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The Role of Language in the Development of False Belief Understanding: A Training Study

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The current study used a training methodology to determine whether different kinds of linguistic interaction play a causal role in children's development of false belief understanding. After 3 training sessions, 3-year-old children improved their false belief understanding both in a training condition involving perspective-shifting discourse about deceptive objects (without mental state terms) and in a condition in which sentential complement syntax was used (without deceptive objects). Children did not improve in a condition in which they were exposed to deceptive objects without accompanying language. Children showed most improvement in a condition using both perspective-shifting discourse and sentential complement syntax, suggesting that each of these types of linguistic experience plays an independent role in the ontogeny of false belief understanding.

Human infants develop some important skills of social cognition before language acquisition begins. For example, they are able to discriminate intentional from nonintentional action, to share attention with other people by following their gaze direction, and even to direct the attention of other people to outside entities by gestures such as pointing and showing (see Carpenter, Nagell, & Tomasello, 1998, for a review). By most accounts, these early skills emerge independent of language and form the social-cognitive foundation for symbolic communication (Tomasello, 1999).

But children's ability to understand more abstract and complex mental states is another story. Recently, a number of investigators have emphasized the important role of language in the development of children's understanding of belief. Understanding belief states requires the realization that every person holds a subjective view of the world based on his or her experience, which might or might not be shared by others and governs that person's behavior. Especially the understanding of false belief, that is, the understanding that a person might be mistaken about reality and is thus holding a false belief, has become of central interest in this development. Evidence for a role of language in false belief understanding has come from two types of studies. The first type is correlational studies. Several studies have noted that children's mastery of the semantics of mental state terms that describe mental or cognitive processes, such as *think*, *know*, and *believe*, emerge in roughly the same age period as their mastery of the various false belief tasks (Moore, Pure, & Furrow, 1990). In general, the finding is that language development and false belief understanding are relatively strongly related, even when the language measures are taken 1 or 2 years before children start mastering false belief tasks. Studies of this kind are reported by Dunn, Brown, Slomkowski, Tesla, and Youngblade (1991), Astington and Jenkins (1999), Gale, de Villiers, de Villiers, and Pyers (1996), de Villiers and de Villiers (2000), Watson, Painter, and Bornstein, (2002), and Farrar and Maag (2002), with some correlation in the .60 to .70 range. The problem with correlational studies, of course, is that they leave open many different interpretations.

The second type of study is training studies. Training studies have the advantage that they are able to demonstrate specific causal relations between children's experience during training and some later outcome measure. The general method here is to begin with children who show little or no understanding of false beliefs, systematically expose them to some kind of training (often involving language) for several days, and then give them one or more posttests of false belief understanding. Relevant studies of this kind are Appleton and Reddy

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(1996), Swettenham (1996), Slaughter and Gopnik (1996), Slaughter (1998), McGregor, Whiten, and Blackburn (1998), Clements, Rustin, and McCallum (2000), and Hale and Tager-Flusberg (in press). The type of training was different in each of these studies, but in all cases in the key conditions children experienced some kind of deceptive scenario involving issues of appearance–reality or false belief (including in some cases training on false belief tasks directly), or both, along with linguistic descriptions of that scenario typically including mental state talk. In some cases children participated more actively in the discourse and were given corrective feedback, whereas in other cases they were given no feedback. The problem here is that none of these studies had a control condition in which children experienced some kind of deceptive scenario during training but without any linguistic description at all. Such a control condition is necessary to unconfound deceptive experience and language and thus to determine whether language influences false belief understanding beyond training involving deceptive experiences.

Thus, although the combination of correlational and training findings is suggestive of the causal role of language in false belief understanding, the evidence is not as strong as it might be. Moreover, beyond the question of whether language plays a role in false belief understanding, very little research has been aimed at identifying more specifically the nature of this role. There are four global hypotheses. The first is that language has no special role to play. The idea is that children are constantly forming theories about other people and their minds and that any and all data are relevant. Data coming from linguistic sources may be used, but it has no special status. Although it is unclear if anyone espouses this view in its pure form, the theory-theory certainly tends in this direction (Gopnik & Wellman, 1992). The second hypothesis is that learning mental state terms such as *think*, *know*, and *believe* plays a key role in the development of false belief understanding (e.g., see Olson, 1988). The idea here is that these linguistic symbols are used by adults to indicate the relevant mental states, and so in learning the referents of these terms children form, in Whorfian fashion, the relevant concepts. Again, it is unclear if anyone espouses this as the exclusive, or even as the single most important, factor involved, but Bartsch and Wellmann (1995) discussed in detail the possible importance of this language-learning process and Astington (2000) also seemed to accord it primary importance.

The other two hypotheses have been directly proposed in stronger fashion. In the third hypothesis, de Villiers and de Villiers (2000; see also Gale et al., 1996) proposed that the syntax, that is, the grammatical form of the way adults talk about beliefs and related mental states, provides children with a necessary representational format for dealing with false beliefs. More specific, what is said to be crucial is the syntax of complementation, in which a sentence takes a full clause as its object complement (sentential complements). For example, the sentences ''Peter thinks Mommy's home'' or ''You know that I'm not coming to the party'' are complex constructions consisting of a main clause with a mental state, perception, or communication verb (Peter thinks X; You know X or Jo says X) that embeds another clause (the complement), indicating the specific content of that mental state (that Mommy's home; that I am not coming to the party). De Villiers and de Villiers argued that it is especially the realization of an open truth value of the embedded proposition (the fact that when Peter thinks that Mommy is home does not necessarily mean that Mommy really is home) that leads children in their understanding of epistemic states in people. The authors acknowledged that the semantics of the matrix mental state verb may play some role as well, but the semantics and syntax in this case are closely interrelated (virtually all sentential complement sentences have as matrix verbs psychological verbs, broadly construed), making a clear syntax–semantic distinction difficult. This hypothesis has received support from a correlational study in which children's mastery of the syntax of complementation was found to be strongly correlated with their subsequent performance on false belief tasks—more so than other aspects of language development (de Villiers & de Villiers, 2000). It has also received support from a training study in which children trained with sentential complement sentences subsequently improved in their false belief understanding (Hale & Tager-Flusberg, 2003). However, it is important to point out that the sentences in this training study were given in talking about deceptive experiences; therefore, it is possible that it was these experiences, and not the sentences themselves, that led to the increase in false belief understanding (i.e., there was no control condition without deceptive experience).

A fourth hypothesis, put forward by Harris (1996, 1999), proposed that not the semantic content of mental state terms or the syntax of complementation are key linguistic influences on the understanding of false beliefs, but rather the key is the process of

linguistic interchange that children experience in discourse with other people. The idea here is that the whole notion of belief as a mental state only makes sense in the context of alternative possible beliefs about a situation, including one that is true (implying that others may be false). Harris claimed that it is in the to and fro of discourse that the child comes to appreciate that other people know things he or she does not know, that they do not know things they ought to know, and that they have different perspectives on things. Along these same lines Tomasello (1999; see also Siegal, 1999) stressed the importance of discourse interactions involving misunderstandings and requests for clarification as particularly clear signals of people's differing perspectives or understandings of situations. Evidence for this discourse-based view comes from the correlational studies of Peterson and Siegal (1999, 2000), in which deaf children who had the opportunity to engage in richer discourse interactions with others were also more skillful in false belief tasks (although the different groups of children differed in other ways as well). Most training studies have employed rich discourse interactions as a part of the training (see especially Appleton & Reddy, 1996); therefore, it is possible that these studies provide support for the discourse view as well. But again, these training conditions typically involved a number of other factors, including mental state terms and sentential complements.

In the current study we attempted to provide more definitive answers than previously available both on the question of whether language causally influences false belief understanding and on the question of the nature of this influence. We used a training methodology with five, later collapsed into four, training conditions involving adult–child interactions with deceptive objects (e.g., children see an object that looks like an apple but is really a candle). We measured as outcome three types of false belief understanding (one appearance–reality test similar to the training and two transfer tests). To answer the first and most basic question, we compared the several training conditions in which language was used with a control condition in which children were provided with deceptive experiences without any substantive linguistic commentary as accompaniment (they were socially engaged with the experience via adult attention getters such as "Look!" "Yeah!" "Hmm!"). No previous training study has included such a condition. To answer the second question, we compared the several linguistic conditions among themselves. We had one condition that included all of the major proposed factors together—as most often happens in the real world (and in previous training studies)—including rich perspective-shifting discourse, mental state verbs, and sentential complement syntax. In another condition we engaged in perspective-shifting discourse using language but did not use in this discourse any mental state terms or sentential complement sentences. In a final condition we gave children sentential complement sentences in the absence of deceptive experience to test (as no previous study has done) whether training with these kinds of syntactic structures would, by itself, be sufficient to facilitate children's false belief understanding.

Method

Particiant

The participants were 138 German children from Leipzig, Germany. There were 64 boys and 74 girls, ranging in age from 3 years, 3 months to 3,10 ($M = 42.6$ months, $SD = 2.4$). The children came from diverse social-economic backgrounds and were all native German speakers. All met the pretest criteria that (a) they had not yet acquired false belief understanding, and (b) their linguistic development fell within the norms of their age group. A total of 46 additional children did not meet one of these two criteria, and an additional 38 children were dropped from the study because of missing sessions (holiday or sickness). Thus, a total of 222 children were seen.

Materials

Each child was given three pretests. These were as follows.

Vocabulary pretest. The vocabulary subtest of the Kaufman Assessment Battery for Children (K–ABC; Kaufman & Kaufman, 1994) was used to determine whether a given child's vocabulary development fell into the normal range.

False belief pretest. A representational change task (Gopnik & Astington, 1988) was used to assess children's false belief understanding. Children were shown an egg box and asked what they thought was inside. After revealing the real content (a toy car) the box was closed again. Then, the children were asked what they had thought was in the box when they had first seen the box, and what a friend would say would be in there when the experimenter showed it to him or her.

Sentential complement pretest. Because some children would be trained in sentential complements, two versions of a sentential complements pretest

were given. First, children were given a modification of Swettenham's (1996) Tom test and the memory for complement test from de Villiers and de Villiers (de Villiers, 1995; de Villiers & de Villiers, 2000). Basically, children were told four stories (accompanied by line drawings) whose comprehension depended on their understanding a character's false belief (e.g., ''This boy thinks that it is sunny outside although it is really and truly raining outside.''). They were then asked both a prediction question (''Will this boy now put his raincoat on?'') and a memory question (''What was this boy thinking?'') about each story, leading to scores from 0 to 8. Examples of the test items (in English and German) are found in Appendix A. Second, based on Hale and Tager-Flusberg (in press), children were told four stories (with line drawings) in which a character says she is doing one activity although she is really doing something else (e.g., she is cutting her hair but says she is cutting paper). At the end of each story the children were asked what the character had said (e.g., ''What did the girl say she was cutting?''), giving a possible score of 0 to 4.

After training (see the following discussion), each child was given three false belief posttests and two sentential complements posttests. These were as follows.

False belief posttests. To test for false belief understanding after training, each child was given: (a) an appearance–reality task with deceptive objects (Flavell, 1986) that was similar in format to the training procedure (1 point was given for the reality, appearance, and third-person prediction questions, for a total of 3 points); (b) a representational change task (Gopnik & Astington, 1988) that was similar in structure to the pretest but with different story content, which served as a transfer task (1 point was given for each of the two questions concerning the child's own and a third person's mental state, for a total of 2 points); and (c) a change of location task (Wimmer & Perner, 1983) that served as another test of transfer of training (1 point was given for a correct answer to the test question: Where will the protagonist look for the object?).

Sentential complement posttests. The same format of the complement pretests was used for the posttest, but with different story content in both cases. Again, each test consisted of four items, for a total possible score of 0 to 12 points.

Procedure

Each child interacted with an adult experimenter on each of four occasions within a 2-week period. Sessions lasted from 20 to 30 min and took place in a separate room in the children's preschool or day care center. In a between-subjects design, children were randomly assigned to one of four training groups. Because of the large number of children interviewed, four experimenters were used, with each experimenter seeing approximately the same proportion of children in each of the four conditions.

The basic training procedure was modeled on that of Slaughter and Gopnik (1996). Children in all training groups were exposed to 16 objects. Each was brought out singly and replaced after discussion of it was completed. Order was randomized across children (except in the sentential complements training condition, in which a fixed order was used to tell a story). Twelve of the objects were deceptive objects in the sense that on first glance they appeared to be one thing (e.g., a flower) but on closer inspection they had another function (e.g., as a writing pen). Four objects did not have a deceptive aspect. Training for each group consisted of discussion of each object, with the experimenter providing feedback and corrections to the child's comments where appropriate (except for the no language training group, where no feedback was given and no questions asked). The child's first session consisted of the pretests and training with three objects. In the second session 5 objects were discussed, in the third session 4 objects were discussed, and in the final session the posttests were administered.

Training in the different groups was as follows (see Appendix B for a fuller description).

Full training. In this condition the deceptive aspect of the training objects was highlighted, and the experimenter (E) talked about this using either mental state verbs (think, know) or communication verbs (say) within sentential complement constructions. Thus, for each object E showed children the object and asked them what they thought the object was, using psychological verbs (e.g., think) and sentential complement constructions. Then, the object was handed to the children so that they could see its real function, which was highlighted by E. Then, the children were asked to recall their previous belief and their current knowledge of the object's nature (which was possibly corrected) and summarized once more by E. The children were also asked to predict a third person's reaction to the deceptive object. A hand puppet, Schnuffi, was used to represent a third person, and the children watched as E informed Schnuffi of the real function of the object. Children could observe the surprise reactions of the puppet and assist the puppet in

Table 1
Experimental Variations in the Training Groups

	Elements in the training		
Training condition	Objects	Syntax	Verbs
Full training	Deceptive experience	Complement structures	Mental verbs
	Deceptive experience	Complement structures	Communication verbs
Discourse only	Deceptive experience	Simple clauses without sentential complementation (No mental or communication verbs)	
Sentential complements	No deception	Complement structures	Mental, communication and perceptual verbs
No language	Deceptive experience	Only attention-getting exclamations (''look!'')	

finding out the real function of the object. Finally, the children were asked about the puppet's new (changed) belief about the object. (To see whether specific verbs made a difference, half the children in this condition were trained using only mental state verbs such as *think* and *know*, and half were trained using only the communication verb *say*. Because these options turned out to produce the same results they were subsequently collapsed; see the Results section.)

Discourse only training. In this condition the deceptive aspect of the training objects was highlighted, but E did this without using either mental state verbs or sentential complement constructions. Thus, for example, instead of asking, ''What do you think this is?'' the children were asked, ''What is this?'' and instead of saying, ''You thought it was a flower'' E said. ''A flower.''

No language training. In this condition the deceptive aspect of the training objects was highlighted, but E did this basically nonverbally. Thus, children were first shown an object and E said, ''Look!'' and then their attention was drawn to the real function by showing it and saying ''But now look!'' The appearance–reality distinction of the objects was highlighted twice by E with appropriate nonverbal emotional expressions; no questions were asked and no feedback was given to the child. For the third-person perspective, the hand puppet was brought out and shown the object ''Look, Schnuffi.'' The children observed the puppet's reactions to the object, which showed surprise reactions to the real function of the object: ''Oh!'' ''Alright,'' and so on.

Sentential complement only training. In this condition the deceptive aspect of the training objects was not highlighted for the child in any way. E simply talked about them as normal objects using mental verbs or communication verbs and sentential complements. Four short stories were designed so that E could talk about the objects without referring to their deceptive nature. Thus, children were asked what they thought the object was and about certain attributes of the object although the deceptive nature of the objects was never revealed. To avoid contrasting mental states, children's answers were not contradicted. To stimulate children's acquisition and comprehension of sentential embeddings, children were also asked to help E clarify what the protagonist of the story had done or said. For example, a hand puppet Ernie says: ''This chair belongs to my grandfather. I know that!'' E then asks the child: ''What does Ernie know?'' To answer the question appropriately, children had to use one clause as a sentential complement of the other, for example, ''He knows that the chair belongs to his grandfather.'' The same number of sentential complement sentences with mental verbs was used in feedback and questions as in the full training group, but without referring to any kind of contrasting deceptive experiences. See Table 1 for an overview of the different experimental conditions in the training groups.

Results

The Results section is divided into three parts. It starts with preliminary results, in which evidence for the equivalence of all training groups at pretest is given as well as the equivalence of a training effect (posttest) for the two versions of the full training condition. The second part looks at the effects of training by testing for differences between the training condition for each false belief posttest separately. In the last section ANOVAs with a

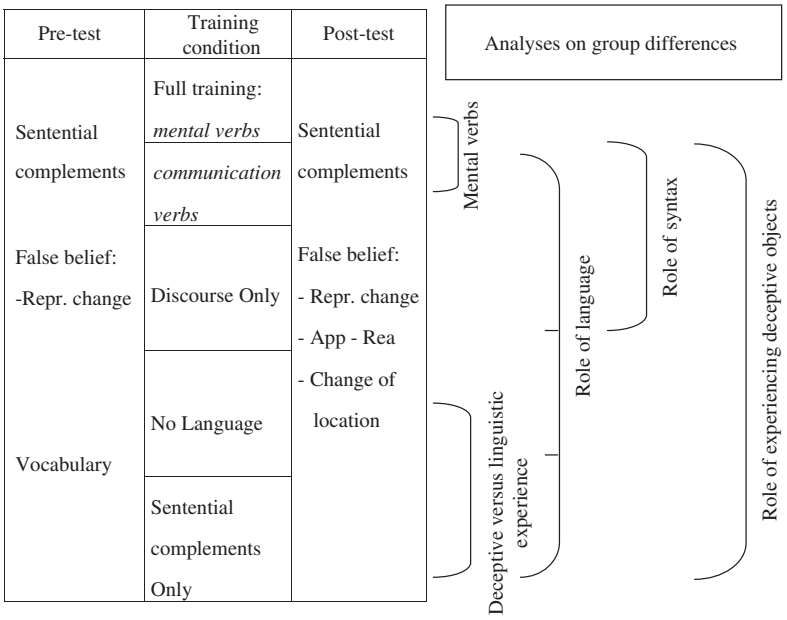

Figure 1. Design of analysis for between-group comparisons.

summed score of all false belief posttests are used for group comparisons, followed by targeted comparisons between specific training groups. Figure 1 depicts the design for the group comparisons.

PreliminarTests

Although children were randomly assigned to training conditions, it was still necessary to establish that they were indeed equivalent in relevant ways before the training began. A series of one-way ANOVAs and one logistic regression were therefore performed to test for differences among the training groups in age, sex, or pretest scores. Results revealed that there were no significant differences on any of these variables. For age, $F(4, 133) = .95$, $p = .43$; sex (logistic regression), $\chi^2 = .027$, $df = 1$, $p = .87$; vocabulary, $F(4, 133) = 1.1$, $p = .38$; sentential complements, $F(4, 133) = .79$, $p = .53$, and $F(4, 133) = .95$, $p = .51$; and false belief pretest score (logistic regression), $\chi^2 = .20$, $df = 1$, $p = .65$. Table 2 presents the ages and pretest scores for the children in each condition.

The second preliminary test involved the two versions of the full training condition. In terms of outcome on the posttests, the two groups —with either mental state verbs or communication verbs—did not differ from each other. As can be seen in Table 3, the two groups performed almost identically on all posttest tasks. In all subsequent analyses this is thus treated as a single training group: the full training group.

Effects of Training on False Belief Posttests

Representational change task. Because the representational change task was given as pretest and posttest, it is possible to analyze outcomes in two ways: as posttest only and as a change score (posttest minus pretest). Figure 2 depicts the performance on the representational change posttest for each training group (out of two possible). A significant effect of group was found for this transfer test of false belief understanding (Kruskal Wallis $\chi^2_3 = 33.8$, $p < .001$). The full training group outperformed each of the other groups on this task (full discourse group, $p < .001$; full sentential complements group, $p < .001$; full no language group, $p < .001$). None of the paired comparisons among these other three groups revealed significant differences. Converted to percentage, the full training group was correct on average on 75% of the posttest questions, the discourse only and sentential complements only groups averaged about 40% correct, and the no language group averaged only about 25% correct answers. No difference between first- and third-person test questions was found.

Pretest and posttest scores on the representational change task are presented in Table 4. Testing each group individually, it was found that all groups except the no language group increased their performance significantly compared with their pretest scores during the training (all sign tests, $p < .05$). A logistic regression confirmed the highest improvement for the full training group, which

Table 2
Means (and SD) of Age and Pretest Scores of Participants in Each Training Group

	Training conditions				
	Full training: mental verbs $N = 24$	Full training: communication verbs $N = 24$	Discourse only $N = 30$	No language $N = 30$	Sentential complements $N = 30$
Age in months	42.3 (2.4)	42.7 (2.4)	43.1 (2.4)	42.2 (2.3)	43.0 (2.2)
Vocabulary	13.8 (1.7)	13.2 (1.5)	13.3 (1.9)	13.0 (1.8)	13.0 (1.3)
Complementary Pretest 1	3.7 (1.4)	3.5 (1.5)	3.5 (1.2)	4.0 (1.4)	3.6 (1.0)
Complementary Pretest 2	2.6 (1.2)	2.4 (1.2)	2.4 (1.1)	2.3 (1.0)	2.1 (1.0)
False belief pretest	0.33	0.33	0.23	0.27	0.33

Table 3
Means on Posttests for the Two Full Training Groups

	Mental verbs	Communication verbs	Test of significance	
Appearance–reality test (0–3)	2.1	2.3	$p = .76$	Mann-Whitney exact
Representational change (0–2)	1.5	1.6	$p = .69$	Mann-Whitney exact
Change of location (0–1)	0.67	0.75	$p = .75$	Fisher exact
Sentential Complementary Test 1 (0–8)	4.5 (1.5)	4.4 (1.3)	$p = .84$	*T* test
Sentential Complementary Test 2 (0–4)	2.7 (1.3)	2.4 (1.3)	$p = .38$	*T* test

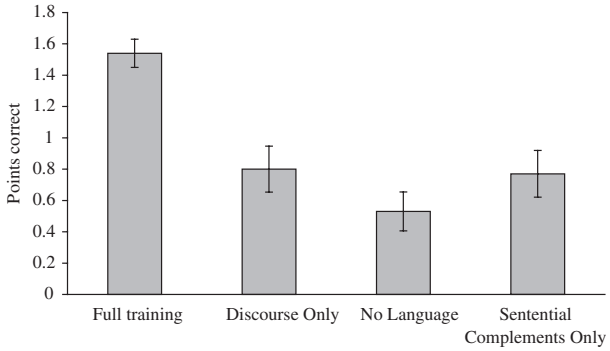

Figure 2. Dependent measure is number of correct responses (means) on representational change task by training group, maximum score 2.

outperformed all other training conditions: model $\chi^2 = 31.9$, $df = 3$, $p = .000$.

Location change task. This task is another transfer task. Figure 3 presents the mean correct answers on this test by groups, with a total possible of one correct per child. There was a significant group difference for this task (logistic regression model, $\chi^2_3 = 4.21$, $p = .04$). Post hoc tests showed that the full training group was significantly better on the location change task than the no language group (Wald = 5.64, $p < .05$), with no other groups differing from one another.

It should be noted that excluding children with mistakes in the memory question of the control questions, as is sometimes done, results in losses of children and removes the effect of group. We therefore decided to leave the children with mistakes on the control questions in the analysis. This procedure is justified, first, by the fact that many false belief measures (unexpected content and appearance–reality task) do not use control questions to exclude children, and, second, in the change of location task, the effect of group still remains when excluding the children who incorrectly state the real location of the object. The number of children with mistakes in the control questions was full training, 5 (memory), 1 (reality); discourse, 5, 0; sentential complement, 6, 0; and no language, 9, 3.

Appearance–reality task. This task measured outcome on a task similar in structure to the training itself. Figure 4 presents mean number of correct answers as a function of group (out of three possible). No significant effect of group was found on the sum of questions in this training-related false belief task (Kruskal Wallis $\chi^2_3 = 4.4$, $p = .22$). It appears that any training procedure with experience of appearance–reality objects seemed to have helped children to pass this test. It should also be noted that even children with no deceptive experience but with linguistic training on sentential complements did well on this task; this may be because the test uses test questions with sentential embeddings.

However, further analyses revealed group differences on the third-person prediction question of the

Table 4
Means and Percentages of Children Failing the Representational Change Task at Pretest and Posttest for Each Training Group

	Full training	Discourse only	No language	Sentential complements
False belief pretest (0-1) mean	0.33	0.23	0.27	0.33
Percentage of children failing	66%	77%	73%	67%
False belief posttest (0-2) mean	1.5**	0.80*	0.53	0.77*
Percentage of children failing	8.3%	43%	56%	47%

Note. Children could not get 2 points in the pretest because passing the test was used as an exclusion criterion for the training. Group of failing children refers to children with 0 points.
*$p < .05$. **$p < .01$. (Sign test; indicates a significant improvement from pretest to posttest score).

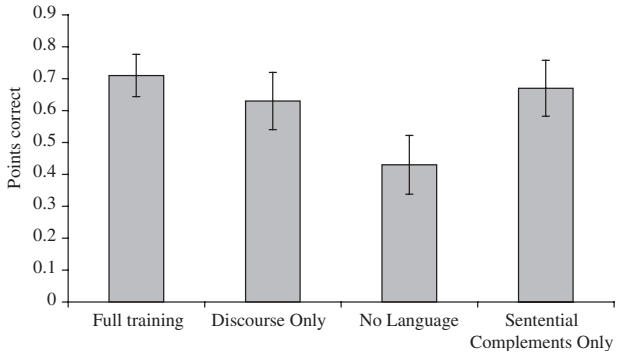

Figure 3. Dependent measure is number of correct responses (means) on change of location task by training group, maximum score 1.

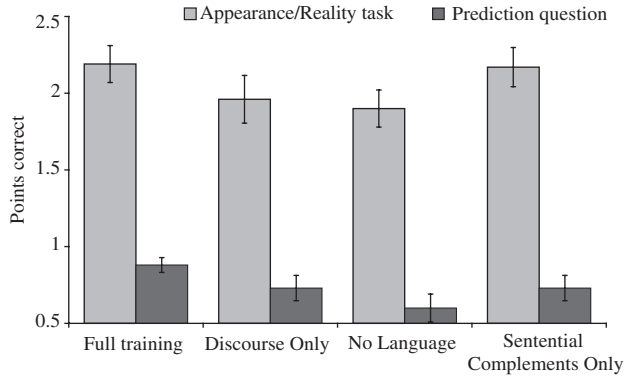

Figure 4. Dependent measure is number of correct responses (means) on appearance reality test and prediction question by training group, maximum score 3.

test. Results of a logistic regression showed a significant group effect (logistic regression model for this question (model $\chi^2_3 = 7.96$, $p = .047$). Post hoc tests showed that that the full training led to significantly more correct answers on this question than the no language training group (Wald = 7.2, $p < .01$), once again duplicating the finding for the representational change task (see Figure 4).

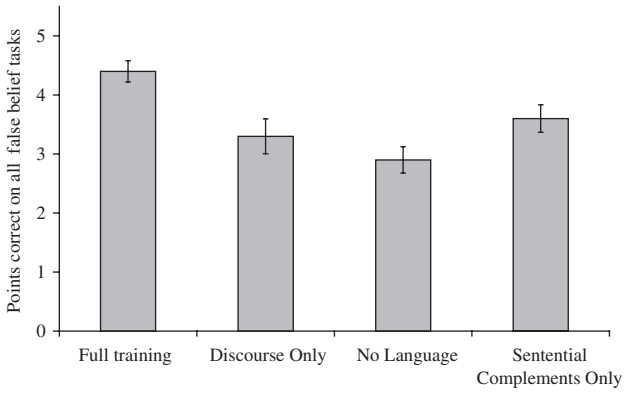

Figure 5. Dependent measure is number of correct responses (means) on all three false belief posttest scores by training group, maximum score 6.

Sum of all false belief posttest tasks. The sum of all three false belief posttests yields a false belief posttest score with a maximum of 6 points for each child, enabling a more powerful parametric approach to the false belief posttests. A one-way ANOVA was conducted and it confirmed a group effect on this summed score, $F(3, 134) = 9.38$, $p < .001$. See Figure 5 for group difference. Post hoc comparisons revealed that thefull training group performed better at posttest than each of the other groups on the sum of false belief scores (Tukey tests, $p < .05$ in all cases). None of the other groups differed significantly from one another in this analysis.

Specific Comparisons Among Groups on False Belief Posttests

The different training conditions were designed to vary in the type of experience or the type of language used during the training. Looking separately at the discourse only and sentential complement training conditions enables us to investigate in more detail the roles of deceptive experience,

perspective-shifting discourse, and sentential complements in facilitating false belief understanding. In the following analyses we use more powerful statistical comparisons than in the preceding group comparisons because we now use the summed false belief scores (ranging from 0 to 6) in targeted comparisons.

The discourse only group provided children with differing perspectives on the deceptive objects using nouns, whereas the full training group did something similar but using the language of sentential complements with mental verbs. The comparison of these groups is thus informative about the role of sentential complements beyond perspective-shifting discourse. Planned comparisons using orthogonal contrasts of the full training against the discourse only condition showed a significant effect of the full training group ($p < .001$). Thus, the use of sentential complements facilitated children's false belief understanding beyond that provided by the discourse only condition. Nevertheless, a planned contrast between the discourse only and the sentential complement groups found no difference, suggesting that the deceptive experience in the full training condition was an important factor as well. In a final planned contrast, the discourse only group did not differ significantly from the no language group.

The sentential complement training group was similar to the full training group except that there was no deceptive experience involved. That is, the children in the full training group experienced deceptive objects and perspective-shifting talk about them (including both first- and third-person perspectives), whereas children in the sentential complement training group did not experience deceptive objects or talk of contrasting mental states during the training. The results of a planned orthogonal contrast showed that the group with deceptive experience (full training) outperformed the group without deceptive experience (sentential complement), $p < .01$. Thus, the experience of changing perspectives on deceptive objects seems to be an important factor in the acquisition of false belief understanding. Comparing the sentential complement training condition with the no language condition again revealed a significant difference ($p < .05$) in favor of the sentential complement training. Moreover, combining the conditions that used sentential complements in the training (full training and sentential complement training) and comparing them with the conditions that did not (discourse and no language) also showed that the groups with sentential complements in the input outperformed the groups that did not use this linguistic construction in the training, $p < .001$. The use of sentential complements thus seems to be an important factor in the acquisition of false belief understanding independent of deceptive experience and perspective-shifting discourse.

Sentential Complements Posttests

One important result is that the use of sentential complements in training was linked to improved scores on false belief understanding. To investigate children's improvement on the sentential complement tasks at post test between all training groups, a one-way ANOVA was conducted with training condition as the independent variable and the increase in correct answers on the sentential complement tasks (change scores) as the dependent variable. Results showed a significant effect of training condition, $F(3, 137) = 4.32$, $p < .01$. Post hoc comparisons revealed the highest improvement in the comprehension of sentential complements in the sentential complement training group. The change scores in this training group were significantly higher than in the no language group, whose scores did not change over the training (Tukey, $p < .01$). These results verify that the training really had an effect on children's linguistic competence.

To investigate the question whether it is the acquisition of a sentential complement construction that helped children improve their false belief understanding, we need to ensure that the same children who improved their false belief understanding also improved their scores on the sentential complement construction test. Table 5 shows the

Table 5
Correlation of Pretest to Posttest Improvements on Both False Belief and Sentential Complements Understanding for Each Training Group

	Change scores on false belief			
	Full training	Discourse only	No language	Sentential complements
Change scores on sentential complements	$r = -.18$ $p = .22$	$r = .08$ $p = .68$	$r = -.01$ $p = .95$	$r = .39$ $p = .035$

correlation of the change scores of false belief understanding with the change scores on sentential complements Test 1 of all training groups. A significant correlation was found for thesentential complement training group. This indicates that it is the children who improved their linguistic skills who also improved their false belief scores in this condition. In contrast, in the full training group children's improvement in false belief understanding was not reliably associated with improved linguistic scores, presumably indicating other effective factors in this condition.

Discussion

The current training study had three main findings. First, language was a necessary condition for young children to make progress in false belief understanding. Simply experiencing deceptive objects was not sufficient, but rather children needed to have that experience structured by some language from other persons, for example, different nouns indicating different possible perspectives on these objects (perspective-shifting discourse). Second, training in the syntax of sentential complements, including mental state predicates as matrix verbs, was sufficient by itself to facilitate children's false belief understanding. This effect was evident even in a condition in which children had no experience with deceptive objects. Third, these two effects—of perspective-shifting discourse and sentential complement syntax—seem to be relatively independent of one another. The strongest facilitator of children's false belief understanding in this study was a training condition incorporating both of these factors, and the correlational findings provided further support for the independence of these two factors. We discuss these three findings in turn.

First, the current study is the first to compare explicitly training conditions incorporating both deceptive experience and language with a training condition containing deceptive experience but no language. The current findings are thus the strongest evidence (at least using a training methodology) that linguistic experience is a strong facilitator, perhaps even necessary condition, in the development of children's false belief understanding. It is important to note that in the no language condition, children did have meaningful communicative interactions with an adult about the deceptive objects; the adult used various kinds of attention getters, some of them verbal (e.g., ''Look! And now look!'') to draw the child's attention to the two perspectives on the object. Therefore, the problem in this condition was not that the children were not paying attention at all to the two ways the object could be construed. However, in contrast to the discourse group, children in the no language group received no verbal feedback. Evidence that shows that the group effect cannot be attributed to the lack of verbal feedback comes from a study by Clements et al. (2000). In a false belief training setting, Clements et al. showed that receiving corrective feedback by itself was not helpful in improving children's false belief understanding unless it offered new information about the situation. In Clements et al.'s study, only children who received explanations of why their answers were wrong were able to improve their false belief understanding. Thus, the difference lies not in the fact that verbal feedback was given, but whether the feedback offered a new construal of the situation for the child. The difference between the no language training condition and the discourse condition suggests that in our training this was the explicit labeling of the speaker's perspective. In the discourse only condition the two perspectives were encoded in contentful linguistic symbols, such as, ''First it is a flower, and now it is a pen.'' Therefore, the effect of language really had to do with the adult using conventionalized symbols (mainly in the form of common nouns) to highlight the differing perspectives. On the other hand, it is important that the explicit encoding in this training condition did not involve reference to mental states themselves; therefore, the effective factor in this condition really was the process of discourse rather than any explicit reference to mental states using mental state language.

It thus would seem to be difficult for children to construct an understanding of the representational nature of mental states purely from visual scenes alone. Especially strong evidence for this proposal comes from research with profoundly deaf children born to hearing families, who have almost no available means in their early years of conversing with their hearing family members, especially about topics such as mental states, which may have no obvious visual referent (de Villiers & de Villiers, 2000; Gale et al., 1996; Peterson & Siegal, 1995, 1998, 1999, 2000). These children presumably experience the same number of situations as normally developing children in which they observe others in surprise reactions or experience their own false beliefs, but these deaf children struggle with false belief tasks up to the age of 16 years. In contrast, deaf children born to signing parents, who share a communicative system and thus have much richer linguistic experiences, develop concepts of false belief at the

same age as do hearing children (Peterson & Siegal, 1999, 2000).

Second, the current study is the first to evaluate explicitly a training condition containing sentential complements but no experience with deceptive objects (or any other kind perspective-shifting discourse) to test the hypotheses that experiencing this syntactic construction is by itself sufficient to facilitate false belief understanding (de Villiers, 1995; de Villiers & de Villiers, 2000). In the only other training study investigating this question (Hale & Tager-Flusberg, in press), the training of sentential complements always occurred in conjunction with deceptive experience. Therefore, the current findings are the first to establish the important role of sentential complement syntax by itself in promoting the understanding of false beliefs. The current findings thus support the hypothesis of de Villiers that sentential complement syntax provides children with a convenient (if not necessary) representational format for conceptualizing and talking about false beliefs.

It is also important to note that the sentential complement sentences in this training condition contained mental state verbs; therefore, these might have played an important role in producing the training effect. However, in an explicit comparison of the two versions of the full training condition —one containing mental state verbs (e.g., think, know) and one containing a communication verb (say)—no difference was found. This is at least indirect evidence that the main effect in the sentential complement condition was not tied primarily to the semantics of mental verbs but rather to the structure of sentential complement syntax with its semantic features accompanying the structure (e.g., see Diessel & Tomasello, 2001). However, although a sufficient factor for false belief understanding in this study, sentential complement syntax might not be a necessary factor for this understanding (see also Perner, Sprung, Zauner, & Haider, 2002). The discourse only training group, which received no sentential complement training, also improved in their false belief understanding (with no significant differences with the sentential complement training group). However, comparing the training of sentential complement group with the no language group revealed a significant advantage of training with sentential complements beyond the experience of changing perspectives alone. The results thus provide several types of evidence suggesting a causal role of sentential complements in the development of false belief understanding.

To identify more precisely the manner in which sentential complement syntax facilitates false belief understanding, further studies using several groups with varying numbers and types of sentential complements are needed. Thus, it is well known that children comprehend sentential complements with verbs of desire and pretense before those with mental state verbs (Custer, 1996; Perner et al., 2002). It is also true that children use sentential complements with different degrees of understanding. Thus, several authors have noted that children's earliest uses of this construction are often conversational in nature and do not really involve embedded clauses; thus, they say ''I think she's home'' as an equivalent of ''Maybe she's home'' (e.g., Diessel & Tomasello, 2001). On one hypothesis, it is only when the child masters embedded structures with an awareness that the complement can be false (and therefore stands in a certain subordinate relation to the matrix clause) does the acquisition of this construction help children to represent false beliefs.

Third, in virtually all analyses the largest training effect was observed in thefull training condition, which contained (as most previous training studies) both perspective-shifting discourse and sentential complement syntax, but no more overall talk compared with the other conditions. In combination with the findings demonstrating the effectiveness of these two factors by themselves, the superiority of the full training condition implies that perspective-shifting discourse and sentential complement syntax each makes a relatively independent contribution to children's false belief understanding.

Like all training studies, the current study can only establish that certain sets of experiences are sufficient to lead to certain outcomes, in this case false belief understanding, not that they are necessary conditions that operate in the real world. However, observational studies of children's development of skills with language and false belief understanding indicate that both of the linguistic factors we have identified as effective are also correlated with false belief understanding in the real world (Astington & Jenkins, 1995; Farrar & Maag, 2002). When the findings of correlational studies and training studies converge, this is the strongest possible evidence (short of randomly assigning children to different life circumstances) that these are the factors involved (MacCall, 1977). An interesting and important question for future research would be whether different languages and parenting styles would lead to individual differences in social-cognitive development (e.g., see Sera, Bales, & Del Castillo Pintado, 1997; Vinden, 2001).

The current study thus provides the strongest evidence that language plays a central role in children's development of false belief understanding. Specifically, engaging in perspective-shifting discourse using contentful linguistic symbols (not necessarily mental state language) and the ready availability of sentential complement syntax as a representational format both seem to make independently important contributions to the ontogenetic process.

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Appendix A Sentential Complement Test Examples

Experimenter: "I'm going to tell you some stories and then I'm going to ask you some questions, so listen carefully!"

Sentential Complement Test 1. A combination of the Tom task (Swettenham, 1996) and memory for complement test (de Villiers & de Villiers, 2000)

"This boy (point to picture) thinks that it is sunny outside (point) - although it is really and truly raining outside (point)."

Test questions: "Will Tom now put his raincoat on?" "What was this boy thinking?"

German (translated by the author):

"Dieser Junge denkt), dass die Sonne scheint, obwohl es in Wirklichkeit und in echt regnet."

Test questions: "Wird der Junge jetzt seine Regenjacke anziehen?" "Was hat dieser Junge gedacht?"

Sentential Complement Test 2. (from Hale & Tager-Flusberg, in press)

"One day, this little girl took some scissors into her room and cut her hair with them (point).

Then, her dad called up to her and asked her what she was doing. The girl said: "I'm just cutting up some paper!" (point) The little girl then went to play with her brother."

Test question: "What did the girl say she was cutting?"

German (translated by the author)

Einmal hat dies Maedchen eine Schere mit in ihr Zimmer genommen und ihre Haare damit geschnitten. Dann rief der Vater sie aus dem anderen Zimmer und fragte, was sie gerade macht. Das Maedchen sagte: "Ich schneide nur etwas Papier!" Dann ist das Maedchen mit ihrem Bruder spielen gegangen.

Was hat das Maedchen gesagt, was sie geschnitten hat?

Appendix B Script of Training Procedures

Full Training (Either Communication Verbs or Mental Verbs Used)

Questions	Feedback
What do you think/say this is?	You think/say it is an X? Yes, I also think it looks like an X.
	- Right, it is really a Y!
Now take it into your hand and look at it really closely: what do you think/say now this is really?	
When I took it out of my suitcase, and you first saw it, what did you first think/say this was?	- Right, at first you thought/said, it is an X. It looks like an X, so you must think/say it is an X.
	- No, it does looks like an X, right?

	So at first you thought/said it was an X, but now you know/say it is a Y.
And what is it really and truly?	- Exactly. Really it is a Y. - No, look: what is it really and truly?
I brought someone with me: the little dog Schnuffi. He was sleeping in my suitcase all the time. Shall I take him out and show him this thing?	
When Schnuffi sees it—what will Schnuffi first think/say this is?	You think, he will think it is X/Y, say X/Y to this? Let's hear what he says.
"Schnuffi, here I have a Y."	Schnuffi: "What, a Y? Never, that is an X. I see that!"
Why does he think/say that?	Alright.
Did Schnuffi know/say before that it is really and truly a Y?	- Right, he did not. At first he thought/said it was an X!
	- No, at first he thought/said it was an X, right?

Discourse Condition

Questions	Feedback
What is this?	An X, all right. OK.
And what is it really?	Right, it is really a Y!
Now again: look! What is it like this? (show X side)	- Good! - No, it does look like an X, right? First so (show X side) and then so (show Y side of object).
But what is it really and truly?	- Exactly. Really it is a Y. - No, look: What is it really and truly?
I brought someone with me: the little dog Schnuffi. He was sleeping in my suitcase all the time. Shall I take him out and show him this thing?	
What will Schnuffi say first to this?	- X? Right. Good. Let's hear what he says. - Y? Let's hear what he says.
Schnuffi, here I have a Y.	Schnuffi: "What, a Y? Never, that is an X. I see that!"
What Schnuffi? Experimenter first shows surprise and understanding, an attempt for a substitution of the why question, which would elicit complex sentences.	
What will Schnuffi now say to this?	- Y? Right! - No—He now says Y to it, right?

No Language Condition (Accompanied by Nonlinguistic Expressions of Emotions, Gaze Checking With the Child)

Look. (show X)
And now look! (show Y)
Now again: look. (show X)
But now look! (show Y)
Look so (show X)—and then so (show Y side of object)
I brought someone with me: the little dog Schnuffi. He was sleeping in my suitcase all the time. Shall I take him out and show him this thing?

''Schnuffi, look!'' (show X)	Schnuffi: ''Alright.''
Mmh?	
''And now, Schnuffi look again!'' (show Y)	Schnuffi shows surprise reactions: ''Wow, OK—Now I see!''

Sentential Complements Condition

Questions	Feedback
What do you think this is?	You think it is a candle? Yes, I also think it is a candle.
Do you think that this candle is really soft or that this candle is really hard?	- Right, I also think that this candle is really hard. - OK. You think that the candle is soft.
Do you think you can light this candle?	- I also think you can light this candle. - Ok. You think you cannot light this candle.
Ernie: ''Look at me: I can lift up this candle!''	
What did Ernie show us?	- Exactly. Ernie showed us that he could lift up this candle. - Ernie showed us that he could lift up this candle.
Ernie: ''Oh, the candle burns real hot. I can feel that.''	
What does Ernie feel?	- Right. Ernie feels that the candle burns really hot. - Ernie feels that the candle burns really hot.
Does Ernie know that candles can be dangerous?	
How does he know that?	- Right! He was just feeling how hot it burns. - He was just feeling how hot it burns, right? So he knows, right?