Reading and theory of mind during the primary-secondary educational transition: a multiple case study in pupils with a cochlear implant.

The transition to secondary education is a sensitive period for social and academic development and also for student identity. Previous studies have observed reading comprehension and theory of mind difficulties in pupils with cochlear implant (CI) at different stages, but there is scarce evidence of their development during the educational trajectory. Our aim is to explore mental states understanding and reading competence during the transition from primary to secondary education. 8 participants with different hearing conditions (four with unilateral CI and four with binaural hearing) were evaluated at 10-11 years old (primary education) and at 13-14 years old (secondary education). The results show that pupils with CI obtain age-appropriate reading scores. Theory of mind development seems to be heterogeneous in CI users and be affected after the educational transition compared to their own performance in the first wave. This variability could be related to adaptation to secondary education and their individual characteristics.

Keywords: Theory of mind, reading, cochlear implant, educational transition.

The educational transition from primary to secondary school is not simply about adaptation to a new space, each pupils must also adapt to new teaching staff, establish new thinking and learning strategies, adjust their learning expectations and interact with more pupils (Hopwood et al., 2017). This change takes place at an important moment for individual development, characterized by the psychological identity crisis and its consequent consolidation (Meeus et al., 2010). These factors could cause academic, emotional, and motivational difficulties during the transition between the two educational stages. The onset of secondary education coincides, in many cases, with the beginning of adolescence and, therefore, pupils' motivations to acquire core academic skills could decrease to the benefit of other interests. Reading difficulties and special needs (i.e. hearing loss) could also become more evident due to the effects of the transition period (McCoy et al., 2020; Nootens et al., 2019).

Theory of mind (ToM) is the ability to appreciate other people's mental states such as intentions and emotions and also infer their behaviours (Premack & Woodruff, 1978). Depending on the affective or cognitive nature of these mental states, two dimensions can be distinguished. On one hand, affective ToM is defined as the process of understanding emotions and, on the other hand, cognitive ToM, is the understanding other people's intentions or beliefs (Shamay-Tsoory et al., 2010).

Some authors have shown that cochlear implant (CI) users with prelinguistic hearing loss could have problems applying ToM efficiently (Figueroa et al., 2020; Peterson et al., 2016). Children with hearing loss can have difficulties learning incidental social behaviours, rules and values from overhearing quick, snappy conversations between other people (Netten et al., 2015). Their limited socioemotional experiences in comparison with the typical hearing (TH) population and, as a consequence, the risk of developing difficulties in the social domain could be one of the

factors for presenting ToM delays (Marschark et al., 2017). But, according to Peterson et al. (2016), children with hearing loss gradually acquire the same ToM milestones that children with TH acquire earlier. In any case, the lack of standardized tests for the assessment of mentalistic competence in adolescence makes the study of the development of ToM over time more difficult. To our knowledge, only one study has longitudinally analysed ToM development in adolescents with CI: the one by Peterson et al. (2016) on 36 children with hearing loss aged between 6 and 14 (half of whom were CI users), whose results showed that none of the participants completed the sarcasm item of the six-step ToM scale. Also, there was no difference between children with or without CI.

Understanding others' thoughts and behaviours and acquiring age-appropriate social skills during early childhood predicts later school achievement in children with TH (Lecce et al., 2017), which could be impacted, for example, by their motivation for learning. At the beginning of secondary education, adolescents attach high value to interpersonal and intergroup relationships and the feeling of being accepted by others in a group is regarded as one of the most salient social aspects (Feigenberg et al., 2008). In the case of pupils with hearing loss, this goal seems harder to achieve as their friendship choices are less reciprocal (Rom & Silvestre, 2012), which could be explained to some extent by educational transition and curricular changes. Difficulties with early ToM skills coupled with the challenging transition between primary and secondary education could mean that pupils with CI need more time and shared activities in order to get to know each other, converse and forge mutual friendships.

In recent years, some researchers have also studied how ToM could be related to reading comprehension in children with TH (Dore et al., 2018), as readers require these skills in order to make judgements about the characters', narrators' and even authors'

intentions. These mentalistic elements of reading could be particularly important around the age of 13 when a change occurs in the reading process (Fitzgerald & Shanahan, 2000) whereby it becomes more automated and is no longer strictly a matter of decoding, but also focuses more intensely on understanding and interpreting characters' ideas and thoughts.

Performance in reading comprehension tests has been shown to be lower in pupils with CI than in their peers with TH at different stages of development and has traditionally been associated with weaker language skills (Figueroa et al., 2020). Some longitudinal studies on reading comprehension have shown that pupils with hearing loss obtain lower scores for understanding texts during primary education compared to their peers with TH. These difficulties also persist in adolescence (Geers & Hayes, 2011; Worsfold et al., 2018). Hence, hearing conditions should be taken into account, as pupils with TH seem to develop better reading performance than their peers with hearing aids, especially if the CI is received before 48 months (Archbold et al., 2008).

Multiple factors converge in reading comprehension (such as social, emotional or previous knowledge), and during the educational transition (or preadolescence) these are all undergoing a process of change. Therefore, our study aims to address reading from a holistic approach, focusing on an ability that we consider fundamental to its development: ToM. This study addressed the following research questions:

- What is the ToM and reading level of pupils with CI before and after the educational transition?
- Which individual characteristics could be related to an improvement or a decline in ToM and reading skills after the educational transition in each case?

Methodology

A longitudinal multiple case study was conducted in which linguistic skills and ToM were evaluated in two educational stages. In Spain, primary education comprises 6 years and it is made up three cycles (each of which lasts 2 years), while secondary education begins at the age of 12 and comprises 4 years. Therefore, pupils with CI were evaluated at 10-11 years (that is, in the last cycle of primary school) and at 13-14 years (in the first two secondary school years). Longitudinal case studies in the field of education can be of value in providing an illustration that enhances understanding and provides a basis for further discussion and analysis (Rose & Shevlin, 2016). These studies are also ideal for the analysis of change and the individual characteristics of each pupil with hearing loss as the cross-sectional studies could not identify correctly changes or factors that influence in reading or ToM development. A longitudinal study would enable to appreciate these individual differences in their development and describe more faithfully the diversity of the population with CI throughout its development. This approach is also adapted to the limited population with a CI in Catalonia, which has some peculiarities such as learning and mastery of two languages, such as Catalan and Spanish. This study takes into account precisely the first language (L1) of each pupil, but also other experiences (such as birth order, number of siblings, socioeconomic status or pupils who were allocated to another school in secondary education) that can help expand and deepen understanding of data obtained from quantitative analysis.

Participants

Pupils with hearing loss were recruited with the collaboration of the *Centres de Recursos Educatius per a Deficients Auditius* (CREDA). This institution provides educational support to pupils with hearing loss since toddlerhood and throughout

compulsory education in Catalonia. Families and pupils with hearing loss sign a consent to participate in the study voluntarily. This study was approved by xxxx.

All participants met the following criteria: 1) Spoken language was their preferred mode of communication, 2) Participants were fluent in Catalan and Spanish, 3) Participants received a CI before 5 years of age, 4) None of the participants had any additional disorders and 5) All must be enrolled in inclusive schools. A sample of 8 pupils with prelingual hearing loss was recruited of which five were female. Their parents were hearing and all participants was fluent in both Catalan and Spanish, so the assessment of reading and ToM skills was done in Catalan language as it is their academic language (see Table 1 for detailed information on each participant).

Materials and procedure

All tests were conducted in the school context and the sessions were performed individually. The tests selected to measure reading and ToM skills are detailed below.

Language skills and reading competence. Standardized test batteries were administered for assessing linguistic and reading skills at 10-11 years and 13-14 years of age: the *Test d'Anàlisi de Lectura i Escriptura en Català* (TALEC; Cervera et al., 2005) and the screening version of the *Batería de Lenguaje, Objetiva y Criterial* (BLOC; Puyuelo et al., 2002) was used in the first wave and the *Bateria d'avaluació dels processos lectors* (PROLEC-SE-R, Cuetos et al., 2016) in the second. These batteries are commonly used by education and health professionals and were administered in previous studies with participants with typical hearing or hearing loss (e.g., Callejón-Póo et al., 2012; Gómez-Merino et al., 2021). It was necessary to use two different reading tests, that is, TALEC and PROLEC-SE-R, since there is still no test in Catalan language that measures reading competence throughout compulsory education.

For this purpose, raw TALEC scores and PROLEC IQ scores were transformed into percentiles.

TALEC has different tasks to measure the identification of letters and the reading of syllables, words, or text. It also evaluates comprehension through narrative texts. At 10-11 years, the screening version of the BLOC was also used for assessing spoken language skills. Specifically, this battery measures the level of each participant in four domains: morphology, syntax, semantics, and pragmatic.

PROLEC-SE-R provides a General Reading Index and sub-indexes of the different processes involved in reading: lexical processes, syntactic processes and semantic processes. Lexical processes include reading decoding skills such as word-reading and non-word reading skills. In semantic processes the battery has five different texts: expository comprehension, narrative comprehension, non-mnemonic comprehension, mnemonic comprehension and oral comprehension. These texts enable the research team to analyse the performance of each participant with different textual typologies (expository and narrative comprehension), as well as to differentiate the effect of memory (non-mnemonic and mnemonic comprehension) or language (oral comprehension) on reading performance. Each of these subtasks consist of 10 questions and each correct response worth as one point.

Theory of mind. The six-step ToM scale of Peterson et al. (2012), which has previously been administered to children with hearing loss, was used to evaluate the ToM level at 10-11 years old. The scale is frequently used to assess ToM skills between 3 and 13 years old and includes six items with increasing complexity. These items are: diverse desires (awareness that different people may want different things), diverse beliefs (awareness that different people may have different beliefs or opinions), knowledge access (not seeing leads to not knowing), false belief (ability to adopt the

perspective of the character of the story or if judgments are according to their knowledge), hidden emotion (awareness that facial expressions may not match people's actual feelings) and sarcasm (awareness that the literal meanings of words may not match the implicit meaning or others' intentions). Children earned one point if they passed the item, except for the hidden emotion that could gain up to two points, one point for each question. Items 1, 5 and 6 of this scale have a predominantly affective component, while items 2, 3, 4 are predominantly cognitive.

During adolescence, to avoid the ceiling effect, a false belief task (Ryskin & Brown-Schmidt, 2014) and *Faux Pas* test (Stone et al., 1998) were administered to assess cognitive and affective ToM, respectively.

The false belief task consists of two pictures and a text about the story of Vicki. She was playing the violin in a room where there are four boxes of different colour placed in the following order from left to right: the blue box, the purple box, the red box and the green box. Vicki decides to keep the violin in the blue box and goes to play outside. When she leaves, her sister appears and changes the violin to the red box and also changes the position boxes (left to right: red, green, purple and blue). So, the red box (false belief, egocentric answer) is in the original position of the blue box (non-egocentric answer). Finally, each participant is asked where the girl will go to look for the violin. The answer should be indicated as a percentage of probability.

For the affective ToM task, two stories were administered: one story with a misunderstanding and a control story. In the story about misunderstandings, the participants answer questions about the characters' feelings, while the questions about the control story were related to physical relationships. In both cases the first question asked if anyone had done anything they should not have done. If the answer was

correct, the other questions could be answered. Otherwise, the story was scored with a zero. The maximum score that can be obtained in this task was 8 points.

Estimates of the socioeconomic status of families were calculated from the Hollingshead Four Factor Index (Hollingshead, 1975). Through a questionnaire for families and an interview with their speech therapist and teachers was obtained personal and family information and also clinical history (e.g. audiological data, information about parental education or occupation). In order to control non-verbal intelligence, the WISC-IV battery (Wechsler, 2007) was also administered.

Results

Participant A

Participant A is the elder of two siblings from a medium-low social-economic family and his L1 is Spanish. This child was unilaterally implanted at one year and three months. At 11 years old, Participant A had been 70th percentile or above in all reading and linguistic measures and completed the six-step ToM task successfully (see Table 2 and Table 3 for detailed scores on reading and ToM tasks, respectively).

Participant A moved to a different setting at the beginning of secondary education. His scores remained in the age-appropriate intervals, however the percentiles obtained in language processes were lower than those registered in primary education. Participant A scored below average in those expository texts with formal concepts and more cognitive resources, that is, expository comprehension, mnemonic reading comprehension and oral comprehension subtasks. Nevertheless, Participant A answered efficiently inferential questions and also apply these skills to solve ToM tasks in secondary education because he almost achieved the maximum score in the Faux Pas test and made judgements based on protagonist's knowledge in cognitive ToM.

<insert Table 1 here>

Participant B

Participant B is the elder of two siblings from a median social-economic family whose L1 is a non-Romance language[1]. This child was implanted at three years of age. Similar to Participant A, Participant B obtained scores in the average range (74th percentile or above) in all reading and linguistic measures and completed the six-step ToM task successfully in the first wave.

Although Participant B remained in the same school in secondary education, her performance in reading tasks at 14 years of age was poorer than in primary education and her Global Index of Reading was below the percentile 50th. The semantic domain was specially affected after the transition period, since Participant B only obtained age-appropriate scores in the narrative comprehension. Taking into account her performance in primary education, surprisingly, Participant B showed difficulties in ToM tasks. These difficulties were more noticeable in the cognitive ToM in which she based her response on her own knowledge and assigned 100% of probabilities to the egocentric answer. In affective ToM, Participant B scored lower because she did not answer why some behaviours were inappropriate, why one of the protagonists said those comments even though they were inappropriate, and she also identified a control story (without a mentalistic component) as a misunderstanding.

<insert Table 2 here>

[1] To preserve anonymity and according to World Medical Association Declaration of Helsinki, very specific details (such as in this case mother tongue) that could facilitate their recognition are not provided.

Participant C

Participant C is the elder of two siblings from a median social-economic family whose L1 is a non-Romance language. This child was implanted at three years of age and received the second CI three years later. Unlike the participants described above, low reading performance and, more specifically, in word decoding skills in Participant C was detected when he was 10 years. Regarding ToM scale, Participant C made mistakes in the last and most complex item of the scale, which consists of understanding sarcasm and is acquired at 11 years old by TH peers.

Participant C moved to a different setting at the beginning of secondary education, yet he improved his performance in reading comprehension. Despite the good performance in syntactic and semantic processes, Participant C showed a low level in the Lexical Index compared with his peers with CI. The Lexical Index is related to decoding skills in which he had already presented difficulties in primary education. These linguistics difficulties could affect to his judgements during ToM tasks since Participant C identified a control story (without a mentalistic component) as a misunderstanding. For this reason, this child scored lower than other participants. However, Participant C opted for the non-egocentric answer as they assigned a higher value to it than the egocentric one.

Participant D

Participant D is the younger of three siblings from a medium-low social-economic family and her L1 is Catalan. This child was implanted at four years of age. Participant D obtained scores in the average range in all reading and linguistic measures in which morphology was her lowest score (percentile 53th). At 10 years of age, Participant D was able to successfully complete the ToM scale, including the sarcasm item.

Participant D moved to a different setting at the beginning of secondary education. After the education transition, her scores remained in age-appropriate intervals, but lexical and semantic performance was lower than that obtained in primary education. Participant D scored below average in almost all text comprehensions tasks, but she showed special difficulties in mnemonic and oral comprehension in which it is necessary cognitive and linguistic resources, respectively. In cognitive ToM, Participant D split the probabilities equally between the egocentric and the non-egocentric answer, therefore her decision was made taking into account her knowledge instead of the protagonist's knowledge. However, she almost achieved the maximum score in the affective ToM.

Participant E

Participant E is a child from a medium-low social-economic background whose L1 is Catalan. Participant E wear a CI received at two years of age and contralateral hearing aid fitted previously to cochlear implantation. When this child completed the non-verbal intelligence test, her results were below average (IQ=87). In linguistic tasks, this child obtained scores in the average range in all linguistic measures, but she struggled during reading comprehension task. These difficulties did not impede her to complete the six-step scale of ToM.

Participant E remained in the same school in secondary education and experienced an increase in their reading comprehension competence. Despite she obtained age-appropriate scores in the semantic index, mild difficulties were detected in the non-mnemonic comprehension. This subtask required inferential skills to complete successfully, as in cognitive ToM task in which Participant E opted for the egocentric answer. However, Participant E apply efficiently the affective ToM and she only failed to answer the reason of the misunderstanding.

<insert Table 3 here >

Participant F

Participant F is the elder of two siblings from a median socio-economic family and her L1 is Catalan. This child was implanted at one year and four months. At 11 years old, Participant F had been 62th or above and 45th percentile or above in all linguistic and reading measures, respectively. Also, Participant F completed the six-step ToM task successfully.

Participant F moved to a different setting at the beginning of secondary education and her linguistic performance decreased slightly compared to other participants. In fact, her reading comprehension test scores remained average or slightly below. Despite this linguistic performance, her ToM scores were not as good as might be expected. Participant F split the probabilities equally between the egocentric and the non-egocentric answer in the cognitive ToM and did not detect that one of the protagonists did something wrong in the Faux Pas story.

Participant G

Participant G is the elder of two siblings from a medium-high socio-economic family and L1 is Catalan. This child was implanted at two years of age who received a second CI 6 years later because it was detected that the benefit of the first CI was unsatisfactory. As expected, language and reading difficulties were found in Participant G who obtained scores below average in syntax and reading comprehension. However, his performance in the six-step scale was acceptable considering that understanding sarcasm is acquired at 11 years old by TH peers.

Participant G moved to a different setting at the beginning of secondary education. Linguistic skills remained delayed in Participant G, even though his semantic

performance improved after educational transition. Mild difficulties were detected in the non-mnemonic subtask which contains inferential questions. Regarding ToM, Participant G also identified a control story (without a mentalistic component) as a misunderstanding. For this reason, this child scored lower than other participants. Even so, Participant G opted for the non-egocentric answer in cognitive ToM as they assigned a higher value to it than the egocentric one.

Participant H

Participant H is the elder of two siblings from a medium-low socio-economic family and her L1 is Spanish. This child was implanted at four years and six months, so she was the last to receive the CI. As expected, Participant H scored below average in language skills, both in the overall score and in different language domains (morphology and syntax, mainly). Surprisingly, however, Participant H obtained an age-appropriate score in the six-step scale considering that understanding sarcasm is acquired at 11 years old by TH peers.

Participant H moved to a different setting at the beginning of secondary education and as happened in primary education linguistic skills remained delayed in Participant H. Her several difficulties in oral comprehension subtask confirmed her linguistic difficulties. In addition, her performance in affective ToM seemed to be affected by these difficulties since she identified a control story (without a mentalistic component) as a misunderstanding and also failed answering questions with affective content. Nevertheless, her scores in the cognitive ToM were again unaffected by his poor language performance, as happened in primary education.

Discussion

To date, we have limited understanding of ToM and reading development during the primary-secondary transition, particularly regarding pupils with hearing loss. Our results provide preliminary data about their ToM and reading competence before and after the educational transition.

After the educational transition, the majority of participants achieved similar performance to their peers with TH at 10-11 years of age in line with previous studies (Asker-Árnason et al., 2007; Geers, 2003), however only five pupils again obtained an age-appropriate percentile in the General Reading Index after educational transition. From an analysis of scores in semantic processes, it can be appreciated that our participants could have more difficulties to understand an age-appropriate text in comparison to their performance in primary education. The possible slowdown in reader development seems to affect semantic processes more than lexical ones. In secondary education, reading comprehension is a complex process that not only focuses on decoding words, but also on other aspects such as text structure, the adoption of different perspectives during reading and global coherence (Fitzgerald & Shanahan, 2000). To achieve this coherence, pupils with CI must apply narrative skills and interpret cohesive elements of texts, for example, connections between pronouns or conjunctions in which they have difficulty (Arfé & Perondi, 2008; Jones et al., 2016). As adolescents progress at school, the curriculum becomes more demanding and they therefore need to be more independent and able to understand a greater number of texts (Duke et al., 2011), so reading comprehension may be more sensitive to the problems that they encounter during the process. Struggling readers may also complete primary education without the basic reading skills that are necessary for secondary education and will enable them to make proper academic progress (Acevedo & Rose, 2007). Hence, there is a need for a certain continuity in the curriculum during the educational

transition in order for pupils with CI or other struggling readers to have more time to adapt (Strand, 2020).

Our study allows us to discuss the different factors that could have affected their reading development depending on the different casuistry of each one. So, for example, reading difficulties of Participants G and H could be related mainly to their linguistic difficulties as a consequence of late cochlear implantation or the effective functioning of their CI. The first CI of Participant G may not have provided the expected benefit and somehow impaired linguistic development during the critical period for language acquisition. Therefore, despite the apparent improvement obtained by participant G in recent years, all reading scores (global, lexical, semantic and syntactic) were below age-appropriate scores. Regular revisions to detect device failures and the age of implementation could be fundamental to prevent language and reading difficulties, as previous studies have suggested (Archbold et al., 2008). Similarly, participant H's results also could indicate the relevance of an early CI in reading development. However, reading competence of Participants C and E seems to be delayed in comparison with TH in primary education due to other additional factors since their linguistic scores were in the average range. These factors could be related to vulnerable conditions to which they were exposed such as being immigrant and educated in a second language. Participant C found lexical difficulties before and after the educational transition, however his scores in the semantic domain were within typical values. The performance of Participant C in the lexical index (which is composed of decoding and word recognition tasks) could have been affected by testing in a second language, i.e. a non-native tongue. On the contrary, Participant E's difficulties are more related to semantic processes and could be partially due to her low intellectual level and a delay in the acquisition and development of reading. It should be noted that Participants C, E

and G did not experience any stagnation or decline in their reading comprehension after the educational transition. Therefore, in these cases they could have reduced or overcome the reading/linguistic delay, or they could also have benefited from the binaural stimulation. These three participants received two CI or a CI and a hearing aid in the contralateral ear, which according to some authors (Figueroa et al., 2020; Guerzoni et al., 2020) could help to obtain better performance in academic skills than their peers with unilateral CI. These participants with binaural hearing could better adapt to the new demands and characteristics of secondary education. Binaural hearing permits better listening in noisy or poor acoustic environments (Gifford et al., 2015), as secondary school classrooms often tend to be (Connolly et al., 2015). Better hearing conditions could give them a long-term advantage over other pupils with CI as they can follow instructions and explanations during the class more easily without requiring as much clarification or support from the teacher, and are better at understanding activities, discussions and conversations between pupils and teachers. In fact, in our study the results of participants with binaural hearing (C, E, F, and G) were better than those obtained by participants with unilateral CI in oral comprehension. Poor performance in this subtask with high involvement of oral language could be related to the short duration of auditory stimuli, as opposed to written language where the stimulus remains stable and pupils can reread it several times until they understand it (Lopez-Higes et al., 2015).

With respect to ToM, our participants do not seem to present difficulties before the educational transition. These results differ from those previously found by Peterson et al. (2016), although these authors also evaluated ToM skills with the 6-step scale and the participants' average age is similar in both studies (10.50 in our sample vs 9.87 in Peterson et al. (2016) with age range between 6 and 14 years old). Peterson et al. (2016)

showed that 3% of the sample was able to understand sarcasm and none of the participants achieved the maximum score on the ToM development scale. As well as the possible effect of cultural factors on ToM development (Hughes et al., 2014), these discrepancies could also be due to hearing conditions and language stimulation, since in Peterson et al. (2016) only half of the pupils with hearing loss wore CI.

In secondary school, the ToM level of participants could become more heterogeneous and difficulties understanding other people's emotions were not only observed in participants who did not solve the sarcasm test properly in primary education. Participants A, D and E who showed good performance in the six-step ToM in primary, also obtained high scores in the Faux Pas task in secondary education. Although of these three, only Participant A could also solve the cognitive ToM task efficiently. So, what factors might influence ToM development and why do some pupils with CI not understand other people's emotions effectively? The answer to this question could lie in the quantity and quality of auditory and linguistic stimulation throughout the development process since differences in terms of ToM might be similar to those found in language skills. This would explain why participants with better scores in affective ToM (A, D or E) also obtain better results in language tasks. Indeed, affective ToM tasks could involve a dual complexity: psycho-affective (understanding other people's emotions) and linguistic (understanding non-literal language, i.e. interpreting other peoples' intentions that are not explicitly expressed in their verbal formulations). Previous studies have related understanding of mental states with global language level and with language domains (i.e., Peterson et al., 2012; Rakhlin et al., 2011). Participant H is a paradigmatic case who achieved poor performance in both affective ToM and language tests but correctly solved cognitive ToM. The discrepancies found in some participants' performance of affective and cognitive ToM could also be related to test

complexity (beyond the cognitive or affective component of each task), but also to the fact that the majority of the participants are the elder sibling (McAlister & Peterson, 2007) or to the effect of cultural factors when the participant must understand what is pragmatically appropriate in a given situation (Hughes et al., 2014). This fact could especially affect Participants B and C whose language and culture is not Spanish or Catalan and obtained lower scores than their peers in the affective ToM.

Development of ToM should be viewed as a modification or mediation process in which previous achievements are expanded upon in order to foster future achievements in terms of understanding other people's emotions and beliefs (Wellman & Liu, 2004). This development may not be linear according to some authors (Blijd-Hoogewys & Geert, 2016; Peterson & Wellman, 2019). For example, Peterson and Wellman (2019) found that some pupils with hearing loss (assessed at approximately 7 and 8 and a half years) also failed to improve their performance in ToM. The results obtained by Participants B and F may also indicate that some pupils experience periods of stagnation or decline. Participants B and F performed ToM task efficiently in primary education but did not detect the misunderstanding three years later and were unable to assign a higher percentage to the non-egocentric answer than to the egocentric one, while their peers solved at least one of the tests positively. In some cases, the challenge to adapt to secondary education could adversely affect their development of ToM, leading to a period of stagnation during the educational transition. Indeed, loneliness has been shown to affect the development of ToM in early adolescence (Bosacki et al., 2020). As noted in the introduction, pupils with hearing loss may need more time to establish friendships at the start of secondary education (Rom & Silvestre, 2012). Individual differences in ToM could be particularly relevant at an early stage of the educational transition when the social structure has yet to be established (Ronchi et al.,

2020). Such difficulties forging friendships in new contexts could influence the development of ToM in some pupils with CI.

Although conclusive statements about causation cannot be made, the fact that cases like Participant A with higher ToM scores also achieve a good level of reading and texts with inferential questions would suggest that ToM could have a direct impact on reading competence through the inferential process. ToM could be relevant during understanding the intentions of the characters, as well as achieving coherence and cohesion (Figueroa et al., 2020).

Teachers and schools should be sensitive to changes in student development during the educational transition and, especially, to pupils at risk of social, emotional or academic difficulty, which includes pupils with hearing loss. Secondary teachers should acquire the necessary pedagogical tools or skills to help struggling readers, who may not receive specialized or individualized attention in their classes and often do not receive explicit instruction regarding learning to read (Hopwood et al., 2017). This study shows the diversity of pupils with CI and suggests that reading or ToM development may be different in each case depending on different individual characteristics. But, taking into account the sample size, the results should be taken with caution, and some considerations can be made. It would be interesting to design new ToM tasks of graded difficulty to facilitate analysis and understanding of the development of both affective and cognitive ToM. It is also advisable for future studies to analyse the impact of hearing conditions, the role of speech and language intervention, benefits of collaborative learning and interpersonal relationships on ToM and language development in pupils with CI.

Conclusions

In conclusion, the performance of pupils with CI in reading and ToM tasks was diverse before and after the educational transition. Half of them achieved age-appropriate scores in reading comprehension, while participants with lower scores in primary education could reduce the gap with their peers with IC after educational transition. The results also showed that ToM acquisition was not delayed in primary school, however the difficulties in pupils with CI seem to remerge or be more evident after the transition and could vary depending on the affective and cognitive nature of the task. The individual characteristics of each participant would help to explain their different reading and ToM level, so teachers must take into account the specificity of each pupil more than their hearing status or disabilities.

References

Acevedo, C., & Rose, D. (2007). Learning to read, reading to learn: A middle years literacy intervention research project: Success for all learners in the middle years of schooling (5-9). *The International Journal of Learning: Annual Review*, *13*(11), 73–84.

Archbold, S., Harris, M., O'Donoghue, G., Nikolopoulos, T., White, A., & Richmond, H. L. (2008). Reading Abilities After Cochlear Implantation: The Effect of Age at Implantation on Outcomes at 5 and 7 Years After Implantation. *International Journal of Pediatric Otorhinolaryngology*, *72*(10). https://doi.org/10.1016/J.IJPORL.2008.06.016

Arfé, B., & Perondi, I. (2008). Deaf and hearing students' referential strategies in writing: What referential cohesion tells us about deaf students' literacy development. *First Language*, *28*(4), 355–374. https://doi.org/10.1177/0142723708091043

Asker-Árnason, L., Wass, M., Ibertsson, T., Lyxell, B., & Sahlén, B. (2007). The relationship between reading comprehension, working memory and language in children with cochlear implants. *Acta Neuropsychologica*, *5*(4), 163–186. http://1035.indexcopernicus.com/abstracted.php?level=5&ICID=838850

Blijd-Hoogewys, E. M. A., & Geert, P. L. C. van. (2016). Non-linearities in Theory-of-Mind Development. *Frontiers in Psychology*, *7*. https://doi.org/10.3389/FPSYG.2016.01970

Bosacki, S., Moreira, F. P., Sitnik, V., Andrews, K., & Talwar, V. (2020). Theory of Mind, Self-Knowledge, and Perceptions of Loneliness in Emerging Adolescents. *The Journal of Genetic Psychology*, *181*(1), 14–31. https://doi.org/10.1080/00221325.2019.1687418

Callejón-Póo, L., Boix, C., López-Sala, A., Colomé, R., Fumadó, V., & Sans, A. (2012). Neuropsychological profile of internationally adopted children in Catalonia. *Anales de Pediatría*, *76*(1), 23–29. https://doi.org/10.1016/J.ANPEDI.2011.07.023

Cervera, M., Toro, J., Gratacós, M. L., de la Osa, N., & Pons, M. D. (2005). *Test d'Anàlisi de Lectura i Escriptura en Català* (A. Machado (ed.)). Aprendizaje.

Connolly, D. M., Dockrell, J. E., Shield, B. M., Conetta, R., & Cox, T. J. (2015). Students' perceptions of school acoustics and the impact of noise on teaching and learning in secondary schools: Findings of a questionnaire survey. *Energy Procedia*, *78*, 3114–3119. https://doi.org/10.1016/J.EGYPRO.2015.11.766

Cuetos, F., Arribas, D., & Ramos, J. L. (2016). *Bateria d'avaluació dels processos lectors PROLEC-SE-R*. TEA Ediciones S.A.

Dore, R. A., Amendum, S. J., Golinkoff, R. M., & Hirsh-Pasek, K. (2018). Theory of mind: A hidden factor in reading comprehension? *Educational Psychology Review*,

30(3), 1067–1089. https://doi.org/10.1007/s10648-018-9443-9

Duke, N. D., Pearson, P. D., Strachan, S. L., & Billman, A. K. (2011). Essential elements of fostering and teaching reading comprehension. In S. J. Samuels & A. Farstrup (Eds.), *What research has to say about reading instruction* (4th ed., pp. 51–93). International Reading Association.

Feigenberg, L. F., King, M. S., Barr, D. J., & Selman, R. L. (2008). Belonging to and exclusion from the peer group in schools: Influences on adolescents' moral choices. *Journal of Moral Education*, *37*(2), 165–184. https://doi.org/10.1080/03057240802009306

Figueroa, M., Darbra, S., & Silvestre, N. (2020). Reading and theory of mind in adolescents with cochlear implant. *The Journal of Deaf Studies and Deaf Education*, *25*(2), 212–223. https://doi.org/10.1093/deafed/enz046

Fitzgerald, J., & Shanahan, T. (2000). Reading and writing relations and their development. *Educational Psychologist*, *35*(1), 39–50. https://doi.org/10.1207/S15326985EP3501_5

Geers, A. E. (2003). Predictors of reading skill development in children with early cochlear implantation. *Ear and Hearing*, *24*(1 Suppl), 59S-68S. https://doi.org/10.1097/01.AUD.0000051690.43989.5D

Geers, A. E., & Hayes, H. (2011). Reading, writing, and phonological processing skills of adolescents with 10 or more years of cochlear implant experience. *Ear and Hearing*, *32*(1 Suppl), 49S-59S. https://doi.org/10.1097/AUD.0b013e3181fa41fa

Gifford, R. H., Driscoll, C. L. W., Davis, T. J., Fiebig, P., Micco, A., & Dorman, M. F. (2015). A within-subject comparison of bimodal hearing, bilateral cochlear implantation, and bilateral cochlear implantation with bilateral hearing preservation: High-performing patients. *Otology & Neurotology*, *36*(8), 1331–

1337. https://doi.org/10.1097/MAO.0000000000000804

Gómez-Merino, N., Fajardo, I., & Ferrer, A. (2021). Did the three little pigs frighten the wolf? How deaf readers use lexical and syntactic cues to comprehend sentences. *Research in Developmental Disabilities*, *112*, 103908. https://doi.org/10.1016/J.RIDD.2021.103908

Guerzoni, L., Mancini, P., Nicastri, M., Fabrizi, E., Giallini, I., & Cuda, D. (2020). Does Early Cochlear Implantation Promote Better Reading Comprehension Skills? *International Journal of Pediatric Otorhinolaryngology*, *133*. https://doi.org/10.1016/J.IJPORL.2020.109976

Hollingshead, A. (1975). *Four factor index of social status*. Yale University Department of Psychology.

Hopwood, B., Hay, I., & Dyment, J. (2017). Students' reading achievement during the transition from primary to secondary school. *Australian Journal of Language and Literacy*, *40*(1), 46–58.

Hughes, C., Devine, R. T., Ensor, R., Koyasu, M., Mizokawa, A., & Lecce, S. (2014). Lost in Translation? Comparing British, Japanese, and Italian Children's Theory-of-Mind Performance. *Child Development Research*, *2014*, 1–10. https://doi.org/10.1155/2014/893492

Jones, A. C., Toscano, E., Botting, N., Marshall, C. R., Atkinson, J. R., Denmark, T., Herman, R., & Morgan, G. (2016). Narrative skills in deaf children who use spoken English: Dissociations between macro and microstructural devices. *Research in Developmental Disabilities*, *59*, 268–282. https://doi.org/10.1016/j.ridd.2016.09.010

Lecce, S., Caputi, M., Pagnin, A., & Banerjee, R. (2017). Theory of mind and school achievement: The mediating role of social competence. *Cognitive Development*,

44, 85–97. https://doi.org/10.1016/J.COGDEV.2017.08.010

Lopez-Higes, R., Gallego, C., Martin-Aragoneses, M. T., & Melle, N. (2015). Morpho-syntactic reading comprehension in children with early and late cochlear implants. *Journal of Deaf Studies and Deaf Education*, *20*(2), 136–146. https://doi.org/10.1093/deafed/env004

Marschark, M., Kronenberger, W. G., Rosica, M., Borgna, G., Convertino, C., Durkin, A., Machmer, E., & Schmitz, K. L. (2017). Social maturity and executive function among deaf learners. *Journal of Deaf Studies and Deaf Education*, *22*(1), 22–34. https://doi.org/10.1093/deafed/enw057

McAlister, A., & Peterson, C. (2007). A longitudinal study of child siblings and theory of mind development. *Cognitive Development*, *22*(2), 258–270. https://doi.org/10.1016/J.COGDEV.2006.10.009

McCoy, S., Shevlin, M., & Rose, R. (2020). Secondary school transition for students with special educational needs in Ireland. *European Journal of Special Needs Education*, *35*(2), 154–170. https://doi.org/10.1080/08856257.2019.1628338

Meeus, W., Van De Schoot, R., Keijsers, L., Schwartz, S. J., & Branje, S. (2010). On the progression and stability of adolescent identity formation: A five-wave longitudinal study in early-to-middle and middle-to-late adolescence. *Child Development*, *81*(5), 1565–1581. https://doi.org/10.1111/j.1467-8624.2010.01492.x

Netten, A. P., Rieffe, C., Theunissen, S. C. P. M., Soede, W., Dirks, E., Briaire, J. J., & Frijns, J. H. M. (2015). Low empathy in deaf and hard of hearing (pre)adolescents compared to normal hearing controls. *PLOS ONE*, *10*(4), e0124102. https://doi.org/10.1371/journal.pone.0124102

Nootens, P., Morin, M.-F., Alamargot, D., Gonçalves, C., Venet, M., & Labrecque, A.-

M. (2019). Differences in Attitudes Toward Reading: A Survey of Pupils in Grades 5 to 8. *Frontiers in Psychology*, *9*, 2773. https://doi.org/10.3389/fpsyg.2018.02773

Peterson, C. C., O'Reilly, K., & Wellman, H. M. (2016). Deaf and hearing children's development of theory of mind, peer popularity, and leadership during middle childhood. *Journal of Experimental Child Psychology*, *149*, 146–158. https://doi.org/10.1016/j.jecp.2015.11.008

Peterson, C. C., & Wellman, H. M. (2019). Longitudinal Theory of Mind (ToM) Development From Preschool to Adolescence With and Without ToM Delay. *Child Development*, *90*(6), 1917–1934. https://doi.org/10.1111/cdev.13064

Peterson, C. C., Wellman, H. M., & Slaughter, V. (2012). The mind behind the message: Advancing theory-of-mind scales for typically developing children, and those with deafness, autism, or asperger syndrome. *Child Development*, *83*(2). https://doi.org/10.1111/J.1467-8624.2011.01728.X

Premack, O., & Woodruff, G. (1978). Does the chimpanzee have a theory of mind? *The Behavioral and Brain Sciences*, *4*, 515–526.

Puyuelo, M., Renom, J., Solanas, A., & Wiig, E. (2002). *BLOC - Batería del Lenguaje, Objetiva y Criterial*. Masson.

Rakhlin, N., Kornilov, S. A., Reich, J., Babyonyshev, M., Koposov, R. A., & Grigorenko, E. L. (2011). The relationship between syntactic development and Theory of Mind: Evidence from a small-population study of a developmental language disorder. *Journal of Neurolinguistics*, *24*(4), 476–496. https://doi.org/10.1016/j.jneuroling.2011.03.001

Rom, M., & Silvestre, N. (2012). Las relaciones sociales entre adolescentes sordos y sus compañeros de clase oyentes. *Infancia y Aprendizaje*, *35*(1), 5–22. https://doi.org/10.1174/021037012798977430

Ronchi, L., Banerjee, R., & Lecce, S. (2020). Theory of mind and peer relationships: The role of social anxiety. *Social Development*, *29*(2), 478–493. https://doi.org/10.1111/sode.12417

Rose, R., & Shevlin, M. (2016). The development of case studies as a method within a longitudinal study of special educational needs provision in the Republic of Ireland. *Journal of Research in Special Educational Needs*, *16*(2), 113–121. https://doi.org/10.1111/1471-3802.12066

Ryskin, R. A., & Brown-Schmidt, S. (2014). Do adults show a curse of knowledge in false-belief reasoning? A robust estimate of the true effect size. *PLoS ONE*, *9*(3), 92406. https://doi.org/10.1371/journal.pone.0092406

Shamay-Tsoory, S. G., Harari, H., Aharon-Peretz, J., & Levkovitz, Y. (2010). The role of the orbitofrontal cortex in affective theory of mind deficits in criminal offenders with psychopathic tendencies. *Cortex*, *46*(5), 668–677. https://doi.org/https://doi.org/10.1016/j.cortex.2009.04.008

Stone, V. E., Baron-Cohen, S., & Knight, R. T. (1998). Frontal lobe contributions to theory of mind. *Journal of Cognitive Neuroscience*, *10*, 640–656.

Strand, G. M. (2020). Supporting the transition to secondary school: The voices of lower secondary leaders and teachers. *Educational Research*, *62*(2), 129–145. https://doi.org/10.1080/00131881.2020.1750305

Wechsler, D. (2007). *WISC-IV. Escala de Inteligencia de Wechsler para Niños-IV* (2a ed). TEA Ediciones.

Wellman, H. M., & Liu, D. (2004). Scaling of Theory-of-Mind Tasks. *Child Development*, *75*(2), 523–541. https://doi.org/10.1111/j.1467-8624.2004.00691.x

Worsfold, S., Mahon, M., Pimperton, H., Stevenson, J., & Kennedy, C. (2018). Predicting reading ability in teenagers who are deaf or hard of hearing: A

longitudinal analysis of language and reading. *Research in Developmental Disabilities*, *77*, 49–59. https://doi.org/10.1016/j.ridd.2018.04.007

Table 1

Descriptive data of each participant

Case	Gender	Age1	Age2	Age of CI	D1-D2	Fitting	FG	SLT	Siblings	SES	NVIQ
A	Male	11	13	1,3	N/A	Unilateral	17	3-4	Elder (1)	27	107
B	Female	11	14	3	N/A	Unilateral	21	1-2	Elder (1)	34	93
C	Male	10	13	3	0	Bilateral	21,25	3-4	Elder (1)	34	101
D	Female	11	14	4	N/A	Unilateral	21	3-4	Younger (2)	29	112
E	Female	10	13	2	0,4	Bimodal	10	N/A*	N/A	22,5	87
F	Female	10	13	1,25	1,75	Bilateral	15	1-2	Elder (1)	37	120
G	Male	11	14	2	4,16	Bilateral	12	3-4	Elder (1)	40	120
H	Female	10	13	4,5	N/A	Unilateral	25	3-4	Elder (1)	29	93

Note. Chronological age in the first wave (Age1), chronological age in the second wave (Age2) cochlear implantation (CI), delay in years between the first hearing device and the second one (D1-D2), functional gain of hearing device (FG), sessions with a speech and language therapist per week (SLT), birth order and number of siblings (siblings), socioeconomic status (SES), non-verbal intelligence (NVIQ), not applicable (N/A). *These data were not available.

Table 2

Descriptive statistics on language and reading tests

Materials	**Case**							
	A	B	C	D	E	F	G	H
Primary								
Global Linguistic Score	96	87	96	97	95	97	49	3
Morphology	70	89	70	53	95	62	61	1
Syntax	74	74	81	81	95	70	3	1
Semantic	92	76	84	99	99	95	92	30
Pragmatic	91	84	99	90	91	99	26	99
Word-reading accuracy	97	97	10	99	85	45	40	1
Word-reading speed	95	77	35	95	95	90	70	23
Text-reading speed	70	75	11	97	75	75	40	20
Reading comprehension	77	89	25	99	10	50	1	1
Secondary								
Global Index of Reading	42	37	9	47	45	30	2	0
Lexical Index	75	58	3	58	58	39	5	2
Syntax Index	42	68	23	81	63	47	3	5
Semantic Index	23	16	47	19	27	23	13	2

Note. Scores are expressed in percentiles.

Table 3

Descriptive statistics on theory of mind tasks

Materials	**Case**							
	A	B	C	D	E	F	G	H
Primary								
Six-step ToM scale	7/7	7/7	6/7	7/7	7/7	7/7	6/7	6/7
Secondary								
Affective ToM	7/8	4/8	5/8	7/8	7/8	2/8	5/8	4/8
Cognitive ToM (%)								
Egocentric answer	0%	100%	30%	50%	80%	50%	30%	1%
Unplausible answer	0%	0%	10%	0%	5%	0%	10%	1%
Unplausible answer	0%	0%	10%	0%	5%	0%	10%	1%
Non-egocentric answer	100%	0%	50%	50%	10%	50%	50%	97%

Note. Theory of mind (ToM)