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Memory and Attention Make Smart Word Learning: An Alternative Account of Akhtar, Carpenter, and Tomasello

Larissa K. Samuelson and Linda B. Smith

Two general types of accounts have been offered to explain the smartness of young children's word learning. One account postulates that children enter the word-learning task with specific knowledge about how words link to categories. The second account puts the source of children's smart word learning in knowledge about the pragmatics of communication and social interactions. The present experiment tested a third idea: that children's seemingly smart word learning derives from general, indeed mundane, cognitive processes. Forty-eight children from 18 to 28 months of age participated in a task designed to test our alternative explanation as applied to Akhtar, Carpenter, and Tomasello's (1996) finding that children use knowledge of the communicative intents of others to interpret a novel noun. Specifically, we suggest that children's attention to the proper referent was guided by the general effects of a contextual shift on memory and attention. The procedure in the present study was identical to that of Akhtar et al. except that we differentiated the target through a nonsocial context shift. Findings similar to that of Akhtar et al. emerged under the present procedures. These results strongly suggest that general attentional and memorial processes, and not knowledge about the communicative intents of others, may guide young children's word learning. These findings provide one demonstration of how smart word learning may emerge from more ordinary (and dumb) cognitive processes.

INTRODUCTION

Young children are smart word learners; in particular, they interpret novel nouns in ways that are typically right from an adult point of view (Imai, Gentner, & Uchida, 1994; Landau, Smith, & Jones, 1988; Markman, 1989; Mervis, Golinkoff, & Bertrand, 1994; Soja, Carey, & Spelke, 1991). This smartness is remarkable because young children have limited cognitive and conceptual skills and because the task of mapping words to possible meanings seems nearly impossible (Quine, 1960). Yet young children succeed even when experimenters make the word learning contexts devilishly ambiguous: when there are many potential referents present (Akhtar, Carpenter, & Tomasello, 1996, Experiment 1; Tomasello & Barton, 1994), when the name and the named object are presented at different times (Baldwin, 1991, 1993b; Merriman, Schuster, & Hager, 1991; Tomasello, Strosberg, & Akhtar, 1996), and when there are competing relevant properties and kinds of categories to be considered (Landau et al., 1988; Markman & Hutchinson, 1984; Waxman, 1990). Two accounts have been offered to explain the smartness of young children's early word learning in ambiguous contexts such as these.

The first kind of account postulates that children enter the word-learning task with knowledge of how words link to categories, knowledge that limits their interpretations of novel words and directs them

toward the linguistically relevant interpretation (Markman, 1989; Mervis et al., 1994; Waxman, 1991, 1994). These accounts are formulated in terms of assumptions or links between specific linguistic notions (nouns, count nouns) and kinds of meaning (taxonomic, whole object). Most research conducted under this framework has sought to demonstrate the existence of this knowledge and its lexical specificity.

The second kind of account puts the source of children's smart word learning in the social/communicative context, in joint attention, and the pragmatics of communication (Baldwin, 1991, 1993a; Nelson, 1985; Tomasello & Akhtar, 1995; Tomasello et al., 1996). The idea here is that children's knowledge of people's goals and purposes limits their interpretations of novel words and directs them to the most likely intended meaning. Most research in this framework seeks to demonstrate wider social influences on word interpretation than the narrow lexical or syntactic context in which a word is presented.

Although these two accounts are frequently seen as competitors in the literature (Nelson, 1985), they are alike in that they ascribe to children knowledge specific to the domain of language or language use. In both accounts, the *cause* of children's smart word interpretations is knowledge about language itself or

about people's goals in discourse. Both accounts thus concentrate on what children know. Neither pays much attention to the processes by which this knowledge is realized—to the processes of perceiving, attending, and remembering that must engage, activate, and turn that knowledge into the act of interpreting a particular novel word. In brief, both accounts are incomplete: they specify the knowledge children may use but not the processes that make that knowledge manifest in a behavioral act (see also Smith & Thelen, 1993).

In this article, we seek evidence for a third possible account of children's smart word learning, one which focuses on process. The central idea is that general processes of perceiving, remembering, and attending when placed in the word-learning context may be sufficient *in and of themselves* to create children's smart word interpretations (Smith & Samuelson, 1997; Smith, Jones, & Landau, 1996). We specifically seek to demonstrate the plausibility of this form of explanation by showing how one result previously interpreted in terms of children's knowledge about speaker's intents can be explained by basic memorial and attentional processes.

Akhtar, Carpenter, and Tomasello (1996)

Akhtar et al. (1996) reported results that suggest that young children made use of discourse pragmatics and the speaker's point of view to determine the intended referent of a novel word. The sequence of events in the relevant experiment (Experiment 2) is summarized in Figure 1. In the first three events of the procedure, four participants (the child, the parent, and two experimenters) jointly played in succession with three objects that were novel to the child and for which the child did not have a name. None of these objects was named by any of the participants. In the fourth event, two of the participants (one experimenter and the parent) left the room; the remaining experimenter and child played with the fourth object, an object also novel to the child and one which was not named by the remaining experimenter. This fourth object was the *target*. The fifth event differed for children in the Experimental and Control conditions. In both conditions, all four objects were put in a transparent box. In the Experimental condition, the parent and second experimenter returned to the room and upon seeing the transparent box of objects (but not looking at any one object in particular) said, "Look I see a gazzer. A gazzer." In the Control condition, the parent and second experimenter returned to the room and upon seeing the box

of objects said, "Look! Look at that!" The remaining events were the same in both conditions. In the sixth event, the four participants played again with all four objects. The seventh event was the test: All four objects were placed in the transparent box and one experimenter asked the child to "Give me the gazzer."

Akhtar et al. found that reliably more children in the Experimental than Control condition interpreted the novel name as referring to the target object. On what basis could these children determine that the target was the intended referent? Recall that all four objects were present and familiar to the child when the name was first offered. The critical disambiguating information was that only the target object was new within the discourse context *for the speaker*. In this situation, the child could infer that the target was the intended referent if the following were true: (1) the child knew that the speaker had not previously seen the object in *this* discourse context; and (2) the child believes that an adult will name a novel object for a child when, in the discourse context, the adult and child first jointly encounter the object. By this analysis, the results suggest that young children "know more about the behavior and cognition of other persons than previously believed" and that children have "a deep and flexible understanding of the behavior of other persons and their referential intentions" (Akhtar et al., 1996, p. 644).

An Alternative Account

Our alternative account starts not with knowledge about referential intentions but with the contextual nature of memory and attention. First, remembering is broadly dependent on context both at the moment an event is encoded and at the moment that it is retrieved. Light and Carter-Sobel's (1970) classic demonstration of encoding specificity provides one good example: the word *jam* encountered in the context of *traffic* does not lead to the same memory as the word *jam* encountered in the context of *strawberry*. Further, the to-be-remembered word, *jam*, is better recognized by subjects in the context that matches the original learning (the word *traffic*) than the one that is different. This relationship between context and memory has been repeatedly demonstrated. The particular room, the particular voice of the speaker, and even the mood of the subject all matter in what is remembered (Butler & Rovee-Collier, 1989; Eich, 1985; Godden & Baddeley, 1980; Palmeri, Goldinger, & Pisoni, 1993; S. Smith, 1986). Indeed, all formal models of memory include context information in what is stored and explain retrieval as a function of the holis-





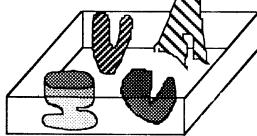

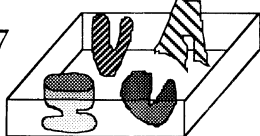
Event	Object(s)	Context	Activity
1		sitting on floor	play with object
2		sitting on floor	play with object
3		sitting on floor	play with object
4	 (target object)	sitting at table with special tablecloth	play with object at table
5		sitting on floor	All objects placed in box . <u>Experimental</u> subjects heard: "Look I see a gazzer! A gazzer!" <u>Control</u> subjects heard: "look! look at that!"
6		sitting on floor	play with objects
7		sitting on floor	test: Objects placed back in box; child asked to "get the gazzer".

Figure 1 Sequence of events in Akhtar, Carpenter, and Tomasello, 1996. "E1" and "E2" refer to experimenters 1 and 2. Note: The illustrated objects do not accurately depict those used by Akhtar et al.

tic match between context at storage and retrieval (e.g., Hintzman, 1988; Humphreys, Bain, & Pike, 1989; Humphreys, Pike, Bain, & Tehan, 1989; Raaijmakers & Shiffrin, 1980, 1992). In sum, in human memory the degree to which some event is unfamiliar (i.e., novel) depends crucially on the contextual match between the moment of remembering and the to-be-remembered event.

Second, attention is generally grabbed by novelty—by events that fail to match (and fail to be predicted by) events in memory. This fact of human attention is demonstrated repeatedly in the habituation and violation-of-expectancy paradigms used to study infant perception and cognition (e.g., Baillargeon &

DeVos, 1991; vonHofsten & Spelke, 1985), and in studies of adult attention (e.g., Connolly, Phillips, Stewart, & Brake, 1992; Kramer & Donchin, 1987; Kramer, Schneider, Fisk, & Donchin, 1986). It is also evident in children's first words which often comment on change (e.g., Bates et al., 1994; Gopnick, 1988; Lempert & Kinsbourne, 1985) and in the mutual exclusivity effect in early word learning. Put simply, young children are more likely to map a novel word to a novel object than to a known object (Experiment 1 of Akhtar et al., 1996; Markman, 1989; Merriman et al., 1991). In sum, novel objects and events *attract* attention.

The contextual nature of memory and children's

attention to novelty provide the basis for our alternative explanation. These factors suggest that it was not the target's newness to the speaker that distinguished it from the other objects in Akhtar et al.'s experiment. Instead, the contextual novelty to the child distinguished the target. To clarify this account, reconsider the sequence of events in Figure 1 from this alternative perspective. In Events 1 to 3, three memories are formed, each consisting of an object (O_i) and the context (C_1). This context for the first three objects includes three adults and the child. Thus, the three memories formed are $O_1 + C_1$, $O_2 + C_1$, $O_3 + C_1$. Event 4 consists of a different object, the target O_T , and a different context (C_2), one that does not contain two of the adults (one of whom is very important to the child and whose absence thus seems likely to constitute a strong contextual shift). The memory stored of this fourth event will be $O_T + C_2$. In the critical Event 5 when the novel name is offered, all objects are presented in the transparent box and *all four participants are present*. This context, which we will call C_1' , is much more similar to the context in which the child experienced the first three objects than it is to the context in which the child experienced the target object. By this analysis, the target object is the contextually most novel at the moment the name is offered; it will therefore be the one attended to most at the moment the name is offered, and it will therefore be the object associated with the novel name and retrieved when the child is subsequently asked to "get the gazzer."

By this account, the children in the study by Akhtar et al. mapped the novel word to the target because of the central role context plays in the general processes of memory and attention. Although children's smart mapping of the word to target *fits* the communicative intent of the speaker, it need not be caused by an understanding of that intent. If this alternative account is right, then any manipulation that makes the target the most novel-in-context at the time of naming should cause children to map the novel word to the target object.

THE EMPIRICAL TEST

We tested the alternative account by replicating Akhtar et al.'s procedure with one critical change: we made the target object contextually novel by playing with it in a unique location relative to the other three objects. Figure 2 shows the sequence of events in our experiment. The first three events are the same as those in Akhtar et al. except there were only three participants: the child, the parent, and one experimenter. These three participants played with the first

three objects in succession on the floor. In the fourth event, we created a new context, not by having some participants leave the room, but by having all participants play with the target object at a table on the other side of the room. In the fifth event (in the Experimental condition), the experimenter returned to the original location, put all four objects in the transparent box, and while looking not at the box but into the child's eyes said, "There's a gazzer in here. A gazzer." The rest of the experimental procedure followed that of Akhtar et al.

Notice that in our procedure, the following are true of the situation when the novel name was offered: (1) All four objects were familiar to the child, just as in Akhtar et al.; (2) all four objects were present and not singled out by the speaker's gaze, just as in Akhtar et al.; and (3) the target object had been experienced by the child in a unique context, just as in Akhtar et al. The critical difference between the two procedures is that in our study, the target object was familiar to the person who named it at the time it was named. If all that matters to young children's seemingly smart mapping of the novel word to the target is the target's contextual novelty at the moment the name is offered, then the children in our experimental condition should interpret the novel name as referring to the target, just as did the children in Akhtar et al.

In sum, if our alternative account is correct, we should replicate Akhtar et al. using our altered sequence of events. If in contrast, Akhtar et al.'s results derive from the children's belief that adults name novel objects for children when they are first jointly encountered and their knowledge that this is the first such encounter for the target, then our procedure should not provide a sufficient basis for mapping the word to the target object.

METHOD

Participants

Forty-eight children (half male, half female) between the ages of 18.2 and 28.2 months participated, mean age 24.7. This is comparable to the mean age (24.2) of the children in the Akhtar et al. study, although their age range was narrower (24.5–25.2). We included in the experiment proper only the data from children who did not spontaneously offer a name for any of the experimental objects. Five additional children were tested and replaced because they offered names for one of the four objects. Half of the participating children were tested using the Experimental procedure and half using the Control procedure.





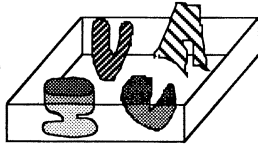

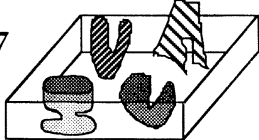
Event	Object(s)	Context	Activity
1		E1, E2, Parent	all play with object
2		E1, E2, Parent	all play with object
3		E1, E2, Parent	all play with object
4	 (target object)	E1 No Parent, No E2	Parent and E2 leave room E1 and child play with object
5		E1, E2, Parent	All objects placed in box . Parent and E2 return <u>Experimental</u> subjects heard: "Look I see a gazzer! A gazzer!" <u>Control</u> subjects heard: "look! look at that!"
6		E1, E2, Parent	all play with objects
7		E1, E2, Parent	test: Objects placed back in box; child asked to "get the gazzer".

Figure 2 Sequence of events in our experiment. The three participants (child, parent, and one experimenter) were present throughout the experiment.

Stimuli

Four novel objects were constructed for use in the experiment: (1) hardened clay painted purple in an irregular pipe-like shape; (2) wood covered with orange plastic grating roughly in a ladle-like shape; (3) hollow cardboard cone with irregular cut-outs painted with glittery green sand; and (4) yellow cotton batting formed into a tunnel-like shape. For 15 children (whose data were included in the experiment) a purple wooden ball-on-a-stick was used instead of the purple clay object. This object was replaced after several children offered the name "sucker" for it. Our stimuli differ from those used by

Akhtar et al. in that ours were specially constructed to be unusual whereas their objects were real (purchased at stores) but unusual. In both conditions, each of the four objects served equally often across subjects as the first, second, third, and target object.

Procedure

Our procedure was designed to replicate as closely as possible that of Akhtar et al. We describe first the procedure in the Experimental condition. Prior to the start of the experiment, the parent was asked not to label or specifically talk about any of the objects but

to make only general comments such as "Your turn" or "You try it." Then the child, parent, and experimenter played on the floor with each of the three distractor objects and a yellow chute. The principal activity was dropping objects down the chute. The experimenter did not name the objects but said only such things as "Here, you try it" and "It's your turn." The play period for each of these three objects lasted approximately 1 min.

At this point, the experimenter said, "Come play over here," and she, the child, and parent moved to a table covered with a glittery blue tablecloth which was situated on the other side of the room. The three participants played with the target object and a basket on the table top for approximately 1 min. The principal activity was spinning the target object in the basket. The experimenter did not name or refer to the object in any special way but said only such things as "Your turn" or "You try it."

Then the experimenter took the target to the other side of the room. She placed the target and the three distractor objects in a transparent box. Then, holding the box out toward the child and looking directly in the child's eyes, she said, "There is a gazzer in here. There is a gazzer. Look there is a gazzer. A gazzer. A gazzer is in here," such that the novel word was repeated five times just as it was in the Akhtar et al. procedure. At this point, all participants moved to the floor and played by putting all four objects down the chute. This play period lasted approximately 1.5 min. Finally, the Comprehension test occurred. The experimenter put all four objects in the transparent box and, holding the box out to the child, said, "One of these is a gazzer. Give me the gazzer."

The procedure for the Control subjects was identical except that the original naming event did not occur. Instead, at that point in the experiment, the experimenter held the transparent box toward the child and, looking directly into the child's eyes, said, "Look. Look in here. Look at that. Look (child's name), look in here."

Our dependent measure was performance on the Comprehension test—the child's response to the request to "Give me the gazzer." Akhtar et al. supplemented this measure with an Elicited Production test that occurred after the Comprehension test. They took the target object (whether it had been selected by the child or not) and asked, "What's this?" We did not include this measure because we felt it gave an unfair advantage to the target object, inviting naming by the target word for this one object only. However, like Akhtar et al., we recorded any spontaneous use of the target word in the play period that just preceded the test event.

Children's choices given the request "Give me the gazzer" were recorded by the experimenter at the end of the session. In addition, coders blind to the hypothesis determined the time each object was played with by the experimenter and child for all but two children whose videotapes had been accidentally erased. These times were submitted to an analysis of variance for a 2 (condition) \times 4 (object) mixed design. The analysis revealed only a main effect of object, $F(3, 132) = 6.32, p < .001$, and no differences between conditions or interaction between condition and object. For both the Experimental and Control conditions, the first object was played with slightly longer than the others, mean play time was 71.4, 62.3, 66.4, and 66.8 s for the first, second, third, and target object. This slightly longer time for the first object was due to the introduction of the child to the task and chute. The final play event with all four objects averaged 98 s and did not differ between conditions. A coder blind to the child's assigned condition also scored a random sample of 25% of the tapes and agreed 100% of the time with the experimenter's on-line designation of the object chosen by the child in the comprehension test. Finally, a naive coder was asked to judge the experimenter's direction of gaze during the event in which the novel name was offered (or the control version of this event) for a random selection of 25% of the subjects. The experimenter was judged to be looking in the child's eyes and *not* at the objects in the box during this event on 100% of the trials.

RESULTS

Table 1 gives the numbers of subjects in the Experimental and Control conditions who selected the target object during the Comprehension test and the number who spontaneously named the target with the novel name during the play period preceding the test. The corresponding numbers from Akhtar et al. (Experiment 2) are given in the second and fourth columns. As is evident, the present results are nearly identical to those reported by Akhtar et al. Indeed the number of children selecting the target object in the Experimental condition of the present study and in the Experimental condition of Akhtar et al. do not differ, $\chi^2(1, N = 48) < 1.00$. More critically, in the present study, as in Akhtar et al., the children in the Experimental condition chose the target when asked to get a "gazzer" reliably more often than did the children in the Control condition, $\chi^2(1, N = 48) = 5.70, p < .02$. This finding indicates that a shift in context between distractor and target object presentation is sufficient to create heightened attention to the target object at the moment of naming. The relevant con-

Table 1 Results of Current Study and Akhtar, Carpenter, and Tomasello, 1996

Test	Experimental (<i>n</i> = 24)		Control (<i>n</i> = 24)	
	Current Study	Akhtar, Carpenter, and Tomasello	Current Study	Akhtar, Carpenter, and Tomasello
Comprehension	13	10	5	4
Production	1	7	0	0
Any learning	14	11	5	4

Note: Number of children in experimental and control conditions selecting the target object in the comprehension test, producing the target word in spontaneous or elicited production tests, and demonstrating any learning (comprehension and/or production).

textual shift need not consist of a change in discourse partners.

The only difference between the present results and those of Akhtar et al. is that only one of our Experimental subjects labeled the target with the name "gazzer" whereas seven of Akhtar et al.'s subjects did. This difference may be accounted for by the fact that we specifically did not ask the children for the name of the target object, as Akhtar et al. did in their Elicited Production test, and by our inclusion of younger children who did not talk much during the procedure.

DISCUSSION

Many more children in the Experimental condition than in the Control condition selected the target object when asked to get a "gazzer." We predicted this effect on the basis of general processes of memory and attention. Considerable evidence indicates that memory traces are holistic contextualized representations. Considerable evidence also indicates that attention is grabbed by the less familiar. We suggest that these two processes are sufficient to direct children's attention to the right object during the naming event.

In more specific terms, our mechanistic account is as follows: The child's memory of the first object experienced consists not just of the object but also of the context of the floor, the parent, the experimenter, the chute, and the actions on the object. The child's memories for the second, third, and fourth objects played with also include the specific circumstances in which each object was experienced. Because these circumstances were markedly different for one object, the target, its stored context overlaps less with the presentation context at the moment the name is offered. Consequently, this object more weakly activates its memory trace, is experienced as "less familiar," and attracts attention. This is how, by our ac-

count, the novel name is associated with the target object. The ambiguous linguistic event is resolved by mundane memorial and attentional processes.

This mechanistic account predicted the present results and is sufficient to explain them. It also explains the earlier result when the contextual shift was people leaving the room. Thus, one need not postulate that children make inferences about the communicative intents of others to explain the previously published result. In brief, Akhtar et al.'s experiment does not demonstrate "a deep and flexible understanding of the behavior of other persons and their referential intentions" (Akhtar et al., 1996, p. 644).

One might counter that our results also do not conclusively show that general memorial and attentional processes are the sole source of children's word interpretations in the two experimental contexts. One can construct an account of our results that is based on the assumption that children make inferences about the communicative intents of others. For example, since the experimenter played with the target toy in a special place, the child might infer that it is special to the experimenter and that it is therefore the toy that the experimenter was thinking about when she offered the novel name. Given the extant evidence, there are three reasons to favor our account. First, we *predicted* the present pattern of results. The social-communicative account of our results is both ad hoc and post hoc. Second, such a social-communicative account is circular and unconstrained: The *only* evidence that children might believe that earlier distinctively played with an object makes that object the later intended referent by the speaker is the finding that children pick the distinctively played with object as the intended referent. Through this line of reasoning, one could construct an explanation of almost any choice made by the child. Third, the processes we propose to explain 2-year-olds' novel word interpretations are known to exist: these processes have been

independently shown to influence memory and attention in children this age (Bauer, 1996; Fantz & Miranda, 1975; Rovee-Collier, Griesler, & Earley, 1985; Ruff & Lawson, 1990). In contrast, the knowledge and inferential skills that Akhtar et al. propose to explain their results are in question. The considerable literature on children's "theories" about the minds of others suggests limited abilities on the part of even older children in making inferences about what others know and believe (e.g., Astington, 1993). Science favors theories that unify empirical domains by explaining them with similar processes, theories that include independently documented components, and theories that are falsifiable. On these grounds, our account appears the better explanation.

Our results and our interpretation of them also raise deeper theoretical issues about the nature of knowledge and knowing. A fully developed version of Akhtar et al.'s account would consist of two parts: (1) a system of represented knowledge and (2) the processes that apply that knowledge in specific behavioral contexts. Presumably, the relevant knowledge is a set of beliefs about speakers and their intentions in discourse, stable beliefs that exist within the child and organize the child's interpretations across the varied communicative contexts that might be encountered. Such knowledge, for example, might include the belief that speakers (at least adult speakers to children) name novel objects when they are first encountered in a discourse context and possibly that speakers offer names for objects that also (at other times) are distinguished by the speaker in other ways. But a fully developed explanation of how children use such hypothesized knowledge in specific contexts must also include the processes that translate represented knowledge into actual specific thoughts. These processes might include the ability to make inferences about intents from behavior. These processes *must* include how children perceive and remember complex events—how they focus attention on specific objects and how they remember objects (e.g., how they remember that an object encountered earlier is the same as the one encountered later). In brief, this more complete version of the social-communicative account must include general memorial and attentional processes. The nature of the attentional and memorial processes included in this potentially more complete social-communicative account would, of course, have to fit the considerable literature on how memory and attention work. That is, a fully developed social-communicative explanation of children's actual behavior in these experiments would have to include both knowledge about communicative intents and *our account about memory*

and attention. The possibility raised by the present results is that our account is all that is needed; there may be no need to postulate anything else.

The fundamental theoretical point is this: although all complete knowledge-based accounts of behavior must include memory and attention, process-based accounts need not postulate fixed knowledge representations (Smith & Thelen, 1993). Although these ideas have not yet made their way into the literature on cognitive development, there are an increasing number of proposals in the wider cognitive literature that knowledge is a transitory event, made on line, in the moment, from more general processes (see Smith & Samuelson, 1997, for a review). The kinds of evidence that support these claims include adults' abilities to form and reason about ad hoc categories such as all the things on one's desk that could hold water (Barsalou, 1983); adults' contextually determined inferences about the relative sizes of things (Cech & Shoben, 1985; Cech, Shoben, & Love, 1990), and adults' ability to invent new featural combinations when categorizing (Goldstone, 1995; Sanocki, 1991, 1992). Many aspects of adult performances in these cases exhibit the same characteristics usually interpreted in terms of fixed representations. However, these on-line creations cannot be explained by fixed representations but only by dynamic processes that make *moments* of knowing.

It is too early to tell whether this process-view of knowing will replace ideas of fixed knowledge structures in the study of cognitive development. There are other hints in the literature, however, that general processes of attention and memory are central to what make children's word learning seem so smart, adaptive, and fit to the communicative context. Merriman and Marazita (1995), for example, showed that children's tendency to link novel names to novel objects varies not just with the novelty of the named object but also with the phonological novelty of the novel word. Merriman et al. (1991) also showed that prior perceptual events that push attention to a particular object property also push novel word interpretation toward categories based on that property. Jones and Smith (1993) reviewed the literature on how children's novel word interpretations depend on the perceptible properties of the named object—how children systematically attend to shape when a rigid artifact is named but attend to material when a nonsolid substance is named and attend to shape and texture when an object with cues predictive of animacy is named. They proposed an explanation of these context-sensitive interpretations in terms of on-line interactions among learned and contextual forces on attention. Finally, the work of several researchers

(Baldwin & Markman, 1989; Roberts, 1997; Woodward & Hoyne, 1997) have suggested that the presence of sound (not specifically words), perhaps through its arousing effects, helps organize younger children's visual attention to objects.

All these results fit the idea that general processes of attention and memory are central in creating children's rapid word learning. Thus, the smartness that we see in children's word learning may be distributed across dumb nonspecific processes and the richness of the word learning context. The real world everyday situations in which children learn new words, unlike the experimental procedure used here, are filled with many cues and events that all pull and push attention and memory. In the coherent contexts in which children successfully develop, these cues most typically pull and push in the same direction, overdetermining the attentional outcome. We suspect that the novelty of the sound that is the novel word, its stress through final position and falling pitch, the direction of gaze of the speaker, the speaker's gesture to or lifting up of the intended referent, the temporal contiguity of all this, along with the contextual novelty of the object, will with near certainty pull the child to the intended referent in real world discourse contexts. Whereas none of these specific cues to an intended referent may be necessary nor singly sufficient to link a word to a referent, they may be, through ordinary cognitive processes, collectively more than enough.

Such collective forces on general cognitive processes may work to get the job done in part because word learning is a social event. The two individuals, child listener and adult speaker, have in common general processes of perceiving, attending, and remembering that work in the same way. Thus speaker and listener can be thought of as coupled cognitive systems—what pulls one person's attention is likely to pull the other's. These general processes that are always operating will typically recruit the same interpretation of the discourse context by speaker and listener.

In conclusion, the present results show that the findings of Akhtar et al. may be explained by general memorial and attentional processes. The larger lesson from this example is that children may well find the intended referent through multiple interacting cues—none of which is by itself certain to pinpoint the target. We strongly agree with Akhtar, Carpenter, and Tomasello that the natural communicative context is richly structured. What we add to the recent advances in research in this area is the idea that the richness of the communicative context may have its effects through the workings of quite general cognitive processes.

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