

# Theory of Mind in deaf adults: the role of verbal ability and interpersonal experiences from early years

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## Abstract

*Theory of Mind (ToM) studies on deafness are focused on childhood. Few studies have analyzed ToM on deaf adults. The present research compared three groups of deaf adults (native signers, late signers, oral deaf) to a hearing-paired group in two ToM tasks and analyzed the role of verbal ability and interpersonal experiences from early years to predict ToM performances. Participants were 15 native signers, 15 late signers, 17 oral deaf and 15 hearing (M = 22 years-1 month; SD = 1 month) who were administered the verbal scale of Wechsler Intelligence Scale – Revised (WAIS-R), Look Prediction, and Strange Stories. The ANOVA showed differences among the four groups in both ToM tasks with late signers showing the worst performances compared to the other groups. HRAs emphasized the role of verbal ability and interpersonal experiences from early years to predict advanced ToM ability in adulthood.*

**Keywords:** Theory of Mind; Deafness; Verbal ability; Interpersonal experiences.

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## 1. Introduction

Theory of Mind (ToM) is the ability to infer cognitive and emotional states of others (i.e. intentions, desires, beliefs, knowledge, emotions) as well as understand that those states guide others' behaviors (Wimmer & Perner, 1983; Hughes & Leekam, 2004; Apperly, 2012).

ToM reflects a social function (Moore & Frye, 1991) and its development allows people to become communicative and competent partners in social interaction so as to explain, predict, and act on their own behavior and that of others. This function is linked to the adaptive function of ToM (Fonagy & Target, 2001), which is the ability to behave in a flexible way regarding the specific social situation. ToM has also a protective function (Fonagy & Target, 2001), especially for people with critical developmental trajectories. In this case, understanding their own and others' mind sets allows people to distinguish their own Self from that of others.

ToM in children has been the focus of intensive investigation (see Liverta Sempio, Marchetti, & Lecciso, 2005; Marchetti, Castelli, Cavalli, Di Terlizzi, Lecciso, Lucchini *et al.*, 2014). Researchers have examined three levels of development of this mental ability: (a) first-order false belief reasoning, (b) second-order false belief reasoning, and (c) advanced level of ToM. First-order false belief reasoning entails simple recursive thinking (i.e. "I think you think something") and appears from the age of 3 to 4 (Wellman & Lagattuta, 2000; Wellman, Cross, & Watson, 2001). Children passing the classic first-order false belief task (Wimmer & Perner, 1983) demonstrate the ability to consider that another person holds a false belief. Second-order false beliefs reasoning entails the consideration of two levels of recursive thinking (i.e. "I think you think he/she thinks something") and also the ability to think what another individual thinks about a third person's thoughts. Researchers have found that children demonstrate this type of ToM ability, if assessed by the classic Perner and Wimmer's task (Perner & Wimmer, 1985; Hogrefe, Wimmer, & Perner, 1986), when they are approximately 6 to 7 years of age.

Advanced ToM ability entails the capacity to understand complex mental states (i.e. Baron-Cohen, Wheelwright, Spong, Scahill, & Lawson, 2001) and intricate social situations (Baron-Cohen, O'Riordan, Stone, Jones, & Plaisted, 1999; White, Hill, Happè, & Frith, 2009). Children demonstrating advanced ToM ability are able to: (a) attribute complex epistemic mental states (i.e., 'remember something', 'sure about something') and complex emotional states (i.e., worry, surprise) to other persons (Baron-Cohen *et al.*,

2001) and (b) understand a speaker's communicative intent in situations of sarcasm, humor, irony, and faux pas (Baron-Cohen *et al.*, 1999; O'Hare, Bremner, Nash, Happe, & Pettigrew, 2009). Studies demonstrate that advanced ToM ability increases with age in children and that they show a basic level of this ability from 8 years of age (e.g., Baron-Cohen *et al.*, 1999; Filippova & Astington, 2008; O'Hare *et al.*, 2009; Peterson, Wellman, & Slaughter, 2012).

### *1.1. ToM and Deafness*

ToM studies on deafness are mostly focused on the childhood age. Research distinguishes three deaf groups following three main criteria: presence/absence of hearing deficit in parents, communicative mode and educational approach. These distinctions offer results in three groups, native signers, late signers and oral deaf, and each group has a specific ToM ability.

Some studies emphasize that native signers reach a higher level of performances than late signers in standard ToM and verbal ability tasks. Therefore, they develop the same ToM abilities as hearing-capable children (Peterson & Siegal, 1997, 1999; Cortin & Melot, 1998; Rimmel, Bettger, & Weinberg, 1998; Woolfe, Want, & Siegal, 2002; Peterson, Wellman, & Liu, 2005). This observation confirms the hypothesis that sharing speaking abilities with parents is crucial in ToM development.

Late signers show a delay in developing ToM abilities when compared to hearing and native signers (Peterson & Siegal, 1995) due to a conversational deprivation with parents since their birth. Late signers did not share with their caregivers a communicative channel, therefore, mental state discourse is compromised (Liverta Sempio, Marchetti, Lecciso, & Petrocchi, 2006; Lecciso, Petrocchi, & Marchetti, 2013).

As for the matter regarding oral deafness, a study (Peterson & Siegal, 1999) comparing oral deafness to native signers and hearings, showed similar performances in these three groups. On the contrary, other studies (De Villiers, 1997; Courtin & Melot, 1998; Courtin, 2000; De Villiers & De Villiers, 2000), showed that oral deaf performances are lower than those of hearing and deaf peer groups. The different results among these studies could be justified with the differences in severity of the hearing deficit. In fact, a lower severity deficit could result in a better performance of children in understanding others' mental state (Greenberg, 1984; Marschark, 1993; Vaccari & Marschark, 1997).

During late childhood and adolescence, longitudinal studies (Falkman, Roos, & Hjelmquist, 2007; Gonzalez, Quintana, Barajas, & Linero, 2007; Peterson, 2009; Wellman, Fang, & Peterson, 2011) revealed a mixed pattern. Falkman *et al.* (2007) and Wellman *et al.* (2011) found that many deaf individuals do not progress at all during the study's time frame, while Gonzalez *et al.* (2009) and Russell, Hosie, Gray, Scott, Hunter, Banks *et al.* (1998) found an improvement in the first-order false belief understanding of deaf adolescents depending on their verbal ability and age.

While deaf children have been extensively studied, there is a paucity of research on deaf teenagers and adults. A study (Henricson, Frolander, Moller, & Lyxell, 2016) has compared adults with Alström or Usher Syndrome to a typical hearing and vision group. Both syndromes cause deafblindness, although with a different degree of sensory loss. In particular, the two groups differed with regard to visual acuity, but not to the degree of hearing impairment. Significant differences were observed in ToM performance across the groups: both groups with Alström and Usher Syndrome showed lower scores on an advanced ToM task (White *et al.*, 2009) compared to the typical hearing and vision group. Significant differences were also found on their verbal ability and working memory and associations were found with ToM. Hao, Su and Chan (2010) studied the predictive role of interpersonal experiences from early years and verbal ability on ToM in 4 groups of deaf adults. They considered shared vs not shared communication modality used by the adult and his/her parents since birth. They analyzed four groups of deaf people: prelingually deaf people of deaf parents and postlingually deaf born from hearing parents (according to the authors in these cases there was a shared communication modality between deaf participants and their parents); prelingually deaf born from hearing parents and late signers (in these cases there were a non shared communication modality between deaf participants and their parents). The study found that both verbal ability and interpersonal experience from early years were significant predictors of advanced ToM.

Reilly, Tomblin, Law, McKean, Mensah, Morgan *et al.* (2014) comparing native signers, late signers, and typical hearing adults, found that late signers have poor performance on false belief tasks and sarcasm (i.e. a form of advanced ToM ability) than the matched native signers and typical hearing adults. Recently, Lecciso, Levante, Petrocchi and Baruffaldi (2016) compared three groups of deaf adults to three matched typical hearing groups. They analyzed the social-cognitive and social-perceptual component of Theory of Mind, as defined by Tager-Flusberg and Sullivan (2000).

Findings indicated that late signers and oral deaf adults showed lower scores than hearing peers both in the social-perceptual and social-cognitive components of ToM, while native signers showed lower scores than hearing peers in the social-perceptual component of ToM. As hypothesized, verbal IQ was found to be a significant predictor of the social-cognitive component, but not of the social-perceptual component of ToM.

## 2. Aims

The present study addressed the following research questions: what is the pattern for ToM during adulthood? What are the determinants of the individuals' ToM performance during adulthood? Specifically, the aims were to compare ToM performance of three groups of deaf adults (native signer, late signer, oral deaf) to a paired-hearing group and to analyze the role of verbal ability and interpersonal experiences from early years to predict the performance in ToM tasks. According to literature (Hao *et al.*, 2010) the interpersonal experiences from early years has been defined as a dichotomous variable: native signers and hearing participants had shared interpersonal experiences with parents from early years, while late signers and oral deaf had not.

## 3. Method

### 3.1. Procedure

A hearing psychologist who is a fluent Italian Sign Language user (5 years of experience issued by the ENS, which correspond to the Italian National Deaf Society) administered the tests to all participants.

Both oral deaf and hearing participants received the original form of the tests. For native and late signers all the tasks and the corresponding instructions were translated into LIS prior to the administration. Materials were subjected to two independent translations: (a) the first was made by the LIS psychologist who administered the tasks in collaboration with a LIS interpreter (registered to ANIOS – Italian Sign Language Interpreters Association), (b) the second was made by a deaf native signing professor who has expertise in linguistics. The two translations were compared and a final common version was obtained. Native and late signers responded to the measures using LIS; oral deaf and hearing participants using oral language.

All the participants were Italian and were recruited within High Schools and Universities or thanks to the collaboration with several national deaf societies in three important cities in the North (Padua, Verona) and South of Italy (Lecce). The three cities were chosen because they are representative of the historical, social, and cultural level of the deaf/hearing Italian people. Besides, they host a University, which is a relevant aspect of the cultural dimension of their social contexts. Within the three cities, the high schools were selected based on their location in the city center in order to reduce the bias due to the socio-economical differences among participants.

Each participant received written information describing the aims of the research and then provided informed written consent. The participants received individually the tasks in a quiet room.

### 3.2. Measures

- *Verbal Ability*. Five verbal subtests (information, vocabulary, comprehension, arithmetic, and similarities) of the WAIS-R (verbal IQ-vIQ; Wechsler, 1981) were administered. For all participants, a final measure of the vIQ was obtained, according to the standardized norms of the WAIS-R (Orsini & Laicardi, 1998). The final vIQ obtained could be considered an approximation of Italian verbal/spoken ability for oral deaf and hearing participants and an approximation of verbal/LIS ability for native and late signers. For an easy reading, the terms of verbal IQ or verbal ability were used in the following sections.
- *Second-Order False Belief Understanding*. The Look Prediction task (LP; Astington, Pelletier, & Homer, 2002) involved the presentation of a story depicting one character having a false belief about the second character's belief (i.e., second-order false belief). Participants judged what the first story character would expect the second story character does. The story was illustrated by 4 pictures. Participants were asked two control questions, one first-order false belief question, one second-order false belief question, and one justification question. The answers for each type of question were scored 1 (correct answer) or 0 (wrong or no answer). A total score was obtained by a scoring that ranged from 0 (2 wrong control questions) to 3 (all 5 correct answers) adjusted for chance answering (see Naito & Seki, 2009), with higher scores denoting higher second-order ability. Protocols

were independently coded by two authors of this paper; inter-rater reliability was  $rs > .98$ .

- *Advanced Theory of Mind*. The Strange Stories (SS; White *et al.*, 2009) assess the extent to which the participant understands why a character says something that is not literally true. The task is composed of eight stories involving double-bluff, misunderstanding of intention, persuasion, and white lie (two stories for each). After each story, the participants were required to reply to a control question (different for each story) and to a test question (“Why did the character say that?”). The answers to the Strange Stories were coded and scored as 0 (incorrect), 1 (answers with implicit attribution of mental states), or 2 (answers with full/explicit attribution of mental states). Two raters independently scored the protocols. There were acceptable inter-rater correlations for all the 8 stories ( $rs. > .95$ ) and acceptable inter-item correlations ( $rs. > .30$ ). The scores for the 8 stories were summed to yield an advanced ToM measure ( $\alpha = .74$ , range = .50-2.88) with higher values denoting greater ability.

### 3.3. Participants

Participants were 47 teenagers and adults ranging from 15 years 9 months to 28 years 1 month, with a mean of age of 22 years and 1 month ( $SD = 1$  month). Fifteen were native signers, 15 late signers, 17 oral deaf and 15 hearing. Deaf participants were compared to a group of hearing young adults. Anovas were performed to control any differences among the four groups, which were similar for chronological, mental age, and mean years of education. Table 1 shows the characteristics of the deaf and hearing participants.

Table 1 - *Characteristics of participants*

	NS	LS	OD	HA
N. of adults	15	15	17	15
Age				
<i>M</i>	22.27	21.92	22.31	21.86
( <i>SD</i> )	(4.03)	(3.4)	(2.7)	(4.08)
Range	16.7-28.1	16.4-26.9	17.5-25.4	16.2-28.32
Mental age				
<i>M</i>	112.27	114.87	120.82	116.46
( <i>SD</i> )	(4.91)	(7.81)	(7.4)	(8.35)

Years of education				
<i>M</i>	12.00	10.31	8.17	10.23
( <i>SD</i> )	(2.07)	(2.87)	(2.62)	(3.26)
Communicative mode	Italian	Italian	Verbal	Verbal
	Language Sign	Language Sign	Language	Language
Type of deafness				
Congenital deafness	15 (100%)	10 (66.7%)	10 (58.8%)	-
Acquired deafness	-	5 (33.7%)	7 (41.2%)	-
Deafness degree				
Mild	-	1 (6.7%)	1 (5.9%)	-
Severe	1 (6.7%)	5 (33.3%)	3 (17.6%)	-
Profound	14 (93.4%)	9 (60%)	13 (76.5%)	-
Hearing aids				
External hearing aids	-	6 (40%)	13 (76.5%)	-
Cochlear implants	-	-	4 (23.5%)	-
None	15 (100%)	9 (60%)	-	-
Shared communication mode with parents from early years				
	Sign Language	No	Oral Language	Oral Language
Interpersonal experiences from early years				
	Yes	No	No	Yes

Note: NS = Native Signers; LS = Late Signers; OD = Oral Deaf; HA = Hearing Adults.

## 4. Results

Two Anovas were performed to compare deaf and hearing participants on ToM tasks. Table 2 shows results from Anovas, means and standard deviations. For both Look Prediction and Strange Stories, late signers scored significantly lower than native signers, oral deaf, and hearing participants who showed similar scores in both tasks.

Table 2 - *Means, Standard Deviations (between brackets), Anovas and Tukey Post-Hoc results of the four groups in ToM tasks*

	LS (1) <i>M (SD)</i>	NS (2) <i>M (SD)</i>	OD (3) <i>M (SD)</i>	HA (4) <i>M (SD)</i>	<i>F</i>	Post-hoc
Look Prediction	1.40 (1.12)	2.33 (.62)	2.35 (.60)	2.38 (.62)	(3 59) = 5.93, $p = .001$	1 2 3 4
Strange Stories	1.22 (.50)	1.83 (.46)	2.07 (.58)	2.22 (.49)	(3 59) = 11.41, $p < .0001$	1 2 3 4

Note: LS = Late Signers; NS = Native Signers; OD = Oral Deaf; HA = Hearing Adults.



Hierarchical regression analyses (HRAs) were carried out to examine the predictive role of vIQ and interpersonal experiences from early years on ToM variables. Look Prediction and Strange Stories scores served as dependent variables, vIQ (which was centered and inserted in Step 1) and interpersonal experiences from early years (inserted in Step 2) served as independent variables.

When Look Prediction was considered the model was not significant. When Strange Stories was considered as dependent variable, the model at Step 2 was significant and explained a bigger portion of variance than in Step 1. Results indicated that both vIQ and interpersonal experience from early years were significant predictor for the Strange Stories performance. The results from the model are reported in Table 3.

Table 3 - *Hierarchical regression analyses with Strange Stories as dependent variable*

Strange Stories	<i>F</i> ( <i>df</i> )	<i>R</i> <sup>2</sup>	<i>F</i> (change)	<i>t</i>	$\beta$
Step 1 vIQ	(1 60) = 4.44, <i>p</i> = .039	.07	4.44	2.11, <i>p</i> = .039	.26
Step 2 vIQ				2.88, <i>p</i> = .005	.35
Interpersonal experiences from early years	(2 59) = 7.20, <i>p</i> = .002	.20	9.34***	3.05, <i>p</i> = .003	.37

\*\*\* *p* < .0001

## 5. Discussion

The first aim of this study was to compare ToM performance of four groups of teenagers and adults (native signer, late signer, oral deaf, and hearing adults). Statistical analyses found that late signers showed poorer performances in both standard and advanced ToM tasks than native signers, oral deaf and hearing participants who had similar scores.

Those results confirmed the pattern found in literature as regards to childhood and increased knowledge on what had happened during adulthood. In particular, ToM poor performance of late signers seems to characterize those people from childhood to adulthood, as found in other studies (Peterson & Siegal, 1995, 1997, 1999; Cortin & Melot, 1998; Remmel *et al.*, 1998; Hao *et al.*, 2010; Reilly *et al.*, 2014; Lecciso *et al.*, 2016). Native signers did not show any delay in ToM during adulthood, as found during childhood (Peterson & Siegal, 1995, 1997, 1999; Woolfe *et al.*,

2002; Peterson *et al.*, 2005) and adulthood (Reilly *et al.*, 2014; Lecciso *et al.*, 2016). Results on oral deaf adults showed a similar performance when compared to hearing and native deaf participants. In this case, it seems that the poor performance on ToM of oral deaf in childhood (Courtin & Melot, 1998; Courtin, 2000; De Villiers & De Villiers, 2000) does not become a permanent delay later on, as found also by Lecciso, *et al.* (2016) and Reilly *et al.* (2014).

Taken together these results allow some considerations. First, second-order false belief understanding, which is considered a basic mentalizing ability mastered during childhood, and the understanding of social situations such as double bluff, misunderstanding of intention, persuasion, and white lie are not completely understood by late signers, such as by those who did not share common early communicative environments with parents or siblings. The difficulty found on late signers was not due to their poor memory or their poor understanding of the meaning of the stories *per se*. In fact, both tasks were controlled for participants' answers of the control questions. In other words, late signers showed poor performance in understanding second-order reasoning and advanced ToM, which reflects a fundamental problem in others' perspective taking. Second, the improvement in first-order false belief understanding, found in several studies (Russell *et al.*, 1998; Gonzalez *et al.*, 2009), does not guarantee the further development of second-order false belief and advanced ToM. Finally, the poor performance of late signers in the present study confirmed Peterson & Siegal's (1995) hypothesis about the role played by early conversational deprivation for ToM and sheds light on the importance of interpersonal experiences from early years to develop ToM ability, which was analyzed in the second aim of this study.

Our second aim was to analyze the role of language and interpersonal experiences from early years to predict performance of ToM tasks. Hierarchical regression analyses showed a different path for standard and advanced ToM ability. Standard ToM ability (i.e., second-order false belief understanding) did not depend on verbal ability, as found in childhood (Courtin & Melot, 2005; Peterson *et al.*, 2005; Moeller & Schick, 2006), or on interpersonal experiences from early years, as found in adulthood (Hao *et al.*, 2010). Since this pattern was found on both deaf and hearing adults, it seems that for the understanding of the developmental pattern for second-order false beliefs during adulthood future research should focus on variables more related to their day-to-day life. For example, Reilly *et al.* (2014) have found a significant relation between second-order false belief

and the high level of language used every day at work, while they did not find any effects of age, gender, educational level, and job experience. These results suggest that having rich and varied exposure to everyday interactions with people and conversations with them could help adults to master their false-belief understanding. The operationalization of these concepts warrants future research in order to deeply study the suggested link.

The advanced ToM ability in adulthood (i.e., Strange Stories) depended on both better verbal ability and interpersonal experiences from early years. Those results confirmed Hao *et al.* (2010) findings on deaf adults. It could be hypothesized the existence of specific/critical periods during the whole life, in which ToM abilities are particularly “sensible” to some factors instead to others. Siegal and Varley (2002) hypothesized the notion of ‘critical period’ in Tom development for deaf children. As for other developmental abilities (e.g., language), children should need to be exposed to discussion of mental states and have experience of others’ minds during a specific period of their life. However, it is not clear enough at what age this critical period end in childhood, if different periods could be identified for different kinds of ToM abilities, and if the same sensitive period (or periods) could be identified during adulthood.

The present research has several limitations and opens new directions for future research. First, this study only analyzed the cross-sectional differences among deaf and typical hearing adults; future studies should consider longitudinal differences among them. Second, the present study analyzed verbal ability and interpersonal experience from the early years as predictive variables of ToM performance. Researchers may be interested in exploring the predictive role played by relational skills in ToM performance, such as interpersonal trust (Lecciso, Petrocchi, Liverta Sempio, & Marchetti, 2011; Rotenberg, Petrocchi, Lecciso, & Marchetti, 2015) and attachment (Lecciso *et al.*, 2013), or other variables linked to adults’ daily experience, such as everyday interactions with others and quality of day-to-day conversations with others. The operationalization of these concepts in adulthood and repeated measures studies would be of interest of researchers. Finally, training studies should be developed to promote effective interventions improving deaf adults’ ToM and mastering their social skills.

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