The role of gaze direction and mutual exclusivity in guiding 24-month-olds’ word mappings

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In these studies, we examined how a default assumption about word meaning, the mutual exclusivity assumption and an intentional cue, gaze direction, interacted to guide 24-month-olds’ object–word mappings. In Expt 1, when the experimenter’s gaze was consistent with the mutual exclusivity assumption, novel word mappings were facilitated. When the experimenter’s eye-gaze was in conflict with the mutual exclusivity cue, children demonstrated a tendency to rely on the mutual exclusivity assumption rather than follow the experimenter’s gaze to map the label to the object. In Expt 2, children relied on the experimenter’s gaze direction to successfully map both a first label to a novel object and a second label to a familiar object. Moreover, infants mapped second labels to familiar objects to the same degree that they mapped first labels to novel objects. These findings are discussed with regard to children’s use of convergent and divergent cues in indirect word mapping contexts.

Studies have demonstrated that young word learners are remarkably adept at exploiting multiple sources of information to establish appropriate mappings between words (e.g. ‘ball’) and objects (e.g. balls). That is, research has demonstrated that children can rely on intentional cues, attentional understanding, syntax, object characteristics, and expectations about word reference to form linkages between words and their referents (e.g. Akhtar & Tomasello, 2000; Bloom, 2000; Hall & Waxman, 2004; Hollich, Hirsh-Pasek, & Golinkoff, 2000; Samuelson & Smith, 1998; Woodward & Markman, 1998). The critical issue, however, of how these various sources of knowledge converge and diverge in different contexts to guide word learning has received much less investigation. In the studies described in this paper, we examined the interaction of a default assumption about word learning, namely mutual exclusivity, and an intentional cue, namely gaze direction, in guiding 2-year-olds’ indirect object–word mappings.

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Young children learn words in many different contexts (for a review, see Akhtar, 2004). Many of these contexts include indirect learning contexts wherein words are learned without explicit instruction from an adult (e.g. Akhtar, 2005; Akhtar, Jipson, & Callanan, 2001; Akhtar & Tomasello, 1996; Lieven, 1994). Given the speed at which young children acquire novel words, researchers have sought to delineate the mechanisms that enable children to learn words so efficiently in these indirect contexts. One particularly fruitful line of research has examined the default assumptions about word meaning that children bring to the word-learning situation. One such assumption is mutual exclusivity, which leads children to prefer that objects have only one category label (Markman, 1989, 1992; Markman & Wachtel, 1988; Merriman, 1991; Merriman & Bowman, 1989). This assumption has been frequently tested in indirect word-learning situations in which children have to establish the referent of a novel word when presented with familiar and novel candidate referents. On a typical trial in these studies, children are presented with two objects, one familiar (e.g. a spoon) and one unfamiliar (e.g. a whisk) and are asked for the referent of a novel count noun (e.g. ‘Show me a dax’). In this situation, children will consistently map the novel word to the novel object (Au & Glusman, 1990; Markman & Wachtel, 1988; Merriman & Bowman, 1989; Merriman & Schuster, 1991). According to mutual exclusivity, children avoid mapping a second label on to an already-labelled object and instead search for a different referent for the novel label (Markman & Wachtel, 1988, but see Diesendruck & Markson, 2001, for a pragmatic account of performance in this situation). Mutual exclusivity, of course, serves as a default assumption about word meaning and thus can be overridden when necessitated by a particular situation, such as when children are faced with the task of learning more than one name for an object (Banigan & Mervis, 1988; Waxman & Hatch, 1992; Waxman & Senghas, 1992). Studies have demonstrated that the mutual exclusivity assumption is honoured by infants sometime during the second year of life (Evey & Merriman, 1998; Graham, Poulin-Dubois, & Baker, 1998; Halberda, 2003; Liitschwager & Markman, 1994; Markman, Wasow, & Hansen, 2003; Mervis & Bertrand, 1994) and increases in strength over the preschool years (Merriman & Bowman, 1989).

Another line of research has focused on children’s reliance on intentional cues to learn the meanings of words in indirect word learning contexts. Research has suggested that children will actively search for cues from a speaker in order to determine the appropriate word–object mappings (Akhtar, Carpenter, & Tomasello, 1996; Baldwin, 1991, 1993a,b; Baldwin et al., 1996; Bloom, 2002; Moore, Angelopoulos, & Bennett, 1999; Tomasello & Barton, 1994). For example, Tomasello and Barton found that 24-month-old children relied on social-pragmatic cues during word learning in that they mapped a novel verb on to an action that was intentional but not accidental. Baldwin and her colleagues have provided seminal work demonstrating the sophistication of young children’s abilities to follow the gaze direction of a speaker in order to learn novel words. In situations in which there are a number of potential options (e.g. two or more novel objects), Baldwin and her colleagues have demonstrated that children will monitor the speaker’s gaze in order to identify the intended referent after a novel word is voiced. For example, Baldwin (1991, 1993b) demonstrated that when 18- to 19-month-old children are presented with a novel label, they will monitor a speaker’s gaze direction, follow that focus, and subsequently map the new label on to the object that is the focus of the speaker’s regard. Moreover, children in this age range can successfully use line of regard to establish correct word–referent mappings even when faced with discrepant labelling situations – that is, when a new word is presented while a child is focusing on an incorrect referent and an adult is focusing on the target object. Research
has also demonstrated that children will use the speaker’s gaze to infer the speaker’s referential intentions even when this cue is pitted against other potential sources of word-learning information such as salience or temporal contiguity (e.g. Baldwin, 1993a, Hollich et al., 2000; Moore et al., 1999). That is, studies have shown that 24-month-old children will rely on gaze direction, rather than a salient cue (e.g. lights), to map novel words to novel objects. This sensitivity to gaze direction, however, is more fragile in children younger than 24 months in that when there is a conflict between saliency and eye-gaze direction, 18- to 19-month-olds do not exhibit a clear pattern of using eye-gaze during their word mapping.

In summary, research has clearly demonstrated that children can rely on both default assumptions about word meaning such as the mutual exclusivity assumption and intentional cues to word reference such as eye-gaze. Despite our progress in identifying the sources of knowledge that children use to establish word–referent mappings, several questions remain unanswered. In particular, research has tended to isolate the different sources of guidance that children rely on for word learning and thus, it is unclear how word learning proceeds when guidance from pragmatic cues conflict with the default assumptions word learners may hold. The present study addresses the issue of how might children privilege one particular word-learning cue over others, particularly when word-learning information provided by these cues diverge. To accomplish this goal, we examined the word-learning performance of 2-year-olds in contexts where more than one word-learning cue was present. In Expt 1, we examined children’s word–referent mappings when information from the mutual exclusivity assumption and gaze direction conflicted and when it coincided. In Expt 2, we examined children’s reliance on eye-gaze to map a first label to a novel object versus a second label to an already-labelled object.

Previous research has demonstrated that both eye-gaze and mutual exclusivity independently provide information that children can rely on when determining a correct referent for a label, however, it is unclear how children will negotiate between conflicting information from both sources. One possibility is that reliance on pragmatic inference, although useful, may impose a heavy cognitive load on the word learner (Saylor, Baldwin, & Sabbagh, 2004). That is, on-line processing of pragmatic information demands that children pay attention to many different cues (eye-gaze direction, facial expression, intonation, body posture, and gestural information) and do so at the rapid rate at which discourse takes place and over large temporal spaces. For this reason, and due to varied cooperation of the speakers, pragmatic inference may not always allow the learner to discover the meaning of a new label. Thus, default heuristics, such as ME, which may operate as fixed assumptions that infants bring to all word mapping situations, may be relied upon unless there is a salient reason not to do so. As such, children in the present study may show a tendency to map labels on to referents based on the information provided by the mutual exclusivity cue rather than the eye-gaze cue, when the cues are in conflict.

**EXPERIMENT 1A**

The goal of Expt 1 was to examine 24-month-olds’ reliance on an adults’ gaze direction to disambiguate word reference under the following conditions: when gaze direction was consistent with the mutual exclusivity assumption (Consistent Gaze group), when gaze direction was inconsistent with the mutual exclusivity assumption (Inconsistent
Gaze group), and when no gaze direction was provided (No Gaze group). This age group was chosen as it is a period in which rapid vocabulary development occurs, and previous research has suggested that both pragmatic information and the mutual exclusivity heuristic emerge as cues that guide word mapping during this stage of development (e.g. Baldwin, 1993a; Markman et al., 2003).

Across a series of trials, we presented infants with object arrays consisting of two familiar objects (e.g. a spoon and keys) and one unfamiliar object (e.g. a garlic press). On some trials, infants were asked to find the referent of a novel label while on others, they were asked to find the referent of a familiar label. In the No Gaze group, the experimenter looked at the infant’s face when requesting the referents of the familiar and novel words. In the Consistent Gaze group, the experimenter directed her gaze towards the novel object when requesting the referent of a novel word and to the appropriate familiar object when requesting the referent of a familiar word. Finally, in the Inconsistent Gaze group, the experimenter directed her gaze to one of the familiar objects while requesting the referent of the novel label or to the novel object when requesting the referent of a familiar label.

We expected that children in the No Gaze group would be guided by the mutual exclusivity assumption and map the novel label to the novel objects. We also predicted that infants in the Consistent Gaze group would map the novel label to the novel object because information from eye-gaze direction and mutual exclusivity converge to identify the novel object as the intended referent. A comparison of the children’s performance in the No Gaze and Consistent Gaze groups allowed us examine whether the addition of gaze cues enhanced infants’ tendency to map the novel label on to the unfamiliar object. Children’s performance in the Inconsistent Gaze group allowed for a close examination of children’s preferred strategy for word mapping at this stage of development. That is, in the Inconsistent Gaze group, the two cues (i.e. eye-gaze and mutual exclusivity) lead to different possible referents for the novel label. If children prefer to rely on mutual exclusivity, then they should choose the novel object as the referent of the novel label. In contrast, if children preferentially attend to eye-gaze, they should attach the novel label to the familiar gazed-at object.

Method
Participants
Sixty-six 24-month-old children participated in this study. Children were recruited from daycares, preschools, and health clinics and were all from homes in which English was the primary language spoken. Children were randomly assigned to one of three groups, each including 22 participants: the No Gaze group (mean age = 23.42 months, SD = 1.18, 11 males), the Consistent Gaze group (mean age = 24.19 months, SD = 2.04, 11 males) or the Inconsistent Gaze group (mean age = 23.65 months, SD = 1.85, 12 males). Children received a certificate and a toy to thank them for participating.

Materials
The stimuli were grouped into six object sets. Each object set included two familiar objects and one unfamiliar object. Familiar objects included a teddy bear, a stuffed rabbit, a stuffed dog, a stuffed cat, a rubber mouse, a rubber duck, keys, a spoon, a
crayon, a ball, a brush, and a cup. The novel objects included an orange stuffed creature with purple hair, a red stuffed creature with wings, a rubber seal-like creature covered in long spindles, a whisk, an unusually shaped corkscrew and a hose connector. Each set was presented twice: once when the child was asked for the referent of a novel word and once when the child was asked for the referent of a familiar word. The novel count nouns presented were: **blick**, **gonk**, **cur**, **lep**, **fic**, and **zav**. The familiar labels were **dog**, **cat**, **duck**, **cup**, **ball**, and **spoon**. A kangaroo puppet was used by the experimenter to keep children engaged in the procedure (e.g. after every trial, the child passed the toys to the kangaroo) and to reinforce the gaze direction of the experimenter (e.g. the experimenter’s and kangaroo’s eyes faced the same object).

**Procedure**
Testing took place in the research lab. The experimenter sat directly across a table from the child, with the parent seated beside and slightly behind the child. Children were randomly assigned to one of three groups: **No Gaze**, **Consistent Gaze**, and **Inconsistent Gaze**. All children were presented with 12 test trials. On half of the trials, the experimenter requested the referent of a novel word (e.g. ‘Show me the **gonk**’) while on the other half, she requested the referent of a familiar word (e.g. ‘Show me the **dog**’).

At the beginning of each trial, the experimenter presented all three items in a given set to the child for a short exposure period (15 s). The experimenter pointed out each object to the child (e.g. ‘Look at this, and this, and this’) to ensure that the child attended to each object. The objects were then retrieved and lined up on the tray. Each item was placed on a mark on the tray to ensure that there was sufficient space between the objects. This allowed us to be confident that children could clearly discern which object was the recipient of the experimenter’s gaze. The experimenter then asked the child for the referent of a familiar word (‘(Child’s name), show me a **dog**’) or for the referent of a novel word the unfamiliar object using a novel label (‘(Child’s name), show me a **gonk**’). The experimenter’s gaze direction when making the requests differed according to group. In the **No Gaze** group, the experimenter and the kangaroo puppet looked at the child, and not at the object array, when requesting word referents. In the **Consistent Gaze** group, the experimenter and the kangaroo puppet directed their gaze at the appropriate object, either the correct familiar object on the familiar word trials or the novel object on the novel word trials. In the **Inconsistent Gaze** group, the experimenter and the puppet directed their gaze towards a familiar object on the novel word trials and towards the novel object on the familiar word trials. In the two gaze groups, the experimenter continued to gaze at the object until the child responded by pointing to or handing any object to the experimenter (or to the puppet). Once the child responded, the experimenter simply said ‘Okay, thank you’ and proceeded to the next trial. No corrective feedback was provided.

The unfamiliar and familiar object pairings, and object test trial presentation and familiar/novel word request were first randomized across children. These orders were then yoked across groups.

**Results**
The primary question of interest was whether the experimenter’s eye-gaze and/or the mutual exclusivity assumption influenced children’s tendency to select a novel
object as the referent of a novel word in a disambiguation task. To assess this question, we first computed the number of target choices for the novel and familiar word-mapping trials for the three groups of children (out of six). The means are presented in Figure 1.

To examine possible group differences on performance on the word-mapping trials, we performed one-way analyses of variance (ANOVA) on the familiar and novel word trial data separately (due to significant differences in variance across word trial type). Analysis of the familiar word trial data revealed no significant differences between the three groups on the familiar word-mapping trials ($p > .45$). Significant group differences did emerge, however, on the novel word-mapping trials, $F(2, 63) = 17.36$, $\eta^2 = .36$, $p < .001$. Follow-up comparisons with a Bonferroni correction indicated that children in the Consistent Gaze group were significantly more likely to map the novel word on to the nameless objects than children in the either the No Gaze group or the Inconsistent Gaze group, $p < .001$. Children in the No Gaze group and the Inconsistent Gaze group did not differ from one another in the number of correct novel word-mappings, $p > .71$. These findings indicate that when the experimenter’s eye-gaze direction was consistent with the mutual exclusivity assumption, children’s novel word mappings were facilitated by this information.\(^1\)

In the next set of analyses, we then compared the mean number of target choices objects to chance levels (two, as there were three objects in each array with only one correct object) for each group (No Gaze, Consistent Gaze, and Inconsistent Gaze), using one-sample $t$ tests. All of the one-sample $t$ tests were significant, all $ps < .001$; that is, children in all three groups selected both the familiar target referents and the novel target referents at levels significantly above chance.

In the final set of analyses, we examined performance in the Inconsistent Gaze group more closely to determine if the experimenter’s gaze direction exerted any influence on children’s novel word-mapping performance. First, we compared the number of choices of the gazed-at familiar object on novel word-mapping trials to the level expected by chance. This analysis indicated that children in this group selected the gazed-at-object at levels significantly less than chance ($M = 1.22$, $SD = 0.65$), $t(21) = 41.46$, $p < .001$. Next, we compared the number of choices of the gazed-at-object in the Inconsistent Gaze group to the number of choices of those same objects in the No Cues group ($M = 0.72$, $SD=1.03$). This analysis revealed no significant differences, $p > .06$. Thus, these results corroborate the results of the primary analyses indicating the mutual exclusivity is more influential on children’s novel word mappings than gaze direction when these two cues conflict.

Discussion

The purpose of this study was to examine the word-mapping performance of 24-month-old children when they were presented with two cues they could potentially rely on, that is, the mutual exclusivity assumption, and/or the eye-gaze of the experimenter.

\(^1\) To ensure that children in this age range would not have labels for these objects, we presented 10, 2-year-old children (4 males and 6 females, mean age = 29.00 months, $SD = 4.78$ with the 18 unfamiliar objects used in Expts 1 and 2, one at a time, and asked them to provide the name of the object. Children, on average, labelled 46% of the objects ($SD = 29\%$) used in Expt 1. None of the objects were named by children more than 50% of the time. Consistent labels were only provided for one object: the hose connector was named as a ‘tunnel’ by 2 of the 10 children. We removed the trial with this object from our analyses and found the identical pattern of results as when this trial was included.
When the experimenter’s gaze was consistent with the mutual exclusivity assumption (i.e. the experimenter looked at the novel object when there were two familiar objects present), 24-month-old children were more likely to map the novel word to the novel object than when the experimenter did not offer any gaze information or when the experimenter’s gaze was directed at one of the familiar objects. Thus, it appears that when both cues converge on the same meaning, children’s novel word mappings are facilitated.

The word mapping performance of children who received eye-gaze information that was in conflict with the mutual exclusivity assumption did not differ significantly from performance of children who received no eye-gaze information. This finding suggests that when the experimenter’s eye-gaze was in conflict with the mutual exclusivity cue, children demonstrated a tendency to rely on the mutual exclusivity assumption rather than follow the experimenter’s gaze to map the label to the object. However, there is a possibility that influence of gaze was undermined by the procedure used on the familiar word trials in this study. On familiar word trials in the Inconsistent Gaze condition, the experimenter gazed at the novel object while asking for the referent of a familiar word. Because the gaze cue was clearly incorrect on these trials, these experiences may have led children to disregard the gaze in general. That is, children may have assumed that the experimenter was unreliable and disregarded her input. To rule out this possibility, we conducted Expt 1B in which we presented children with only novel word trials in the No Gaze and Inconsistent Gaze groups.

**EXPERIMENT 1B**

As in Expt 1A, we presented infants with object arrays consisting of two familiar objects (e.g. a spoon and keys) and one unfamiliar object (e.g. a garlic press). On all trials,
infants were asked to find the referent of a novel label. In the Novel-Only No Gaze group, the experimenter looked at the infant’s face when requesting the referents of the novel words. In contrast, in the Novel-Only Inconsistent Gaze group, the experimenter directed her gaze to one of the familiar objects while requesting the referent of the novel label.

If children were disregarding the experimenter’s eye-gaze cues in Expt 1A because of the familiar word trials, there should be an effect of eye-gaze cues in the Inconsistent Gaze group in this experiment. That is, if children preferentially attend to eye-gaze, they should attach the novel label to the familiar gazed-at-object. In contrast, if children prefer to rely on mutual exclusivity, then they should choose the novel object as the referent of the novel label.

**Method**

**Participants**
Forty-two 24-month-old children participated in this study. Children were recruited as in Expt 1A and were all from homes in which English was the primary language spoken. Children were randomly assigned to one of two groups, each including 21 participants: the Novel-Only No Gaze group (mean age = 25.52 months, SD=2.01, 12 males) or the Novel-Only Inconsistent Gaze group (mean age = 25.73 months, SD = 1.38, 11 males). Children in this experiment did not differ significantly in age from children tested in Expt 1A, \( p > .75 \). Children received a certificate and a toy to thank them for participating.

**Materials**
The materials were the same as used in Expt 1A.

**Procedure**
The procedure was identical to that used in Expt 1A for except only the novel word trials were administered and children were tested only in the Inconsistent Gaze and No Gaze groups.

**Results and discussion**
As in Expt 1A, we first computed the number of novel object choices (out of six). To examine possible group differences on performance on the word-mapping trials, we first compared children’s selections of novel objects across the two groups tested in this experiment. An independent groups \( t \) test indicated that children in the Novel-Only Inconsistent Gaze group (\( M = 2.85, SD = 1.77 \)) and the Novel-Only No Gaze group (\( M = 3.23, SD = 1.34 \)) did not differ in number of novel object selections, \( p > .45 \). Next, we used a one-way ANOVA to compare children’s performance in the three groups tested in Expt 1A with those tested in Expt 1B. This analysis yielded a significant group differences, \( F(4,103) = 10.68, \eta^2 = .29, p < .001 \). Follow-up comparisons with a Bonferroni correction indicated that children in the Consistent Gaze group were significantly more likely to map the novel word on to the nameless objects than children in the No Gaze group, the Inconsistent Gaze group, the Novel-Only Inconsistent Gaze group.
group, and the Novel-Only No Gaze group, \( ps < .001 \). Children in four remaining groups did not differ from one another in the number of correct novel word-mappings, \( ps > .70 \).

In the next set of analyses, we then compared the mean number of target choices objects to chance levels for each group tested in this experiment (Novel-Only No Gaze, Novel-Only Inconsistent Gaze), using one-sample \( t \) tests. Children in both groups selected the novel target referents at levels significantly above chance, \( ps < .05 \).

Finally, as in Expt 1A, we examined performance in the Novel-Only Inconsistent Gaze group more closely to determine if the experimenter’s gaze direction exerted any influence on children’s novel word-mapping performance. Children’s selection of the gazed-at-object in the Novel-Only Inconsistent group did not differ from chance \((M = 1.67, SD = 1.31), p > .26\). A comparison of the number of choices of the gazed-at-object in the Novel-Only Inconsistent Gaze group to the number of choices of those same objects in the Novel-Only No Gaze group \((M = 1.38, SD = 1.07)\) revealed no significant differences, \( p > .62 \). Similarly, a comparison of number of gazed-at choices in the Novel-Only Inconsistent Gaze group to the number of choices of those same objects in the Inconsistent Gaze group from Expt 1A revealed no significant differences, \( p > .15 \).

The results of Expt 1B are remarkably similar to those of Expt 1A, indicating that children’s lack of attention to eye-gaze information in the first experiment was not due to children assuming that the experimenter was an unreliable source. Instead, the findings confirm that mutual exclusivity is more influential on children’s novel word mappings than gaze direction when these two cues conflict. Together, the results of both experiments suggest that the mutual exclusivity assumption generally works as the default heuristic that children make use of in particular word mapping situations. In the next study, we pursued the examination of children’s use of eye-gaze information to guide their word mapping under conditions where mutual exclusivity might also be operational. That is, we examined children’s reliance on gaze direction to map novel labels to already-labelled objects.

**EXPERIMENT 2**

In this study, we again examined 24-month-olds’ word mapping when faced with information from more than one word learning cue. More specifically, we examined children’s tendency to use an experimenter’s gaze direction to map a novel label to a novel object versus children’s tendency to use the experimenter’s gaze direction to map a second label to a familiar, already-labelled object. Children were presented with sets of three novel objects and sets of three familiar objects in one of two groups. In the No Gaze group, the experimenter requested a word referent whilst looking directly at the infant. In the Gaze condition, the experimenter directed her gaze to one target object within the set of objects. The inclusion of the novel objects and familiar objects allowed us to compare children’s use of gaze direction to map a first label to a novel object versus children’s reliance on gaze direction to map a novel label to a familiar object. The No Gaze group was included as a baseline condition to control for object salience and preferences.

Following from previous research (e.g. Baldwin, 1991, 1993a,b), we expected that children in the Gaze group would use eye-gaze information to guide their word referent mappings when all objects are novel. Furthermore, we expected that when children
were presented with a potentially challenging word mapping situation – that is, when they heard a novel label in the context of three familiar objects, they would rely on the gaze of the experimenter to establish a second label for that particular object. Finally, we expected that children would more readily map a first label to a novel object than a second label to an already-labelled object in the Gaze group, given the operation of the mutual exclusivity assumption.

**Method**

**Participants**

Thirty-six 24-month-old children participated in this study. Children were recruited from daycares, preschools, and health clinics and were all from homes in which English was the primary language spoken. Children were randomly assigned to one of two groups, each including 18 participants: the No Gaze group (mean age = 24.06 months, SD = 1.26, 8 males) or the Gaze group (mean age = 24.03 months, SD = 1.04, 9 males). Children received a certificate and a toy to thank them for participating. None of the children had participated in Expt 1A or 1B.

**Materials**

The stimuli consisted of six sets of three familiar objects and six sets of three unfamiliar objects. Six sets were animate-like objects (three novel and three familiar) and six sets were artefacts (three novel and three familiar). Familiar animate-like objects included a teddy bear, a stuffed rabbit, a stuffed dog, a stuffed cat, a rubber mouse, a rubber duck, a plastic dog, a rubber bird, a plastic horse, a plastic fish, a plastic cow, and a plastic elephant. Familiar artefacts included a plate, a brush, a spoon, a phone, keys, a fork, a crayon, a ball, and a cup. The novel animate-like objects included an orange stuffed creature with purple hair, a red stuffed creature with wings, a cream-coloured creature, four novel different shaped creatures made of Femo®, a rubber seal-like creature covered in long spindles, and a wooden cat-like creature. The novel artefacts included a whisk, an unusually shaped corkscrew, a garlic press, a turkey baster, a clothesline pulley, an apple corer, a honey dipper, a bottle top, and a hose connector. The novel count nouns presented were: *wug*, *gonk*, *bif*, *cur*, *wex*, *dep*, *toop*, *dax*, *fic*, *flum*, *zav*, and *blick*. A kangaroo puppet was used to keep children engaged in the procedure and to reinforce the gaze direction of the experimenter.

**Procedure**

Testing took place in the research laboratory with the experimenter seated directly across a table from the child and the parent seated beside and slightly behind the child. Children were randomly assigned to one of two groups: No Gaze or Gaze. All children were presented with 12 test trials. On half of the trials, children were presented with familiar objects sets while on the other half of the trials children were presented with novel objects sets.

The procedure for the trials was similar to that used in Expt 1A except the experimenter always requested the referent of a novel word (e.g. 'Show me the *gonk*'). The experimenter's gaze direction again differed according to group when making the request for the referent of the novel word. In the No Gaze group, the experimenter and the puppet looked at the child, and not at the object array, when requesting word
referents. In the Gaze group, the experimenter and the puppet directed their gaze at one of the novel objects (novel target) on the novel objects sets and directed their gaze at one of the familiar objects (familiar target) on the familiar object sets. The object sets and object test trial presentation were first randomized across children and then these orders were yoked across groups.

Results

The primary question of interest was whether the experimenter’s eye-gaze influenced children’s mappings of a novel word to a novel object or a novel word to a familiar object. As in Expt 1, we first computed the number of target choices for the novel and familiar word-mapping trials for the two groups of children (out of six). The means are presented in Figure 2.

To examine possible group differences on the children’s performance on the word-mapping trials, we performed a 2 (group: No Gaze, Gaze) × 2 (object set: familiar vs. novel) mixed factor ANOVA on these data. This analysis yielded a significant main effect of group, $F(1, 34) = 16.59, \eta^2 = .33, p < .001$. Children in the Gaze group were more likely to map the novel word to the target objects ($M = 3.50, SD = 1.40$) than children in the No Gaze group ($M = 2.00, SD = 0.69$). The object set main effect and group by object set interaction were not significant, $p_s > .50$. Thus, there were no differences in the mappings of novel words to novel objects or to familiar objects.

We then compared the mean percentage of target choices to chance levels (2) for each group, using one-sample $t$-tests. As one would expect given that children in the No Gaze group were given no word-mapping cues, only children in the Gaze group selected both the familiar target referents and the novel target referents at levels significantly above chance ($ps < .001$).

Discussion

In this study, children relied on the experimenter’s gaze direction to map successfully both a first label to a novel object and a second label to a familiar object. Moreover, infants mapped second labels to familiar objects to the same degree that they mapped first labels to novel objects. These findings suggest that in situations where mutual exclusivity does not provide any information that could be used to unambiguously determine a referent, children relied on the experimenter’s gaze direction. That is, in the familiar objects sets, there were no objects that did not already posses a label; therefore, the mutual exclusivity assumption would not allow the children to narrow down the potential referent objects. It appears that 24-month-old children were willing to attach a second label to a familiar object using intentional cues provided by the experimenter. What cannot be determined, however, is whether children preserve the mutual exclusivity bias by attaching a label to a part of one of the familiar objects, rather than to the object itself. For example, Markman and Wachtel (1988) found that preschool age

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2 Children, on average, labelled 45% of the objects ($SD = 27\%$) used in this experiment. Two of the objects were named by children in the label test group more than 50% of the time: the wooden cat-like creature and one of the Femo creatures. Even though children did overextend labels to these objects, they did not offer consistent labels. As in Expt 1, we removed the trials with these objects from our analyses and found no change in our pattern of results.
children interpret novel labels for familiar objects as a reference to a part or substance term. If this were the case in the present study, it would seem that children are coordinating both eye-gaze and mutual exclusivity in that the ‘object part’ they are attaching the label to happens to be on the object that the experimenter is gazing towards (i.e. as opposed to the other familiar objects in the display). That is, children relied on gaze cues over the joint implication of the mutual exclusivity and whole object assumptions. Thus, regardless of the specific interpretation of the children’s performance, it appears than when a situational context makes the mutual exclusivity less informative, children make use of social cues.

GENERAL DISCUSSION

It is well documented that young word learners can rely on both default assumptions about word meaning, such as the mutual exclusivity assumption, and intentional cues, such as eye-gaze, to establish appropriate word–object mappings. The goal of our studies was to examine how 2-year-olds’ indirect object–word mappings operate when these two sources of knowledge regarding word reference converge and diverge. In Expts 1A and 1B, we examined children’s word–referent mappings when information from the mutual exclusivity assumption and gaze direction conflicted and when it coincided. In Expt 2, we examined children’s reliance on eye-gaze to map a first label to an unnamed object versus a second label to an already-labelled object.

The present findings offer a number of insights into the role of mutual exclusivity and eye-gaze in young children’s word–referent mappings. First, when eye-gaze and mutual exclusivity offer divergent information about the referent of a novel word, infants will rely on mutual exclusivity to guide their mappings. In Expts 1A and 1B, when the experimenter’s gaze direction signalled a familiar object, a situation inconsistent with the mutual exclusivity assumption, children tended to rely on the mutual exclusivity assumption and mapped the novel label to the novel object.

Figure 2. Expt 2: Number of target object choices as a function of group and trial type.
Moreover, the word mapping performance of children who received eye-gaze information that conflicted with the mutual exclusivity assumption did not differ significantly from the performance of infants who received no eye-gaze information. This finding suggests that at 24-months of age, mutual exclusivity acts as a default heuristic that children rely on during indirect word mapping situations. These results are consistent with a study by Jaswal and Hansen (2006) that found that 3- and 4-year-old children selected the novel object as the correct referent for a novel label even when the speaker pointed towards (Study 1) or looked at (Study 2) a familiar object. Thus, consistently across the preschool period, children tend to rely on mutual exclusivity over social cues, when there is a conflict between these two types of word-mapping information.

Second, children will use intentional cues when mutual exclusivity does not provide information about a specific referent for a novel label. Results from Expt 2 indicated that children relied on the experimenter’s gaze direction to map both a first label to a novel object and a second label to a familiar object. Importantly, children’s mappings of second labels to familiar objects did not differ from their mappings of first labels to novel objects, indicating that children relied on the experimenter’s gaze direction to override the default assumption that objects generally possess one label. These findings indicate that under some circumstances, namely, when there is no nameless referent available, children will map a second label to an already-labelled object. These findings indicate that mutual exclusivity is indeed a flexible assumption that can be disregarded when it does not provide clear information. These findings are consistent with research demonstrating that even very young children are capable of learning more than one label for an object in naturalistic (e.g. Clark, 1988; Merriman & Bowman, 1989) and experimental settings (e.g. Banigan & Mervis, 1988; Waxman & Hatch, 1992; Waxman & Senghas, 1992). It is important to note, however, that our study only compared accuracy in assigning first labels versus second labels to objects. It is possible that a measure other than accuracy may have documented some sort of resistance to assigning a second label to an already-labelled object. Other research has indicated that children have more difficulty learning second labels than initial labels (Markman & Callanan, 1983), in particular in situations when the processing capacity of infants is taxed (Littschwager & Markman, 1994). Thus, future research should examine whether the speed of mapping and/or stability of mappings of second labels versus first labels are also comparable.

Together, these first two findings suggest that children privilege mutual exclusivity over gaze cues in word-mapping situations in which there is one novel object present. However, when all objects in the visual arena are familiar, mutual exclusivity does not assist the child in narrowing down the potential referent for a novel word. In this situation, children rely on gaze direction as it provides the disambiguating information. Thus, young children are flexible in their use of cues during word mapping and rely on those that will provide the most informative guide in a particular context.

Third, gaze direction alone appears to be as effective as the mutual exclusivity assumption alone in guiding novel word-object mappings. That is, children’s mappings of novel words in the No Gaze group in Expt 1, when only mutual exclusivity was available to guide their mappings, was comparable to children’s mappings of novel words to novel objects in the Gaze group in Expt 2, when only gaze direction was available to guide their mappings.

Finally, and not unexpectedly, when different word mapping cues offered convergent guidance towards a particular referent, word mapping was optimized. In Expt 1, when the experimenter’s gaze direction signalled the same referent as the
mutual exclusivity assumption, children’s tendency to map the novel word to the novel object was enhanced. Consistent with other recent research (see Saylor et al., 2004), this finding highlights the powerful role of convergence in guiding young children’s word mappings. For example, Saylor and Sabbagh (2004) found that preschool children’s acquisition of names for object parts was facilitated when provided with two or more kinds of word learning information.

Although the present findings suggest that mutual exclusivity operates as a default, albeit flexible, assumption, in word mapping, these findings do not address the debate around the nature of this heuristic. That is, researchers have proposed a number of different mechanisms that may account for children’s tendency to map novel words to novel objects (see Merriman, Marazita, & Jarvis, 1995, for a review). For example, Golinkoff, Mervis, and Hirsh-Pasek (1994) argue that children adhere to a Novel Name-Nameless Category (N3C) principle, which states that novel words map to previously unnamed objects, rather than to a mutual exclusivity assumption (see also Hollich et al., 2000). Merriman and his colleagues have proposed that young children’s disambiguation may be guided by a Feeling of Novelty principle, which is the assumption that novel labels should be assigned to objects that seem new to the child (Merriman, Marazita, & Jarvis, 1993; Merriman et al., 1995). Other researchers have argued that the demonstration of mutual exclusivity within word learning is one example of a domain-general tendency to conserve cognitive resources (Piccin & Blewitt, 2007). Finally, others have proposed that children behave in a ‘mutually exclusive’ fashion for pragmatic, not cognitive reasons. That is, it has been proposed that mutual exclusivity operates due to pragmatic inferences (Bloom, 2000; Callanan & Sabbagh, 2004; Clark, 1987). For example, Diesendruck and Markson (2001) argue that children assign the novel word to the novel object in disambiguation tasks, as they are motivated to avoid lexical overlap as a general communicative strategy.

The present studies do not allow us to differentiate between the pragmatic versus cognitive explanations for mutual exclusivity. That is, children may have chosen the novel object as the referent of a novel word because they are adhering to mutual exclusivity constraint or because past experience has taught them that when a speaker wants a familiar object, they tend to use the familiar term for the object. Thus, in the Inconsistent Gaze condition, it might not be that children ignored the speaker’s gaze direction, but rather that they were they are basing their referent decisions on what might be well-learned pragmatic information (i.e. speakers generally use familiar labels when they want familiar objects) and ignoring other pragmatic information (i.e. eye-gaze indicates an intended referent). Although our results do not distinguish between these two possibilities, recent research with children with autism, who characteristically have deficits in pragmatic understanding, suggests that mutual exclusivity may be more of a cognitive, rather than pragmatically based, word-mapping strategy. For example, Preissler and Carey (2005) found that children with autism did not differ from typically developing toddlers on their performance on a mutual-exclusivity word-mapping task but did perform significantly worse than typically developing children on a task that involved monitoring referential intent (Preissler & Carey, 2005; see also Parish-Morris, Hennon, Hirsh-Pasek, Golinkoff, & Tager-Flusberg, 2007).

In summary, the present experiments provide insight into the remarkable manner through which young children mediate between the different cues available to them in the context of indirect word mapping. When 24-month-old children are faced with eye-gaze information that is in conflict with the mutual exclusivity assumption, they demonstrate a tendency to rely on the default mutual exclusivity assumption. However,
eye-gaze information does allow them to successfully map words to objects in some situations where the mutual exclusivity assumption does not assist them in determining a correct referent for a label.

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References


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Q1  Reference Samuelson and Smith (1999) is changed to Samuelson and Smith (1998) as per list. Please check and approve.

Q2  References Clark (1987) and Lieven (1994) have been cited in text but not provided in the list. Please supply reference details or delete the reference citations from the text.

Q3  Please provide expansion for ME, if applicable.

Q4  References Hall, Quantz, and Persoage (2000), Baldwin (1995), and Baldwin and Moses (2001) are provided in the list but not cited in the text. Please supply citation details or delete the reference from the reference list.