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Mild-to-moderate hearing loss and language impairment: How are they linked?

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Abstract

What is the nature of the link between prelingual mild-to-moderate hearing loss (MMHL) and impaired language in children and adolescents? Although the scientific literature is sparse, it is clear that many experience considerable difficulty acquiring language, and that this difficulty is not limited to phonetic form. We report on a series of studies we have conducted involving a number of French-speaking children and adolescents ($N > 80$) aged 6–16, all of whom have bilateral sensorineural, prelingual hearing loss. Using a variety of methodologies to test a wide range of language skills, we have found that morphosyntactic development in children with MMHL is highly likely to be impaired, that it is often very severely impaired, and that difficulties continue into adolescence. Comparisons with other contexts of atypical acquisition of French, both with pathology (SLI, epilepsy) and without pathology (second language acquisition) show that aspects of morphosyntax which are subject to difficulty are not specific to the context of hearing loss. Although there is some evidence for correlations with degree of hearing loss, these are not regular and do not predict morphosyntactic performance: the link between hearing loss and language impairment is indirect. It is suggested that this link might be mediated by working memory and auditory attention, which could thus be explored as a plausible avenue for finding an explanation for the heterogeneity in language performance observed in individuals with MMHL.

Keywords: Mild-to-moderate hearing loss; Acquisition; Morphosyntax; French

1. Mild-to-moderate hearing loss as a model of atypical language acquisition

Mild-to-moderate hearing loss (MMHL) corresponds to an average hearing loss (as measured by pure tone average, PTA), in the range of 21–70 decibels (21–40 dB for mild HL, 41–70 dB for moderate HL). This degree of congenital, sensorineural HL is much more frequent in children than severe and profound HL. So, for example, Russ et al. (2003) found that 75% of a group of 134 Australian children fitted with hearing aids between the age of 0 and 6, had mild or moderate HL (respectively 42% and 33%), compared to severe and profound HL (16% and 9%).[1] Since not all children with mild HL use hearing aids,[2] this means that the total proportion of children with mild HL is necessarily bigger than the

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[1] See also Fortnum et al. (2002), who found 53% moderate hearing loss in a group of 17,160 British children ages 3–18 with hearing loss over 40 dB.

[2] In the case of HL less than 30 dB, if this HL is considered not to have negative impact on language development, it is possible that no hearing aids are proposed at all.

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figure reported in this study. The advent, technical improvement, and generalization of cochlear implants in children with profound (90–120 dB), and even severe (70–90 dB) HL, entails that the number, and the proportion of children functioning with this level of HL is now even greater. Hearing gains due to cochlear implantation result in PTAs of 30–45 dB (Verbist, 2010), and thus to levels equivalent to mild or moderate HL.[3] The question of language development in the context of MMHL therefore currently takes on new significance, in terms of the number of children involved, but also in terms of the relevance of this population as a control group in studies evaluating children with cochlear implants. Understanding language development in this context thus has broader implications and clinical applications.

An important fact about MMHL is that it is frequently detected relatively late: around the age of five in countries where neo-natal hearing screening is not yet universal, as in France (Delage, 2008; Delage and Tuller, 2007, 2010; Tuller and Jakubowicz, 2004). Furthermore, neonatal screening (which uses brain stem ERPs) only detects HL higher than 40 dB (Govaerts et al., 2002), and thus cannot identify children with mild HL.[4] Once again, a certain parallel can be made between language development in the context of a cochlear implant and in the context of MMHL: the age of HL detection in children with MMHL is akin to the variable of age of cochlear implant. In both of these cases, prior to aided hearing (whether by hearing aids, in the case of MMHL, or by cochlear implant), language input is degraded. Late detection of HL in children with MMHL thus means that many of these children experience several years of degraded language input, years which fall squarely within the temporal window typically regarded to constitute a critical period for language acquisition (Bishop and Mogford, 1993; Bortfeld and Whiteburst, 2001; Newport et al., 2002). Studies of the classical context for critical period effects, that of second language acquisition (see Johnson and Newport, 1989, 1991), have shown that language acquisition after the age of 6–7 does not resemble native acquisition in its outcome, particularly in formal aspects of language (phonology, morphosyntax), though the interpretation of these results is not unanimous (see Abrahamsson and Hyltenstam, 2009, for review). Studies of children with cochlear implants have also found strong correlations between language performance and age of implant, highlighting the existence of critical periods for both maturation of language (Nicholas and Geers, 2004; Tomblin et al., 2005) and maturation of audition (Sharma et al., 2002, 2005). The literature supporting the existence of a critical period for language acquisition includes studies of deaf children with early exposure to sign language compared to those having had late exposure. These have also shown strong critical period effects, for both first language sign language acquisition and for second language acquisition of an oral language (Newport, 1990; Mayberry and Lock, 2003). Children with MMHL are generally not exposed to sign language, and they do display (some) spontaneous oral language development (doubtless one of the causes for the frequent late HL detection in this population). MMHL thus constitutes a different constellation for exploration of potential critical period effects: early oral language input is clearly more accessible than it is to severely or profoundly deaf children who learn sign language late and/or who undergo cochlear implantation. On the other hand, late sign input is entirely accessible to a deaf child, whereas late aided auditory input through hearing aids is not entirely accessible (even if conventional hearing aids have also undergone considerable technical improvements). In other words, both early timing of language development and long-lasting quality of input are altered in MMHL. What is then the combined effect of early degraded input followed by continued less than optimal input (even after hearing aid fitting) on language development? This constellation suggests that an interesting comparison group would be the case of second language acquisition, the classical context for study of critical period effects, in which input starts late (similarity then in timing of language exposure), but is entirely accessible.

Another, obvious, but important fact about children with MMHL is that, all other things being equal, they have a normal language acquisition device, meaning that, putting aside for the moment the question of co-morbidity, any language impairment found in this population would be a consequence of factors external to Universal Grammar and thus this population constitutes a particularly interesting comparison group for children with Specific Language Impairment (SLI), for which proposals about the source of language impairment include the suggestion that language competence is altered in these children (van der Lely et al., 2011). Such comparative studies are so far rather scarce, though results obtained so far point to remarkable similarities.

Summarizing, language development in children with MMHL poses interesting questions for the study of language acquisition, and constitutes a particularly pertinent model for comparative study of language acquisition in deaf children with cochlear implants, but, more generally, of atypical language acquisition in children.

Previous studies focused on language performance in children with MMHL have shown significant rates of language impairment, especially in the areas of phonology and morphosyntax, although all of these studies have pointed out considerable inter-subject variability (see for example Gilbertson and Kamhi, 1995; Briscoe et al., 2001; Norbury et al., 2001, 2002; Tuller and Jakubowicz, 2004; Hansson et al., 2004, 2007; Delage and Tuller, 2007). Table 1 lists published studies which have presented results on oral language development in children and adolescents with mild and/or

[3] Children with MMHL are not CI candidates since conventional hearing aids result in aided hearing at/below level obtained by CI, and, of course, destruction of a (partially) functioning cochlea raises clear ethical questions.

[4] Current technology entails an unacceptable number of false positives if levels below 40 dB are used.