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Preexposure to objects that contrast in familiarity improves young children's lexical knowledge judgment

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ABSTRACT

The ability to judge the limits of one's own knowledge may play an important role in knowledge acquisition. The current study tested the prediction that preschoolers would judge the limits of their lexical knowledge more accurately if they were first exposed to a few objects of contrasting familiarity. Such preexposure was hypothesized to increase the salience of the metacognitive experiences that distinguish known from unknown kinds. These experiences include both the feeling of familiarity that a kind evokes and the amount of information about the kind that is retrieved spontaneously. In Experiment 1, 3- and 4-year-olds performed a matching task involving familiar and unfamiliar objects, then made lexical knowledge judgments about both objects and words. The accuracy of these judgments was predicted to exceed that of children who had not performed a matching task (Experiment 1) or who had performed one involving wooden blocks (Experiment 1) or only familiar objects (Experiment 2). This prediction was supported for children with vocabulary sizes typical of a younger 4-year-old but not for children with larger vocabularies. Additional analyses suggested that the primary source of error in the former group was insensitivity to both feeling of familiarity and amount of information retrieval. In contrast, the occasional errors made by the children with the larger vocabularies were likely due to lapses in executive control.

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Awareness of limitations in one's knowledge can facilitate learning and comprehension (Dunlosky, Hertzog, Kennedy, & Thiede, 2005; Koriat, Ma'ayan, & Nussinson, 2006; Son & Metcalfe, 2000). Realizing that one does not possess some piece of information may not only promote seeking it but also cause one to allocate resources to remembering the information once it has been obtained. Likewise, judging that one does not have an adequate understanding of some message may prompt one to ask that it be repeated or clarified, which in turn may increase one's comprehension of it.

During the preschool years, children's skill in judging their knowledge and understanding increases (Beal & Belgrad, 1990; Lyons & Ghetti, 2011; Revelle, Wellman, & Karabenick, 1985). Our focus is on knowledge judgments that may be relevant to word learning. Most older 4-year-olds can judge whether they know names for various objects, but younger children often overestimate such knowledge (Marazita & Merriman, 2004). A similar trend is evident in children's judgments of whether they know the meanings of various words (Chaney, 1992; Merriman, Lipko, & Evey, 2008; Smith & Tager-Flusberg, 1982).

Two heuristics—cue familiarity and target generation—are fairly reliable strategies for making these judgments (Merriman & Lipko, 2008). When asked whether one knows a name for an object, for example, a good strategy is to say, "Yes," only if the object (the cue) evokes a strong sense of familiarity or a name for the object (the target) can be generated with confidence. Similarly, when

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asked whether one knows the meaning of some word (e.g., "Do you know what a zav is?"), a good strategy is to say, "Yes," only if the word (the cue) evokes a strong sense of familiarity or an interpretation of the word (the target) can be generated with confidence. These strategies are not foolproof. For example, an as-yet-unnameable object could seem familiar if one has seen it frequently or recently. Also, an object may have a known name, but the name might just not be readily retrieved or constructed. However, the cue familiarity and target generation heuristics would yield correct judgments in most circumstances.

Both heuristics involve making an inference based on the metacognitive experiences (Flavell, 1981; Schwarz, 2009) that occur as one attempts to answer a question about one's knowledge. There is indirect evidence that young children use these heuristics. When asking 3- or 4-year-olds to judge their lexical knowledge about a word (e.g., "Do you know what a zav is?") or an object (e.g., "Do you know what this is called?"), it is necessary to tell them that they are not to generate the target (i.e., to describe the word's meaning or produce a name for the object). Otherwise, many will respond by doing so (Marazita & Merriman, 2004; Merriman et al., 2008). They must be told to only answer the questions "Yes" or "No." Thus, it is likely that they would consider whether the target of a question can be generated when deciding whether to answer it "Yes" or "No." For example, they would decide how to answer "Do you know what a zav is?" by considering whether or not they can generate a meaning for *zav*.

Second, the accuracy of children's judgments correlates with measures of the efficiency of specific processes that support using the cue familiarity or target generation strategies (Lipowski & Merriman, 2011; Merriman & Lipko, 2008; Merriman et al., 2008). For example, efficient object recognition memory processes support using object kind recognition to judge whether one knows a name for an object, whereas efficient object name retrieval processes support using retrieval of the object's name to make this judgment. Consistent with this prediction, Lipowski and Merriman (2011) found that the accuracy of preschoolers' object recognition memory and the speed of their object naming were strongly related to the accuracy of their judgments of whether various objects had known names.

Third, when preexposed to both familiar and unfamiliar kinds of objects, some preschoolers tend to report knowing names for the preexposed unfamiliar kinds at a higher rate than they make this error for nonpreexposed unfamiliar kinds (Marazita & Merriman, 2004, 2011). This within-participant priming effect could be due to the children making a judgment based solely on cue familiarity (object recognition), that is, without waiting to see whether a name for the object could be retrieved. Marazita and Merriman (2011) observed this priming effect only in preschoolers whose scores on a receptive vocabulary test fell within one *SD* of the normed mean for children 4 years, 7 months old. Those whose scores fall below this range may have little tendency, if any, to use cue familiarity to make these judgments, and so do not show the effect. Those whose scores exceed the range may rely on cue familiarity in some circumstances, but not show the priming effect because they realize that an as-yet-unnameable object may seem familiar only because it has been encountered recently.

The goal of Experiment 1 was to examine whether preschoolers' tendency to use these heuristics could be increased by first having them examine a small set of objects that contrasted in familiarity. In the familiarity contrast condition, children completed object-photograph matching tasks that required repeated inspection of three highly familiar and three unfamiliar kinds of objects. Other preschoolers, in the no matching condition, spent the same amount of time coloring and chatting with the adult tester. A third group, in the block matching condition, performed object-photograph matching tasks that involved wooden building blocks that did not contrast in familiarity. This last group was included to insure that any differences that might be observed between the other two conditions were not attributable to performing a matching task per se.

Figure 1. One set of objects used in familiarity contrast condition in Experiment 1.

After the initial matching/control experiences, the children were asked to make lexical knowledge judgments about words and objects. As children in the familiarity contrast condition performed their matching task, the familiar kinds were expected to evoke a strong feeling of familiarity and cause names and other information about themselves to be retrieved, whereas the unfamiliar kinds were expected to evoke a feeling of novelty and cause little information to be retrieved (see Figure 1). The contrast in both feeling of familiarity and amount of information generated was expected to increase the salience of these types of metacognitive experiences, and so increase the likelihood that the children would base lexical judgments about other objects upon them.

Note that this prediction concerned the effect of encoding various objects on judgments about other objects, that is, ones not presented in the encoding task. The latter objects shall be referred to as unprimed objects, and the objects presented in the matching task shall be referred to as primed objects. Children in the familiarity contrast condition were asked to make judgments about both primed and unprimed objects. Although their performance on unprimed objects was of primary interest, primed objects were included to allow us to determine whether the priming effect documented by Marazita and Merriman (2004, 2011) could be replicated with a procedure that required no semantic processing. In previous studies, children were encouraged to encode objects during preexposure by asking them semantic-orienting questions such as, "Is this for mommies and daddies or for kids?" One problem with this procedure is that it complicates interpretation of the priming effect. One cannot be sure whether children's subsequent tendency to mistakenly judge that they knew names for preexposed unnameable objects was the result of the greater feeling of familiarity that these objects evoked or the greater amount of semantic information that came to mind about

them (e.g., that they were for mommies and daddies). If the priming effect were replicated in the 115
current study, this result would be evidence that children at least occasionally judge an object to have
a known named based on the object's feeling of familiarity without also considering what other
information about the object comes to mind.

We also hypothesized that judgments about whether various words had known meanings would be
more accurate in the familiarity contrast condition than in the other conditions. When asked whether 120
they knew what a *blicket* is, for example, children in the familiarity contrast condition might be more
likely to note that this word felt rather novel and that no information about it came to mind, similar to
the metacognitive experiences evoked by the unfamiliar kinds of objects in the object-photograph
matching task. In contrast, when asked whether they knew what a *table* is, for example, the children
might be more likely to note that it felt quite familiar and that information about it readily came to 125
mind, similar to the experiences evoked by the familiar kinds of objects in the matching task.

Because receptive vocabulary size has been found to moderate the effect of object preexposure on
preschoolers' lexical knowledge judgments (Marazita & Merriman, 2011), receptive vocabulary was
also assessed. Although the priming effect observed by Marazita and Merriman is not the same as the
predicted overall positive effect of object preexposure that was our focus, both effects may be related 130
to receptive vocabulary size. The feeling of familiarity and the stream of information retrieval that an
object or word evokes may already be quite salient metacognitive experiences for those preschoolers
who have larger vocabularies. Therefore, performing the object-photograph matching task with
objects of contrasting familiarity may not increase this group's already-strong tendency to base
lexical knowledge judgments on cue familiarity and target generation.
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Finally, children were administered a test of object recognition memory. Lipowski and Merriman
(2011) found performance on this test to be associated more strongly with the accuracy of lexical
knowledge judgments about objects than with the accuracy of such judgments about words. This
finding was taken to support the hypothesis that the more advanced a child's object recognition
memory processes, the more likely he or she is to judge an object's name to be known if the object 140
evokes a sufficiently strong feeling of familiarity. Because preexposure to a mix of unfamiliar and
familiar objects was predicted to improve the accuracy of both object and word judgments, it was also
expected to increase the correlation between these two types of judgments and reduce differences
between their correlations with other measures. That is, the result obtained by Lipowski and Merriman
(2011) was expected to be weaker in the familiarity contrast condition than in the control conditions.
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Method

Participants

Ninety-four children (M = 4 years, 2 months; range = 3 years, 4 months to 5 years, 0 months) were
recruited from preschools in middle class neighborhoods in the Great Lakes region of the United
States. They were assigned to one of three conditions: familiarity contrast (N = 32; 15 boys), no
matching (N = 31; 15 boys), and block matching (N = 31; 15 boys). Mean ages in these conditions 150
(4−3, 4−2, and 4−1, respectively) were not significantly different, F < 1. Each condition was divided
into children with raw vocabulary scores at or below the median for the entire sample and those with
scores above the median. Children in the smaller vocabulary groups (M age = 3 years 11 months)
had an average vocabulary score (68) that was equal to that of a child 4 years, 3 months in the
norming sample for the Peabody Picture Vocabulary Test 4 (PPVT—4) (Dunn & Dunn, 2007). 155
Among these children, conditions did not differ in age or receptive vocabulary size, Fs < 1. Children
in the larger vocabulary groups (M age = 4 years 6 months) had an average vocabulary score (90)
that was equal to that of a child 5 years, 6 months in the norming sample. Among these children,
condition also did not differ in age or receptive vocabulary size, Fs < 1. The age difference between
the larger and the smaller vocabulary groups was significant, F (1, 92) = 26.54, p < .001, partial 160
η^2 = .26.

Materials and procedure

Children were assessed individually in a quiet room at their preschool. They were administered tasks in the following order: matching/control, word judgment, object judgment, object recognition memory, and PPVT 4—Form A (Dunn & Dunn, 2007).

Matching/Control

Six familiar kinds of objects (shoe, toy car, spoon, plastic flower, key, and sock) and six unfamiliar kinds of objects (part of a plastic bike lock, egg slicer, waterbed hose adapter, tool for twisting off caps, tube with four wheels and feathers attached, small foil pan filled with pipe cleaners and attached to a suction cup) were divided into two sets containing three of each kind (see Figure 1 for an example). Half of the children in the familiarity contrast condition performed matching tasks with one set and the other half performed these tasks with the other set. Three × five inch color photographs were made of each object.

Twelve toy wooden building blocks were also obtained and divided into two sets of six (see Figure 2 for an example). Half of the children in the block matching condition performed matching tasks with one set and other half performed these tasks with the other set. Three × five inch color photographs were made of each block.

Figure 2. One set of objects used in the block matching condition in Experiment 1.

For the first matching task, photographs of each object/block in the set were arranged randomly in two rows of three on a table in front of the child. The child was then shown each object/block one at a time in a random order, and was told to find its corresponding photograph. For the second matching task, the objects/blocks and photographs switched places. The six objects/blocks were arranged randomly in two rows on the table, each photograph was presented one at a time, and the child was told to find the corresponding object/block. Finally, the first matching task was repeated, but with a different random arrangement of photographs and different random order of object/block presentation. Every child made a correct selection on every matching trial.

Children in the no matching condition did not perform the matching tasks, but colored and talked with the adult tester for three minutes. Children in the other conditions also took approximately three minutes on average to complete the matching tasks.

Word judgment

A child was told, "You are going to hear some words. Some are words that you will know, but others are just made-up or pretend words. I want you to tell me which words you know. If I say a word that you know, say 'yes.' If you don't know the word, say 'no.'" The child was then asked, "Do you know what a is?" regarding 12 words. Six were familiar words (*book, cat, school, bed, boat, and flower*) and six were nonsense words (*zimbiddy, blicket, hust, pilson, zav, and jegger*). Order of presentation was random, except that words of the same type never occurred more than twice in a row. The tester responded to the child's answers with an occasional "OK" or "Good."

After the final test question, the questions about some of the nonsense words were repeated so as to identify any word that the child may have misperceived or interpreted as a mispronunciation. If a child had indicated that a particular nonsense word was known, the tester asked, "What is it?" In one instance, a child identified it by a similar-sounding familiar word (e.g., "blanket" for *blicket*). This trial was excluded from the computation of the child's rate of judging nonsense words correctly.

Object judgment

A child was told, "I am going to show you some things that you know and some things that you don't know. When I show you each one, I want you to tell me if you know its name. If you know its name, say 'yes.' If you don't know its name, say 'no.'" The child was warned not to say anything else. The child was then asked, "Do you know the name for this?" regarding the six familiar kinds of objects and six as-yet-unnameable objects. Order of presentation was random except that objects of the same type never occurred more than twice in a row. Children in the familiarity contrast condition had performed the matching tasks with three of the familiar and three of the as-yet-unnameable objects. The tester responded to the child's answers to the twelve questions with an occasional "OK" or "Good."

After the final judgment trial, the child was asked to name any of the as-yet-unnameable objects that he or she had just identified as having a known name. In four instances, a child named the object correctly or overextended a familiar name to it. The yes-no judgment trial that the child had previously made for this particular object was excluded from the computation of the child's rate of judging unnameable objects correctly.

Object recognition memory

This test was developed by Lipowski and Merriman (2011). Fourteen black-and-white line drawings of unfamiliar objects were scanned into computer files. Six served as practice items and eight served as test items. For half of these drawings, a second copy was made that differed in visual detail from the original. The drawings were presented on a Dell Latitude laptop computer, and Direct RT software was used to control the onset and duration of these presentations.

The child was told, "You are going to see some pictures come up on the screen. They are not going to be things that you know. They are just silly things, so you do not have to tell me what they

are. When the first picture comes up, I want you to take a good look at it. Then you are going to see a second picture come up. I want you to tell me if the pictures are exactly the same or a little bit different. Do you think you know how to play?" The six practice trials followed. In each trial, a drawing was presented for five seconds, followed by a black screen with a white addition sign in the center of it for one second. A second drawing that was either identical to it (three practice trials) or slightly different from it (three practice trials) was then presented. When this drawing appeared, the child was asked, "Are those two pictures exactly the same or a little bit different?" If the child made a correct "same" response, the tester said, "You're right. Those are the same. The first picture looked just like that." If the child made a correct "different" response, the tester said, "You're right. Those two pictures are different because [for example: the first one had a line on it, but the second one was plain.]" If the child made an incorrect "same" response, the tester said "No. Those pictures were different because [for example: the first one has a small top, but this one has a big top.]" If the child made an incorrect "different" response, the tester said, "No. Those pictures were the same. The first one looked just like that one." The recognition memory test itself consisted of four "same" trials and four "different" trials. On these trials, the tester accepted the child's responses and provided no other feedback.

Results

In all analyses, the measure of accuracy was mean proportion of trials correct. Table 1 presents a summary of test performance and correlations with child age. As in previous studies (e.g., Marazita & Merriman, 2011; Merriman et al., 2008), lexical knowledge judgment posed a challenge for some children, but not others. Note that a value of .50 correct represents floor performance. The accuracy of both object and word judgments increased with age. As in Lipowski and Merriman (2011), the object recognition memory test was difficult for most children, and performance showed only a weak tendency to increase with age.

Tests of the main prediction

The accuracy of children's lexical knowledge judgments was predicted to improve if they first examined a small set of objects that contrasted in familiarity. Our first test of this prediction also assessed whether it depended on children's vocabulary size. A 3 (condition: familiarity contrast vs. no matching vs. block matching) × 2 (vocabulary size: raw score at/below vs. above the median) × 2 (type of judgment: object vs. word) mixed analysis of variance was conducted with age in months entered as a covariate. The objects that had been preexposed to children in the familiarity contrast condition were not included in their object judgment accuracy score for this analysis.

There was no main effect of type of judgment nor was this variable involved in any significant interactions, all $Fs < 1$. Thus, results were the same for both object and word judgments. The other main effects were significant: condition, $F(2, 87) = 4.21$, $p < .02$, $\eta^2 = .07$; and vocabulary size, $F(1, 87) = 12.99$, $p < .005$, $\eta^2 = .11$. Most importantly, the condition × vocabulary size interaction was significant, $F(2, 87) = 4.03$, $p < .025$, $\eta^2 = .07$. This interaction is depicted in Figure 3.

Table 1. Test performance and its correlation with age in Experiment 1.

TEST	M	SD	r with Age
Lexical Knowledge Judgment			
Objects (Unprimed)	.80	.20	.36**
Words	.75	.20	.37**
Object Recognition Memory	.66	.19	.23[†]
Peabody Picture Vocabulary - 4	79	13	.49**

*Notes—Raw score for Form A of the vocabulary test is listed. For all other tests, proportion of responses correct is listed. ** two-tailed p < .01 * two-tailed p < .05 [†] one-tailed p < .05*
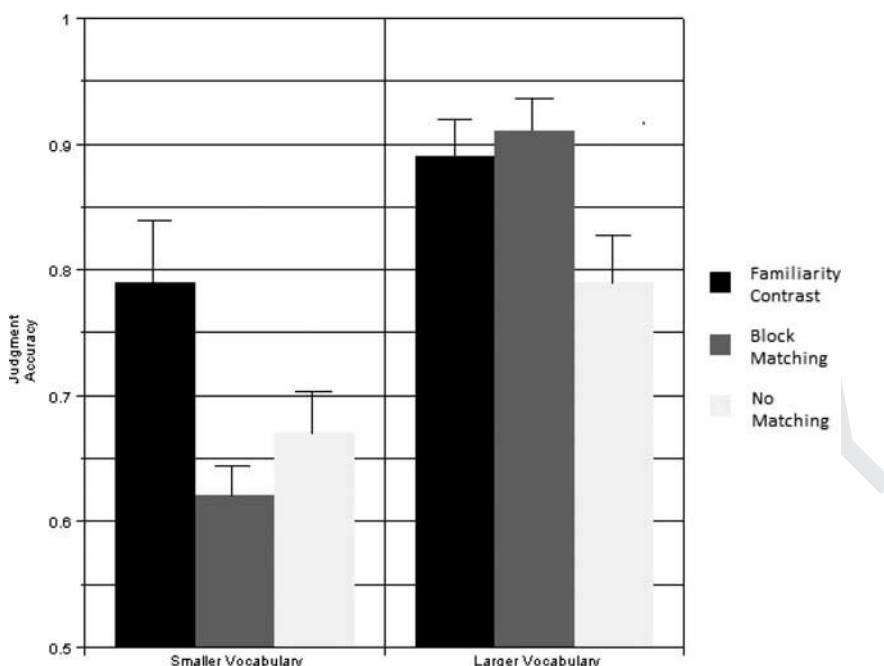
Figure 3. Mean judgment accuracy (SE) by vocabulary size in Experiment 1.

The significant interaction was followed up with separate analyses of the effect of condition in each vocabulary size group. Among the children with smaller vocabularies, the effect of condition was significant, F (2, 45) = 5.40, p < .01, η^2 = .19. In support of the main prediction, lexical knowledge judgments were more accurate in the familiarity contrast condition (M = .79 correct) than in either the block matching condition (.62), F (1, 45) = 10.20, p < .005, η^2 = .22, or no matching condition (.67), F (1, 45) = 5.10, p < .05, η^2 = .11. Among the children with larger vocabularies, the effect of condition was also significant, F (2, 42) = 3.39, p < .05, η^2 = .14. The main prediction was not fully supported, however. Although knowledge judgments were more accurate in the familiarity contrast condition (M = .89 correct) than in the no matching condition (.79), F (1, 42) = 4.21, p < .05, η^2 = .09, they were not more accurate than in the block matching condition (.91), F < 1.

To examine whether the main prediction might depend on children's age, a 3 (condition) × 2 (age: at/below vs. above the median) × 2 (type of judgment) mixed analysis of variance was conducted with vocabulary size entered as a covariate. The effect of condition was significant, F (2, 87) = 4.92, p < .01, η^2 = .10, but neither the effect of age, F (1, 87) = 1.85, p = .18, nor the condition × age interaction, F < 1, was significant. Thus, when covariation with vocabulary size was controlled, there was no evidence that older children made these judgments more accurately than younger ones or that condition affected these two age groups differently. The mean accuracy of judgment for each age group in each condition is depicted in Figure 4.

The priming effect in object judgment

In the familiarity contrast condition, judgments of primed unnameable objects were less accurate than judgments of unprimed ones (M = .72 and .79, respectively), but this difference was not significant, t (31) = 1.69, two-tailed p = .10. The weakness of this effect (r^2 = .08) is not surprising given that Marazita and Merriman (2011) only found a significant effect among children with vocabulary scores within 1 SD of the normed mean for children 4 years, 7 months old. The scores
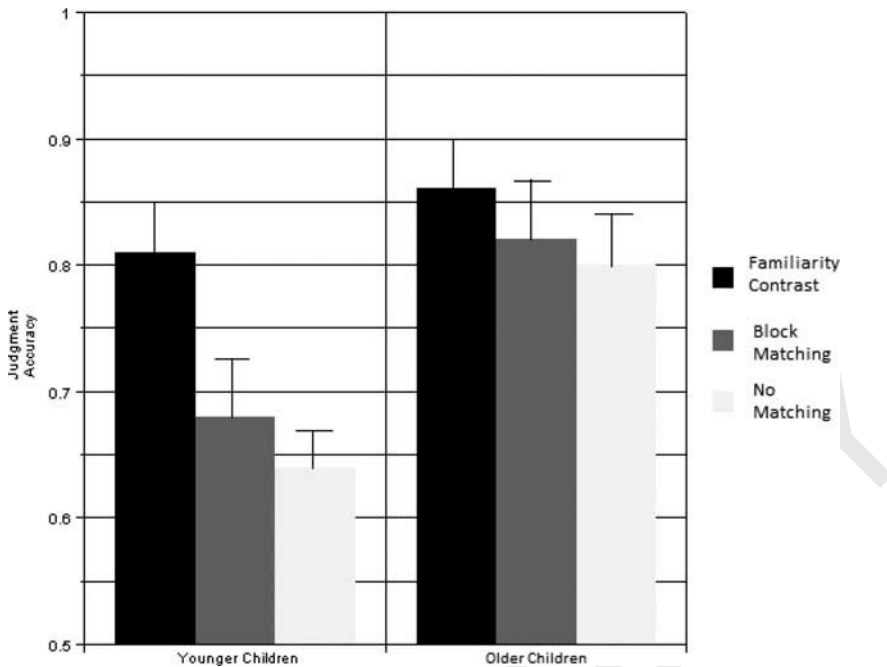
Figure 4. Mean judgment accuracy (SE) by age in Experiment 1.

of 25 of the 32 children in the familiarity contrast condition fell within this range; the scores of the remaining children exceeded it. Among those with scores in this range, the priming effect was significant ($M = .65$ and $.76$ for primed and unprimed unnameable objects, respectively), t $(24) = 2.53$, two-tailed $p = .02$, $r^2 = .21$. In contrast, there was no evidence of a priming effect among the small group with vocabulary scores beyond this range—five of the seven made no errors in judging the type of object, and the other two made only a single error, in both instances about an unprimed object. Note that unlike Marazita and Merriman (2011), there were no children in our sample with vocabulary scores less than 1 SD of the normed mean for children 4 years, 7 months old.

In the no matching control condition, children with vocabularies in the range for the priming effect did not judge unfamiliar kinds of objects any more accurately than such children in the familiarity contrast condition had judged primed versions of these objects ($M = .49$ and $.65$, respectively), t $(50) = 1.48$, $p > .10$. So the priming effect that was found within the familiarity contrast condition was not found between this condition and the no matching control condition. Although children in the familiarity contrast condition were occasionally misled by the feeling of familiarity that primed unfamiliar kinds of objects evoked, this error tendency was offset by the experience of having performed a matching task involving these objects and highly familiar objects. This result implies that performing the matching task caused an increase in the salience of the two types of metacognitive experiences that differentiate unknown from known kinds. That is, not only did children's tendency to base lexical knowledge judgments on the feeling of familiarity that an object evokes increase, so too did their tendency to base these judgments on what, if any, information about the object spontaneously comes to mind.

Test intercorrelations

Test intercorrelations are summarized in Table 2. Lipowski and Merriman (2011) had found a distinctive relation between children's object recognition memory and the accuracy of their lexical

Table 2. Test intercorrelations.

Condition Test	1	2	3	4	5
Familiarity Contrast					
1. Object Recog Mem	—				
2. Lex Know Judg: Obj (Unprimed)	.41*				
3. Lex Know Judg: Word	.49**	.62**			
4. Peabody Picture Vocab	.37*	.35*	.20		
5. Age	−.11	.26	.17	.29	
No Matching					
1. Object Recog Mem	—				
2 Lex Know Judg: Obj (Unprimed)	.64**	—			
3 Lex Know Judg: Word	.35†	.29	—		
4 Peabody Picture Vocab	.52**	.45*	.39*		
5. Age	.61**	.45*	.54**	.76**	—
Block Matching					
1. Object Recog Mem	—				
2. Lex Know Judg: Obj (Unprimed)	.28	—			
3. Lex Know Judg: Word	.43*	.72**			
4. Peabody Picture Vocab	.52**	.76**	.74**		
5 Age	.08	.50**	.34†	.52**	—

Notes—*df* = 30 for Familiarity Contrast condition and *df* = 29 for other two conditions. ** two-tailed *p* < .01 * two-tailed *p* < .05
† one-tailed *p* < .05

knowledge judgments about objects. This result was replicated in the no matching condition, where object recognition memory accounted for more than three times as much of the variance in object judgment accuracy (r^2 = .41) as in word judgment accuracy (r^2 = .12). The result was not replicated in the other two conditions, however. The trend was in the opposite direction—in familiarity contrast, r^2 = .17 for the relation between object recognition and object judgment and r^2 = .24 for the relation between object recognition and word judgment; in block matching, r^2 = .08 and .18, respectively.

As already noted, preexposure to a mix of unfamiliar and familiar objects increased the accuracy of both object and word judgments. This result is consistent with our hypothesis that the preexposure task increased the salience of the metacognitive experiences that distinguish familiar from unfamiliar kinds, making children more likely to use these experiences as the basis for both types of judgments. The correlational patterns in Table 2 are also consistent with this proposal. The correlation between object and word judgments was higher in the familiarity contrast condition (*r* = .61; . with age and PPVT partialled, *r* (28) = .59, *p* = .001) than in the no matching control condition (r = .29; with age and PPVT partialled, *r* (27) = .06, *p* > .10).

This result is consistent with the higher correlation found between these judgments in the one study in which preexposure to a mix a unfamiliar and familiar objects preceded the judgments (Marazita & Merriman, 2004; *r* = .72 after partialling out age) than in three studies in no preexposure preceded the judgments (Lipowski & Merriman, 2011; Merriman & Lipko, 2008; Merriman et al., 2008, Study 1; M age-partialled r = .46; range = .39−53). The average age-partialled correlation in the two studies in which a mix of unfamiliar and familiar objects was preexposed (*M* = .66) is significantly greater than in the four studies in which no objects were preexposed (M = .39), Z = 2.48, *p* = .013, by the Stouffer method (Rosenthal, 1991).

The word and object judgments were also substantially intercorrelated in the block matching condition (*r* = .72). In contrast to the familiarity match condition, however, this correlation was greatly attenuated when age and PPVT were partialled out (*r* (27) = .38, *p* = .04) or when just PPVT was partialled out (*r* (28) = .36, *p* = .05). (In the familiarity contrast condition, PPVT-partialled *r* (29) = .60, *p* < .001). This differential effect of removing the contribution of PPVT to the correlation between the judgments is consistent with the finding that the familiarity contrast matching task had

a generally positive effect on children's judgments, whereas the block matching task only caused the judgments of children with larger vocabularies to improve.

Discussion

The lexical knowledge judgments of children who had vocabularies typical of a younger 4-year-old were consistent with our prediction. They made more accurate knowledge judgments about both objects and words in the familiarity contrast condition than in the other two conditions. The judgments of children with larger vocabularies were not consistent with our prediction. Although these children made highly accurate judgments in the familiarity contrast condition, they were just as accurate in the block matching condition.

Thus, for children with the vocabulary knowledge of a younger 4-year-old, we have evidence that exposure to objects that contrast in familiarity increases their tendency to base lexical knowledge judgments on the metacognitive experiences that distinguish known from unknown kinds. However, even for this group of children, an alternative explanation must be considered. Perhaps they performed best in the familiarity contrast condition only because they were preexposed to highly familiar kinds of objects. That is, the source of the positive effect of the matching task in this condition was not the contrast between familiar and unfamiliar objects, but just the familiar objects. Because the children encountered a few objects that each (presumably) evoked a strong feeling of familiarity and caused a name and other information about itself to come to mind, they may have become more likely to consider feeling of familiarity and/or information retrieval in subsequent lexical knowledge judgments. To address this possibility, Experiment 2 assessed the lexical knowledge judgments of children who had just performed a matching task involving only familiar kinds of objects. According to the alternative explanation, children with the vocabulary of a younger 4-year-old who perform this matching task should judge their lexical knowledge just as accurately as the corresponding group of children in the familiarity contrast condition of Experiment 1. According to our explanation, they should not.

Experiment 2 also had the potential to shed light on why the children with more advanced vocabularies benefitted as much from the block matching task as from the matching task that involved a mix of familiar and unfamiliar objects. One possible explanation is that both matching tasks compelled the more advanced children to examine stimuli closely, to keep the goal of the task in mind, and to inhibit impulsive or dominant responses. They then maintained this high level of executive control when later judging whether various words or objects "matched" a knowledge representation in their mental lexicons (i.e., when making lexical knowledge judgments). If so, then children with the larger vocabularies may also benefit from performing a matching task involving only familiar kinds of objects. This explanation presumes that the main cause of error in the judgments of the children with more advanced vocabularies in the no matching control condition was poor executive control, not insensitivity to the metacognitive experiences that distinguish known from unknown kinds.

On the other hand, perhaps the children with larger vocabularies benefitted from the two matching tasks because both required encoding at least some unfamiliar kinds of objects. Some of the blocks were a bit unusual looking (see Figure 2), and so may have evoked a feeling of unfamiliarity. Others might have evoked a feeling of familiarity or have even caused a familiar shape name to come to mind (e.g., *triangle*). Consequently, the children with larger vocabularies may have become more likely to note the various metacognitive experiences that the blocks evoked, which promoted their using such experiences as the basis for subsequent lexical knowledge judgments. If this explanation is valid, then children with larger vocabularies should not benefit from performing the matching task in Experiment 2 because it only involved familiar kinds of objects.

Experiment 2

Participants

Thirty-one children (*M* = 4 years, 3 months; range = 3 years, 7 months to 4 years, 11 months; 18 boys) were recruited from the same preschools as in Experiment 1. None had participated in Experiment 1. Children were classified as having smaller vocabularies if their raw score on the PPVT-4 was at or below the median (*N* = 16). Mean age (3 years, 10 months) and receptive vocabulary score (67) of the smaller vocabulary group as well as mean age (4 years, 8 months) and receptive vocabulary score (90) of the larger vocabulary group were comparable to those in Experiment 1, *F* < 1 for all comparisons.

Materials and procedure

The matching task that was used in the familiarity contrast condition of Experiment 1 was altered so that all six objects and their corresponding photographs were familiar kinds. This change was achieved by replacing the three unfamiliar kinds of objects in the matching task with three familiar kinds of objects (a bird, a crayon, and a ball). The instructions and procedures for the matching task were the same. The word and object judgment tasks were identical to the ones used in Experiment 1. The order of tasks was: matching, word judgment, object judgment, and PPVT-4. The object recognition memory task was dropped. Note that although the objects used in the object judgment task were the same as in Experiment 1, six were now unprimed unfamiliar kinds, three were primed familiar kinds, and three were unprimed familiar kinds. The bird, crayon, and ball never appeared in the object judgment task; the primed familiar kinds in the judgment task were always the other three familiar kinds that had been encountered in the matching task.

Results and discussion

For the object judgment task, a child's accuracy score was the average of proportion correct for the three unprimed familiar kinds and proportion correct for the six unprimed unfamiliar kinds. Judgment accuracy in the current experiment was compared to that in the baseline no matching condition of Experiment 1 by conducting a 2 (condition: Experiment 2 vs. no matching) × 2 (vocabulary size: raw score at/below vs. above the median) × 2 (type of judgment: object vs. word) mixed analysis of variance with age in months entered as a covariate.

The only significant effects were vocabulary size, *F* (1, 57) = 6.14, *p* < *.02,* η^2 = .10, and condition × vocabulary size, *F* (1,57) = 7.10, *p* < *.02,* η^2 = .11.

The significant interaction was followed up with separate analyses of the effect of condition in each vocabulary size group. Among the children with vocabulary sizes typical of a young 4-year-old, the effect of condition was significant, *F* (1, 30) = 4.38, *p* < .05, η^2 = .13. This group's accuracy was actually lower in the current experiment (*M* = .58, *SE* = .029) than in the no matching condition of Experiment 1 (*M* = .67, *SE* = .029). This result does not support the alternative explanation for why children with age 4 vocabularies made more accurate knowledge judgments in the familiarity contrast condition than in the no matching condition of Experiment 1. According to this explanation, they benefitted from preexposure to familiar kinds but not from the contrast between familiar and unfamiliar kinds. Contrary to this explanation, after preexposure to only familiar kinds, children with age 4 vocabularies tended to judge their lexical knowledge less accurately. The experience of encoding only familiar kinds may have increased their tendency to focus on features that distinguish one familiar kind from another, and reduced their tendency to focus on the metacognitive experiences that distinguished familiar from unfamiliar kinds.

Among the children with larger vocabularies, the effect of condition was also significant, *F* (1, 28) = 5.27, *p* < .05, η^2 = .16. This group's accuracy was higher in the current experiment (*M* = .90, *SE* = .026) than in the no matching condition of Experiment 1 (*M* = .79, *SE* = .044).

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This result is consistent with the enhanced executive control explanation for why the children with larger vocabularies benefitted as much from the block matching task as from the familiarity contrast matching task in Experiment 1. According to this explanation, both matching tasks compelled these children to examine stimuli closely, to keep the goal of the task in mind, and to inhibit impulsive or dominant responses. They then maintained this high level of executive control when later judging whether various words or objects "matched" a knowledge representation in their mental lexicons (i.e., when making lexical knowledge judgments). Assuming the matching task in the current experiment made similar demands on the children, then the task was expected to produce a similar increase in the accuracy of the children's lexical knowledge judgments. Indeed their mean accuracy (.90) was comparable to that of the larger-vocabulary children in both the block matching (.91) and familiarity contrast (.90) conditions. This explanation presumes that the main cause of error in the judgments of these children in the no matching control condition was an occasional lapse in executive control, not insensitivity to the metacognitive experiences that distinguish known from unknown kinds.

The results are not consistent with the alternative explanation that the larger-vocabulary children benefited from the block matching task in Experiment 1 because some of the blocks contrasted in familiarity and/or "nameability." By this explanation, the matching task in the current experiment should not have produced a benefit because the objects did not contrast on these dimensions. All of the objects were highly familiar kinds that could be named readily (e.g., car, sock).

To examine whether judgment accuracy varied according to age when the contribution of vocabulary size was controlled, a 2 (condition: Experiment 2 vs. no matching) × 2 (age: at/below vs. above the median) × 2 (type of judgment: object vs. word) mixed analysis of variance was conducted with vocabulary size entered as a covariate. Age was the only significant effect, F (1, 57) = 5.02, $p < .03$, $\eta^2 = .08$, and no interactions were significant. So when effects of vocabulary size were controlled, age accounted for variance in overall performance ($M = .61$ and .84 for the younger and older groups, respectively). However, unlike vocabulary size, it did not account for more variance in one condition than in the other.

Test intercorrelations

The correlation between the accuracy of object judgments and accuracy of word judgments was quite strong, r (29) = .72, $p < .001$. The accuracy of each judgment was also strongly related to vocabulary size, $r = .68$ for object judgment and .77 for word judgment, both $p < .001$. These correlations are similar to the ones observed in the block matching condition of Experiment 1 (see Table 2). These findings are consistent with the claim that these "control" matching tasks reduced the main source of error in the judgments of the children with larger vocabularies, which was their occasional lapse in executive control. Consequently, these children made highly accurate judgments of both words and objects. In contrast, neither of the "control" matching tasks reduced the main source of error in the judgments of children with average-size vocabularies, which was their insensitivity to the metacognitive experiences that distinguish familiar from unfamiliar kinds. Thus, these children tended to make inaccurate judgments of both words and objects.

General discussion

The ability to judge the limits of one's knowledge is a fundamental metacognitive skill that may play a role in knowledge acquisition. The current study focused on the failure of some preschoolers to make accurate judgments about the limits of their lexical knowledge. We examined whether a rather brief exposure to objects of contrasting familiarity could cause their lexical knowledge judgments to improve. We predicted that the experience of repeatedly encoding three unfamiliar objects and three highly familiar objects would draw their attention to the contrasting metacognitive experiences that these two kinds of objects evoke. Only the familiar kinds evoke a strong feeling of familiarity and

trigger the retrieval of names and other information about themselves. Because attention to these metacognitive experiences increased, children were expected to be more likely to base lexical knowledge judgments on such experiences. Consequently, the accuracy of these judgments was expected to increase.

This prediction was supported for children with vocabularies typical of a younger 4-year-old. Their judgments were more accurate in the familiarity contrast condition than in other conditions—no matching, block matching, or familiar object matching. These findings support several theoretical proposals. First, one reason that younger children judge their lexical knowledge inaccurately is that they are not sufficiently attuned to how the metacognitive experiences evoked by unfamiliar kinds differ from those evoked by familiar kinds. They often judge unfamiliar kinds to be known kinds because they fail to take note of either the feeling of unfamiliarity that these evoke or the absence of information that comes to mind about them (Merriman & Lipko, 2008). When compelled to pay close attention to a few familiar and unfamiliar kinds of objects, the contrast between the metacognitive experiences evoked by these objects becomes more salient. This experience also sensitizes the children to the contrast between the metacognitive experiences evoked by unfamiliar versus familiar words. Consequently, the children become more likely to base lexical knowledge judgments about objects and words on these metacognitive experiences, and so make these judgments more accurately.

It could very well have turned out that preexposure to objects promoted knowledge judgments about objects but not about words. In some studies, these two types of judgments have been found to be only moderately correlated and to have distinct memory correlates (Lipowski & Merriman, 2011; Merriman & Lipko, 2008; Merriman et al., 2008) The metacognitive experiences that were allegedly highlighted by preexposure to familiar and unfamiliar objects are the very ones that can be used to judge lexical knowledge about objects accurately. That is, a child could make accurate judgments about objects if he or she were to follow the rule of only judging an object to have a known name if it evoked a strong feeling of familiarity and/or caused information about itself (e.g., its name) to come to mind. It was not obvious that highlighting the metacognitive experiences evoked by objects would sensitize children to the corresponding metacognitive experiences for words (i.e., that only some words evoke a strong feeling of familiarity and/or cause information about their meaning to come to mind.) The fact that knowledge judgments about words did improve suggests that young children represent the metacognitive experiences evoked by familiar words as being like those evoked by familiar objects and the metacognitive experiences evoked by unfamiliar words as being like those evoked by unfamiliar objects.

Preschoolers with larger vocabularies did not perform as predicted. Although those in the familiarity contrast condition made more accurate judgments about objects and words than those in the no matching control condition, they benefited as much from performing the matching tasks that did not involve a mix of familiar and unfamiliar kinds. The contrasting metacognitive experiences evoked by familiar versus unfamiliar kinds may already be sufficiently salient to these children. Something else is likely the cause of their occasional errors in knowledge judgment in the no matching condition. We propose that they experience periodic lapses in executive control, so that on a few trials they fail to examine a stimulus carefully, keep the goal of a judgment in mind, and/or inhibit an impulsive or dominant response. Moreover, performing an object-photograph matching task, whether it involves a mix of familiar and unfamiliar objects, only familiar objects, or only toy wooden blocks, helped them establish a more careful, controlled approach to task performance that carried over to the lexical judgment tasks. In all of the matching tasks, successful performance depended on attending closely to stimuli, keeping the goal of the task in mind, and inhibiting impulsive or dominant responses.

Given the post hoc nature of this explanation, it should be viewed with caution until deliberate tests of it can be conducted. One testable implication of the explanation is that other procedures that increase children's tendency to examine stimuli carefully, keep the goal of a judgment task in mind, and/or inhibit impulsive or dominant responses should promote more accurate lexical knowledge judgment in children with larger, but not smaller vocabularies. Also, measures of executive control, in particular, the ability to inhibit a dominant response (e.g., in versions of the Simon Says game or Stroop effect, see

Carlson, Moses, & Claxton, 2004), should correlate with the accuracy of lexical knowledge judgment more strongly in children with larger vocabularies than in those with smaller vocabularies.

We have proposed that the metacognitive experiences that distinguish familiar from unfamiliar kinds were more salient to the children with larger vocabularies than to those with smaller vocabularies. Why might this be? It could be a consequence of the former group's greater speed and accuracy in recognizing familiar kinds and in retrieving information about them (Fernald, Perfors, & Marchman, 2006; Ford & Keating, 1981; Rose, Feldman, & Jankowski, 2009). The more frequently that a word or object evokes rapid recognition and rapid retrieval of information about itself, the more likely a child may be to notice when a word or object does not evoke such responses. Hearst (1991) has shown that an organism's tendency to notice the nonoccurrence of an event in some situation increases as the likelihood that the event will occur in that situation increases. The base rate probability that a word or object will evoke recognition as well as retrieval of information about itself is presumably greater in children with larger rather than smaller vocabularies.

Another contribution of the current investigation was the demonstration that young children sometimes decide that an object has a known name based solely on the feeling of familiarity that the object evokes. Children do not always verify that a name or other information can be generated for an object before deciding that they know what it is called. This conclusion is based on the negative priming effect shown by the children in the familiarity contrast condition with vocabulary sizes within one standard deviation of the normed mean for a child 4 years, 7 months. Marazita and Merriman (2011) found a similar negative priming effect for children with vocabulary sizes within this range, but because the children had made semantic judgments about objects during the preexposure task, the effect was open to an alternative interpretation. It could have been caused by the children mistakenly deciding that an object had a known name because semantic information about it came to mind. In the familiarity contrast condition of the current investigation, no semantic judgments were made during the matching task, and so the negative priming effect in that condition is unlikely due to semantic retrieval, but to the feeling of familiarity that preexposed objects evoked.

As interventions go, the task of finding object-picture matches for a small set of familiar and unfamiliar objects has many features to recommend it. It takes only about five minutes, and our participants found it easy and enjoyable. In the current study, its positive effect on the judgments of children with vocabularies typical of a younger 4-year-old was substantial; Cohen's $d = .71$ for the increase in mean accuracy of these judgments over that of the no-matching condition. This positive effect was not due to allowing children to warm up to the testing environment or to getting them to examine things closely so as to make judgments about them. Rather, the task sensitized them to the metacognitive experiences that distinguish familiar from unfamiliar kinds, which promoted using such experiences as the basis for making lexical knowledge judgments about objects and words.

One might question the usefulness of our intervention because it produced a negative priming effect on children's knowledge judgments about unfamiliar kinds of objects. However, the intervention did not cause children to judge preexposed unfamiliar objects any less accurately than the children in other conditions judged nonpreexposed unfamiliar objects. Although preexposure allegedly caused an unfamiliar object to later evoke a misleading feeling of famil-iarity, the object should still have evoked the metacognitive experience of minimal target generation, that is, of no name or other information about the object spontaneously coming to mind. The finding that a priming effect occurred within the familiarity contrast condition but not between this condition and the no-matching control condition is evidence that exposing children to a mix of unfamiliar and familiar objects made them more likely to use *both* the cue familiarity and the target generation heuristics for judging whether objects have known names (Merriman & Lipko, 2008).

Our intervention can be exported readily to other kinds of metacognitive judgment. If the mechanisms responsible for its benefits are general, then one would expect preexposure to words

of contrasting familiarity to also boost the accuracy of children's lexical knowledge judgments. 585
Likewise, preexposure to a mix of grammatical and ungrammatical utterances (e.g., "Sweep the
floor." vs. "Teeth your brush.") might well improve children's grammaticality judgments (Chaney,
1992; Smith & Tager-Flusberg, 1982). In memory monitoring paradigms, the experience of success-
fully recalling some trained items while failing to recall others might increase the accuracy of
children's judgments of learning (see Lipowski, Merriman, & Dunlosky, 2013; Schneider, Visé, 590
Lockl, & Nelson, 2000). In comprehension monitoring paradigms, hearing some instructions that
make sense while hearing others that do not might cause children to make better-calibrated
comprehension judgments (Beal & Belgrad, 1990; Flavell, 1981). Tests of these possibilities may
yield important insights regarding the development of metacognitive judgment in early childhood.

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