

Language and Theory of Mind: A Study of Deaf Children

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Theory-of-mind (ToM) abilities were studied in 176 deaf children aged 3 years 11 months to 8 years 3 months who use either American Sign Language (ASL) or oral English, with hearing parents or deaf parents. A battery of tasks tapping understanding of false belief and knowledge state and language skills, ASL or English, was given to each child. There was a significant delay on ToM tasks in deaf children of hearing parents, who typically demonstrate language delays, regardless of whether they used spoken English or ASL. In contrast, deaf children from deaf families performed identically to same-aged hearing controls ($N = 42$). Both vocabulary and understanding syntactic complements were significant independent predictors of success on verbal and low-verbal ToM tasks.

The purpose of this paper is to examine the possible role of language in theory-of-mind (ToM) development by examining the performance of a large sample of deaf children. If the development of understanding others' mental states requires only normal cognitive development coupled with acute observation of human behavior, then as long as a deaf child lives in a socially and cognitively nourishing environment, ToM should develop on a normal timetable even if language were deficient. However, this view that social observation and cognitive development suffices seems untenable given the increasing number of studies that show the importance of the child's language environment, and the child's own language development, to the development of a ToM. Yet the precise mechanism by which language has its effects remains highly controversial. Does language have its effects only because the tasks demand it, or because it affects other cognitive processes, or provides a means of knowledge acquisition? Or is language a more direct tool of thought in this domain?

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Language and ToM Tasks

Initially, attention focused on the fact that the standard tests of false belief reasoning require rather sophisticated language skills. For example, the widely used unexpected contents task (Perner, Leekam, & Wimmer, 1987) involves showing a child a familiar container, such as an M&M's (or Smarties) candy box. Predictably, children believe the container holds its familiar contents. However, when they look inside, the box turns out to contain something unexpected—for example, a plastic fork in the crayon box. Children are then asked what they thought (or "first thought") was in the box before they looked inside. The false belief questions in this task contain mental state verbs, embedded clauses, and if/then statements. Another common task, the unseen change-in-location task (Wimmer & Perner, 1983), involves a character putting an object in a location and then leaving the scene. While he is away, a second character moves the object to a new location. The first character returns to the scene to get the object. The child is asked where the character will look for the object. Even though the question is simpler, the child needs some linguistic and narrative sophistication in order to follow the story in the first place. Therefore, clearly a modicum of language is needed even to participate in the standard tasks.

Language and False Belief Reasoning

There are stronger theoretical claims about why language might be facilitative, or even necessary, for reasoning about false beliefs (for an excellent recent

survey, see Astington & Baird, 2005). For example, researchers who emphasize how executive function skills or working memory capacity contribute to false-belief reasoning have argued that language facilitates those cognitive processes (Zelazo, 1999). *Having verbal labels* allows the child to keep two things in mind at once, and being able to remember verbal instructions enables staying on track in the task (Gordon & Olson, 1998). Other theorists stress that language *provides evidence* about minds to children. For instance, Astington (2001) and Dunn and her colleagues (Brown, Donelan-McCall, & Dunn, 1996; Dunn, Brown, Slomkowski, Tesla, & Youngblade, 1991; Dunn, 1994) argue that talking about the mind focuses the child's attention on explicit mental explanations of behavior, introducing them to a vocabulary of terms for unseen and abstract concepts such as thoughts, feeling, ideas, memories, and so forth that are inaccessible to direct observation (see also Bartsch & Wellman, 1995; Olson, 1988). Essentially, language provides access to this obscure domain. The act of conversation itself has also been held as an important source of evidence (Harris, 1996; Peterson & Siegal, 2000). As people converse, the very language they use conveys their intentions, presuppositions, beliefs, and knowledge, even when it contains no particular explicit reference to mental terms. Hence, on that view, language conveys evidence for *minds in action*, more so than ordinary behavior.

Quite apart from the role of language as either a facilitator or a source of evidence for minds, other theorists have proposed a different role for language as *enabling representations* about mental states. Karmiloff-Smith (1992) and Ruffman, Slade, Rowlandson, Rumsey, and Garnham (2003) argue that the reflective or *offline thinking* that language permits opens up a new level of representation of complex phenomena (see also Bickerton, 1995). In Karmiloff-Smith's terms, the child's ToM becomes more explicitly representational because of the generalized ability to meta-represent that language enables. Nelson (1996) supports a similar view, that focuses on language as a representational tool.

Each of these positions stresses different aspects of language. The vocabulary of mental state terms is important for views such as Olson's (1988) in which the use of mental state vocabulary is critical. Some researchers stress the access to interactions, while others focus on language as a representational tool. However, in these theories, grammar plays little, if any, role. Other researchers have emphasized the contribution that grammar, specifically syntactic complements, makes to mastering mind-talk (J. de

Villiers, 1995, 2005; de Villiers & de Villiers, 2000, 2003). Mental state verbs fall into a special class of verbs in that they take a kind of grammatical argument structure called a *complement*. Complements are linguistic structures where one sentence is embedded within another (Hauser, Chomsky, & Fitch, 2002). A complement is embedded under the verb and, importantly, dependent on it. Relevant to this investigation, the set of mental verbs (e.g., think, believe, know, forget, pretend, see) and communication verbs (e.g., say, tell, ask, report, promise) take complements. Complements can be *irrealis*—referring to states not yet achieved or hypothetical, as in:

Bill said he would come tomorrow.
Frieda wanted to see the carnival.

In English, irrealis complements are usually encoded by modal verbs (should, will) or infinitival clauses (to see). The complements cannot be judged as true or false, although promises or desires may or may not be fulfilled. However, complements can also be *realis* (usually clauses with an overt present or past tense) and refer to states of affairs that are true or false.

Marge said that her chair collapsed.
Marge said that her chair giggled.

It is a crucial property of these latter forms that a false proposition—"her chair giggled"—can nonetheless be included in a true sentence. Such a structure permits the representation of a state of the world as seen through someone else's eyes, and the contrast of one person's mental world with another's. These complements are to be distinguished from other complex clauses with respect to this embedding of truth. Consider the sentence:

Marge screamed after her chair giggled.

Setting aside the possibility of Halloween pranks, if we know the second clause to be a false proposition, then the whole sentence becomes a falsehood. An adjunct clause (e.g., after, because, so that) may be syntactically complex, but it does not have the right properties for representing contrasting truths. A relative clause, another form of embedding under a noun, also has the requirement that all its clauses be true; therefore, the following statement is false if the chair did not giggle:

Marge sat on a chair that giggled.

However, many mental and communication verbs allow *false* propositions in their complements.

Marge thought/believed/told him/announced that the chair giggled.

Learning to distinguish such structures from adjuncts, and knowing the verbs with which they can occur, is a major achievement of preschool syntax (Roeper & J. de Villiers, 1994). Tager-Flusberg (1997, 2000) and J. de Villiers (1995; de Villiers & de Villiers, 2000; J. de Villiers & Pyers, 2002) proposed that acquisition of this particular form, specifically *realis* complement clauses, then provides the child the representation for false beliefs.

There has been some debate on the role of syntax in the development of ToM. Perner, Sprung, Zauner, and Haider (2003) argue that the breakthrough cannot be in the syntax because in German, desire and belief verbs have the same surface complement but children can answer desire questions before belief. However, J. de Villiers (2005) argues that the complements are not grammatically equivalent, and that the *verb+complement* combination is what is crucial. She claims that the lexical semantics of the verb alone are insufficient, and the relation of the verb to the embedded proposition is critical. The range of possible options in the grammars of languages is only now being explored.

In principle, then, complement clauses allow the representation of multiple possible worlds, the child's own mind, and the minds of others. Even if a belief is false, it can be represented in a person's mind. Complements therefore provide a way to discuss lies, mistakes, and other social cognitions involving false beliefs. This view challenges the usual thinking that language merely maps conceptual understanding. The argument is that the representational capacity of the child is enhanced by having language of this degree of complexity, and the strongest version of the claim would be that *only* a child with language of this degree of complexity could reason explicitly about the truth and falsity of the contents of others' minds (Jackendoff, 1996; Segal, 1998). This is a strong claim regarding the role of language in ToM development. Language on this view is more than facilitative; it is necessary.

Evidence that Language Facilitates ToM

Evidence from typically developing preschool children shows that language plays at least a facilitative role in ToM development, but the mechanism remains ambiguous. For example, many studies

have shown how the linguistic environment of the child is related to understanding false beliefs (e.g., Cutting & Dunn, 1999; Dunn, 1994; Hughes et al., 2005; Meins et al., 2002; Ruffman, Slade, & Crowe, 2002), but none of the studies can tease apart which aspect of the language input is facilitative. Second, several studies have documented that the child's own language makes a difference in their late ToM skills (Farrar & Maag, 2002; Watson, Painter, & Bornstein, 2001), but few studies pit one kind of linguistic skill against another to see which is responsible. Some researchers have tried to distinguish one kind of influence, such as vocabulary, from another, such as syntax, on a standard test, and found mixed results, which could be a function of differential variance in the tasks (Astington & Jenkins, 1999; Ruffman et al., 2002, 2003). The problem with small cross-sectional studies and even small longitudinal studies in this narrow age range of 3–5 years is that so much is changing at once: grammar is maturing, vocabulary is expanding, executive function is being mastered, working memory is increasing, meta-cognitive skills are emerging, and children are engaged in rich conversations about social cognitive topics. Any small-scale study that samples from these many plausibly relevant abilities alongside false-belief tasks may find a convincing story to tell about the interrelationships that another study might contradict, simply because of the wide range of variables not considered given the small sample size.

Children in whom development of these skills may be asynchronous, for whatever reason, help us see how the relationships among them might vary. In particular, the performance of deaf children has been explored because of the opportunity to study a group of children who have normal social, emotional, and cognitive skills (unlike the case of autism), adequate ability to observe other people's behavior, and yet, all too frequently, have delayed language skills due to lack of access to speech or to skilled signing (Clark, Marschark, & Karchmer, 2001; P. de Villiers, 2003; Schick, 2003). By studying deaf children, one can perhaps assess more directly, over a longer time span, the role that language plays in the development of false belief reasoning.

ToM in Deaf Children

For the majority of deaf children, namely those with hearing parents, language deficits often exist for those learning American Sign Language (ASL; Schick & Hoffmeister, 2001; Strong & Prinz, 1997), English-based signing (Geers, Moog, & Schick, 1984; Schick & Moeller, 1992), or spoken English (P. de

Villiers, 2003; Geers et al., 1984). Nevertheless, deaf children with hearing parents (DoH) are actively sociable, even with language delays. Studying DoH children's ToM reasoning can therefore tease out the effects of language acquisition from those of cognitive maturation and engagement in social interaction, at least to the extent that the latter do not themselves depend on language acquisition. In contrast with DoH children, deaf children who have deaf parents (DoD), who provide natural access and exposure to ASL, demonstrate developmental benchmarks in language acquisition similar to typically developing hearing children (Newport & Meier, 1985; Schick, 2003). DoD children provide a natural control for any effects of deafness per se. If language acquisition plays a central causal role in ToM development, then DoH children with delayed language will experience corresponding delays in their understanding and reasoning about mental states, but DoD children will show no delays in ToM development.

Many studies of deaf children suggest some causal role for language acquisition in the development of an understanding of false beliefs (see P. de Villiers, 2005). Studies that have investigated ToM understanding in DoH children have found that these children often have skills that are quite significantly delayed compared with their hearing peers (Courtin & Melot, 1998; Courtin, 2000; Gale, de Villiers, de Villiers, & Pyers, 1996; Jackson, 2001; Moeller & Schick, 2006; Peterson & Siegal, 1995, 2000; Peterson, Wellman & Liu, 2005; Russell et al., 1998; Steeds, Rowe, & Dowker, 1997), in some cases not reliably understanding false belief until early adolescence. Results have been fairly consistent across a variety of tasks, such as standard tasks involving false belief as well as appearance-reality tasks. For example, in a recent study by Peterson et al. (2005), only a third of the late-signing deaf children aged 5.5–13.2 years could pass a false belief task, although the ranking of five different ToM tasks was similar to that of hearing children, albeit at a much later age (Wellman & Liu, 2004). Although substantial deficits are reported in the research literature on deaf children, some studies find less delay. Moeller and Schick (2006) showed that deaf children reliably pass false belief tasks at younger ages (6- and 7-year-olds: 63% passed; 8- and 9-year-olds: 75%). As would be expected, there is also evidence that DoD children, who develop language typically, perform significantly better on ToM tasks than their DoH peers. However, many of these studies tested DoD children at ages much older than the age where hearing children typically pass false belief tasks, with mean ages of participants ranging from 8 years 11 months to 11 years (Peterson

& Siegal, 1997, 1999) Given the older ages, it is difficult to determine how DoD children compare with hearing children in terms of development of false belief understanding. In the only study so far to compare DoD with hearing children at the same age, Courtin (2000) studied ToM skills in a group of 79 French deaf children, including 37 children who were from signing deaf families (mean age = 5 years 4 months). Courtin found that the DoD children outperformed the 7-year-old DoH children, regardless of whether the latter were learning sign language or spoken French. The DoD children were significantly better than a control group of hearing children on the false belief tasks. As an aside, Courtin argues that the results show an enhanced performance in deaf children learning sign language because most sign languages (if not all) have grammatical structures to indicate that point of view and visual perspective taking underlie aspects of sign language grammar. Thus, deaf children learning sign language may be particularly advantaged when learning concepts about mental states.

Several methodological issues in the studies of deaf children are problematic. Many of the previous studies testing signing deaf children have used interpreters or hearing individuals who are reportedly fluent in sign language. It is also possible that some results may be due to less-than-fluent sign skills on the part of the examiner or interpreter. Even when the interpreter is highly fluent, deaf adults routinely report that they greatly prefer direct communication, and information is often lost. Deaf children's performance may also be hindered by being required to look at materials presented by the examiner and simultaneously watch an interpreter, requiring visual coordination.

An additional problem with many of the existing studies with deaf children is that only verbal tasks were used to assess ToM skills. Because many deaf children have difficulties with language comprehension, it is possible that performance on the verbal tasks is limited by the children's language skills, and not by their understanding of ToM, especially given that the verbal false belief tasks entail language that is grammatically complex. Because of this, a deaf child's failure at a task may reflect general language limitations rather than ToM issues. However, other work suggests that DoH children also show delayed levels of performance on much less verbal or nonverbal tests of reasoning about cognitive states (de Villiers & de Villiers, 2000; P. de Villiers & Pyers, 2001; Figueras-Costas & Harris, 2001; Gale et al., 1996; Woolfe, Want, & Siegal, 2002). These results suggest that their delayed performance on standard

tests of false belief reasoning does not just result from the language demands of the tasks themselves.

According to Peterson and Siegal (1995, 2000), the primary cause of a delayed development of ToM is the lack of access to conversations. Because hearing families with a deaf child have difficulty communicating about everyday routines, they have extreme difficulty talking about thoughts, beliefs, and intentions. As a result, language-delayed deaf children miss out on references to abstract, unseen entities such as mental states, and have less raw material to develop ToM concepts. Deaf children do not have any special problems with social interaction other than that imposed by delayed language skills, unlike children with autism, who have also been shown to be significantly delayed in ToM development (Peterson & Siegal, 2000; Tager-Flusberg, 2000). But even if language-delayed deaf children participate in rich social interaction, that may not be enough for normal ToM development.

Very little work has looked at deaf children's conversational input directly. Hearing mothers of deaf children often must also learn the sign vocabulary for mental state concepts and we know that not all mothers know these signs. Moeller and Schick (2006) found that hearing mothers varied in their ability to use signs for mental state terms and that the mothers' ability and willingness to talk about the mind was correlated with their own child's ability to pass false belief tasks. There is also evidence that teachers of the deaf, as well as hearing teachers of hearing children, vary a great deal in how much they talk about the mind (Caldwell, Schick, & Hoffmeister, 2002). Given that many deaf children often have a limited range of social partners who can communicate freely with them, restricted input is a serious issue for many children.

There is mixed evidence as to whether a deaf child's own language skills are related to ToM skills, and unfortunately, existing studies have not used very sophisticated language measures. For example, Lundy (2002) found that the language skills of 34 deaf and hard of hearing children, ages 5–10, were only modestly related to false-belief reasoning, and age was the most significant predictor of performance. Unfortunately, the only index of their language skills was a 56-item rating scale, the Language Proficiency Profile, filled out by their teachers, and only verbal false belief tasks were administered. Stronger evidence was provided by Moeller and Schick (2006), who found that grammatical skills were highly correlated with false belief measures. Both maternal language and the children's own language were highly correlated with the children's ToM scores, but

in a regression that first took out both age and maternal language, the children's own language scores predicted a small but significant 14% of the variance in their ToM scores. Similarly, P. de Villiers and Pyers (2001) found that both vocabulary comprehension (on the Peabody Picture Vocabulary Test) and syntax production (the Index of Productive Syntax; Scarborough, 1990) were significant predictors of 23 oral deaf children's performance on both verbal and nonverbal tests of false belief reasoning, even when the effects of age, nonverbal IQ, and hearing loss were factored out. Other research has shown that even when DoH children are matched with DoD children in terms of language age, they are still significantly delayed in their false belief reasoning (Woolfe et al., 2002). Clearly, it is difficult to draw conclusions about the role of the child's own language without more sophisticated measures of that language.

No studies to date have examined the possible connection of specific complement syntax in ASL to children's performance on false belief tasks. There were no such measures in the Test of British Sign Language used by Woolfe et al. (2002). Just as in English, verbs of communication and mental state in ASL can take embedded propositions as their complements, and these can be false. There is no overt complementizer, such as *that*, in ASL, but there are complements with a wide range of verbs (e.g., want, think, tell, feel, inform, persuade; Padden, 1987; Wilbur, 1979). Padden reports examples such as the following:

MY FATHER PERSUADE ME BUY HIS CAR.
 "My father persuaded me to buy his car."
 MARY HOPE BILL COME VISIT WILL
 "Mary hopes Bill will come to visit"

ASL also distinguishes between irrealis and realis forms, using explicit lexical tense markers, a full range of lexical modals, as well nonverbal markers of modality (Shaffer, 2004, 2005). There is also a rich system of subject–verb agreement that in many cases can differentiate the subject of the two verbs (Padden, 1987). Therefore, like all spoken languages, ASL has the machinery to carry exactly the meanings conveyed by English *mental verb+complement* and it has the representational power for propositional attitudes and possible worlds.

In sum, many studies of both signing and oral DoH children agree that deaf children with language delay are significantly delayed in their mastery of false-belief reasoning. However, existing studies of ToM in deaf children often suffer from insufficiencies in design from the perspective of answering

questions about the role of language (see P. de Villiers, 2005, for a more detailed review). The extent to which the native-signing children were delayed or not in their ToM development could not be assessed accurately—all that could be said was that their performance was significantly better than that of the nonnative signers.

In the present study, our goal is to investigate more thoroughly the ToM skills of deaf children with and without language delay by investigating the following predictions:

1. If language skills do *not* contribute to the understanding of cognitive states, then language-delayed deaf children should not be delayed in ToM as long as the language demands of the tasks are made unimportant.
2. If general language skills do matter, then either vocabulary or general grammar should predict how well children do on ToM reasoning, whether the task is low or high verbal.
3. If grammar contributes as a representational tool, then complement mastery with communication verbs should predict reasoning about others' beliefs and knowledge states, whether the task is verbal or low-verbal.

Method

Participants

The 176 deaf participants ranged in age from four years to 8 years 3 months, the mean age was similar for each group (ASL-DoD = 6.07; ASL-DoH = 6.11; Oral = 6.06), and there were approximately equal numbers of 4-, 5-, 6-, and 7-year-olds (see Table 1). An analysis of variance (ANOVA) with post hoc pair-wise least significant (LSD) tests revealed that there were no differences in average or distribution in age between the four groups (Oral-DoH, ASL-DoD, or ASL-DoH, and Hearing) of 4- through

Table 1
Numbers of Children in Each Experimental Group by Age Group

	4 years	5 years	6 years	7 years
Hearing	20	11	11	
ASL-DoD	11	14	11	13
ASL-DoH	8	10	10	13
Oral-DoH	18	27	17	24

Note. ASL = American Sign Language, DoD = deaf children who have deaf parents, DoH = deaf children with hearing parents.

6-year-old participants, $F(3, 164) = 1.39, p = .247$. We did not test a group of 7-year-old hearing children because of ceiling effects on most ToM measures, even though we did test the 7-year-old DoD children because previous research has not demonstrated a ceiling effect in young DoD children and research is scarce on this population.

Orally taught participants. Eighty-six deaf children with hearing parents from oral-only educational settings with hearing teachers participated in the study (Oral-DoH). These programs focus on the use of spoken English and do not use any sign language. The programs were in different geographical regions of the US: East Coast, West Coast, and Midwest, and contained ethnically diverse populations (African American = 9.3%; Hispanic = 11.6%; Asian = 8.1%). Forty-nine (56.9%) of the children were profoundly deaf; their average better-ear unaided-hearing loss was 92 dB (range 47 dB–120 dB). Fifty-three of the children wore hearing aids and 33 had cochlear implants. Aided hearing loss from pure tone audiological testing was available for each of the oral deaf children. It ranged from 18 to 62 dB, with a mean of 35.7 dB. All of the children experienced their hearing loss before 18 months of age, and they all had nonverbal IQs and nonverbal sequence memory (tested by Knox's Cubes Test) within the normal range. The children represented a wide range of socioeconomic status ranging from working class to upper-middle class.

ASL signing participants. Ninety deaf children were from educational settings that used ASL. These programs were also in different geographical regions of the United State: East Coast, West Coast, and Midwest, and served ethnically diverse populations (African American = 12.1%; Hispanic = 14.3%; Asian = 16.8%). These programs used ASL and written English as the languages of instruction; no instruction was with spoken English. Just as important, the children were surrounded by adults and peers who were fluent in ASL. Forty-nine children had deaf parents (ASL-DoD); 41 had hearing parents (ASL-DoH). Fifty-seven (63.3%) of the children were profoundly deaf; average unaided-hearing loss was 90 dB (range 45–120 dB), and all of the children experienced their hearing loss before the age of 18 months. As with the oral deaf children, the signing group all had nonverbal IQs and nonverbal sequence memory within the normal range.

Hearing control participants. As a comparison group to determine whether the deaf children in the different groups were delayed in their mastery of false belief reasoning, 42 control children with normal hearing (Hearing) were tested. Although no exact measures of parental education or income were obtained, the hearing children were sampled

primarily from preschools and elementary schools in working-class districts to roughly match the socioeconomic background of the ASL children, particularly the DoD children who tend to be from families in the lower range of income and type of employment. They ranged in age from 4 years to 6 years 8 months, with an average age of 5 years 4 months, and all were reported by their schools to have IQs within the normal range. There was also a range of race/ethnicity (African American = 19.1%; Hispanic = 7.1%; Asian = 8.1%).

Procedure

Each of the deaf children received a battery of tasks that included measures of nonverbal intelligence, false-belief reasoning, and language. Testing occurred individually across four to six testing sessions, each session lasting approximately 30 min. The hearing control children were tested on all of the false belief tasks in two individual testing sessions, but they did not receive the language and nonverbal IQ tests due to limitations in available testing personnel when the control data were collected.

For the oral deaf children, the testing was carried out by examiners who were highly familiar with the speech of deaf children. All of the children were using individualized amplification systems (typically some combination of FM systems, hearing aids, or cochlear implants). The ASL-signing children were all tested by deaf examiners with native skills in ASL. All but one of the examiners had deaf parents. None of the testing was performed through interpreters. All ASL examiners had bachelor degrees, most had master's degrees, and were certified deaf educators.

Measures of Nonverbal IQ and Memory

The general nonverbal cognitive skills of the deaf children were assessed by two tests. The Pattern Construction subtest of the Differential Ability Scales (DAS; Elliott, 1990) requires the child to manipulate colored blocks to match pictured patterns of increasing complexity and is standardized for ages 3 years 6 months to adults. Knox's Cube Test of nonverbal sequence memory (Stone & Wright, 1979) requires that the child imitate the examiner in tapping a set of four identical cubes in an increasingly complex sequence. It has been widely used with deaf children.

ToM Measures

Standard verbal false belief reasoning assessments. There were three *unseen change-in-location* narratives

(Wimmer & Perner, 1983) presented in a picture sequence format. The story was told in simple language, using the pictures for clarification. Gale et al. (1996) argued that the picture sequence story format was better for deaf children because it was a familiar educational activity and it is easier to sign and point to a picture than it is to sign and manipulate puppets or figures. P. de Villiers and Pyers (2001) reported that this format was equivalent for hearing preschoolers to the more typical acted-out story with puppets or dolls. This was therefore a more suitable format for the deaf participants because the signer had hands free to sign, and the oral deaf children could glance between the book and the speaker to read lips when the book was held against the speaker's chest.

In each story, a character put an object in one of two or three possible locations and then left the scene. While he or she was away, a second character moved the object to a new location. Control questions were asked to ensure that the child remembered where the object was first placed and where it was moved to. If the child answered one or more of the control questions incorrectly on the first asking, the tester turned back in the picture book and reviewed the facts of the event again. The control questions were then asked for a second time. When the child answered both control questions, he or she was asked where the character would "first look" for the object (Siegel & Beattie, 1991).

The children were also tested using two *unexpected contents* tasks with two familiar containers: a Crayola crayon box that turned out to contain a plastic spoon, and a milk carton that contained a small car (Perner et al., 1987). The children were asked both about their own previous false belief (what they "thought was in the box before they looked inside it") and about what a friend of theirs would think was in the box before he or she looked inside it.

Low-verbal ToM tasks. Two low-verbal games that required minimal language to convey the task or respond were used to test the children's ToM reasoning about another person's cognitive states. These tapped into the children's understanding of the relationship between seeing and knowing and what someone might expect based on what they had seen or not seen. Although these are not strictly analogues of the standard verbal false belief tasks, they were designed to assess the children's understanding of a component of ToM (the seeing/knowing relationship) that is necessary for reasoning about the characters' false beliefs in the unseen change-in-location narratives. Wellman and Liu (2004) and Peterson et al. (2005) have recently shown that with equivalent wording of the test questions,

seeing-knowing is understood before false beliefs in a verbal test by both hearing and deaf children.

A sticker-finding hide-and-peek task, or *hidden sticker game*, was adapted from research by Povinelli and deBlois (1992) with preschoolers and with chimpanzees. The children played a game with the experimenters in which they had to locate stickers that were hidden in one of four identical white boxes. A training phase involved only the examiner and the child, who sat across from each other with a moveable opaque screen between them. First the examiner pulled down the screen, hid a sticker in one of the four boxes, and then opened the screen. Then the examiner pointed to the box with the sticker and motioned to the child to take the box, and keep the sticker. At least two more trials were completed until the child understood that it was advantageous always to pick the box that was pointed to. Then two adult confederates ("helpers") were introduced for the test phase of the game. One of the confederates (the knower) sat next to the examiner watching where the sticker was hidden; the other (the guesser) sat next to the child, screened from seeing the boxes like the child and wearing a blindfold. After the sticker was hidden, the screen was removed and the confederates moved to the side of the table opposite the child. Each confederate pointed to a different box and hence the child received ambiguous advice about which box to choose. The knower pointed to the correct box, and the guesser pointed to an empty box according to a preordained rotation. The two adult confederates took turns in a random sequence at being the knower or the guesser, so the child could not solve the problem by just sticking with the same person's advice throughout the game. Before each trial the child was reminded about who was watching and who was wearing the blindfold. In addition, to reduce the load on the children's memory, the guesser lifted the blindfold, but kept it up on top of her forehead when she came round to the examiner's side of the table to point at a box. Ten test trials with the knower and guesser were run. In essence the child had to determine which helper knew where the sticker was hidden based on their visual access to the event. In previous studies this game was mastered by hearing children at approximately the same age as they passed the standard unseen change-in-location task (P. de Villiers & Pyers, 2001; Povinelli & deBlois, 1992) and it was significantly correlated with performance on the standard unseen change-in-location task (P. de Villiers & Pyers, 2001; Gale et al., 1996).

In the *surprise face game*, the child had to complete a picture at the end of a story sequence by putting a

surprised or *not surprised* (neutral) face on a character depending on the character's knowledge state (see de Villiers & de Villiers, 2000; P. de Villiers & Pyers, 2001). P. de Villiers and Pyers reported that performance on the surprise face game was significantly correlated with scores on the standard false-belief reasoning tasks in hearing preschoolers and oral deaf children. Stories involved a familiar container that would lead someone to expect it to contain certain items, but in which an unusual object had been substituted. In three of the stories, the character was not surprised to discover the substituted object and in three of the stories, the character was surprised. In the first type, the target character clearly watched the unusual item being substituted for the familiar contents of the box, and hence would not be surprised when he or she tipped that item out of the box at the end of the picture sequence. In the second type, the target character had not observed the substitution and saw only the closed box until the strange contents were revealed, and so would be surprised. The child had to indicate whether the character would be *surprised* or *not surprised* by the unusual contents of the container at the end of the picture sequence. The child did this by choosing between two pictures of the character's face: one with the facial expression showing *surprised* and the other showing *not surprised*. The child placed transparencies of these expressions over the character's blank face in the final picture of the story, the picture in which the unusual contents of the box were revealed. In the warm-up to the task, the general idea of the procedure was communicated to the child through two stories in which characters were *surprised* or *not surprised* depending on what they had seen before, as well as the vocabulary ("surprised," "not surprised," "see," and "did not see"). The stories were communicated through gestures and minimal language, ascertaining that the child could correctly identify which face represented *surprised* and *not surprised*. On these trials the children were corrected if they chose the wrong face.

The testing phase consisted of six picture sequences, each consisting of five colored pictures. As in the warm-up, minimal language was used in playing the game. Pointing was used to direct the child's attention to the crucial objects and characters in each picture. The examiner pointed to the character in the final picture and then back to that character in each of the pictures in which he or she appeared and said (or signed): "This boy/girl . . . Which face? Surprised or not surprised? (pointing to the two faces on the transparencies)." The order of the two faces and emotion words varied across sequences and across children for each sequence.

Language Measures: Oral Deaf Children

Spoken one-word vocabulary comprehension and production was assessed by two picture-based tests of word knowledge, widely used with both hearing and deaf children. The Peabody Picture Vocabulary Test–Revised (PPVT–R; Dunn & Dunn, 1981) requires the child to choose which of four pictures match the experimenter’s spoken word, and the Elicited One-Word Picture Vocabulary Test (EOWPVT; Gardner, 1990) asks the child to name a single picture and tests primarily simple nouns and category labels such as fruit.

General spoken English syntax comprehension was tested on the Sentence Structure subtest of the Clinical Evaluation of Language Function for preschoolers (CELF–Preschool; Wiig, Secord, & Semel, 1992). This subtest consists of 22 sentences varying in complexity including prepositional phrases, coordinated clauses, passive voice, and relative clauses, but it does not include any complement clauses. The stimulus sentences were presented orally and the child had to choose which of three pictures best depicted the meaning of the sentence.

Comprehension of false complement clauses with communication verbs (tell) was tested on a memory for complement clauses task (P. de Villiers & Pyers, 2002). The child was shown two colored photographs depicting the events of a brief two-sentence anecdote in which a character was described as making a mistake or telling a lie. The four items involved what the character *told* someone, (e.g., “She told the girl there was a bug in her hair (Picture 1). But it was only a leaf (Picture 2, close up).” After each sequence the child was asked “What did s/he tell X?”

To answer correctly, the child had to process the syntax and remember the embedded false complement with the verb of communication in the story. J. de Villiers and Pyers (2002) argue that the communication verb does not require any understanding of false beliefs. In their longitudinal study of hearing preschoolers, J. de Villiers and Pyers showed that performance on communication verbs around age 3:4 was the primary predictor of later levels of false-belief reasoning (around age 3:8). Indeed, memory for false complements was a separate and stronger predictor than other more general measures of the children’s language level.

Language Measures: ASL-Signing Deaf Children

Because there are no existing standardized tests for ASL, all of the tests were designed specifically for

this study, or were adapted from tests for spoken English. The design of the tests and the items were based on the research literature on which aspects of ASL show developmental timetables across the age range included in this study, mostly focusing on the use of complex syntax, morphology, and vocabulary (Schick, 2003). Three tests of ASL were devised that parallel the English language assessments carried out with the oral deaf children: a test of ASL sign vocabulary based on the structure and format of the PPVT–R; a test of general ASL syntax comprehension that did not include complement clauses; and an ASL version of the false complement comprehension test. All of the tests were reviewed by linguistically trained native signers of ASL and were pilot tested on signing deaf children, with deaf parents and with hearing parents.

The *Receptive ASL Vocabulary Test (ASLVT)* was created to assess the children’s receptive vocabulary in ASL (Schick, 1997), modeled on the PPVT–R (Dunn & Dunn, 1981). The PPVT–R itself was not used for two reasons. First, in translating the test from English into ASL, there are not always equivalent signs in ASL. Consequently, some words must be represented using fingerspelling, which uses a manual alphabet to spell a word. Children’s ability to recognize English words in fingerspelling is not a reflection of their vocabulary skills in ASL, although the two appear to be related (Padden & Ramsey, 2000; Sedey, 1995). Second, in the PPVT–R, the foils were not designed to prevent a child from using iconicity in a sign to determine which picture is a plausible response. For example, in the PPVT–R, in the plate for the target word *wheel*, the correct picture is the only one with something round. The ASL sign for *wheel* easily communicates the fact that you are talking about something round, and hence the child might correctly guess without knowing the word. In contrast, in the ASLVT, foils were selected to prevent a correct guess due to iconicity. For example, the ASL sign for *compass* has an element that iconically represents that the object has a long thin component. Because of this, the foils consisted of pictures of a weathervane, a syringe, and a telescope and hence the iconic clue was ambiguous on its own.

Vocabulary was selected using the following criteria. The sign had to be a commonly accepted ASL sign, not a word borrowed from English, with minimal regional variation. No sign had an obligatory lexical nonmanual component, such as facial expression. Each item on the test was reviewed by a team of hearing and deaf native signers, all with extensive experience with deaf children who use ASL. Items were sorted according to perceived

difficulty, with easier signs first. Pilot testing was conducted with signing deaf children in the age range of the larger study, with deaf parents and with hearing parents. Items were revised, and the order of the items was changed based on the pilot testing. The final test consists of 61 plates, each with four pictures. During testing, the examiner signed a single sign and the child selected the matching picture. Testing was stopped when the child missed 10 items in a row. The percent of the signs scored as correct was used as the child's vocabulary comprehension score.

It was not suitable to simply translate an existing standardized test such as the CELF-Preschool Sentence Structure subtest into ASL because its grammatical structure is very different from English; therefore, it was necessary to devise a new test of *comprehension of ASL syntax*. The new test consisted of a series of 16 plates, each with three or four pictures, which were sufficiently similar that a child would need to understand some aspect of complex syntax or morphology in order to choose the right picture. For this test, the examiner signed a sentence and the child selected the appropriate picture. The test included sentences in which a syntactic object was topicalized and moved to a sentence-initial position. It also included complex forms of verb agreement, a morphological marker for person, with several participants in a scene. It did not include complements; therefore, in this sense it served the same purpose as the CELF-Preschool for the oral deaf children, namely, as an index of how much general grammar and morphosyntax of ASL the child understood. The selection of the final 16 items was based on pilot testing with signing deaf children in the age range of the larger study, with deaf parents and with hearing parents. An ASL general syntax score was calculated as percent correct.

Comprehension of false complement clauses was assessed by translating the communication verb items from the memory for complements task into ASL and administering the test in the same way as for the oral deaf and hearing children. The translations were made by native signers in the research team and the task was pilot tested with signing deaf children in the age range of the present study.

Results

Background Matching of Groups

Before comparing the different groups of deaf children from different backgrounds, it is necessary to ensure that they are matched in background

measures. The three groups of deaf children were closely matched on almost all of the background measures. Scores for the DAS, Test of Nonverbal Intelligence-2 (TONI-2), and the Knox Cubes test are shown in Table 2. ANOVAs revealed no statistical differences between the groups in age, $F(2,173) = 0.02, p = .98$, hearing loss, $F(2,167) = 0.41, p = .66$, or action sequence memory on Knox's Cubes Test, $F(2,173) = 0.75, p = .47$. On the DAS Pattern Construction subtest, there was a significant group effect, $F(2,173) = 6.24, p < .01$, and a post hoc LSD comparison showed that the ASL-DoD children had significantly higher scores on that test than the Oral-DoH children (LSD, $p < .05$). The ASL-DoH children scored midway between the ASL-DoD and Oral-DoH children, but were not statistically different than either of those groups.

The groups of signing deaf children were also compared in terms of the three ASL measures. There were significant differences between the groups on the ASLVT, $F(1,89) = 8.752, p = .004$, but not for the Syntax Comprehension, $F(1,89) = .621, p = .433$. On Complement Processing the difference between the two groups approached significance, $F(1,89) = 3.444, p = .067$ —ASL-DoD Means: 4-year-olds = 1.9 (1.6); 5-year-olds = 1.8 (1.4); 6-year-olds = 3.6 (0.7); 7-year-olds = 3.5 (1.2); ASL-DoH Means: 4-year-olds = 1.5 (1.4); 5-year-olds = 2.0 (1.3); 6-year-olds = 1.9 (1.9); 7-year-olds = 2.6 (1.6).

Table 2
Mean Scores and Standard Deviations for Each Age Group of Deaf Children on the DAS, TONI-2, Knox Cubes Test, and the Complement Processing Test

	4		5		6		7		Total	
	M	SD	M	SD	M	SD	M	SD	M	SD
DAS										
ASL-DoD*	53.8	5.6	49.8	5.5	56.5	9.4	53.6	9.6	53.2	7.9
ASL-DoH	50.3	6.8	49.5	8.3	51.7	4.6	52.8	13.2	51.2	9.1
Oral*	50.3	5.0	47.3	6.2	47.1	7.3	48.3	11.6	48.1	8.1
TONI-2										
ASL-DoD			94.7	15.8	116.5	14.0	102.5	17.2	103.7	17.8
ASL-DoH			104.4	12.3	98.6	13.9	102.4	18.2	101.8	15.0
Oral			101.6	13.8	93.9	17.1	98.3	14.9	98.5	15.1
Knox Cubes										
ASL-DoD	5.9	1.9	6.6	3.2	10.9	2.2	10.2	2.7	8.4	3.3
ASL-DoH	4.6	2.4	5.8	1.7	7.2	2.8	11.5	2.4	7.8	3.6
Oral	5.7	2.6	6.6	2.5	8.3	2.9	10.0	3.0	7.7	3.2

Note. ASL = American Sign Language, DAS = Differential Ability Scales, DoD = deaf children who have deaf parents, DoH = deaf children with hearing parents, TONI-2 = Test of Nonverbal Intelligence-2.

*ASL-DoD > Oral, $p < .05$

The normally hearing control group was also closely matched in age to the three groups of 4- to 6-year-old deaf children, with no significant differences between any of the groups in average age, $F(3, 164) = 1.39, p = .247$.

Scoring of ToM Tasks

For the standard verbal false belief tasks, the children were given one point for each of the false belief questions for which they gave the correct answer, the three "where will X first look?" questions on the unseen change-in-location narratives, and two *own belief* and two *other belief* questions on the unexpected contents containers. For children in all groups, scores on the unseen change-in-location and the unexpected contents tasks were significantly correlated (ASL: $r = .37, df = 88, p < .001$; Oral: $r = .31, df = 84, p < .01$; Hearing: $r = .61, df = 40, p < .001$). Therefore, a combined verbal false belief score (out of seven false belief questions) was calculated for each child by combining the scores from the standard tasks. Chance in the verbal false belief tasks is considered to be zero because the default is that the child responds according to his own belief, not randomly.

On the low-verbal tasks, however, chance guessing produces 50% correct responses and hence the raw scores for those games are not particularly useful. Instead, the two low-verbal games were scored on a pass-fail basis with a statistical criterion for passing ($\alpha = .05$). Children passed the Sticker Finding game if they located the hidden sticker, that is, they took the advice of the knower, on nine or more of the ten test trials ($p < .05$ on a Sign test). On the Surprise Face game, children passed if they chose the correct face (*surprised* or *not surprised*) on all six of the six picture sequences ($p < .05$ on a sign test). Pass-fail performance on the two low-verbal games was significantly correlated for each of the three groups of children (ASL: $r = .36, df = 88, p < .001$; Oral: $r = .27, df = 84, p < .01$; Hearing: $r = .51, df = 36, p < .01$). Hence, again, a combined Low-verbal ToM Tasks Score was calculated as the number of tasks (out of two) that each child passed.

Performance of the Different Groups of Participants

In the next analysis, we compare the performance of the different groups on both the verbal and the low-verbal ToM tasks across age. For each group, Figure 1 shows the average total score on the standard verbal false belief tasks across the different age groups. Figure 2 shows the average number of low-verbal tasks passed by the children in the dif-

ferent groups by age. Table 3 shows the percent of children who scored perfectly on the verbal and low-verbal tasks.

ANOVAs with age in years and group as fixed independent factors compared the average performance of the different groups on the standard verbal false belief tasks and the low-verbal tasks. Only the data from the children aged 4 through 6 were considered for this analysis so that the performance of the deaf children could be compared with that of the hearing controls matched for age.

For the children's performance on the verbal false belief questions, there was a significant main effect for age in years, $F(2, 156) = 7.26, p < .01$, and for group, $F(3, 156) = 10.07, p < .001$. Post hoc LSD tests demonstrated that the hearing control children and the DoD-ASL children were indistinguishable on the verbal ToM tasks (LSD, $p = .863$), but both of those groups were significantly better than the two groups of deaf children with hearing parents: Hearing versus ASL-DoH (LSD, $p < .01$), Hearing versus Oral-DoH deaf (LSD, $p < .001$), ASL-DoD versus ASL-DoH (LSD $p < .01$), ASL-DoD versus Oral-DoH (LSD $p < .01$). The performance of the two groups of deaf children with hearing parents was equivalent on the verbal tasks (LSD, $p = .785$); hence, at these ages there was no significant effect of the predominant language of school instruction, ASL versus oral English.

On the low-verbal games, there was again a significant main effect for age in years, $F(2, 156) = 11.72, p < .001$, and for group, $F(3, 156) = 5.15, p < .01$. The two groups with normal language acquisition (hearing controls and ASL-DoD children) were equivalent in their performance (LSD, $p = .511$), and they were significantly better than the children in the two groups with hearing parents who were delayed in their language acquisition: Hearing versus ASL-DoH (LSD, $p < .05$), Hearing versus Oral-DoH deaf (LSD $p < .01$), ASL-DoD versus ASL-DoH (LSD, $p < .01$), ASL-DoD versus Oral-DoH deaf (LSD, $p < .01$). Again no significant difference was observed in this age range between the ASL-DoH and Oral-DoH deaf groups (LSD, $p = .941$). The LSD post hoc analysis of group effects did not reveal any earlier ToM understanding in the ASL-DoD children versus the Hearing control children on either the verbal false belief tasks or the low-verbal seeing/knowing games. Further analyses using t tests to compare the ASL-DoD and Hearing children also revealed no significant differences for either measure of ToM at any of the three age groupings—4-year-olds, 5-year-olds, or 6-year-olds.

Because there were group differences for the 4- to 6-year-old DoD and DoH children on DAS

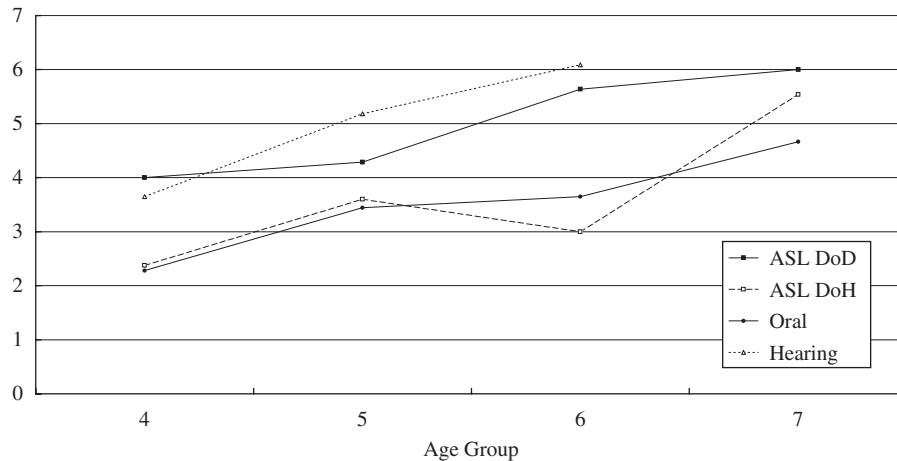


Figure 1. Mean total score of the children in each group on the standard verbal false belief tasks (out of 7 false belief questions).

performance, a separate analysis of covariance ANCOVA was calculated using the DAS *T* score as the covariate. Results were similar for the verbal tasks, showing a significant group effect, $F(2,126) = 5.97$, $p < .01$, as well as an age effect, $F(2,126) = 4.14$, $p < .05$, and for the low-verbal tasks; group: $F(2,126) = 3.93$, $p < .01$; age: $F(2,126) = 12.38$, $p < .001$. The three groups of children also differed in their performance on the complement processing tasks, showing a significant group effect, $F(2,175) = 7.12$, $p < .001$, as well as an age effect, $F(2,175) = 3.11$, $p < .05$.

An ANOVA was also carried out on the three groups of 7-year-old deaf children (ASL-DoD, ASL-DoH, and Oral; see Figures 1 and 2). There were main effects for group for the verbal false belief score, $F(2,47) = 3.13$, $p < .05$, and the number of low-verbal tasks passed, $F(2,47) = 4.97$, $p < .01$. Post hoc LSD analyses revealed that at age 7, the native-signing ASL-DoD children were still significantly

better than the Oral children on both the standard verbal and the low-verbal tasks (verbal false belief: LSD $p < .05$; low-verbal tasks: LSD, $p < .01$). The ASL-DoH children were now much more similar to the ASL-DoD children in their performance on both the verbal and low-verbal ToM tasks. Post hoc LSD tests revealed no significant differences at age 7 between the ASL-DoD and ASL-DoH groups (verbal false belief: LSD, $p = .473$; low-verbal tasks: LSD, $p = .590$), but the ASL-DoH children were now significantly better than the Oral-DoH children on the low-verbal tasks (LSD $p < .05$), although not on the verbal false belief tasks (LSD, $p = .127$).

To summarize, there were no differences between the Hearing children and the age-matched native-signing ASL children who had deaf parents, that is, the two groups of children expected to have typical language acquisition. However, both of these groups were significantly better than the two groups of deaf children with hearing parents, the ASL-DoH and

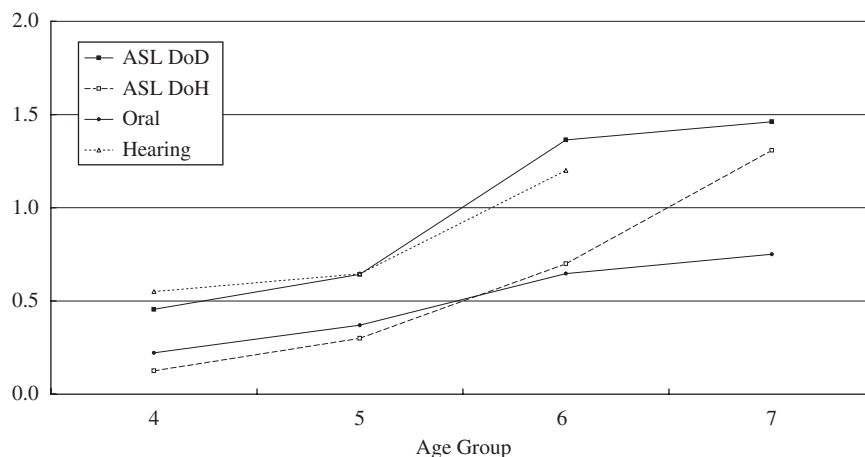


Figure 2. Average number of low-verbal seeing/knowing tasks passed by the children in each group.

Table 3
Percent of Children Who Scored 7/7 for the Verbal False Belief Tasks and 2/2 for the Low-Verbal Tasks in each Experimental Group by Age Group

Tasks		4 years	5 years	6 years	7 years
Hearing	Verbal	10	64	64	
	Low-verbal	4	18	27	
ASL-DoD	Verbal	0	14	36	54
	Low-verbal	9	14	36	62
ASL-DoH	Verbal	0	0	0	46
	Low-verbal	0	0	10	46
Oral-DoH	Verbal	0	13	18	25
	Low-verbal	0	7	6	12

Note. ASL = American Sign Language, DoD = deaf children who have deaf parents, DoH = deaf children with hearing parents.

Oral children, on both the standard verbal false-belief reasoning tasks and the low-verbal ToM games. By age 7 the ASL-DoH children who had now had several years of exposure to intensive ASL appeared to be catching up with the native signers, falling between the ASL-DoD and the Oral-DoH group in their performance on the low-verbal ToM tasks but not on the verbal tasks.

Predictors of ToM Performance in the Deaf Children

To begin to address the prediction about factors contributing to the development of a mature ToM, the relationships among background measures, performance on the ToM tasks, and language skills in the deaf children were analyzed in several ways, using the total verbal false belief reasoning score (out of 7) and the number of low language games that the children passed (out of 2) as the dependent variables.

Table 4
Bivariate Correlations of Background Measures and ToM Scores for ASL and Oral Deaf Children

	Verbal false belief score		Low-verbal tasks passed	
	ASL	Oral	ASL	Oral
Age	.46***	.41***	.61***	.33**
DAS nonverbal IQ	.22*	.04	.25*	.16
Sequence memory (Knox's Cubes)	.38***	.27*	.51***	.32**
Hearing loss	.08	-.05	.09	-.02

Note. ASL = American Sign Language, DAS = Differential Ability Scales.

* $p < .05$, ** $p < .01$, *** $p < .001$.

First, bivariate correlations were calculated (Table 4) between the two ToM scores and the background measures of age, hearing loss, nonverbal IQ on the DAS Pattern Construction subtest, and action sequence memory on Knox's Cubes Test. This analysis was carried out separately for the ASL and Oral deaf groups. Age and sequence memory were significantly correlated with both verbal and low-verbal tasks for both groups of deaf students. DAS nonverbal IQ was significantly correlated with both ToM scores for the ASL children, but not for the Oral children. There were no significant relationships with degree of hearing loss but there was a limited range of hearing loss in the sample, which included mostly children with profound losses.

Partial correlations were calculated to explore the relationship between the language measures and the children's ability to pass the ToM tasks, controlling for the effects of the three most significant background variables (Age, DAS nonverbal IQ, and sequence memory; see Table 5). The analysis was conducted separately for the ASL and Oral children because the language measures were not identical. For both the ASL and Oral children, all of the language measures were significantly correlated with the verbal false belief score. For the low-verbal tasks (which were scored differently than the verbal tasks), however, the general syntax comprehension measure was not a significant predictor of the ASL children's performance. Only ASL vocabulary comprehension and processing of false communication complements on the complement comprehension task were significantly related to the ToM score.

The most effective procedure for teasing out the contribution of the different variables to the performance of the children on the false belief tasks is a

Table 5
Partial Correlations for the ASL and Oral Children between Language Measures and ToM Scores, Controlling for Age, Nonverbal IQ (DAS), Sequence Memory (Knox's Cubes), and Hearing Loss

	Verbal false belief score		Low-verbal tasks passed	
	ASL	Oral	ASL	Oral
ASL vocabulary comprehension	.51***	.57***	.32**	.26*
ASL general syntax comprehension	.41***	.47***	.18	.28*
False communication complement processing	.42***	.46***	.37**	.37**

Note. ASL = American Sign Language.

* $p < .05$, ** $p < .01$, *** $p < .001$.

regression analysis that separates out the independent effects of different background and language measures on each of the dependent ToM measures (total verbal false belief score and number of low-verbal games passed). Separate linear regressions were therefore calculated for the ASL and Oral children. In each regression the background measures that had shown significant correlations with the ToM measures were first entered as a block. Once any shared variance from the background variables was removed, the language measures were entered as a second block of predictors to determine what additional effect language skills seemed to have on the children's ToM.

For the verbal false-belief score (Table 6), the same results were observed for both the ASL children and the Oral children. The set of background measures was a significant predictor of false belief reasoning for each group—ASL: $F(3, 84) = 8.76, p < .001$; Oral: $F(3, 76) = 3.94, p < .01$ —with age being the strongest and only significant independent predictor in the set. For both groups, language skills accounted for a substantial additional percentage of the variance in ToM. Vocabulary comprehension and the processing of false complement clauses were independent sig-

nificant predictors for both ASL and Oral children. However, general syntax measures were not significant independent predictors.

For the low-verbal ToM tasks (Table 7), background measures were again significant predictors of the children's performance—ASL: $F(3, 84) = 19.85, p < .001$; Oral: $F(3, 77) = 3.54, p < .05$. Age was the strongest predictor among the background variables for both ASL and Oral children. The language measures again accounted for a significant additional percentage of the variance in ToM. Processing of false complement clauses with verbs of communication was the only reliable significant independent predictor among the language variables, although vocabulary comprehension narrowly missed significance for the ASL children ($p = .076$). As in the case of the verbal tasks, general syntax measures were not significant independent predictors of performance on the low-verbal games.

To summarize the regression analyses, age and processing of false complement clauses with verbs of communication were independent predictors of the deaf children's reasoning about false beliefs or states of knowledge, whether the reasoning was tested in the standard verbal tasks or in games with much lower

Table 6
Regression Analysis Predicting Verbal False Belief Reasoning Score—ASL and Oral Children

	β	<i>T</i>	<i>P</i>
ASL group			
Step 1: Background control variables entered			
Age	.40	3.02	.003**
Nonverbal IQ (DAS—Pattern Construction)	.15	1.44	.155
Action sequence memory (Knox's Cubes test)	.06	0.47	.638
Percentage of variance (R^2) accounted for by background variables = 23.8%			
Step 2: Language variables then entered			
ASL vocabulary	.41	2.91	.005**
Complement processing	.22	2.19	.031*
ASL general syntax	.12	1.01	.317
Percentage of additional variance (ΔR^2) accounted for by language measures = 24.5%			
Oral group			
Step 1: Background control variables entered			
Age	.30	2.24	.028*
Nonverbal IQ (DAS—Pattern Construction)	-.06	-0.45	.654
Action sequence memory (Knox's Cubes Test)	.10	0.67	.505
Percentage of variance (R^2) accounted for by control variables = 13.5%			
Step 2: Language Variables then Entered			
PPVT-R vocabulary comprehension	.48	3.48	.001***
Complement processing	.24	2.31	.024*
CELF-Preschool sentence structure subtest	.06	0.48	.622
Percentage of additional variance (ΔR^2) accounted for by language measures = 33.6%			

Note. ASL = American Sign Language, CELF = Clinical Evaluation of Language Function, DAS = Differential Ability Scales, PPVT-R = Peabody Picture Vocabulary Test-Revised.

* $p < .05$, ** $p < .01$, *** $p < .001$.

Table 7
 Regression Analysis Predicting Number of Low-Verbal Tasks Passed—ASL and Oral Children

	β	t	p
ASL group			
Step 1: Background control variables entered			
Age	.53	4.62	.001***
Nonverbal IQ (DAS—Pattern Construction)	.15	1.68	.097
Action sequence memory (Knox's Cubes test)	.099	0.81	.421
Percentage of variance accounted for by background variables = 41.5%			
Step 2: Language variables then entered			
Complement processing	.26	2.63	.010**
ASL vocabulary	.25	1.80	.076
ASL general syntax	-.067	-0.58	.564
Percentage of additional variance (ΔR^2) accounted for by language measures = 10.0%			
Oral group			
Step 1: Background control variables entered			
Age	.27	1.98	.050*
Nonverbal IQ (DAS—Pattern Construction)	.12	0.89	.375
Action sequence memory (Knox's Cubes test)	.09	0.61	.543
Percentage of variance (R^2) accounted for by control variables = 12.1%			
Step 2: Language variables then entered			
Complement processing	.26	2.13	.036*
PPVT-R vocabulary comprehension	.11	0.70	.489
CELF-Preschool sentence structure subtest	.08	0.50	.616
Percentage of additional variance (ΔR^2) accounted for by language measures = 12.6%			

Note. ASL = American Sign Language, CELF = Clinical Evaluation of Language Function, DAS = Differential Ability Scales, PPVT-R = Peabody Picture Vocabulary Test-Revised.
 * $p < .05$, ** $p < .01$, *** $p < .001$.

language requirements for the tasks. Vocabulary comprehension emerged as a strong predictor in the more verbal tasks, but not for the low-verbal games. Very similar results were obtained in these analyses for both the Oral deaf children and the ASL signing children, despite the difference in language modality and syntax between ASL and spoken English.

Discussion

Prediction 1 stated that deaf children at risk for language delay should show good performance on a regular timetable if the language requirements of the tasks are made unimportant. This prediction receives clear disconfirmation in the present study. Regardless of the language demands of the task, the deaf children from hearing families, who were delayed in language compared with their DoD peers (Schick & Hoffmeister, 2001), are also significantly delayed in their reasoning about cognitive states—both false beliefs and knowledge versus ignorance. This study included both traditional verbal tasks to assess false belief understanding as well as tasks that required minimal language skills, even though these tasks assess slightly different aspects of performance (and

they are scored differently). As predicted, the DoH children were significantly delayed on the low-verbal tasks as well as the tasks requiring either the comprehension or production of complex language to participate. These results show that it is not simply the language of the task that causes deaf children with language delay to demonstrate a delay in such tasks. Rather, the reasoning about the mental states is the problem for the child. Even when the language demands are minimized, deaf children who have hearing families are significantly delayed compared with deaf children who are acquiring ASL from birth from their parents, or hearing children acquiring English. The nonverbal tasks were not passed easily by the DoH children, even though they can be argued to tap slightly earlier achievements such as *seeing and knowing* rather than *false belief*. These data confirm results by obtained Figueras-Costas and Harris (2001), Gale et al. (1996), and Woolfe et al. (2002).

As in other studies, the deaf children with hearing parents were delayed in their ability to reason about false beliefs and knowledge states. This was true for deaf children being educated using spoken English (Oral-DoH) as well as DoH children being educated using ASL (ASL-DoH). In contrast, deaf children

who have deaf parents, and who learn sign language naturally from birth, performed much like the hearing children, with no significant differences between the two groups on any of the ToM tasks, either verbal or low verbal. Contrasts at each age—4, 5, and 6—confirmed no differences. This means that the deaf children with hearing parents are not delayed in ToM because of their deafness per se. Early access to an equivalent language in another medium, namely ASL, is just as effective for communicating ToM, as demonstrated by the DoD performance. However, the current study does not show that the DoD children are advantaged in their ToM development compared with their hearing peers, providing no evidence that sign language was facilitative over spoken language, in contrast to a finding by Courtin (2000).

In sum, any theories that propose that ToM, even false belief reasoning, is not affected by language skills, would have difficulty with the results found here. These deaf children are well above the usual age at which false belief reasoning is mastered, and yet they are often failing the tasks of all varieties. It is clear that language is a critical factor in children's ability to reason about the mind.

It is also important to note that in many aspects of ToM, deaf children reveal a rich understanding of other people's mental states. For example, deaf children are good at predicting simple emotional reactions from stereotypical situations (P. de Villiers, Hosler, Miller, Whalen, & Wong, 1997; Pyers & P. de Villiers, 2003) and readily appeal to desires and other mental states as explanations of emotion (Rieffe & Terwogt, 2000). In contrast, their performance on tasks involving judgments about emotions based on characters' false beliefs is delayed to the same degree as their reasoning about false beliefs on the classic tasks (P. de Villiers et al., 1997; Pyers & P. de Villiers, 2003). P. de Villiers et al. (1997) found that oral deaf children's judgments about characters' emotional reactions in different causal situations were predicted by different background and language measures, specifically mastery of cognitive state verbs and the syntax of complementation. The children's understanding of simple emotions based on stereotypical situations was predicted by nonverbal IQ and age, not by language measures or by their reasoning on standard false belief tests.

Furthermore, deaf children's delay in ToM reasoning seems to be specific to the representation of cognitive states that do or do not correspond to perceived reality. Other research has shown that they do not have any problem in judging the contents of a physical representation (a photograph) that no longer reflects the scene that is in front of them (P. de

Villiers & Pyers, 2001; Peterson & Siegal, 1997; Peterson, 2002). In fact their performance on the *false photographs* test (Zaitchik, 1990) matched that of hearing peers of the same age (P. de Villiers & Pyers, 2001). Thus, their failure on traditional false belief reasoning tasks is not the result of general meta-representational problems or being unable to detach themselves from the tendency to give reality answers to the test questions.

Another possible explanation of deaf children's difficulties with ToM reasoning relates to potential delays in the inhibitory or control features of language in language-delayed deaf children. For example, having language of a certain degree can be shown to assist working memory (Gathercole & Baddeley, 1993), and may also allow the child to inhibit prepotent responses of the sort that could undermine performance on a false belief task (Jacques & Zelazo, 2005). The present study cannot rule these out as influences on performance. However, there was no discernible effect of deafness on Knox's cube task, as compared with reported standards for hearing children, which can be considered to have some loading on at least working memory. Furthermore, other evidence is accumulating that deaf children are not delayed on a battery of executive function tasks, or not sufficiently delayed to explain the delay in false belief reasoning (P. de Villiers, 2005; Jackson, 2002; Woolfe et al., 2001).

Role of Language in ToM Development

What impact do the results of this study have for the different theories about the role of language for false belief reasoning in the literature? We discuss our data in the light of these theories and what still needs to be investigated.

Prediction 2 proposed that if general language matters then measures of the deaf child's vocabulary and general grammar may predict ToM measures. In contrast, Prediction 3 stated that if language plays a role as a more specific *representational* tool, then complement mastery should predict reasoning about others' mental states.

General grammar skills were not found to be predictive of ToM performance in the current study, despite the fact that the language measures included other types of complex grammar in ASL and English. This finding is evidence against the argument that language is a proxy (like age) for maturation and might simply indicate the amount of linguistic exposure the child may have had. The specific ability to process syntactic complements was predictive, which was consistent with Prediction 3. That is,

complements may have a role in the ability to talk about and represent mental state concepts. These data are in contrast to those of Ruffman et al. (2003), who argued that general language skills were better than embedded clauses at predicting false belief performance in his sample of hearing preschool children studied longitudinally.

Ruffman et al. (2003) did not use complement clauses as a measure of complex grammar in their study because they argued that such clauses *entail* false belief reasoning. J. de Villiers (2005) has argued that using verbs of communication avoids this confound with mental state verbs. Furthermore, the task used in the present study never requires the child to represent anything about the content of anyone else's mind; the task is simply answering a question about what was actually said. Furthermore, if the complement task *required* false belief reasoning as well as syntactic skill, then one would expect that language-delayed children would pass nonverbal ToM tasks before being able to answer questions involving complements. However, both the present study and that of P. de Villiers and Pyers (2001) found that the nonverbal ToM tasks were difficult for the children, deaf or hearing, unless they had mastered complements (see also Woolfe et al., 2002).

The only other linguistic measure that was an independent predictor of ToM in the current study was vocabulary skills, a fact reported before for verbal false belief tasks (Happé, 1995; Peterson et al., 2005). This can be construed as evidence for the theory that children learn about minds through conversation, even when the topic is not mind talk. So why does general grammatical ability fail to predict as well? Some studies suggest that vocabulary development is more dependent on conversational experience than is general grammatical development (Arriaga, Fenson, Cronan, & Pethick, 1998; Hoff-Ginsberg, 1998). It is very likely that the vocabulary measure is a proxy for how much rich conversation the children have been exposed to, and hence general vocabulary will always predict ToM.

However, two distinct representational alternatives are theoretically possible: one, that learning the labels for mental events might help set the concepts, and two, that the formal structure involved in communication and belief sentences would allow the representation of false beliefs. Clearly, more precise work needs to be carried out to discover the lexical precursors for ToM. For instance, no training study to date has shown that teaching mental state terms in isolation from syntax could enhance reasoning, but it might be an important test. We can achieve some separation in the present study as the complement

comprehension test included verbs of communication with the necessary structures. Both the complement comprehension test and the general vocabulary measures are predictors of false belief reasoning for the more verbal tasks; therefore, it is possible that some kind of lexical semantics and the particular complement syntax contribute independently as representational bootstraps for a mature ToM.

Similar results have been found with children with autism. Tager-Flusberg and Joseph (2005) showed that comprehension of communication verbs with complements was more predictive than general language measures of false belief reasoning in autistic subjects in a longitudinal study. They suggested that for some high-functioning children with autism, cracking the linguistic code for mental events may supply them with access to a kind of explicit reasoning about false belief situations. Deaf children with language delay might be considered the opposite of children with autism in this respect. They are richly endowed with interest in human social behavior, but they can only get so far in developing a mature ToM without access to representational structures for reasoning about other's cognitive states.

It is informative to turn these arguments around and ask, what would be the optimal kind of input for a child to learn about others' false beliefs? First, the evidence suggests that time alone with exposure to ordinary life events and behavioral observation, even acute behavioral observation, is insufficient, but it may well be necessary. As Lohmann and Tomasello (2003) state, it appears to be "difficult for children to construct an understanding of the representational nature of mental states purely from visual scenes alone" (p. 1139). They conclude that both perspective-shifting discourse and the availability of sentential complement syntax as a representational format make independent contributions to the development of mental reasoning. Second, the data suggest that language modality does not matter; signing children do as well as English speakers, as long as their input is early and complete. Third, having enough access to the language to learn a sizeable vocabulary is likely to help, although which vocabulary, and why, is as yet unclear. Fourth, being able to understand the syntax of complement-taking verbs is not just useful but possibly essential to reasoning about mental states. Whether this is because having such comprehension gives the child access to the evidence about minds, or because it gives the child a representational bootstrap for reasoning, is far from settled.

The present data cannot discriminate between these possibilities, although in conjunction with

training study results, the latter possibility becomes at least plausible. In two training studies (Hale & Tager-Flusberg, 2003; Lohmann & Tomasello, 2003), preschool children who had not passed false belief tasks received training on the false complement structures but not in conjunction with mental verbs, and yet improved in their posttest false belief reasoning. However, both training studies chose children on the cusp of both grammatical and ToM developments. No one would claim that a 2-year old could be so trained. The intervention was occurring on top of whatever ordinary life and language exposure had provided the child to that date, and to that point both processes could have been at work simultaneously.

It would seem that hearing full sentences or mental verbs and complements, together with some claim about their truth value, in the presence of a behavioral discrepancy, is the optimum condition for learning. For a variety of reasons this optimum may not be achieved. If children are deaf, their access to a range of speakers and range of complex structures may be limited. Some parents may not engage in rich talk with children that includes mental state explanations, perhaps because they doubt their children's capacity to understand, or for reasons of time, exigencies of other responsibilities, or cultural norms. Parents may not have the sign language skills to engage in elaborate mental state talk (Moeller & Schick, 2006). Without a way to connect the sentence structures to truth values, much of the linguistic input might be uninformative.

In sum, our data suggest a significant role for language in the development of false belief reasoning in deaf children. There is still room for disagreement about exactly what this role is. We believe that the problem does not lie with the verbal demands of the task. Nevertheless, the specific facilitative or enabling role of language for false belief reasoning is still not clear. It is very hard to tease out whether a child could glean the evidence for ToM from conversations without simultaneously learning the vocabulary and complement structures. Using complements with communication verbs represents our best effort to separate the roles played by language-as-evidence and language-as-representation. In this study, complement comprehension plays a significant role independent of the deaf children's general language skills.

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