The Use of Grammatical and Social Cues in Early Referential Mapping

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A thesis submitted in conformity with the requirements for the degree of Masters of Arts
Graduate Department of Psychology
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Abstract

The preferential looking paradigm was used to investigate how toddlers integrate recently learned grammatical cues with well-established social cues in a novel word-learning scenario. To test this we examined children’s ability to decipher the referent of a novel noun using the grammatical information from a plural cue and social information from an eye-gaze cue. Experiment 1 is the first study showing that children as young as 24 months of age can rely on plural markings alone to infer the referent of a novel noun. Preliminary results of Experiment 2 suggest that when the plural cue is presented alongside contradicting information from a gaze direction cue, children still map the novel word to the grammatically cued object. Taken together, these results suggest that by the time children reach their second birthday, even newly learned grammatical information, such as plural markings, might already outweigh established social cues.
Acknowledgments

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1 Literature Review

1.1 Introduction

Children are extremely adept at learning words. By the second year of life, toddlers have successfully navigated through a myriad of unique and often complex word learning situations to learn an estimated 14,000 words (Carey, 1982). Despite the sophisticated nature of later word learning, early referential mapping strategies are often simplistic. For example, ten-month-olds appear to learn words by associating novel labels with the most perceptually salient objects in their environment (Pruden, Hirsh-Pasek, Golinkoff, & Hennon, 2006). However, in just over a year’s time they will learn to implement a variety of complex social and linguistic strategies to map words to their referents. Research is just beginning to explore how children transition from early associative strategies to the refined techniques that characterize later word learning. Are earlier strategies immediately overridden by newer, more informative cues or does it take time for this strategic shift to occur? This study aims to explore how children’s word learning strategies change over the course of development, specifically whether grammatical cues are dominant from the moment they are acquired, or if reliance on these cues develops over time.

Although adults can use a variety of complicated strategies to decipher the meanings of words (e.g., Ramscar, Klein, Dye, Aguirre, & Ruiz, 2011), it takes time for children to acquire all the referential mapping tools that adults have readily at their disposal. Throughout the course of childhood, referential mapping strategies develop in a dynamic fashion. It has been argued that the stark contrast between the slow learning of 12- to 18-month-olds and the fast mapping abilities of 24-month-olds is likely indicative of a fundamental change in the way children are acquiring words (Hirsh-Pasek & Golinkoff, 2008). Although a range of cues are always available to the child, there is thought to be a shift in the weighting of word-learning strategies from...
simple attentional cues in infancy to social and linguistic information in childhood. This shift in strategies has been formalized by one group of researchers in the Emergentist Coalition Model (ECM; Hollich, Hirsh-Pasek & Golinkoff, 2000). The model conceptualizes that in Phase I children rely on attentional cues like perceptual salience and temporal contiguity, whereas in Phase II they rely more on social and linguistic cues (See Figure 1). While research supports the notion that different strategies are dominant at different times, it is still unclear how the child transitions from one phase to another. Furthermore, the ECM focuses almost exclusively on the major shift between attentional and social/linguistic word learning strategies. There is, however, evidence to support the notion that smaller shifts occurring within the phases also have an impact on the way children are learning words.

Figure 1. Emergentist Coalition Model. Adapted from “King solomon's take on word learning: An integrative account from the radical middle.” by Hirsh-Pasek, and R.M. Golinkoff, 2008, In Robert V. Kail (Ed.), Advances in child development and behavior p. 6. Copyright 2008 Elsevier B.V.

1.2 Phase I: Early Referential Mapping Strategies

Early vocabularies of English-learning toddlers have been argued to contain predominately
concrete nouns (Gentner, 1982; see, however, Bloom, Tinker, & Margulis, 1993). Children’s first words are often frequently occurring labels for the objects that are present in their environment (e.g., bottle, baby, mama; Bloom, 2001). This is presumably because most early referential strategies are based on the temporal contiguity between a label and an object. For example, there is evidence that children will map a novel utterance to the most perceptually salient object in the environment (Pruden et al., 2006). It also appears that they are able to use the temporal synchrony between gesture and speech to learn words (Jesse & Johnson, 2008; Gogate, Bahrick, & Watson, 2000). For example, children as young as 7 months of age are able to develop relationships between vowel sounds and objects through the intersensory redundancy between the sound and the object’s motion (Gogate & Bahrick, 1998). However, reliance on these early cues, such as simple motion, has been shown to decrease as the child ages (Gogate, Walker-Andrews, & Bahrick, 2001).

1.3 Phase II: Later Referential Mapping Strategies

1.3.1 The Emergence of Social Cues

Between 10 and 19 months of age there is a shift in strategies as children begin to learn to ignore low-level perceptual cues in favor of other more sophisticated cues (Hirsh-Pasek & Golinkoff, 2008). Up until this age, when presented with conflicting perceptual and eye-gaze cues infants will attach the label to the most perpetually salient object. However, between 9 and 12 months of age infants become increasingly more attuned to the social information in their environment as they begin to appreciate the referential nature of eye gaze and point cues (Baldwin, 1993; Brooks & Meltzoff, 2005). It seems that at 12 months of age, this increase in social awareness actually inhibits word mapping when perceptual and eye gaze cues conflict. It is not until 19 months of
age that children are able to ignore perceptual cues and attach the label to the socially cued object (Hollich, et al., 2000).

There is considerable evidence that once children have reached this stage, their reliance on social cues is so strong that in some instances their absence prevents the establishment of a word-object relation. For example, when 18- to 20-month-olds were taught a novel word by a speaker displaying concurrent attention to the novel toy, they willingly mapped the label onto the object. However, when the label came from a speaker that was out of sight they were less likely to acquire the novel name (Baldwin, Markham, Bill, Desjardins, Irwin, & Tidball, 1996).

If gaze following can help children to map words onto their referents, it is plausible that a greater awareness of this social cue early in infancy might lead to superior word learning abilities in childhood. Experimental evidence has shown that this does appear to be the case. 10-to 11-month-olds who were able to follow the gaze of others tended to have accelerated vocabulary growth through to their second birthday. Furthermore, the length of time the infant fixated on the gaze-directed object was positively correlated with productive vocabulary size at 2 years of age (Brooks & Meltzoff, 2008). Thus, the ability to follow the eye gaze of others is thought to predict later linguistic competence, supporting the notion that the shift from an earlier reliance on perceptual cues to a later reliance on social cues represents an important step towards developing adult-like language skills.

1.3.2 Transition to Grammatical Cues

Grammatical proficiency has also been thought to be related to word learning ability. For example, it has been shown that greater lexical and grammatical competence at 12-25 months is correlated with accelerated spoken word recognition at 2 years of age (Marchman & Fernald, 2008). It seems logical that a thorough understanding of grammar may help children to learn
words faster, as grammatical information can be a valuable cue to decipher word referents.

Later referential strategies often take into account the linguistic context in which the word is said. There is evidence to suggest that older children are able to use grammatical cues to work out the meanings of novel words. For example, 25-month-olds can decipher the meaning of a novel verb based on the surrounding sentence structure (e.g., Goksun, Kuntay, & Naigles, 2008; Naigles, 1990; Naigles, Bavin, & Smith, 2005). Moreover, toddlers are still able to perform this task when the grammatical context is heard one day prior to viewing the referent action, indicating that syntax can even shape the future search for a verb referent (Yuan & Fisher, 2009; Arunachalam & Waxman, 2010). There is also evidence that 36-month-olds are able to use syntax cues to resolve the ambiguity between a novel verb and two plausible novel actions based on whether the sentence frame indicates that the action was done “to” or came “from” the other person (Fisher, Hall, Rakovitz, & Gleitman, 1994). Due to the prevailing notion that verb referents are often more difficult to decipher than nouns, many of these studies focus almost exclusively on the application of grammatical cues to learn verbs. However, in many cases the process of determining the referent of a novel noun can also be remarkably complex.

There are many situations in which grammatical information can be a valuable tool to decipher noun referents. For example, when presented with images of a single novel object and a pair of novel objects, 30-month-olds could use plural ‘-s’ inflection to map a novel noun to the correct object. If they heard the passage “JeelS! Look at the jeelS!” they mapped the word “jeelS” to the object that there were two of. Conversely, if they heard the word “jeel”, without the plural inflection, they mapped the word to the singular object (Jolly & Plunkett, 2008). Twenty-four month olds tested using the exact same paradigm failed to show any evidence of being able to use the plural cue to work out the meaning of a novel word. This suggests that the
ability to rely on the grammatical plural cue develops somewhere between 24 and 30 months of age. However, this result is somewhat surprising, given evidence that children can both perceive (Kouider, Halberda, Wood, & Carey, 2006) and produce (Barner, Thalwitz, Wood, Yang, & Carey, 2007) the plural ‘-s’ inflection far earlier in development. Note, however, that in Jolly and Plunkett’s study, the plural inflection is the only cue given to decipher the noun referent. Perhaps if both the noun and verb had been marked with plural information, the younger group of children may have performed better. Furthermore, the images used in Jolly and Plunkett’s study were 2-dimensional black-and-white drawings that were not very distinct from one another. It may have been the case that the younger children had difficulty recalling and distinguishing the images in this study. Finally, Jolly & Plunkett’s (2008) task may have also been unnecessarily demanding, as it required the children to learn two novel word referents at the same time. As a result, it may be the case that 24-month-olds in this study were unsuccessful due to the cognitive demands of the task and if given a simplified task, their true abilities may be more apparent.

1.3.3 Paralinguistic Cues

There is also evidence that children in the second phase of the ECM can use the paralinguistic contextual cues, such as vocal affect and disfluencies, to help them identify and learn new words. These cues may be some of the last to be acquired, as they require a rather complex understanding of how the quality of the speech signal is affected by the cognitive/emotional state of the speaker. Studies have shown that 30-month-olds can use disfluencies in speech to rationalize whether the speaker is labeling something that is “known” or common, as opposed to something novel. Utterances marked by an “ummm” or “ahh” tend label something new. Upon hearing these disfluencies children will shift their gaze to the novel object in anticipation of the label (Kidd, White, & Aslin, 2011). Furthermore, there is research suggesting that 4- and 5-year-olds are able to use the emotional tone of a speaker’s voice to determine the referent of an
utterance. When a toy is referred to in a “sad” vocal affect, children show evidence of understanding that the speaker is referring to a broken exemplar of a novel category, as opposed to an intact exemplar (Callaway, Berman, Chambers, & Graham, 2010).

### 1.4 Shifts in Cue Weighting Strategies

Although we know a lot about the types of cues child use to learn words, we know very little about how children weight these cues at various points in their development. A great deal of support has been provided for the notion that there is a major shift from associationist to referential world learning strategies at around the time of the vocabulary spurt (Hirsh-Pasek & Golinkoff, 2008; Nazzi & Bertoncini, 2003). Even though the ECM focuses almost exclusively on this transition from attentional cues in phase I to social/linguistic cues in phase II, earlier drafts of the model actually suggest that there is a second shift from social to sentence-level linguistic strategies (Hollich et al., 1998). Although there is some overlap, it has been well documented that social cues typically come online before linguistic cues. For example, social cues such as eye gaze are relatively well established by 19 months of age (Hollich et al., 2000), whereas the earliest grammatical cues are not available until close to two years of age (Naigles, 1990). Furthermore, empirical data support the notion that linguistic cues eventually take precedence over social information. For example, studies have indicated that when gaze cues conflict with the assumption that objects usually have only one mutually exclusive label, 24-month olds tend to rely on the mutual exclusivity assumption (Graham, Nilsen, Collins, & Olineck, 2010). Furthermore, when 3- to 9-year-olds were presented with conflicting speakers gaze and syntactical information they relied heavily on the syntax cues in order to determine the referent action of a newly labeled verb (Nappa, Wessel, McEldoon, Gleitman, & Trueswell, 2009). In this study children were presented with an ambiguous scene of an elephant and a rabbit
that could be interpreted as ‘chasing or fleeing’ accompanied by a speaker who gazed at one animal while saying “the rabbit is mooping the elephant” or “the elephant is mooping the rabbit”. Although there was evidence that children actively followed the speaker’s gaze, when the grammatical and social cues conflicted children decided whether ‘mooping’ meant ‘to chase’ or ‘to flee’ based on the position of the subject in the sentence. Thus indicating that they are relying on grammatical information to decipher the verb referent (Nappa et al., 2009).

Although there is evidence that when presented with conflicting cues children eventually shift from relying on social cues to linguistic cues, it is not fully understood whether this shift occurs immediately after linguistic cues are learned or whether this shift in cue weighting strategies occurs over time. Even though there is evidence that 3-to 9-year-olds rely on grammatical cues over social information, to decipher a verb referent, it is not known whether children would react similarly when learning nouns. Furthermore, it is quite plausible that they have had the grammatical cue in their repertory for a long time and that this heavy reliance on grammar develops through experience. It has yet to be determined whether cues (like grammar) are dominant from the moment they are acquired or whether it takes time for a cue to be seen as a reliable strategy.

1.5 The Current Study

In this project, we propose to examine whether toddlers rely on information from a recently learned grammatical cue over that of a well-established social cue in a controlled word-learning scenario. We aim to explore whether grammatical cues are dominant soon after they are acquired or whether this dominance develops over time. In order to do so, we must first establish that young 24-month olds can successfully use this information to infer the referent of a novel noun. Thus Experiment 1 will use the Preferential Looking Paradigm to test whether 24-month-olds
can use plural markings to infer the intended referent of a novel word form. Experiment 2 will present this age group with the plural clue along side contradicting information from a gaze direction cue to investigate whether children rely on newly learned grammatical cues over well-established social cues. Thus this line of research will begin to explore how social and grammatical word-learning strategies develop over time, and whether newly learned grammatical cues initially take precedence over social cues in early childhood.

2 Experiment 1

2.1 Introduction

Recent evidence has shown that 30-month-olds but not 24-month-olds can use plural inflection “-s” to decipher a word referent (Jolly & Plunkett, 2008). However casual speech often contains multiple markers of plurality. It is suspected that young children will use plural information more readily if these additional cues are presented. This experiment was designed to examine the possibility that if given plural markings on the noun, demonstrative determiner and verb form (e.g., “THESE ARE nice blicketS”) 24-month-olds are in fact able to use these grammatical cues. Although there is some variability in children’s plural productions, parental reports indicate that by 22 to 24 months of age English learning children are producing the plural marking (Barner et al., 2007). Moreover, the production of the ‘numeral + bare stems noun’ structure is thought to emerge at an even younger age than the conventional plural ‘-s’ ending (Clark & Nikitina, 2009). Although there are noticeable differences between perception and production data, it is likely the case that children understand even more than they can say. In the perceptual domain, there is evidence that 24-month olds understand the grammatical singular-plural distinction when it is represented by both noun and verb morphology (i.e. “There ARE some blicketS”; Kouider et al., 2006). Both perception and production studies seem to suggest that an
understanding of the plural grammatical structure emerges around the second year of life. Thus it would be logical to predict that if they were presented with redundant plural information in the demonstrative determiner and verb morphology 24-month-olds will be able to use this cue to infer the referent of a novel noun.

To test this, each child was trained on four novel words using a variant of the Preferential Looking Paradigm (Hollich et al., 2000). In this paradigm two images of novel objects were simultaneously presented on a television screen accompanied by an auditory passage labeling one of the objects. The only cue that was given to help them determine the correct referent object in the training phase were the grammatical plural/singular markings in the auditory passage. The referent of the novel label was completely ambiguous except for the grammatical cues in demonstrative determiner, verb form and ‘–s’ inflection. Each training phase was followed by two test trials that tested their memory of the newly learned word/object parings. If children are able to use plural information to decipher the novel referent (in training) then they should look towards the correct object when it is labeled in the test phase.

2.2 Method

2.2.1 Participants

Sixteen 23- to 25.5-month-old toddlers (\(M_{\text{age}} = 739\) days; range = 688 – 767 days, 5 females) from the Greater Toronto Area were tested. According to parental reports, all participants received at least 90% English language input and had no ear infections in the two weeks prior to participating in the study. Three participants were excluded from the study prior to data coding due to extreme fussiness. A fourth participant was excluded because his/her proportion of looks to target was greater than three standard deviations away from the mean. Two additional children were excluded because Vocabulary development on the MacArthur-Bates CDI was below the
15th percentile for their age range and they failed to speak at all during their time at the lab, which is unusual for this age.

2.2.2 Stimuli

The visual stimuli consisted of two static images presented side by side on a white background for the duration of each trial. The images were approximately matched for size and interest. The visual stimuli were accompanied by auditory passages labeling one of the objects. The warm up trials and familiarization stimuli were recorded in a variety of singular and plural sentence frames (i.e., “Where IS the ___?”, “Can you see A ___?”，“THESE ARE nice ___S.”, “Can you find the ___S’”). The test trial the target words (blicket/s, miggy/ies, toma/s, zurpel/s) were recorded in the frames “Look at the __. Do you like IT?” and “Look at the ___S. Do you like THEM?” All auditory stimuli were produced in an infant-directed manner by a female native English speaker. The audio and visual stimuli were combined to create four 3.5 min videos.

2.2.3 Design

Participants were randomly assigned to one of four videos. All the videos trained and tested children on the same four novel words, however, the object that was given the target label and the object that was used as the distractor, along with the order of presentation of the trials was counterbalanced across participants. In each video, the target image appeared an equal amount of times on the left and right sides of the screen.

2.2.1 Procedure

During the experiment the child was seated on their parents lap in the center of a 6 ft x 6 ft double walled sound-attenuating IAC booth. The parents were asked to wear closed headphones and listen to masking music to prevent them from biasing their child’s responses. Masking music consisted of loud music mixed with the speech recordings used in the study, as has been shown
to most effectively prevent parental bias in these types of studies (Pinto, Fernald, McRoberts & Cole, 1998) The videos were presented on a Sony LDC television located one meter away from the child. The children were videotaped by a camera situated below the screen for offline coding following the completion of the study.

Each child watched a video comprised of four blocks. Each block began with two warm-up trials followed by two training trials and two test trials (for a sample layout of trials see Figure 2). In order to simplify the cognitive demands of the task only one novel word was taught and tested per block. A 2 s flashing white star on a black background was presented before each trial to attract the toddler’s attention to the centre of the television. The 6 s warm-up trials labeled known objects (i.e.: ball, car, apple, cookie) in order to attract their attention and familiarize the participants with the design of the experiment. The warm-up trials presented one familiar object alongside a pair of another familiar object. The images were accompanied by an auditory passage labeling the target object/objects in its plural or singular form (i.e.: “Where are the carS?” , “Look at the car”). Following labeling the correct target was denoted by a jiggle.

After the warm up trials there was a pair of 8 s training trials, in which the child was taught one of the four novel words. In one of the trials, a picture of a single target object was presented alongside a picture of two of distractor objects and the object was labeled twice in its singular form (i.e. “Where IS the blicket_?” , “Can you see A blicket_?”). In the other trial, a pair of target objects was presented alongside a single distractor object, and the plural form of the target word was given (i.e. “THESE ARE nice blicketS.” Can you find the blicketS?”). Throughout the course of the training trials the referent object was labeled twice in the singular form and twice in the plural form. The only cues to decipher the target word referent were the singular and plural markings in the training passages. In the passages the plural/singular forms
were marked in the “–s” noun inflection but also in the auxiliary sentence frame and verb morphology. There is evidence that 24-months-olds are unsuccessful if the plural is indicated using the “–s” inflection alone (Jolly & Plunkett, 2008). Here the plural cue was indicated by the plural inflection as well as by the determiner and verb form used in the sentence frame. Thus we were not looking exclusively at the plural inflection as a cue but at the understanding and application of plural grammatical cues (demonstrative determiners, verbs and infections) in general. Furthermore, we trained and tested one novel object at a time (instead of two) to reduce the cognitive demands of the task.

In the test phase, the children were tested on whether they successfully utilized the grammatical cues to determine which object was being referred to. Since we suspect that multiple objects might be perceptually more interesting than an image of one object, all the objects in the test trials were matched in number (i.e.: one of the target and one distractor, or two of the target and two of the distractor). There were two 6 s test trials for each object. One tested the singular form “Look at the blicket. Do you like it?” accompanied by an image of one blicket and one distractor object. The other trial tested the plural form “Look at the blickets. Do you like THEM?” accompanied by an image of a pair of ‘blickets’ and a pair of distractor objects. In each test trials, the target word onset occurred 3 s after the images appeared on the screen. The test items did not carry any cues as to the identity of the objects. Thus, if the child was unable to use the grammatical cues to infer the target object, no differences should be seem between the looking times to the target and distractor objects.

After the experiment parents were asked to complete the MacArthur-Bates Communicative Developmental inventory: Words and Sentences form to assess their vocabulary development (Fenson, Dale, Reznick, Bates, Thal & Pethick, 1994).
<table>
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<th>Audio</th>
<th>Right Screen</th>
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<td><img src="image2.png" alt="Image" /></td>
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<td></td>
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<td>Training</td>
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<td>2</td>
<td><img src="image6.png" alt="Image" /></td>
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<td></td>
</tr>
<tr>
<td>Test</td>
<td></td>
<td>&quot;Look at the blicket. Do you like IT?&quot;</td>
<td></td>
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<tr>
<td>2</td>
<td><img src="image9.png" alt="Image" /></td>
<td>&quot;Look at the blickets? Do you like THEM?&quot;</td>
<td></td>
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</tbody>
</table>

*Figure 2.* Sample block of trials from Experiment 1. One block consisted of a pair of warm up trials followed by a pair of training and test trials. The duration of each of the training trials was 8s and the test trials were 6s, with the onset of the target word occurring 2s into each test trial.

### 2.2.4 Coding

The video recordings of the toddlers’ eye movements were hand-coded offline. Videos were coded with the audio track disabled and the onset and offset of each trial was marked by subtle lighting changes produced by the white star animation positioned before each trial in the videos watched by the children. Each 33 ms frame was coded as a look to the left image, right image or neither. Two of the films were chosen to be re-coded by a second coder and correlations were high (mean $r = .97$, $SD = .04$).
2.3 Results and Discussion

We examined the proportion of fixations to the target objects in the test trials in the 1 s time window immediately following target word onset. We chose a short 1 s window of analysis because at this age looks are most strongly influenced by verbal labels in the time immediately following word onset. (e.g., Fernald, Pinto, Swingley, Weinberg, & McRoberts, 1998; Johnson, McQueen & Huettig, 2011, Swingley & Fernald, 2002). We computed the ratio between the proportion of fixations to the target and the sum of the target- and distractor-fixations for each test trial (see Huettig & McQueen, 2007; Johnson & Huettig, 2011). We then took the average proportion across all the test trials for each participant and compared the mean proportion of looks to chance (.5). Chance performance predicts equal looking time to the target and distractor. There was no significant effect of test trial type, children performed equally well when the target and distractors were presented in their singular ($M = .52$, $SD = .15$) or plural forms ($M = .61$, $SD = .17$), $t(15) = 1.54$, $p = .14$, thus for the analysis both types of test trials were collapsed. In the 1 s window in all the test trials, a two-tailed one-sample t-test indicated that the target object was fixated more than the distractor, mean ratio of .56; $t(15) = 2.697$, $p = .017$, $d = .67$, suggesting that 24-month-olds were able to map the target word to its referent based on the grammatical cues presented in the training trials. Furthermore, they were able to retain this information as they showed a greater proportion of fixations towards the target object after it was cued in the test trials. However, this effect is only intermediate in strength, which may be due to the fact that it is a newly learned cue. It is also possible that some of the children in the sample may be able to use the grammatical information where as others cannot. This prompted us to examine whether there was a relationship between age and ability to use the grammatical cue.
Interestingly, the tendency to look at the target during the 1 s window after target word onset correlates with age, with the slightly older children looking longer than their younger counterparts, $r(15) = .605, p = .013$ (see Figure 3). This suggests that the plural cue is newly learned and that it maybe acquired between 23 and 25 months of age.

![Figure 3](image.png)

**Figure 3.** Mean Proportion of Looks to Grammatical target in Experiment 1 as a function of age in days. The line represents linear relationship between age and the proportion of looks to the target in the 1s window of analysis, $r(15) = .605, p = .013$.

3 Experiment 2

3.1 Introduction

In Experiment 1 we established that 2-year-olds can use plural information to work out the intended meaning of novel words. The main goal of Experiment 2 was to examine whether children will rely on newly learned grammatical cues when potentially conflicting information is available. Given that the results of Experiment 1 suggest that the plural cue is just being learned at this age, it is an excellent opportunity to explore whether grammatical cues are dominant soon after they are learned. Previous research has suggested that when grammatical and social cues
conflict 3-to 9-year-olds rely heavily on the grammatical information (Nappa et al., 2009). It is plausible that reliance on cues changes over the course of development and it may take time for grammatical cues to become dominant over other less informative cues. Perhaps, older children rely on grammatical cues, but younger children may rely on a well-established social cue rather than a newly learned grammatical cue. However, it is also possible that, like social cues, once learned they are relied on quite heavily. For example, social cues are so robust that when they are first acquired, their absence in some situations can actually inhibit word learning (Baldwin et al., 1996). To test this we compared their reliance on a newly learned grammatical cue to that of a well-established social cue by providing the child with conflicting eye gaze and plural information. This experiment employed a similar methodology to Experiment 1, with the addition of an on screen woman who labels target object in the training trials (using the same plural marked sentence frames as in Experiment 1) while turning her head to look at one of the images. In addition, unlike Experiment 1, there was no training phase with known objects, as this may alter the children’s perceived reliability of the speaker.

In this study, children were assigned to one of two groups, one group was presented with convergent cues trials first (in which the eye gaze cues and the plural marking cues will refer to the same object), followed by a series of divergent trials in which the eye gaze cue and plural cues indicated different objects (Con-Div group). The other half of the participants experienced the divergent trials before the convergent trials (Div-Con Group). This experiment was designed to determine which cue is followed when the cues conflict, or if cue collision inhibits mapping altogether. Furthermore, differences between groups due to the order of presentation should shed light on whether children have stereotyped automatic strategies for cue weighting, or whether they can be flexible in their use of cues depending on the perceived reliability of the speaker.
3.2 Method

3.2.1 Participants

Twelve 23.5- to 25.5-month-old toddlers (M_{age} = 745 days; range = 715 – 768 days, 7 females) from the Greater Toronto Area were tested. According to parental report all participants received at least 90% English language input and had no ear infections in the two weeks prior to participating in the study. Four participants were excluded from the study prior to coding due to extreme fussiness. Two additional children were excluded because vocabulary development on the MacArthur-Bases CDI was below the 15th percentile for their age range and they were not speaking during their time in the lab.

3.2.2 Stimuli

The target images were the same as those used in Experiment 1. In the training phase, participants saw a video of a colorfully dressed speaker in the centre of the screen facing forward, with the novel objects used in Experiment 1 to her left and right. The recordings were made by the same female native speaker in Experiment 1 and the same sentence frames and objects labels were used. While saying the target phrase, the speaker turned her head 90 degrees and looked at images on her left or right side. Her head turn was approximately timed with the onset of the first plural cue in the auditory passage. The audio and visual stimuli were combined to make four 3.5 min videos.

3.2.3 Design

Participants were randomly assigned to watch one of four counterbalanced versions of the video. As mentioned above, to control for any possible ordering effects, half the videos presented the convergent blocks first, whereas the other half presented the divergent blocks first. Further, as in
Experiment 1, the order of presentation of the trials as well as which object was the target and which was the distractor was counterbalanced across participants.

3.2.4 Procedure

The basic testing procedure was the same as in Experiment 1. In each video there were four blocks and in each block the child was trained and tested on one new word. A block consisted of two 16 s training trials (in which the target object was labeled twice) followed by two 6 s test trials. In the training trials a picture of an object in its singular form and a picture of a pair of objects were presented on screen. Two seconds into the trial the female speaker appeared. During each trial she said the target phrase while turning her head to look at the object or pair of objects on her left or right side. In this study the only cues given to decipher the target word referent were the speaker’s eye gaze and the singular/plural grammatical markings in the auditory passage. In the convergent familiarization phase the auditory passages and objects were the same as in Experiment 1, except the person on screen looked towards the correct object or set of objects during each trial. In the divergent training trials, the eye gaze and grammatical cues conflict. The person’s gaze would lead the child to map the utterance to one object where as the grammatical cues in the auditory passage would lead them to the other (See Figure 2). As in Experiment 1, the test trials consisted of two objects presented on screen accompanied by a passage cueing the target word.

After the experiment parents were asked to complete the MacArthur-Bates Communicative Developmental Inventory: Words and Sentences form (Fenson et al., 1994) to assess their vocabulary development.
<table>
<thead>
<tr>
<th>Convergent Training Trial</th>
<th>Convergent Test Trial</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Convergent Training Trial Image" /></td>
<td><img src="image2" alt="Convergent Test Trial Image" /></td>
</tr>
<tr>
<td>“THESE ARE nice blickets. Can you find the blickets?”</td>
<td>“Can you find the blicket? Do you like it?”</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Divergent Training Trial</th>
<th>Divergent Test Trial</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image3" alt="Divergent Training Trial Image" /></td>
<td><img src="image4" alt="Divergent Test Trial Image" /></td>
</tr>
<tr>
<td>“THESE ARE nice zurpels. Can you find the zurpels?”</td>
<td>“Can you find the zurpel? Do you like it?”</td>
</tr>
</tbody>
</table>

*Figure 4.* Sample of convergent and divergent training and test trials from Experiment 2. Note that in the divergent training trial the social and grammatical cues lead to different objects, whereas in the convergent trials the grammatical and social cues lead to the same referent.

### 3.2.5 Coding

Identical to Experiment 1.

### 3.3 Results and Discussion

Previous research suggests that when older children receive conflicting grammatical and social information they tend to follow the grammatical cue. Thus, for this analysis we looked at the proportion of fixations to the grammatically cued object in the test trials. Similar to Experiment
1, we computed the mean proportion of fixations to the grammatical object in the 1 s window after target word onset and compared it to chance (.5). The results of a two-tailed one-sample t-test indicated that the grammatically cued object was fixated more than the socially cued object in the 1 s window, mean ratio of .60; \( t(11) = 2.267, p = .045 \). Thus it appears that similar to Experiment 1, children are following the grammatical cues to decipher the word referent.

However, it is possible that this effect could be driven by the convergent trials in which both cues point to the same object, rather than the divergent trials in which cues conflicted. It is also possible that children participating in the convergent blocks before the divergent blocks (Con-Div group) may be reacting differently than those that received the divergent before convergent (Div-Con group). Thus we conducted a two-factor mixed design ANOVA to investigate the effects of order (between subjects) on the mean proportion of looks to grammatical target in each trial type (within subjects). The ANOVA showed no significant main effect of trial type, \( F(1,10) = .448, p = .518 \), and no interaction between trial type and order, \( F(1,10) = .090, p = .771 \), indicating that children are not performing differently when cues converged compared to when they diverged. This suggests that the grammatical cue was truly overpowering the social cue. There was however a significant main effect of order, \( F(1,10) = 10.69, p = .008 \), indicating that the Div-Con group is reacting differently than the Con-Div group. This prompted us to examine these two groups separately.

Follow-up t-tests indicated that the Con-Div group showed no preference for the grammatically cued object in the 1 s window, mean ratio .50; \( t(5) = .009, p = .993 \). However the Div-Con group demonstrated a strong preference for the grammatically cued object, mean ratio of .70; \( t(5) = 7.238, p = .001 \). mean 67; \( t(5) = 3.02, p = .030 \). Therefore it appears that the overall preference for the grammatically cued object was entirely driven by the Div-Con group. The
Con-Div group, in contrast, demonstrated no evidence of learning in the test phase. Although we did not predict this order effect, there are at least two good explanations for this pattern of results. Due to the very small sample size there may be sampling errors resulting in unequal performance across the groups. The children assigned to the Con-Div group may have, by chance, been children who were not yet able to use the plural cue. Alternatively, there could be a genuine effect of the order of presentation of trials that caused children to perform differently in the Con-Div and Div-Con conditions. Children may be reacting differently to the speaker depending on whether she was reliable in the first two block or became reliable in the last two blocks.

The small sample size makes it possible that the groups may not have been fully equal in all aspects. However, both groups were closely matched in age ($M_{\text{Div-Con}} = 744.6$ days, $M_{\text{Con-Div}} = 744.8$ days). The Div-Con group had slightly higher the vocabulary scores on the Mac-Arthur Bates CDI (Mean number of words spoken = 321) compared to the Con-Div group (mean number of words = 305), but given the absence of a correlation between vocabulary and performance, $r(11) = .088$, $p = .786$, it is unlikely that the slight differences in vocabulary are driving the differences between groups.

Although the groups were approximately matched in age and vocabulary size, there appeared to be marked differences in attention between the two groups. In order to measure attention we looked at the proportion of on-screen looks in the 1s window after target word onset. This was computed by dividing the sum of looks towards the target and distractor by the total duration of the window. In the 1 s window, children in the Con-Div condition spent significantly less time looking at the screen ($M = .55$, $SD = .13$) than those in the Div-Con condition ($M = .87$, $SD = .09$), $t(10) = -2.77$, $p = .02$. The differences in attention between these
two groups could reasonably be attributed to sampling error, especially given the small sample size. However it is also possible that the Con-Div group may be disinterested by the simple convergent trials, especially due to the repetitive cueing of the same object and confused by the divergent trials in which the speaker suddenly becomes unreliable. Although it is impossible to draw any firm conclusions based on this small sample, these preliminary results at least suggest that 24-month-olds are relying on the newly acquired plural cue even when provided with conflicting information from a well-established social cue.

Figure 5. Mean proportion of looks to the grammatically cued object in Experiment 2. In the 1 s window of analysis, the Con-Div group showed no preference for the grammatical over the socially cued test object in the convergent, mean ratio .49, t(5) = -.092, p = .930, or divergent test trials, mean ratio .46; t(5) = -.428, p = .69. The Div-Con group fixated significantly the grammatically cued object in the divergent test trials, mean ratio of .67; t(5) = 3.017, p = .030, and significantly longer to the target object in the convergent test trials, mean ratio of .76; t(5) = 4.40, p = .007. Error bars represent the standard error of the mean.

*p<.05,  **p<.01, two-tailed
4 General Discussion

Experiment 1 is the first study to demonstrate that children as young as 24 months of age are able to use grammatical information to decipher a novel noun referent. Furthermore, there seems to be a correlation between age and success rate, with the slightly older children fixating more on the grammatically cued target in the test trials than their younger counterparts. This can be taken as evidence that this cue likely comes on line sometime between 23- and 25-months. This result differs from the findings of Jolly and Plunkett (2008), who reported that 24-month-olds were unable to use the plural inflection to learn words. The discrepancy between these two studies could be due to the fact that the mean age in our sample was slightly older (closer to 24.5 months of age). It could also be that they used a less powerful measure of word learning. In their analysis they compared the 3 s window before the target label to the 3 s window after. The fixations occurring during a large 3 s window may be less driven by the word label than those occurring immediately after the target word. In contrast we used a shorter 1 s window which has been used in many other studies examining words recognition in young children (e.g., Swingley & Aslin, 2000; Johnson, McQueen & Heuttig 2011, Johnson & Huettig, 2011).

Differences in the performance of 24-month olds could also be attributed to differences in the way the novel words were taught and tested. Jolly and Plunkett (2008) marked the singular/plural distinction using the plural ‘-s’ inflection alone, whereas our study provided children with additional plural cues in the verb tense (is/are) and demonstrative determiner (this/these). These additional markings may have allowed 24-month-olds to be successful at this task. This finding is consistent with previous research suggesting that younger children will only look at the correct novel object or pair of objects if the plural form is marked on both the noun and verb at this age (Kouider et al., 2006). Simply giving the plural ‘-s’ inflection may not be enough information to
prompt 24-month-olds to fixate on the plural object. Also, instead of training and testing two words simultaneously, we trained and tested one word at a time. It could also be that this simplified designed was less cognitively demanding which allowed this younger group to successfully map these words to their referents.

Thus it seems that 2-year-olds can use plural information to learn words. Although more children need to be tested to draw any firm conclusions, the preliminary results of Experiment 2 at least suggest that reliance on grammatical cues is quite robust once it emerges. Assuming this pattern of results holds up once additional data has been collected, it seems quite remarkable that even though the plural cue is recently learned and the social cue we presented was arguably stronger those used in other studies, children still mapped the novel noun to the grammatically cued object. Similar results have been seen in cue collision studies that presented weak social cues in the form of static eye-gaze images or had the target phrase and social cue delivered by a different person (Houston-Price, Plunkett, & Duffy, 2006). However, it is possible that the weak manipulation of social cues in these studies may not be reflective of the cues encountered in the real world, thus making it easier for the child to ignore the social information. In contrast, our experiment had a colorful, videotaped person delivered both cues in an infant-directed manner. However, even though the social cue was very salient, similar to the findings of cue weighting studies with older children, the 24-month olds followed the grammatical cues (Nappa et al., 2009).

Furthermore, the social cue in this experiment was made even stronger by the fact that in some divergent trials it may not have been completely irreconcilable with the grammatical information. In the singular divergent training trials, when the speaker looks at the plural image and says, “...This is a nice bicket!...”, the child could have rationalized that the speaker might
be referring to one of the two objects in the pair, and thus map the label to the socially cued object, but this does not seem to be the case. Even though in some divergent trials the social cue could be seen as partially correct, the novel word referent was still strongly influenced by grammatical information. Thus despite a strong social manipulation, the grammatical cues still tended to dominate the referential mapping process.

The surprisingly strong reliance on the newly learned plural cue prompts a more thorough examination of the potential reasons why grammatical strategies are dominant. There are two possible theoretical explanations for this finding. One explanation posits that once cues are learned they are weighted in a hierarchical fashion. Thus children are automatically relying on grammatical cues over other sources of information. This automatic weighting could be a product of the developmental stage the child is in, or it could be that grammatical cues are generally more reliable thus they are weighted higher, or some amalgamation of the two. The alternative explanation is that children are generally flexible in their use of strategies. Thus, they may have decided in this particular situation that the grammatical cue is more reliable than the social cue. This view aligns with evidence that children can take into account the reliability of the speaker when learning words (Jaswal, McKercher, & VanderBorght, 2008).

According to the first explanation, the robustness of this mapping combined with the notion that 24-month-olds are following this newly acquired cue could indicate that linguistic strategies are automatically weighted higher than other cues. It is possible that either the plural cue is dominant from the moment it is acquired or that the child only needs minimal experience using the cue before it takes precedence. This view aligns nicely with the ECM which posits that children rely on certain strategies over others in each stage of development. The work of Hirsh-Pasek and Golikoff (2008) describes the shift from reliance on perceptual salience cues to social
and linguistic cues between 10-and 19-months as being stage related. They suggest that once the child has transitioned into a particular stage, they selectively attend to the cues belonging to this stage. Thus if the child is able to use sentence-level linguistic cues, it is posited that they are in the final stage of this model, and they will rely heavily on these syntax cues to decipher the meaning of words. If the 24-month-olds in Experiment 2 are in the ‘linguistic stage’, the social cue still exists in their repertoire, but it is ranked lower than linguistic information. Thus social information may not be ignored, but rather focused on less than linguistic information at this point. A greater understanding of how children are parsing this cue collusion scene could be revealed by examining the portion of looks to the socially cued object in the training trials.

It may also be the case that grammatical cues are dominant because they are inherently more reliable than social cues. At this age children understand that there is not always a direct one-to-one correspondence between an object label and a speaker’s gaze. They are also cognizant of the fact that words are not always represented in immediate visual form and are capable of learning words for objects and actions that are absent during the labeling incident (Akhtar & Tomasello, 1996).

Although grammatical cues are usually quite reliable, the child may have experienced a few situations where the grammatical cues may appear to be incorrect. For example, the use of irregular plurals in the English language (i.e. mice, teeth) may, to the inexperienced speaker, be perceived as contradicting other cues. By a similar token, young children’s common omission of the plural (-s) inflection may lead to cue collisions in peer-to-peer interactions (Matthews & Theakston, 2006). Despite these examples, it is likely the case that in a word learning scenario grammatical information is generally more reliable than social information. In fact, in elderly populations it is posited that the decline in the ability to process the grammatical information
present in the speech signal may drive some of the difficulties older adults have in comprehending language (Golinkoff & Hirsh-Pasek, 2006; Kemper, Thompson, & Marquis, 2001). Thus indicating that grammatical cues are inherently strong cues, so much so that their absence may cause difficulties understanding speech.

Alternatively, it is possible that the robust reliance on grammatical cues could be due to the fact that children may have perceived the plural cue to be more reliable than the social cue in this particular experiment. It is plausible that these children are at a point in development socially, linguistically and cognitively that they are not just following automatic cue weighting strategies but are actively able to select the most informative cue in a given situation. In the second year of life developmental increases in cognitive capacity as well as a greater understanding of other’s intentions and social dynamics may foster greater word learning abilities (Bloom, 2001). These emerging abilities may better enable to children to judge on a situational basis which cues are most informative. Thus the use of the plural cue in this experiment may be less of an automatic state dependant strategy, rather an evaluation of the situation based on the perceived reliability of the speakers, and the perceived reliability of the redundant grammatical information.

It is possible that the redundant plural information in the sentence frame made the grammatical information appear more reliable. Although there are instances in the English language where an irregular word ends in ‘-s’ in its singular form, it is unlikely that a person would refer to a singular object using the demonstrative determiner “these” and verb “are”. Thus the redundant grammatical information especially the determiner and plural verb forms may have lead this to be a much stronger grammatical cue, than the ‘-s’ inflection alone. It may be the case that if the cues were equally matched, children would have exhibited more difficult mapping the
word to the grammatically cued object. It may not be that the grammatical cues are automatically weighted higher in the child’s repertoire, rather it could be that the redundant plural cue is perceived to be more reliable in this particular study.

It could also be that the design of this experiment lead children to view the eye-gaze cue as unreliable. It is possible for children to get the impression that the speaker is searching for the novel object rather than labeling it. Questions in the auditory passages like “where are the blickets?” or “can you find the blickets?” might have indicated to the child that the speaker did not know which object was the referent. Moreover, it seems unlikely that someone would ask where something is if they are looking at it. Studies have shown that children are in fact using the sentence context to determine when a speaker’s gaze is less informative. When a speaker gazed at a novel object and said “This is a [novel word]” 2- to 4-year-olds were much more likely to attach the label to the gaze-directed object than when the speaker said “where is the [novel word]” (Nurmsoo & Bloom, 2008). Thus the set-up of the experiment may have prompted the child to view the social cues as unreliable.

In fact, there are many studies suggesting that children take into account the circumstances surrounding the delivery of the cue. For example, when a speaker demonstrates that they are knowledgeable about the word referent 3- and 4-year-olds learn the word better than when the speaker expresses uncertainty (Sabbagh & Baldwin, 2001). Additionally, it has been shown that 3 to 5-year-olds will choose to learn novel object names from speakers who correctly label familiar objects over speakers who label them incorrectly. Similarly, they will endorse the novel noun names given by speakers who use the correct plural form when labeling familiar nouns over speakers that express familiar plurals incorrectly (Jaswal et al., 2008). This research suggests that children consider the reliability of the source when applying grammatical and
social cues to learn words. Thus if the speaker’s gaze appeared unreliable the have mapped the object based on grammar. Future studies would be needed to tease apart these two different explanations.

An examination of the differences in performance between the groups that watched the Convergent-Divergent order and the Divergent-Convergent order may also shed light on how children are weighting cues. If the order of presentation of the trials really does have an impact on the perceived reliability of the speaker, then children may be somewhat flexible in their use of cues, or perhaps the Con-Div order is less interesting. However, if the performance differences between the Con-Div group and the Div-Con group are a result of sampling error and small sample size, then maybe children are employing automatic cue weighting strategies. Although these groups were approximately matched in age and vocabulary, the Con-Div group was significantly less attentive during the task. It could be that by chance this group is less attentive, or this lack of attention could be related to the trial order. It is possible that they were bored by the redundant social and grammatical information in the Convergent trials, and thus by the time they reach the test phase for the convergent object they were not interested in looking at the same object. In fact, pilot testing with 5-year-olds using the same stimuli used in this study indicated that although these older children can certainly learn the words, they are bored by redundant information, and tended not to look towards the target object in the test trials (see Johnson & Huettig, 2011; Swingley & Fernald, 2002; for similar looking away behavior when children are bored or frustrated by a study). Presumably, this is because the target object has been cued so many times in the training phase. In order to resolve this, we may have to test two objects at a time so that the child does not anticipate that one object will be cued, making the experiment less predictable and less boring. Furthermore, since children have been accustomed to following the ‘correct’ social cues, they might have been very confused by the divergent trials. It is quite
possible that early on these children are sensitive to reliability information. In the Div-Con group children might have learned early on that the speaker’s social cues are unreliable and thus shift to grammatical cues for the rest of the experiment. Since it is a newly acquired cue, it is also possible that through random sampling many of the participants in the Con-Div group had not yet learned to use the plural cue. In order to ensure that an equal number of participants in each group can use the cue, there may have to be a series of trials similar to Experiment 1 to ensure that the child can use the plural cue alone, before adding conflicting or convergent social information.

Taken together, this line of research aimed to uncover the youngest age at which children can use plural information to decipher a novel noun. It is also makes a unique contribution to the literature by investigating whether children still rely on grammatical cues when conflicting social information is present. Further research is needed in order to investigate whether linguistic strategies are always weighted higher than other cues or whether children are flexible in their use of cues. It would be interesting to directly manipulate the perceived reliability of the cues to see if this information can force children to shift strategies. Perhaps by presenting children with a series of warm-up trials in which the speaker labels known objects using grammatically incorrect plural cues will compel children to shift their reliability to social cues in order to determine the word referent. It is also possible that if strategies are weighted automatically then the child will not learn the word at all, or will learn the grammatically cued referent regardless of whether the speaker is reliable. If flexibility is minimal or not seen in this experiment, follow up experiments could test older children to see whether flexibility develops with age.

Future research could also explore the effects of manipulating the reliability of the speaker. One can examine how inaccurate the speaker has to be for the child to disregard that cue
or what kinds of cues need to be given for the child to view the speaker as inaccurate. If grammatical inaccuracy is manipulated in a less direct fashion (i.e. speaker uses in proper verb tense, but gives plural cues to the word identity) will this reliability information be generalized across domains or are children only sensitive to cue specific errors? Also, it would be interesting to see if the children are viewing the particular speaker to be unreliable or the cue as a whole. If one speaker is inaccurate when using grammatical cues will the children continue to disregard the grammatical cue is the speaker switches? Finally can these reliability effects be extinguished or will it fade with time?

In sum, the results of this study indicate that 24-month-olds are able to use plural information to decipher the referent of a novel noun. Moreover, even when the plural cue is recently acquired there is evidence that it takes precedence over other sources of information. Cue collision is an interesting and ecologically valid phenomena. Thus, it is of interest to explore how this progression from social to grammatical strategies occurs and whether their understanding of these cues is sophisticated enough that they can adjust their use based on feedback from the external environment.
References


Johnson, E.K., McQueen, J., & Huettig, F. (2011). Toddlers' language-mediated visual search: They need not have the words for it. Quarterly Journal of Experimental Psychology. 64, 1672-1682.


Appendices

Appendix 1. Sample video script from Experiment 1. The order of trials, target side and order of word blocks was counterbalanced across the 4 conditions.

<table>
<thead>
<tr>
<th>Trial</th>
<th>Phase</th>
<th>Target Side</th>
<th>Trial Type</th>
<th>Passage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>WARM-UP 1</td>
<td>R</td>
<td>Plural</td>
<td>Where ARE the <em>car</em>S?</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>L</td>
<td>Single</td>
<td>Look at the <em>car</em>!</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Do you like it?</td>
</tr>
<tr>
<td>3</td>
<td>FAMILIARIZATION 1</td>
<td>L</td>
<td>Plural</td>
<td>THESE ARE nice <em>blicket</em>S.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Can you find the <em>blicket</em>S?</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>R</td>
<td>Single</td>
<td>Where IS the <em>blicket</em>?</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Can you see A <em>blicket</em>?</td>
</tr>
<tr>
<td>5</td>
<td>TEST 1</td>
<td>R</td>
<td>Single</td>
<td>Look at the <em>blicket</em>!</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Do you like IT?</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>R</td>
<td>Plural</td>
<td>Look at the <em>blicket</em>S!</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Do you like THEM?</td>
</tr>
<tr>
<td>7</td>
<td>WARM-UP 2</td>
<td>L</td>
<td>Single</td>
<td>Where’s the <em>cookie</em>?</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>R</td>
<td>Plural</td>
<td>Look at the <em>cookies</em>!</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Do you like THEM?</td>
</tr>
<tr>
<td>9</td>
<td>FAMILIARIZATION 2</td>
<td>L</td>
<td>Single</td>
<td>THIS IS A nice <em>toma</em>_.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Do you see A <em>toma</em>?</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>R</td>
<td>Plural</td>
<td>Where ARE the <em>toma</em>S?</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Can you point to the <em>toma</em>S?</td>
</tr>
<tr>
<td>11</td>
<td>TEST 2</td>
<td>L</td>
<td>Plural</td>
<td>Look at the <em>toma</em>S!</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Do you like THEM?</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>L</td>
<td>Single</td>
<td>Look at the <em>toma</em>!</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>Do you like IT?</td>
</tr>
<tr>
<td>13</td>
<td>WARM-UP 3</td>
<td>R</td>
<td>Plural</td>
<td>Where ARE the <em>ball</em>S?</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td>L</td>
<td>Single</td>
<td>Look at the <em>ball</em>!</td>
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<td>Do you like it?</td>
</tr>
<tr>
<td>15</td>
<td>FAMILIARIZATION 3</td>
<td>R</td>
<td>Plural</td>
<td>THESE ARE nice <em>zupel</em>S.</td>
</tr>
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<td></td>
<td>Can you find the <em>zupel</em>S?</td>
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<tr>
<td>16</td>
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<td>L</td>
<td>Single</td>
<td>Where IS the <em>zurpel</em>?</td>
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<td></td>
<td>Can you see A <em>zurpel</em>?</td>
</tr>
<tr>
<td>17</td>
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<td>R</td>
<td>Single</td>
<td>Look at the <em>zurpel</em>!</td>
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<td></td>
<td>Do you like IT?</td>
</tr>
<tr>
<td>18</td>
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<td>R</td>
<td>Plural</td>
<td>Look at the <em>zurpel</em>S!</td>
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<td></td>
<td>Do you like THEM?</td>
</tr>
<tr>
<td>19</td>
<td>WARM-UP 4</td>
<td>L</td>
<td>Single</td>
<td>Where’s the <em>apple</em>?</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>R</td>
<td>Plural</td>
<td>Look at the <em>apple</em>S!</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td>Do you like THEM?</td>
</tr>
<tr>
<td>21</td>
<td>FAMILIARIZATION 4</td>
<td>R</td>
<td>Single</td>
<td>THIS IS A nice <em>miggly</em>_.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Do you see A <em>miggly</em>?</td>
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<tr>
<td>22</td>
<td></td>
<td>L</td>
<td>Plural</td>
<td>Where ARE the <em>migglies</em>?</td>
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<tr>
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<td>Can you point to the <em>migglies</em>?</td>
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<tr>
<td>23</td>
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<td>Plural</td>
<td>Look at the <em>migglies</em>!</td>
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<tr>
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<td></td>
<td>Do you like THEM?</td>
</tr>
<tr>
<td>24</td>
<td></td>
<td>L</td>
<td>Single</td>
<td>Look at the <em>miggly</em>!</td>
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<tr>
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<td>Do you like IT?</td>
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Appendix 2. Sample video script from Experiment 2. The order of trials, target side and order of word blocks was counterbalanced across the 4 conditions.

<table>
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<tr>
<th>Trial</th>
<th>Phase</th>
<th>Con/Div</th>
<th>Plural cue</th>
<th>Passage</th>
<th>Gaze Cue</th>
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<tbody>
<tr>
<td>1</td>
<td>FAMILIARIZATION 1</td>
<td>CON L</td>
<td>L</td>
<td>THESE ARE nice bicketS. Can you find the bicketS?</td>
<td>L</td>
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<td>CON R</td>
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<td>Where IS the bicket_? Can you see A bicket_?</td>
<td>R</td>
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<td>TEST 1</td>
<td>R</td>
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<td>Look @ the blicket_! Do you like IT?</td>
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<td>L</td>
<td>Look @ the blicketS? Do you like THEM?</td>
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<td>CON R</td>
<td>R</td>
<td>THIS IS A nice toma_ . Do you see A toma_ ?</td>
<td>R</td>
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<td>6</td>
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<td>CON L</td>
<td>L</td>
<td>Where ARE the tomaS? Can you point to the tomaS?</td>
<td>L</td>
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<td>R</td>
<td>R</td>
<td>Look at the tomaS! Do you like THEM?</td>
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<tr>
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<td>L</td>
<td>R</td>
<td>Look at the toma_ ! Do you like it?</td>
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<tr>
<td>9</td>
<td>FAMILIARIZATION 3</td>
<td>DIV R</td>
<td>R</td>
<td>THESE ARE nice zuipelS. Can you find the zuipelS?</td>
<td>L</td>
</tr>
<tr>
<td>10</td>
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<td>DIV L</td>
<td>L</td>
<td>Where IS the zuipel_? Can you see A zuipel_ ?</td>
<td>R</td>
</tr>
<tr>
<td>11</td>
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<td>L</td>
<td>R</td>
<td>Look at the zuipel_ ! Do you like IT?</td>
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<td>L</td>
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</tr>
<tr>
<td>13</td>
<td>FAMILIARIZATION 4</td>
<td>DIV L</td>
<td>R</td>
<td>THIS IS A nice miggly_ . Do you see A miggly_ ?</td>
<td>R</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td>DIV R</td>
<td>L</td>
<td>Where ARE the migglies? Can you point to the migglies?</td>
<td>L</td>
</tr>
<tr>
<td>15</td>
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<td>L</td>
<td></td>
<td>Look at the migglies! Do you like THEM?</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td></td>
<td>R</td>
<td></td>
<td>Look at the miggly_ ! Do you like IT?</td>
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</table>