More research will be required to tease apart these possibilities.

Related to reduced exposure to English is the fact that infants in the bilingual group had significant exposure to a non-English language. Although word learning strategies such as mutual exclusivity are theorized to be universal constraints, used no matter what the language being acquired, few studies have actually examined the mutual exclusivity effect in a non-English language (although for some work with Japanese preschoolers see Imai & Haryu, 2004; Sugimura & Maeda, 1997). It may be that the structures of certain languages do not promote the use of a principle such as mutual exclusivity to the same degree. For example, there are differences between languages in the importance of nouns in early lexical development. Mandarin-speaking caregivers emphasize nouns less than English-speaking caregivers (Tardif, Shatz, & Naigles, 1997). Further, unlike English-learning children, whose early vocabularies are overrepresented by nouns, the vocabularies of young Chinese learners may be more balanced between these two classes of words (Tardif, 1996; Tardif, Gelman, & Xu, 1999). If the mutual exclusivity effect is tied to noun learning, then the development of this principle could be different in languages in which the relative importance of nouns is different. Studies are needed that directly test the strength of the mutual exclusivity effect between groups of monolinguals learning different languages, and further studies are needed to examine how the interaction of these languages influences the mutual exclusivity effect in groups of bilinguals.

Another important difference between monolinguals and bilinguals, which must be accounted for, is in the relationship between mutual exclusivity and CDI scores at 18 months. For bilingual infants, those with larger English vocabularies tended to show the mutual exclusivity effect more than those with smaller English vocabularies, while this same relationship did not hold with monolingual infants. On the surface, this pattern appears to be consistent with Mervis and Bertrand's (1994) proposal for the novel name-nameless category principle (N3C). N3C describes mutual exclusivity as a lexical principle that comes online around the same time as the vocabulary spurt, when word production appears to "take-off". As some bilingual infants had small English vocabularies, they may not yet have yet reached the vocabulary spurt – perhaps only those with higher English vocabularies had developed this lexical principle. By this theory, there was no relationship between CDI scores and performance for monolingual infants because most of these infants had already undergone the vocabulary spurt and had acquired the N3C principle.

If the emergence of the mutual exclusivity effect is tied to proficiency in a particular language, then bilinguals with unequal proficiency across their two languages might show a surprising developmental pattern. One description of infants with lower English CDI scores could be as low-proficiency English users. However, given the strong link between amount of exposure to English and English CDI scores, those same infants could likely be described as high-proficiency other language users. If a high degree of proficiency in a given language is needed for an infant to apply a principle such as mutual exclusivity in that language, then the same infants who do not show the mutual exclusivity effect in an English context would be more likely to show it in the context of their other language. The somewhat surprising hypothesis that emerges from this line of reasoning is that bilingual infants might show the mutual exclusivity effect in one language- their higher proficiency language- and not in the other language. The mutual exclusivity effect might, therefore, emerge at different times in each of the bilingual's two languages, coinciding with a vocabulary spurt in each language.

Unfortunately, testing these hypotheses is beyond the scope of the current study, as the heterogeneous nature of the bilingual group prevented data collection in both of the bilinguals' languages. However, future research that accounted for both of the bilinguals' languages by collecting two sets of language proficiency measures, and by testing infants in two languages, could be extremely valuable.

5. Conclusions

The results of these experiments show that, like monolinguals, bilingual 18-month-olds are able to respond to a familiar word by looking at its referent. Monolinguals and bilinguals show the same pattern of response, although bilinguals respond somewhat slower and less robustly, either due to lower exposure to and proficiency in English, or due to the dual structure of the bilingual lexicon. Future studies that compare monolingual and bilingual infants both of the same chronological age, and of the same level of language proficiency in the language of testing may help to tease apart these two possibilities.

A second important finding is that both monolingual and bilingual 18-month-olds show the mutual exclusivity effect in response to novel words by increasing attention to an unfamiliar object. Even though bilinguals continually hear two labels for each object in their lives (one in each language) this does not prevent the development of a principle such as mutual exclusivity. However, monolinguals and bilinguals appear to differ in exactly how the mutual exclusivity effect is shown. Compared to monolinguals, bilinguals appear to take more time to consider the familiar distracter object as a possible referent for the novel word. This may be due to the groups' unequal proficiency in the language of testing (English), differences in lexical structure, or differences that stem from the influence of bilinguals' non-English language.

The differences found between monolinguals and bilinguals underscore that linguistic experience and proficiency does play a role in the early stages of the development of the mutual exclusivity effect, and that bilingualism affects even the comprehension of familiar words. The exact mechanism for these differences must still be explored. Studies that account for bilinguals' two languages, and studies that can equate for proficiency in a single language between monolingual and bilingual groups could help to extend our understanding.

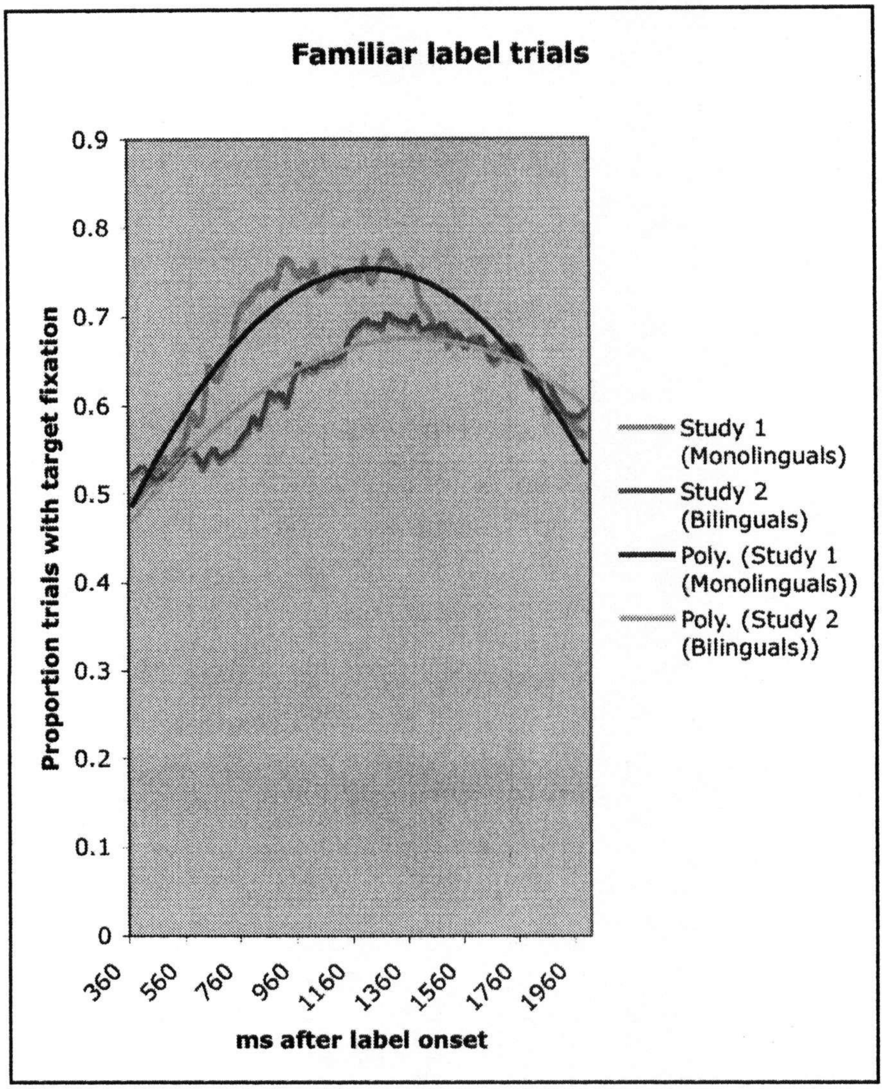

Figure 1. Time course plot and trend lines for familiar label trials

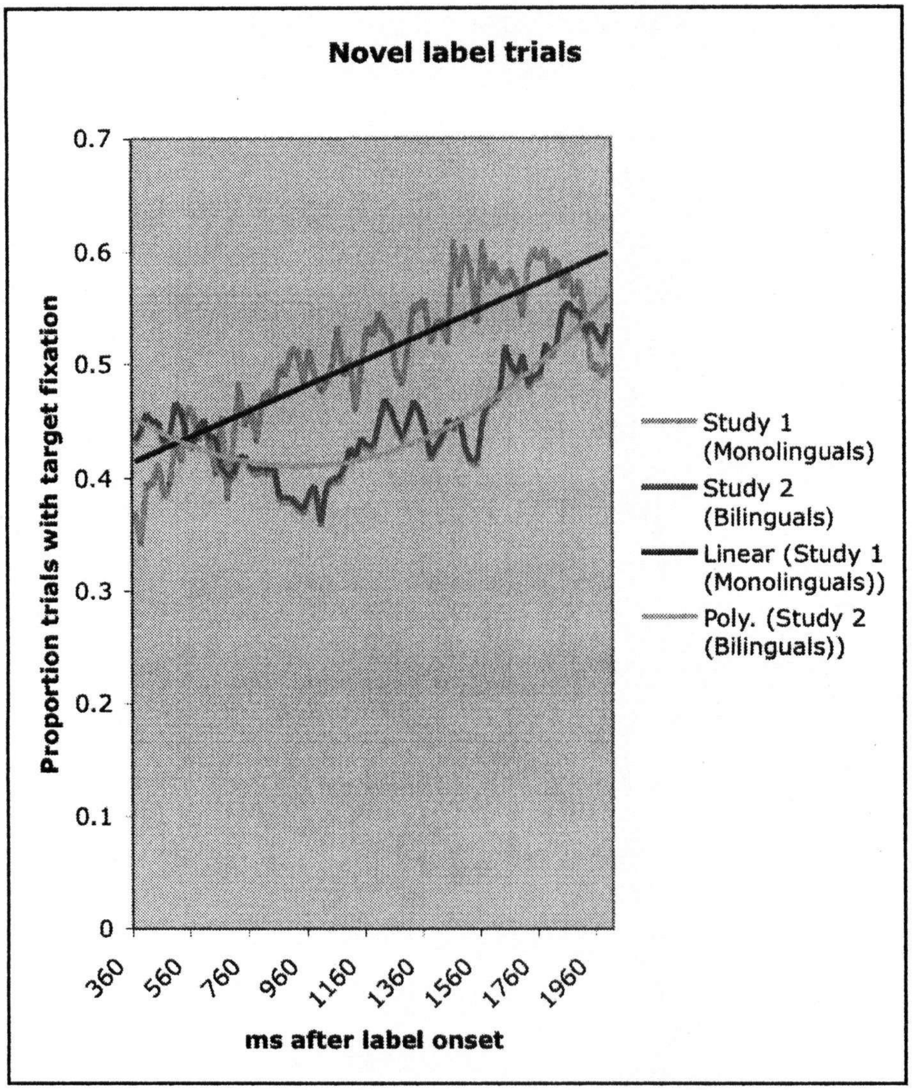

Figure 2. Time course plot and trend lines for novel label trials

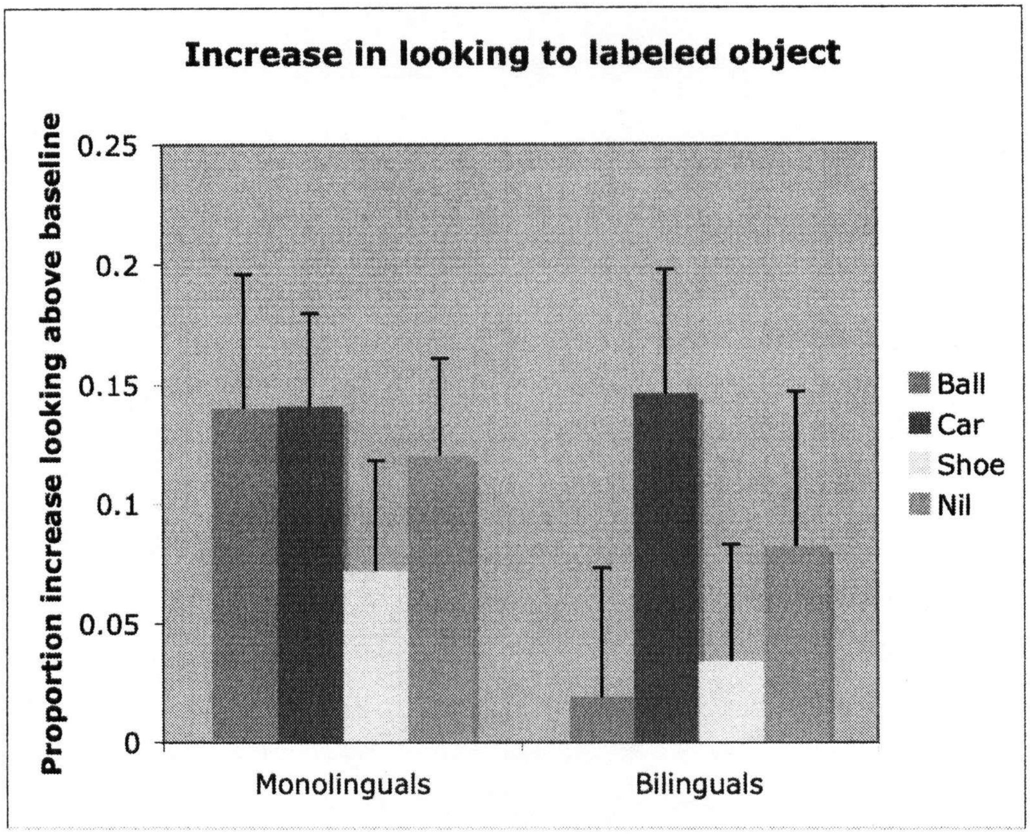

Figure 3. Difference of proportion looking to target measure between baseline and labeled time periods

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Appendix

UBC Research Ethics Board's Certificates of Approval