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Early conversational environment enables spontaneous belief attribution in deaf children

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ABSTRACT

Previous research suggests that deaf children who grow up with hearing parents display considerable difficulties in understanding mental states of others, up to their teenage years when explicitly asked in a verbal test situation (Meristo et al., 2007). On the other hand, typically developing pre-verbal infants display evidence of spontaneous false belief attribution when tested in looking-time tasks, although verbal tests are typically not passed before the age of 4 years (Onishi & Baillargeon, 2005). The purpose of the present study was to examine whether deaf children of hearing parents are able to demonstrate spontaneous belief attribution in a non-verbal eye-tracking task. Thirty 4- to 8-year-old, deaf and hearing children, completed a non-verbal spontaneous-response false-belief task and a verbal elicited-response false-belief task. The deaf children were either children with cochlear implants or children with hearing aids. Comparative analyses were also carried out with a previous sample of deaf and hearing 2-year-olds (reported in Meristo, Morgan, et al., 2012). We found that in the non-verbal spontaneous-response task typically hearing children, but not deaf children, were able to predict that a person with a false belief about an object's location will search erroneously for the object. However, hearing children and deaf children with implants, but not deaf children with hearing aids, passed the verbal elicited-response task. Language development was significantly correlated with both types of false-belief tasks for the whole sample. Our findings strengthen the hypothesis that the emergence of the ability to recognize others' beliefs needs to be supported initially by very early conversational input in dialogues with caregivers.

1. Introduction

Children who are born profoundly deaf and grow up with hearing parents are disadvantaged in important ways in participating in everyday conversational interactions with their family and peers. These children do not have impairments that lead them to be averse to social interaction, but the lack of access to communicative situations using a common language is likely to have serious consequences for their language development, literacy and social-emotional development. Previous research has demonstrated that deaf children from hearing families display considerable difficulties in understanding mental states of others (theory of mind or ToM) up to their teenage years, when explicitly asked in a verbal test situation (Meristo et al., 2007). This delay does not affect deaf children from deaf families who are exposed to a signed language from birth (Peterson & Siegal, 1999). Thus, the case of environmental influences in ToM development in deaf children is of great theoretical interest since they offer an opportunity to disentangle some of the variables thought to be of importance in this respect (Corina & Singleton, 2009). Previous studies have investigated the ways in which children's ToM development is fostered by interaction with caregivers, and have shown that deaf children's early experiences of communicative interaction with their hearing parents are very different compared to hearing children (Harris & Chasin, 2005; Meadow-Orlans & Spencer, 1996; Moeller & Schick, 2006; Morgan et al., 2014; Vaccari & Marschark, 1997).

Onishi and Baillargeon (2005) designed a non-verbal looking time task to examine typically developing hearing infants' abilities to attribute a false belief to another person. Even 15-month-olds displayed a pattern of visual attention in line with the suggestion that they expected a person with a false belief about an object's location to search unsuccessfully for the object. There is now

Abbreviations: CI, cochlear implant; ER-FB, Elicited-Response False-Belief task; HA, hearing aid; PPVT, Peabody Picture Vocabulary Test; RCPM, Raven's Coloured Progressive Matrices; SR-FB, Spontaneous-Response False-Belief task.

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further evidence from various tasks that typically developing infants during the first half of their second year of life exhibit an incipient ability to attribute both reality congruent and reality incongruent mental representations to others (Buttelmann, Carpenter, & Tomasello, 2009; Luo & Baillargeon, 2007; Meristo & Surian, 2013; Southgate, Chevallier, & Csibra, 2010; Surian, Caldi, & Sperber, 2007), and possibly even earlier (Kovács, Téglás, & Endress, 2010; Southgate & Vernetti, 2014).

Mentalizing skills in typically developing, hearing children have been related to mothers' use of mental state talk with their young infants. Meins et al. (2002, 2003) found that mental state comments that match with their 6-month-old infants' concurrent state of mind (the so-called 'mind-minded' talk) affects the infants' ToM performance several years later. In the case of deaf preschool and school age children, hearing parents' use of appropriate mental state comments may be more difficult to accomplish when the children have severe language delays and the hearing caregivers find communication with their deaf children effortful (Moeller & Schick, 2006). Hearing mothers of deaf infants and toddlers tend to use less cognitive mental state language and their conversations are characterized by less communicatively effective turn-taking (Morgan et al., 2014). Moreover, hearing parents seem to spend less time in coordinated joint attention with their deaf children than with their hearing children (Harris & Chasin, 2005) and tend to interrupt the child's attention by initiating new unrelated activities (Meadow-Orlans & Spencer, 1996). A key issue from this perspective is whether such mismatching in early interaction between deaf infants and their hearing caregivers is reflected in differences in mentalizing abilities.

The aim of the present study was to explore to what extent deaf children between 4 and 8 years of age demonstrate spontaneous looking behavior indicative of ToM reasoning. In a recent Swedish study, Meristo, Morgan, et al. (2012) found that deaf two-year-olds from hearing homes, in contrast to typically developing hearing infants and toddlers, were not able to predict the search behavior of a cartoon character who held a false belief about an object's current location in an anticipatory looking spontaneous-response false-belief (SR-FB) task ("Tom & Jerry"), developed by Surian and Geraci (2012). Here, we extend the previous results with an older age group of deaf preschool and primary school children, by contrasting children with various degrees of access to a language and conversational environment and giving them the same SR-FB task. The data from the 2-year-olds in Meristo, Morgan, et al. (2012) are here also reanalyzed together with the current group of hearing and deaf children aged 4–8 years. In this way we can study the developmental trajectory of spontaneous, non-verbal false belief among deaf children of hearing parents from infancy to early school age. Our hypothesis is that the lack of the earliest language-monitored social interaction will considerably delay also the development of the spontaneous false belief attribution at ages far above the two-year-olds we previously studied. If our hypothesis is supported, it would importantly add to the many results showing that the verbal elicited-response false-belief tasks show a protracted development among deaf children of hearing parents (Woolfe, Want, & Siegal, 2002). It would also strengthen the need for probing even further down in the ages to delineate the factors promoting and impeding, respectively, the development of the earliest mentalizing skills, where variations in language access will be of paramount interest.

2. Material and methods

2.1. Participants

These were 15 typically developing hearing children from Sweden and 15 pre-lingually deaf children from Estonia. All children were healthy and without additional disabilities such as cerebral palsy, autism, intellectual disability, or visual impairment. The parents of deaf children were contacted through Tartu University Hospital and two deaf schools in Estonia. We also contacted parents of deaf children in Western Sweden through relevant organizations but the response rate of this group was very low. As the societal contexts for hearing children in Sweden and Estonia are similar, we did not add an additional sample of typically developing hearing children from Estonia. All parents were informed about the purpose and procedure of the study and gave signed consent. The Regional Swedish Government Ethical Review Board and Tallinn Medical Research Ethics Committee in Estonia approved the study.

The children were divided into three groups (Table 1).

Group 1 (TH-children) included 15 typically hearing Swedish children (7 girls, 8 boys) with a mean age of 5 years and 11 months (range: 4 years 1 month–8 years 11 months). The majority of parents had completed high school (93%) and 14 out of 15 children had at least one sibling.

Group 2 (CI-children) consisted of 8 Estonian children (6 girls, 2 boys), with pre-lingual profound hearing loss, who used cochlear implants (CIs) (mean age 6 years 5 months; range: 3 years 11 months–8 years 5 months). The CI is an electronic device directly stimulating the auditory nerve (Rauschecker & Shannon, 2002). The mean age of first implantation was 21 months (range: 16 months–33 months) and the mean time since the first implantation was 4 years and 8 months (range: 2 years 4 months–6 years 3 months). At the time of the study, 5 children had bilateral CIs, while 3 had a unilateral CI. None of the children in Group 2 had any deaf relatives, or native signers, in their immediate family. All children were tested in spoken Estonian by a hearing assistant, except one child who preferred Estonian Sign Language (ESL). All parents in this group had completed at least high school, and 6 out of 8 children had at least one sibling.

Group 3 (HA-children) included 7 Estonian children (3 girls, 4 boys) without cochlear implants. They had hearing levels in the moderately deaf range (between 45 and 65 dB in the better ear) and used conventional amplifying hearing aids (HAs), except one child who used a bone anchored hearing aid. The mean age of Group 3 was 5 years and 8 months (range: 4 years 0 months–7 years 11 months). They were on average 22 months old (range: 6 months–56 months) when they first started to use the HAs, and they had used their HAs on average 5 years 0 months (range: 2 years 4 months–7 years 2 months). None of the children in Group 3 had any deaf relatives, or native signers, in their immediate

Table 1
Mean chronological age (CA), Raven's Coloured Progressive Matrices (RCPM), Peabody Picture Vocabulary Test (PPVT) and Elicited-Response False-Belief task (ER-FB).

	Typical hearing (TH)			Cochlear implants (CI)			Hearing aid (HA)		
	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
CA	5:11	1:6	4:1–8:11	6:5	1:6	3:11–8:5	5:8	1:7	4:0–7:11
RCPM	21.1	7.4	11–35	25.1	6.0	16–33	19.3	5.6	12–28
PPVT	119.7	27.4	70–168	99.6	34.8	42–134	78.7	33.3	45–136
ER-FB (max 3)	2.4	0.8	1–3	1.6	1.4	0–3	0.4	0.8	0–2