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RESEARCH ARTICLE

Language predictors of theory of mind in cochlear implant children compared to normal-hearing peers

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Abstract

Background and Aim: Theory of mind (ToM) is very necessary to have successful social interaction. Hearing impairment disrupts the ToM development and language acquisition. This study aimed to compare ToM abilities of children with cochlear implant (CI) and normal hearing (NH) to clarify the role of language skills in ToM development.

Methods: Participants were CI and NH children in two age ranges of 5–6 and 8–9 years. Main measures were basic and advanced tasks of ToM test (Abbreviated as B. ToM and A. ToM), and comprehension of mental–state verbs and relative clauses. Regression analysis was used to assess how language skills predict ToM.

Results: CI children obtained significantly lower scores in all subscales of ToM test ($p \leq 0.001$). Regression models for CI group aged 5–6-year showed that their comprehension of mental-state verbs predicted 53% of B. ToM. In CI children aged 8–9 years, comprehension of relative clauses and mental-state verbs together predicted 61% of B. ToM and 73% of A. ToM variances. Furthermore, comprehension of relative clauses predicted 43% of B. ToM and 31% of A. ToM in younger NH children.

Conclusion: Comprehension of mental-state verbs can predict only B. ToM in CI children aged 5–6 years and both B. ToM and A. ToM in CI children aged 8–9 years. Therefore, it is the main factor to predict ToM ability of preschool and school-age children with CI. The role of language should be considered by people who are helping these children for their cognitive problems.

Keywords: Theory of mind; mental verb; relative clause; cochlear implant

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Introduction

The ability to assign mental states (beliefs, desires, feelings, etc.) to others and ourselves is defined as the theory of mind (ToM) [1]. ToM is acquired in infancy. As children grow up, they find out that different people have different viewpoints. They realize it possible that an object to be visible to them but invisible to others or vice versa. They also find that attention is restricted and various people may describe an attended input differently. In this way, they understand that people have diverse viewpoints on an event. There are different tasks for the

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assessment of ToM. These tasks have been designed based on the normal development of ToM in children. For example, false-belief understanding is considered as a mature ToM. It is developed at the age of four years old. Hence, children start by representations of false beliefs. Sally-Ann task [2] and Smarties-box task [3] are two methods for assessment of false beliefs. In next stage, children can find out that other people can think and give a reason for their mental states. This ability is developed at the age of 6 or seven years. John- Mary task [4] is used to assess ToM at this stage. At the final stage, children learn to understand the meaning of jokes and metaphors. This ability is developed at the age of 9−11 years [5]. Happe's Strange Story test is used for the assessment of ToM in this stage [6]. Comprehension and representation vary from child to child. An important early discovery in middle childhood is that the mind acts as an interpretive mechanism. For example, when a preschool child spots a visible object, s/he cannot be certain of the object's identity. Later, at the early school age, thinking becomes an internal activity in relation to real or unreal things [7].

It has been shown that ToM development in children is affected by their language [8]. Language has a fundamental role in improving the children's understanding of the mind. Both semantics and syntax structures are two elements of language that influence ToM [9]. Milligan et al. [8] in a meta-analysis of the correlation between language skill and false-belief understanding in children revealed that ToM tasks require comprehension of both mental state terms and complex syntax. Mental-state verbs play important roles in systems of language including grammar, semantic and pragmatic. These verbs influence the type of sentences in which they appear. At around age three, children start to develop lexical elements for mental states followed by adding clauses. The semantic cognition of mental-state verbs (e.g. know, think, mean, forget, and guess) and the complement syntax of these verbs plays a vital role in false-belief representation [10]. Involvement in conversation and mastery of syntax complementation are two important factors contributing to the development of false-belief understanding [11]. In order to show the content of someone's mind, language users produce a complement structure. For example, the following sentences characterize a false proposition with a complement clause in italics [12]: "Mary thought *that it was her skirt*, but in fact, it was a cloth".

To assess the effect of language on ToM, children with language disorders such as deaf or hard of hearing children have been studied. Children with hard of hearing are unable to access linguistic inputs sufficiently. These children usually have delayed language acquisition. They do not experience normal conversation that can help with the development of ToM. Delayed ToM development has also been reported in late-signing deaf children of hearing parents [13]. Deaf children with normal intelligence quotient (IQ) exposed to sign language from their deaf parents or siblings perform much better under standard ToM assessments than their oral deaf or late-signing peers, because the late-signing children have fewer social interactions [14]. Unlike children with hearing aids, children with cochlear implants (CIs) are a group whose hearing can partially be restored, indicating an opportunity to clarify the relationship between language skill and ToM performance in them. CI directs sound signals to the brain. It acts as a damaged part of the inner ear.

Remmel and Peters found an increasing access to mental state language in CI children [15]. Therefore, it is expected that ToM performance be improved in these children. The age to get a CI is an important factor to improve language abilities and ToM performance. Early cochlear implantation for deaf children with hearing parents is in conjunction with early social and communicative stimulation. This can prepare a foundation for more normalized ToM development. Sundqvist et al. found that early CI children (before 27 months) solved ToM problems to a significantly higher degree compared to late CI children (after 27 months), although the two groups had no difference in language or cognitive measures at baseline [16]. Ketelaar et al. assessed multiple features of ToM (intention,

desire and belief tasks) in early-implanted children. They showed that CI children's performance on intention tasks was the same as that of normal hearing (NH) children who had better performance on desire and belief tasks, ever after excluding children with delayed language. They concluded children with CI master the first phases of ToM development, but fail in advanced phases of ToM; however, both NH and CI children showed similar patterns of development [17].

Understanding of mental-state verbs and relative clauses is considered as two language skills. Studies have indicated that the understanding of relative clauses and mental-state verbs are associated with the performance level on ToM tasks [18,19]. Moreover, most of the studies on the relationship between language and ToM have been conducted on English-speaking children. Therefore, this cross-linguistic research study aims to assess ToM abilities, comprehension of mental-state verbs and relative clause, and the relationship between them in children with CIs and age-matched NH peers. We recruited children from two different age groups (5–6 and 8–9 years) and used different ToM tasks to determine the role of the comprehension of mental-state verbs and relative clauses in predicting ToM ability in both groups.

Methods

Participants

This is a descriptive-analytical study conducted on two groups of CI and NH children. Children with CI were selected from the CI clinic of Amir-Alam Hospital in Tehran, Iran. To match social and economic status of the two groups, we asked the parents of CI children to introduce one of the friends of their children with NH with the same age. A total of 72 participants (36 girls and 36 boys) were included in this study using a convenience sampling method, and divided into two groups of children aged 5–6 years (n = 36) and 8–9 years (n = 36). Each group included 18 children with CI and 18 with NH.. Participants were selected according to Delkhah et al.'s studies [20,21]. In addition to the assessment of ToM abilities, language skills were assessed in these children. The inclusion criteria for all participants were: Age 5–6 and 8–9 years, being monolingual Persian-speaker, no other sensory disorders such as blindness, and no psychiatric disorders. For CI children, the inclusion criteria were: having the surgery at least two years ago, not receiving any treatment in the field of ToM, using auditory-oral communication modes, and normal performance on non-verbal IQ test. NH children had normal development of speech and language with normal IQ range. The exclusion criteria for all participants were unwillingness to follow orders, complete the tasks, and continue participation in the study. Prior to study, a written informed consent form was signed by the parents of all children and an ethical approval was obtained from the Ethics Committee of Tehran University of Medical Sciences (Code: IR.TUMS.REC.1394.1279). The tests were administered in a quiet room to children who were alone or accompanied by their parents.

Procedures

TOM abilities were assessed by using the Persian version of ToM test developed by Ghamarani et al. for Persian-speaking children [22] by forward-translation and back-translation of Muris et al.'s ToM test [23]. The test is valid based on cross-cultural and conceptual factors. Its test-retest reliability ranges from 0.70 to 0.94 and has an inter-rater reliability of 0.98. The alpha coefficient value for its internal consistency has been reported 0.86 [22]. The translation modifications were made according to the opinions of a panel of experts. The Persian version of ToM test has 38 Items and three subscales: a) foundations of ToM (20 items), b) first manifestations of real ToM (13 items), and c) more advanced aspects of ToM (5 items). Each answer is scored as either failed (0) or passed (1). The total score of first subscale was considered as basic TOM (B. ToM) and the total scores of second and third subscales were considered as advanced ToM (A. ToM). The child has to answer several questions about pictures and stories in the ToM test. The child looked at the picture then the examiner asked questions.

Table 1. Demographic characteristics of participants

		CI	NH
Age (months)			
5-6 (Mean ± SD)		72.72 ± 12.87	66.44 ± 4.76
8-9 (Mean ± SD)		103.83 ± 4.51	96.55 ± 24.25
Hearing age (months)			
5-6 (Mean ± SD)		31.27 ± 11.30	Nr
8-9 (Mean ± SD)		53.88 ± 24.19	Nr
Gender (n, %)			
5−6	**Female**	(8, 44.4)	(12, 66.7)
	Male	(10, 55.6)	(6, 33.3)
8−9	**Female**	(8, 44.4)	(8, 44.4)
	Male	(10, 55.6)	(10, 55.6)

CI; cochlear implant, NH; normal hearing, Nr; normal

Each story consists of three or four sentences which are described by the examiner. When the child did not understand the questions that were asked after the story, the story retold. Understanding of mental-state verbs in this study was assessed by nine short stories developed by Hajgholam Rezayi [24]. Each story consists of three or four sentences. There are one mental state in eight stories and two mental states in the last story. Think, desire, and decide are the sample of mental-state verbs. A trained examiner read stories aloud at a speed same to all children. The child is asked to listen to the story and answer to the questions related to the mental-state verbs immediately. Each answer is scored as either failed (0) or passed (1). The total scores varies from 0 to 10, where higher scores represent a more mature understanding of mental-state verbs. Understanding of relative clauses was assessed using a picture selection task according to Rahmany et al.'s study [25]. This task uses 20 sentences each with a relative clause. Each sentence read to children by the examiner and then the child is asked to choose a picture that matched the description. No verbal response is required in this task; the child gives a response by pointing to the matched picture. Three pictures are presented vertically on each page for each sentence, of which only one picture matches the sentence. Each answer is scored as correct (1) or wrong (0). First the assessment of the understanding of relative clauses was conducted followed by ToM test and assessment of the understanding of mental-state verbs. There was a short rest interval between each test when the children were allowed to eat, play with the favorite toys, or talk about an interesting subject. The test lasted 40−50 minutes in CI children and 25−30 minutes in NH children.

Data analysis

We used the regression analysis to examine the role of the mental-state verbs and relative clauses in predicting the ToM ability in each group, separately. Normality of data distribution is known as one of the assumptions of regression analysis, but, it has been reported that the normality of error distribution should be considered as the assumption of regression analysis, at least in small samples [26]. In this regard, although some of our variables in our study had no normal distribution, errors were normally distributed. Therefore, we employed the linear regression method when there was just one predictor and the sequential regression method when two predictors were available. In the hierarchical regression approach, we entered the mental-state verb measures into the model before the relative clause measures, because, according to the correlation test results, the relationship between mental-state verbs and ToM abilities was stronger.

Results

Table 1 shows the demographic characteristics of participants.The descriptive statistics for each group are presented in Table 2. Fig. 1 illustrates the comparison of age groups, indicating considerable differences between NH and CI children. The Mann-Whitney U test results also revealed significant differences in all measures between the CI and NH groups. In the age group

Table 2. Mean (SD) of mental verbs, relative clauses and theory of mind among different groups of children

	Mean mental verbs (SD)		Mean relative clauses (SD)		Mean B. ToM (SD)		Mean A. ToM (SD)	
Age range	**NH**	**CI**	**NH**	**CI**	**NH**	**CI**	**NH**	**CI**
*5–6 (n = 18)	7.11 (2.08)	1.11 (1.71)	14.00 (10.51)	2.91 (4.75)	16.44 (8.33)	2.28 (5.94)	15.66 (8.83)	1.53 (3.43)
*8–9 (n = 18)	9.17 (3.94)	0.85 (3.91)	14.55 (10.88)	4.09 (5.26)	19.11 (11.55)	3.27 (5.63)	15.47 (5.23)	2.27 (3.69)

NH; normal hearing, CI; cochlear implant, B. ToM; basic theory of mind, A. ToM; advanced theory of mind

*Data for B. ToM and A. ToM are from Delkhah et al. [20,21]

5–6 years, the CI children had significantly lower scores in understanding of relative clauses ($p = 0.002$) and mental-state verbs ($p \leq 0.001$), and in B. ToM ($p \leq 0.001$) and A. ToM ($p \leq 0.001$). In the age group 8–9 years, the CI children's scores were also significantly lower in understanding of relative clauses ($p = 0.020$) and mental-state verbs ($p \leq 0.001$) and in B. ToM ($p \leq 0.001$), and A. ToM ($p \leq 0.001$).

The Pearson correlation test was used to assess the relationship between measures in each group separately. In NH children aged 5–6 years, understanding of relative clauses had a significant relationship with B. ToM ($r = 0.68$, $p = 0.002$), and A. ToM ($r = -0.59$, $p = 0.009$). Understanding of mental-state verbs had a significant relationship with B. ToM ($r = 0.74$, $p \leq 0.001$) and A. ToM ($r = 0.70$, $p = 0.001$) in CI children aged 5–6 years. Among CI children aged 8–9 years, understanding of relative clauses had a significant relationship with understanding of mental-state verbs ($r = 0.58$, $p = 0.010$), B. ToM ($r = 0.64$, $p = 0.004$), and A. ToM ($r = 0.67$, $p = 0.002$). Furthermore, understanding of mental-state verbs had a significant correlation with B. ToM ($r = 0.77$, $p \leq 0.001$) and A. ToM ($r = 0.84$, $p \leq 0.001$) in this group. We found no significant relationship between the measures in NH children aged 8–9 years.

The simple linear regression analysis showed that understanding of the relative clauses could significantly predict 46% and 35% of the variances in B. ToM ($p = 0.002$) and A. ToM respectively ($p = 0.009$) in NH children. Understanding of relative clauses had a significant negative relationship with A. ToM in NH children aged the 5–6 years. Understanding of mental-state verbs could significantly predict 56% of the variance in B. ToM ($p \leq 0.001$) in CI children. The hierarchical regression analysis results revealed that understanding of mental-state verb was a strong predictor of both B. ToM ($r = 0.60$, $p \leq 0.001$) and A. ToM ($r = 0.71$, $p \leq 0.001$) in CI children aged 8–9 years. Understanding of relative clauses could not predict B. ToM and A. ToM ($p > 0.05$) in these children.

Since there was no significant correlation between variables in NH group aged 8–9 years, we were unable to perform regression analysis for this group.

Discussion

In this study, we first compared children with CI and NH in terms of B. ToM and A. ToM. Then, we investigated the relationship between language and ToM in two groups. We selected two different age groups (5–6 and 8–9 years) to study the effect of age on B. ToM and A. ToM. In literature, ToM has been investigated in deaf children more than in CI children. CI children have hearing experience but this experience is not the same as that of NH children. Therefore, the study of CI children provides an opportunity to assess how hearing experience after hearing loss influence the ToM development. The results of the present study revealed that: a) Persian-speaking children with NH had better

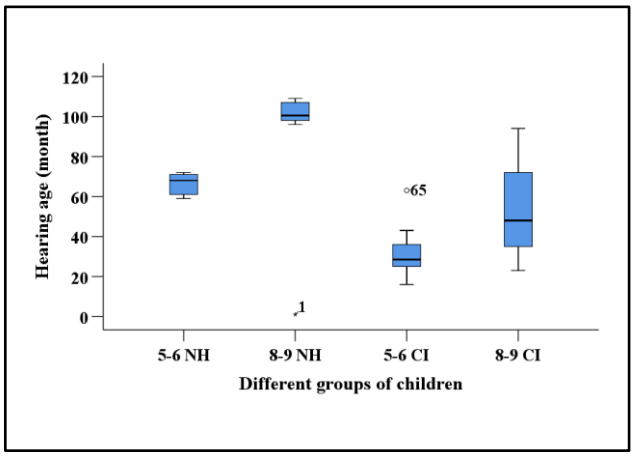

Fig. 1. Box plot showing mean of hearing age (month) for cochlear implant and normal hearing children. NH; normal hearing, CI; cochlear implant.

performance in understanding of mental-state verbs, relative clauses, B. ToM, and A. ToM compared to CI children; b) understanding of mental-state verbs was correlated with B. ToM and A. ToM in CI children; c) understanding of mental-state verbs was the main predictor of B. ToM in CI children aged 5–6 years and the main predictor of B. ToM and A. ToM for CI children aged 8–9 years, and; d) understanding of relative clauses was not able to predict ToM abilities in CI and NH children.

Our study showed that the scores in understanding of mental-state verbs and relative clauses, B. ToM and A. ToM were lower in CI children than in NH children. In order to complete ToM tasks, it requires cognitive and language abilities. It is believed that these skills are delayed in CI children [16]. Several studies have confirmed that CI children experience a delay in language development compared to NH children [27], but contradictory results have been reported about ToM development. Our findings are consistent with the results of Peterson [28] who showed that children with NH performed significantly better than CI children in ToM tasks. The results of present study are also somehow consistent with the results of Ketelaar et al. [17], who indicated that hearing experience in CI children provides a chance to pass the initial phases of ToM development, but early hearing loss causes them to fall behind the advanced phases (A. ToM). In contrast, Remmel and Peters [15] stated the CI children show little to no delay on TOM. It is worth to mention that the age of CI children, age at implantation and ToM tasks were different in these studies.

The result of the present study showed a relationship between language and ToM in NH children aged 5–6 years in terms of understanding relative clauses. The positive relationship between B. ToM and understanding of relative clauses indicated a direct relationship between two skills at this age group. The negative relationship between A. ToM and understanding of relative clauses may indicate that A. ToM is related to more complicated language skills. These results are consistent with the results of other studies [29,30] where no relationship between ToM and the use of mental-state terms was reported. The use of mental state words (thoughts, beliefs, desires, and intentions) is an indicative of ToM development [31]. In order to confirm the hypothesis that these two skills are related to each other, further studies are required. The use of mental states begins in the third year of life, but it does not mean that children fully understand these terms. They use them to start a conversation. These terms are gradually used for mentioning the ideas, beliefs, and emotions of oneself and others [9]. The results of our study regarding the relationship between understanding relative clauses and ToM abilities in NH children is consistent with the results of Hale and Tager-Flusberg [32]. They showed that teaching relative clauses to preschool children improved their scores on ToM tasks.

In this study, the relationship between language and ToM showed that understanding mental-state verbs had correlation with B. ToM and A. ToM in both age groups of CI children. That is, the higher score in comprehension resulted in higher scores in B. ToM and A. ToM. Mental-state verbs provide semantic support for creating complex sentences with embedding. That is, one sentence is fitted into another sentence. Mental-state verbs are related to thoughts, beliefs, desires, and intentions. It is assumed that

these verbs are used for assigning mental states to others which is related to ToM. The understanding of relative clauses had correlation with B. ToM and A. ToM only in CI children aged 8–9 years. This result is consistent with the findings of Smith et al. [33]. They found a relationship between success on false-belief tasks and the acquisition of relative clause sentences. Remmel and Peters [15] also reported that CI children's ToM performance was related to general syntactic proficiency.

Comprehension and correct use of complex language structures have a correlation with ToM development. Language not only relies on ToM, but also help with its development [8]. The mental-state verbs used for indicating intentions, feelings and beliefs. The sentences with these verbs are considered as the mastery of linguistic statements [34]. In children, the use of mental state terms is a sign for ToM development [31]; however, the relationship between ToM and mental state language is not clear [29]. In the present study, understanding of mental-state verbs had no correlation with B. ToM and A. ToM in both age groups of NH children. In comparison with conversation, the frequency of mental state language use in non-interactive tasks such as story telling is not correlated with ToM [29]. The present study assessed comprehension of mental-state verbs in children by answering questions. This task seems to be somehow interactive; this may be the reason why we found no relationship between them.

This study revealed that the understanding of relative clauses could predict B. ToM in NH children aged 5–6 years. This is consistent with the results of de Mulder et al. [35], who showed that the strong predictor of ToM in children aged 0–4 and 4–11 years was sentence comprehension. However, the present study showed this measure was not able to predict ToM in older children. As Fontana et al. [36] discussed in their review study, the role of syntax in ToM development is not clear. Several studies have assessed the relationship between syntax and ToM in CI and NH population using different tasks. Since the results of these studies are contradictory, the relationship between syntax and ToM is not clear. In order to find the connection between ToM and syntax, it is suggested that implicit and explicit tasks with a lifetime method should be used in future studies.

The results of this study reported that mental-state verbs could predict B. ToM in CI children aged 5–6 years as well as B.ToM and A. ToM in CI children aged 8–9 years. Use of mental state terms and general linguistic proficiency are two abilities that can predict ToM in children with CI aged 3–12 years [37]. Comprehension of relative clauses was not able to predict variations of ToM in children with CI in our study. This is consistent with the results of Liu et al. [38] who showed that verbal ability is not the predictor of ToM. Considering the results of this study and other studies, the role of language on ToM during childhood is not clear, because different language abilities in the field of grammar, vocabulary, executive function, working memory, and metacognitive and social skills reach maturity at the same time [39]. Vissers and Koolen [40] discussed that there are three causal models for describing the relationship between language and ToM: a) ToM predicts language, b) language predicts ToM, and c) ToM and language are predicted by another factor (the same root cause in children with language disorders). These models need further assessment to examine the theoretical models that are used for assessing the association between ToM and language. Further studies using interventional programs can solve the uncertainties on the association between ToM and language [41].

There were some limitations and disadvantages in this study. Hearing level and auditory characteristics of CI children were not available It is suggested that future studies consider auditory information. Moreover, the expressive language of children was not assessed in the present study. Since the assessment of expressive and receptive language can predict ToM [42], further studies are suggested to examine whether expressive language can influence ToM. Furthermore, we did not use low-verbal tasks for assessing ToM abilities. The performance of CI and NH children may be at the same level on

these tasks. It is strongly recommended that future studies use verbal and nonverbal tasks for CI children. Moreover, further studies should be conducted on different skills (e.g. linguistic, cognitive, metacognitive and social skills) in children with NH, CI, and deaf children.

Conclusion

Children with normal hearing had better performance than cochlear implanted (CI) children in comprehension of mental-state verbs and relative clauses, and in basic and advanced aspects of theory of mind (ToM). Comprehension of mental-state verbs have correlation with basic and advanced aspects of ToM in CI children, and it was the main predictor of basic aspects of ToM for CI children aged 5−6 years and the main predictor of both basic and advanced aspects of ToM in CI children aged 8−9 years. The results confirm the role of mental-state verbs in ToM development in children with CI. This suggests that clinicians and parents should focus on mental-state verbs during conversation and narration for CI children to increase their linguistic and cognitive abilities.

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Conflict of interest

The authors declare no conflict of interest.

References

1. Perner J. Memory and theory of mind. In: Tulving E, Craik FIM, editors. The Oxford handbook of memory. 1st ed. The Oxford University Press; 2000. p. 297-312.
2. Wimmer H, Perner J. Beliefs about beliefs: Representation and constraining function of wrong beliefs in young children's understanding of deception. Cognition. 1983;13(1):103-28. doi: 10.1016/0010-0277(83)90004-5
3. Gopnik A, Astington JW. Children's understanding of representational change and its relation to the understanding of false belief and the appearance-reality distinction. Child Dev. 1988;59(1):26-37. doi: 10.1111/j.1467-8624.1988.tb03192.x
4. Perner J, Wimmer H. "John thinks that Mary thinks that…" attribution of second-order beliefs by 5-to 10-year-old children. Journal of experimental child psychology. 1985;39(3):437-71. doi: 10.1016/0022-0965(85)90051-7
5. Baron-Cohen S, O'riordan M, Stone V, Jones R, Plaisted K. Recognition of faux pas by normally developing children and children with Asperger syndrome or high-functioning autism. J Autism Dev Disord. 1999; 29(5):407-18. doi: 10.1023/a:1023035012436
6. Happé FG. An advanced test of theory of mind: Understanding of story characters' thoughts and feelings by able autistic, mentally handicapped, and normal children and adults. J Autism Dev Disord. 1994;24(2):129-54. doi: 10.1007/BF02172093
7. Flavell JH. Theory-of-mind development: Retrospect and prospect. Merrill-Palmer Quarterly. 2004: 274-90. Retrieved March 17, 2021, from http://www.jstor.org/stable/23096166
8. Milligan K, Astington JW, Dack LA. Language and theory of mind: Meta-analysis of the relation between language ability and false-belief understanding. Child Dev. 2007;78(2):622-46. doi: 10.1111/j.1467-8624.2007.01018.x
9. Miller CA. Developmental relationships between language and theory of mind. Am J Speech Lang Pathol. 2006;15(2):142-54. doi: 10.1044/1058-0360(2006/014)
10. Astington JW, Baird JA. Why language matters for theory of mind. Oxford University Press; 2005.
11. Lohmann H, Tomasello M. The role of language in the development of false belief understanding: A training study. Child Dev. 2003;74(4):1130-44. doi: 10.1111/1467-8624.00597
12. de Villiers JG, de Villiers PA. The role of language in theory of mind development. Top Lang Disord. 2014; 34(4):313-28. doi: 10.1097/TLD.0000000000000037
13. Woolfe T, Want SC, Siegal M. Signposts to development: Theory of mind in deaf children. Child Dev. 2002;73(3):768-78. doi: 10.1111/1467-8624.00437
14. Peterson CC, Siegal M. Representing inner worlds: Theory of mind in autistic, deaf, and normal hearing children. Psychological Science. 1999;10(2):126-9. doi: 10.1111/1467-9280.00119
15. Remmel E, Peters K. Theory of mind and language in children with cochlear implants. J Deaf Stud Deaf Educ. 2009;14(2):218-36. doi: 10.1093/deafed/enn036
16. Sundqvist A, Lyxell B, Jönsson R, Heimann M. Understanding minds: Early cochlear implantation and the development of theory of mind in children with profound hearing impairment. Int J Pediatr Otorhinolaryngol. 2014;78(3):537-43. doi: 10.1016/j.ijporl.2013.12.039
17. Ketelaar L, Rieffe C, Wiefferink CH, Frijns JHM. Does hearing lead to understanding? Theory of mind in toddlers and preschoolers with cochlear implants. J Pediatr Psychol. 2012;37(9):1041-50. doi: 10.1093/jpepsy/jss086
18. de Villiers J. The interface of language and theory of mind. Lingua. 2007;117(11):1858-78. doi: 10.1016/j.lingua.2006.11.006
19. Cheung H, Chen H-C, Yeung W. Relations between mental verb and false belief understanding in Cantonese-speaking children. J Exp Child Psychol. 2009;104(2): 141-55. doi: 10.1016/j.jecp.2009.05.004
20. Delkhah Z, Soleymani Z, Dadgar H, Mousavi N. [Comparison of basic theory of mind in 5-6 years Farsi speaking children with cochlear implant and normal peers]. Journal of Modern Rehabilitation. 2016;9(7):72-8. Persian.
21. Delkhah Z, Soleymani Z, Dadgar H. Basic and advanced theory of mind in school-aged children with cochlear

implants. Aud Vestib Res. 2018;27(3):137-42. doi: 10.18502/avr.v27i3.55
22. Ghamarani A, Alborzi S, Khayer M. [Validity and reliability of the theory of mind test (TOM test) for use in Iran]. Journal of Psychology. 2006;10(2):181-99. Persian.
23. Muris P, Steerneman P, Meesters C, Merckelbach H, Horselenberg R, van den Hogen T, et al. The TOM test: A new instrument for assessing theory of mind in normal children and children with pervasive developmental disorders. J Autism Dev Disord. 1999;29(1):67-80. doi: 10.1023/a:1025922717020
24. Hajgholam Rezayi Z. Comparison of the effect of theory oh mind and storytelling on understanding of mental verbs in 5-6 years old children with hearing impairment in Kerman. [Master Thesis]. Tehran: University of Social Welfare and Rehabilitation Sciences; 2012. Persian. [unpublished]
25. Rahmany R, Marefat H, Kidd E. Persian speaking children's acquisition of relative clauses. European Journal of Developmental Psychology. 2011;8(3):367-88. doi: 10.1080/17405629.2010.509056
26. Williams MN, Grajales CAG, Kurkiewicz D. Assumptions of multiple regression: Correcting two misconceptions. Practical Assessment, Research, and Evaluation. 2013;18:11. doi: 10.7275/55hn-wk47
27. Guo L-Y, Spencer LJ. Development of grammatical accuracy in English-speaking children with cochlear implants: A longitudinal study. J Speech Lang Hear Res. 2017;60(4):1062-75. doi: 10.1044/2016_JSLHR-H-16-0182
28. Peterson CC. Theory-of-mind development in oral deaf children with cochlear implants or conventional hearing aids. J Child Psychol Psychiatry. 2004;45(6):1096-106. doi: 10.1111/j.1469-7610.2004.t01-1-00302.x
29. Longobardi E, Spataro P, Rossi-Arnaud C. Relations between theory of mind, mental state language and social adjustment in primary school children. European journal of developmental psychology. 2016;13(4):424-38. doi: 10.1080/17405629.2015.1093930
30. Charman T, Shmueli-Goetz Y. The relationship between theory of mind, language, and narrative discourse: An experimental study. Curr Psychol Cogn. 1998;17(2):245-71.
31. Brooks R, Meltzoff AN. Connecting the dots from infancy to childhood: A longitudinal study connecting gaze following, language, and explicit theory of mind. J Exp Child Psychol. 2015;130:67-78. doi: 10.1016/j.jecp.2014.09.010
32. Hale CM, Tager-Flusberg H. The influence of language on theory of mind: Dev Sci. 2003;6(3):346-59. doi: 10.1111/1467-7687.00289
33. Smith M, Apperly I, White V. False belief reasoning and the acquisition of relative clause sentences. Child Dev. 2003;74(6):1709-19. doi: 10.1046/j.1467-8624.2003.00633.x
34. Longobardi E, Spataro P, Renna M, Rossi-Arnaud C. Comparing fictional, personal, and hypothetical narratives in primary school: story grammar and mental state language. Eur J Psychol Educ. 2014;29(2):257-75. doi: 10.1007/s10212-013-0197-y
35. de Mulder HNM, Wijnen F, Coopmans PHA. Interrelationships between Theory of Mind and language development: A longitudinal study of Dutch-speaking kindergartners. Cognitive Development. 2019;51:67-82. doi: 10.1016/j.cogdev.2019.03.006
36. Fontana E, Adenzato M, Penso JS, Enrici I, Ardito RB. On the relationship between Theory of Mind and syntax in clinical and non-clinical populations: State of the art and implications for research. The Open Psychology Journal. 2018;11(1):95-104. doi: 10.2174/1874350101811010095
37. Peters K, Remmel E, Richards D. Language, mental state vocabulary, and false belief understanding in children with cochlear implants. Lang Speech Hear Serv Sch. 2009;40(3):245-55. doi: 10.1044/0161-1461(2009/07-0079)
38. Liu M, Wu L, Wu W, Li G, Cai T, Liu J. The relationships among verbal ability, executive function, and theory of mind in young children with cochlear implants. Int J Audiol. 2018;57(12):875-882. doi: 10.1080/14992027.2018.1498982
39. Schick B, de Villiers P, de Villiers J, Hoffmeister R. Language and theory of mind: A study of deaf children. Child Dev. 2007;78(2):376-96. doi: 10.1111/j.1467-8624.2007.01004.x
40. Vissers C, Koolen S. Theory of mind deficits and social emotional functioning in preschoolers with specific language impairment. Front Psychol. 2016;7:1734. doi: 10.3389/fpsyg.2016.01734
41. Smit L, Knoors H, Hermans D, Verhoeven L, Vissers C. The interplay between theory of mind and social emotional functioning in adolescents with communication and language problems. Front Psychol. 2019;10:1488. doi: 10.3389/fpsyg.2019.01488
42. Brock LL, Kim H, Gutshall CC, Grissmer DW. The development of theory of mind: predictors and moderators of improvement in kindergarten. Early Child Development and Care. 2018;189(12):1914-24. doi: 10.1080/03004430.2017.1423481