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BRIEF RESEARCH REPORT

Direct and indirect cues to knowledge states during word learning*

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ABSTRACT

The present study investigated three-year-olds' sensitivity to direct and indirect cues to others' knowledge states for word learning purposes. Children were given either direct, physical cues to knowledge or indirect, verbal cues to knowledge. Preschoolers revealed a better ability to learn words from a speaker following direct, physical cues to their knowledge state. Implications for children's emerging pragmatic competence are discussed.

Young children depend on a wide range of information as they acquire a vocabulary. For example, preschoolers are sensitive to form-class cues (e.g. Hall, Waxman & Hurwitz, 1993), juxtaposition between familiar and novel labels (Saylor, Sabbagh & Baldwin, 2002; Saylor & Sabbagh, 2004), and cues to others' mental states (Birch & Bloom, 2002; Sabbagh & Baldwin, 2001). A remaining question is what kind of evidence best supports children's recognition of others' mental states during word learning. The present study addresses this question by investigating preschoolers' sensitivity to direct and indirect information about others' knowledge states during word learning.

[*] Portions of these data were used for Brooke Carroll's honors thesis at Vanderbilt. The findings were presented at the Tennessee Psychological Association Conference in Nashville, TN in October of 2004 and at the Jean Piaget Society Conference in Vancouver, BC in June of 2005. We would also like to offer our special thanks to the parents and children who participated and to Mark Sabbagh for lively discussions about the research and to Georgene Troseth for comments on the manuscript. Address for correspondence: Megan M. Saylor, Vanderbilt University, Psychology and Human Development, Nashville, TN 37203, USA. Email: m.saylor@vanderbilt.edu

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The central role of others' knowledge

Theorists have long recognized that inferences about others' knowledge states are necessary for conversation to move smoothly (Chafe, 1976; Clark & Haviland, 1977; Clark & Marshall, 1981). This includes not only recognizing what others know, but also recognizing what knowledge is shared between speakers. The ability to recognize that knowledge is shared is a critical component of interpreting others' references to objects. For example, if a child hears her father say, 'I love that dog!' (when no dog is present) she will need to determine which dog among the many she has come into contact with is the particular dog being referred to. Determining which dog is known jointly is central to identifying the referent.

Clark & Marshall (1981) outlined two ways a listener might do this. Mutual knowledge includes the speaker's recognition that (a) the listener shares knowledge with them and that (b) the listener knows that this knowledge is shared with the speaker. Traditional formulations of mutual knowledge are iterative and meta-cognitive (e.g. I know that you know that I know …). Because of the processing intensive nature of these inferences, it is unlikely that young children will have access to this level of reasoning. However, they may be able to appreciate a more modest form of mutual knowledge – what Clark & Marshall (1981) called SHARED KNOWLEDGE, that involves a tacit recognition that knowledge is shared without the iterative or meta-cognitive components (see also Keysar, 1997; Lee, 2001).

There are several ways that children may recognize that knowledge is shared between speakers. For one, speakers who belong to the same community are likely to share knowledge (e.g. two people who both attend a particular college would be assumed to know about the same things). A study by Graham, Stock & Henderson (2006) suggests that children aged 1;7 may have access to such information, because they assume that knowledge of labels is shared among speakers of the same language. Of course, not all speakers of a language will know about the same set of particular referents (e.g. I will know about a different subset of dogs than someone else). Additional sources of information that help to establish these particulars include verbal and physical co-presence between speakers and events. Using verbal co-presence involves noticing that a person talks about something and then using this information to infer knowledge. Using physical co-presence would involve noting the spatial proximity between a person and an event and then using this information to infer knowledge. One possibility is that young children will have an easier time inferring that knowledge is shared following physical evidence that a person knows something because verbal cues require a somewhat more elaborated set of inferences. Below we review evidence from children's understanding of others' mental states that supports this possibility.

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Physical and verbal cues to others' mental states during word learning

It has been shown that children are sensitive to the mental states of others and that this sensitivity may facilitate word learning. For example, during word learning children utilize information about others' intentions (Saylor *et al*., 2002; Jaswal, 2004), desires (Saylor & Troseth, 2006), beliefs (Happé & Loth, 2002; Carpenter, Call & Tomasello, 2002) and knowledge states (Birch & Bloom, 2002; Sabbagh & Baldwin, 2001). This previous work has demonstrated that preschool children interpret mental state information with both gestural (e.g. pointing, gestures expressing uncertainty) and verbal cues (e.g. juxtaposition between familiar and novel labels; expressions of belief, desire, familiarity and uncertainty).

To date, there have been few attempts to directly compare children's sensitivity to different cues to others' mental states during word learning, despite hints that some information may be more accessible than others. For example, young children may find gestural information easier to interpret than verbal information due to limitations in their language skills. Partial support for this possibility comes from studies that have demonstrated that older children are more likely to learn words following verbal cues than younger children (e.g. Gelman & Raman, 2003; Saylor & Sabbagh, 2004).

There may also be differences in the clarity of the link between others' mental states and the information that signals them. For example, in a study using FACIAL/EMOTIONAL expressions of desire, children aged 1;6 understood that people can hold different desires (Repacholi & Gopnik, 1997); however, when information about desire is primarily VERBAL, it is not until 4;0 or 5;0 that children show such an understanding (Moore, Jarrold, Russell, Lumb, Sapp & MacCallum, 1995; Reiffe, Terwogt, Koops, Stegge & Oomen, 2001). Furthermore, children display an earlier appreciation of information about knowledge states THAT DO NOT INVOLVE INFERENCE (e.g. seeing another view an object versus being given a clue – Gopnik & Graf, 1988; O'Neill & Gopnik, 1991). These findings raise the possibility that preschool children will be more likely to learn words after being given information that is physical and direct (i.e. visually available and context bound), than information that is verbal and indirect.

Knowledge states and word learning

Previous research has revealed that young word learners recognize direct and indirect sources of information about others' knowledge states, but that only older children use indirect cues effectively. For example, Sabbagh & Baldwin (2001, Study 1) revealed that preschool children are unlikely to learn words from speakers who expressed uncertainty (by shrugging and saying, 'I don't know what a blicket is!'). In a second study, four-year-olds,

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but not three-year-olds, understood that if a person made an object that they were allowed to name it. This is a more indirect cue that a person is knowledgeable because children have to understand that a person who invents an object knows what it is called. In a similar vein, Birch & Bloom (2002) demonstrated that preschoolers understand the relationship between speaker familiarity and naming. In a first study, the researcher expressed her familiarity with one group of objects and lack of familiarity with another group of objects by telling children which toy she was familiar with. When she then went on to request one of the items using a proper name ('Where's *Jessie*?') children were more likely to give her a toy she was familiar with. In a second study, only five-year-olds were able to INFER that the speaker was familiar with an item following her use of a proper name (e.g. 'Hey there's *Jessie*!'). This is a more indirect cue to others' knowledge because children have to recognize using a proper name means that you know about an object.

While this previous work provides suggestive evidence that direct cues to others' knowledge states will be more easily recognized than indirect cues, neither of these previous studies were designed to directly test the possibility that children are better at using more direct sources of information about others' knowledge states. Furthermore, the evidence of the benefit of direct sources of information in this previous work comes from a comparison across quite different experimental conditions. To address these concerns, the current study investigates the possibility that three-year-olds are better able to use direct, physical cues to others' knowledge than indirect, verbal cues during word learning, using a single methodology.

Our direct physical cue to another person's knowledge was that a child and researcher shared the experience of playing a game together. This experience established that the researcher knew about novel objects that she would later go on to name in a separate part of the session. The indirect verbal cue was that the researcher TOLD the child that they would share the experience of playing the game. However, the child did not see the researcher engage in the activity that would establish her knowledge of the to-be-named novel objects. To interpret this verbal cue it would thus be necessary for the child to make an inference that the researcher knew about the to-be-named novel objects based on what she said. These two knowledge conditions were compared to each other and to a baseline condition in which the child was not given evidence that the researcher knew about the to-be-named novel objects. The predictions were that children should show higher levels of word learning following both direct and indirect cues to the other person's knowledge states than in the baseline condition, and that children would show higher levels of word learning when given direct physical cues to the other person's knowledge than when given indirect verbal cues.

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The investigation focused on three-year-olds because their understanding of others' knowledge states is still emerging, making it likely they would reveal differences in their sensitivity to cues to others' knowledge (e.g. Montgomery, 1992).

METHOD

Participants

Forty children ranging in age from 3;0 to 4;1 ($M = 3;8$, 26 females, 14 males) participated. All children were typically developing and came from monolingual, English-speaking families from a predominantly middle-class Caucasian community in the southern United States. Six additional children participated, but were not included because of refusal to play (3), failing to understand the game by not performing correct actions on either game (2), and experimenter error (1).

Materials and equipment

Children were shown two board games made out of colored construction paper that were made for the purposes of this study. The game boards were constructed to be distinctive from each other: one was yellow and the other green, one was rectangular and the other was kidney-shaped. As with conventional board games, the games included a trail of colored spaces that included landing sites on which a game piece could be placed. Each landing site depicted a novel object. The depictions of novel objects were created in the lab, so that they would be unfamiliar to children. There were three novel objects depicted on each game board (a distinctive color and shape from the others), and each appeared three times (always in the same color; e.g. one triad was red, the other purple and the other blue). To make the games appealing to preschoolers, the game boards were decorated with a variety of familiar objects (e.g. clouds, trees, dots, stars).

For each game board, two sets of cards (target and generalization) depicting each of the novel objects on the game board were used for the comprehension trials. The depictions of novel objects were identical in size to those on the game boards. In the target set, the depictions of novel objects were identical to those on the game board; in the generalization set, the depictions of novel objects were identical to those in the target set except that the objects were a different color. In addition, a small plastic orange snake was used as the game piece for both games.

Two novel words were used during the study (*dorpy* and *gepper*). Each word was consistently used with one of the two games.

The experimental sessions were videotaped.

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Design

A between-subjects design was used. Children were randomly assigned to one of three experimental conditions: DIRECT (N = 13, *M* age = 3;8, 7 females, 6 males), INDIRECT (N = 13, *M* age = 3;7, 9 females, 4 males) or BASELINE (N = 14, *M* age = 3;8, 10 females, 4 males). Preliminary analyses revealed no differences in children's responding based on sex (independent-samples $t(38) = 0{\cdot}65$, $p = 0{\cdot}52$, $d = 0{\cdot}22$) so sex was not included in the analyses.

In the DIRECT condition the main cue to knowledge was that E1 and the child played the game together. In the INDIRECT condition, the cue to knowledge was E2 telling children she played the same game that they did. In the BASELINE condition, E2 left the room and told children she was playing a different game out in the hall. In the DIRECT condition, E1 played the games with children and taught them a novel word that could refer to one of the novel objects on the game. In the INDIRECT and BASELINE conditions, E1 played the games with the children and E2 taught them a novel word that could refer to one of the novel objects on the game. There were three experimenters who played E1 and E2. One experimenter was E1 for only one child in the direct condition (she played E2 for three children in each of the other conditions). Because of this imbalance, and to control for possible experimenter effects, the person who played the role of the labeler is included as a covariate in our analyses.

Each child played both novel board games. The order in which the two game boards were presented and the novel object that served as the target was roughly counterbalanced across children. During comprehension trials, the target novel object appeared in each position (left, center, right) at least once for each participant (because there were four questions, one position was repeated) and the order of the positions was roughly counterbalanced across children.

Procedure

The session began with a 10–15-minute warm-up, during which E1 told parents about the study and obtained consent, while E2 played puzzles with children. During the experimental session, children played board games with E1. Following the warm-up, children were seated at a small table facing E1. E1 brought out one of the two games and E2 said she was going to leave the room. In the DIRECT and BASELINE conditions E2 said she was going to play a different game (e.g. 'I am going to go out there and play a different game and you are going to play this game right here.'). In the INDIRECT condition E2 said she was going to play the same game (e.g. 'I am going to go out there and play the same game and you are going to play this game right here.'). The experimental session was divided into four

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parts: game familiarization, game introduction, label phase and comprehension phase.

Game familiarization. After E2 left the room, E1 familiarized children with the game. To be sure that children noticed all of the different novel objects on the game, E1 asked them to point to the objects that were the same colors (e.g. 'Can you show me all the red ones?'). To avoid children erroneously believing that the novel word referred to the game piece, we used a familiar object (previous research has found that preschool children are unlikely to attach a novel word to a familiar object; Markman & Wachtel, 1988). As a check, E1 asked children to tell her what the game piece was called (a snake). All children who participated identified the objects by color and named the snake.

Game introduction. Children then were taught how to play the game, the object of which was to produce a target action on one triad of novel objects, but not the others. For one game, children were told, 'In this game, we hop up and down on some of the spots'. (For the other game the target action was standing the game piece on its head.) E1 demonstrated where the target action could be performed by moving the game piece to each of the three spaces that depicted the target novel object and narrating her actions (e.g. 'Look, you can hop up and down on this one!'). She then reminded children that the target action could only be performed on the designated spots (e.g. 'Remember you can only hop up and down on this one and this one and this one.'). Next the researcher asked children to show her where the action could be performed. If children did not perform the target action on the correct novel objects, E1 reminded them where they could perform the action and then asked children to perform the action again. If children still did not perform the target action after her reminder the data for that trial were not included.

Once children performed the action on the correct novel objects the researcher reminded them once more where the target action could be performed and asked children to demonstrate the target action on the novel objects (e.g. 'Show me where you can hop up and down again.'). Overall children were given up to three opportunities to demonstrate the actions on the target novel objects. The game introduction phase lasted one to two minutes.

Label phase. Once children had practiced playing the game, E1 put the game out of sight and E2 returned and did one of two things. In the DIRECT condition, she sat off to the side, and in the BASELINE and INDIRECT conditions she switched spots with E1 (who then sat off to the side). In the DIRECT condition, E1 taught children a novel word (e.g. by saying 'I really liked hopping up and down on the *dorpy* with you. We were hopping up and down on the *dorpy* in here.'). In the BASELINE and INDIRECT conditions, E2 taught children a novel word (e.g. by saying, 'I really liked hopping up

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and down on the *dorpy* out there. I was hopping up and down on the *dorpy* in the hall.'). After labeling the object twice the labeler asked children to say the novel label (e.g. 'Can you say *dorpy*?').

In all three conditions, a researcher linked the novel label with the children's prior experience with the game (e.g. hopping up and down on a space depicting a novel object). The main difference was whether the labeler had shared the experience with the child: she did in the DIRECT and INDIRECT conditions, and she did not in the BASELINE condition. The labeling experimenter also included subtle verbal reminders about where she had performed the target action. She used the pronoun 'we' and said 'in here' and 'with you', in the DIRECT condition and used the pronoun 'I' and said 'out there' and 'in the hall', in the BASELINE and INDIRECT conditions.

Comprehension phase. During the comprehension phase the labeling researcher (E1 in the DIRECT condition, and E2 in the BASELINE and INDIRECT conditions) placed three cards depicting the novel objects on the game board in front of the child and asked them to select the target object ('Show me the *dorpy*.'). She then repeated these steps with cards showing the generalization objects (identical to the objects on the game board except for their color). The entire procedure was then repeated for the second game board.

Coding

Our dependent measure was whether children chose the target novel object. Data were analyzed as a proportion of correct responding, because three children had one of their game trials omitted (two for failure to correctly produce the target action after three attempts, and one because the researcher forgot to ask one of the test questions). Children were asked one target and one generalization question about each game. A paired sample *t* test did not reveal significant differences in children's responses to the test and generalization items (paired $t(39) = 1{\cdot}43$, $p = 0{\cdot}16$), so test questions were combined for the purpose of analysis. Coding was conducted during the session by the researchers. A second coder, naïve to the experimental predictions and to the identity of the target, coded the sessions from 21 children from video. Agreement between the researchers' and coder's judgments was 100%.

RESULTS

To investigate children's sensitivity to direct and indirect cues to others' knowledge states a one-way ANCOVA was conducted on children's responses to comprehension questions in the DIRECT, INDIRECT and BASELINE condition. Means and standard deviations are reported in Table 1.

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TABLE 1. *Proportion correct target selection by condition*

	Mean	Standard Deviation
Direct (N = 13)	0·79	0·36
Baseline (N = 14)	0·44	0·41
Indirect (N = 13)	0·43	0·36

The person who played the role of the labeler was entered as a covariate to control for experimenter effects. A paired-samples *t* test comparing correct target selection for the two different games revealed no differences in children's responding, so analyses were conducted collapsed across the two games (paired-samples $t(36) = 1{\cdot}28$, $p = 0{\cdot}21$).

After controlling for the effects of the labeler, the analysis revealed a main effect of condition ($F(2, 36) = 3{\cdot}42$, $p = 0{\cdot}04$, $\eta_p^2 = 0{\cdot}16$). Planned comparisons revealed that children had higher comprehension scores in the DIRECT than BASELINE conditions ($t(25) = 2{\cdot}40$, $p = 0{\cdot}02$). This finding indicated that children were more likely to learn words when given cues that the speaker was knowledgeable. In addition, higher scores on the comprehension measure emerged in the DIRECT than in the INDIRECT condition ($t(24) = 2{\cdot}14$, $p = 0{\cdot}04$) indicating that children were better able to recognize the more transparent cue to knowledge offered in the DIRECT condition. However, contrary to predictions, children did not have higher scores in the INDIRECT condition than in the BASELINE condition ($t(25) = 0{\cdot}20$, $p = 0{\cdot}84$).

As a second look at children's performance, tests against chance were conducted to determine whether children were reliably choosing the target novel object in response to our comprehension questions. Consistent with the analyses above, one-sample *t* tests revealed above chance ($u = 0{\cdot}33$) responding only in the DIRECT condition ($t(12) = 4{\cdot}52$, $p = 0{\cdot}001$). Children's responding did not differ from chance levels in the INDIRECT ($t(13) = 0{\cdot}99$, $p = 0{\cdot}34$) and BASELINE conditions ($t(13) = 1{\cdot}03$, $p = 0{\cdot}32$).

GENERAL DISCUSSION

The current findings provide a first direct test of three-year-old children's ability to recognize direct and indirect cues to others' knowledge during word learning. The results indicate that three-year-old children were more aware of direct, physical cues to others' knowledge states than indirect, verbal cues. These findings suggest that three-year-olds may require direct, physical evidence of others' knowledge states before interpreting their referential intentions. When such information was not offered, children did not reliably learn words. These findings suggest that preschoolers view

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shared knowledge as a prerequisite for interpreting others' references to objects, as they only reliably learned words in the presence of direct physical evidence of shared knowledge.

One possibility is that children's memory skills may underlie their ability to make use of information about others' knowledge states. Events that are encoded after direct, physical experience may be better encoded and more easily retrievable than those encoded following less direct, verbal experience. The role of memory has long been suggested as a mechanism underlying adults' ability to infer what others know during conversation (e.g. Clark & Marshall, 1981). Investigations of this relationship during development are a fascinating avenue for future research.

There is a need for future work to investigate the generalizability of the results of the current study. The present study only investigated children's ability to learn noun words following direct versus indirect experience with speakers. Future research should investigate whether these results generalize to other grammatical classes. Furthermore, the word learning task was quite challenging in that it required children to learn words for objects that were absent when labels were offered. Future work should investigate whether the same difference between children's use of direct and indirect sources of information would hold when objects are present.

SUMMARY

In the current study we asked whether three-year-olds recognized direct and indirect cues to others' knowledge states to learn words. As predicted, they revealed greater sensitivity to direct than indirect cues. This work provides fertile ground for future investigations of links between children's word learning skills and other areas of cognitive development.

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