Sentential complements and false belief understanding in Chinese Mandarin-speaking preschoolers: A training study

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Sentential complement
False representation
Training, language

**Abstract**
We conducted a training study to better understand how Chinese Mandarin-speaking preschoolers’ facility with sentential complement grammatical constructions affects performance on false belief tasks. Eighty-four Mandarin-speaking Chinese 3–4-year-olds who were initially unsuccessful on false belief tasks were randomly assigned to four training conditions. Two involved training on sentential complement structures, one involved training on understanding of false representations, and one was a control condition that involved no specific training. Participants who received training on sentential complements with communication verbs performed significantly better on false belief posttests than those in the control group. Children in the false representation training group did not show improvement in the sentential complement tests. The findings suggest facility with sentential complement grammatical structures can promote false belief reasoning. However, explicit false belief understanding can emerge even when children have little competence with sentential complement constructions.

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1. Introduction

False belief understanding is a milestone in representational theory of mind development (Wellman, Cross, & Watson, 2001). Children’s performance on false-belief tasks is associated with language ability (Astrington & Jenkins, 1999; Hughes & Dunn, 1998). A recent meta-analysis (Milligan, Astrington, & Dack, 2007) concluded that children’s early-developing language skills predict subsequent development of theory of mind during the preschool years. The goal of this study is to examine Chinese Mandarin-speaking preschoolers to investigate the role of one aspect of language development – facility with the sentential complement grammatical construction – in the development of false belief understanding.

The hypothesis that facility with sentential complement grammatical constructions is critical for false belief understanding was first advanced in a series of influential papers by de Villiers and colleagues (de Villiers & Pyers, 2002; de Villiers & de Villiers, 2000). Noting that mental state verbs (e.g., think) take sentential complements – meaning that the clause that complements the mental verb is itself a complete sentence (e.g., Mary thinks that the chocolate is in the cupboard). De Villiers and colleagues argued that the syntax provides a formal mechanism for contrasting the truth value of two clauses within a single sentence. With reference to the above example, Mary may truly think that the chocolate is in the cupboard, but the content of Mary’s belief may or may not be true depending on the preceding events. de Villiers and de Villiers (2000) suggested that this class of syntactic construction provides a format for thinking about epistemic mental states, and that until facility with this construction is acquired, an understanding of belief may be seriously limited.

There is some evidence that facility with sentential complement constructions is important for the development of preschoolers’ false belief reasoning. In one study, de Villiers and Pyers (2002) asked children to report the propositional content of a story character’s mistake, lie, or false belief (e.g., He thought he found his ring, but he was really a bottlecap. What did he think?). Ability to report the propositional contents and produce sentential complements themselves showed rapid gains between the ages of 3 and 4, about the time false belief understanding emerges. Indeed, false belief understanding could be uniquely predicted by the earlier onset of sentential complements (de Villiers & Pyers, 2002).

A second source of evidence in support of the association between sentential complement facility and theory of mind development comes from studies of deaf children born into hearing families. Schick, de Villiers, de Villiers, and Hoffmeister (2007) reported that deaf children from hearing families showed a significant delay in theory of mind tasks. Importantly, vocabulary and sentential complement comprehension were independent predictors of success on both typical verbal and low-verbal theory of mind tasks.

In addition to these correlational studies, several studies have shown that training to increase children’s facility with sentential complements leads to improvements in false belief performance. For example, Hale and Tager-Flusberg (2003) found that children trained on sentential complements not only acquired the linguistic knowledge fostered by the training, but also significantly increased their scores on a range of theory of mind tasks, including false belief tests. In a typical training session, an experimenter acted out a story with characters (e.g., Big Bird, Grover and a boy). In the story, the boy does one thing, but says that he does another. For instance, in one story, the boy is shown kissing Big Bird, but the boy says, “I kissed Grover.” The experimenter then asks the child: “What did the boy say?” Correct responses were responded to with, “That’s right. The boy said, ‘I kissed Grover,’ but he really kissed Big Bird.” If the child made an incorrect response, the examiner acted out again and said, “But remember, the boy says, ‘I kissed Grover,’ but he really kissed Big Bird.” The results showed that those who participated in the sentential complement training also improved in false belief performance relative to a control group.

Hale and Tager-Flusberg’s (2003) training protocol was specifically designed to determine whether it was the grammatical features of sentential complement structures, rather than other kinds of more semantic content, that affected children’s theory of mind development. Thus, these researchers used “communication” verbs (i.e., said that). However, it is not entirely clear whether the aim of leaving out semantic content was fully achieved. Their training involved a kind of deception in which participants were told that although a story character intentionally said one thing, something else was in fact
true. The deceptive aspect of the story was not emphasized in the training protocol, but its presence makes it unclear as to whether the training promoted children’s understanding of deception (which is relevant to theory of mind), sentential complement constructions, or both.

With this in mind, Lohmann and Tomasello (2003) developed a training protocol that avoided deceptive communication and obtained the same results, thereby suggesting that the deceptive content of the training was not the sole factor promoting false belief understanding in Hale and Tager-Flusberg’s study. Yet, Lohmann and Tomasello’s protocol had interpretive difficulties of its own. Specifically, their training involved the use of terms that could, arguably, be interpreted as having mental content (e.g., discussion of what story characters “feel” or “know”). Thus, it remains unclear whether the association between facilitating sentential complement understanding and false belief reasoning is specific to the cognitive-structural “template” that sentential complements provide, or the semantic content of the training.

Other concerns about the empirical relation between sentential complement facility and false belief have been raised by researchers working in languages other than English. For instance, Perner, Sprung, Zauner, and Haider (2003) noted that in German, sentences involving the mental verb want obligatorily take sentential complements; yet, German children (like others) appear to understand the entailments of want well before they understand the entailments of think and believe. Also, in studies with Cantonese-speaking preschoolers that are more analogous to those conducted by de Villiers and colleagues, two groups have shown that once relevant factors are controlled (e.g., general language ability, age, prior theory of mind development), understanding of sentential complements does not make a unique contribution to false belief reasoning (Cheung et al., 2004; Tardif, So, & Kaciroti, 2007, study 2). Taken together, these findings suggested that the relation between sentential complement and false belief understanding may not extend across languages or cultures, which calls into question its validity as a strong explanatory theory of acquisition of false belief understanding.

With these concerns in mind, the goal of the present study was to provide some clear evidence regarding whether facility with sentential complements is necessary for false belief understanding. We hoped to achieve this goal by conducting a training study with Mandarin speaking Chinese preschoolers. There are important differences between English and Mandarin with respect to the use of mental terms and sentential complements. Relative to English speakers, the use of mental terms with sentential complements is rare among Mandarin-speaking parents and children (Tardif & Wellman, 2000; Snedeker & Li, 2000). Yet Mandarin-speaking parents and children use sentential complement constructions for communication verbs (e.g., say, in Mandarin) more commonly and earlier in development than their English-speaking counterparts (Tardif & Wellman, 2000).

This comparison raises two interesting possibilities. The first is that perhaps Mandarin-speaking preschoolers trained on sentential complements with the more common communication verbs will show more efficient acquisition of the construction relative to those trained on sentential complements with mental verbs. The second possibility is that training with sentential complements involving mental verbs may be less effective in facilitating children’s acquisition of the structure because the use of mental verbs with sentential complements is non-canonical and potentially confusing. If so, this may allow for a fairly compelling test of the role that sentential complement understanding plays in false belief reasoning. Namely, if sentential complement understanding per se contributes to false belief reasoning, children who receive sentential complement training with communication verbs may perform better on false belief tasks than do children who receive sentential complement training with mental verbs. Investigating this hypothesis is the main goal of the present study.

A second goal is to gain evidence regarding the mechanisms by which sentential complement training may affect false belief understanding. Some have suggested that tests of false belief understanding and tests of sentential complement understanding both rely on an understanding of misrepresentation more generally – that is, they both require one to consider that the propositional contents of a representation (either a communicative utterance or a belief) may not be consistent with the true state of affairs it is meant to represent (Ruffman, Slade, Rowlandson, Rumsey, & Garnham, 2003). If so, sentential complement training may be one way to increase children’s understanding of misrepresentation, but perhaps not the only way (Ruffman et al., 2003). In the present study, we included for comparison a condition that trained children on concepts of misrepresentation without the use of sentential complements. Specifically, we borrowed a procedure first used by Wellman, Hollander,
and Schult (1996), who investigated preschoolers' understanding of thought bubbles. They found that vast majority of 3–4-year-olds understand that thought bubbles can be used as graphical depictions of “what a person is thinking”, and thus can reveal the contents of characters' thought in a variety of situations. More important, thought bubbles can be used to graphically depict a person's misrepresentation of some states of affairs (that is, the propositional content of the thought bubble can be discrepant with some true state of affairs). If facility with sentential complements per se is critical to false belief understanding, the misrepresentation training should have little effect on false belief reasoning independent of whatever effects it might also have on sentential complement facility. Alternatively, if sentential complement training has its effects through the more general mechanism of developing a broader understanding of misrepresentation, we might expect a relatively robust effect of misrepresentation training, irrespective of whether it also affects facility with sentential complements.

2. Methods

2.1. Participants

A total of 120 kindergarten children participated (mean age = 46.3 months, SD = 4.9 months, range = 40–55 months). They came from kindergartens affiliated with two universities in Beijing, China. Most came from working- and middle-class families. All spoke Mandarin. According to parents’ or teachers’ reports, no children had linguistic or psychological abnormalities. Eighty-four children from this original sample failed at least one of two questions in false belief pre-test (see below) and thus were considered eligible for the training study. Post-test data from three participants were missing due to children’s illness (n = 2) or the family relocating (n = 1). Thus, a full set of data was acquired for 81 children (33 boys). Each child received a gift for participation.

2.2. Design

We employed a between-subject design in which participants were randomly assigned to one of the four training groups: (1) sentential complement-communication verb (SC-COMM), (2) sentential complement-mental verb (SC-MENTAL), (3) false representation (FR), and (4) control.

2.3. Pre and posttest measures

2.3.1. False belief pretest

A standard unexpected contents false belief task was used to assess false belief understanding (Perner, Leekam, & Wimmer, 1987). A child was shown a candy box and asked what he or she thought was inside. After children responded saying that they believed the box contained candy, the box was opened to reveal a ball-point pen. After closing the box, the experimenter asked a false belief question: When another child sees this closed box for the first time, what would he say is inside the box? This was followed by an ignorance question: Does he know what is in the box before it is opened? Children received a point for each correct answer.

2.3.2. Sentential complement pretests

Two tasks of memory for sentential complements were administered using the procedure from previous studies (de Villiers & Pyers, 2002; Lohmann & Tomasello, 2003). Children were told a story involving sentential complement with a mental verb (e.g., think) or communication verb (e.g., say) accompanying with line drawings relevant to the sentence. One story involving a mental verb was as follows, “A little rabbit was playing at home, and a wolf was knocking at the door; however, the rabbit though it was his/her Mom knocking at the door”. The test question on memory for sentential complement for the mental verb think was, “Who did the little rabbit think was knocking at the door?”

A story to assess understanding of sentential complements with communication verbs was as follows: Xiaohong was asked to go buy milk by her mother, but she bought a tin of Cola instead of milk. When she went home, her mother asked her, “Xiaohong, what did you buy?” Xiaohong said, “I
bought milk”. The test question on memory for sentential complement for the communication verb say was, “What did Xiaohong say that she bought?”

Children received 1 point for correctly answering the content of complement or for using the entire complement structure.

Children performed better than expected on the tests for sentential complements. Specifically, although four children in each training group did not pass either of the two questions, some children in all groups (4 children in SC-COMM, 4 in SC-MENTAL, 3 in the FR group and 6 in control) answered both correctly. Thus there were children in our final group who performed poorly on false belief tasks although they already showed facility with sentential complements. This pattern would be unexpected if sentential complement understanding were itself sufficient for false belief understanding. Nonetheless, average performance on the sentential complement pretest was equivalent across the different training groups (see Table 1), which allowed us to assess the effects of different kinds training on false belief understanding at the group level.

2.3.3. False belief posttests

Two standard location-change tasks (Wimmer & Perner, 1983) and two standard unexpected-content tasks (Hogrefe, Wimmer, & Perner, 1986; Perner et al., 1987) were administered to children following training.

In the location-change tasks, children were told stories. In one, a boy Xiaogang put his cake into a cupboard and then went out to play. Then his mother transferred the cake from the cupboard to the refrigerator. Children were asked two control questions (Where did Xiaogang put the cake before he left? Where is the cake now?). If a child did not answer correctly the story was repeated up to three times. The false belief questions included a standard behavior prediction question (When Xiaogang comes home, where will he first look for the cake?) and a justification question (Why will he look for it there?). A justification was judged as appropriate if it included references to location (e.g., He put it there before he went out), knowledge (e.g., He does not know it was moved), or belief (e.g., He thinks it still is there). All other justifications were coded as inappropriate (e.g., I do not know; the cake is in the cupboard; he wants to find the ball; he cannot find the ball).

A second story involved a girl who put a ball in a box and in her absence, her classmate moved the ball to a drawer. The two unexpected contents tasks were similar to the false belief pretest except that the false belief prediction question was, “When another child comes in, before having opened it, what does he/she think is inside the box?”

In the false belief tasks, each correct answer to the behavior prediction question was awarded 1 point. Across the four trials, total scores for the prediction question ranged from 0 to 4.

2.3.4. Sentential complement posttests

The sentential complement posttests were identical in structure to the pretests. Children were orally presented ten brief stories in random order, each accompanied by line drawing pictures. Each story involved a character who made a mistake, told a lie, or held a false belief. Of the ten stories, five involved mental state verbs (e.g., think) and five involved communication verbs (e.g., say). The test questions assessed children’s memory for a sentential complement presented with each of the

<table>
<thead>
<tr>
<th></th>
<th>SC-COMM (n = 20)</th>
<th>SC-MENTAL (n = 20)</th>
<th>FR (n = 20)</th>
<th>Control (n = 21)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (months)</td>
<td>45.35 (4.40)</td>
<td>47.80 (5.22)</td>
<td>45.45 (5.79)</td>
<td>46.70 (4.20)</td>
</tr>
<tr>
<td>FB prediction (0–1)</td>
<td>0.20 (0.41)</td>
<td>0.15 (0.36)</td>
<td>0.15 (0.36)</td>
<td>0.14 (0.35)</td>
</tr>
<tr>
<td>FB ignorance (0–1)</td>
<td>0.50 (0.51)</td>
<td>0.60 (0.50)</td>
<td>0.60 (0.50)</td>
<td>0.52 (0.51)</td>
</tr>
<tr>
<td>MCwMV (0–1)</td>
<td>0.50 (0.51)</td>
<td>0.45 (0.51)</td>
<td>0.45 (0.51)</td>
<td>0.61 (0.49)</td>
</tr>
<tr>
<td>MCwCV (0–1)</td>
<td>0.52 (0.50)</td>
<td>0.55 (0.51)</td>
<td>0.50 (0.51)</td>
<td>0.47 (0.50)</td>
</tr>
</tbody>
</table>

Note: Sentential complement-communication verb = SC-COMM, sentential complement-mental verb = SC-MENTAL, false representation = FR.
verbs. Based on previous work (de Villiers & Pyers, 2002), our Mandarin version was revised slightly for Chinese children (Cheung, Chen, & Yeung, 2009). Two of the stories were as follows:

- **Story 1:** He thought he found his ring, but it was really a bottle cap.
- **Test question:** What did he think he found?

- **Story 2:** Mom asked Limei to buy some milk. But Limei bought some orange juice. Mom asked Limei, “Did you buy milk?” Limei said, “Yes, I bought milk.”
- **Test question:** What did Limei say she bought?

As with the pretest, children’s responses were scored as correct if they included the content of the complement or use of the entire complement structure (de Villiers & Pyers, 2002; Perner et al., 2003). Children received 1 point for each correct answer, resulting in a maximum score of 5 each for sentential complements involving either mental or communication verbs.

### 2.4. Training protocols

Children interacted with one of three adult experimenters alone in a quiet room in their preschools. The two training sessions took place within two weeks of each other, with each session lasting about 25 min (range: 20–30 min), with a 7-day interval between sessions. Posttests were administered about 4 days after the second training session.

#### 2.4.1. Sentential complement training

The training procedure was modeled on that used by Lohmann and Tomasello (2003) and was revised slightly to make it culturally appropriate for Chinese children. In addition, in order to stimulate children’s interest in talking about some topics and to improve the ecological validity of the study, the sentential complement training was conducted in an elaborated, conversational manner.

Each of the two sessions consisted of four trials and lasted about 25 min. In the first session, trials involved the experimenter presenting an object (e.g., apple) which was wrapped in a piece of thin paper and letting children touch it. Children were then asked about characteristics of the objects with questions that included a sentential complement whose verb depended on condition (mental vs. communication). The experimenter repeated or corrected children’s responses to the questions. For example, if the question was, “What do you think/say this is?” the feedback was, “Okay, you think it is an apple. Yes, I also think it is an apple.”

In the second session, trials involved the experimenter telling children two short stories accompanied by relevant pictures. One story was as follows. “Xiaoming wants to get a toy airplane for his birthday gift. On his birthday, his mother bought him a toy airplane. Xiaoming thought/said that his mother bought him a toy airplane. He thought/said that his mother loved him very much. After each story, the experimenter asked the child questions regarding the parts of the story that involved sentential complements (e.g., “Can you tell me, what did Xiaoming think/say his mother bought him?” The experimenter repeated or corrected children’s answers. For example, the experimenter said, “Right, Xiaoming thought/said that his mother bought him a toy airplane.”

#### 2.4.2. False representation training

A training paradigm based on the “thought bubble” experimental paradigms discussed earlier was adapted for use with Mandarin-speaking children (Flavell, Everett, Croft, & Flavell, 1981; Wellman et al., 1996).

To begin, an experimenter presented children with three black and white line drawings, two of which depicted a familiar object (e.g., horse and turtle); the third was a “thought bubble” picture, i.e., a set of bubbles appearing above the right side of the pictured child’s head. The experimenter first presented children with the thought bubble picture and said, “Look at the large bubble that

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2 Mandarin materials are available on request from the authors.
contains a horse. It shows what is in the character’s mind. Have you ever seen this kind of thought bubble in cartoons?” Children typically demonstrated understanding of the relation between thought bubbles and mental states following this description. Children were then shown scenarios in which the contents of thought bubbles did not match some true state of affairs.

The experimenter presented the first picture (e.g., of a horse) and asked children to name the object. Then, presenting the “thought bubble” picture again, the experimenter said to the child, “When this boy/girl saw this picture, does he/she know there is a horse in this picture?” After children answered correctly, the experimenter continued, “Well now this boy/girl turned away from us.” (The thought bubble picture was turned away.) The experimenter then showed the second picture, saying, “Look at this picture (showing the second object, e.g., a car), replacing the first picture with this one and asking, ‘What is the object in this picture now?’” The experimenter then continued, “Well, the boy/girl turned and does not see the object in this picture.” Children were then asked, “Now, what is the object in this picture in his/her mind?”

If children answered correctly, the experimenter asked them to explain why. If not, the experimenter explained that the boy/girl had not seen the picture being replaced and then asked the question again. If children did not answer correctly (i.e., by naming the object in the second picture), the experimenter asked, “Is he/she right (or wrong)? Why?” If children answered incorrectly, the experimenter asked, “If you do not see the picture, do you know what it is in the picture (the experimenter turned the picture away)?”

The false representation training included two sessions, each consisting of four trials, with each trial lasting about 5–7 min.

2.4.3. Control group

The control training condition was based on the procedure used by Lohmann and Tomasello (2003) and the same objects as in the sentential complement training condition. However, the experimenter did not ask children questions involving sentential complement with communication or mental verbs, and only asked simple questions with clear answers to keep their attention. Children’s responses were given neutral feedback, although an effort was made to keep children engaged. Finally, an effort was made to ensure that the control training episodes were roughly as long as in the other training conditions.

3. Results

3.1. Preliminary analyses

Children’s mean ages and average performance on the various pretests in each group are presented in Table 1. A one-way analysis of variance (ANOVA) and Kruskal–Wallis tests showed no significant age differences or any of the pretests across the four groups. Nor were there significant gender differences. These preliminary analyses demonstrated that the four groups were indeed equivalent before training.

3.2. Training effect on false belief posttests

3.2.1. Prediction measures

Performance on the prediction questions in the two false belief tasks (contents and location) was significantly correlated, \( r(81) = .45, p < .001 \). Thus, scores on the two tasks were summed to obtain a total score for each child, ranging from 0 to 4 (see Table 2).

A one-way ANOVA, with training condition as independent variable and the aggregated false belief post-test scores as dependent variable, revealed a significant training condition effect, \( F(3, 77) = 3.14, p = .03 \), partial \( \eta^2 = .10 \). Post hoc tests revealed that the SC-COMM group and the FR group performed significantly better than the control group (Tukey HSD, \( p < .05 \)). The SC-MENTAL group did not significantly outperform the control group (Tukey HSD, \( p > .1 \)). No other significant differences were found.
Table 2
Performance on posttest tasks across groups (mean and SD).

<table>
<thead>
<tr>
<th>Groups</th>
<th>SC-COMM (n = 20)</th>
<th>SC-MENTAL (n = 20)</th>
<th>FR (n = 20)</th>
<th>Control (n = 21)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FB prediction (0–4)</td>
<td>2.45 (1.50)</td>
<td>2.20 (1.47)</td>
<td>2.45 (1.38)</td>
<td>1.28 (1.27)</td>
</tr>
<tr>
<td>MCwMV (0–5)</td>
<td>3.25 (1.21)</td>
<td>3.55 (1.14)</td>
<td>2.45 (1.43)</td>
<td>2.48 (1.28)</td>
</tr>
<tr>
<td>MCwCV (0–5)</td>
<td>4.25 (0.96)</td>
<td>3.80 (0.95)</td>
<td>3.50 (1.27)</td>
<td>3.61 (1.07)</td>
</tr>
</tbody>
</table>

Table 3
Percentage of participants giving appropriate or inappropriate reasons in cake story task.

<table>
<thead>
<tr>
<th>Groups</th>
<th>SC-COMM (n = 20) (%)</th>
<th>SC-MENTAL (n = 20) (%)</th>
<th>FR (n = 20) (%)</th>
<th>Control (n = 21) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appropriate justification</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location or knowledge</td>
<td>40</td>
<td>35</td>
<td>20</td>
<td>9.5</td>
</tr>
<tr>
<td>Mental state</td>
<td>10</td>
<td>15</td>
<td>20</td>
<td>9.5</td>
</tr>
<tr>
<td>Inappropriate justification</td>
<td>50</td>
<td>50</td>
<td>60</td>
<td>81</td>
</tr>
</tbody>
</table>

Did improvement reach a level of above-chance responding? Tests comparing posttest performance in each group to chance (i.e., $\mu = 2.00$) showed that the control group performed significantly below chance, $t = -2.57$, $df = 20$, $p = .018$. Performance in the focal training groups did not exceed chance.

Tables 3 and 4 showed the percentage of children by group who gave appropriate explanations for their responses in the two location-change tasks. In the “cake story” task, both sentential complement training groups outperformed the control group, $\chi^2(1, N = 41) = 4.36, p = .037$, for both comparisons. In the “ball story” task, however, only the SC-COMM group gave more appropriate reasons than the control group, $\chi^2(1, N = 41) = 5.53, p = .019$.

3.3. Training effect on sentential complement posttests

The scores of the two sentential complement tests (mental and communication verbs) were significantly correlated, $r(81) = .25, p = .02$ (see Table 2) and therefore combined. Thus, composite scores ranged from 0 to 10. A one-way ANOVA with condition as independent variable showed a significant main effect of condition, $F(3, 77) = 3.99, p = .01$, partial $r^2 = .11$. Post hoc comparison revealed that the SC-COMM group and SC-MENTAL group outperformed the FR group and control group (Tukey HSD, the SC-COMM group > control group, $p = .016$; SC-MENTAL group > control group, $p = .03$; SC-COMM group > FR group, $p = .009$; SC-MENTAL group > FR group, $p = .018$). No other significant differences were found (see Fig. 1). Thus, sentential complement training promoted facility with complement syntax.

3.4. Reduced sample analyses

As noted, several children in each group passed the sentential complement pretests. This made it difficult to test the hypothesis that the sentential complement training involving communication

Table 4
Percentage of participants giving appropriate or inappropriate reasons in ball story task.

<table>
<thead>
<tr>
<th>Groups</th>
<th>SC-COMM (n = 20) (%)</th>
<th>SC-MENTAL (n = 20) (%)</th>
<th>FR (n = 20) (%)</th>
<th>Control (n = 21) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appropriate justification</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location or knowledge</td>
<td>40</td>
<td>40</td>
<td>35</td>
<td>19.1</td>
</tr>
<tr>
<td>Mental state</td>
<td>20</td>
<td>5</td>
<td>10</td>
<td>4.7</td>
</tr>
<tr>
<td>Inappropriate justification</td>
<td>40</td>
<td>55</td>
<td>55</td>
<td>76.2</td>
</tr>
</tbody>
</table>
verbs would be more effective than complement training involving mental verbs at promoting both general sentential complement understanding and false belief reasoning. To address this difficulty, we performed some exploratory analyses to determine whether the above patterns would remain when children who performed perfectly on sentential complement pretests were removed from the analysis. A one-way ANOVA with false belief prediction score across all four false belief tasks as dependent variable demonstrated a significant effect of group, \( F(3, 60) = 3.09, p = .03 \). Tukey HSD test showed that the SC-COMM group (\( n = 16, M = 2.25, SD = 1.57 \)) outperformed the control group (\( n = 15, M = 0.93, SD = 1.03, p = .05 \)), and FR group (\( n = 17, M = 2.29, SD = 1.49 \)) performed better than the control group (\( p < .05 \)). There was no significant difference between the SC-MENTAL group (\( n = 16, M = 2.12, SD = 1.58 \)) and the control group (\( p > .10 \)). A similar one-way ANOVA with sentential complement posttest scores as dependent variable showed a significant effect of condition, \( F(3, 60) = 3.56, p = .02 \). Post hoc tests showed significant differences between the SC-COMM group (\( M = 7.37, SD = 1.70 \)) and FR group (\( M = 5.76, SD = 2.27 \)) (\( p = .01 \)), between the SC-MENTAL group (\( M = 7.37, SD = 1.78 \)) and FR group (\( p = .01 \)), between the two sentential complement training groups and the control group (\( M = 6.00, SD = 1.46, ps < .05 \)). There was no significant difference between FR and control groups.

4. Discussion

This study explored the extent to which sentential complement and false representation comprehension training affected false belief understanding among Mandarin-speaking children. First, we found that training with sentential complement with communication verbs and false representations significantly improved performance on false belief posttests. Second, only the sentential complement training groups performed better than the control group on the sentential complement posttests.

Children who were trained with sentential complements involving communication verbs showed greater improvement on false belief posttests than did children trained on sentential complements with mental verbs. This asymmetry was predicted for Mandarin-speaking children because of the differences in the kinds of verbs that typically take sentential complements in Mandarin. Mandarin-speaking children hear and use sentential complements with the communication verb “Shuo1” [/say/] earlier and more commonly than they do with mental verbs (Snedeker & Li, 2000; Tardif & Wellman, 2000). Thus, sentential complement training with a communication verb may have provided a more straightforward opportunity for children to capitalize on whatever structural benefits acquiring the sentential complement construction has for reasoning about false beliefs.

These findings have implications for understanding of the mechanisms by which sentential complement training might promote false belief understanding. The literature to date left open the possibility that the sentential complement training protocols used by past researchers unintentionally provided information relevant to mental state reasoning (such as using deceptive objects or talking about story characters’ preferences and feelings). Here, we designed our training to avoid this possibility and examined a group of children who showed a greater benefit of sentential complement training involving
verbs that were explicitly non-mental. These findings clarify that sentential complement training can confer benefits on false belief reasoning even when there is no (or minimal) mental state content within the training.

Thus, these findings are generally in line with the view that mastery of sentential complements may provide an important template for reasoning about others’ mental states (de Villiers & Pyers, 2002). This view, sometimes called the “syntactic enrichment” view, is that as children acquire the syntactic structures that allow for embedding one thought in another (e.g., embedded propositions), they gain a format that can facilitate reasoning that requires the explicit separation of two different perspectives on a single situation (de Villiers & Pyers, 2002; Harris, de Rosnay, & Pons, 2005). Our findings here are, at least in part, consistent with this view, given that our training protocols that involved communication verbs were carefully designed to avoid false-belief relevant content but they still promoted false belief understanding.

The enhanced effectiveness of sentential complement training with communicative verbs relative to mental verbs was predicted specifically for Mandarin-speaking preschoolers given the relative frequency with which sentential complements are used for the two verbs in everyday language. An open question is whether, if investigated more directly, a similar advantage might be seen for children who speak other languages. de Villiers and her colleagues argued that an early emerging facility with sentential complements involving communication verbs might provide children with a sort of syntactic bootstrap to developing a more sophisticated (i.e., representational) understanding of mental verbs that are used in sentential complement formats. Evidence from Lohmann and Tomasello (2003) suggests that training with both communication and mental verbs is equally effective and thus that the advantage for communication verb training is specific to Mandarin for the reasons mentioned. Nonetheless, given that our training was designed with the explicit goal of separating the contents of communication and mental verb training, it may be worthwhile to apply our paradigm to other languages to see whether the advantage for communication verbs may be more general, for the reasons described by de Villiers (2003).

A final note about our training protocols concerns the particular mental verbs we used in the training and false belief task protocols. Like some other languages, Mandarin includes several verbs for “think” and “believe”. One such verb is/yi3-wei2/which is usually translated as “think falsely”. Lee, Olson, and Torrance (1999) found that Mandarin-speaking children performed significantly better in the false belief tests when this false belief verb was used, compared with more neutral verbs (see Cheung et al., 2009, for a similar finding in Cantonese). In the present study, we used the neutral mental verbs/ren4-wei2/and/jue2-de/during the sentential complement training and false belief tasks, respectively. Our choice to use these rarer, semantically neutral verbs may have weakened the extent to which children capitalized on the training protocols. Yet, this caveat does not negate the main finding, which is that sentential complement training involving communication verbs can benefit false belief reasoning, even when that training has no explicit or implicit mental content.

We also found that children in the false representation group showed evidence of improved false belief performance relative to the control group, although the false representation training group did not show any measurable gains in their facility at processing sentential complements. At some level, this finding was expected. As previous work had shown (Wellman et al., 1996), training paradigms that use thought bubbles to emphasize the representational nature of mental states can improve even 3-year-olds’ performance on standard false belief tasks. Similar findings have been shown with individuals with autism, a neurodevelopmental disorder in which false belief reasoning is particularly affected (Wellman et al., 2002). Our results extend these findings and clarify that the benefits children receive from thought bubble training likely do not have their effects through promoting facility with sentential complement constructions. In doing so, our findings are consistent with those of Hale and Tager-Flusberg (2003), who showed that training on false belief only (i.e., without exposure to sentential complement training) improved false belief performance but not sentential complement understanding. We see these findings as having two important implications. First, they show that the ability to reason about false representation is not sufficient for processing sentential complement syntax (Ruffman et al., 2003). Second, they show that explicit false belief understanding can emerge in the absence of sentential complement understanding (Hale & Tager-Flusberg, 2003; Lohmann & Tomasello, 2003).
It should be noted that the false representation training protocol was not fully non-linguistic; we did use a neutral Mandarin epistemic mental verb that we felt was appropriate to the situation (i.e., [zhi]dào4). Thus, we do not wish to argue against the possibility that naturalistic exposure to mental verbs plays some role in children's false belief development across cultures. Our argument, rather, is that making explicit the representational nature of mental states was effective in promoting false belief understanding, although it apparently did not affect children's facility with sentential complements.

A limitation of the present study is that we have no assessments of children's cognitive and linguistic capacities beyond those investigated. Children's general linguistic abilities are related to both sentential complement understanding and false belief performance in Chinese- and English-speaking preschoolers (Tardif et al., 2007). By knowing more about how the training protocols that we used interact with general linguistic abilities, we might gain greater insight into the specific mechanisms by which these interventions affected false belief development. Also, we did not include measures of representational understanding other than false belief understanding, such as measures of false photograph or false sign performance (Sabbagh, Moses, & Shiverick, 2006). Doing so might have allowed us to determine whether the training protocols that promoted false belief understanding had their effects on representational understanding more broadly or more specifically on mental state understanding.

In conclusion, the present study supports the view that training protocols aimed at improving children's facility with sentential complements can promote false belief understanding, even when the training protocols are structured so as not to include explicit or implicit mental state content. Indeed, there was some evidence that with Mandarin-speaking children, sentential complement training that involved communication verbs was more effective than training with mental state verbs. Yet the findings also showed that false belief performance can be improved by a training protocol that involved no training with sentential complements. Together, these findings suggest that sentential complement understanding may be one path that contributes to false belief understanding, the importance of which may depend on particular sociocultural and linguistic factors.

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