

Contents lists available at [ScienceDirect](#)

# Cognitive Development



## Young children's disambiguation across the senses



Jenna L. Wall<sup>a,\*</sup>, William E. Merriman<sup>a</sup>, Jason Scofield<sup>b</sup>

<sup>a</sup> Department of Psychology, Kent State University, Kent, OH 44242, USA

<sup>b</sup> Human Development and Family Studies, University of Alabama, 222 Child Development Research Center, Tuscaloosa, AL 35487, USA

### ARTICLE INFO

#### Article history:

Received 9 February 2015

Received in revised form 11 June 2015

Accepted 12 June 2015

#### Keywords:

Novel word mapping  
Cross-modal matching  
Avoiding label overlap  
Awareness of  
knowledge

### ABSTRACT

When asked to find the referent of a novel label, young children usually select a novel object rather than an object that has a known label. However, children did not show this so-called disambiguation effect in a situation that required cross-modal generalization of the known label (Scofield et al., 2009). In three experiments, children learned a label for an object that they could see, but not touch, then examined two objects that they could touch, but not see. One of these tactile objects was novel, whereas the other was an exemplar of the just-trained label. On the critical trials, children were asked to decide which object was the referent of a novel label. Neither 3- nor 4-year-olds favored the novel object unless they were first asked to choose the one that was the referent of the just-trained label (both age groups) or choose the one that was the same as the visual training object (4-year-olds only). Children's tendency to disambiguate across the senses was associated with how accurately they judged their own knowledge of object labels. These findings are consistent with the claim that the cross-modal disambiguation effect can be undermined by children's reactions to discovering the cross-modal match and by their failure to retrieve the known label for this matching object when considering whether a novel label applies to it.

© 2015 Elsevier Inc. All rights reserved.

### 1. Introduction

From an early age, children show adaptive biases in their interpretation of novel words. For example, when asked to find the referent of a novel label, toddlers as young as 15 or 16 months old tend to prefer a novel object rather than an object that has a known name (Halberda, 2003; Markman, Wasow, & Hansen, 2003; Mervis & Bertrand, 1994). This tendency, which Merriman and Bowman (1989) dubbed the "disambiguation effect," is quite robust among children 2½ years and older (Evey & Merriman, 1998; Golinkoff, Hirsh-Pasek, Bailey, & Wenger, 1992; Markman & Wachtel, 1988).

Children do not show the disambiguation effect across the senses, however, Scofield, Hernandez-Reif, and Keith (2009) taught 2-to-5-year-olds a label for an object (e.g., "zav") that was presented only tactually (Experiment 1) or only visually (Experiment 2). This object was then presented along with a novel object in the other sense modality. On some trials, children were asked which one was an exemplar of the just-trained label (e.g., "Which one is the zav?") On other trials, they were asked which one was an exemplar of a novel label (e.g., "Which one is the tigg?"). All age groups, except 2-year-olds, tended to map the trained label onto the training object. That is, they showed cross-modal extension of the trained label. However, no age group avoided selecting the training object when tested on the novel label. In fact, children selected it more often than the novel object.

\* Corresponding author.

E-mail addresses: [jwall4@kent.edu](mailto:jwall4@kent.edu) (J.L. Wall), [wmerrima@kent.edu](mailto:wmerrima@kent.edu) (W.E. Merriman), [scofield@shes.ua.edu](mailto:scofield@shes.ua.edu) (J. Scofield).

Why do children who usually show a robust disambiguation effect nevertheless fail to disambiguate across the senses? The answer to this question has the potential to inform theories of both novel word mapping and cross-modal sensory integration. We shall argue that our results support accounts of novel word mapping that grant a critical role to the processes of label retrieval and comparison and that also acknowledge factors that can block the disambiguation effect. Regarding theories of cross-modal integration, we shall argue that our results support the claim that from age three to four years, children become increasingly likely to represent their detection of a cross-modal match as a significant discovery. Consequently, they become more likely to react to the detection of the match in a way that interferes with rejecting it as an exemplar of a second label.

Regarding the role of label retrieval and comparison in the disambiguation effect, it may be significant that the children in [Scofield et al. \(2009\)](#) were not tested for their ability to recall the label that was introduced for the initial training object (e.g., the visual object in Experiment 2). When the children later encountered the training object and a novel object in the new sense modality (e.g., as two tactile objects), and were asked which one was an exemplar of a novel label, they might not have been able to recall the trained label for the training object. Children may only show the disambiguation effect if they spontaneously retrieve the known label for the familiar object and note that it differs from the novel label that they are considering extending to the object. In support of this possibility, [Grassmann, Schuzle, and Tomasello \(2009\)](#) found that children did not avoid mapping a novel label onto a familiar kind of object if they could not recall, but only recognize the familiar label for this object.

This familiar label retrieval hypothesis is consistent with both the Mutual Exclusivity and Pragmatic Contrast accounts of novel word mapping. According to the first account ([Markman & Wachtel, 1988](#); [Merriman & Marazita, 1995](#)), the disambiguation effect results from children rejecting the familiar “already-nameable” object to avoid contradicting the default assumption that labels are mutually exclusive. Similarly, according to the Pragmatic Contrast account ([Clark, 1990](#); [Diesendruck & Markson, 2001](#); [Gathercole, 1989](#)), children reject the familiar object to avoid contradicting the default assumption that a speaker will refer to an object with a mutually known referring expression, if one exists. For example, if the child believes that a speaker wants him or her to look at a cup, the speaker will use the word “cup” rather than some unfamiliar word to refer to it.

As [Halberda \(2003, 2006\)](#) has noted, both of these accounts imply that children are not merely drawn to the novel object, but are actively rejecting the object whose name differs from the novel label. Indeed, [Halberda \(2006\)](#) found that when asked which of the two objects was the exemplar of a novel label, preschoolers and adults who were looking at the novel object nearly always looked back at the “already nameable” object before selecting the novel one.

Not all accounts of the disambiguation effect grant a central role to retrieval of the label for the already-nameable object, however. Some emphasize positive properties of the novel object. For example, according to the Novel-Names-for-Nameless-Categories (N3C) principle ([Golinkoff, Hirsch-Pasek, Bailey, & Wenger, 1992](#); [Mervis & Bertrand, 1994](#)), selecting the novel object satisfies children’s motivation to find a label for a salient novel category. Another proposal is that children may have simply learned that novel words are more likely to denote physical entities that feel new rather than feel familiar ([Merriman, Marazita, Evey-Burkey, & Jarvis, 1996](#)). According to various competitive activation models, the disambiguation effect results simply because the child’s representation of the novel object receives more activation from the novel word than his or her representation of the familiar object does ([McMurray, Horst, & Samuelson, 2012](#); [Merriman, 1999](#); [Regier, 2005](#)). No explicit role for label retrieval is proposed in these models.

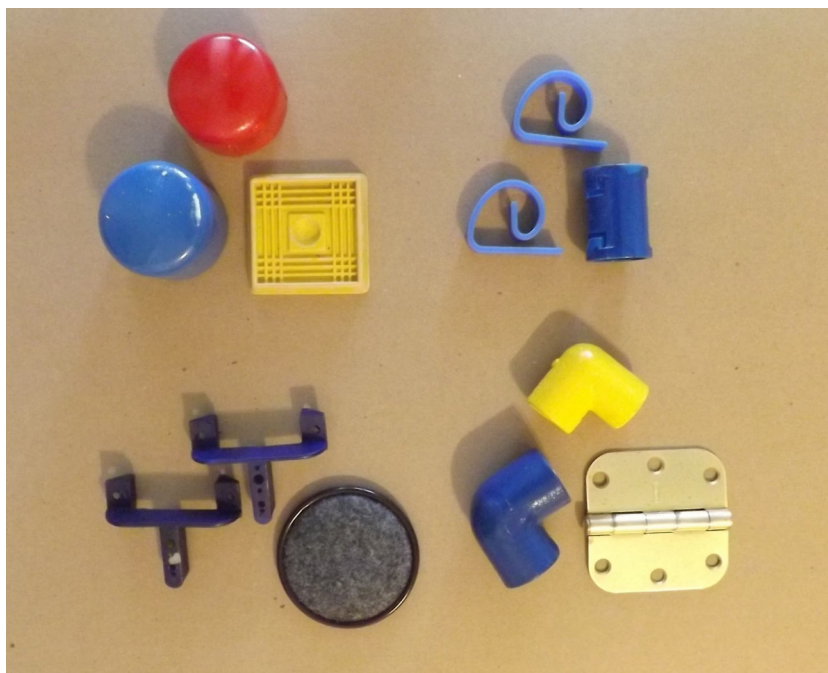
If children in [Scofield et al. \(2009\)](#) failed to disambiguate because they did not retrieve the label that had been trained for the already-nameable object, then children might disambiguate if a stronger label training procedure were used. In particular, they might show the effect if the label training procedure insured that the children could recall the trained label. In Experiment 1, 3- and 4-year-olds were repeatedly trained and tested on a label for a visually-presented object until they were able to recall it. The training object and a novel object were then presented tactilely, and on the critical trials, children were asked to select the referent of a novel label. They were credited with showing the disambiguation effect if they selected the novel object more often than the training object. The experiment also assessed whether children who were better able to judge their knowledge of object labels showed a stronger disambiguation effect. Children’s ability to make such judgments has been found to predict the strength of disambiguation effect in standard non-cross-modal paradigms ([Marazita & Merriman, 2004](#)).

To foreshadow our results, the children in Experiment 1 did not show the disambiguation effect, although unlike the children in [Scofield et al. \(2009\)](#), they did not favor the already-nameable tactile object either. Unexpectedly, some selected the already-nameable tactile object before the experimenter even mentioned the label that she wanted them to map.

Experiments 2 and 3 tested an explanation for this last observation as well as for the general failure of children in Experiment 1 to show a cross-modal disambiguation effect. According to this explanation, children’s discovery that one of the tactile choice objects matched the visual training object caused them to react in ways that interfered with executing the processes that usually produce the disambiguation effect. The procedures used in Experiments 2 and 3 were designed to control for these possible reactions.

## 2. Experiment 1

On each of four trials, 3- and 4-year-olds were repeatedly taught a label for a visual training object until they showed that they could recall the label. They then examined two hidden objects with their hands. One of these objects was identical to the visual training object and the other was novel. On two of the trials, they were asked to choose the tactile object that was the



**Fig. 1.** The stimuli used in the label extension task. Each stimulus set consisted of 3 novel objects, two of which were identical.

referent of the label that had just been trained (i.e., the cross-modal match). On the other two trials, which were the critical ones, they were asked to choose the tactile object that was the referent of a novel label. Children were also administered a separate test of their ability to judge whether various visually-presented objects had known names.

Two versions of Experiment 1 were run, one after the other. Results did not differ, and so were combined to increase the statistical power of analyses. The versions differed in how the request to find the referent of a novel label was posed on the novel label trials. In one version (basic condition), children were not reminded of the trained label immediately before being asked to find the referent of the novel label. In the other version (contrastive condition), they were given this reminder.

## 2.1. Material and methods

### 2.1.1. Participants

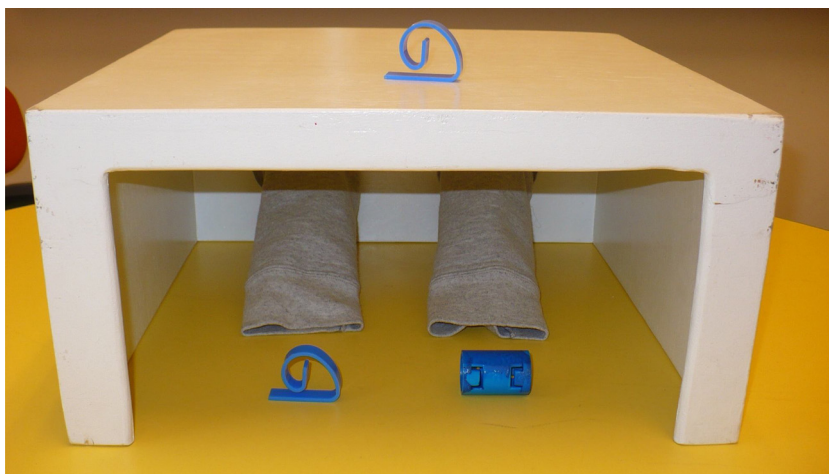
Eleven 3-year-olds ( $M = 43$  months, range = 36–47 months; five boys) and 13 4-year-olds ( $M = 56$  months, range = 52–59 months; seven boys) were tested in the basic condition. Fifteen 3-year-olds ( $M = 43$  months, range = 38–47 months; seven boys) and 17 4-year-olds ( $M = 54$  months, range = 48–58 months; nine boys) were tested in the contrastive condition. An additional seven children were excluded from data analysis due to failure to follow directions. All of the children were recruited from preschools in middle- to upper-class regions of Northeast Ohio. Nearly all were Caucasian and all were monolingual speakers of English. Each child received a sticker for his or her participation.

### 2.1.2. Materials and procedure

After obtaining parental consent, the children participated in a brief 10–15 min session in a quiet room at their preschool. Each child completed a label training and extension task and an object name knowledge judgment task. Task order was counterbalanced.

**Materials.** A white wooden box measuring 16 in  $\times$  17 in  $\times$  8.5 in was used for the cross-modal label extension task. The inside of the box was empty, and one side of the box was open so that the experimenter could transfer objects in and out of the box. The opposite side of the box had two arm holes cut into it. These were 3 inches in diameter and had cotton sleeves attached to them. The side with the arm holes faced the child so he or she could put his or her arms inside the box without seeing inside of it.

A different set of three unfamiliar objects (two of which were identical to each other) was used on each of four trials (see Fig. 1). These objects were small and easy to manipulate, and had names the children did not know (e.g., a plastic t-joint). Six nonsense words (e.g., *zav*, *cobe*, *ferp*, *jeet*, *hust*, and *lide*) were used as either one of four trained labels or two novel labels. None of these words was used on more than one trial, and the order of trial type and novel labels was counterbalanced across all children. Twelve additional objects were used for the object name knowledge judgment task. Six were common, familiar objects (i.e., flashlight, key, sock, toy car, fork, toothbrush) and the other six were uncommon objects that were likely to be unnameable for preschoolers (i.e., plate hanger, tube squeezer, egg slicer, spouncer, latch hook, gel heel cushion).



**Fig. 2.** Example of a label extension trial. The training objects remains visible while children examine two hidden objects inside of the experimental box.

**Warm-up.** The experimenter and child sat opposite of each other at a small table. After the child was comfortable, the experimental box was introduced. As a warm up, the child was asked to close his or her eyes while the experimenter placed a soft, foam ball inside the box. The child was then asked to place his or her arms inside the arm holes, pick up the object, and answer three questions: “*Is it hard or is it soft?*”, “*Is it big or is it small?*”, and finally, “*What is it?*” While there was little agreement on the size of the object (51% said “big”), nearly every child agreed that the object was soft (91%) and was a ball (93%). Each child was provided feedback and shown the object afterward.

**Label training and extension.** The children were told that they were going to play a game. The experimenter explained that she was going to show them an object and tell them the name for it. The children were also instructed that they were not allowed to touch the object; they were only allowed to look at it.

Four label training and extension trials were then administered. On each trial, the child learned a label for a visible object and then was tested for cross-modal extension of either that label (two trials) or a novel label (two trials). A trial began with the experimenter showing the child a novel object and labeling it three times (e.g., “*This is a zav. It’s a zav. You’re looking at a zav.*”). The child was prompted to repeat the name out loud. To ensure that the child had learned the label for the object well enough to recall it later, a distractor task that lasted approximately 5 s followed. The object was removed from sight and the child was asked to state how many fingers the experimenter held up. The child did this for two finger displays. The experimenter then placed the object back on top of the box and asked the child what it was called. If the child recalled the label correctly, the label extension test was then administered. If the child did not recall the label correctly, the experimenter labeled it herself and then repeated the whole training procedure (beginning with, for example, “*This is a zav. It’s a zav. You’re looking at a zav*”) until the child successfully recalled the label. If the child did not recall the label after three training and test cycles, the experimenter taught the name one more time and then proceeded to the label extension test.

For the label extension test, the training object was placed on top of the box so that it remained visible to the child. The experimenter instructed the child to close his or her eyes while she placed two objects inside of the box. One was identical to the training object (i.e., another “zav”) while the other was a different object (see Fig. 2). The child was then instructed to open his or her eyes, place his or her hands through the sleeves, hold the objects that the experimenter placed in each hand, and then indicate which one was the referent of a label. Depending on the trial, the label was either the same one that had been trained for the visible object (the trained label) or a novel label.

In the basic condition, the label request took the form: “*Do you know what a \_\_\_ is? One of these is a \_\_\_ Which one is the \_\_\_?*” On two test trials, the trained label filled the blanks in the form, and on the other two test trials, a novel label filled these blanks. Children were never tested on both labels on a particular trial. The form of the label request was nearly identical in the contrastive condition, except that on the two novel label trials, the first slot was filled by the trained label to highlight the contrast between it and the novel label (e.g., “*Do you know what a zav is? One of these is a tigg. Which one is the tigg?*”). For half of the participants in each condition, the first and fourth trials involved trained label tests; for the other participants, the first and fourth trials involved novel label tests. Thus, order of label test was counterbalanced. Children indicated their response to the extension test questions by shaking, lifting, or extending one of the objects toward the experimenter. The objects remained hidden until after children made their selection. Some children also made a confirming statement (i.e., “this one”) while making their selection. Minimal feedback was provided (e.g., “Ok.”) After children made their selection, the objects were removed, and the next label training and extension trial was presented.

**Object name knowledge judgment.** To test reflective judgment of object name knowledge, the child was shown six familiar and six unfamiliar objects one at a time and asked, “*Do you know the name for this?*” The child was instructed to only say “yes” or “no” and not name the object out loud. The experimenter first provided a short demonstration with one familiar object (a flashlight) and one unfamiliar object (a plate hanger) to make sure the child understood the task. Once the child had

**Table 1**  
Children classified by choices on tests of the trained and novel labels in Experiment 1.

Label test			
Age	# Correct	Trained	Novel
3 Years	0	2	8
	1	3	11
	2	21	7
4 Years	0	1	9
	1	4	10
	2	25	11

responded “yes” or “no” on the test trials, the child was prompted to name any unfamiliar object that he or she had identified as having a known name (i.e., said “yes” when asked to judge whether its name was known). If the children named the (so-called) unfamiliar object correctly, or produced a plausible overextension, that trial was dropped from the computation of the child’s rate of judging as-yet-unnamable objects to have known names ( $M$  trials dropped = 0.96, range = 0–3). None of the six unfamiliar objects were used in the label extension task.

## 2.2. Results

### 2.2.1. Trained label – visual trials to criterion

Children were considered to have learned the visual training object’s label if, after the brief retention interval, they correctly recalled the label when shown the object. Participants often met this criterion on their first attempt (63% of the trials). However, only five 3-year-olds and nine 4-year-olds met the criterion for every trained label on the first recall test. The younger group tended to require more training trials to reach criterion ( $M = 1.67$ ,  $SD = .51$ ) than the older group ( $M = 1.40$ ,  $SD = .41$ ),  $t(54) = 2.22$ ,  $p = .03$ ,  $\eta^2 = .08$ . Failures to meet the criterion (i.e., even after three attempts) were rare (10% of trials).

### 2.2.2. Trained label – tactile label extension

After meeting criterion, the training object and a novel object were placed in the box. On two of four trials, the children were asked to indicate which object was the exemplar of the trained label. Table 1 summarizes how often children chose correctly. Performance was excellent ( $M$  correct = 1.77,  $SD = .54$ , max = 2), and did not vary by age, condition, or age  $\times$  condition. None of the latter factors increased the fit of a log-linear model to the data,  $ps > .10$ .

### 2.2.3. Novel label – tactile label extension

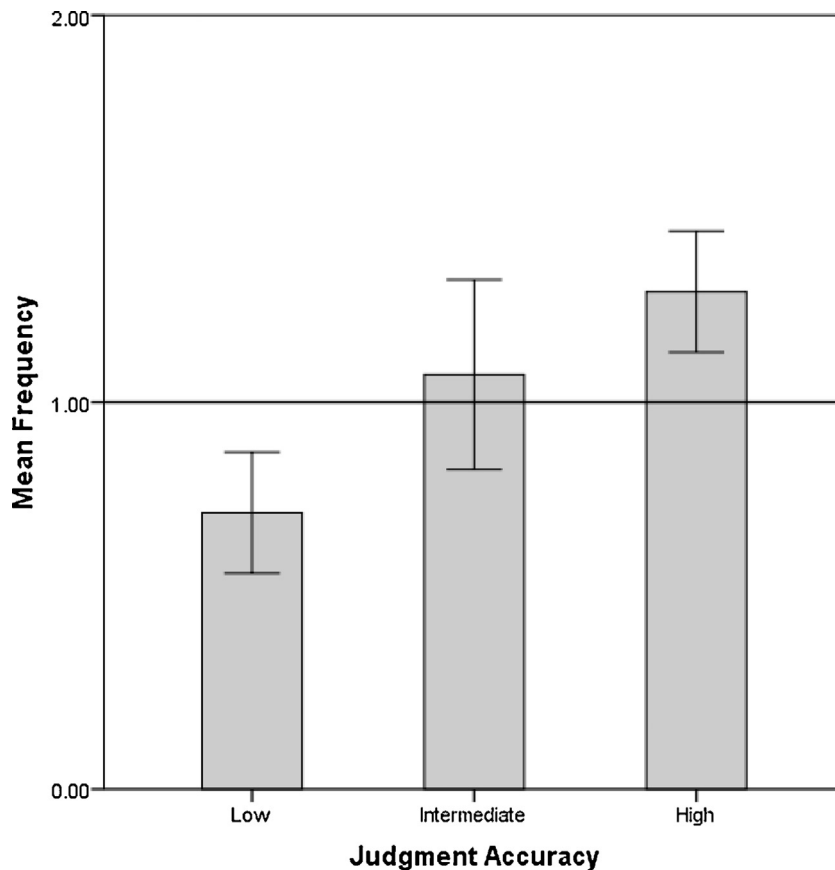
On the other two trials, the children were asked to indicate which object was the exemplar of a novel label. Table 1 summarizes how often children chose correctly. Performance was at chance ( $M$  correct = 1.02,  $SD = .78$ ), and did not vary by age, condition, or age  $\times$  condition. None of the latter factors increased the fit of a log-linear model to the data,  $ps > .10$ .

### 2.2.4. Object name knowledge judgment

Children were more accurate at judging whether they knew the names for the familiar objects (i.e., said “yes”) ( $M = .83$ ,  $SD = .30$ ) than for the unfamiliar objects (i.e., said “no”) ( $M = .59$ ,  $SD = .41$ ),  $t(55) = 3.43$ ,  $p = .001$ . As in previous studies (Marazita & Merriman, 2004; Merriman & Lipko, 2008), overall accuracy of these judgments was positively correlated with age,  $r(54) = .37$ ,  $p = .001$ .

As predicted, children who were more accurate at judging whether they knew various objects’ names also selected the hidden novel object more often on the novel label test trials,  $r(54) = .28$ ,  $p = .04$ . This relation remained significant after age was partialled out,  $r(53) = .28$ ,  $p = .04$ . To explore this relation, the children were split into three groups based on their average name knowledge judgment score: low (range = .20–.575;  $M = .46$ ;  $N = 21$ ); intermediate (range = .60–.80;  $M = .67$ ;  $N = 14$ ); and high (range = .875–1.00;  $M = .98$ ;  $N = 21$ ). Their average frequency of selecting a novel object as a referent of a novel label is depicted in Fig. 3 (max = 2). The high scorers avoided label overlap more often than not ( $M$  number of selections = 1.29; no preference = 1.00), although this tendency only exceeded chance by a one-tailed test,  $t(20) = 1.83$ ,  $p = .04$ . In contrast, the exact opposite tendency was evident in the low scorers ( $M = 0.71$ ),  $t(20) = -1.83$ ,  $p = .04$ . The intermediate scorers neither favored label overlap nor avoided it ( $M = 1.07$ ,  $t(13) = .29$ ,  $p = .78$ ).

Accuracy of object name knowledge judgment was also related to how often the trained label was extended to the tactile version of the training object, even though this mapping frequency was near ceiling,  $r(54) = .31$ ,  $p = .02$ . Among those whose name knowledge judgment score was above the median, 26 extended the trained label correctly on both tactile test trials and two extended it correctly on one such test trial. Among those whose judgment score was below the median, 20 extended the trained label correctly on both tactile test trials, five extended it correctly on one test trial, and three extended it correctly on neither test trial.



**Fig. 3.** For Experiment 1, novel object selections on novel label trials as a function of object name knowledge judgment accuracy. Error bars are  $\pm 1$  standard error of each mean.

### 2.3. Discussion

When tested on the trained label, preschoolers showed that they could integrate lexical information about an object across sense modalities. That is, after learning a label for a visual object, 3- and 4-year olds consistently extended this label to a tactile version of this object rather than to a novel tactile object. This result replicated [Scofield et al. \(2009\)](#) (Experiment 2). Note that the test of the trained label did not require children to retrieve this label. The experimenter presented the label and children had to retrieve a representation of the object for which it had been trained.

When tested on a novel label, children chose the cross-modal match as often as the novel object. Just as in [Scofield et al. \(2009\)](#) (Experiment 2), the children did not disambiguate across the senses. The children in the experiment by [Scofield et al. \(2009\)](#) actually chose the cross-modal match more often than the novel object, but this finding was not replicated. This discrepancy in results can be interpreted in line with the familiar label retrieval hypothesis. That is, the stronger procedures used in the current experiment to train the label for the visual object may have made it more likely that when children were tested on the novel label, they retrieved the trained label, applied it to the cross-modal match, and noted that this label differed from the novel label. This realization may have worked against a general tendency to select the cross-modal match in response to a request to select one of the objects.

Individual differences in children's tendency to disambiguate were associated with how accurately they judged their own knowledge of object names. Label retrieval may account for this relation as well. As already argued, to avoid mapping the novel label onto the training object, the child must retrieve the label that had been trained for this object. Children who judge their object name knowledge more accurately than their peers tend to retrieve names for objects more rapidly than their peers do ([Lipowski & Merriman, 2011](#)). [Merriman and Lipko \(2008\)](#) proposed that the greater a child's name retrieval ability, the easier it should be for the child to learn that failure to retrieve the name for an object is a fairly reliable cue that they do not know its name. Alternatively, the correlation between disambiguation and name knowledge judgment could reflect a stronger tendency to favor extending a novel label to a novel object among those who represent this option in terms of knowledge states, that is, as mapping a label "I don't know" onto a kind of object "I don't know" ([Marazita & Merriman, 2004](#)).

Although the children who judged their object name knowledge the most accurately showed a disambiguation effect, this effect was not very strong (see Fig. 3). This result was somewhat surprising because every child demonstrated recall of the visual object's trained label immediately before the cross-modal test and every child performed at ceiling on the trained label trials. In the contrastive condition, children were even reminded of the trained label immediately before being tested on the novel label. All of these factors should have promoted a tendency to avoid mapping the novel label onto the already-nameable object. Some other factor(s) must have opposed this solution to the novel label mapping problem.

We propose that one of these factors may have been discovery-based interference. When children were first asked to examine the two tactile choice objects, it is likely that they readily detected the match between one of the objects and the visual training object. Even pre-linguistic have been found to spontaneously detect such tactile-visual matches (Gottfried, Rose, & Bridger, 1977; Hernandez-Reif & Bahrick, 2001; Meltzoff & Borton, 1979 see Scofield et al., 2009, for a review). According to the discovery-based interference hypothesis, after children detected the match between one of the tactile objects and the visual training object, at least some wanted to let the experimenter know that they have made this discovery and/or expected the experimenter to ask about it. Such a desire/expectation may have interfered with comprehending the experimenter's request to select the referent of a novel label. Thus, some children may have selected the already-nameable tactile object without retrieving its trained label or noting that its trained label mismatched the novel label. In addition, the children's discovery that one of the tactile objects matched the visual training object may have elicited a surprise reaction that interfered with comprehending the experimenter's request. A common consequence of surprise is disruption of ongoing processes and reallocation of processing to the surprise-inducing stimulus (Reisenzein, 2000; Roseman, 2013).

In Experiment 2, this potential interference was reduced or eliminated by giving children an opportunity to inform the experimenter about the cross-modal match before the test of the novel label (i.e., before the test of the disambiguation effect.) Two conditions were run. In the labeled condition, every test trial began with a request to select the tactile object that was the referent of the trained label. In the unlabeled condition, every test trial began with a request to select the tactile object that was "the same as" the visual training object (which was still in view in both conditions). If children responded correctly to either of these initial requests, then they would have satisfied any expectation or desire they might have had about communicating about this object. Also, any surprise at having discovered this match would have had a chance to dissipate. After the children in each condition responded to the initial request, they were asked to make two other choices between the two tactile objects, such as deciding which one was heavier. Finally, they were asked to decide which tactile object was the referent of a novel label.

Because discovery-based interference was assumed to be eliminated or reduced in each condition, children in each condition were expected to show the cross-modal disambiguation effect. However, if some children occasionally failed to spontaneously retrieve the trained label for the cross-modal match when considering whether it was an exemplar of the novel label, the disambiguation effect would be weaker in the unlabeled than in the labeled condition.

### 3. Experiment 2

#### 3.1. Material and method

##### 3.1.1. Participants

The labeled condition consisted of 16 3-year-olds ( $M=42$  months, range = 36–47 months) and 16 4-year-olds ( $M=54$  months, range = 49–59 months). The unlabeled condition also consisted of 16 3-year-olds ( $M=43$  months, range = 36–47 months) and 16 4-year-olds ( $M=53$  months, range = 48–59 months). Every age  $\times$  condition group had equal numbers of boys and girls. The children were recruited from the same types of preschools as were sampled in Experiment 1. An additional four children were excluded from analyses for failure to follow directions (3) or because they required more than 2.5 training trials on average to recall a trained label (1). All of the children were monolingual speakers of English and nearly all were Caucasian. Each child received a sticker for participating.

##### 3.1.2. Materials and procedure

The materials and procedure were the same as in Experiment 1 except for changes to the tactile test trials. After successfully recalling the visual object's trained label, children placed their hands in the box and picked up both tactile objects. The experimenter then asked the child to indicate which one was the training object (i.e., the cross-modal match). The wording of this request varied according to condition. In the labeled condition, the trained label was used (e.g., "Do you know what a zav is? One of these is a zav. Which one is the zav?"). In the unlabeled condition, the experimenter asked instead, "Which one [looking in the direction of the tactile objects] is the same as that one [gazing at the visual version of the training object which had been placed on top of the box]?" Children in both conditions were then asked two distractor questions about the tactile objects, followed by a request to select the referent of a novel label (e.g., "Do you know what a tigg is? One of these is a tigg. Which one is the tigg?") Every child completed four such trials.

The distractor questions were intended to convey that either tactile object could be the correct referent of a request by the experimenter. Some distractor questions had correct answers ("Which one is smaller?"), while others did not ("Which one do you like better?") Two distractor questions were asked immediately before the novel label test to eliminate any expectation regarding the particular object the experimenter might ask about. Children indicated their response by shaking, lifting, or

**Table 2**  
Children classified by choices on tests of the trained label in Experiment 2.

Condition			
Age	# Correct	Labeled	Unlabeled
3 Years	0	0	0
	1	1	0
	2	1	0
	3	5	2
	4	9	14
4 Years	0	0	0
	1	0	1
	2	1	3
	3	3	1
	4	12	11

extending one of the objects toward the experimenter. The objects remained hidden, however, until after children responded to the subsequent novel label test. The order of the pairs of distractor questions was counterbalanced over participants.

### 3.2. Results

#### 3.2.1. Warm up trials

Similar to Experiment 1, children's performance on the warm up trials was excellent. Although they disagreed about whether the object was big or small, 94% agreed that it was soft and that it was a ball.

#### 3.2.2. Trained label – visual trials to criterion

On the majority of trials (73%), children recalled the trained label after only one attempt. Ten 3-year-olds and 17 4-year-olds recalled the trained label on the first recall test of all four trials. The age difference in average number of trials needed to learn to produce the label (3-year-olds:  $M = 1.52$ ,  $SD = .53$  versus 4-year-olds:  $M = 1.28$ ,  $SD = .40$ ), was in the same direction as Experiment 1, but was only significant by a one-tailed test,  $t(57.08) = 1.99$ , one-tailed  $p = .03$ . Failures to meet the criterion (i.e., even after three training trials) were rare (3% of trials).

#### 3.2.3. Identification of the cross-modal match

On each trial, after having learned the trained label for the visual object, children were asked to examine the two tactile objects and pick the cross-modal match. The trained label was used in this request in the labeled condition, but not the unlabeled condition. Table 2 summarizes how often children chose correctly. Overall, performance was excellent ( $M = 3.58$ ,  $SD = .77$ ). Because of the distribution of responses was non-normal, a 2 (age)  $\times$  2 (condition)  $\times$  2 (number correct: 4 vs. fewer) log-linear analysis was conducted. Performance did not vary by age, condition, or age  $\times$  condition.

#### 3.2.4. Distractor questions

After the request to select the cross-modal match, children received two distractor questions which they were to answer by selecting one of the tactile objects. Children selected the cross-modal match in response to one of these questions and the novel object in response to the other on a greater proportion of trials ( $M = .59$ ) than they either selected the cross-modal match twice ( $M = .09$ ) or the novel object twice ( $M = .31$ ). Although the children rarely chose the cross-modal match in response to both distractor questions, 3-year-olds were more likely than 4-year-olds to respond this way ( $M = .16$ ,  $SD = .26$  and  $M = .03$ ,  $SD = .08$ , respectively),  $t(37.41) = 2.59$ ,  $p = .01$ . Only one 3-year-old and one 4-year-old restricted their selections to one type of object (i.e., the cross-modal match or the novel object) in response to the distractor questions on all four trials, however.

#### 3.2.5. Novel label – tactile label extension

At the end of each test trial, the children were asked to select the referent of a novel label. Table 3 summarizes how often children chose the novel object. An age  $\times$  condition analysis of variance of these responses could not be conducted because of heterogeneity of variance; main effects were examined with  $t$  tests. A Bonferroni correction was used to correct for the fact that both age and condition comparisons were made (i.e., critical  $p$  was set to .025). Regarding age, most 4-year-olds chose the novel object on every trial ( $M = 3.50$ ,  $SD = .88$ ,  $\max = 4$ ), whereas 3-year-olds showed only a weak tendency to select this object rather than the training object ( $M = 2.47$ ,  $SD = 1.32$ ),  $t(54.02, \text{equal variances not assumed}) = 3.68$ ,  $p = .001$ . The younger group's frequency of selecting the novel object did not exceed chance,  $t(31) = 2.01$ ,  $p = .06$ . Regarding condition, frequency of selecting the novel object in the labeled condition ( $M = 3.25$ ,  $SD = 0.98$ ) did not differ from that in the unlabeled condition, ( $M = 2.72$ ,  $SD = 1.40$ ),  $t(55.68) = 1.76$ ,  $p = .08$ . Selection of the novel object exceeded chance in both the labeled,  $t(31) = 7.19$ ,  $p < .001$ , and unlabeled condition,  $t(31) = 2.91$ ,  $p = .01$ . Although a two-way analysis of variance could not be



**Table 3**  
Children classified by choices on tests of the novel label in Experiment 2.

Condition			
Age	# Correct	Labeled	Unlabeled
3 Years	0	0	4
	1	3	0
	2	3	4
	3	6	4
	4	4	4
4 Years	0	0	0
	1	0	2
	2	0	2
	3	3	3
	4	13	9

performed, the mean difference between the labeled and unlabeled condition was somewhat larger in the 4-year-olds (3.81 vs. 3.19) than in the 3-year-olds (2.69 vs. 2.25). Neither difference was significant, however (4-year-olds:  $t(18.90) = 2.12$ ,  $p = .048$ ; 3-year-olds:  $t(30) = .94$ ,  $p = .36$ ). Although this last result does not constitute sufficient support for the claim that condition affected children's selections, 3-year-olds' frequency of selecting the novel object exceeded chance in the labeled condition,  $t(15) = 2.55$ ,  $p = .02$ , but not the unlabeled condition,  $t(15) = .66$ ,  $p = .52$ .

### 3.2.6. Object name knowledge judgment

Children were more accurate at judging whether they knew the names for familiar objects ( $M = .89$ ,  $SD = .21$ ) compared to unfamiliar objects ( $M = .56$ ,  $SD = .41$ ),  $t(63) = 5.44$ ,  $p = .000$ . The overall accuracy of these judgments increased with age,  $r(62) = .43$ ,  $p = .000$ , replicating Experiment 1. As in Experiment 1, judgment accuracy was positively associated with how often a child extended novel labels to novel objects,  $r(62) = .31$ ,  $p = .01$ . When this relation was examined within condition, however, it was significant in the unlabeled condition,  $r(30) = .42$ ,  $p = .02$ , but not the labeled condition,  $r(30) = .19$ ,  $p = .29$ .

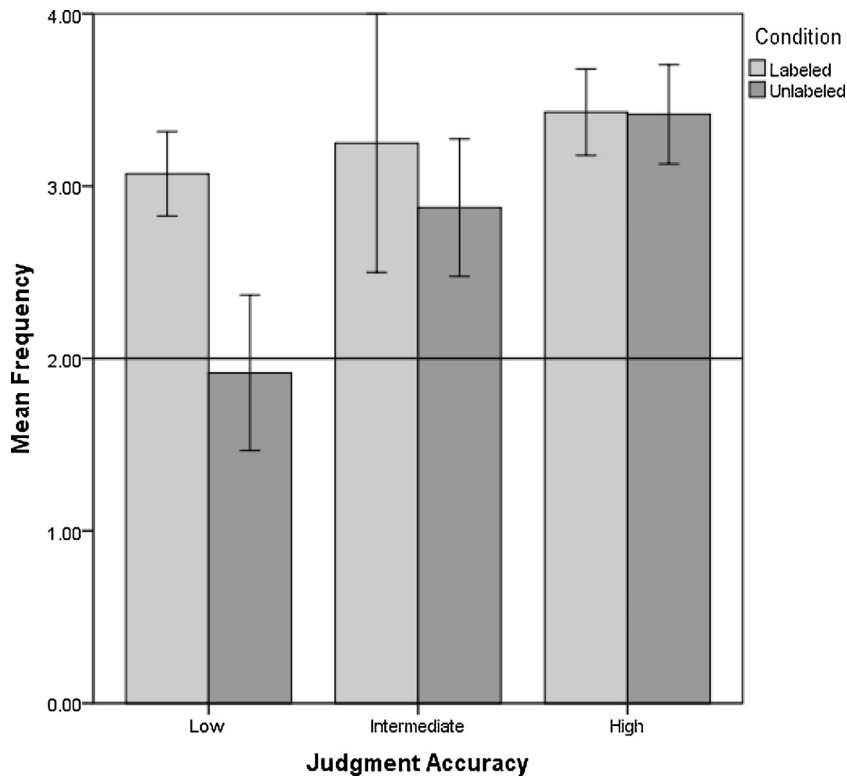
To further examine the relation in the unlabeled condition, children were split into three groups based on their object name knowledge judgment score: low (range = .37–.50;  $M = .49$ ;  $N = 12$ ); intermediate (range = .60–.83;  $M = .71$ ;  $N = 8$ ); and high (range = .88–1.00;  $M = .96$ ;  $N = 12$ ). The low scorers extended the novel label onto the novel object with a frequency no different from chance ( $M = 1.92$ ,  $SD = 1.56$ , chance = 2),  $t(11) = -.19$ ,  $p = .86$ , whereas the high scorers showed a strong preference for this mapping ( $M = 3.42$ ,  $SD = 1.00$ ),  $t(11) = 4.93$ ,  $p = .000$ . The intermediate scorers showed a moderate preference for it ( $M = 2.88$ ,  $SD = 1.13$ ),  $t(7) = 2.20$ , one-tailed  $p = .03$ . When the accuracy of object name knowledge judgment was partialled out, the correlation between age and frequency of extending novel labels onto novel objects in this condition was no longer significant,  $r(29) = .07$ ,  $p = .73$ . Thus, in the unlabeled condition the greater frequency with which older children disambiguated was accounted for by their greater ability to make reflective judgments of their object name knowledge.

Fig. 4 depicts novel label extension performance as a function of object name knowledge judgment accuracy in both the unlabeled and labeled conditions. Condition only affected the novel label extension of the children who showed no ability to judge whether objects had known names (i.e., low scorers). In the unlabeled condition, these children did not consistently map novel labels onto novel objects ( $M = 1.92$ ,  $SD = 1.56$ ), but in the labeled condition, they did ( $M = 3.15$ ,  $SD = 0.90$ ),  $t(17.26) = 2.25$ ,  $p = .03$ . In contrast, those children who showed at least some ability to judge object name knowledge (i.e., intermediate and high scorers) disambiguated with comparable frequency in the unlabeled and labeled conditions (3.20 and 3.39, respectively),  $t(36) = .56$ ,  $p = .58$ .

### 3.3. Discussion

Results supported the discovery-based interference hypothesis. In contrast to Experiment 1, children in both conditions tended to disambiguate across the senses. By beginning every test trial with a request to select the cross-modal match, children were allowed to communicate their discovery that one of the tactile objects matched the training object. Therefore, when then asked which one was the referent of the novel label, their performance could not be disrupted by a desire or expectation to communicate their discovery of the match. Also, any surprise that they may have experienced at having made this discovery would have had a chance to dissipate.

Four-year-olds benefitted from the procedural changes that were implemented in Experiment 2 more than 3-year-olds did. Even in the unlabeled condition, where the trained label was not used in the request for the cross-modal match, the majority of 4-year-olds mapped novel labels onto novel objects on every trial. The mean proportion of trials in which they selected the novel object in this condition (.80) exceeded the near-chance-level rate (.55; chance = .50) shown by the 4-year-olds in Experiment 1,  $t(44) = 2.19$ ,  $p = .03$ . In the labeled condition, an even greater proportion of 4-year-olds selected the novel object on every trial; the difference between conditions was not significant, however. So even if they were just asked



**Fig. 4.** For Experiment 2, novel object selections on novel label trials as a function of condition and object name knowledge judgment accuracy. Error bars are  $\pm 1$  standard error of each mean.

to identify the tactile object that was “the same as” the visual training object, 4-year-olds avoided this object in the test of novel label. They did not need to be reminded of the “known” label for this object.

Three-year-olds’ tendency to avoid label overlap was significant in the labeled condition, but not in the unlabeled condition at a rate (.56) that did not differ from chance or from the rate shown by 3-year-olds in Experiment 1 (.48),  $t(40) = 0.68$ ,  $p = .50$ . Even in the labeled condition this tendency was weak ( $M$  rate = .67). Because conditions did not differ significantly in the 3-year-olds, there is not sufficient support for the claim that reminding this age group of the “known” label for one of the tactile objects strengthened their disambiguation effect. The reason why this effect was rather weak even in the labeled condition will be addressed in Section 5.

Although 4-year-olds’ strong tendency to disambiguate across the senses in Experiment 2 is consistent with the discovery-based interference hypothesis, two alternative explanations need to be ruled out. First, in Experiment 1, children were tested on trained labels on some trials and novel labels on other trials. Children in Experiment 1 may have been disrupted by switching between the two types of labels or children in Experiment 2 may have benefitted from the greater practice with novel label tests.

The second alternative explanation is related to another procedural difference. Only in Experiment 2 were children asked distractor questions about the tactile objects before the test of the novel label. These distractor questions (e.g., “Which one do you like better?”) were intended to communicate that either tactile object could be the correct referent of a request by the experimenter. However, these questions may have promoted further exploration of the tactile objects, increasing children’s likelihood of retrieving and applying the trained label to the tactile version of the training object, which in turn may have promoted avoiding mapping the novel label to it.

In Experiment 3, 4-year-olds were tested using procedures that differed from those of Experiment 1 in only one way. As in Experiment 1, a novel label was tested on two trials and the trained label was tested on two trials, and the children were not asked distractor questions about the tactile objects. The only difference was that in Experiment 3, every test trial began with a request to select the object that was “the same as” the visual training object. This procedure, which had been followed in the unlabeled condition of Experiment 2, was intended to prevent children’s discovery of the cross-modal match from interfering with their response to the request to map the novel label to one of the tactile objects. Three-year-olds were not tested in Experiment 3 because this age group did not disambiguate in the unlabeled condition of Experiment 2.

## 4. Experiment 3

### 4.1. Method

#### 4.1.1. Participants

Twenty-four 4-year-olds ( $M = 54$  months; range = 49–59 months; 14 boys) were recruited from preschools similar to those sampled in Experiments 1 and 2. All of the children were monolingual speakers of English and nearly all were Caucasian. Each child received a sticker for participating.

#### 4.1.2. Materials and procedure

The materials and procedure were identical to Experiment 1 except every child was asked to identify the cross-modal match before they were asked to select the referent of a label. The cross-modal match request was similar to that of the unlabeled condition in Experiment 2. That is, after recalling the visual training object's label (e.g., "zav") and placing their hands inside of the box, children were asked, "Which one is the same as that one [gazing at the visual training object on top of the box]?" On some trials, children were then asked to extend the trained label (i.e., "Do you know what a zav is? One of these is a zav. Which one is the zav?"). On others, children were asked to extend a novel label (i.e., "Do you know what a tigg is? One of those is a tigg. Which one is the tigg?"). Trial type was counterbalanced so that some children extended the trained label on the first and fourth trials, while others extended a novel label on these trials. As in the previous experiments, children also completed an object name knowledge judgment task.

### 4.2. Results

#### 4.2.1. Warm up trials

Performance was similar to Experiments 1 and 2. Children disagreed about whether the object was big or small, but most agreed that it was soft (88%) and that it was a ball (96%).

#### 4.2.2. Trained label – visual trials to criterion

On the majority of trials (88%), participants recalled the trained label on their first attempt. Sixteen children did so on all four trials. Failures to meet the criterion (i.e., even after three attempts) were rare (2% of trials).

#### 4.2.3. Identification of the cross-modal match

As in Experiment 2, children readily identified the cross-modal match. Performance was near ceiling ( $M = 3.83$ ,  $SD = .48$ ;  $\max = 4$ ). Only three children failed to identify the match correctly on all four trials. Of these children, two chose correctly on three out of the four trials, and one chose correctly on two out of the four trials.

#### 4.2.4. Trained label – tactile label extension

On two of the four trials, children were asked to indicate which tactile object was the exemplar of the trained label immediately after identifying the cross-modal match. Performance was excellent ( $M = 1.71$ ,  $SD = .62$ ) and comparable to that of Experiment 1 ( $M$  for 4-year-olds = 1.80,  $SD = .48$ ).

#### 4.2.5. Novel label – tactile label extension

On the other two trials, children were asked to indicate which tactile object was the exemplar of a novel label immediately after identifying the cross-modal match. Unlike Experiment 1, performance was near ceiling ( $M = 1.83$ ,  $SD = .48$ ). Twenty-one 4-year-olds selected the novel tactile object on both trials, two selected this object on one trial, and only one failed to select this object on either trial. This pattern differed considerably from what was observed in Experiment 1. A 2 (Experiment)  $\times$  3 (Trials correct: 2, 1, 0) Fisher's Exact Probability test revealed that this difference in performance is unlikely to occur by chance ( $p = .00068$ ).

#### 4.2.6. Object name knowledge judgment

Children were accurate at judging whether they knew the names for both familiar objects ( $M = .98$ ,  $SD = .10$ ) and unfamiliar objects ( $M = .85$ ,  $SD = .25$ ). Overall, their judgments were more accurate ( $M = .90$ ,  $SD = .16$ ) than those of the 4-year-olds in Experiment 1 ( $M = .79$ ,  $SD = .23$ ),  $t(51.59, \text{equal variances not assumed}) = 2.08$ ,  $p = .04$ . Correlations between judgment accuracy and label mapping performance were not computed because of restricted range (i.e., nearly every child performed at ceiling on these measures).

### 4.3. Discussion

Results supported the discovery-based interference hypothesis. In contrast to Experiment 1, but similar to Experiment 2, 4-year-olds showed a strong tendency to disambiguate across the senses. The only procedural difference between the current experiment and Experiment 1 was that after learning the label for the visual object, but before being tested on a label for the tactile objects, children in the current experiment were asked to select the object that was "the same as" the visual

training object. This procedure was intended to reduce or eliminate discovery-based interference by satisfying any desire or expectation to communicate about the discovered cross-modal match and by allowing any surprise at having made this discovery to dissipate.

An alternative explanation does need to be addressed. Asking 4-year-olds to first identify the tactile object that was “the same as” the visual training object may have promoted their disambiguation effect only because it strengthened their mapping of the trained label to this tactile object. This explanation presupposes that 4-year-olds did not experience discovery-based interference in Experiment 1, but rather just had too weak a tendency to spontaneously retrieve the trained label as the name for the tactile version of the training object. One piece of evidence against this presupposition is that children’s performance in Experiment 1 did not vary by age. One would expect 3-year-olds to have weaker name retrieval tendencies than 4-year-olds, but the two age groups did not differ in how frequently they avoided mapping the novel label onto the already-nameable tactile object. Also, the alternative explanation is not consistent with the results of a recent experiment that used the same procedures as Experiment 1, but reversed the direction of cross-modal generalization (Scofield & Merriman, 2013). Children learned a label for a tactile object, and then on the critical trials, were asked whether some novel label referred to a visual version of the training object or a novel visual object. Three-year-olds showed the disambiguation effect, but 4-year-olds did not. This result is consistent with our claim that 4-year-olds are more likely than 3-year-olds react to the discovery of a cross-modal match in ways that interfere with the processes that underlie the disambiguation effect.

## 5. General discussion

As in Scofield et al. (2009) (Experiment 2), 3- and 4-year-olds recognized that a label that had been trained for a visual object also applied to the same object in the tactile modality. However, in contrast to Scofield et al. (2009), children’s decision about whether to avoid mapping a second, novel label to this same tactile object varied across experiments and individuals. We propose that this variability can be explained by variation in retrieval of the trained label for this object and by whether or not children had an opportunity to communicate their discovery that this object was identical to its visual counterpart.

According to the familiar label retrieval hypothesis, a child will only avoid mapping a novel label onto an already-nameable object if he or she retrieves the known label for this object when deciding whether it might be a referent of the novel label. According to both the Mutual Exclusivity (Markman & Wachtel, 1988; Merriman & Bowman, 1989) and Pragmatic Contrast accounts (Clark, 1990; Diesendruck & Markson, 2001; Gathercole, 1989), children must note that the known label mismatches the novel label (Halberda, 2003). Children’s tendency to allow label overlap in instances in which they comprehend a known label for an object, but cannot produce it (Grassmann et al., 2009) is consistent with the familiar label retrieval hypothesis.

Experiment 1 provided indirect support for the familiar label retrieval hypothesis. In contrast to the children tested by Scofield et al. (2009), the participants in Experiment 1 did not prefer to map the novel label onto the already-nameable object rather than the novel object—they chose both objects equally. This difference may reflect our use of stronger procedures for training the label for the visual object in Experiment 1 than had been used by Scofield et al. (2009). The stronger procedures may have increased the likelihood that children recalled the trained label and applied it to the cross-modal match during the test of the novel label.

Label retrieval could also account for findings concerning the relation between how often individuals disambiguated and how accurately they judged their name knowledge. These two variables were positively correlated in both Experiment 1 and the unlabeled condition of Experiment 2. The primary error made by inaccurate judges of object name knowledge is to report knowing a name for an object that they cannot actually name (Marazita & Merriman, 2004). This error tendency may stem from less efficient name retrieval processes and/or a weaker tendency to try to retrieve labels for objects. Poorer judges of name knowledge have been found to name familiar kinds of objects less rapidly than other children (Lipowski & Merriman, 2011).

If the accuracy of name knowledge judgment is a marker for the strength of name retrieval processes, and the familiar label retrieval hypothesis is valid, then it makes sense that the accuracy of this judgment would correlate with avoidance of label overlap in Experiment 1 and the unlabeled condition of Experiment 2, but not the labeled condition of Experiment 2. Only in the latter condition were children asked to verify that the trained label applied to the cross-modal match. Because children nearly always succeeded in verifying this mapping, even those with weaker name retrieval processes likely represented the cross-modal match by the trained label during the ensuing test of the novel label.

According to the discovery-based interference hypothesis, children’s discovery that one of the tactile objects matches the visual object in shape evokes reactions that interfere with the disambiguation effect. They may want to let the experimenter know that they have made this discovery or expect the experimenter to ask about it. They may also experience surprise at the discovery. These reactions then interfere with comprehending the request to select the referent of a novel label. Consequently, the children often select the already-nameable tactile object without retrieving its trained label or noting that its trained label mismatches the novel label.

There was evidence that 4-year-olds were influenced by discovery-based interference. They showed no tendency to disambiguate in Experiment 1, but showed a strong tendency in Experiments 2 and 3. Experiment 1 was the only one in which participants did not have the opportunity to communicate their discovery of the cross-modal match before being

tested on the novel label. Indeed, the only change in procedure from Experiments 1 to 3 involved inserting a request to identify the cross-modal match immediately before the label test.

Three-year-olds showed a significant tendency to disambiguate in the labeled condition of Experiment 2, but did not show it in either the unlabeled condition of Experiment 2 or in Experiment 1. (This age group was not included in Experiment 3). The reason that they only showed the disambiguation effect when first asked to identify the tactile object that was an exemplar of the trained label is likely that this procedure strengthened their subsequent tendency to retrieve this label for this object when considering whether to apply the novel label to it.

There was no evidence that 3-year-olds were affected by discovery-based interference. They did not show the disambiguation effect in the unlabeled condition of Experiment 2 even though they correctly identified the tactile object that was the “same as” the visual training object before they were asked to decide whether this object or a novel tactile object was the referent of a novel label.

Even though the procedures used in the labeled condition of Experiment 2 should have promoted label retrieval (and reduced discovery-based interference), the 3-year-olds in this condition disambiguated on only two-thirds of the trials. Their working on memory resources may not have been adequate to support consistently executing all of the processes required to infer that the novel tactile object was the referent of the novel label. Another possibility is that they were negatively affected by the distractor questions posed in Experiment 2. These questions, which were intended to communicate that the experimenter was equally likely to ask about either object, may have shifted children’s attention to properties that are not salient in the visual modality. For example, one of the distractor questions was, “Which one is heavier?” While weight may be a salient feature of a tactile object, the children may not have encoded the weight of the visual training object. Thus, even though the 3-year-olds usually succeeded in identifying the tactile version of the training object by the trained label, the distractor questions may have shifted their attention to other features of this object, reducing their tendency to represent it by its trained label. According to [Bushnell and Baxt \(1999\)](#), the varying salience of some properties across modalities can explain why young children’s cross-modal matching is sometimes less accurate than their within-modality matching. Future research should examine whether 3-year-olds’ tendency to disambiguate across the senses can be increased by testing the novel label immediately after the children identify the cross-modal match as an exemplar of the trained label.

Previous research has shown that even very young children will spontaneously inform an adult about having discovered an object of mutual interest. In a study by [Carpenter, and Tomasello \(2010\)](#), 18-month-olds played with a set of toys with one experimenter and a different set of toys with a second experimenter. Later, one of the experimenters led the infants to a room where there was a picture of each type of toy. The majority of infants spontaneously pointed towards the toy that they and the accompanying experimenter had played with earlier (see also [Moll, Richter, Carpenter, & Tomasello, 2008](#); [Saylor & Ganea, 2007](#)). Similarly, [Liszkowski, Carpenter, and Tomasello \(2007\)](#) found that 12-month-olds pointed more toward an event that an experimenter had previously expressed interest in, even if the experimenter was already aware that it was occurring.

Despite this evidence of an early developing tendency to communicate a discovery, 3-year-olds in the current study may not have desired or expected to communicate their discovery of the cross-modal match. They may have assumed that because the experimenter had visual access to the tactile choice objects as well as the training object, she did not need to be informed of the cross-modal match. Only children with a more advanced theory of mind may realize that the experimenter does not know that they have made this discovery, and so only these children may desire or expect to communicate about it. It is only after their fourth birthday that most children understand that a teacher’s belief about what a learner does not know, rather than the learner’s actual ignorance, determines whether teaching will occur ([Ziv & Frye, 2004](#)). Moreover, only older children understand that teachers sometimes ask for information that they themselves already possess in order to determine if the learner also possesses it ([Ziv, Solomon, & Frye, 2008](#)).

Our account of the current findings implies that in the typical test of disambiguation (i.e., a non-cross-modal one), the already-nameable object must not evoke discovery-based interference. If it did, then children would not show such a robust tendency to reject this object as the referent of a novel label. In some of these studies (e.g., [Markman & Wachtel, 1988](#); [Merriman & Bowman, 1989](#)), no label was trained at the beginning of a trial; rather, an exemplar of a highly familiar label (e.g., a shoe) and an unfamiliar kind of object were presented and the child was asked to select the referent of a novel label. So it is not the case that the participants discovered that one of the choice objects matched the object for which a label was just trained. In other studies (e.g., [Diesendruck & Markson, 2001](#); [Suanda & Namy, 2013](#)), a label was first trained for an unfamiliar kind, then the child was asked to decide whether this object or another unfamiliar kind was the referent of a novel label. However, in these studies, the training object remained in view after the label was trained for it. So the fact that the training object was one of the choices in the test of the novel label did not have to be discovered by the child.

One testable prediction of the discovery-based interference hypothesis is that if children were to discover that one of two visual objects matched a visual object for which a label had been trained, then their reaction(s) to this discovery should undermine their tendency to avoid mapping a novel label onto this object. This prediction may only be supported if the experimenter’s view of the choice objects is blocked. Otherwise, children may decide that the experimenter knows that they have made the discovery, and so the children would not react by desiring to communicate the discovery or expecting to be asked about it.

The familiar label retrieval hypothesis also has broader implications. Even in situations that do not require cross-modal integration, if a child does not retrieve a known label for some object, then his or her tendency to reject it as a potential referent of a novel label should be reduced. Future research should examine whether other factors that affect a child’s likelihood of

applying a known label to something also affect the child's willingness to accept a different label for it. Variation in label retrieval may account for children's greater tolerance for overlap between a known and novel label when the object is an atypical rather than typical exemplar of the known label (Merriman & Bowman, 1989; Merriman & Schuster, 1991). Also, retrieval differences may explain why some studies have found young children's tendency to reject a second label for an object to be greater than their tendency to reject a second factual description of it (Scofield & Behrend, 2007) or a second symbolic gesture for it (Suanga & Namy, 2013). Participants in these studies may have been more likely to spontaneously retrieve the known labels than the known factual descriptions or symbolic gestures.

## Acknowledgments

We are grateful to the children and parents who volunteered to participate in these studies. We also thank the participating preschools from the Kent and surrounding areas. Our work would not be possible without their support.

## References

- Bushnell, E. W., & Baxt, C. (1999). Children's haptic and cross-modal recognition with familiar and unfamiliar objects. *Journal of Experimental Psychology*, 25, 1867–1881. <http://dx.doi.org/10.1037/0096-1523.25.6.1867>
- Clark, E. V. (1990). On the pragmatics of contrast. *Journal of Child Language*, 17, 417–431. <http://dx.doi.org/10.1017/S0305000900013842>
- Diesendruck, G., & Markson, L. (2001). Children's avoidance of lexical overlap: A pragmatic account. *Developmental Psychology*, 37, 630–641. <http://dx.doi.org/10.1037/0012-1649.37.5.630>
- Evey, J. A., & Merriman, W. E. (1998). The prevalence and the weakness of an early name mapping preference. *Journal of Child Language*, 25, 121–147.
- Gathercole, V. C. (1989). Contrast: A semantic constraint? *Journal of Child Language*, 16, 685–702. <http://dx.doi.org/10.1017/S0305000900010795>
- Golinkoff, R. M., Hirsh-Pasek, K., Bailey, L. M., & Wenger, N. R. (1992). Young children and adults use lexical principles to learn new nouns. *Developmental Psychology*, 28, 99–108. <http://dx.doi.org/10.1037/0012-1649.28.1.99>
- Gottfried, A. W., Rose, S. A., & Bridger, W. H. (1977). Cross modal transfer in young infants. *Child Development*, 48, 118–123. <http://dx.doi.org/10.1037/0012-1649.48.1.118>
- Grassmann, S., Schulze, C., & Tomasello, M. (2009). A pragmatic perspective on mutual exclusivity. In *Presentation at the biennial meeting of the society for research in child development* Denver, CO.
- Halberda, J. (2003). The development of a word-learning strategy. *Cognition*, 87, B23–B34. [http://dx.doi.org/10.1016/S0010-0277\(02\)186-5](http://dx.doi.org/10.1016/S0010-0277(02)186-5)
- Halberda, J. (2006). Is this a dax which I see before me? Use of the logical arguments disjunctive syllogism supports world-learning in children and adults. *Cognitive Psychology*, 53, 310–344. <http://dx.doi.org/10.1016/j.cogpsych.2006.04.003>
- Hernandez-Reif, M., & Bahrlick, L. E. (2001). The development of visual-tactile perception of objects: A modal relations provide the basis for learning arbitrary relations. *Infancy*, 2, 51–72. <http://dx.doi.org/10.1207/S15327078IN0201.4>
- Liebal, K., Carpenter, M., & Tomasello, M. (2010). Infant use of shared experience in declarative pointing. *Infancy*, 15, 545–556. <http://dx.doi.org/10.1111/j.1532-7078.2009.00028.x>
- Lipowski, S. L., & Merriman, W. E. (2011). Knowledge judgments and object memory processes in early childhood: Support for the dual criterion account of object nameability judgment. *Journal of Cognition and Development*, 12, 481–501. <http://dx.doi.org/10.1080/15248372.2010.544694>
- Liszkowski, U., Carpenter, M., & Tomasello, M. (2007). Pointing out new news, old news, and absent referents at 12 months of age. *Developmental Science*, 10, F1–F7. <http://dx.doi.org/10.1111/j.1467-7687.2006.00552.x>
- Marazita, J. M., & Merriman, W. E. (2004). Young children's judgment of whether they know names for objects: The metalinguistic ability it reflects and the processes it involves. *Journal of Memory and Language*, 51, 458–472. <http://dx.doi.org/10.1016/j.jml.2004.06.008>
- Markman, E. M., & Wachtel, G. F. (1988). Children's use of mutual exclusivity to constrain the meaning of words. *Cognitive Psychology*, 20, 121–157. [http://dx.doi.org/10.1016/0010-0285\(88\)90,017-5](http://dx.doi.org/10.1016/0010-0285(88)90,017-5)
- Markman, E. M., Wasow, J. L., & Hansen, M. B. (2003). Use of mutual exclusivity assumption by young word learners. *Cognitive Psychology*, 47, 241–275. [http://dx.doi.org/10.1016/S0010-0285\(03\)34-3](http://dx.doi.org/10.1016/S0010-0285(03)34-3)
- McMurray, B., Horst, J. S., & Samuelson, L. K. (2012). Word learning emerges from the interaction of online referent selection and slow associative learning. *Psychological Review*, 119, 831–877. <http://dx.doi.org/10.1037/a0029872>
- Meltzoff, A. N., & Borton, R. W. (1979). Intersensory matching by human neonates. *Nature*, 282, 403–404. <http://dx.doi.org/10.1038/282403a0>
- Merriman, W. E. (1999). Competition, attention, and young children's lexical processing. In B. MacWhinney (Ed.), *The emergence of language* (pp. 331–358). Hillsdale, NJ: Erlbaum.
- Merriman, W. E., & Bowman, L. L. (1989). The mutual exclusivity bias in children's word learning. *Monographs of the Society for Research in Child Development*, 54(3–4) <http://dx.doi.org/10.2307/1166130>. Serial Number No 220
- Merriman, W. E., & Lipko, A. R. (2008). A dual criterion account of the development of linguistic judgment in early childhood. *Journal of Memory and Language*, 58, 1012–1031. <http://dx.doi.org/10.1016/j.jml.2007.10.003>
- Merriman, W. E., & Marazita, J. M. (1995). The effect of hearing similar-sounding words on young 2-year-olds' disambiguation of novel noun reference. *Developmental Psychology*, 31, 973–984. <http://dx.doi.org/10.1037/0012-1649.31.6.973>
- Merriman, W. E., Marazita, J. M., Evey-Burkey, J. A., & Jarvis, L. (1996). Young two-year-olds' tendency to map novel verbs onto novel actions. *Journal of Experimental Child Psychology*, 63, 466–498. <http://dx.doi.org/10.1006/jecp.1996.0059>
- Merriman, W. E., & Schuster, J. M. (1991). Young children's disambiguation of object name reference. *Child Development*, 62, 1288–1301. <http://dx.doi.org/10.1111/j.1467-8624.1991.tb01606.x>
- Mervis, C. B., & Bertrand, J. (1994). Acquisition of the novel name–nameless category (N3C) principle. *Child Development*, 65, 1646–1662. <http://dx.doi.org/10.1111/j.1467-8624.1994.tb00840.x>
- Moll, H., Richter, N., Carpenter, M., & Tomasello, M. (2008). Fourteen-month-olds know what “we” have shared in a special way. *Infancy*, 13, 90–101. <http://dx.doi.org/10.1080/1525000701779402>
- Regier, T. (2005). The emergence of words: Attentional learning in form and meaning. *Cognitive Science*, 29, 115–135. <http://dx.doi.org/10.1207/s15516709cog0000.31>
- Reisenzein, R. (2000). The subjective experience of surprise. In H. Bless, & J. P. Forgas (Eds.), *The message within: The role of subjective experience in social cognition and behavior* (pp. 262–279). Philadelphia, PA: Psychology Press.
- Roseman, I. J. (2013). Appraisal in the motion system: Coherence in strategies for coping. *Emotion Review*, 5, 141–149. <http://dx.doi.org/10.1177/1754073912469591>
- Saylor, M. M., & Ganea, P. (2007). Infants interpret ambiguous requests for absent objects. *Developmental Psychology*, 43, 696–704. <http://dx.doi.org/10.1037/0012-1649.43.3.696>
- Scofield, J., & Behrend, D. A. (2007). Two-year-olds differentially disambiguate novel words and facts. *Journal of Child Language*, 34, 875–889. <http://dx.doi.org/10.1017/S0305000907008100>

- Scofield, J., Hernandez-Reif, M., & Keith, A. B. (2009). Preschool children's multimodal word learning. *Journal of Cognition and Development*, 10(3), 06–333. <http://dx.doi.org/10.1080/15248370903417662>
- Scofield, J., & Merriman, W. E. (2013). Word retrieval training helps young children disambiguate novel words in a cross-modal task. In *Presentation at the biennial meeting of the society for research in child development* Seattle, WA.
- Suanda, S. H., & Namy, L. L. (2013). Young word learners' interpretations of words and symbolic gestures within the context of ambiguous reference. *Child Development*, 84, 143–153. <http://dx.doi.org/10.1111/j.1467-8624.2012.01847.x>
- Ziv, M., & Frye, D. (2004). Children's understanding of teaching the role of knowledge and belief. *Cognitive Development*, 19, 457–477. <http://dx.doi.org/10.1016/j.cogdev.2004.09.002>
- Ziv, M., Solomon, A., & Frye, D. (2008). Young children's recognition of the intentionality of teaching. *Child Development*, 79, 1237–1256. <http://dx.doi.org/10.1111/j.1467-8624.2008.01186.x>