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Nicaraguan Sign Language and Theory of Mind: the issue of critical periods and abilities

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Background: Previous studies in the literature report that deaf individuals who experience late access to language perform poorly on false belief tests of Theory of Mind (ToM) compared with age-matched deaf and hearing controls exposed to language early. **Methods:** A group of 22 deaf Nicaraguans (aged 7 to 39 years) who learned Nicaraguan Sign Language (ISN) at different ages were tested on a false belief and a nonverbal cartoon retell task designed to elicit talk about the contents of character's mental states. **Results:** Access to sign language by 10 years of age with possible advantages in language fluency was a strong predictor of performance on both the false belief task and mental state narrative task. However, a comparison of performance on the two tests indicated that children and adults who learned sign after the age of 10 were still able to demonstrate a more general ability to use mental state expressions in narratives. Results are discussed in terms of late access to language and critical periods for the parallel development of Theory of Mind and language. **Conclusions:** The findings point to age 10 years as a crucial period when lack of language exposure can lead to long-lasting deficits in false belief abilities. Late exposure to sign language does not, however, rule out all aspects of the ability to consider others' mental states. This paper also highlights the need to take into consideration a variety of communication responses when evaluating deaf children's ToM reasoning. **Keywords:** Theory of Mind, false belief, deaf, sign language. **Abbreviations:** ToM: Theory of Mind; ISN: Nicaraguan Sign Language.

Theory of Mind (ToM) allows an individual to understand that other people have mental states different from one's own that motivate their actions (e.g., knowledge, belief and desire) and is considered the hallmark of successful human social cognition. Research on deaf children's ToM abilities has focused on the role of language development and the understanding of false belief (e.g., Peterson, 2004; Courtin & Melot, 2005; Harris, de Rosnay, & Pons, 2005). This research consistently finds an advantage shown by early/native signers over late signers in performance on ToM tests. While false belief may be the epitome of the realisation of ToM, it is only one piece in a constellation of knowledge components of mental states. The present study investigates language exposure and success on false belief tasks as well as more general reasoning about others' mental states. We ask new questions about how reasoning about false belief and early exposure to language are linked. By what process do deaf children build a ToM in the absence of formal language exposure? What ToM abilities are robust enough to develop in situations of late language exposure?

We have access to a unique population of deaf individuals on the Atlantic coast of Nicaragua whom we have studied longitudinally since their first contact with Nicaraguan Sign Language (ISN). They came to this situation at different ages spanning development before, during and after those maturational points at which the critical period for language acquisition is said to be in effect (exposure before 6 years for native abilities and not later than 10 years for near native abilities – e.g., Newport, Bavelier, & Neville, 2001; Senghas & Coppola, 2001). We have a rare opportunity to look at, within this natural experiment, the interaction between the development of language and ToM. Furthermore, since we have lived with these subjects over long periods of time, we can bring to bear on the interpretation of these false belief results not only language data, but also observations of the coping strategies that individuals who pass or fail the false belief task use in their daily lives.

As we examine the results of a false belief task administered to early and late learners of ISN, we will grapple with the issue of whether one can develop ToM capacities in a non-linguistic fashion or via a variety of hybrid processes that bring together world experience, observation, mental simulation and possible linguistic reflection. Ultimately, we question what behaviours and results can be considered evidence of ToM.

Developmental studies of ToM

Typically developing hearing children express ToM reasoning around the age of 4 years (Wimmer & Perner, 1983) and possibly considerably earlier (Yazdi, German, Defeyter, & Siegal, in press). ToM performance itself may be dependent on the language processing requirements of the tasks and the child's access to a language environment that allows him or her to make sense of others' mental states. Part of the problem in acquiring a ToM is that chil-

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dren need to join up their observations of the behaviour of others with developing language ability in describing and labelling mental states. Access to language enables the ambiguous behaviour of others to be described in focused terms ('thinking', 'wondering', 'dreaming', 'forgetting' etc.). Some researchers claim that children gain insights into others' behaviours through simulation and inward reflection on their own mental states, when hearing explanations for other people's similar behaviours (Gordon, 1986).

Language ability is considered as one of the crucial ingredients in the development of ToM (e.g., Lohmann & Tomasello, 2003). One possibility is that exposure to human verbal interaction promotes the child's ToM (Siegal, Varley, & Want, 2001; Ruffman, Slade, & Crowe; 2002; Harris et al., 2005). Peterson and Siegal (1995, 1999) have suggested that an understanding of people's mental states is both a prerequisite for and emerges out of the pragmatics of conversational communication. Ruffman et al. (2002) studied pairs of mothers and their children aged 3 to 4 years and recorded conversations about picture books that included mental state language by the mother. Mothers' use of terms such as *think*, *know* and *hope* predicted children's later theory of mind performance. Another approach argues that it is the child's acquisition of the syntax of complementation that enables the child to reason about other minds. Complementation is needed for the expression of propositional attitudes such as beliefs and attitudes and so would be uniquely suited to the conceptual representation of false beliefs (De Villiers, 2000; de Villiers & Pyers, 2002). Recent studies of ToM development in children learning languages other than English have argued against the idea that syntax contributes uniquely to ToM development (Cheung et al., 2004).

Determining the nature of the relationship between language development and ToM is difficult because normal language development is inextricably part of the experience of children in the typical case. Both cognitive domains develop in parallel. However, the common experience for a deaf child frequently involves late and impoverished access to a first language, because 90 to 96% of deaf children are born to hearing parents.[1] These adults have no knowledge of sign language or how to modify their communication when interacting with a young deaf child, making conversation with their children about the mind difficult (Spencer, 1993).

Several studies have reported that deaf children from hearing homes with language delay also exhibit delayed development of ToM as measured on false belief tasks. The findings from deaf children with late access to a sign language contrast with recent studies of deaf children who, with full access to a sign language from early childhood, show no language or ToM delays (e.g., Courtin, 2000; Woolfe, Want, & Siegal, 2002; Courtin & Melot, 2005).

Siegal and Varley (2002) p. 469), writing about the delayed development of ToM in deaf children, argue for the notion of 'a critical period in ToM'. Just as children need exposure to language (or language-like) input within a critical period of language development, it seems children need critical exposure to discussions of mental states and evidence that the mental states of others can be different from their own to develop a viable system of social cognition. It is not clear at what age a critical period for ToM might end, although if we assume it is tied into first language acquisition then some language studies point to age 6 years as a cut-off period for determining a signer's ability to be judged native-like (Newport et al., 2001; Kegl, Senghas, & Coppola, 1999). More recent studies of children exposed to ISN at different ages put the critical period for acquisition benefits before 10 years, after which children are judged late learners (Senghas & Coppola, 2001).

Difficulties in reasoning about ToM would extend into problems in understanding humour, deception, confusion, reasons for social events and rituals and, importantly, preclude one from forming mature interpersonal relationships. There is therefore a crucial importance in getting the measurement and interpretation of the test right when working with deaf late language learners. Would a deaf adult be a responsible parent if he or she were to fail a ToM task that 5-year-old hearing children pass?

There are other ways to assess children's ToM (Bloom & German, 2000). Moore, Pure, and Furrow (1990) used stories that hearing children told about themselves, others and fantasy characters to assess ToM. The more children used mental state propositions in their narratives the better they performed on the false belief task. Marschark et al. (2000) adopted this methodology with a group of 15 deaf children aged 9–15 years who had learned some language in early childhood, compared with their hearing agemates. Despite the deaf children having varying language abilities, very few differences in talking about mental states were found between the two groups.

One question not addressed up to this point in the literature is how a deaf child could develop an understanding of the opaque mental world of others without the language input that accompanies social interaction. Some indication comes from simulation theory (e.g., Gordon, 1986). In this framework normally developing children gain an insight into others' mental states and develop ToM by analogical reasoning using their own thoughts and reactions to particular situations and events they observe which they extend to third persons who appear in similar situations (Meltzoff & Brooks, 2001). ToM achieved through observation and inference would be labor-

[1] 'Deaf' in this context means born with a hearing loss that significantly impacts on the ability to acquire spoken language.

ious and unreliable (Perner, 2000) and it is not clear what specific abilities this atypical learning experience would give you in terms of successfully understanding different mental states. For example, if deaf children used appearance to gain an insight into the mental world of others, situations where other people behave one way but are thinking another would be extremely difficult to capture.

The Nicaraguan case

During the past 25 years a community and sign language has developed in Nicaragua following the establishment of the first schools and vocational colleges for deaf children and young adults. During this period Nicaraguan Sign Language (ISN) emerged through interaction between previously isolated deaf people and the process of language acquisition by subsequent cohorts of children exposed to their initial gestural contact communication (Kegl & Iwata, 1989; Kegl et al., 1999; Senghas, Kita, & Ozyurek 2004).

Despite there being an established community and sign language in Nicaragua, there continue to this date to be many cases of deaf children growing up in relative isolation from other deaf people, and with no access to signed or spoken language. Despite these individuals being Nicaraguan, they share many experiences with other deaf children in North America and Europe who find successful language development under such conditions extremely difficult and consequently have language and ToM delays.

Within the deaf population of Nicaragua there are children who learned to sign during early childhood and have no delays in language and also adults who have only started to learn to sign for the first time (Kegl et al., 1999). Across these individuals differences are apparent in the naturalness of language learning. Because signed language development has taken place out of the critical period for language acquisition (e.g., Newport et al., 2001) it resembles more a second language (Kegl, 2002).

Communication and language in gesture and signed language

Because late learners use a variety of means to communicate, tests of false belief might not be sensitive enough to measure expressions of ToM in all cases. All signed languages use manual signs that express mental states, e.g., MIND, MEMORY, THINK, KNOW, NOT-KNOW CONFUSION, BELIEVE.[2] However, signers may choose to express these ideas not with signs on their hands but instead through facial expressions and gestures (Emmorey, 1999). For example, signed languages make frequent use of a discourse device called role shift to express direct speech (quotation) or direct action (commentaries on what someone is doing at a give moment (e.g., 'there I was writing a note'). Often a facial or body gesture may occur during one of these role shifts that could be taken to express a mental state (a confused look, diverted gaze indicating inattention). When signing 'John did not know' it is allowable to sign John's mental state through a puzzled facial expression.

The current study will use role shift as one of the measures of mental state talk. As hinted at previously, using narrative to examine children's understanding of mental states has limitations. It is only possible to look at signed stories as the expression of ToM understanding while false belief tasks are assumed to be a direct measure of the reasoning behind false belief, as they require predictions of future behaviours based on inferred mental states. Late learners may have learned appropriate actions and reactions in certain situations (laughing when somebody falls over, hiding by moving behind a door etc.) without having in their possession an understanding of others' mental states. Gesture and facial expression could equally sometimes be over-interpreted.

Aims of the research

This investigation looks at false belief abilities in children and young adults who have had access to language at different ages. It compares success on false belief tasks with narratives which talk about general mental states. The assessment of ToM in this group takes account of a wider range of communication strategies than just manual signs in the expression of others' mental states. How far ToM can develop without full access to language relates to the simultaneous early development of language and ToM in the typical case (Bartsch & Wellman, 1995; Peterson & Siegal, 1995; de Villiers, 2000) and developmental critical or sensitive periods (Newport, Bavelier, & Neville, 2001; Siegal & Varley, 2002).

Methods

Participants and language abilities

A total of 22 ISN signers aged 7 to 39 years took part. All the participants were severely to profoundly deaf and the offspring of hearing parents. Each participant was a student in a deaf school with a signed language intervention program, situated in the town of Bluefields on the eastern coast of Nicaragua. Participants differed in ages when they entered the school and began learning full ISN from fluent adult signers (ranging from 5 to 33 years). Based on the critical period literature, we compared ToM abilities in two groups: 1) those who had been exposed to ISN by 10 years of age (early learners) and 2) those who had been exposed to ISN after this age (late learners).

[2] Signs are translated into English glosses with hyphens if more than one English word is needed to capture the sign's full meaning.

The eleven early language learners were aged between 8 and 24 years at the time of testing (M = 13.9 years, SD = 4.87) and had had access to ISN from the ages of 5–10 years (M = 6.8 years, SD = 1.79) for between 1 and 19 years' duration (M = 7.18 years, SD = 5.72). The eleven late language learners were aged between 12 and 39 years at the time of testing (M = 24.1 years, SD = 7.31) and had had access to ISN from the ages of 12–33 years (M = 19.1 years, SD = 6.75) for between 2 and 14 years' duration (M = 5.9 years, SD = 3.02).

None of the participants had deficits in non-verbal intelligence indicated through standard performance tests (e.g., Raven's Progressive Matrices). There are currently no standardised measures of ISN fluency in child or adult signers and so we could not carry out a full measure of language competence with participants prior to ToM testing. However, each participant, according to teacher judgements (native signers), exhibited command over ISN grammar that was commensurate with age at exposure and years of contact with the deaf community. We also compared the linguistic complexity of the narratives produced by all the signers in both groups. While there were differences between the groups in terms of the mental state propositions mentioned, both groups were comparable in their use of different linguistic devices.

As a control group we collected signed language data from 5 adult fluent signers from the capital city of Managua (aged between 17 and 35 years). These signers had been exposed to ISN during early childhood from older children and adults in a school for deaf children.

Assessment of ToM

Test of false belief. The choice of material was based on previous research involving deaf individuals with different language abilities and 'thought bubble' pictures (Woolfe et al., 2002). Although this is a common cartoon device for showing thinking in Nicaragua, and in fact the sign for daydreaming or thinking to oneself is indeed a THOUGHT-BUBBLE, as a prerequisite for inclusion, participants had to demonstrate understanding of the concept. Participants had to decide from two pictures showing a boy with an object (either in front of him or inside a thought bubble) as to which showed the boy 'thinking about the object'.

Four scenarios are then presented: 1) a boy fishing thinks he has caught a fish but really it is an old boot; 2) a girl thinks she sees a tall boy over a fence but really the boy is stood on a box; 3) a man reaches towards a can of beans but finds a mouse in there instead; and 4) a man thinks he sees a fish in the sea but really it is a mermaid.

In each trial, a flap acting as an obstruction covered the central object (the old boot, box, mouse or mermaid) from the character's view. In the true belief version of the fishing scenario, when the reeds were removed it was revealed that the character had caught a fish, but in the false belief version, removal of the flap revealed that the boy had caught an old boot. The fish scenario is shown in Figure 1 where both false and true belief scenarios are shown with the flap removed.

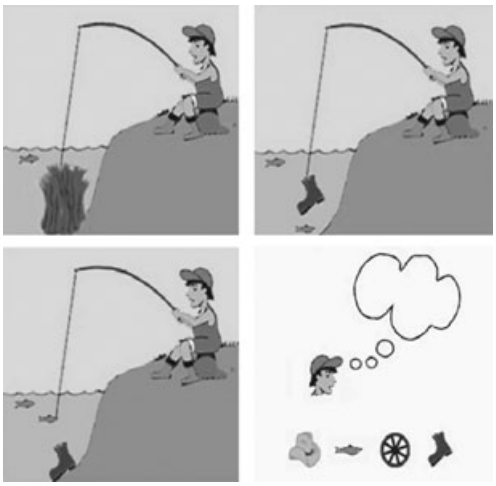

Figure 1 Pictures used in one of the 'false belief' scenarios. (Adapted from Woolfe, Want, & Siegal, 2002). The first picture (top left) shows the initial scenario as presented to the participant. The central object is clearly not visible behind the obstruction. Once the flap is removed the false belief version is shown in the next picture (top right) and the true belief version of the third picture (bottom left). The response picture showing the empty thought bubble is shown in the fourth picture (bottom right) along with the example false belief picture items including the actual item, the belief item and two distracters

First, participants were asked to describe the picture, e.g., 'the man is fishing'. Then participants were instructed to cover the character's eyes with their hand while the flap was removed in order to emphasise the character's ignorance of the contents. Once the participants had viewed the pictures (e.g., either an old boot or a fish) and replaced the flap, they were shown a separate picture of the main character with a blank thought bubble above his/her head. Next to this picture were a further four small pictures. For the false belief version, two of these were distracters (e.g., a wheel and a hat), one showed the character's belief (e.g., a fish) and the other was the actual object (e.g., an old boot). In the true belief version, the true object of the belief was shown along with three distracters. Participants were asked to point to which of the four picture items showed what the character was thinking about. The four scenarios were randomised as to whether they were true or false belief tests. Participants passed this test only if they were correct on all four of the trials.

Moral dilemma narrative. A narrative was elicited based on the retelling of a 1.5-minute non-verbal cartoon entitled 'Mr Koumal battles his conscience' (Studio Animovaného Filmu, 1973). Participants were asked to explain the events in the story to a fluent adult signer. The cartoon follows the moral dilemmas of Mr Koumal as he argues with himself whether to keep or return a bundle of bank notes he observes a rich lady accidentally let fall. Signed narratives were collected from the control group of 5 adult fluent signers and transcribed and coded by the authors and trained researchers. Intercoder reliability for a sample of narratives was above 90%.

Scoring. When assessing the control group's and participants' narratives criteria were followed to avoid over-interpretation. In scoring descriptions of mental states we included reference to the character's words, actions and thoughts through both manual signs and also descriptions through role-shift. In the latter category descriptions were coded as expressions of mental states only if the signing elaborated on the actions, facial expression or gestures of characters depicted in the non-verbal cartoon. A direct imitation by a participant of a character's puzzled expression alone was not counted. Elaboration of the character's behaviour through subsequent signing by the participant was required.

For example, after Mr Koumal changes into the Devil, he thinks about or imagines how he is going to keep the money and spend it. Participants had to refer to this event through some description of the desire, thought process and planning involved that was not directly evident in the cartoon. This could be through a manual sign, e.g., IMAGINE, and/or through facial expressions describing the malevolent scheming or temptation the character was experiencing.

This conservative process produced a list of eight core mental states that all 5 fluent adult signers talked about which was used as the standard narrative content with which we compared the participants' narratives. The mental states expressed in the control group's narratives are shown in Table 1.

Results

There were two true belief and two false belief trails. All participants correctly identified the contents of the thought bubble in the two true belief trials (scoring 2/2). Only some of the late learners resolved the false belief trials (scoring 2/2). None of the participants passed one of the true belief/false belief trials but failed the other. The early learners significantly outperformed late learners on the false belief element. In terms of passes on the two false belief trials, 10 early learners passed both trials ($M = 1.81$, $SD = .6$) compared with only 4 passes from the 11 late learners ($M = .73$, $SD = 1.01$, $t(20) = 3.078$, $p < .01$). We looked at length of exposure to the language as a variable in the differences in understanding false belief, $t(20) = .65$, not sig. Years of exposure to ISN did not therefore predict success on the false belief task.

Table 1 List of standard mental states described in the control group's narratives

Events	Mental states
1. A rich-looking woman drops a bundle of bank notes without noticing.	Lack of knowledge
2. Mr Koumal sees that the woman has left without realising her loss.	Knowledge, belief
3. Mr Koumal cannot decide what to do.	Doubt
4. The Devil wants to keep the money.	Desire
5. The Devil imagines what he could do with the money.	Thinking, dreaming, scheming, imagination
6. The Angel tries to resist temptation.	Decision
7. The Angel thinks about giving back the money and being rewarded.	Purpose/goal, intention
8. The beggar takes the money without Mr Koumal seeing or knowing.	Deception

In the second measure narratives were scored against the list of 8 propositions identified in the control group. All participants mentioned some mental states (between 1 and 8 propositions). A comparison of the two groups of signers revealed that age of exposure to ISN by 10 years of age had less impact on ToM abilities measured in the narrative task than it did in the false belief task. The early signers mentioned between 3 and 8 propositions ($M = 6.55$, $SD = 2.16$) compared with the late learners who mentioned between 1 and 8 propositions ($M = 5.64$, $SD = 2.5$), $t(20) = .912$, not sig. While the total scores did not differ between groups, the particular types of mental states mentioned did differ.

Although participants mentioned all of the mental states in the control group list, there were markedly more omissions of the propositions *'lack of knowledge'* and *'deception'* across the set. Crucially, both mental states include elements of false belief, the mental state linked to performance on the thought bubble test. From the 14 participants who passed the false belief task, ten individuals (71%) mentioned both *'lack of knowledge'* and *'deception'*. From the eight individuals who failed the false belief task, only three (37%) mentioned *'lack of knowledge'* and two (25%) described *'deception'*. The two propositions closest to false belief are difficult for the individuals (mostly late learners of ISN) who fail the false belief task.

Although length of exposure to ISN was not important in determining participants' success on the false belief test, it was related to participants' narrative abilities, $r = .43$, 18 d.f., $p < .05$. The low scoring participants on the narrative task (1–3 propositions) had differing amounts of exposure to ISN than others in the group (less than 5 years), suggesting that amount of exposure to ISN influences the ability (linguistic or metacognitive) to talk about mental states in narrative. Put simply, the better signers were able to talk more (including talk about mental states) than the signers who had had less exposure to ISN.

We revisited age of access to sign and narrative abilities by looking at the children up to age 8 years as one group. We did this so as to isolate where most success on the task seemed to fall. If the early learners are grouped as 5–8 years rather than 5–10 years for first access, 7 out of 9 scored a perfect 8 on the narrative and one of the children that did not score 8 (participant 9) had experienced only 1 year of

Table 2 Scores on the false belief and narrative tasks (X = no mention of mental state)

Participant	Age at test (years)	Age at access to ISN (years)	Years of exposure to ISN	True belief (2 trials = pass)	False Belief (2 trials = pass)	Narrative (max. 8)	Lack of knowledge	Knowledge, belief	Doubt	Desire	Thinking	Decision	Purpose/ goal	Deception
Early learners	10	5	5	2	2	8								
	24	5	19	2	2	8								
	9	5	4	2	2	3	x	x		x	x			x
	22	5	17	2	2	8								
	14	5	9	2	2	8								
	11	7	4	2	2	8								
	14	8	6	2	2	8								
	11	8	3	2	2	8								
	8	8	1	2	2	3	x		x	x			x	x
	15	9	6	2	0	6	x							x
	15	10	5	2	2	4	x		x				x	x
Late learners	26	12	14	2	0	6			x	x				x
	18	13	5	2	0	2		x	x	x	x	x		x
	20	14	6	2	2	8								
	20	14	6	2	2	8								
	20	14	6	2	2	6	x							x
	17	12	5	2	0	7	x							
	23	17	6	2	0	6	x							x
	35	29	6	2	2	8								
	26	23	3	2	0	1	x	x	x		x		x	x
	26	24	2	2	0	3	x	x		x	x		x	x
	39	33	6	2	0	7			x					

sign language exposure. By contrast, of the now 13 late learners (age of access 9–33 years) only 3 had a perfect score of 8, Fisher's Exact, $p < .025$. While the late learners are able to talk about mental states in their narratives, they talk about different types and significantly less than earlier learners.

Next we looked at performance across the two tests. The 14 participants who passed the false belief task talked about more mental states in their narratives (M = 6.7) than the 8 participants who failed (M = 4.5). Furthermore, of the 8 who failed the false belief measure, none had a perfect narrative score compared with 10 of the 14 false belief passers, $\chi^2 = 10.48$, $p < .02$. This difference suggests a strong relationship between the two tests in picking out aspects of ToM reasoning abilities. Individual performance on both tasks is presented in Table 2 along with participants' age of first exposure and years of exposure to ISN.

Discussion

Our findings confirm several previous studies of early and late language exposure in deaf children and effects on ToM reasoning (e.g., Peterson, 2004; Courtin & Melot, 2005; Harris et al., 2005). Early language exposure predicts deaf children's performance on false belief measures. Our research, however, confirms that late exposure to language does not preclude deaf children from developing important ToM abilities. Late learners can demonstrate a wide range of insights into others' mental states. We are restricted in our study of this new sign language by lack of any standardised measures of ISN receptive or expressive fluency. It could be the case that late learners, despite having the same amount of exposure to ISN as the early learners, fail the false belief task because of linguistic rather than ToM reasons. However, narratives in the late learners were judged to be linguistically complex by teachers while lacking false-belief-related mental state propositions.

The pool of subjects for this study is unique. None of them came to the task as native speakers of ISN in the sense of exposure to the language from birth, but many came within that window of time said to be the critical period for language acquisition – less than 6 for native-like acquisition; less than 10 for some acquisition benefit (see Kegl et al., 1999; Newport et al., 2001; Senghas & Coppola, 2001; Mayberry, Lock, & Kazmi, 2002). The data seem to fall roughly into two classes: those under the age of 10 at first exposure and those older than 10 at first exposure. The possible critical period for native language acquisition and potential for passing this false belief ToM task seem staggered in time but still in lockstep.

Much has been said about the interdependence between language capacity and ToM. De Villiers and Pyers (2002) have made the strong claim that children must have syntactic mastery over sentential complement constructions such as *John thinks that X* before they can pass the false belief task. Review of the literature reveals more and more consensus regarding a criterial relation between language development, in particular syntactic development, and ToM. Language development through fragmented and inefficient simulation and inference will lead to parallel non-native ToM abilities.

Falkman (2005) argues for a possible separation between *competence* in terms of the conceptual understanding required to solve the false belief task and *performance* in terms of the linguistic and pragmatic skills needed to understand the instructions of the task and to more efficiently demonstrate competence in the task. Siegal and Varley (2002) have used the term scaffolding to cover those performance factors that impact the demonstration of competence.

Since performance can mask conceptual competence, we cannot conclude that individuals who fail the false belief task lack ToM. However, the strong relationship between language exposure in childhood before 10 years of age (leading to native or near native language capacity) and performance on the false belief task is highly suggestive of the conclusion that the false belief task is language dependant. Early exposure to language is important in fostering efficient and natural ToM development and for providing children with effortless types of linguistic computation required for the false belief task. Late exposure to language does not preclude deaf individuals from understanding the mental world of others but it does set up a more difficult problem for deaf children to solve: how to develop an understanding of others' mental states without the necessary linguistic labels to explicitly reflect on these concepts. Deaf people who fail the false belief task do not exist without a ToM for understating the mental world of themselves and people around them.

In our everyday experience, the individuals who are failing and those that are passing this false belief task are currently conversing with each other on a daily basis regarding their beliefs, desires and thoughts. Despite a bifurcation in those who passed and failed the false belief task, in the second test there were less marked differences between the groups in talking about mental states. There was no significant distinction between the reference to belief, doubt, desire, thought, decision, purpose and goal in their recounting of the moral dilemma narrative task. All eight participants who did not pass the false belief task mentioned at least one mental state and five individuals expressed between 6 and 7 different mental states in their narratives. A narrative measure does not demonstrate unambiguously false belief reasoning, only that there is an appreciation of behaviour-relevant mental states (Marschark et al., 2000; Terwogt & Rieffe, 2004). Narratives also allow the possibility to produce scripted or simple descriptive explanations of the events in a cartoon

without understanding the difference between an inferred mental state and reality. Withstanding these difficulties, the task demonstrates that deaf individuals, who fail a false belief task, understand that mental states can cause action, which is the essence of ToM (Bloom & German, 2000).

However, we do recognise that difference in performance between the early and late learners does extend to aspects of performance on the narrative test. Although the late signers did appear to perform better than on the false belief task, a closer inspection of the data shows that whereas 10 of the 13 participants who passed the false belief tasks also had a perfect score of 8/8 on the narrative tasks, none of the 8 participants who failed the false belief tasks had a perfect score. The mental states that late learners of ISN consistently failed to mention in their narratives were *'lack of knowledge'* and *'deception'*.

Why does late access to language lead to poor performance on both tasks in areas related to false belief? Reasoning about beliefs has always been judged as one of the most difficult mental states to capture from others' behaviour without good language abilities (de Villiers, 2000). Deception and false belief are situations where appearance does not match reality. Simulation theory (Gordon, 1986) requires young children to go from an understanding of their own mental states to understanding the thinking of others (Meltzoff & Brooks, 2001). It is always assumed that this is achieved with full access to the conversation about mental states that hearing children are exposed to. The mental states that are understood by late language learners may be those most accessible through observation coupled with fragmented exposure to language.

For many deaf late sign learners, language and ToM have not developed in tandem. Instead, the relationship between the two is disjointed and fragmented. In this framework, the nature of computing false belief is much like doing grammaticality judgements in language tests. Early exposed speakers perform perfectly and effortlessly on grammaticality tasks compared with late learners whose knowledge, when put in demanding situations, appears superficial and errorful (Birdsong, 1992). In the same way it may be the case that the false belief task requires you to be a native 'ToM speaker'. Native in this sense means having developed an understanding of the metal states of others through a natural process of language acquisition beginning at some time period before 10 years of age.

Conclusions

The main findings of this study are that Nicaraguan deaf children exposed to sign language by 10 years of age do significantly better on a false belief task of ToM than children exposed to language after 10 years, supporting previous studies in the literature. Performance on a narrative measure of a wider range of ToM abilities showed that late learners were able to reason and talk about many ToM components (including knowledge, desire, decision making and beliefs), suggesting that even very late language development does not preclude children from developing an understanding of the invisible mental world of others. However, on both ToM measures, the late group of language learners had consistent difficulties with 'deception' and behaviour motivated by 'lack of knowledge'. Building a ToM without language means that either reasoning about or expressing an understanding of the nature of false beliefs proves a difficult challenge.

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