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Early speech perception in Mandarin-speaking children at one-year post cochlear implantation

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ABSTRACT

Purpose: The aim in this study was to examine early speech perception outcomes in Mandarin-speaking children during the first year of cochlear implant (CI) use.
Method: A hierarchical early speech perception battery was administered to 80 children before and 3, 6, and 12 months after implantation. Demographic information was obtained to evaluate its relationship with these outcomes.
Results: Regardless of dialect exposure and whether a hearing aid was trialed before implantation, implant recipients were able to attain similar pre-lingual auditory skills after 12 months of CI use. Children speaking Mandarin developed early Mandarin speech perception faster than those with greater exposure to other Chinese dialects. In addition, children with better pre-implant hearing levels and younger age at implantation attained significantly better speech perception scores after 12 months of CI use. Better pre-implant hearing levels and higher maternal education level were also associated with a significantly steeper growth in early speech perception ability.
Conclusions: Mandarin-speaking children with CIs are able to attain early speech perception results comparable to those of their English-speaking counterparts. In addition, consistent single language input via CI probably enhances early speech perception development at least during the first-year of CI use.
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1. Introduction

According to a national disability survey, there are 137,000 children under the age of 7 years with severe-to-profound hearing loss and 30,000 are born with a wide range of hearing loss each year in mainland China (The Ministry of Health, 2001). As of 2012, more than 10,000 people in China had received cochlear implants (CIs), with a 25% average annual growth rate. In 2011, the Chinese central government allocated funding to implant 17,000 children over the next 4 years (Liang & Mason, 2013). However, this funding only covered the costs of the surgery, speech therapy and mapping during the first year after implantation and a large number of children did not receive proper intervention after this period. As early speech perception plays an important role in language development (for example, Tsao, Liu, & Kuhl, 2004 demonstrated that speech perception at 6 months predicts language at 2 years), it is important to identify children with delays in early auditory and

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speech perception skills so that proper intervention can be provided at an early stage. This requires the establishment of appropriate milestones for clinicians' reference and the identification of factors influencing early auditory and speech perception development in Mandarin-speaking children.

1.1. Evaluation of early speech perception outcomes

The Child Development after Cochlear Implantation (CDaCI) study was a multicenter, longitudinal, and national cohort study that systematically evaluated early CI outcomes in English-speaking children in the United States (Eisenberg et al., 2006). The study found the use of a hierarchical battery of speech perception measures a practical strategy for tracking emergent skills in pediatric implantees. This hierarchical speech perception test battery includes the Infant-toddler Meaningful Auditory Integration Scale (IT-MAIS) and the Meaningful Auditory Integration Scale (MAIS) (both assessing early prelingual auditory development using a structured interviews); the Early Speech Perception (ESP) test (a closed-set word identification task); and the Pediatric Speech Intelligibility (PSI) test (a closed-set word and sentence perception test for children who achieved high scores in the ESP and are able to perform word and sentence perception either in quiet or in the presence of noise).

However, linguistic diversity precludes the generalization of the outcomes of the CDaCI to other languages as a universal normative reference. To address this problem, a parallel Mandarin assessment battery was developed by Zheng et al. (2011), which consisted of the Mandarin versions of the IT-MAIS and MAIS (Zheng, Soli, et al., 2009b), the ESP (Zheng, Meng, et al., 2009), and the PSI (Zheng, Soli, et al., 2009a). These tests were designed to parallel as closely as possible the tests used in the CDaCI study. Without using statistical analyses, Zheng et al. (2011) compared the results obtained using this battery in the first year after cochlear implantation in Mandarin-speaking children with those from English-speaking children reported by Eisenberg et al. (2006). They concluded that early speech perception development, in general, was comparable across these two studies. However, the children in Zheng et al.'s (2011) study were exposed to Chinese dialects to varying degrees, and it is necessary to document speech perception development in children who are exposed to Mandarin only since dialects may affect speech perception development (Zheng et al., 2011). Furthermore, while Zheng et al. (2011) examined outcomes in children who had tried hearing aids prior to cochlear implantation, as many as 40% of implantees in mainland China may have not trialed hearing aids (Chen et al., 2010). Thus, research was still needed to examine whether a hearing aid trial (HAT) would make a difference in outcomes, and whether it should be required before CI.

The primary aims of the current study were, therefore, to provide evidence on early speech perception at several intervals during the first year after implantation and to compare outcomes between those who had undergone an HAT and those who had not. Unlike the participants in Zheng et al. (2011) who were living in southwest mainland China and exposed to local dialects to varying degrees, the children in this study were living in northern China and exposed to Mandarin only. Furthermore, statistical analyses were employed to compare outcomes in the current study with those obtained from the English-speaking children in the CDaCI study and the Mandarin-speaking children with greater dialect exposure in Zheng et al. (2011) study. These analyses would be helpful in identifying outcomes that could be generalized between two cultures with significant linguistic differences (i.e., with Mandarin being a tonal language and English being a stress-based language, in addition to phonological and other semantic differences) and across Mandarin-speakers with diverse dialectal exposure. It was hoped that the findings could lead to the more rapid establishment of outcome expectations and best practices in China.

1.2. Factors influencing early auditory and speech perception development

A number of demographic characteristics affect early speech perception development in children with CIs. Children who receive implants at an earlier age, and who have better preoperative residual hearing have demonstrated better performance on speech perception tasks (Chen, Wong, Zhu, & Xi, 2015; Dettman et al., 2004; Gantz et al., 2000). In addition, some implant characteristics (e.g., the use of the most current speech processor technology and complete insertion of electrodes), and educational characteristics such as attendance at a mainstream school, oral mode of communication and provision of appropriate auditory habilitation) may have positive effects on speech perception performance in children with CIs (Geers, Brenner, & Davidson, 2003; Sarant, Blamey, Dowell, Clark, & Gibson, 2001). Furthermore, among Mandarin-speaking children, higher maternal educational level has been found to be significantly related to better sentence perception in quiet and in noise. Having undergone a HAT before implantation and having better residual hearing are additional factors contributing to better sentence perception in noise (Chen, Wong, Chen, & Xi, 2014). Other factors may have negative effects on auditory and speech perception development. For example, children with other impairments, and who exhibit lower cognitive abilities do not benefit as much from CIs as those with normal cognitive abilities and with no comorbid disabilities (Holt & Kirk, 2005; Waltzman, Scalchunes, & Cohen, 2000; Wiley, Meinzen-Derr, & Choo, 2004). While the above studies focused on children with more than one year of CI use, few studies have examined the effects of these factors on early speech perception development during the first year of CI use.

Although Zheng et al. (2011) found that Mandarin-speaking children who had undergone an HAT before implantation seem to perform better than those who had not during the first year of CI use, their conclusion was based on descriptive comparisons; statistical analysis was not carried out. Moreover, other factors that may affect early speech perception, such as those described above, were not well controlled in their study. Therefore, the second aim of the present study was to identify sources of variability in early speech perception development in newly implanted, Mandarin-speaking children during their

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