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# Theory of Mind Acquisition in Children who are Deaf: The Importance of Early Identification and Communication Access

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**Abstract**

**Objectives:** The aim of this study was to compare Theory of Mind (ToM) acquisition in preschool-age children with typical hearing (TH), and children who are deaf and have hearing parents (DHP) who received a cochlear implant by 18 months of age, to determine if early access to spoken language via a cochlear implant affected ToM acquisition.

**Methods:** Participants included 25 children with cochlear implants ages 3.0 to 6.5 years and 25 age-matched children with TH all of whom were enrolled in preschools with typical peer models. The test battery included measures of expressive and receptive language and ToM.

**Results:** There were no differences between children who are DHP and their peers with TH on language or ToM performance. Hearing age was significantly different; children who are DHP had been exposed to spoken language for less time than their hearing counterparts by approximately 12 months. Language skills were correlated with ToM after controlling for chronological age.

**Discussion:** Early cochlear implantation may ameliorate some of the deleterious effects of congenital, profound deafness on oral language development; this could positively influence the development of social cognition.

**Conclusions:** Children who are deaf who receive a cochlear implant early and who have good oral language skills are more likely to acquire ToM in a typical time frame.

**Key words:** cochlear implants, theory of mind, social cognition, language

**Acronyms:** CI = cochlear implant; DDP = deaf with deaf parents; DHP = deaf with hearing parents; EHDI = Early Hearing Detection and Intervention; OWLS = Oral-Written Language Scales; TH = typical hearing; ToM = Theory of Mind

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Theory of mind (ToM) is one component of social cognition that reflects a child's developing understanding of the mind, and how mental and emotional states affect behavior (for reviews, see Wellman, 2011, 2014). In the early stages of ToM development, children understand that others can want different things (e.g., the child knows to give someone who likes vegetables a carrot for a snack rather than a cookie, even if the *child's* favorite snack is cookies) or believe different things (e.g., one person may believe a cat is hiding in the garage, and another may believe a cat is hiding in the attic). By 5 years of age, children with typical development have a relatively sophisticated understanding of the thinking and mental states of others. False belief understanding (the hallmark of ToM) is mastered by the end of preschool by most children and can be measured via several experimental tasks (Wellman and Liu, 2004). False belief understanding is signified by the child's realization that others can hold differing ideas or beliefs, that the beliefs of others can be false, and that these false cognitive representations can influence a person's actions (Apperly, 2010; Bretherton & Beeghly, 1982; Custer, 1996; Gopnik et al., 1994; Perner, 1991; Wellman, 2002). Having a mature ToM enables a child to predict, explain, and justify the actions of others;

it also supports their engagement in academic and social tasks, including inferring meaning from context, predicting and explaining the actions of people and characters, tricking others, lying, persuading, and understanding jokes (Moeller, 2002; Peterson, Slaughter, et al., 2016; Peterson et al., 2018; Watson et al., 1999). Preschoolers who possess better theory of mind skills are also more socially accepted and popular in their peer group (Slaughter et al., 2015), demonstrate more pro-social behaviors (Eggum et al., 2011), and tend to experience less friendlessness over time (Fink et al., 2014).

Although the sequence of ToM skill acquisition in preschoolers who are neuro-typical has been well established (Meltzoff et al., 1999; Wellman & Liu, 2004), the mechanisms underpinning acquisition and mastery of ToM are less well understood in children with risk factors for language delay. Language ability, in general, appears to influence ToM acquisition in children with typical development (Astington & Jenkins, 1999; Milligan et al., 2007). Specific language skills such as understanding advanced syntactic structures (de Villiers, 1995; de Villiers & de Villiers, 2000), use of mental state vocabulary (Grazzani & Ornaghi, 2012; Peterson & Slaughter, 2006; Ruffman et al., 2002), conversational exposure (Astington & Baird, 2005; de Rosnay & Hughes, 2006; Harris et al., 2005), and understanding of intentional behavior in infancy (Wellman et al., 2008) are also correlated with performance on ToM tasks in preschoolers with typical development.

In addition to language ability, language environment and conversational access to mental state terminology appear to play a role in the development of ToM and social competence in preschool age children that are typically developing. Mothers' conversational style and preference for mental state talk (talk about feelings, emotions, and thinking) is correlated with performance on false belief tasks (Peterson & Slaughter, 2003; Slaughter & Peterson, 2012) and children's mental state language usage can be predicted from their mothers' tendency to use mental state language (Taumoepeau & Ruffman, 2008). Children with more siblings tend to acquire false belief understanding earlier (Perner et al., 1994); and research shows a significant correlation between ToM and time in a preschool setting for children with typical development (Altun, 2019), and a positive correlation between social competence and peer play opportunities (Newton & Jenvey, 2010).

Research examining the development of ToM in children that are at high risk for late or atypical access to language supports the notion that language and conversational experiences are important for acquisition of ToM. Studies of children who are deaf indicate that ToM development is delayed in children who are deaf and whose parents have normal hearing (see Peterson, 2009 for a review), but is not delayed in children who are deaf whose parents are also deaf and who are immersed in sign language from birth (Courtin, 2000; Courtin & Melot, 2005), suggesting that early access to a natural language supports ToM development. The extant research on ToM in children who are deaf indicates that ToM development is related to language ability, timing of access to a shared language, quality of language input, communication mode of the children in the sample, and hearing status of the parents (Moeller & Schick, 2006; Peterson, 2004; Peterson & Siegal, 1999, 2000; Remmel & Peters, 2009; Sundqvist et al., 2014) and is often delayed by many years, compared to children with typical hearing (TH; Peterson & Wellman, 2009; Peterson et al., 2012). Such delays can have important social consequences for school age children as well as for teenagers who are deaf (Peterson, O'Reilly, et al., 2016; Peterson, Slaughter, et al., 2016; Peterson et al., 2018; Slaughter et al., 2015).

**ToM in Children who are Deaf**

Numerous studies of ToM in children who are deaf and have hearing parents (DHP) have demonstrated that this population is characteristically delayed in ToM compared to peers with TH and to children who are deaf and have deaf parents (DDP), most of whom acquire a first language through care providers who are fluent users. Early research showed that children who were DHP were elementary school or even middle school age before they could pass a standard false belief task (Courtin, 2000; Courtin & Melot, 1998; de Villiers & de Villiers, 2000; Figueras-Costa & Harris, 2001; Jackson, 2001; Lundy, 2002; Peterson & Siegal, 1995, 1997, 1998, 1999; Steeds et al., 1997; Woolfe et al., 2002). Russell and colleagues (1998) showed that fewer than half of high school age students who were deaf demonstrated false belief understanding. Most children in these studies were classified as *late signers*—children who did not learn sign language until they entered formal schooling. Schick et al. (2007) measured ToM abilities in 176 children who were deaf or hard of hearing aged 3 years 11 months to 8 years 3 months who used either American Sign Language (ASL) or spoken English. Regardless of communication mode, all children who were DHP demonstrated significant ToM delays.

In one of the earliest studies to demonstrate the importance of early language access in ToM development, Courtin (2000) showed that 5 to 8-year-old children who were DDP outperformed hearing peers and children who were DHP (oral and signing) on several false belief tasks. The author concluded that referential shifting in sign language (changing body position or gesturing to indicate shifts among multiple referents) assists with specific aspects of perspective-taking and mental representation, and that early language access and exposure is critical to ToM development. In a follow-up study, Courtin and Melot (2005) found that 5 to 7-year-old children who were DDP outperformed children who were DHP (both those who acquired sign language later, and those who used spoken language) on an appearance-reality task (What does it look like? What is it really?), and a false belief task. Neither of these studies included measures of receptive and expressive language (other than a report that the participants could understand language and pass the control items). The authors wrote, "[T]hus the differences in performances observed between deaf children groups may in part be due to some differences in their linguistic skills" (p. 23). Numerous studies since have supported the findings of Courtin and others, that children who are native sign language users do not demonstrate ToM delays (Edmonson, 2006; Hao et al., 2010; Jackson, 2001; Meristo & Hjelmquist, 2009; Meristo et al., 2007; Peterson and Siegal, 1999; Siegal & Peterson, 2008; Woolfe et al., 2002).

**ToM in Children with Cochlear Implants**

Statistically, more than 90% of children born deaf will have parents who have normal hearing (Mitchell & Karchmer, 2004). This can present significant communication and social challenges for families who do not use sign language naturally. Cochlear implants have altered the language-learning landscape for deaf children by providing an avenue by which some children who are DHP who receive a cochlear implant (CI) early and who have appropriate intervention and school supports can access spoken conversation and can develop intelligible spoken language (Geers & Sedey, 2011; Nicholas & Geers, 2017; Percy-Smith et al., 2017; Spencer et al., 2012).

Given the spoken language outcomes that some children achieve with cochlear implants, researchers have posited that the use of cochlear implants might mitigate some of the negative aspects of deafness and early auditory language deprivation on social cognition; however, ToM outcomes for this group are mixed. Meristo and colleagues (2012) compared the anticipatory looking behaviors of 10 infants who were deaf and 10 infants with normal hearing (age 24 months). All children who were deaf had been identified and amplified early (5 with CIs, 5 with hearing aids). The authors found significant differences between groups in false belief attribution, but not true belief attribution, suggesting that delayed language access affects the development of false belief reasoning. Remmel and Peters (2009) tested 30 children who were DHP with cochlear implants ages 3 to 12 years on a 5-item, developmentally ordered Theory of Mind scale developed by Wellman & Liu (2004). These children received cochlear implants on average at the age of 2.9 years and used spoken language as their only mode of communication. Findings indicated that false belief understanding was delayed, but not as significantly delayed as had been reported in previous studies, particularly for the younger participants. Peters and colleagues (2009) measured false belief use in a video description task to ascertain false belief task performance in 30 children with cochlear implants (the same cohort group as Remmel & Peters, 2009). The majority of children with cochlear implants used false belief reasoning when describing a character's anomalous actions, suggesting mature ToM despite poor performance on an experimental false belief task (unexpected contents). Similarly, Ziv and colleagues (2013), in their study of understanding of emotion and false belief among kindergarteners with normal hearing and those who were deaf, found that children who used oral language with cochlear implants outperformed children who used sign language on the false belief measure. The authors reported delays in ToM performance relative to hearing children, however, and high variability on both the false belief measure and receptive vocabulary ability. Finally, Sundqvist and colleagues (2014) found that very early auditory access to spoken language through a cochlear implant (prior to about 2 years of age) correlated with better ToM development.

Although one might expect children who are DHP with cochlear implants who have caught up verbally to their peers to have typical ToM, age-appropriate language skill appears to be insufficient for ToM mastery. Ketelaar and colleagues (2012) found that desire and belief reasoning were significantly poorer for children who were DHP compared to hearing peers even in children with age-appropriate vocabulary skills. The authors found no differences in performance on desire, intention, or false belief tasks for children who used sign language compared with children who use speech; nor was age at implantation a significant predictor of ToM. The authors concluded that access to spoken language through a cochlear implant is insufficient for ToM development and that the focus of intervention and parent education must shift to the *quality* of early conversations.

The majority of research to date has shown that children who are DHP with cochlear implants significantly underperform on ToM tasks when compared to their peers with TH. Additionally, at least one study suggested that children with cochlear implants do no better than children who acquire sign language late (Peterson, 2009) and that "The use of spoken modality does not seem to benefit ToM development….Irrespective of whether they used cochlear implants or hearing aids, most of the oral deaf children were delayed in ToM development to the same extent as late-signers." (p. 476). Even children with moderate to severe hearing loss (who presumably have good acoustic access to spoken language using traditional amplification) demonstrated social cognitive deficits (Netten et al., 2017).

Several gaps in the ToM literature remain. Many ToM studies failed to measure expressive and receptive language ability at all, or only partially, in children who were DHP or DDP, making it difficult to determine the underlying mechanisms associated with ToM growth (or lack thereof). Ketelaar and colleagues (2012), for example, measured language abilities via a receptive vocabulary test (picture pointing). Such a vocabulary measure cannot accurately assess a child's understanding of non-observable concepts—the domain of language that is correlated with false belief performance (Grazzani & Ornaghi, 2012; Peterson & Slaughter, 2006; Ruffman et al., 2002). Also, receptive vocabulary knowledge might not be a reasonable proxy for the advanced morphology and syntax thought to correlate best with ToM understanding (Astington & Jenkins, 1999; Milligan, et al., 2007).

In studies in which language *was* measured, the majority of children who were DHP (either children who use oral communication or children who are late signers) were identified with hearing loss late, outside of the federal Early Hearing Detection and Intervention (EDHI) guidelines (e.g., after the age of 6 months); received amplification or a cochlear implant after the age of 2 years; and as a result experienced significant delays in spoken language. Late identification and treatment of hearing loss results in long-term language learning delays regardless of language modality (Mayberry et al., 2002) or the form of first language input (Mayberry & Lock, 2003). Such language delays create subsequent delays in conversational access to a complete language model (including talk of the mind and other non-observable concepts) past the age at which many children with typical hearing are beginning to acquire early ToM skills (Wellman et al., 2005). This is true for children who are developing spoken language, sign language, or both. Peterson (2004) measured ToM in 52 children who were deaf, aged 4 to 12 years. There were 26 participants who used spoken language to some extent, half with cochlear implants and half with hearing aids, evenly divided between oral-only versus sign-plus-oral specialized schools for the deaf. Comparison groups of age-matched high-functioning children with autism and younger hearing children were also included.

> No significant ToM differences emerged between deaf children with implants and those using hearing aids, nor between those in oral-only versus sign-plus-oral schools….The finding that deaf children with cochlear implants are as delayed in ToM development as children with autism and their deaf peers with hearing aids or late sign language highlights the likely significance of peer interaction and early fluent communication with peers and family, whether in sign or in speech, in order to optimally facilitate the growth of social cognition and language. (Peterson, 2004, p. 1096)

However, the 13 children with cochlear implants in that study were all implanted after the age of 2 years; delayed ToM skills might be expected in these children, due to delays in conversational access. Early conversational access seems as important as closing language gaps in children who are deaf (which is often the primary goal in language intervention).

Finally, due to the relatively low incidence of childhood deafness, studies of ToM have relied on specialized, typically self-contained schools for the deaf to recruit participants. The downside of this approach is that these children are more likely to be conversing with other children that have language and ToM delays (Boyle, 1994), or concomitant disabilities affecting communicative competence (Shaver et al., 2013). This may reduce opportunities to converse about the mind and may affect ToM acquisition (De Rosnay & Hughes, 2006).

The above research suggests that the acquisition of a mature ToM in a typical timeframe depends on the ability to communicate early, easily, and proficiently about mental states with other skilled language users. Research shows that deaf children who are language delayed and/or late identified are likely to be delayed in ToM, and that children whose hearing and communication status match that of their parents are less likely to be delayed in language and less likely to be delayed in ToM. Auditory access per se seems insufficient to ensure typical ToM development; rather conversational access to and understanding of language of the mind (mental, emotional, and cognitive terms) and the beliefs of others from an early age are key variables—regardless of communication mode. If children are identified late, receive technology late, and do not develop strong early language and conversational skills, a cochlear implant itself will confer little advantage in ToM acquisition. By contrast, children who are deaf and who are identified early, treated early, and acquire conversational language in a typical time frame should demonstrate ToM development that more closely approximates that of their hearing peers.

This paper measured language and ToM performance in a group of young children who are DHP and received cochlear implants prior to 18 months of age to determine if very early auditory access to spoken language facilitates social cognitive development. This study adds meaningful and unique information to the current research on ToM in children who are deaf in that it measured complex expressive and receptive language skills and ToM in very early implanted children who used spoken language at school and at home. It also included an age-matched control group with TH that completed identical ToM and language measures.

## Method

### Participants

Participants were 25 children who were DHP with cochlear implants and 25 children with typical hearing (TH); the groups were matched for chronological age. The children who were DHP (12 males and 13 females) ranged in age from 36 months to 76 months ($M = 57.32$, $SD = 10.67$) at the time of testing. Children in the DHP group received their first cochlear implant between 6 and 18 months of age ($M = 12.5$, $SD = 3.151$, median age of CI = 13 months) and had been using their implant(s) for an average of 44.84 months (range = 19 to 68 months, $SD = 10.92$) at the time of testing. For the purposes of data analyses, *hearing age* was operationalized as months of cochlear implant use. The children with typical hearing (13 males and 12 females) ranged in age from 42 to 71 months ($M = 56.36$, $SD = 8.276$) at the time of testing. Their hearing age and chronological age were equivalent. None of the children in either group had any known diagnosed developmental, cognitive, or neurological conditions, per school and parent report.

Children with cochlear implants were recruited through direct solicitation, word of mouth, newsletter advertisement, social media, and database retrieval from specialized cochlear implant clinics and schools for the deaf in the Midwest, Northeast, and Pacific Northwest. Subject recruitment and data collection occurred over approximately 3 years, primarily due to the wide geographical range from which participants were recruited and the time-intensive nature of data collection. Children with typical hearing were recruited by word of mouth from preschools and childcare centers in the Midwest and

Pacific Northwest. All children with cochlear implants used spoken English as their primary mode of communication. All children attended either mainstream preschool settings (children with TH), or specialized preschools for the deaf or hard of hearing in which peer models with TH were also enrolled (blended or co-enrolled preschools). Ninety percent of the mothers of children in both groups had either a college education or graduate degree; the remaining ten percent in each group were high school graduates or had at least one year of college. There was no significant between group difference with respect to socio-economic status.

**Procedure**

This study was approved by the Western Washington University Internal Review Board (IRB protocol #10-077) and the Indiana University-Purdue University Indiana Internal Review Board (IRB protocol #1007-63). All participants were individually tested in their home by a clinical professional familiar with speech and language development of children with cochlear implants. Children completed a measure of expressive and receptive language and a modified version of the ToM Scale (Wellman & Liu, 2004). Administration procedures were identical for children with CIs and those with typical hearing. All tests were administered in accordance with standard administration procedures provided in the testing manual or in published literature, unless otherwise specified.

**Measures**

***Expressive and Receptive Language***

**Oral-Written Language Scales (OWLS; Carrow-Woolfolk, 1995).** This standardized language test measures expressive and receptive language ability including lexical/semantic, syntactic, pragmatic, and supra-linguistic language structures in individuals ages three through twenty-one.

**Theory of Mind.** Theory of mind was assessed using the five-item scale developed by Wellman and Liu (2004) with one addition; a second false belief task was added (Change in Location task) to provide more robust data on this task. Items were presented exactly as described in the Wellman and Liu (2004) paper with minor modifications in props, but no deviation in script or scoring with exception of the Real-Apparent Emotion task where an alternate script was presented to eliminate the narrative of *teasing*.

***1. Diverse Desires.*** This test measures a child's understanding that different people can have different *wants*. A child is presented with a picture of two different snacks, a carrot and a cookie and is asked which snack he/she would choose. The child is then introduced to a character Mr. Jones, and told that he likes the snack not chosen by the child. The child is asked which snack Mr. Jones will pick. The response is scored correct if the child picks the snack Mr. Jones likes.

***2. Diverse Beliefs.*** This test measures a child's understanding that different people can *think* different things. A child is shown a picture of some bushes and a garage and presented with a toy figure, Linda, who has lost her cat. The child is asked to guess where the cat is hiding and is provided two choices—in the garage or in the bushes (the actual location of the cat is unknown). The child is then told that Linda thinks her cat is in the location not chosen by the child (e.g., if the child chose garage, then Linda thinks the cat is in the bushes). The child is asked where Linda will look for the cat. The response is scored correct if the child chooses the location opposite to his/her own (i.e., responds to the question from Linda's perspective).

***3. Knowledge Access.*** This test measures a child's understanding that perceptual information leads to knowledge. The child is asked to guess what is in a nondescript metal can. After the child responds, he/she is shown that a small toy dog is inside the can. The child is introduced to a character (Polly) and told that Polly has never seen inside the can. The child is asked if Polly knows what is inside the can. The response is scored correct if the child answers that Polly does not know what is in the can despite the child having seen inside the can (i.e., responds to the question from Polly's perspective).

***4. Contents False Belief*.** This test measures a child's understanding that a person can believe something that the child knows to be untrue. The child is shown a Band-Aid box and is asked what is inside (most children say Band-Aids). The child is then shown that there is a pig inside the box. The child is introduced to a character (Peter) who has never seen inside the Band-Aid box. The child is then asked what Peter thinks is inside the box. The response is scored correct if the child answers Band-Aids.

***5. Change in Location False Belief***. Similar to the contents false belief task, this task measures a child's understanding that a person can believe that something is in a location that the child knows to be false. The child watches Ernie play with a marble and put the marble in a box before leaving the room. The child then moves the marble to a jar and Ernie returns to look for his marble. The child is asked where Ernie will look for his marble. The response is scored correct if the child answers "in the box."

***6. Real-apparent Emotion.*** This test measures a child's understanding that a person's facial expression may not match the emotion they really feel inside. The child is shown illustrations of a happy, okay, and sad face and asked to identify the emotions. The child is then told the story of a boy (Matt) who loves toy trucks and gets a present from his grandmother which he hopes is a toy truck. When Matt opens the present, he finds a book. The child is told that Matt does not really like the book, but he does not want to hurt his grandmother's feelings. The child is asked to remember what toy Matt wanted to get and what toy Matt did get. The child is asked to label how Matt really feels inside (happy, sad, or okay) and then asked to label how Matt tried to look on his face (happy, sad, or okay). The response is scored correct if the child answers with a more negative response for how Matt felt inside than for the facial expression Matt displayed on his face (e.g., Matt really felt sad, but tried to look happy on his face).

### Statistical Analyses

The main objective of this paper was to compare performance of children with TH and children who are DHP on measures of ToM, and expressive and receptive language. A second goal was to determine which variables were most strongly correlated with ToM for the group of children who are DHP. To that end, independent samples *t*-tests were conducted comparing the means on the ToM scale, and receptive and expressive language for the children who are DHP and and those with TH. Bivariate correlations were then conducted on the above variables for the group of children who are DHP with the ToM scale.

## Results

### Group Differences

Bonferroni corrections were applied to all between group comparisons to reduce the likelihood of a Type 1 error. Children with cochlear implants were not significantly different from children with TH on chronological age ($p = .724$) and SES ($p = .885$; see Tables 1 and 2). There was a significant between group difference with respect to hearing age. The children with TH had been exposed to spoken language significantly longer than children who were DHP by about 12 months ($p = .000$). There were no significant differences on the total ToM Scale between the children who were DHP compared to the children with TH ($p = .716$); 16% percent of the children who were DHP passed all 6 ToM tasks compared to 20% of children with TH (see Table 3).

### Correlation Analyses

To examine the relations between predictors and ToM scale performance for the children who were DHP, all predictor variables were correlated with ToM Scale

**Table 1**
*Participant Demographics and Hearing History*

| | Group | | | | |
|---|---|---|---|---|---|
| | Children who are Deaf with Hearing Parents (*n* = 25) | | Children with Typical Hearing (*n* = 25) | | |
| Variable | *M (SD)* | Range | *M (SD)* | *Range* | *t (df)* |
| Age at implant (mos) | 12.48 (3.15) | 6.0–18.0 | | — | |
| Age at identification (mos) | 3.71 (4.07) | 1–14 | | — | |
| Chronological age (mos) | 57.32 (10.67) | 36–76 | 56.64 | 43–71 | .249 (48) |
| Hearing Age[b] | 44.84 (10.92) | 19–68 | 56.65 (8.5) | 43–71 | -4.23(48)* |
| Maternal education[a] | 6.32 (1.08) | 4–7 | 6.48 (0.77) | 4–7 | -0.297 (48) |

[a]Maternal education is coded on a scale from less than 7th grade (coded 1) to graduate degree (coded 7).
[b]Hearing age is defined as age at cochlear implantation subtracted from chronological age.
*p < .001

**Table 2**
*Children with Typical Hearing (TH) compared to Children who are Deaf with Hearing Parents (DHP): Language Measures and Theory of Mind (ToM)*

| | Group | | | | | | |
|---|---|---|---|---|---|---|---|
| | Children who are DHP | | | Children with TH | | | |
| Variable | *n* | *M* | *SD* | *n* | *M* | *SD* | *t(df)* |
| Expressive language age[a] | 25 | 62.68 | 20.211 | 25 | 63.60 | 17.428 | -.172 (48) |
| Receptive language age[a] | 25 | 65.84 | 19.356 | 25 | 64.24 | 14.652 | .330 (48) |
| Expressive language SS[b] | 25 | 104.84 | 19.334 | 25 | 108.88 | 14.578 | -.834 (48) |
| Receptive language SS[b] | 25 | 107.56 | 17.628 | 25 | 108.00 | 11.680 | -.104(48) |
| ToM 6-item scale | 25 | 3.80 | 1.443 | 25 | 3.96 | 1.645 | -.223 (48) |

[a]Oral-Written Language Scales (OWLS) age equivalent
[b]OWLS standard score (SS)

**Table 3**
*Percentage of Correct Responses on a 6-item Theory of Mind (ToM) Scale*

| | Children who are Deaf with Hearing Parents | | Children with Typical Hearing | |
|---|---|---|---|---|
| Task | *n* | Percent Passed | *n* | Percent Passed |
| Diverse Desires | 25 | 80 | 25 | 84 |
| Diverse Beliefs | 25 | 92 | 25 | 76 |
| Knowledge Access | 25 | 64 | 25 | 76 |
| Contents False Belief | 25 | 36 | 25 | 48 |
| Location False Belief | 25 | 60 | 25 | 68 |
| Hidden Emotion | 25 | 48 | 25 | 44 |
| All 6 ToM tasks | 25 | 20 | 25 | 16 |
| Mean total score (0–6) | 25 | 3.80 | 25 | 3.96 |
| SD Total Score | | 1.443 | | 1.645 |
| Mean Age (months) | | 57.32 | | 56.64 |
| Mean Hearing Age (months) | | 44.84 | | 56.64 |
| SD Age | | 10.668 | | 8.495 |

Scores. Additionally, partial correlations were conducted controlling for chronological age to attempt to exclude effects of maturation. These correlations are presented in Tables 4 and 5. Expressive and receptive language skills were significantly positively correlated with scores on the ToM Scale for the children who were DHP group, even after controlling for age. Maternal education level was significantly correlated with expressive and receptive language scores, but not ToM performance.

## Discussion

In this study of 25 young early implanted children who were deaf and used cochlear implants and spoken language, and 25 children with TH, there were no differences between children with cochlear implants and their age-matched peers with TH on expressive language, receptive language, or ToM performance. The only significant difference between these two groups of children was their hearing age; children who were DHP had been exposed to spoken language for significantly less time than their TH counterparts by 12 months on average. Expressive and receptive language skills were correlated with ToM performance in the group of children who were DHP, even after controlling for the effects of chronological age. These results provide evidence that early cochlear implantation can ameliorate some of the deleterious effects of congenital, profound deafness on language development, which in turn may positively influence social cognition; and that children who are DHP who receive cochlear implants relatively early *and* who have age-appropriate language skills are more likely to acquire ToM in a typical time frame. The present findings contrast with earlier literature showing that children who are DHP

**Table 4**
*Bivariate Correlations for Children who are Deaf with Hearing Parents*

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1. Theory of Mind score | - | .348 | .363 | -.079 | .422* | .471* | .509** | .542** | .381 |
| 2. Chronological age | | - | .958** | .068 | -.149 | .011 | .447* | .501* | -.023 |
| 3. Hearing age | | | - | -.222 | -.144 | .027 | .410* | .489* | .046 |
| 4. Age at implant | | | | - | -.007 | -.057 | .093 | .004 | -.237 |
| 5. Receptive language SS+ | | | | | - | .897** | .790** | .666** | .586** |
| 6. Expressive language SS+ | | | | | | - | .795** | .845** | .633** |
| 7. Receptive language age | | | | | | | - | .915** | .486* |
| 8. Expressive language age | | | | | | | | - | .524** |
| 9. Maternal Education | | | | | | | | | - |

*Note. N = 25*
+Standard Score (SS; where 85–115 represents average range)
*$p < .05$
**$p < .01$

**Table 5**
*Chronological Age Controlled Partial Correlation for Children who are Deaf with Hearing Parents*

| | | | |
|---|---|---|---|
| 1. Theory of Mind score | - | .421* | .453* |
| 2. Receptive language age | | - | .893** |
| 3. Expressive language age | | | - |

*Note.* $n = 25$ for all variables.
$^{*}p < .05$. $^{**}p < .001$

who used cochlear implants performed no differently than children who used hearing aids on a ToM test battery (Peterson, 2009). However, in contrast with previous studies, this study was the first to include only children who received cochlear implants early, and who used spoken English as their primary language at home and at school. In this regard, the present sample of children was more similar to children with typical hearing and children who are DDP in that they shared a natural language with their parents from an early age. In addition, this study was unique in that all participants who were deaf attended mainstream, or co-enrolled/blended preschool programs. This educational environment provided them with opportunities to interact frequently with typical language and social peer models, and to observe and participate in typical conversational exchanges among other children.

A novel finding of this study is that children who are DHP performed no differently than children with TH on measures of expressive and receptive language and social cognition. This result was observed despite the fact that the children who were DHP had fewer months of language access than the hearing control group. Linguistic deprivation has been raised as a troubling phenomenon in children who are deaf and whose parents have normal hearing (the majority of congenitally deaf children; Hall, 2017; Hall et al., 2019). Children who are born deaf are not eligible for cochlear implants until at least 9 months of age (per FDA guidelines), although some children receive a cochlear implant as early as 6 months of age. This lag in auditory language access is concerning as it may lead to short and long-term language, social, cognitive, and academic delays. However, this study suggests that some children who receive cochlear implants by 18 months of age can function similarly to children with typical hearing, not only in their spoken language ability, but also in their social cognitive skills indexed by tests of ToM. Social cognitive abilities correlate with pro-social behaviors, social skills, and social well-being in preschoolers with normal hearing (Eggum et al., 2011; Fink et al., 2014) and children who are deaf (Peterson, O-Reilly et al., 2016; Peterson, Slaughter, et al., 2016). In this group of children who had CIs implanted early, 20% passed all ToM tasks, compared to 16% of the participants with TH (this difference was not statistically significant). In the group of children who were DHP, only three out of 25 performed greater than one standard deviation below the mean on receptive language and only four of the 25 fell greater than one standard deviation below the mean on expressive language; one child out of 25 exhibited expressive language scores greater than two standard deviations below the mean. Nine children in the group of children who were DHP demonstrated receptive language skills that were greater than one standard deviation above the mean on the OWLS, and 11 children who were DHP demonstrated expressive language skills above the average range.

One caution about these language findings is that all participants in this study were young (kindergarten age at the oldest), and therefore did not possess mature linguistic skills. Language delays can emerge in middle and high school despite advanced early language function (Marschark & Knoors, 2019). Language plateau in this population may also affect the acquisition of more advanced ToM skills such as understanding of deceit, irony, and sarcasm. Research on college students that are deaf shows that they are vulnerable to delays in these advanced ToM skills (Marschark et al., 2019), reinforcing the need for diligence in supporting language and social skill development as children who are deaf progress through elementary and secondary school.

This study also found that expressive and receptive language skills were strongly correlated with ToM in children who are DHP, even after controlling for the effects of maturation. This finding is supported by most of the literature on children with TH (Milligan et al., 2007; Astington & Jenkins, 1999), children who are DHP (Peterson, 2004; Peterson & Siegal, 1999; Peterson & Siegal, 2000; Remmel & Peters, 2009; Sundqvist et al., 2014), and children who are DDP (Courtin, 2000). One exception is research by Ketelaar et al. (2012) who found that children who are DHP with age-appropriate receptive vocabulary still did not pass the desire and belief reasoning tasks. It is possible that receptive vocabulary is not a good proxy for the domains of language that might support ToM mastery. The current study included more comprehensive measures of expressive and receptive language, including vocabulary, figurative language, morphology, and syntax. This study also compared the children who were DHP with the control group that was TH on all measures, which provided for a direct comparison of language and ToM skills, as well as the relationship between measured language (versus inferred language based on chronological age) and ToM for both groups. It is possible that language skill alone is insufficient to ensure typical ToM acquisition. The participants in Ketelaar and colleagues' study were older at the time of receiving their CI and as such, experienced a shorter period of access to auditory language and, by extension, spoken conversation. It may be that language competence combined with opportunity for practice are important for the acquisition of ToM. In this study, children who were DHP not only had good language skills, but likely more exposure to social exchanges and more opportunities for conversational practice than deaf children of the same age who received auditory language access later.

Results of this study when considered in light of previous research on ToM in children that are deaf suggests that technology alone is insufficient for addressing social cognitive deficits. Cochlear implants are a sensory aid and neural prosthesis that can improve auditory access to sound and speech and, with appropriate early intervention, can facilitate language development and conversational access for many deaf children. This, in turn, might provide an avenue for ToM development. Children who are profoundly deaf and who have hearing parents are still at risk for language delays (Nittrouer et al., 2018). These language deficits are likely to put them at higher risk for ToM delays as well. Children who learn sign language from adults who are not proficient sign language users are also at risk for ToM delays (Moeller & Schick, 2006). Very early access to conversation (whether signed or spoken) appears to facilitate ToM acquisition. Professionals should focus on strategies that build linguistic fluency and social engagement to promote strong social cognitive skills. For children who are deaf and who have typically hearing parents, cochlear implants may provide auditory access to natural, complex conversations about more abstract concepts such as cognitive, emotional, and mental states. On the other hand, if care providers and family members acquire conversational competence in ASL relatively quickly, including the vocabulary and syntax required to convey cognitive (unobservable) concepts, this could also be a reasonable means by which a child who is deaf can be exposed to theory of mind language and concepts at an early age.

### Study Limitations

This is a relatively small sample of mostly middle-class children. In this group of participants, language ability was predicted by maternal education level, a finding observed in previous research on children with cochlear implants (Szagun & Stumper, 2012). Such children may be advantaged in other ways as well; they may have more access to attentive care providers and more intensive, specialized therapy services—both of which might positively influence ToM acquisition. In fact, all of the children who participated in this study were receiving speech-language and listening therapy at specialized clinics for children who are deaf or hard of hearing in addition to school-based speech pathology services. This may have influenced both language and ToM development; Percy-Smith and colleagues (2017) suggested that children who are deaf and who receive intervention from providers with expertise in developing listening and spoken language skills of preschoolers who are deaf or hard of hearing have better outcomes than children who receive speech language therapy alone.

Another limitation was that the ToM tasks used for this research were binary (children either passed or failed each task) and not standardized—although widely used in research with this population. They are not necessarily a robust measure of all ToM behaviors exhibited by neurotypical 3 to 6-year-olds. Standardized measures of ToM such as the ToMI-2 (Hutchins et al., 2017), could further elucidate ToM gaps in children who are deaf across a wider age range, and describe the impact of early identification and treatment of hearing loss on a multitude of ToM skills.

Several gaps in the research remain. Studies that include children implanted prior to 12 months of age are necessary. Dettman and colleagues (2021) found that children implanted by 9 months of age demonstrated significantly better long-term language outcomes than children implanted later; this could positively influence social cognitive acquisition and development. Additionally, studies that include preschoolers who are classified as hard of hearing might provide further insights into the contribution of acoustic hearing (and overhearing) to ToM development. Studies of early implanted children who are bilingual-bimodal (use both spoken language and sign language fluently) would also be useful in ascertaining if use of a visual language enhances access to social cues and abstract, mental state talk in children who also use speech. Children who have used signed supported speech may also demonstrate a different trajectory of ToM development, assuming that supplemental visual language cues enhance vocabulary and/or language development (van Berkel-van Hoof et al., 2019).

Studies of teenagers who are deaf and received a cochlear implant at a very early age could provide information about the longitudinal trajectory of ToM (second order ToM, advanced ToM, future thinking). Language and learning gaps tend to show up later for children who are deaf, regardless of their abilities in elementary school (Marschark & Knoors, 2019); language delays in middle and high school might affect acquisition of these more advanced ToM skills.

Finally, the development of ToM in children who are deaf with additional developmental and cognitive disabilities has not been described at all in the literature. The clinical implications of such research would be valuable to both parents and educators.

## Conclusion

Theory of mind acquisition for children who are deaf and who have hearing parents (DHP) is a complex process and probably the result of several intersecting variables: expressive and receptive language ability, high-quality and frequent linguistic and social input by care providers, early exposure to conversations about the mind, opportunities to engage regularly in conversation about the mind with adults and peers, and typical sensorimotor and neurocognitive abilities.

The findings of this study suggest that children who receive cochlear implants by 18 months of age and who acquire age-appropriate spoken language skills may acquire ToM in a timeframe comparable to their peers with typical hearing; ToM acquisition can be supported through optimizing communication access and function from a very early age.

Future research should include more children from a variety of home environments and educational settings, children who are bilingual-bimodal, and children who receive cochlear implants by 6 to12 months of age. Longitudinal studies of very early implanted children would provide further insights into the developmental trajectory of ToM and the possible influence of language plateau on ToM development. The influence of language input and environment on ToM acquisition should be studied systematically, using standardized measures; and the effectiveness of therapy approaches to enhance ToM in young children who are deaf should be reviewed, as this remains a significant gap in the literature.

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