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Narrative spoken language skills in severely hearing impaired school-aged children with cochlear implants

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ABSTRACT

Cochlear implants have a significant positive effect on spoken language development in severely hearing impaired children. Previous work in this population has focused mostly on the emergence of early-developing language skills, such as vocabulary. The current study aims at comparing narratives, which are more complex and later-developing spoken language skills, of a contemporary group of profoundly deaf school-aged children using cochlear implants ($n = 66$, median age = 8 years 3 months) with matched normal hearing peers. Results show that children with cochlear implants demonstrate good results on quantity and coherence of the utterances, but problematic outcomes on quality, content and efficiency of retold stories. However, for a subgroup ($n = 20$, median age = 8 years 1 month) of deaf children without additional disabilities who receive cochlear implantation before the age of 2 years, use two implants, and are raised with one spoken language, age-adequate spoken narrative skills at school-age are feasible. This is the first study to set the goals regarding spoken narrative skills for deaf children using cochlear implants.

1. Introduction

1.1. Congenital severe to profound hearing loss

Profound congenital hearing loss is estimated to affect 1 to 2 of every 1000 newborns (Nikolopoulos & Vlastarakos, 2010). During the past 2 decades, cochlear implantation has gradually become a standard treatment for profoundly deaf children. Worldwide, about 80,000 children are treated with cochlear implants (Kral & O'Donoghue, 2010; NIH, 2011). Cochlear implants (CIs) consist of an externally worn microphone and a microprocessor that extracts intensity, frequency, and timing cues from acoustic signals. The system transforms these acoustic cues into an electrical code. Internally, a surgically placed receiver transmits the code to an implanted electrode array that stimulates surviving auditory neurons.

The purpose of a cochlear implant is to access, stimulate, and grow auditory neural connections throughout the brain as the foundation for spoken language, reading, and academics (Gordon, Papsin, & Harrison, 2004). Many children achieve open-set speech recognition within the first year of implantation (Yoon, 2011). Without doubt, auditory experience enabled by pediatric cochlear implantation has a significant positive effect on spoken language development (Peterson, Pisoni, &

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Miyamoto, 2010). Cochlear implantation changes the trajectory of spoken language learning in most recipients, elevating the rate of learning relative to the pre-CI period (Ganek, McConkey Robbins, & Niparko, 2012). In congenitally deaf infants, babbling starts after a short interval of 1–4 months after activation of the cochlear implant. Consequently, if implantation takes place very early, babbling occurs at a chronologic age comparable to that of normal hearing infants (Schauwers, Gillis, & Govaerts, 2004). With regard to vocabulary development, age adequate vocabulary scores are feasible for children implanted before the age of 2 years 6 months (McDonald Connor, Craig, Raudenbush, Heavner, & Zwolan, 2006). The improved auditory input from the cochlear implant facilitates children's ability to perceive and comprehend morphological structures such as bound morphemes (Spencer, Tye-Murray, & Tomblin, 1998). However, in comparison with normal hearing children, morphological deviations in spoken language are still evident in pediatric CI users (Le Normand, Ouellet, & Cohen, 2003). At the sentence level, significant differences are reported in the ability of pediatric cochlear implant users to correctly utilize grammatical structures such as conjunctions and correct verb forms (Spencer, Barker, & Tomblin, 2003). In a recent study, spoken language performance of 132 pediatric CI users was evaluated after 10 years of cochlear implant use. The benefits appeared to keep stable over the years. No deterioration was identified within a period of 10 or more years of follow-up (Peixoto et al., 2013). A sample of 112 teenagers who used a CI for more than 10 years provided an optimistic outlook on the language benefits of early cochlear implantation. Seventy-one percent of the teenagers obtained verbal IQ-scores within or above one standard deviation of normal hearing age-mates (Geers & Sedey, 2011).

1.2. Predictive factors

The large variability in language outcomes in children using cochlear implants remains a significant concern. Some children achieve adequate spoken language levels and others lag behind (Niparko et al., 2010; Peterson et al., 2010). Different studies have investigated the relationship between language outcomes and possible predictors. Age at diagnosis of hearing loss (Korver et al., 2010) and age at cochlear implantation have an effect on language outcomes. Several authors demonstrated that cochlear implantation before the second birthday of congenitally deaf children can lead to good spoken language development (Boons, Brokx, Dhooge, et al., 2012; Hayes, Geers, Treiman, & Moog, 2009; McDonald Connor et al., 2006; Svirsky, Teoh, & Neuburger, 2004; Tait, Nikolopoulos, & Lutman, 2007). Furthermore, better language outcomes are related to longer duration of CI use (Nicholas & Geers, 2007) and bilateral implantation (Boons, Brokx, Frijns, et al., 2012; Tait et al., 2010; Wie, 2010). Children with CIs raised in monolingual families, where parents speak one spoken language to the child, demonstrate higher language scores (Boons, Brokx, Dhooge, et al., 2012). As in normal hearing children, the presence of additional disabilities, specifically learning disorders, can disturb language development (Boons, Brokx, Dhooge, et al., 2012; Gérard et al., 2010).

These findings influence the policy of pediatric cochlear implantation in many countries and led to an increase in early and bilateral implantation (Peters, Wyss, & Manrique, 2010). Stimulated by the positive effects of early implantation and facilitated by universal newborn hearing screening, the average age at cochlear implantation in severely hearing impaired children has dropped rapidly over the last decade (Boons et al., 2013; Philips et al., 2009). Additionally, the growing scientific evidence regarding the benefits of bilateral implantation has led to a consensus statement in favor of early bilateral cochlear implantation (Ramsden et al., 2012). It is expected that spoken language development will benefit from these measures. However, due to the large variability in spoken language outcomes (Ganek et al., 2012) and these relative new developments of early and bilateral implantation, it is unclear at which spoken language level these children will be able to perform.

1.3. Narrative skills

Studies of language development in this population have focused mainly on the emergence of early language skills. Little is known about the effect of cochlear implantation on more complex, decontextualized aspects of language, such as narrative production, which begins to emerge in the preschool years and continues to develop as children progress through school. Narratives are a comprehensive measure of spoken language. They not only provide information on discourse but also on component skills such as semantics, syntax, working memory and general knowledge base (Wellman et al., 2011). In order to form a cohesive, well-formulated, meaningful story, children should integrate all language components (Seiger-Gardner, 2009). Moreover, narrative production is important in everyday interaction. Narratives are closer to spontaneous language than elicited language in standard language tests (Merritt & Liles, 1989) and (semi-)spontaneous language samples provide a more representative picture of actual linguistic abilities than formal testing (Duchesne, Sutton, & Bergeron, 2009). Furthermore, narrative skills are strong predictors of written language (Wellman et al., 2011), reading comprehension (Crosson & Geers, 2001), academically related language skills (Wellman et al., 2011) and participation in mainstream education (Gillam, Pena, & Miller, 1999). Overall, narratives provide an ecologically valid way to examine the effect of cochlear implantation in the context of a complex language task.

1.4. Present study

In hearing impaired children with and without CIs, narrative skills are related to early diagnosis (Worsfold, Mahon, Yuen, & Kennedy, 2010), better speech intelligibility (Huttunen, 2008) and better speech perception (Crosson & Geers, 2001). However, in-depth analyses of narrative abilities in children with cochlear implants are lacking (Da Silva, Comerlatto Junior,