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Metacognitive developments in word learning:

Mutual Exclusivity and theory of mind

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Abstract

This study examines the flexibility with which children can use pragmatic information to determine word reference. Extensive previous research shows that children choose an unfamiliar object as referent of a novel name: the disambiguation effect. We added a pragmatic cue indirectly indicating a familiar object as intended referent. In three experiments, preschool children's ability to take this cue into account was specifically associated with false belief understanding and the ability to produce familiar alternative names (e.g., rabbit, animal) for a given referent. The association was predicted by the hypothesis that all three tasks require an understanding of perspective (linguistic or mental). The findings indicate that perspectival understanding is required to take into account indirect pragmatic information to suspend the disambiguation effect. Implications for lexical principles and socio-pragmatic theories of word learning are discussed.

Keywords: word learning, mutual exclusivity bias, disambiguation effect, theory of mind, alternative naming, pragmatics

Metacognitive developments in word learning:

Mutual Exclusivity and theory of mind

A frequent observation, both in word learning research and in everyday life, is that young children appear to assume that each object kind has only one name. This tendency can be demonstrated experimentally using what is known as the *disambiguation paradigm* (e.g., Markman & Wachtel, 1988; Merriman & Bowman, 1989). In the presence of a familiar nameable object and an unfamiliar object children are asked to pick the referent of a novel name. For example, when shown a familiar apple, and an unfamiliar whisk, and asked to pick the "hinkle", children typically choose the novel object. This disambiguation effect is very robust and has been extensively used in research. It can be demonstrated from late infancy (e.g., Halberda, 2003; Markman, Wasow, & Hansen, 2003). It also constitutes a test case for differing theories about the nature of word learning, and about the relationship between word learning and metacognitive development. Determining the underlying cause of disambiguation is of broad theoretical importance.

There are three general explanations of the phenomenon. (Others have proposed combinations of these explanations or hybrid accounts, e.g., Hollich, Hirsh-Pasek, & Golinkoff, 2000a, but we focus on these three for brevity.) The phenomenon is frequently identified as the 'Mutual Exclusivity bias' (e.g., Markman, 1989; Merriman & Bowman, 1989), based on the idea that children assume word extensions to be mutually exclusive. Other lexical principles accounts have been proposed in which children prefer to map novel names to nameless categories (N3C; Golinkoff, Mervis, & Hirsh-Pasek, 1994) or vice versa (bias to fill lexical gaps, Merriman & Bowman, 1989). Unlike the Mutual Exclusivity bias, neither account predicts difficulty mapping novel names to nameable categories if other options are not apparent.

According to these accounts, the bias exists to aid word learning. It has frequently been noted (e.g., Quine, 1960) that the number of possible meanings of an unknown word is indefinitely high, but children nevertheless readily learn nouns. One possible way of narrowing down the number of plausible meanings is to assume that a novel word cannot refer to objects one can already name. For basic level categories, this assumption is typically true, and thus could be a useful initial approximation. Later in development, as children encounter more superordinate, subordinate, and otherwise overlapping terms, the bias is assumed to be relaxed, possibly on a case-by-case basis (Markman, 1989, p. 215).

The main competitor to this view is the sociopragmatic account, according to which lexical principles are unnecessary. Instead, children are able to infer word meanings by judging others' communicative intentions (Bloom, 2000; Diesendruck & Markson, 2001; Tomasello, 2000) and other theory of mind judgements (Diesendruck, 2005; Diesendruck & Markson, 2001). To do this, children employ two connected pragmatic principles proposed by Clark (1988, p. 319), the principles of conventionality and of contrast: "For certain meanings, there is a conventional form that speakers expect to be used in the language community, that is, if one does not use the conventional form that might have been expected, it is because one has some other, contrasting meaning in mind". Thus, in the Disambiguation task, children infer that, had the experimenter wanted to refer to the familiar object, she would have used the familiar name. Since she did not, she must have some other meaning in mind, and the novel object is the most straightforward possibility.

In support of the sociopragmatic claim, Diesendruck and Markson (2001) have shown that a disambiguation effect occurs not only with novel labels, but also with idiosyncratic facts about objects. Children were shown two novel objects and told a fact about one of them, for example "my uncle gave this to me". They were then asked for "the one my cat likes to play with". Most 3- to 4-year-old children chose the previously unmentioned object. If the

same bias occurs with multiple labels and multiple facts then it cannot be a specifically lexical bias. As Diesendruck and Markson (2001, p. 639) caution though, it remains to be shown that it *is* the same bias: lexical constraints could underlie disambiguation with labels, and pragmatic constraints disambiguation with facts. Consistent with this possibility, a comparison of fact and label version of the Disambiguation task with the same participants found no correlation, both with typical and participants with autism (de Marchena, Eigsti, Worek, Ono, & Snedeker, 2011). Scofield and Behrend (2007) examined the two versions developmentally and found that 2-year-olds showed the disambiguation effect for labels (81%) but not for facts (19%), whereas performance on the two versions was equivalent by 4 years old.

A third account differs from the other two in that it sees the disambiguation phenomenon as a result of a cognitive limitation, rather than a word learning strategy or sophisticated sensitivity to speaker intention. This may seem counterintuitive, since choosing the novel object as referent for a novel word is typically the best guess, and adults usually do this. However, adults can also hypothesise that the novel word may be an alternative label for the familiar object. There are good reasons to think that younger children cannot do this. Doherty and Perner (1998) showed children objects for which they knew two familiar names, such as *truck* and *lorry*, as demonstrated by a vocabulary test. Nevertheless, when presented with one of the names, children were not able to provide the other (the 'Alternative Naming task'). This could not be explained by word-finding difficulties; children had equivalent difficulties when simply asked to judge whether another person was correctly playing the alternative naming game.

The ability to apply alternative names to an object is claimed to be part of general metacognitive development at preschool age. Doherty and Perner (1998) showed that children's difficulties with alternative names were comparable to and highly associated with

their performance on the False Belief task. This task requires children to predict where a character with a false belief about the location of an object will search for it.

Doherty and Perner (1998) argued that both the False Belief and Alternative Naming tasks require children to make a distinction between the object or situation and how it is thought or talked about. This distinction can be characterized in terms of *perspective* (Perner, Stummer, Sprung, & Doherty, 2002). The False Belief task requires children to distinguish between their own perspective on the situation and that of the protagonist, who falsely believes the object is where she left it. Regarding the Alternative Naming task, psycholinguists point out that the use of alternative labels puts different perspectives on a referent (Clark, 1987; Tomasello, 1999). Flexibly switching between alternative labels therefore involves the ability to distinguish between different perspectives.

Perner et al. (2002) distinguish between switching, and coordinating or confronting perspectives. Clearly children can take different perspectives at different times, thus *switching*. This can be externally induced. Most straightforward, moving to a new location alters one's visual perspective. Verbal perspective switches can be induced by other speakers using an alternative name. Plausibly children do this without noticing that a different name has been used. However, in order to deliberately to switch perspective, one must be aware that one is doing so. This requires understanding that there are perspectives, and that perspective differences are therefore possible. This is the ability that is taken to be demonstrated by the False Belief or Alternative Naming tasks.

Thus, it appears children have difficulties simultaneously applying two words to one object. Doherty and Perner's (1998) findings concerned words children had already learned. However, the theory makes no principled distinction between two known words and one known and one novel word. Equivalent difficulties when one of the words is novel would

produce the disambiguation effect: if children were unable to apply a second, novel word to the familiar object, the only remaining possible referent would be the novel object.

Children become able to pass the Alternative Naming task around the age they pass standard False Belief tasks. This does not mean that children should stop showing the disambiguation effect at this age. As noted, in the standard version of the task, the novel object is the appropriate choice, so that even when children become capable of applying the novel word to the familiar object, they will not do so in this situation. What should occur is an increase in flexibility. Children should be able to apply a novel word to a familiar object if pragmatic factors indicate it is appropriate. We test this claim in the current study.

Disambiguation versus other cues

Jaswal and Hansen (2006) addressed whether children could avoid the disambiguation effect when other cues suggested the familiar object. The experimenter used a novel name while pointing to the familiar object. Children continued to pick the novel object. Grassmann and Tomasello (2010) argued that a static pointing gesture was not sufficient for children to realise it was a communicative act towards them. They showed that when the experimenter pointed and additionally alternated gaze from the child to the familiar object, 2- to 4-year-old children then overwhelmingly chose the familiar object. Jaswal (2010) found comparable results. In neither study were there developmental effects.

These findings show that when an adult provides clear direct cues that the reference of a novel name is a familiar object children will be guided by these. Such cues are presumably very important for correcting mislearning of names and overextensions. Failure to account for their use would be a weakness for any theory. Although Grassmann and Tomasello accounted for performance in terms of socio-pragmatic understanding, both the lexical principles and perspectival accounts can also explain these findings. Children can relax the bias in specific cases given strong evidence it does not apply (Markman, 1989, p. 215). An adult giving clear

ostensive cues about the referent of a novel word is clearly strong evidence (so long as the adult is viewed as reliable). In terms of the perspectival account, children's own perspective on an object can be externally switched by another speaker using an alternative name, without requiring the child's control or reflective awareness (Perner et al., 2002).

What is needed is a task where the three theoretical accounts yield different predictions. Haryu (1991; Haryu & Imai, 1999) developed a task that does so. The task assesses children's ability to coordinate two indirect linguistic cues in a Disambiguation task. Haryu presented half of a sample of 3-, 4-, and 5-year-old Japanese children with a standard disambiguation paradigm (e.g., presented them with an apple and a lipstick holder and asked to give puppet a *heku*, a novel Japanese word). The other half was additionally given a strong pragmatic cue indicating that the intended referent was the familiar object: "Mary is hungry. I would like to give Mary (the) heku". The standard disambiguation condition replicated previous findings. All age groups selected the unfamiliar objects as referents for the novel terms. The second condition (Pragmatic Cue task) presented a very different picture, a clear developmental shift in object choice: 3-year-olds continued to pick the novel object and disregard the pragmatic cue; 5-year-olds selected the familiar object as referent for the novel word and thus no longer demonstrated a mutual exclusivity bias.

The task involves two cues: 1) the novel word implies that the referent is not the familiar object; and 2) the clear implication that the referent should be something edible. In this situation the cues suggest different referents. The lexical principles account does not predict Haryu's findings, but could explain them post hoc: the developmental change in selection of the familiar object in the Pragmatic Cue task could reflect a greater reliance on pragmatic information. Supporters of the account acknowledge that children use numerous cues to determine word meaning, and that the ME bias is gradually relaxed over time. The

shift from novel to familiar referent choice simply reflects a shift in the reliance of different strategies.

From the sociopragmatic point of view, the task involves two pragmatic cues that suggest different referents. However, according to the sociopragmatic account, the cues should successfully work together. The account assumes that children have no difficulty accepting that two labels apply to the same referent if it is clearly indicated that this is what the speaker intends. The additional cue constitutes a clear indication. For the account to be able to explain Haryu's findings would require auxiliary assumptions, for example that the additional cue is not well understood by younger children, or that coordinating the two cues is too taxing on children's executive functioning.

According to Perner et al.'s (2002) perspectival account, the developmental shift shown by Haryu results from children developing an understanding of perspective. Prior to this, children cannot conceive of objects having more than one label, and are therefore unable to choose the familiar object for the novel label, despite the strong pragmatic cue that this is appropriate.

The perspectival account makes a further prediction not made by the other two accounts. Success on the Pragmatic Cue task should coincide with success on other tasks measuring the developing understanding of perspective. Neither of the other accounts naturally predicts this; possible ways of modifying them to account for it are considered in the General Discussion. The aim of the present study is to test this prediction. We do so by comparing performance on the Pragmatic Cue task with the tests of conceptual and linguistic perspective taking used by Perner et al. (2002) and Doherty and Perner (1998), the False Belief and Alternative Naming tasks. The hypothesis is that performances on these tasks will be strongly associated, over and above age and verbal mental age.

Experiment 1

Haryu's procedure and the one developed below assume that children would readily provide the appropriate object when simply told the doll is hungry and asked to give her one of the two objects, without the additional factor of a novel name. Although intuitively very plausible, we first verify this.

Method

Participants.

Participants were 20 children (6 girls) from a predominantly middle-class nursery in central Scotland. There were 9 children below 3&1/2-years-old ($M = 37$ months, $SD = 2$ m, range 33 – 41 m), and 11 children above 3&1/2-years-old ($M = 50$ months, $SD = 4$ m, range 44 – 55 m). All children in the present study took part in only one experiment.

Design.

Each child was administered the Pragmatic Cue-Only task and the False Belief task in counterbalanced order.

Procedure and Materials.

Pragmatic Cue-Only task.

The child was introduced to Puppet (a bear glove puppet), then presented with a familiar object (e.g., a banana) and an unfamiliar object (e.g., a bottle stopper). Children were told: *"Puppet is hungry and would like one of these. Please give Puppet one."* Four additional trials paired novel objects with familiar objects that would satisfy the puppet's implied need (sleepy, cold, thirsty, bored). Presentation of objects was left/right randomised.

Table 1

Pragmatic cues, familiar and novel objects for Experiment 1and 2a, and novel words for Experiment 2a.

Pragmatic cue	Familiar object	Novel object	Novel word
hungry	Banana	Bottle stopper	Hinkle
sleepy	Bed	Bracket	Flinder
cold	Jumper	Drill slack adjuster	Budit
thirsty	Juice	Hose connector	Jintoff
bored	Book	Bicycle trouser clip	Lozee

Note: The Disambiguation condition in Experiment 2a used the same materials.

False Belief task.

The following story was acted out with two Playmobile® figures, a box, a jar and a marble:

"Now look, this is Sally and this is Tom. They have a box and a jar. Sally has a green marble. Sally puts her marble in the box and then she goes away. Now, Tom picks up Sally's marble from the box and puts it in the jar. Then Tom goes away. Look, Sally is coming back."

Each child was asked three questions in order:

Belief question:　　*Where will Sally look first for her marble?*

Reality question:　　*Where is the marble really?*

Memory question:　　*Where did Sally put the marble in the beginning?*

Children had to answer all three questions correctly to pass the task.

Results

The familiar object was selected as referent in 93% of trials. Two children selected the familiar object 3 out of 5 times, three children 4 out of 5 times (Table 2). The remaining 15 children picked the familiar object on every trial. Performance was significantly above chance: $t = 14.333$, $df = 19$, $p < .001$, $d = 6.58$. Younger children selected correctly on 94% of trials, and older children on 93% of trials, a non-significant difference.

The False Belief task was passed by 2 younger children and 6 older children (overall 40%). The association between the performance on the Cue-Only task and the False Belief task was not significant ($r = .281$, $p = .230$).

Table 2

Task performance for Experiment 1, 2a, 2b and 3

Condition	Experiment 1	Experiment 2a		Experiment 2b		Experiment 3	
	Cue only n = 20	Standard DT n = 43	Pragm. Cue n = 45	PC cue + word n = 21	PC word + cue n = 23	Standard DT n = 28	Pragm. Cue n = 28
Age [a]	43	43	45	47	47	48	
BPVS stand.score [a]		97	97	102	94		
False Belief [b]	40%	49%	53%	43%	43%	46%	
Disambiguation [c]	93%	88%	68%	60%	54%	94%	52%
Alternative Naming [c]		28%	43%	45%	40%	39%	
Day-Night-Stroop [c]				66%	60%		

Note: DT, Disambiguation task; PC, Pragmatic Cue task.
[a] *Mean.*
[b] *Percentage passing.*
[c] *Percentage correct.*

Discussion

Preschool children have little difficulty selecting the pragmatically appropriate object when cued with a need state. This provides the baseline for the following experiments, which examine children's behaviour when the request also includes a novel name. We compare this with performance on the False Belief and Alternative Naming tasks in order to test the prediction that success on the Pragmatic Cue task indicates an understanding of perspective. We also include a standard Disambiguation task of the same general format as the Pragmatic Cue task. It is predicted that performance on this task will approach ceiling, as typical in the literature (Haryu, 1991; Markman & Wachtel, 1988). In this and subsequent experiments we continue to employ a single False Belief task, in view of the number of other measures and the young age of participants. As these measures include the theoretically relevant Alternative Naming task, which in previous research has been closely associated with performance on the False Belief task, we do not consider this a serious limitation.

Experiment 2a

Method

Participants.

Participants were 88 children (44 girls) from four predominantly middle-class nurseries in central Scotland: 43 children took the standard Disambiguation task, 21 children in the younger group (M = 37 months, SD = 3 m, range 31 – 42 m) and 22 children in the older group (M = 48 months, SD = 4 m, range 43 – 59 m); 45 children took the Pragmatic Cue task, 20 children in the younger group (M = 39 months, SD = 3 m, range 34 - 42) and 25 in the older group (M = 50 months, SD = 5 m, range 43 – 60 m). Assignment to either was randomised. Children's verbal mental age was measured by the British Picture Vocabulary Scale II (Dunn, Dunn, Whetton, & Burley, 1997) and did not differ between groups (Disambiguation group: M = 41 months, SD = 7 m, range = 29 – 59 m; Pragmatic Cue group: M = 44 months, SD = 12 m, range 20 – 84 m; t (86) = 1.25, p = .215, d = 0.27).

Design.

A False Belief task, the Alternative Naming task (after Perner et al., 2002), and either the Disambiguation task or the Pragmatic Cue task were administered over two sessions in randomized order. The BPVS II was administered last.

Procedure and Materials.

Disambiguation task and Pragmatic Cue task.

The child was introduced to Jimmy the puppet, then presented with a familiar object (e.g., a banana) and an unfamiliar object (e.g., a bottle stopper). Children were asked to choose the referent of a novel word through pointing or picking up an object. Each of five trials presented a new set of one familiar and one unfamiliar object, and a novel word. The Pragmatic Cue task also used a different state of need for each trial (hungry, sleepy, cold,

thirsty, bored). Presentation of objects was left/right randomised. The wording of the request differed according to condition:

Disambiguation condition:

"Jimmy would like a hinkle, please give Jimmy a hinkle."

Pragmatic Cue condition:

"Jimmy is hungry and would like a hinkle, please give Jimmy a hinkle."

The objects, novel words, and pragmatic cues are listed in the order presented in Table 1.

False Belief task.

The False Belief task was the same as in Experiment 1.

Alternative Naming task.

Vocabulary check.

Four sheets of paper (21 x 29.7 cm) were presented individually, each displaying six pictures. Children had to point to each experimental item twice on different sheets, once under the basic label (e.g., "Show me the cat") and once under the superordinate label ("Show me the animal"). The correct item was pointed out on the rare occasion that the child refused to make a choice or pointed incorrectly.

Alternative Naming phase.

Children were presented with an individual picture and told:

"Now, here are some more pictures. Each picture has two names. I am going to tell you one name for it and you can then tell me another name for it. Let's try that. This is fruit. What else is it?" If the child did not respond, encouragement was given. "We can also call it an apple."

After this practice trial, the procedure continued with four pictures (*cat*, *food*, *owl*, *drink*), then a second time using the alternative label (*animal*, *burger*, *bird*, *milk*). Children had to provide both superordinate and basic labels to pass a particular item.

Results

Disambiguation and Pragmatic Cue task.

Figure 1 shows the number of times children chose the familiar item. For the Disambiguation task, most children chose the unfamiliar object on every trial ($M = 4.4/5$, *SD* $= .90$); the most frequent response for the Pragmatic Cue task was to choose the *familiar* object on every trial ($M = 3.4/5$, $SD = 1.6$), and there was a highly significant difference between mean performances on each task: $t(86) = 9.87$, $p < .001$, $d = 2.13$.
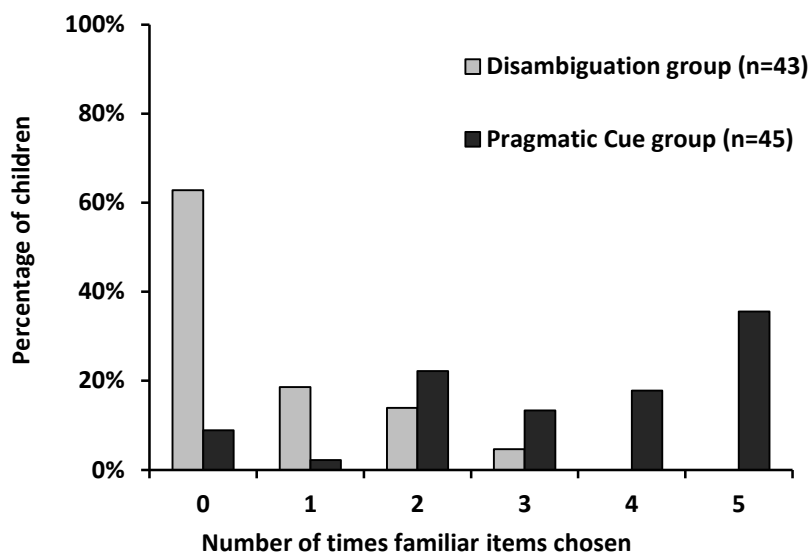
Figure 1. Performance on Disambiguation and Pragmatic Cue task.

Age effects

For the Disambiguation group, both age groups performed above chance (younger group: $t(20) = 16.41$, $p < .001$, $d = 7.34$; older group: $t(21) = 26.14$, $p < .001$, $d = 11.41$). For the Pragmatic Cue group, younger children performed at chance, choosing the familiar item on 57% of trials, $t(19) = .892$, $p = .384$, $d = 0.41$. Older children performed significantly

above chance, choosing the familiar item on 75% of trials, $t(24) = 4.43$, $p < .001$, $d = 1.81$ (Figure 2). The age improvement approached significance, $t(43) = 1.92$, $p = .061$, $d = 0.59$.
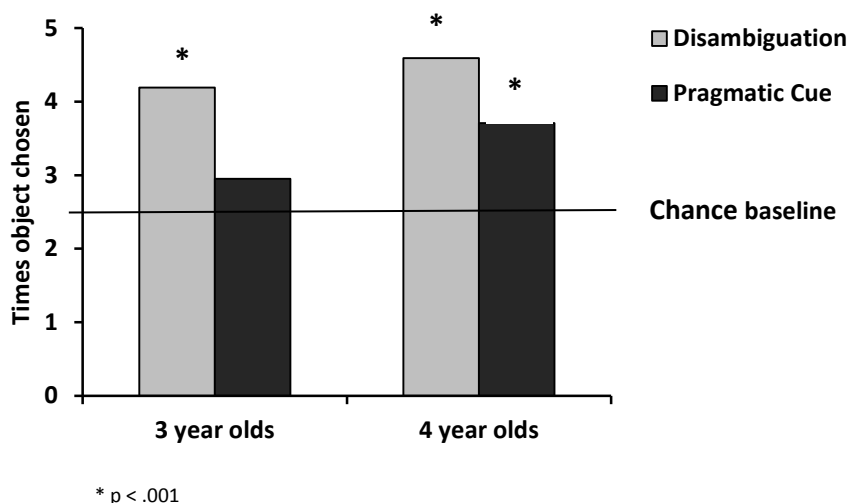
Figure 2. Performance on novel word tasks by age (novel object chosen in DT, familiar object chosen in PC task)

False Belief task.

Roughly half the children passed the False Belief task in each group: Disambiguation group 49%, Pragmatic Cue group 53%, $U(86) = 894.50$, $Z = -0.67$, $p = .500$. Younger children (29% pass) performed significantly less well than older children (70%), $U(86) = 513.50$, $Z = -4.17$, $p < .001$.

Alternative Naming task.

Twenty-one percent of responses were unanticipated but deemed valid, such as "sandwich" instead of "burger" and "pussycat" instead of "cat". The analysis leniently scored a particular item as correct if children gave different acceptable responses on the two trials. A separate analysis using strict criteria produced the same overall pattern of results.

Mean performance on the vocabulary check was 7.4 out of 8 items ($SD = 0.70$), indicating that failures on the ANT were not due to lack of relevant vocabulary. In the experimental phase, children named a mean of 1.35 ($SD = 1.48$) pairs correctly. Younger

children performed less well than older children, (16% correct vs. 50% pairs correct; t (86) = 4.76, $p < .001$, $d = 1.03$).

Comparison of tasks.

Associations between task performances were examined separately for the Disambiguation and Pragmatic Cue groups. Performance on the Disambiguation task approached ceiling ($M = 4.40/5$, $SD = .90$) and was not significantly associated with other variables. Age and verbal mental age correlated strongly with performances on the False Belief and the Alternative Naming task for this group (Table 3). The correlation between False Belief and Alternative Naming performances remained stable after the influences of age and verbal mental age were accounted for.

Table 3

Correlations between tasks for Disambiguation group (correlation after partialling out age and verbal mental age (BPVS))

	BPVS	False Belief	Alternative Naming	Disambiguation
Age	.53***	.62***	.43**	.26
BPVS		.56***	.40**	-.05
False Belief			.63*** (.47**)	.09 (-.02)
Alternative Naming				-.03 (-.11)

**p < .01. ********p* < .001.

Table 4

Correlations between tasks for Pragmatic Cue group (correlation after partialling out age and verbal mental age (BPVS))

	BPVS	False Belief	Alternative Naming	Pragmatic Cue
Age	.75***	.46***	.55***	.41**
BPVS		.54***	.60***	.52***
False Belief			.68*** (.52***)	.65*** (.51***)
Alternative Naming				.68*** (.53***)

**p < .01. ********p* < .001.

Correlations between age, verbal mental age, and performances on the False Belief and Alternative Naming tasks were similar between the Disambiguation and Pragmatic Cue groups. Performance on the Pragmatic Cue task was significantly correlated with performances on the ANT and False Belief task (Table 4) and remained substantial and significant after age and VMA were partialled out.

Figure 3 shows selection of familiar objects in the Pragmatic Cue group by False Belief performance. Children who failed the False Belief task selected markedly fewer familiar objects than those who passed, rising from below chance to close to ceiling: FB_{Fail}: 45% vs FB_{pass}: 87%; $t\,(43) = 5.61$, $p < .001$, $d = 1.71$.
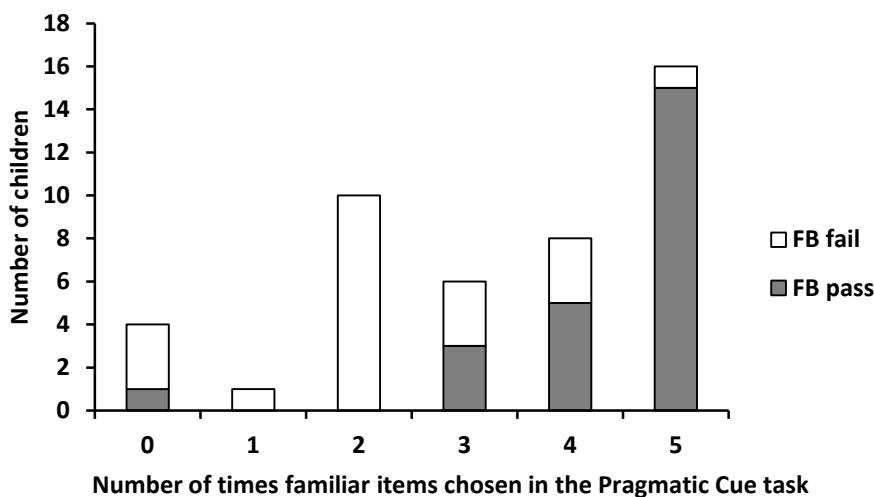
Figure 3. Comparison of Pragmatic Cue and False Belief performance

Discussion

As is typical, in the Disambiguation task, children chose the novel object on the vast majority of trials. There were no apparent relationships with the metarepresentational tasks. By contrast, performance on the Pragmatic Cue task was strongly related to performance on both the False Belief and Alternative Naming tasks, beyond common relationships with age and verbal mental age. Children who passed the False Belief task scored significantly higher on the Alternative Naming and also the new the Pragmatic Cue task. This supports the

hypothesis that children cannot override the tendency to assign novel labels to novel objects until they develop an understanding of perspective.

A methodological concern was that in the Pragmatic Cue task the cue (e.g., "Jimmy is hungry…") was always stated before the novel word ("… and would like a hinkle"). More impulsive children might have chosen a referent based on the cue, without attending to the following word, producing false positives. On the other hand, children might only attend to the novel word as this was the last piece of information. Recency effects might therefore influence the data and produce false negatives.

A further experiment was therefore conducted with the order of mention of the cue and novel word reversed for half of participants. Additionally, a test of executive inhibition (Day&Night-Stroop, after Gerstadt, Hong, & Diamond, 1994) was added to address the possible influence of inhibitory difficulties on object selection. Successful use of the pragmatic cue plausibly involves inhibiting a tendency to apply novel names to unfamiliar objects. Preschool children are known to be developing inhibitory abilities (e.g., Jones, Rothbart, & Posner, 2003). This development has also been hypothesised as critical to False Belief performance; a number of studies have found relationships between the two, although lack of a close relationship is also not uncommon (see Montgomery & Koeltzow, 2010, for a review). The Alternative Naming task also plausibly requires children to inhibit the name the experimenter provides in order to produce the alternative. Thus inhibitory difficulties may be a common factor between the experimental tasks.

Experiment 2b

Method

Participants.

Participants were 44 children from three predominantly middle-class nurseries in central Scotland. Twenty one children (9 girls; $M = 47$ months, $SD = 6$ m, range $35 - 57$ m)

heard the pragmatic cue followed by the novel word as in Experiment 2a; 23 children (11 girls; M = 47 m, SD = 6 m, range 40 – 59 m) heard the novel word followed by the pragmatic cue.

Design.

The design was as for Experiment 2a, with the addition of the Day-Night Stroop task included either in the first or second session, counterbalanced. Children's verbal mental age was measured by the BPVS 3 (Dunn, Dunn, Sewell, & Styles, 2009).

Procedure and Materials.

Pragmatic Cue task.

There were two versions of the instructions:

Cue + novel word:

"Jimmy is very hungry and would really like a hinkle. Every time when he is hungry he likes a hinkle. Please give Jimmy a hinkle."

Novel word + cue:

"Jimmy would really like a hinkle, because he is very hungry. He always likes a hinkle when he is hungry. Please give Jimmy a hinkle."

The procedure was the same as in Experiment 2a, with one minor change. Pictures of familiar and unfamiliar objects were used instead of real objects (Table 5) to avoid distractions caused by children manipulating the objects. Use of pictures is common in word-learning research (e.g., Axelsson & Horst, 2014; Diesendruck, 2005, Experiment 1; Plunkett, Hu, & Cohen, 2008).

Table 5

Novel words, pragmatic cues and pictures for Pragmatic Cue task, Experiment 2

Novel word	Pragmatic cue	Familiar picture	Novel picture
Hinkle	hungry		
Flinder	sleepy		
Budit	cold		
Jintoff	thirsty		
Lozee	sore [a]		

[a] *Pragmatic cue "sore" was included to replace "bored" in Experiment 1 and 2a, which elicited unwanted responses like children offer to play with the puppet if he is bored.*

False Belief task.

The False Belief task was the same as in Experiment 1.

Alternative Naming task.

To avoid unanticipated responses, cat/animal and burger/food were replaced by dog/animal and vegetable/carrot. Otherwise the procedure was as before.

Day-Night Stroop.

The child was presented with coloured sun pictures and black and white moon pictures, and told to respond to the sun card by saying "night" and to the moon card by saying "day." After a brief training phase, children were presented one at a time with eight sun and eight moon cards randomly mixed. The correct responses for each set were compared, following a previously used procedure (Sabbagh, Xu, Carlson, Moses, & Lee, 2006).

Results

Children in the cue + novel word condition chose the familiar object on 3.0 out of 5 trials ($SD = 1.3$) compared to 2.7 out of 5 trials for children in the novel word + cue condition ($SD = 1.2$). This difference was not significant: $t(42) = .687$, $p = .496$, $d = 0.11$. The two groups performed virtually the same on all other tasks (all ps $> .582$) and were therefore combined for the analysis below.

Age effects

The combined sample was split into a 3-year-old ($N = 22$, $M = 41$ m, $SD = 3$ m, range 35 − 45 m) and 4-year-old group ($N = 22$, $M = 52$ m, $SD = 3$ m, range 48 − 59 m). Performance on the Pragmatic Cue task did not differ significantly between the groups (t (42) = .239, $p = .813$, $d = 0.07$), and performance of each group overall did not differ from chance (3-year-olds: t (21) = 1.27, $p = .220$, $d = 0.55$; 4-year-olds: t (21) = 1.43, $p = .167$, $d = 0.62$).

False belief task.

Of the whole sample of 44, 19 children passed the False Belief task. The improvement with age was modest: $M_3 = .20$, $M_4 = .25$; U (42) = 184.500, $Z = -1.51$, $p = .130$.

Alternative naming task.

Children recognised a mean of 7.5 out of 8 items correctly in the vocabulary check ($SD = 0.79$). In the experimental phase children correctly named a mean of 1.68 pairs ($SD = 1.50$). 4-year-olds produced significantly more word pairs ($M_3 = 1.18$, $M_4 = 2.18$; t (42) = 2.31, $p = .026$, $d = 0.71$).

Day&Night Stroop.

Children gave a mean of 10.0 ($SD = 5.7$) out of 16 correct responses; 28 children scored more than 50% correct, 8 of whom scored 100%. The 4-year-olds gave significantly more correct responses ($M_3 = 8.23$, $M_4 = 11.82$; t (42) = 2.19, $p = .034$, $d = 0.68$).

Comparison of tasks.

Correlations between the Pragmatic Cue, False Belief and Alternative Naming tasks were similar to the previous experiment, remaining substantial and significant after partialling out age, verbal mental age, and Day-Night Stroop performance (Table 6).

Table 6

Correlations between tasks (correlation after partialling out age, BPVS and Day-Night Stroop (DNS))

	BPVS	False Belief	Alternative Naming	Pragmatic Cue	DNS
Age	.59***	.32*	.46**	.07	.35*
BPVS		.51***	.46**	.35*	.38**
False Belief			.56*** (.43**)	.52*** (.44**)	.16
Alternative Naming				.40** (.35*)	.15
Pragmatic Cue					.09

*p < .05. **p < .01. ***p < .001.

Figure 4 presents the number of familiar objects selected in the Pragmatic Cue task according to False Belief performance. Again, children's performance on the Pragmatic Cue task is strongly related to performance on the False Belief task (FB-fail: 46% vs FB-pass: 72%; $t(42) = 3.80$, $p < .001$, $d = 1.17$).
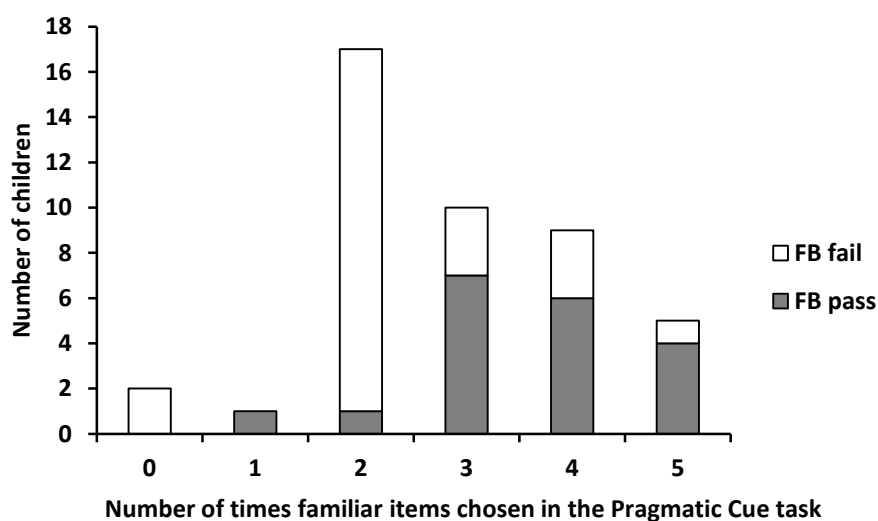
Figure 4. Comparison of Pragmatic Cue and False Belief performance

Discussion

Experiment 2b replicates the findings of Experiment 2a of a strong specific relation between performances on the Pragmatic Cue task and on the False Belief and Alternative Naming tasks. The order in which the pragmatic cue and the novel word were presented had

no discernible influence on performance. This suggests that impulsivity does not account for the findings.

There was also no apparent relationship between performance on the Pragmatic Cue task and the Day-Night Stroop, a common test of preschool inhibitory ability. Performance on this task was related to age and verbal mental age, but not to False Belief performance. Although studies frequently find the two task performances are related, a lack of close relationship is not uncommon (Montgomery & Koeltzow, 2010).

Relationships between age and other variables in Experiment 2b were not as strong as in Experiment 2a. In particular, performance on the PC task was not related to age (although it was related to BPVS performance). Participants came from three different preschools, and it is plausible that this lead to a heterogenous sample of able younger children and more diverse older children. Our main aim has been to compare performance on the experimental tasks. This requires a range of performances, but age relationships were not critical to this endeavour (and indeed, were partialled out of the analysis). Nevertheless, age-related change in the Pragmatic Cue task is of interest. To further investigate this, we conducted a third experiment. To ensure a more homogenous sample we recruited from one single middle-class nursery. The nursery was in Salzburg, Austria simply because that was where both authors were at the time. Performance on the Alternative Naming task has been examined in English in England (Doherty & Perner, 1998) and Scotland (Doherty, 2000; current study E1, E2a, E2b), and in German in Austria (Perner et al., 2002) with comparable results. The first author is fluent in both languages and translated all tasks. An Austrian researcher fluent in English verified the accuracy of the translation.

Experiment 3

Method

Participants.

This study was performed with 28 children (18 girls) in two age groups from a local middle-class nursery in Salzburg (Austria): 3-year-old children ranged between 36 and 47 months ($N = 15$, $M = 42$ months, $SD = 4$ m), 4-year-old children between 49 and 60 months ($N = 13$, $M = 55$ months, $SD = 4$ m).

Design.

Each child was seen individually in a small room next to the playroom. The tasks were randomly split over the course of two days and included amongst others (which we intend to report elsewhere) a False Belief task, the Alternative Naming task, Pragmatic Cue task and a Disambiguation task.

Procedure and Materials.

Disambiguation task & Pragmatic Cue task.

The cues used for previous PC tasks were translated into German and German sounding novel words were chosen, which were adopted from Grassmann, Schulze and Tomasello (2015), see Table 7.

Table 7

Materials for Disambiguation and Pragmatic Cue task

Disambiguation task			Pragmatic Cue task			
Novel word	Familiar picture	Novel picture	Novel word	Pragmatic cue	Familiar picture	Novel picture
Kulde			Nohle	hungry		
Fende			Tahne	sleepy		
Albe			Doffe	cold		
Mehfe			Nehbe	thirsty		
Losse			Puhne	sore		

The procedure was similar to Experiment 2b, but with another alteration to improve focus on the novel word:

The child was presented with the two face-down pictures first and told in the Disambiguation task: "Puppet would like a Kulde. Do you know what that is? – There is a Kulde on one of the pictures." In the Pragmatic Cue task the need-state was added: "Puppet is hungry and would like a Kulde.". The pictures were then both turned over at the same time for the child to select the "Kulde". This further alteration was introduced so that children were presented with the pragmatic cue and novel word before they could make a choice.

False Belief task.

The False Belief task was the same as before.

Alternative Naming task.

The carrot-vegetable pair was used as teaching item and water replaced milk in the drink-milk pairing. The procedure was as before.

Results

Children chose the familiar object as referent for the novel word on average 2.61 times ($SD = 1.81$) in the Pragmatic Cue task, compared to 0.32 times ($SD = 0.91$) in the Disambiguation task, a highly significant difference: $t(27) = 6.710$, $p < .001$, $d = 2.58$.

Age effects

Performance did not differ between 3-year-old and 4-year-old children for the Disambiguation task: $M_3 = 4.93$, $SD = 0.26$, $M_4 = 4.38$, $SD = 1.26$, $t(26) = 1.54$, $p = .147$, $d = .0.60$. Both groups performed significantly above chance: $t_3(14) = 36.50$, $p < .001$, $d = 19.51$; $t_4(12) = 5.39$, $p < .001$, $d = 3.11$. Performance improved significantly with age for the Pragmatic Cue task: $M_3 = 1.67$, $SD = 1.35$, $M_4 = 3.69$, $SD = 1.70$, $t(26) = 3.52$, $p = .002$, $d = 1.38$, (Figure 5). Older children performed significantly above chance: $t_4(12) = 2.53$, $p = $

.027, d = 1.46; younger children performed significantly *below* chance: t_3 (14) = 2.40, p = .031, d = 1.28.
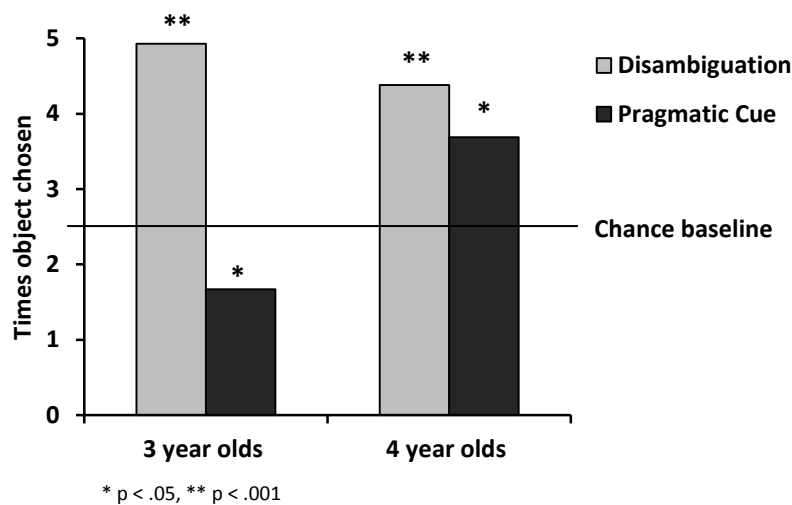
Figure 5. Performance on novel word tasks by age (novel object for DT, familiar object for PC task)

False Belief task.

The False Belief task was passed by 13 children. The age improvement was not significant: M_3 = .40, M_4 = .54, U (26) = 81.00, Z = -.863, p = .388.

Alternative Naming task.

Children identified an average of 7.39/8 items (SD = .69) correctly in the vocabulary check. During the test phase, children produced an average of 1.57 pairs (SD = 1.23). The 3-year-olds produced on average 0.93 (SD = 1.03) word pairs compared to 2.31 (SD = 1.03) produced by the 4-year-olds, a significant difference (t (26) = 3.51, p = .002, d = 1.38).

Comparison of tasks.

Performance on the False Belief task, the Alternative Naming task, the Pragmatic Cue and Disambiguation task were entered in a correlational analysis.

Table 8

Correlation of tasks (correlations after partialling out age)

	FB	AN	PC	D
Age	.49**	.74***	.65***	.20
False Belief		.69*** (.56**)	.63*** (.47*)	.01 (-.10)
Alternative Naming			.67*** (.37‡)	.13 (-.03)
Pragmatic Cue				.26 (.17)

Note: FB, False Belief; AN, Alternative Naming; PC, Pragmatic Cue, D, Disambiguation
‡ p < .10, * p < .05,   ** p < .01,   *** p < .001

Children's ability to produce familiar alternative labels and accept an unfamiliar label for an already named object correlated strongly with false belief understanding. Figure 6 presents the number of familiar objects selected in the Pragmatic Cue task according to False Belief performance. Again, children who passed the False Belief task performed markedly better on the Pragmatic Cue task than those who failed (t (26) = 3.90, p = .001, d = 1.53).
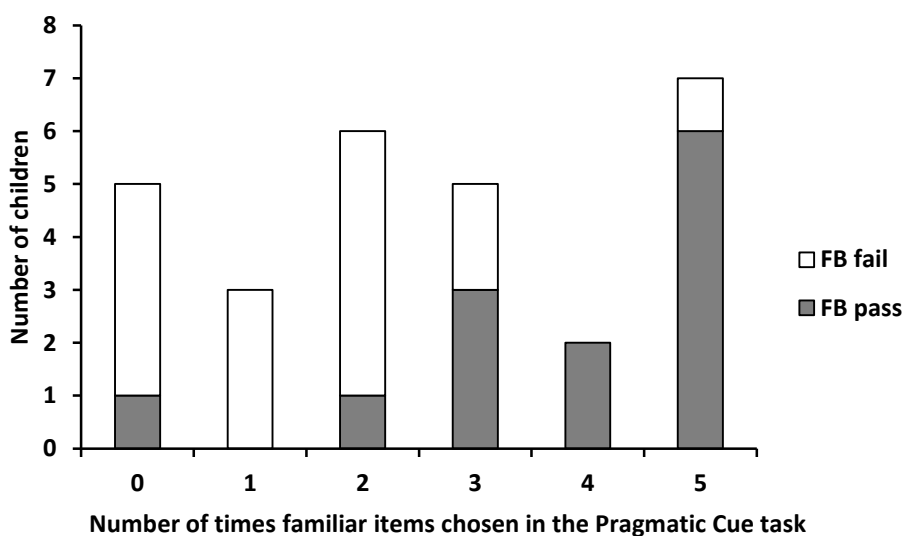

Figure 6. Comparison of Pragmatic Cue and False Belief performance

Discussion

The findings of Experiment 3 confirm those of Experiments 2a and 2b of a strong and specific association between the Pragmatic Cue task performance and understanding of false belief, and to a slightly lesser extent, the ability to produce alternative names for familiar

objects. It also provides clearer evidence of how performance relates to age. Younger children performed significantly below chance on the PC task, rising to significantly above chance in the older group.

The below chance performance is interesting; it suggests systematic choice of the novel object. In Experiments 2a and 2b children who failed the False Belief task tended to pass 2 out of 5 trials on the PC task (compare Figures 3 and 4 with Figure 6). This is only slightly below the chance level of 2.5, consistent with children who cannot coordinate the pragmatic cue and alternative name largely choosing at random. Haryu's (1991) original findings were also of below chance performance at 3 years, with children choosing the novel object almost as often as in the Disambiguation task. Japanese children have been found typically to pass False Belief tests somewhat later (Naito & Koyama, 2006; Wellman, Cross, & Watson, 2001), which is consistent with the transition period in Haryu's sample occurring between 4- and 5-years. Whether similar systematic novel object choice would occur with younger British or Austrian children will require further research on a younger sample.

General Discussion

This study examined development of the ability to select a familiar object as referent for a novel label. The typical Disambiguation task requires children to determine which of a familiar and a novel object is the referent of a novel name. We compared this task with one in which an additional pragmatic cue is given indicating that the familiar object is the intended referent. The ability to use this pragmatic cue was strongly and specifically associated with the abilities to understand another's false belief and to produce familiar alternative names for objects. The relationship between the latter two metacognitive abilities has previously been established, and has been attributed to the fact that both require a clear distinction between the object talked or thought about and how it is mentally or verbally represented (Doherty & Perner, 1998). Following Perner et al. (2002), we refer to this distinction in terms of requiring

a common understanding of perspective. This distinction also seems critical to success in the Pragmatic Cue task. Children need to be able to consider the novel word as a potential new label for the familiar target. The principle difference to the Alternative Naming task is that in the Pragmatic Cue task the alternative name is novel rather than familiar. Prior to these developments, children's tendency to choose the novel object as referent of a novel label is remarkably strong. Even when told first that puppet Jimmy is hungry, and then asked to give Jimmy a *hinkle*, children still chose the clearly inedible novel object.

As noted in the Introduction, the lexical principles and socio-pragmatic accounts would not predict the developmental shift from selecting the novel to selecting the familiar object, or the association of this shift with the False Belief and Alternative Naming tasks. However, both could do so if modified to incorporate the development of understanding of perspective.

Fit with Lexical Principles accounts

The Mutual Exclusivity bias is conceived of as one of a number of ways of determining word reference. Thus, it readily combines with other accounts, and thus could be modified to account for early lack of perspectival understanding. Its basic claim is that children assume word extensions do not overlap. Our argument here has been that the disambiguation effect initially occurs because children cannot conceive of two words referring to the same thing (since this would involve two distinct perspectives on it). To avoid this, children attach novel words to objects they do not have a name for. Thus early lack of perspectival understanding could lead to children treating word extensions as non-overlapping, within a given conversation. This is consistent behaviourally with the ME bias account. Once children become able to reason about the relation between words and their referents they can effectively relax the bias in specific cases.

Note that this theory purely concerns determining referents for words, not learning the words *per se*. Hence, the common objection to the existence of an ME bias, that children's vocabularies contain numerous overlapping terms (e.g., Gathercole, 1989; Nelson, 1988) does not apply. The perspectival account only predicts problems identifying the referent of a novel word if children both already know a word for the object *and* if they are aware of this word at the time. That is, if children fail to notice that they know a word for the object, the theory does not predict difficulties.

It is likely children typically are aware of the familiar word in situations like the Disambiguation task. Children as young as 18 months have been found to implicitly name visually fixated images (Mani & Plunkett, 2010). Interestingly, Grassmann et al. (2015) report that for disambiguation to occur the familiar object label must be in children's productive vocabulary (which would be required for implicit naming), not simply in their receptive vocabulary.

In sum, the perspectival account and the findings presented here are compatible with an extension of the lexical principles account. However, the bias is seen not as existing in order to aid word learning, rather from an inability to conceive of more than one perspective on a given object. Any word learning benefits may be a fortuitous consequence. This view of the bias can explain why children learn multiple words for objects (typically when they do not notice they are doing so) and is consistent with findings that the bias appears very early in language learning.

Fit with the sociopragmatic account

The present findings could also be explained within the sociopragmatic framework if it is allowed that children develop a more sophisticated understanding of meaning over the preschool period. As noted in the Introduction, the basic assumption of the sociopragmatic account is that children learn words using the principles of conventionality and of contrast

from the start of word learning (Bloom, 2000; Clark, 1997). In the typical Disambiguation task the speaker does not use the conventional form for the familiar object, and thus is assumed to have some contrasting meaning in mind. However, most meaning differences also involve differences in perspective: differences in denotation, dialect, or register, for example, when referring to the same object all constitute differences in perspective (Clark, 1990). Children without an understanding of perspective would not be able to reason about contrasting meanings of these kinds. However, differences in reference do not create perspective difficulties: because they involve different objects, they do not require the distinction between an object and how it is talked about.

Thus development of perspectival understanding could therefore be incorporated into the pragmatic account by arguing that younger children have a restricted concept of meaning: they can only consider differences in meaning in terms of differences in referent. This would limit their ability to apply the principle of contrast, in a way that would explain the current findings. The only contrasting meanings children could consider would be contrasting referents, and thus would choose the novel object as referent for the novel word, regardless of the additional cue. It would also explain the association with the Alternative Naming task, which would also be difficult with this restricted concept of meaning.

For older children, developing a more sophisticated understanding of meaning would principally entail understanding differences in perspective, i.e., that different words can be used to refer to the same thing (e.g., Clark, 1997; see Perner et al., 2002 for a discussion; Tomasello, 1999). Thus allowing for developmental change in children's understanding of contrast in this way would result in an account very similar to the one we propose, and would imply specific limitations on children's ability to use speaker intentions to infer word meanings.

Alternative ways of incorporating pragmatic factors into word learning

It is not our intention to deny that pragmatic principles are important in word learning. However, they do not need to be explicitly represented or involved in sophisticated reasoning (see Hollich, Hirsh-Pasek, & Golinkoff, 2000b, for a hybrid account on early word learning). In younger children, the disambiguation effect plausibly results from the incorporation of basic pragmatic principles into the automatic procedures for determining reference. The intuitions behind the sociopragmatic account are clearly valid and descriptive of the way speakers typically behave: adults rarely refer to familiar objects with novel names, and in a given conversation speakers rapidly adopt a consistent set of terms for the referents (Brennan & Clark, 1996; Matthews, Lieven, & Tomasello, 2010). However, conformity to these norms may not require computationally-demanding consideration of speakers' referential intentions (which arguably, would limit children's ability to determine reference in on-line interactions). In most cases, an automatic tendency to resist second names for objects in a given conversation would achieve the same result. Exceptions like those in the Pragmatic Cue task are unusual, and if children have limited cognitive resources, the possibility of meeting cases like these can be ignored as a reasonable trade-off. Increasing metacognitive sophistication would lead children to understand *why* this automatic tendency is sensible. It would also allow them to behave otherwise in cases like that posed by the Pragmatic Cue task.

Conclusion

In the current study we compared performance on a modified version of the Disambiguation task, the Pragmatic Cue task, with performance on the False Belief and Alternative Naming tasks, success on which indicates an understanding of perspective. When a request clearly implies the familiar object but uses a novel name, children's ability correctly to select the familiar object is strongly associated with their performance on other tests of perspectival understanding. From this we conclude that young children's success on the

typical Disambiguation task is not the result of sophisticated reasoning about speaker intention, nor the operation of a specifically lexical principle. Instead we argue it results from a failure to understand perspective, and thus an inability to conceive of two words applying to the same object in a given situation. Older children and adults are able to conceive of different words in terms of differences in perspective. This allows them to choose flexibly if other information implies the familiar object is the referent, as in the novel Pragmatic Cue task.

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Highlights

- Children use pragmatic information to select a familiar referent for a novel word

- Use of indirect pragmatic information associated with theory of mind development

- Flexible interpretation of novel words associated with flexible use of known words

- Metacognitive development leads to increasingly flexible word learning