Journal of Experimental Child Psychology 151 (2016) 131–143

Contents lists available at ScienceDirect

Journal of Experimental Child Psychology

journal homepage: www.elsevier.com/locate/jecp

Children's understanding of first- and third-person perspectives in complement clauses and false-belief tasks

Silke Brandt [a,*], David Buttelmann [b,c], Elena Lieven [d,e], Michael Tomasello [e]

[a] Department of Linguistics and English Language, Lancaster University, Lancaster LA1 4YL, UK
[b] Research Group "Kleinkindforschung in Thueringen", University of Erfurt, D-99089 Erfurt, Germany
[c] Department of Developmental Psychology, University of Bern, 3012 Bern, Switzerland
[d] School of Psychological Sciences, University of Manchester, Manchester M13 9PL, UK
[e] Department of Developmental and Comparative Psychology, Max Planck Institute for Evolutionary Anthropology, D-04103 Leipzig, Germany

ARTICLE INFO

Article history:
Available online 8 April 2016

Keywords:
Theory-of-mind development
False belief
First-language acquisition
Complement clauses
Mental verbs
Epistemic modality

ABSTRACT

De Villiers (*Lingua*, 2007, Vol. 117, pp. 1858–1878) and others have claimed that children come to understand false belief as they acquire linguistic constructions for representing a proposition and the speaker's epistemic attitude toward that proposition. In the current study, English-speaking children of 3 and 4 years of age ($N = 64$) were asked to interpret propositional attitude constructions with a first- or third-person subject of the propositional attitude (e.g., "*I think* the sticker is in the red box" or "*The cow thinks* the sticker is in the red box", respectively). They were also assessed for an understanding of their own and others' false beliefs. We found that 4-year-olds showed a better understanding of both third-person propositional attitude constructions and false belief than their younger peers. No significant developmental differences were found for first-person propositional attitude constructions. The older children also showed a better understanding of their own false beliefs than of others' false beliefs. In addition, regression analyses suggest that the older children's comprehension of their own false beliefs was mainly related to their understanding of third-person propositional attitude constructions. These results indicate that we need to take a closer look at the propositional attitude constructions that are supposed to support children's false-belief reasoning. Children may come to understand their

* Corresponding author.
E-mail address: s.brandt@lancaster.ac.uk (S. Brandt).

http://dx.doi.org/10.1016/j.jecp.2016.03.004

own and others' beliefs in different ways, and this may affect both their use and understanding of propositional attitude constructions and their performance in various types of false-belief tasks.

Introduction

A large number of studies have shown that language plays a facilitative role in children's development of false-belief understanding (for overviews, see Astington & Baird, 2005; Milligan, Astington, & Dack, 2007). However, it is still unclear which aspects of language are responsible. Some researchers have looked to discourse because children must constantly confront mismatches between what they and their interlocutor know or do not know for pragmatically appropriate communication (e.g., Harris, 1996, 1999; Peterson & Siegal, 2000; Tomasello & Rakoczy, 2003). Others have looked to the more representational aspects of language, in particular (a) children's mastery of mental state terms, such as *think* and *know* (e.g., Bartsch & Wellman, 1995; Olson, 1988; Ruffman, Slade, & Crowe, 2002), and (b) children's mastery of propositional attitude constructions in which these mental state terms prototypically occur, such as *I think that he will be late again* (e.g., de Villiers & de Villiers, 2000; Hale & Tager-Flusberg, 2003; Lohmann & Tomasello, 2003; Low, 2010). In the remainder of this article, we use linguistic terminology and refer to these propositional attitude constructions as complement-clause constructions or just complements. These complement-clause constructions contain a main clause expressing the attitude toward a proposition (e.g., *I think*) and a subordinate clause expressing that proposition (e.g., *he will be late again*).

In the current study, we took a closer look at children's understanding of these complement-clause constructions and the parallel development of their false-belief understanding. Around the age of 4 years, children typically start to pass explicit tests of false belief (Wellman, Cross, & Watson, 2001). To investigate whether this developmental achievement is equally supported by different kinds of complement-clause constructions, we compared 3- and 4-year-olds' comprehension of complement-clause constructions with first- and third-person subjects in the main clause (henceforth, first-person complements, such as "*I* think the sticker is in the red box", and third-person complements, such as "*The cow* thinks the sticker is in the red box"). We further investigated how the same children perform in tasks testing their understanding of their own and others' false beliefs.

Our main hypothesis was that third-person complements are more tightly related to false belief because they are more likely to encode genuine references to mental states. Linguistic research suggests that whereas first-person complements can refer to mental states, they are also regularly used as epistemic parentheticals, which are produced to alert the listener to the relative (un)certainty of a proposition. Phrases like *I think* can be translated as *maybe* (e.g., Thompson & Mulac, 1991; Verhagen, 2005). In other words, first-person complements are ambiguous because they can either refer to mental states or function as (un)certainty markers (see also Manson, 2002).

Moreover, even when used as epistemic parentheticals, first-person complements are ambiguous on another level. That is, a phrase like *I think* in *I think it's in the red box* can express either certainty or uncertainty, and it has been suggested that children up to the age of 5 years treat *I think* as if it means *I know* (e.g., Bassano, 1985; Miscione, Marvin, O'Brien, & Greenberg, 1978; Naigles, 2000). Therefore, first-person complements are highly ambiguous, and this ambiguity may affect the way in which children interpret them and the way in which they are related to their false-belief understanding.

Production of complement-clause constructions

The idea that first-person complements do not necessarily refer to mental states is supported by studies of spontaneous speech demonstrating that children produce first-person complements

considerably before they typically show an explicit understanding of false belief. When Diessel and Tomasello (2001) looked at young English-speaking children's production of complement clauses, they found that at around the age of 3 years children used many mental verbs only in the first person, as in *I think it's in there* (see also Bloom, Rispoli, Gartner, & Hafitz, 1989). Following functional linguists (e.g., Thompson & Mulac, 1991; Verhagen, 2005), they argued that in this case the *I think* phrase is not being used to refer to a mental state or mental activity but rather is being used as a kind of epistemic marker to alert the listener to the speaker's relative uncertainty (for similar findings in German children's spontaneous speech, see Brandt, Lieven, & Tomasello, 2010).

Comprehension of complement-clause constructions and false belief

To investigate the developmental gap between children's production of first-person complement-clause constructions at around the age of 3 years (e.g., Diessel & Tomasello, 2001) and their successful performance in explicit false-belief tests at around the age of 4 years (Wellman et al., 2001), Moore, Bryant, and Furrow (1989) and Moore, Pure, and Furrow (1990) tested whether and when young English-speaking children correctly interpreted first-person complements and whether they understood them before they passed explicit false-belief tests. Moore and colleagues (1989) developed a hidden-object task where two puppets indicated which of two boxes contained some candy. The puppets produced first-person complements only. For example, one puppet said *I think it's in the red box*, and then the other puppet said *I know it's in the blue box*. In this case, children who understood these verbs and sentence types were expected to pick the blue box. Moore and colleagues (1989) contrasted three mental state verbs: *guess*, *think*, and *know*. Overall, 3-year-olds performed at chance level, whereas 4-year-olds tended to perform at above chance level but still performed worse than 6- and 8-year-olds. Looking at the *think–know* contrast in particular, the 3-year-olds, on average, went for the correct box in 2 of 4 trials ($M = 2.07$), whereas the 4-year-olds, on average, went for the correct box in 3 of 4 trials ($M = 3.14$). Moore and colleagues (1990) showed that, in addition, 4-year-olds' performance in this hidden-object task was strongly correlated with their performance in various explicit tests of false belief. These findings suggest that, even though children *produce* first-person complements with mental verbs before they show an explicit understanding of false belief, their *comprehension* of first-person complements develops at the same time as they start to show an explicit understanding of false belief.

A similar developmental pattern and dissociation between production and comprehension has been observed in children's use and understanding of epistemic modals. Like first-person complements, modal verbs, such as *must* and *will*, are ambiguous. For example, *must* can express necessity (e.g., *you must go to bed now*) or epistemic modality (e.g., saying *that must be the postman* on hearing the doorbell). Studies looking at children's production and comprehension of modal verbs suggest that children first use them to express notions like necessity (e.g., Wells, 1979). At around the age of 3 years, they start using the same verbs to express epistemic modality in apparently appropriate contexts. However, when children are tested on their comprehension of the epistemic meaning of modal verbs, they do not seem to understand them in any systematic way until the age of 4 or 5 years, and Papafragou (1998) suggested that children's full understanding of the epistemic functions of modal verbs depends on their theory-of-mind understanding (see also Moore, Pure, & Furrow, 1990).

For mental verbs and complement clauses, it has been suggested that children's comprehension and correct use of the more complex (i.e., mental state) functions do not just depend on, but also support, their theory-of-mind development (e.g., Astington & Baird, 2005; de Villiers, 2007; Milligan et al., 2007). In the current study, we explored the possibility that children's theory-of-mind development is mainly associated with children's understanding of third-person complements. This assumption is suggested by a number of studies that found that caregivers' talk about their own mental states (e.g., *I think this is a golf ball*) shows weaker links to children's false-belief understanding than their talk about others' mental states, including those of the children (e.g., *you think this is a golf ball*) (Adrián, Clemente, & Villanueva, 2007; Booth, Hall, Robison, & Kim, 1997; Howard Gola, 2012; Taumoepeau & Ruffman, 2006). Howard, Mayeux, and Naigles (2008) also found that mothers' use of first-person complements does not support children's ability to systematically distinguish between the epistemic functions of *I think*, expressing relative uncertainty, and *I know*, expressing certainty.

This is probably due to the fact that, when used with first-person subjects, mental verbs (such as *think* and *believe*) can express either certainty or uncertainty. For example, when a child hears an utterance like *I think it's bedtime now* from their mother, the mother is pretty certain that it indeed is bedtime (cf. Howard et al., 2008; Naigles, 2000). In this case, the meaning of *I think* cannot easily be distinguished from the meaning of *I know* (see also Bassano, 1985; Miscione et al., 1978). Howard and colleagues (2008) found that in the linguistic input of 3- and 4-year-old English-speaking children, more than half of the phrases containing the verb *think* were used to express certainty rather than uncertainty, that *think* was most often used with first-person subjects, and that these phrases did not directly support children's understanding of false belief and the epistemic functions of mental verbs.

To summarize, previous research suggests that first-person complements do not necessarily refer to mental states, and thus their use in children's own language and in their input does not directly support children's false-belief understanding. Neither does the everyday use of first-person complements seem to support children's understanding of the semantics of mental verbs and the complement-clause constructions in which these verbs are used (Howard et al., 2008). What has not been investigated yet is (a) whether young children find it easier to distinguish the semantics and epistemic functions of mental verbs when they are used in third-person complements (e.g., *she thinks the sticker is in the red box* vs. *she knows the sticker is in the blue box*) as opposed to first-person complements and (b) how young children's understanding of third-person complements is related to their false-belief understanding.

First-person versus third-person complements and false-belief understanding

In the current study, we modified the hidden-object task (cf. Moore, Bryant, & Furrow, 1989) to directly compare 3- and 4-year-olds' comprehension of first- and third-person complements. For example, in the first-person version, one puppet said *I think the sticker is in the red box*, and the other puppet said *I know the sticker is in the blue box*. In the third-person version, the experimenter spoke for the puppets: *The cow thinks the sticker is in the red box. The pig knows the sticker is in the blue box*. In addition, we used a more balanced set of false-belief tasks that allowed us to directly compare children's understanding of their own and others' false beliefs and how this relates to their understanding of first- and third-person complements.

Based on the assumption that phrases like *I think* in first-person complements can express either certainty or uncertainty (e.g., Howard et al., 2008), we expected children to perform worse on the first-person *I think–I know* contrast than on the third-person *the cow thinks–the pig knows* contrast. Based on the assumption that first-person complements can either refer to mental states or function as (un)certainty markers (e.g., Diessel & Tomasello, 2001), we also expected stronger developmental associations between third-person complements and false-belief understanding than between first-person complements and false belief.

Method

Participants

The children were recruited through a child participant database and tested in a quiet room at the university of a medium-sized English city. In total, 32 young 3-year-olds (M = 3 years 4 months, range = 3;1 [years;months] to 3;5, 17 girls) and 32 young 4-year-olds (M = 4 years 4 months, range = 4;1 to 4;4, 15 girls) participated in the study. One additional 3-year-old was tested but needed to be excluded from the analyses because she failed the pretest (described below). All children were English-speaking monolinguals. None of the participants had any known language impairment.

Design and materials

All children started with the hidden-object task (cf. Moore et al., 1989) and did four false-belief tests afterward. As described in more detail below, we used the classic unexpected content and change

of-location tests (Perner, Leekham, & Wimmer, 1987; Wimmer & Perner, 1983) as well as a new version of the change-of-location test, which tests children's understanding of their own false belief (Buttelmann, 2016). In the hidden-object task, we had two conditions that were tested between participants. In each age group, 16 children (8 girls) were tested in each condition. In the first-person condition, for each trial children heard two contrastive statements from two hand puppets (a cow and a pig). The complement clauses were used with one of two mental verbs and a first-person singular subject in the main clause (e.g., pig: *I think the sticker is in the blue box;* cow: *I know the sticker is in the red box*). As in one of Moore and colleagues' (1989) conditions, the two mental verbs that were contrasted were *think*, marking relative uncertainty, and *know*, marking certainty. In the first-person condition, the test sentences were prerecorded and played from little speakers hidden under the hand puppets. In the third-person condition, the experimenter spoke for the puppets and the children heard, for example, *The pig thinks the sticker is in the blue box; The cow knows the sticker is in the red box.*

Each child received eight trials. Across trials, we counterbalanced the order of the statements (whether the first statement contained *think* or *know* in the main clause), the assignment of the statements to the hand puppets (whether the pig or cow *knew* or *thought*), and the assignment of the statements to the boxes (whether it was *known* or *thought* that the sticker was hidden in the red or blue box).

Procedure

All children were tested by a female experimenter who sat opposite them at a small table. For each trial, the child saw two opaque boxes on the table—always a red one and a blue one. The red box was always placed to the left of the child.

The experiment started with a pretest. The experimenter told the child that she, the pig, and the cow had hidden many stickers in the boxes and that the pig and cow would help the child to find these stickers. She also told the child that the pig and cow might not remember all the hiding places. For each of four trials a new pair of boxes was placed on the table in front of the child. After the experimenter put the two boxes on the table, she asked the puppets, *Can you help X* [child's name] *find the sticker? Which box is the sticker in?*

In the pretest, the child heard two non-contrastive statements about the location of the sticker from the two hand puppets. One statement was affirmative and the other was negated (e.g., pig: *The sticker is in the red box;* cow: *The sticker is not in the blue box*). Whether the cow or the pig used the affirmative or negated statement, and which statement came first, was counterbalanced. In the pretest, children were allowed to choose and open one of the two boxes right away. Children who picked the right box in at least three of four trials continued with the experiment. Children who scored lower than three of four trials received two additional trials. If they then picked the right box in four of six trials, they also continued with the experiment. As indicated above, we needed to exclude one 3-year-old because she did not reach this criterion.

In each experimental trial, children needed to choose one box but were not allowed to look into any of the boxes before they were finished with all eight trials. In the first-person condition, the hand puppets uttered the prerecorded test sentences. In the third-person condition, the hand puppets first whispered into the experimenter's ear, and the experimenter then uttered the test sentences. The whispering did not contain any actual words, and the experimenter produced the third-person complements right after the whispering. No additional instructions were given to the child. Because the task was quite demanding, after four experimental trials there was a break during which the experimenter played a puzzle game with the child. They played this game for approximately 5 min and then continued with the second set of experimental trials. Before they did the false-belief tests, children were allowed to look into the boxes they chose and collect their stickers. Note that, finally, all boxes contained stickers so that children were not differently rewarded before they began the subsequent false-belief tests.

For testing children's understanding of false belief, we presented participants with four different tasks. In the classic change-of-location test (Wimmer & Perner, 1983), children needed to answer a test question about another person's false belief. The experimenter told the story and acted it out with two little dolls and props: Sally puts a ball into her basket, Sally leaves the room, Ann transfers the ball

from Sally's basket into her box, and Sally returns. The experimenter then asked three questions: (a) the test question (*Where will Sally look for her ball?*), (b) the reality control question (*Where is the ball really?*), and (c) the memory control question (*Where did Sally put her ball in the first place?*).

The change-of-location own-belief test is based on the classic change-of-location paradigm but tests children's understanding of their own false belief (Buttelmann, 2016). For this, things were arranged such that children searched in the incorrect location for a small toy. The experimenter placed two boxes (a green one and a pink one) on the table and told the child that she was going to hide a small toy ball in one of them. She then put an occluder on the table to block the child's view and put the toy ball into one of the boxes (the pink one in Fig. 1A and B). At the same time, she slightly manipulated the position and the cover of the other box (the green one in Fig. 1). So, after the occluder was removed, it looked like the experimenter had manipulated one box, but had not touched the other one (see Fig. 1C and Buttelmann, 2016, for details regarding the procedure of this test). She then asked the child (a) the manipulation control question (*Where is the ball?*). Except for one 3-year old, all children pointed to the box that looked like it had been manipulated and thus held a false belief concerning the location of the ball. The experimenter then showed the child that this box was actually empty and that the ball was hidden in the other box. She then put the ball back in the same box (i.e., the one that did not look like it had been manipulated) and asked (b) the test question (*Where did you first think the ball was?*). As in the classic change-of-location test, the experimenter also asked (c) the reality control question (*Where is the ball now?*).

The unexpected content (or "Smarties") test included questions about both children's own false belief and another person's false belief (Perner et al., 1987). We followed the original procedure of the task and used a Smarties tube that was filled with crayons. The experimenter first asked the child what he or she thought was is in there. After the child said *Smarties*, *chocolate*, *sweets*, or something similar, the experimenter showed the child the actual content of the box (crayons). She then put the crayons back into the tube, closed it, and asked the child three questions: (a) the memory control question (*Can you remember what's inside here?*), (b) the own-belief test question (*What did you first think was inside here?*), and (c) the other-belief test question (*What will pig think is inside this box?*).

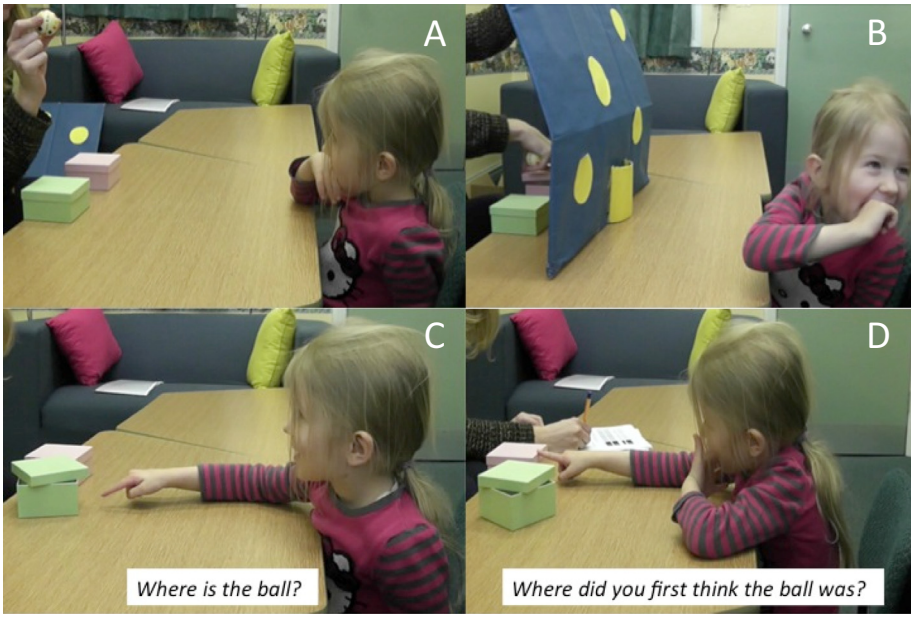

Fig. 1. Depictions from a 3-year-old girl indicating her responses in the change-of-location own-belief test.

The order of the own-belief test question (b) and the other-belief test question (c) was counterbalanced across children.

Thus, we were able to test children's understanding of their own and others' false beliefs in scenarios involving unexpected contents and the change of an object's location. The unexpected content and change-of-location tests were presented as blocks, and the order was counterbalanced. Within these blocks, we also counterbalanced the order of own and others' false-belief questions. Test sessions lasted 20 to 25 min.

Scoring

Children's choices in the hidden-object task were scored as correct when participants chose the box marked by *I know* in the first-person condition and the box marked by *the pig knows* or *the cow knows* in the third-person condition.

For each false-belief task, children got a score of 1 (pass) if they correctly answered both the test question and the corresponding control question(s). Overall, eight 3-year-olds failed to correctly answer the reality control question (about the actual location of the object) in the change-of-location task (five in the change-of-location own-belief test and three in the change-of-location other-belief test). In addition, six 3-year-olds did not give a correct answer to the memory control question (about the actual content of the Smarties tube) in the unexpected content task. Among the 4-year-olds, only two gave incorrect answers to the reality control questions (about the actual location of the object) in the change-of-location own-belief test. Trials in which children did not answer the control question(s) correctly were dropped from the analyses. That is, for that specific false-belief test, children did not get a score of either 0 (fail) or 1 (pass). For the unexpected content task, this means that they did not get a score for either the own- or other-false-belief test question. However, no child failed all control questions. So, each child got a score of 0 (fail) or 1 (pass) for at least one false-belief measure and was considered in the subsequent analyses.

Results

First, we analyzed children's performance in the hidden-object task. A 2 (Age: 3- vs. 4-year-olds) by 2 (Condition: first- vs. third-person complements) analysis of variance (ANOVA) suggested that there was a significant interaction between age and condition, $F(1, 60) = 10.56$, $p = .002$. Therefore, we ran separate analyses for the two age groups. The 3-year-olds performed at chance in both the first- and third-person conditions (first-person: $M = 52.3\%$ of trials, $SD = 13.1$; Wilcoxon test: $Z = .577$, $N = 16$, $p = .564$; third-person: $M = 50.0\%$ of trials, $SD = 12.9$; Wilcoxon test: $Z = .054$, $N = 16$, $p = .957$) (see Fig. 2). Similarly, there was no significant difference between the younger children's performances in the first- and third-person conditions (Mann–Whitney *U*-test: $U = 117.0$, $Z = .443$, $N_{\text{first-person}} = 16$, $N_{\text{third-person}} = 16$, $p = .657$). The 4-year-olds, in contrast, performed above chance in both conditions (first-person: $M = 58.6\%$ of trials, $SD = 16.3$; Wilcoxon test: $Z = 2.08$, $N = 16$, $p = .038$; third-person: $M = 79.7\%$ of trials, $SD = 15.1$; Wilcoxon test: $Z = 3.434$, $N = 16$, $p = .001$). Unlike the 3-year-olds, the older children also performed significantly better in the third-person condition than in the first-person condition (Mann–Whitney *U*-test: $U = 46.0$, $Z = 3.157$, $N_{\text{first-person}} = 16$, $N_{\text{third-person}} = 16$, $p = .002$) (see Fig. 2). When we directly compared the two age groups, we found that the 4-year-olds performed better than the 3-year-olds in the third-person condition (Mann–Whitney *U*-test: $U = 238$, $Z = 4.23$, $N_{\text{3-year-olds}} = 16$, $N_{\text{4-year-olds}} = 16$, $p < .001$). For the first-person condition, however, we did not find any significant age differences (Mann–Whitney *U*-test: $U = 148$, $Z = .793$, $N_{\text{3-year-olds}} = 16$, $N_{\text{4-year-olds}} = 16$, $p = .468$).

Table 1 shows the number and percentage of children who passed each false-belief test in each age group. Remember that we had to exclude a number of 3-year-olds and two 4-year-olds from some trials because they did not answer the corresponding control question(s) correctly. In addition, one 3-year-old did not have a false belief in the own-false-belief version of the change-of-location test. Therefore, depending on the task, the total number of 3-year-olds included in the analyses ranged from 26 to 29 and the number of 4-year-olds included in the analyses ranged from 30 to 32.

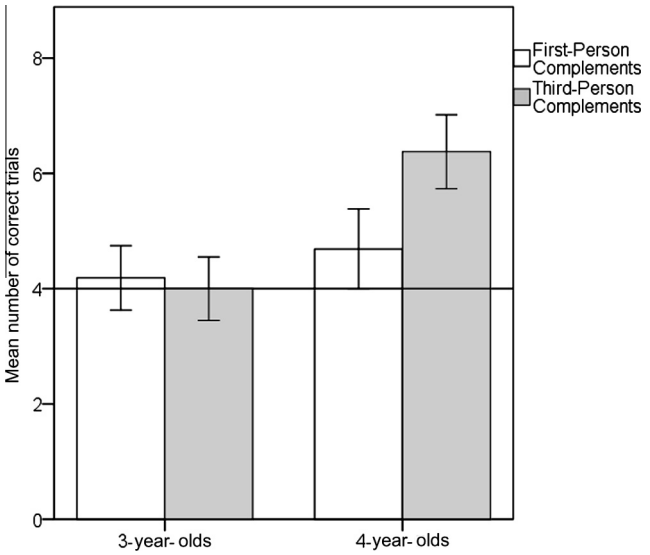

Fig. 2. Mean number of correct trials in the hidden-object task as a function of age and condition. The horizontal line indicates chance level. Error bars represent 95% confidence intervals.

Table 1
Numbers and percentages of children who passed the false-belief tests out of children who correctly answered the corresponding control questions.

False-belief test	Version	3-year-olds	4-year-olds
Change of location	Own	35% (9/26)	83% (25/30)
	Other	24% (7/29)	63% (20/32)
Unexpected content	Own	31% (8/26)	84% (27/32)
	Other	35% (9/26)	50% (16/32)

The 4-year-olds performed better in the own-false-belief tests than in the other-false-belief tests. No significant differences were found between the own-false-belief versions of the unexpected content test and the change-of-location test (McNemar test: $N = 50$, $p = .804$). Similarly, there was no significant difference between the other-false-belief versions of the two tasks (McNemar test: $N = 56$, $p = .839$). Therefore, both tasks were combined for percentages of trials passed in the own- and other-false-belief tests. The 4-year-olds performed above chance in the own-false-belief tests ($M = 84.4\%$ of trials, $SD = 29.6$; Wilcoxon test: $Z = 4.315$, $N = 32$, $p < .001$) and at chance in the other-false-belief tests ($M = 56.3\%$ of trials, $SD = 39.7$; Wilcoxon test: $Z = .894$, $N = 32$, $p = .371$). The 3-year-olds performed below chance in both the own- and other-false-belief tests (own: $M = 31.3\%$ of trials, $SD = 37.6$; Wilcoxon test: $Z = 2.558$, $N = 32$, $p = .011$; other: $M = 25.8\%$ of trials, $SD = 31.3$; Wilcoxon test: $Z = 3.441$, $N = 31$, $p = .001$). In accordance with these results, we found that the 4-year-olds performed better than the younger group in both own-false-belief tests (Mann–Whitney U-test: $U = 857$, $Z = 4.98$, $N_{3\text{-year-olds}} = 31$, $N_{4\text{-year-olds}} = 32$, $p < .001$) and other-false-belief tests (Mann–Whitney U-test: $U = 704$, $Z = 3.06$, $N_{3\text{-year-olds}} = 31$, $N_{4\text{-year-olds}} = 32$, $p = .002$).

The pairwise comparisons presented so far suggest that between the ages of 3 and 4 years, children develop a better understanding of third-person complements and of their own false belief. Their understanding of others' false beliefs also develops, but even the 4-year-olds still performed at chance in tasks testing the understanding of others' false beliefs. To further investigate whether there is a relationship between children's understanding of first- and third-person complements and their

understanding of false belief, we ran two regression models in R (R Core Team, 2014). In the first model, we entered children's performance in the hidden-object task (percentage trials correct), condition (first- vs. third-person complements), and age (3- vs. 4-year-olds) to predict their performance in own-false-belief tasks. Condition and age were coded as categorical variables (third-person and 4-year-olds, respectively). Performance in the hidden-object task was coded as a continuous numerical variable. We found main effects for age, performance in the hidden-object task, and condition as well as a three-way interaction among all the factors (see Table 2). Together with the pairwise comparisons presented above, these main effects and complex interaction suggest that it is the older children's growing understanding of third-person complements that is related to their improved understanding of their own false belief.

When we entered the same variables to predict children's performance in other-false-belief tasks, we found a main effect for their performance in the hidden-object task and a two-way interaction between age and performance in the hidden-object task. Together with the pairwise comparisons presented above, this suggests that only the 4-year-olds' understanding of complement clauses was positively related to their understanding of others' false beliefs (see Table 3).

Discussion

In the current study, we found developmental differences between 3- and 4-year-old English-speaking children's understanding of third-person complements and between 3- and 4-year-olds' understanding of false belief. In particular, the older children performed above chance level and also significantly better than the younger age group in the third-person condition of the hidden-object task (with third-person complements) and in the own-false-belief tests. Unlike the younger age group, the 4-year-olds also performed just above chance in the first-person condition of the hidden-object task (with first-person complements), but their performance in this condition did not significantly differ from that of the 3-year-olds. In addition, the 4-year-olds performed at chance level in the other-false-belief tasks, whereas the 3-year-olds were below chance and significantly worse than the older age group. Together with these pairwise comparisons, the main effects and complex interactions in the regression analyses suggest that the older children's understanding of own false belief was positively related to their understanding of third-person complements. Their developing understanding of others' false beliefs seems to be related to their understanding of both first- and third-person complements. These findings support our main hypothesis that the developmental link between third-person complements and false-belief understanding should be stronger than the relation between first-person complements and false belief because third-person complements are more likely to encode genuine reference to mental states and mental processes (e.g., Diessel & Tomasello, 2001; Howard et al., 2008; Manson, 2002). In addition, the older children found it easier to distinguish the semantics of the mental verbs *think* and *know* in a third-person context than in a first-person context, which supports the assumption that the semantics of mental verbs is less ambiguous when used with third-person subjects (cf. Howard et al., 2008).

We found no clear developmental links between first-person complements and false-belief understanding. In the hidden-object task, the 4-year-olds did not perform significantly better with

Table 2
Linear regression model to predict children's understanding of own false belief based on age, performance in the hidden-object task, and condition.

Predictor	Estimate	*SE*	*t*	*p*
(Intercept)	−0.46	0.35	−1.33	.19
Age (4-year-olds)	0.98	0.47	2.10	<.05
Condition (third-person)	1.27	0.48	2.63	<.05
Hidden-object task (% correct)	1.47	0.64	2.30	<.05
Age * Condition	−1.44	0.74	−1.95	.06
Age * Hidden-Object Task	−0.98	0.83	−1.19	.24
Condition * Hidden-Object Task	−2.46	0.91	−2.70	<.01
Age * Condition * Hidden-Object Task	2.62	1.19	2.20	<.05

Table 3
Linear regression model to predict children's understanding of others' false belief based on age, performance in the hidden-object task, and condition.

Predictor	Estimate	*SE*	*t*	*p*
(Intercept)	3.19	0.75	4.25	<.001
Age (4-year-olds)	−1.36	1.02	−1.34	.19
Condition (third-person)	−2.08	1.04	−2.00	.05
Hidden-object task (% correct)	−2.90	1.38	−2.10	<.05
Age * Condition	1.66	1.59	1.04	.30
Age * Hidden-Object Task	3.61	1.78	2.02	<.05
Condition * Hidden-Object Task	3.42	1.97	1.74	.09
Age * Condition * Hidden-Object Task	−3.40	2.57	−1.32	.19

first-person complements than their younger peers. However, we did find developmental differences for children's understanding of false belief in the sense that the 4-year-olds were significantly better than the 3-year-olds despite the older group being only at chance on others' false beliefs. It could also be possible that the understanding of first-person complements was linked to children's understanding of their own false beliefs. But the regression analysis and pairwise comparisons suggest that only the third-person complements, not the first-person complements, were positively linked to children's understanding of their own false beliefs. These findings provide further support for the assumption that it is third-person complements that are intrinsically related to children's development of false-belief reasoning. We suggest that first-person complements show weaker links to children's false-belief development because they do not necessarily refer to mental states and are ambiguous even when they are used as epistemic markers (cf. Diessel & Tomasello, 2001; Howard et al., 2008).

However, previous studies did find correlations between children's understanding of first-person complements and false belief as well as developmental differences between 3- and 4-year-olds' understanding of first-person complements with mental verbs (e.g., Howard et al., 2008; Moore et al., 1989, 1990). The discrepancies between the current study and previous studies might be due to methodological differences. For example, Moore and colleagues' (1989) finding that there were developmental differences for children's understanding of first-person complements might be due to the fact that the age ranges applied in that study were much wider than those applied in the current study (i.e., the 4-year-olds were between the ages of 4 and 5). Therefore, the effect might have been driven by the older participants. Another possible explanation is that in Moore and colleagues' original study the experimenter produced all test sentences, whereas we used prerecorded test sentences in the first-person condition. However, when we did a similar study with German-speaking children, the test sentences were produced live in both conditions of the hidden-object task as in Moore and colleagues' study. The pattern of results was similar to that in the current study; we found developmental differences only for third-person complements and false-belief understanding (Brandt & Buttelmann, 2015).

As mentioned before, previous studies also found correlations between children's understanding of first-person complements and their general understanding of false belief (Howard et al., 2008; Moore et al., 1990). However, unlike the current study, previous investigations have not systematically distinguished between children's understanding of their own and others' false beliefs. For example, Howard and colleagues (2008) also used the unexpected content test but gave children a combined score for their answers to the questions about their own and someone else's false beliefs. When we systematically distinguished between children's understanding of their own and others' false beliefs, we found a positive relation between the older children's developing understanding of others' false beliefs and their comprehension of both first- and third-person complements (see regression analysis in Table 3). However, the older children's understanding of their own false beliefs was more advanced than their understanding of others' false beliefs and was positively related only to their understanding of third-person complements (see regression analysis in Table 2).

The relationship between first-person complements and false-belief understanding is probably due to the fact that although phrases like *I think* and *I know* are often used just like adverbials expressing (un)certainty (e.g., Diessel & Tomasello, 2001; Thompson & Mulac, 1991; Verhagen, 2005), this

function is not completely independent of the more complex meanings of these mental state verbs. Most of the time, we do not use these phrases to explicitly refer to mental states. Still, even using them to express different degrees of certainty requires some concept of mind. Indeed, recent proposals suggest that even if first-person complements are not used to refer to mental states directly, their mastery may bootstrap young children into understanding true reference to mental states. This might be because children notice that the verbs they use and comprehend as a signal of, for example, (un)certainty are being used in a slightly different way and might be used and comprehended as more or less explicit reference to mental states (Gordon, 1995; Tomasello & Rakoczy, 2003). Children's comprehension of mental verbs in first-person contexts is also likely to be informed by their understanding of mental verbs in other contexts, such as third-person complements, where these verbs are more likely to refer to mental states. However, as has been shown for a variety of linguistic terms and constructions (for an overview, see Tomasello, 2003), developing a more abstract, context-independent representation of mental verbs takes time. And, as our current and previous findings suggest, the acquisition of an abstract representation of mental verbs also interacts with children's false-belief development.

A similar developmental story has been put forward for the acquisition of modal verbs and other forms of epistemic markers and evidentials, such as sentence-final particles, where children use apparently semantically and/or syntactically complex terms and structures appropriately before they understand the full range of concepts behind these terms and structures (e.g., Aksu-Koç, Ögel-Balaban, & Alp, 2009; Matsui, Yamamoto, & McCagg, 2006; Papafragou, 1998; Papafragou, Li, Choi, & Han, 2007). For example, children start using the modal auxiliary *will* at around the age of 2.5 years (Wells, 1979). However, early in development, this modal auxiliary is most likely to be used to communicate intention. Only at around the age of 5 years do children use *will* to express how certain they are about something (e.g., saying *that will be the postman* on hearing the doorbell) (Wells, 1979). This latter use is referred to as epistemic modality, and Papafragou (1998) argued that children's comprehension and correct use of modal verbs with an epistemic function depends on their theory-of-mind development. To grasp the epistemic function of modal verbs, children need to have developed a "representational model of mind" (Forguson & Gopnik, 1988, as cited in Papafragou 1998, p. 383). However, Papafragou also suggested that this epistemic function is related to other, more basic functions of modal verbs and that it is, indeed, not always easy to distinguish between epistemic and other kinds of modals when looking at spontaneous speech. It seems possible that once children have acquired a theory of mind, they extend the more basic root functions of modal verbs expressing intention, ability, obligation, and so on to the more complex epistemic functions of modal expression.

For mental verbs and complement clauses, it has been suggested that children's comprehension and correct use of the more complex functions not only depend on but also support their theory-of-mind development (e.g., Astington & Baird, 2005; de Villiers, 2007; Milligan et al., 2007). When children start using mental verbs and complement clauses, they tend to use first-person complements with restricted phrases and fixed discourse functions (Köymen, Lieven, & Brandt, 2016). Most important, it has been claimed that children's first uses of mental verbs and complements do not refer to mental states (e.g., Bartsch & Wellman, 1995; Diessel & Tomasello, 2001; Shatz, Wellman, & Silber, 1983). Nevertheless, children start to talk about their own mental states at around the age of 3 years (Bartsch and Wellman, 1995). Results from the current study and previous research suggest that this talk about own mental states might be related to children's developing understanding of (others') false beliefs. However, third-person (and possibly also second-person) complements show a stronger developmental link with children's understanding of false belief. As has been suggested by de Villiers (2007), complement clauses serve as representational tools for children's (and adults') false-belief understanding because "the complement is embedded under the verb and takes the particular perspective or point of view of the subject, not the speaker, licensing also the subject's terms of reference even when these are not the speaker's" (p. 1868). In other words, third-person complement-clause constructions (e.g., *she thinks he'll be late*) allow us to distinguish between our own and someone else's perspective (e.g., *she*). First-person complements, on the other hand, express only one perspective because the subject (e.g., *I* in *I think he'll be late*) refers to the speaker herself.

The current data do not allow us to make substantial claims about the causal relationship between developments in language and theory of mind, but previous studies suggest that language supports

explicit false-belief understanding rather than the other way around (see meta-analysis by Milligan et al., 2007). Results from the current study allow more detailed hypotheses, which need to be tested in follow-up training and longitudinal studies. Our findings suggest that even though first-person complements also play a role in children's developing understanding of false belief, it is the understanding of third-person complements that shows a parallel development with that of false belief. In particular, children's understanding of their own false belief develops together with their understanding of third-person complements. A more general and explicit understanding of both own and others' false beliefs might develop out of children's understanding of own beliefs, very likely supported by their understanding of first- and third-person complements. In both linguistic and sociocognitive development, children develop more abstract representations of mental verbs and belief as they discover commonalities across different discourse contexts.

Acknowledgments

Silke Brandt and Elena Lieven are members of the International Centre for Language and Communicative Development (LuCiD) at Lancaster University and the University of Manchester. The support of the Economic and Social Research Council (ES/L008955/1) is greatly acknowledged. We thank the children with their parents who took part in this study and thank Anna Coates, who collected the data. We also thank Robert Davies for helping us with the statistical analyses.

References

Adrián, J. E., Clemente, R. A., & Villanueva, L. (2007). Mothers' use of cognitive state verbs in picture-book reading and the development of children's understanding of mind: A longitudinal study. *Child Development, 78*, 1052–1067.

Aksu-Koç, A., Ögel-Balaban, H., & Alp, I. E. (2009). Evidentials and source knowledge in Turkish. In S. A. Fitneva & T. Matsui (Eds.). *Evidentiality: A window into language and cognitive development (New Directions for Child and Adolescent Development)* (Vol. 125, pp. 13–28). San Francisco: Jossey-Bass.

Astington, J. W., & Baird, J. A. (2005). *Why language matters for a theory of mind*.Oxford, UK: Oxford University Press.

Bartsch, K., & Wellman, H. M. (1995). *Children talk about the mind*.Oxford, UK: Oxford University Press.

Bassano, D. (1985). Five-year-olds' understanding of "savoir" and "croire". *Journal of Child Language, 12*, 417–432.

Bloom, L., Rispoli, M., Gartner, B., & Hafitz, J. (1989). Acquisition of complementation. *Journal of Child Language, 16*, 101–120.

Booth, J., Hall, W., Robison, G., & Kim, S. (1997). Acquisition of the mental state verb *know* by 2- to 5-year-old children. *Journal of Psycholinguistic Research, 26*, 581–603.

Brandt, S., & Buttelmann, D. (2015, September). Theory of mind and complex syntax. Paper presented at the Developmental Section and Social Section Annual Conference of the British Psychological Society, Manchester, UK.

Brandt, S., Lieven, E., & Tomasello, M. (2010). Development of word order in German complement-clause constructions: Effects of input frequencies, lexical items, and discourse function. *Language, 86*, 583–610.

Buttelmann, D. (2016). The development of the explicit understanding of own versus others' beliefs and intentions. Manuscript in preparation.

de Villiers, J. (2007). The interface of language and theory of mind. *Lingua, 117*, 1858–1878.

de Villiers, J., & de Villiers, P. (2000). Linguistic determinism and the understanding of false belief. In P. Mitchell & K. J. Riggs (Eds.), *Children's reasoning and the mind* (pp. 191–228). Hove, UK: Psychology Press.

Diessel, H., & Tomasello, M. (2001). The acquisition of finite complement clauses in English: A corpus-based analysis. *Cognitive Linguistics, 12*, 97–141.

Forguson, L., & Gopnik, A. (1988). The ontogeny of common sense. In J. W. Astington, P. L. Harris, & D. Olson (Eds.), *Developing theories of mind* (pp. 226–243). New York: Cambridge University Press.

Gordon, R. M. (1995). Simulation without introspection or inference from me to you. In M. Davies & T. Stone (Eds.), *Mental simulation: Evaluations and applications* (pp. 53–67). Oxford, UK: Blackwell.

Hale, C. M., & Tager-Flusberg, H. (2003). The influence of language on theory of mind: A training study. *Developmental Science, 6*, 346–359.

Harris, P. (1999). Acquiring the art of conversation: Children's developing conception of their conversation partner. In M. Bennett (Ed.), *Developmental psychology: Achievements and prospects* (pp. 89–105). Philadelphia: Psychology Press.

Harris, P. (1996). Desires, belief, and language. In P. Carruthers & P. K. Smith (Eds.), *Theories of theories of mind* (pp. 200–220). Cambridge, UK: Cambridge University Press.

Howard Gola, A. A. (2012). Mental verb input for promoting children's theory of mind: A training study. *Cognitive Development, 27*, 64–76.

Howard, A. A., Mayeux, L., & Naigles, L. (2008). Conversational correlates of children's acquisition of mental verbs and a theory of mind. *First Language, 28*, 375–402.

Köymen, B., Lieven, E., & Brandt, S. (2016). Syntactic and semantic coordination in finite complement-clause constructions: A diary-based study. *Journal of Child Language, 43*, 22–42.

Lohmann, H., & Tomasello, M. (2003). The role of language in the development of false belief understanding: A training study. *Child Development, 74*, 1130–1144.

Low, J. (2010). Preschoolers' implicit and explicit false-belief understanding: Relations with complex syntactical mastery. *Child Development, 81*, 597–615.

Manson, N. C. (2002). What does language tell us about consciousness? First-person mental discourse and higher-order thought theories of consciousness. *Philosophical Psychology, 15*, 221–238.
Matsui, T., Yamamoto, T., & McCagg, P. (2006). On the role of language in children's early understanding of others as epistemic beings. *Cognitive Development, 21*, 158–173.
Milligan, K., Astington, J. W., & Dack, L. A. (2007). Language and theory of mind: Meta-analysis of the relation between language ability and false-belief understanding. *Child Development, 78*, 622–646.
Miscione, J. L., Marvin, R. S., O'Brien, R. G., & Greenberg, M. T. (1978). A developmental study of preschool children's understanding of the words "know" and "guess". *Child Development, 49*, 1107–1113.
Moore, C., Bryant, D., & Furrow, D. (1989). Mental terms and the development of certainty. *Child Development, 60*, 167–171.
Moore, C., Pure, K., & Furrow, D. (1990). Children's understanding of the modal expression of speaker certainty and uncertainty and its relation to the development of a representational theory of mind. *Child Development, 61*, 722–730.
Naigles, L. (2000). Manipulating the input: Studies in mental verb acquisition. In B. Landau, J. Sabini, J. Jonides, & E. L. Newport (Eds.), *Perception, cognition, and language: Essays in honor of Henry and Lila Gleitman* (pp. 245–274). Cambridge, MA: MIT Press.
Olson, D. R. (1988). On the origin of beliefs and other intentional states in children. In J. W. Astington, P. Harris, & D. R. Olson (Eds.), *Developing theories of mind* (pp. 414–426). New York: Cambridge University Press.
Papafragou, A. (1998). The acquisition of modality: Implications for theories of semantic representation. *Mind & Language, 13*, 370–399.
Papafragou, A., Li, P., Choi, Y., & Han, C. (2007). Evidentiality in language and cognition. *Cognition, 103*, 253–299.
Perner, J., Leekham, S., & Wimmer, H. (1987). Three-year-olds' difficulty with false-belief: The case for a conceptual deficit. *British Journal of Developmental Psychology, 5*, 125–137.
Peterson, C., & Siegal, M. (2000). Insights into theory of mind from deafness and autism. *Mind & Language, 15*, 123–145.
R Core Team (2014). *R: A language and environment for statistical computing*.Vienna, Austria: R Foundation for Statistical Computing. URL: http://www.R-project.org/.
Ruffman, T., Slade, L., & Crowe, E. (2002). The relation between children's and mothers' mental state language and theory-of-mind understanding. *Child Development, 73*, 734–751.
Shatz, M., Wellman, H. M., & Silber, S. (1983). The acquisition of mental verbs: A systematic investigation of the first reference to mental state. *Cognition, 14*, 301–321.
Taumoepeau, M., & Ruffman, T. (2006). Mother and infant talk about mental states relates to desire language and emotion understanding. *Child Development, 77*, 465–481.
Thompson, S. A., & Mulac, A. (1991). A quantitative perspective on the grammaticization of epistemic parentheticals in English. In B. Heine & E. C. Traugott (Eds.), *Approaches to grammaticalization* (pp. 313–329). Amsterdam: John Benjamins.
Tomasello, M. (2003). *Constructing a language: A usage-based theory of language acquisition*.Cambridge, MA: Harvard University Press.
Tomasello, M., & Rakoczy, H. (2003). What makes human cognition unique? From individual to shared to collective intentionality. *Mind & Language, 18*, 121–147.
Verhagen, A. (2005). *Constructions of intersubjectivity*.Oxford, UK: Oxford University Press.
Wellman, H. M., Cross, D., & Watson, J. (2001). A meta-analysis of theory of mind development: The truth about false belief. *Child Development, 72*, 655–684.
Wells, G. (1979). Learning and using the auxiliary verb in English. In V. Lee (Ed.), *Cognitive development: Language and thinking from birth to adolescence* (pp. 250–270). London: Croom Helm.
Wimmer, H., & Perner, J. (1983). Beliefs about beliefs: Representation and constraining function of wrong beliefs in young children's understanding of deception. *Cognition, 13*, 103–128.