Child Development, May/June 2002, Volume 73, Number 3, Pages 768–778

Signposts to Development: Theory of Mind in Deaf Children

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Possession of a "theory of mind" (ToM)—as demonstrated by an understanding of the false beliefs of others—is fundamental in children's cognitive development. A key question for debate concerns the effect of language input on ToM. In this respect, comparisons of deaf native-signing children who are raised by deaf signing parents with deaf late-signing children who are raised by hearing parents provide a critical test. This article reports on two studies ($N = 100$ and $N = 39$) using "thought picture" measures of ToM that minimize verbal task-performance requirements. These studies demonstrated that even when factors such as syntax ability, mental age in spatial ability, and executive functioning were considered, deaf late signers still showed deficits in ToM understanding relative to deaf native signers or hearing controls. Even though the native signers were significantly younger than a sample of late signers matched for spatial mental age and scores on a test of receptive sign language ability, native signers outperformed late signers on pictorial ToM tasks. The results are discussed in terms of access to conversation and extralinguistic influences on development such as the presence of sibling relationships, and suggest that the expression of a ToM is the end result of social understanding mediated by early conversational experience.

INTRODUCTION

The ability to understand that other people have mental states (thoughts, desires, and beliefs) that may be different from one's own, termed a "theory of mind (ToM; Flavell, 1999; Premack & Woodruff, 1978), is vital to everyday life. One central measure of ToM understanding involves knowledge that others can hold false beliefs about the location or contents of an object, and that these beliefs produce undesired behavioral consequences. There is a consensus that by the age of about 4 years, most typically developing children have a grasp of the consequences of holding false beliefs, and thus have ToM understanding (Perner, Leekam, & Wimmer, 1987; Surian & Leslie, 1999).

Although previous studies have shown that ToM understanding develops in tandem with aspects of language development (Tager-Flusberg, 2000), the nature of this relation is not yet clear. One proposal (e.g., Astington & Jenkins, 1999; de Villiers & de Villiers, 2000) is that ToM performance is closely tied to the development of children's language skills, particularly competence in syntax. Another proposal is that children's exposure to talk about mental states gives rise to ToM reasoning (Siegal, Varley, & Want, 2001). According to this view, the effects of language extend beyond syntax. Language is the medium through which children learn about the unobservable mental states of others; through immersion in conversation, children become aware of mental states and develop pragmatic knowledge in following the purpose and relevance of messages in conversation. They come to understand others' beliefs and communicative intentions and how these may differ from their own. Dunn (1994) has reported that preschoolers' success on ToM tasks is associated with the frequency with which they exchange mental state terms in conversations with parents, siblings, and friends. Similarly, Lewis, Freeman, Kyriakidou, Maridaki-Kassotaki, and Berridge (1996) found that the availability of exposure to mature speakers (adults, older children, and siblings) predicted children's performance on tasks involving ToM. These observations are consistent with the view that the more children are exposed to talk about thoughts and other invisible mental processes, the earlier they develop a ToM of other persons' mental states. Indeed, it has long been noted that children who are isolated in their contact with others have specific difficulty in adopting the perspectives of others (Hollos & Cowan, 1973).

A key test of these proposals comes from congenitally deaf children who are raised in hearing families and often have no easy means of communication with hearing family members and other children, especially about topics such as mental states, which may have no concrete referent (Marschark, 1993; Meadow, 1975; Morford & Goldin-Meadow, 1997; Power & Carty, 1990). An important question thus arises: given that developing a ToM may be dependent on hearing other people talk about mental states, does the restricted conversational world of some deaf children result in difficulties that are specific to understanding the (invisible) thoughts of others?

Previous studies have shown that on key tests of

ToM understanding, deaf children of hearing parents lag several years behind hearing children of hearing parents, even when care has been taken only to include children of normal intelligence and social responsiveness in the deaf samples (Courtin & Melot, 1998; Deleau, 1996; Deleau, Guéhéneuc, Le Sourn, & Ricard, 1999; de Villiers & de Villiers, 2000; Figueras-Costa & Harris, 2001; Peterson & Siegal, 1995, 1997, 1998, 1999, 2000; Russell et al., 1998). These children acquire a sign language mainly outside the family and are thus "late signers." In contrast, deaf children who are born into families with a deaf communicative partner who uses a sign language are "native signers." They have access to language even before school owing to the presence in their household of at least one fluent user of a sign language, and they resemble typically developing hearing children in their ToM performance. This finding is in line with the observation that deaf preschoolers with deaf parents converse as readily about nonpresent ideas, objects, and events in sign as do hearing children in speech with hearing parents (Meadow, Greenberg, Erting, & Carmichael, 1981).

Nevertheless, there are significant issues that arise in interpreting existing research with deaf children. For example, tasks designed to test ToM understanding often rely on children giving a verbal or signed response. In samples of deaf late-signing children, it is not clear whether all possess sufficient verbal or sign language skills to either understand, or respond to, ToM tests of understanding how false beliefs may lead to an undesired outcome. Accordingly, the abilities of late-signing children may have been underestimated in previous research. For example, Peterson and Siegal (1999) reported a highly significant advantage in ToM performance to native-signing children over their late-signing counterparts. Yet the children in this investigation were given ToM tasks that can require significant verbal comprehension skills, and competence in communication was estimated solely on the basis of teacher ratings of deaf children's language.

The aim of the first study in the present investigation, therefore, was to test deaf children on false-belief tasks using "thought pictures" (Custer, 1996). These minimize the need for verbal comprehension. Activation of perisylvian language zones, however, has been found in similar picture-based tasks that do not require language decoding or production (Brunet, Sarfati, Hardy-Bayle, & Decety, 2000), suggesting a role for language in mediating ToM performance that extends beyond a simple input/output function to central cognition. Consequently, despite the use of pictorial ToM tasks, deaf children's language skills were directly assessed using a newly developed test of receptive ability in the syntax and morphology of British Sign Language (BSL; Herman, Holmes, & Woll, 1999). The goal was to determine whether a difference in performance on pictorial tasks would emerge between late- and native-signing deaf children, and whether this difference would disappear when the children's abilities in syntax, as well as in spatial intelligence, were controlled.

STUDY 1

Method

Participants. Sixty prelingually profoundly deaf children, 4 to 8 years of age, of whom 40 were late-signing children (M = 6,8) and 20 were native-signing children (M = 5,10) participated in this study. Most of the late-signing children were recruited from five day schools in the United Kingdom (three mainstreamed schools with sign language provision and two special schools with bilingual communication in English and BSL). A small number of native-signing children were also recruited from such schools. It was necessary to recruit most native-signing children through direct contact with their parents, however, because native signers are rare among the deaf population as a whole.

In addition to the deaf children, forty hearing children, twenty 3-year-olds (M = 3,7) and twenty 4-year-olds (M = 4,4) were recruited as controls. The hearing children attended five nursery schools in the United Kindom.

Procedure. All deaf children were tested in BSL by a deaf experimenter who was himself a native BSL signer. Children were first tested for their level of receptive skill in the syntax and morphology of BSL with the BSL Receptive Skills Test (Herman et al., 1999). This test begins with a vocabulary check (e.g., the signs for items such as "apple" and "umbrella") to ensure that children are able to both comprehend and produce the signs relating to objects and people that are subsequently used in the test proper. In the test proper, children watch a video of a deaf adult who presents three practice sentences followed by 40 test sentences in BSL. The sentences are designed to assess six grammatical features in BSL (Sutton-Spence & Woll, 1999): spatial verb morphology (e.g., "box under bed"), number/distribution (e.g., "lots apple"), negation (e.g., "can't reach"), size/shape specifiers (e.g., "curly hair"), noun/verb distinctions (e.g., "boy drink"), and handling classifiers (e.g., "hold umbrella open walk"). For each sentence children respond by selecting a picture to match the signed sentence from a choice of three or four alternatives in a picture booklet. Testing continues until four consecutive test sentences are failed. Children's raw scores on this test (out of 40) were converted to standardized scores and used to calculate their "signing" age.

Following the BSL assessment, children's understanding of "thought bubbles" was evaluated following the procedure of Wellman, Hollander, and Schult (1996). Two pictures were shown, one depicting a boy thinking about a dog (a boy with an attached thought bubble containing a dog) and the other depicting a boy with a real dog (a boy with a dog on a lead). Children were asked to point to the picture showing a boy thinking about a dog: "Which (pointing to the two pictures) boy think dog?" in BSL syntax, or "Which boy is thinking about a dog?" in English. All but one of the children gave the correct answer, and in all cases the correct answer was confirmed for the children: "This (pointing to picture) boy think dog" in BSL syntax, or "This boy is thinking about a dog" in English.

Subsequently, children were shown four ToM "thought pictures": two involved understanding a central character's True Belief (TB), and the other two involved a False Belief (FB). The four thought pictures were: (1) a boy fishing thinks he has caught a fish (TB = fish/FB = boot), illustrated in Figure 1; (2) a girl thinks she sees a tall boy over a fence (TB = a tall boy/FB = a small boy standing on a box); (3) a man thinks he is reaching into a cupboard for a drink (TB = a drink/FB = a mouse); and (4) a man thinks he sees a fish in the sea (TB = a fish/FB = a mermaid). In each

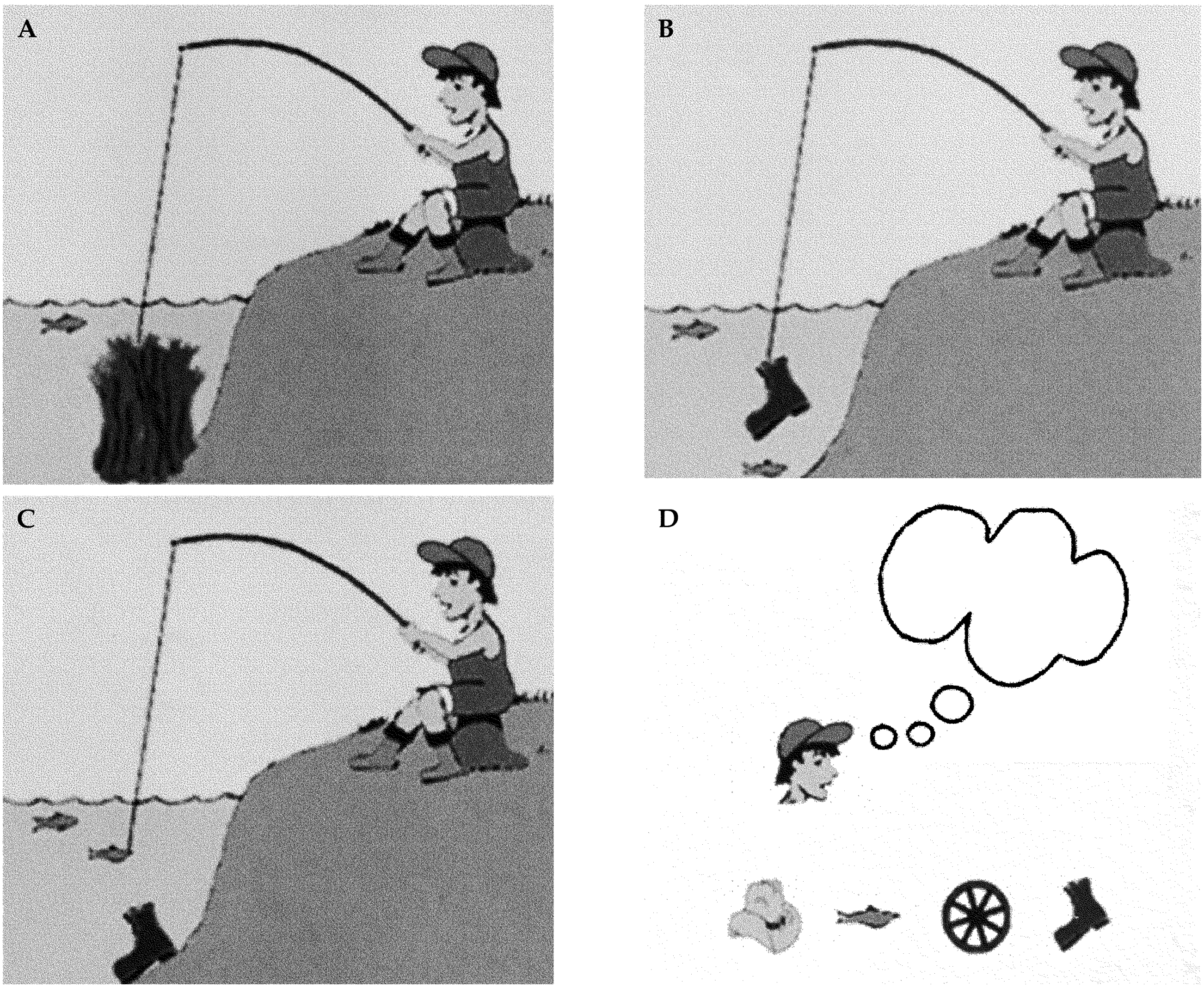

Figure 1 Central elements of the "thought picture" presented in the theory of mind "fishing" task (adapted from Custer, 1996). (A) The thought picture illustration as first presented to the child (with removable flap in place). (B) The False Belief (FB) version of the picture (with flap removed). (C) The True Belief version of the picture (with flap removed). (D) The four response cards, along with the thought bubble in which children had to place the card that illustrated the character's belief. The four cards are (from left to right): distracter 1, belief item, distracter 2, and actual object (FB only).

Table 1 Mean Theory of Mind (ToM), Spatial Mental Age, and British Sign Language (BSL) Scores for Children from Study 1

Group	N	Age (months)	Age Range (months)	ToM (0–2)	Spatial Mental Age (months)	Standardized BSL	Raw BSL
Native signers	19	71.11 (15.78)	48–102	1.42 (.61)	86.21 (24.98)	109.95 (10.22)	27.37 (5.45)
Late signers	32	81.75 (13.79)	54–105	0.34 (.65)	76.97 (23.02)	90.03 (13.15)	24.03 (15.56)
Hearing 4-year-olds	20	51.75 (3.16)	48–57	1.30 (.86)	N.A.	N.A.	N.A.
Hearing 3-year-olds	20	43.05 (3.38)	38–47	0.35 (.67)	N.A.	N.A.	N.A.

Note: Values in parentheses are standard deviations. N.A. = not applicable.

case, a flap on which was depicted some plausible obstruction (item 1, reeds; item 2, the fence; item 3, the cupboard door; item 4, reeds) covered the critical object from the central character's view. Thus in all stories some aspect of the scene was obscured from the central character's sight. For example, in the fishing scene, a flap depicting reeds concealed the end of the protagonist's fishing rod. In the TB version of the picture, removal of the flap revealed that the protagonist had caught a fish; however, in the FB version, removal of the flap revealed a boot on the end of his line. Children covered the central story character with their hand while the flap was removed, to emphasize the character's ignorance of the contents of the flap. Once the children had viewed the picture and had lifted and replaced the flap, they were shown a separate picture of the central character (from the original picture) with a blank thought bubble above his or her head. Next to this picture were four small pictures. For the FB tasks, two of these pictures were of distracter items, one showed the content of the protagonist's belief and the other showed the actual object. In the TB condition, the true content of the belief was represented together with three distracters. The deaf children were asked, through gesture and pointing, to indicate which of the four pictures showed what the character was thinking. Finally, children were asked to point to the picture of the actual object concealed by the flap. The four thought pictures were presented in a counterbalanced order to the children and the selection of an individual thought picture as an FB or TB item was randomized across subjects.

To summarize, for each picture children were asked to identify what a character believed was behind the flap and what was truly there. They were only credited with passing the task if they answered both the belief and reality questions correctly. Each child therefore received an FB score from 0 to 2 and a TB score from 0 to 2.

After receiving the thought pictures, children were given the colored version of Raven's Progressive Matrices (Raven, 1962). The purpose was to assess their nonverbal (spatial) mental age. The hearing control children were tested by a hearing experimenter and were assessed on the thought pictures (as described above) to establish age norms for typically developing children.

Results

Eight of the late-signing deaf children in this study either had very minimal BSL ability, or did not understand the procedure for the BSL Receptive Skills Test and hence no measure of their language was possible. A single, native-signing child did not understand the procedure for Raven's Progressive Matrices and was also excluded. Therefore, the analysis was based on results from 32 late signers and 19 native signers. The mean ToM (FB only), mental age, and (standardized) receptive language scores for all groups of children are presented in Table 1.

The deaf native signers were significantly younger than their late-signing counterparts, $t(49) = -2.53$, $p < .05$. Nevertheless, as can be seen in Table 1, the native signers significantly outperformed the late signers on the ToM tasks, $t(49) = 5.84$, $p < .001$. The difference between the late and native signers was comparable with that between the hearing 3- and 4-year-olds, because the hearing 4-year-olds significantly outperformed the hearing 3-year-olds, $t(38) = -3.88$, $p < .001$.[1] The difference in spatial mental age between

[1] In conjunction with this study, another sample of twenty 3-year-old ($M = 3{,}6$) and twenty 4-year-old ($M = 4{,}4$) hearing children were given the same four pictorial tasks (two as FB versions and two as TB) as in Study 1 together with two "standard" ToM tasks (the deceptive box and change-in-location, or "Sally-Anne," tasks: Baron-Cohen, Leslie, & Frith, 1985; Perner et al., 1987). All children passed the two TB pictorial trials. The mean pass rate for the two types of FB tasks was highly similar to those of the children in Study 1, both for the 3-year-olds (pictorial = .55, standard = .53) and the 4-year-olds (pictorial = 1.37, standard = 1.45). For the entire sample of 40 children, the correlation between scores on the two types of FB tasks (pictorial and standard) was .42, $p < .01$. Call and Tomasello (1999) reported a similar association between children's performance on nonverbal and verbal ToM tasks.

the deaf native and late signers was nonsignificant, $t(49) = 1.34$; although the native signers scored significantly higher than the late signers in their standardized scores on the BSL test, $t(49) = 5.66$, $p < .001$. When the children's raw BSL scores were considered, however, the two groups did not differ significantly, $t(49) = .90$.

For the combined sample of native and late signers, or for the two groups alone, there were no significant correlations between ToM and chronological age or spatial mental age or between ToM and the raw BSL scores. For the combined sample only, there was a significant correlation between ToM and standardized BSL scores, $r = .31$, $p < .05$. The correlation between standardized BSL and spatial mental age was also significant, $r = .30$, $p < .05$.

The results from this first analysis showed that deaf native and deaf late signers did indeed differ on ToM performance. However, the native and late signers also differed in their standardized BSL scores. Whereas the mean scores of both groups were within the normal range in BSL receptive skills for their age, the native signing group (ranging from 93 to 129 in their standardized scores) were somewhat more advanced and the late signers were somewhat delayed (66–119). Therefore, to investigate further the role of proficiency in BSL, an additional analysis of the scores of a smaller group of deaf native and deaf late signers was conducted; namely, on all those children who had standardized BSL scores between 90 and 110 ($N = 24$) . All of these children passed both TB control tasks (all achieving a TB score of 2). The ToM, mental age, and BSL scores of these children are presented in Table 2.

In this reduced sample of children, the native and late signers differed significantly on their ToM scores, $t(22) = 7.60$, $p < .001$, and (marginally) in their chronological age, $t(22) = -2.06$, $p = .051$. They did not differ significantly on their spatial mental age, $t(22) = .56$, or on their standardized, $t(22) = 1.88$, or raw, $t(22) = -.98$, BSL scores.

Discussion

Despite their younger age, the native-signing children outperformed the late-signing children who were matched for BSL proficiency and spatial mental age. In this sense, the ToM performance of the native signers was particularly impressive. The native-signing children were advanced for their age in spatial ability, in keeping with the advanced performance on measures of spatial cognition shown by deaf adult signers (Emmorey, Klima, & Hickok, 1998). Consistent with other studies that have used measures of nonverbal intelligence (Peterson & Siegal, 1999), however, there was no significant direct relation between the spatial measures and ToM. It should be noted that the ToM tasks used in this study minimized receptive language demands (and required only nonverbal, pointing responses).

The pattern of differences in ToM development between native and late signers demonstrated in Study 1 is consistent with the previous literature on ToM in deaf children. In terms of the entire sample of deaf children, there was a modest statistically significant correlation between the standardized BSL scores and ToM performance that was similar to the findings reported by Astington and Jenkins (1999) on the relation between syntax and ToM in hearing children. In the present study, however, it is important to note that children were assessed for their level of ability in a sign language using a new, standardized test of receptive ability in syntax and morphology. When the BSL Receptive Skills Test was used to match two groups of native- and late-signing deaf children for skill in BSL, the groups differed in terms of their ToM understanding, demonstrating that syntax alone (at least as shown on this standardized test) did not explain the difference in ToM ability between native and late signers.

Study 1 points to the native signers' familiarity with mental states as inferred from conversations with other signers as a major candidate explanation for the difference in ToM ability between the native

Table 2 Mean Theory of Mind (ToM), Spatial Mental Age, and British Sign Language (BSL) Scores for a Subsample of Children with Standardized BSL Scores between 90 and 110

Group	N	Age (months)	Age Range (months)	ToM (0–2)	Spatial Mental Age (months)	Standardized BSL	Raw BSL
Native signers	12	72.17 (17.43)	50–102	1.58 (.52)	88.00 (25.60)	104.00 (6.18)	25.50 (5.30)
Late signers	12	85.17 (13.13)	62–104	.17 (.39)	83.00 (17.08)	100.17 (3.43)	32.17 (23.06)

Note: Values in parentheses are standard deviations.

and late signers. It could be argued, however, that a difference in "executive functioning" (EF)—which involves the ability to plan and shift attention flexibly in problem solving—between the two groups was responsible. In recent research, some studies (e.g., Frye, Zelazo, & Palfai, 1995; Perner & Lang, 1999) have suggested that EF does play a role in the ToM performance of hearing children. It is possible that the ability to inhibit immediate responses (an ability dependent on proper EF) may help children to succeed on ToM tasks because it enables them to overcome any "reality bias" present in the task (Mitchell, 1994). One might hypothesize that EF may play a greater role in the performance of late, rather than native, signers given the suggestion that late signers are more impulsive than native signers and typically developing children (R. I. Harris, 1978).

Study 2 was designed to examine the role of EF in a sample of native- and late-signing children. Additionally, Study 2 included a test of the children's ability to deal with representations that were physical (photographic) rather than mental. This test was added as a further control to determine whether the difficulties that late signers display with ToM tasks are specific to mental representation or apply to representation more generally.

STUDY 2

Method

Participants. All 51 deaf children (of the original 60 from Study 1) who were included in the analyses from Study 1 were to have taken part in Study 2. Unfortunately, as a result of illness or absence, only 39 of the 51 deaf children from Study 1 could be retested. The sample therefore included 21 late signers ($M =$ 7,10) and 18 native signers ($M =$ 6,0).

Procedure. As in Study 1, all the deaf children were tested individually by a deaf native-signing experimenter, using communication methods appropriate to the individual child. In Study 2, children were given a measure of EF, along with a measure of their ability to reason about nonmental (photographic) representation. A version of the Wisconsin Card-Sorting Task, adapted for young children (see, Cole & Mitchell, 2000), was used to test children's EF. The task involves sorting cards according to rules that change during the testing session. The largely nonverbal procedure of the card-sorting task makes it ideal for use with deaf children. For this task, a deck of cards was created that varied according to the shape and color on each card. In total, there were four different shapes (triangles, stars, squares, and circles) and four different colors (pink, brown, green, and blue). Before testing, all children were tested for their ability to discriminate all four shapes and colors; all children managed successfully. The children and the experimenter were then given two different sets of 20 cards in which each set varied on shape and color. For example, a sample child's set might include 10 circles (5 blue and 5 green) and 10 squares (5 blue and 5 green). The corresponding experimenter's set would consist of 10 stars (5 pink and 5 brown) and 10 triangles (5 pink and 5 brown). Both sets of cards were shuffled into a random order prior to testing. In the initial phase, the experimenter sorted five of his cards according to one dimension (shape or color) and the children were asked to do the same to their cards ("You do similar me" in BSL syntax). During this initial phase, corrective feedback was given. After successfully sorting five consecutive cards according to this dimension, the experimenter indicated that the children were then to change the dimension on which the cards were to be sorted (from shape to color or vice versa). The experimenter then sorted five of his cards according to this new dimension. The children were asked to sort five of their cards according to this new dimension. In this part of the procedure, no corrective feedback was given. Finally, the sorting rule (sort by color or by shape) was changed again and the children were asked to sort five more cards. One point was given for each correctly placed card in each of the last two phases of the procedure (without corrective feedback). Each child was therefore given a combined score of 0 to10.

The test of nonmental representation used was the False Photo task (Zaitchik, 1990) following closely the procedure used by Peterson and Siegal (1998). The children were first shown a Polaroid™ instant camera with which the experimenter took a photograph of each child. The children then watched as the photograph developed. Next, the children were shown two dolls, a mother and baby, and a toy bath and bed, placed on a white board with a white background. The baby was in the bath and the mother was placed next to it. The children observed as the experimenter took a photograph with the dolls in this position. While this second photograph was developing, the experimenter made the mother doll move the baby doll from the bath to the bed. With the developing photograph still face down, the children were then given two "ready-made" photographs, one of the original setup (the dolls in their original places) and another with the altered setup (the dolls in their "current" places). The children were asked to point to the ready-made photograph that matched the developing Polaroid photograph. The children were then

Table 3 Mean Theory of Mind (ToM), Spatial Mental Age, British Sign Language (BSL), and Executive Functioning (EF) Scores in Study 2

Group	N	Age (months)	ToM	Spatial Mental Age (months)	Standardized BSL	Raw BSL	EF (out of 10)
Native signers	18	72.00 (15.73)	1.44 (.62)	87.67 (25.58)	109.94 (10.51)	27.78 (5.30)	9.06 (1.21)
Late signers	21	82.24 (14.24)	.33 (.66)	80.86 (23.95)	95.10 (10.16)	26.90 (18.47)	8.52 (1.33)

Note: Values in parentheses are standard deviations.

asked the control question, "Where was the baby before?" (signed as "baby before where?") and had to point to the correct location. Finally the children were asked, "Where is the baby now?" (signed as "baby now where?").

Results

The children's performance on the various measures in Study 2 is shown in Table 3. The mean scores of the late and native signers on the measure of EF were not significantly different, $t(37) = 1.30$. For the combined sample, EF was correlated with ToM scores, $r = .35$, $p < .05$, and spatial mental age, $r = 44$, $p < .01$. These correlations were nonsignificant for the late signers and only the correlation between EF and mental age remained significant for the native signers, $r = 50$, $p < .05$. For the combined sample or the two groups alone, EF scores did not correlate significantly with BSL scores (raw or standardized), chronological age, or spatial mental age. All children, whether late or native signers, succeeded on the False Photograph task, answering both the test and control questions correctly.

As in Study 1, the differences between the two groups of deaf children were not significant for the measure of spatial mental age, $t(37) = .61$, or raw scores on the BSL test, $t(37) = .19$. The two groups were significantly different in terms of chronological age, $t(37) = -2.13$, $p < .05$, standardized BSL scores, $t(37) = 4.48$, $p < .001$, and ToM scores, $t(37) = 5.41$, $p < .001$.

Discussion

Although native-signing children outperformed late-signing children on pictorial ToM tasks, they did not differ significantly on tests of either False Photographic reasoning or EF. Whereas in the combined sample, EF was correlated with ToM responses, this did not explain the overwhelming advantage of native signers in ToM performance. A recent study by Remmel (1999) also found that EF did not explain ToM differences between late- and native-signing children. Moreover, as was reported in Peterson and Siegal's (1998) study of representational abilities in late-signing deaf children, there was very good performance on the False Photograph task. Study 2, therefore, served to demonstrate that the differences between the native and late signers could not be seen in terms of general differences in representation or EF. Executive functioning may play a significant role in explaining the ToM performance of other groups of children, however, such as impulsive children with behavioral disorders (Hughes, Dunn, & White, 1998).

GENERAL DISCUSSION

In the sample of late-signing children, standardized scores on a measure of syntax and morphology in BSL were modestly associated with ToM responses and so in this sense, the data of the present research are consistent with the proposal that syntax has an initial role in performance on ToM reasoning tasks. However, compared with the late signers with whom they were equated for level of ability in syntax, the native signers in the present studies excelled in their ToM performance although they were actually younger in age. The advantage shown by native signers on standard ToM tasks (Peterson & Siegal, 1999) extended even to pictorial tasks that minimized the need for verbal comprehension skills.

It is plausible that proficiency at syntax in the form of sentence complementation (e.g., understanding sentences such as "John thought [falsely] that the cookies were in the cupboard") as described by de Villiers and de Villiers (2000) may play an important role in performance on certain ToM measures. For example, deaf children have been shown a sequence of pictures that convey a story involving a "changed-contents" false-belief task, in which the contents of a container have been changed without the knowledge of a central story character. The child is required to select either a surprised or not surprised facial expression for the character in the story as aided by the pictorial content. On such "relatively nonverbal" tasks, measures of sentence complementation given to oral deaf children (who converse in speech rather than in a sign language) correlate significantly with performance (de Villiers, 2000; de Villiers, de Villiers, Schick, & Hoffmeister, 2000). The BSL Receptive Skills Test that was given to the signing children in the present investigation does not directly assess the syntax of sentence complementation. Astington and Jenkins (1999) incisively note, however, that children who fail standard verbal ToM tasks spontaneously produce object complements in their speech. Moreover, as Astington and Jenkins observed, on pictorial tasks very similar to those used in this investigation (namely, those employed by Custer, 1996), hearing 3-year-olds correctly answered questions involving sentence complementation if those sentences took the structure [person]–[pretends]–[that *x*]: for example, "He pretends that his puppy is outside." In contrast, hearing 3-year-olds did poorly when given sentences that took the form [person]–[thinks]–[that *x*]: for example, "He thinks that his puppy is outside." Both the "think" and "pretend" sentences use the same object complement, yet children answer correctly only when "pretend" is used. Given these considerations, the syntax of sentence complementation falls short of providing a complete account of ToM performance, at least on pictorial tasks.

Because the two deaf groups in the present investigation were also equivalent in their spatial intelligence and EF, these findings can be seen as pointing to the powerful impact of early access to conversation on ToM performance. In contrast with deaf late-signing children, deaf children for whom sign is their native language have early opportunities to converse about the beliefs of others and to formulate an understanding of how these can be false. In related research, we have investigated whether these effects may alternatively be seen in terms of extralinguistic influences, such as the special quality of sibling relationships in the families of native signers, irrespective of the level of sign language abilities (Woolfe, Want, & Siegal, 2001). In this work, the perceived quality of the sibling relationship and proficiency on referential communication measures (namely, those of Lloyd, Camaioni, & Ercolari, 1995) significantly predicted deaf children's performance on pictorial ToM tasks independently of scores on the BSL Receptive Skills Test. In keeping with the results of recent studies with hearing children (Cole & Mitchell, 2000; Cutting & Dunn, 1999), ToM performance was unrelated to the number of siblings. Thus communication itself, rather than mere exposure to sibling relationships, is independently associated with ToM reasoning in both deaf and hearing children.

Although there appear to be no significant differences between the deaf and hearing in the quality of attachment and mother–toddler interaction (Lederberg & Mobley, 1990), deaf children of hearing parents receive much less communication than do deaf children of deaf parents. Hearing mothers of deaf 2- and 3-year-olds direct more visual communication to their children than do hearing mothers of hearing children but they still communicate primarily through speech to which the children often do not attend (Lederberg & Everhart, 1998). In contrast, through proficiency in visual communication, deaf mothers of deaf children can match the responsiveness of hearing mothers of hearing children (Spencer & Meadow-Orlans, 1966).

Further work is required to determine whether there is a sensitive or optimal period for displaying ToM reasoning and whether hearing families who strive to acquire a sign language early can serve to boost ToM in the deaf child. As a number of studies (M. Harris, 1992; Marschark, 1993; Vaccari & Marschark, 1997) have shown, most hearing parents do not have sufficient proficiency in manual communication to optimize social interactions with their deaf children and to converse freely about imaginary or unobservable topics such as others' beliefs. Moreover, they will often use the oral mode to converse with other hearing family members, innocently limiting a deaf child's access to informal conversations that may encourage ToM development as well as related skills in social cognition (Forrester, 1993). In the present investigation, the level of BSL attained by hearing family members of late-signing deaf children was highly variable. It should be noted that one 8-year-old late signer who failed the ToM tasks had family members who nevertheless were all actively learning BSL.

Similarly, the schools of late signers cannot be relied on to provide a substitute for these kinds of conversations about the unobservable beliefs of others. Although attending signing all-deaf schools should promote more conversations in a sign language, the sign language fluency of adult figures in schools is variable and hence the quality of communication is not uniform. For late signers who attend mainstreamed schools, adults who have the responsibility to translate information to a sign language for deaf children (and to use complementary forms of visual communication) are often only present for the translation of curricular matter, and not for informal conversations in school that have the potential to stimulate development reflected in ToM reasoning. Few hearing children are taught to sign and, for those who do, this is usually extremely limited and is a mode of communication that is not used among their hearing peers.

The present studies converge with research on ToM in hearing children that points to the importance of conversational awareness in successful task performance. In research on hearing children, specifying that the ToM task is intended to refer to how a person with a false belief will initially be misled—rather than to the revised true belief of a person once a deception is discovered—facilitates children's correct responses (Joseph, 1998; Lewis & Osborne, 1990; Siegal & Beattie, 1991; Surian & Leslie, 1999). In contrast with hearing 3-year-olds, however, late-signing deaf children did not improve significantly on ToM tasks when the questions were explicitly "conversationally supported" along these lines (Peterson & Siegal, 1995, 1999).

As noted elsewhere (Siegal, 1999), this pattern points to the importance of delineating two types of abilities in conversation. First is the ability to understand the pragmatic implications of questions (e.g., that they refer to an initial, rather than a final, search). A failure to follow these implications can mask hearing children's conceptual understanding, and that understanding only becomes apparent once the need to make specific conversational implications about the purpose and relevance of the task is removed. Second, there is the awareness involved in understanding the general shared grounding for communication in the mutual beliefs, knowledge, and assumptions underpinning conversational exchanges (Clark & Brennan, 1991). Deaf late-signing children are liable to be cut off from the early exchanges about similarities and differences in mental states with parents and siblings that are familiar to hearing children and native signers. Moreover, they are isolated from experience with the structure of well-formed conversation. This experience alerts normal hearing-children by the age of 3 years that speakers are epistemic subjects who store and seek to provide information about the world (P. L. Harris, 1996). Thus, ToM is not simply a matter of vocabulary and syntax, but is the end result of social understanding mediated by early conversational experience. In the case of deaf late-signing children, limitations in conversational knowledge that involve the general shared grounding for communication may preclude good performance on ToM tasks. Late signers retain difficulties even when questions are conversationally supported in specifying that the tasks are intended to refer to how a person with a false belief will initially be misled.

Of course, the results of the present investigation do not mean that late signers are completely without insight into others' mental states. Marschark, Green, Hindmarsh, and Walker (2000) have recently reported that late signers age 8 to 13 years (considerably older than most children tested in the present studies) have the ability to attribute mental states correctly in generating stories about others with whom they have interacted hypothetically. Yet paradoxically Russell et al. (1998) found that problems on certain ToM tasks that require verbal story comprehension remain in deaf children of hearing parents even at the age of 13 to 16 years of age. Although performance on a wider range of tasks should be considered, this discrepancy may be reconciled in terms of Keil's (1989) observation with regard to children's lack of success on tasks in which they are required to reason about reality and the phenomenal world of appearances and beliefs. According to this account, it may be that children's difficulties do not necessarily reflect their intrinsic inability to deal simultaneously with two representations in general (i.e., of reality and false beliefs), but rather their lack of knowledge about how to deal with the apparent contradiction between the two in predicting behavior. In comparison with late-signing children even in adolescence, native-signing deaf children enjoy an early conversational access that facilitates acquisition of the specific ability to interpret the behavioral outcome of mental states (i.e., that behavior is determined by false beliefs rather than reality) on measures of ToM reasoning.

In this respect, more research is required to address processes by which children come to share others' beliefs in the conversational networks of deaf late- and native-signing children. There is a need to explore how the actual quality of communication between the deaf and their conversational partners influences their ToM understanding.

ACKNOWLEDGMENTS

This article was prepared with support to T. W. from the Lord Snowdon Trust and the Wingate Scholarship Fund and by a Nuffield Foundation New Career Development Fellowship grant to S. C. W. and M. S. The authors thank the anonymous reviewers for their many helpful suggestions.

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