Phonak Field Study News

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Use of remote microphone systems in homes of children with hearing loss

Introduction

Classroom settings are well known to be challenging environments for listening, especially for children with hearing loss. The high levels of background noise, reverberation, and speaker-listener distance found in classrooms results in degradation of speech perception. A commonly used intervention for ameliorating these conditions in classrooms is a remote microphone system (RMS). These systems improve the signal-to-noise ratio (SNR) and overcome the impact of distance, thus, enhancing speech perception. Access to high-quality, clear speech is critical for optimum development of receptive and expressive language in typically developing children (Hoff & Nagles, 2002) and children with hearing loss (e.g., Stelmachowicz, Pittman, Hoover, Lewis, & Moeller, 2004). In addition, the number of words to which children are exposed is linked positively to their subsequent vocabularies (Hart & Risley, 1995).

For these reasons and more, use of an RMS in school settings is widespread. However, despite their popularity in schools, the use of an RMS in other environments, such as the home, is not common place. To date, studies of RMS use at home that report positive benefits have been limited to parental reports (e.g., Flynn, Flynn, & Gregory, 2005; Mulla & McCracken, 2013). It is possible that the lack of empirical evidence to support the use of an RMS at home for children with hearing loss has limited their common use.

The purpose of this study was to examine the impact of RMS use in the homes of children with hearing loss on the amount of talk by caregivers, and the amount of caregiver talk to which the children had access. A brief description of the study and three key findings are presented. More details can be found in Benitez-Barrera, Angley, and Tharpe (in press).

Methodology

Ten families of preschool-aged children with bilateral permanent hearing loss participated in this study (age = 2:6 to 6:4, years:months). All children were full-time hearing technology users. One adult caregiver was identified as the *key caregiver* and the child with hearing loss was the *key child*.

Each participating family was provided with a Phonak Roger™ RMS for use during the study. All devices were set with the child's own hearing aid or cochlear implant microphones activated; thus, the environmental microphones were active when the RMS microphone was active. The Roger settings were set to default values, which provides the RMS signal with a 10 dB advantage relative to the incoming signal.

Key caregiver talk was measured using Language Environmental Analysis (LENA™) technology (Xu, Yapanel, & Gray, 2009). LENA allows for automated measurement and analysis of large quantities of data (i.e., daylong audio-recordings) relevant to a child's language environment as collected in natural settings (Oller et al., 2010).

Families were provided with LENA recorders, which can record up to 16 hours of data that can subsequently be downloaded and automatically analyzed by LENA software. Based on acoustic parameters of the

language environment, the LENA software yields an estimate of the amount of talk produced in close proximity (i.e., within approximately 6 to 8 feet) to the recorders. Estimated female (i.e., Female Adult Near; FAN) and male (i.e., Male Adult Near; MAN) word counts were used to quantify key caregiver talk. In previous studies, the child of interest (i.e., key child) wore a LENA recorder to obtain an estimate of the caregiver talk that is produced close to the child (e.g., Aragon & Yoshinaga-Itano, 2012). However, in the present study, interest was not only in caregiver talk that was produced near the child, but in *all* caregiver talk that was accessible or potentially accessible to the child via the RMS. Thus, the key child, as well as the key caregiver, wore LENA recorders while participating. Caregivers were instructed to activate both recorders simultaneously (the key child's and the key caregiver's) as soon as possible after their child awoke in the morning and to allow the recorders to run throughout each day up to the maximum recording time (i.e., 16 hours). Families were provided with four fully-charged recorders for each weekend in which they participated in the study (one for the key child and one for the key caregiver for each day of the weekend). Recorders were clearly marked as 'child' or 'caregiver' with pictures to avoid confusion.

Families agreed to be recorded in their homes for two consecutive weekends – one weekend while using the RMS (the key child wore the RMS receiver, and the key caregiver wore the RMS transmitter) and one weekend without the RMS. In an attempt to reduce potential novelty effects, families were instructed to use the RMS at home for the three nights immediately prior to the RMS weekend (Wednesday, Thursday, Friday).

Results

Key Finding 1. No significant difference was found between the mean number of hours families were recorded during the no-RMS and the RMS weekends, $t(8) = 0.38$, $p > .05$ ($d = 0.12$). In addition, there was no significant difference between the number of words the key caregivers produced (words per minute) during no-RMS and RMS weekends, $t(8) = 0.53$, $p > .05$ ($d = 0.18$; 30 and 32 words per minute, respectively). That is, the use of the RMS did not encourage the key caregiver to produce more words than when not using the RMS.

Key Finding 2. To determine whether use of the RMS provided a child with more access to caregiver talk in the home than when not using the RMS, only data from the no-RMS weekend was analyzed. Because the LENA recorder only captures talk that is produced within approximately 6 to 8 feet of the device, the FAN word count or the MAN word count (depending on the gender of the key caregiver) from the key child's recorder was considered to represent close key caregiver talk that was likely accessible to the child without the RMS. The FAN or MAN from the key caregiver's recorder was considered to represent all talk produced by the key caregiver that would be potentially accessible to the child if using an RMS.

A significantly greater number of key caregiver words was retrieved from the key caregiver's recorder than from the key child's recorder, $t(8) = 6.71$, $p < .05$ ($d = 2.24$; see Figure 1). This difference represents the amount of key caregiver talk made accessible to children with hearing loss during a typical weekend at home when using an RMS. This difference was approximately 11 words per minute (for example, 5280 words per day if a child was awake and wearing the RMS for eight hours a day); these are words that would potentially be accessible to children with hearing loss only if they were using an RMS during a weekend at home.

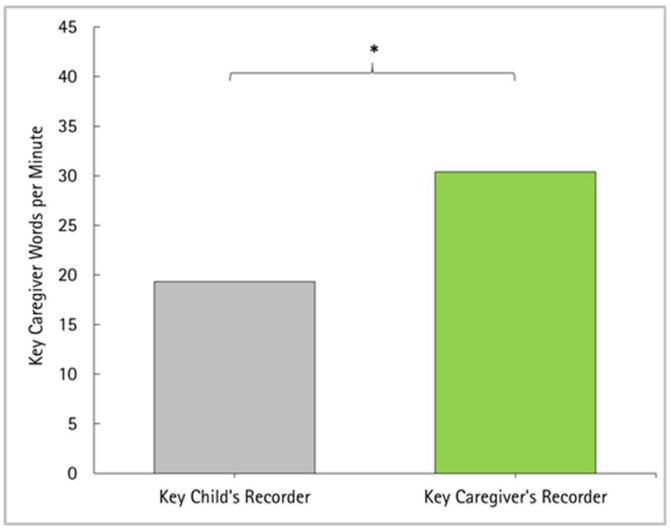

Figure 1: Key caregiver words per minute as measured by the key child's recorder and the key caregiver's recorder.
***= significant difference**

Key Finding 3. To determine whether caregivers produced a greater proportion of talk from a distance when using the RMS than when not, a paired sample t-test was conducted to examine the mean difference in the proportion of far key caregiver talk during the no-RMS and RMS weekends. Derivation of proportion of far key caregiver talk was calculated by the following formula where FarKCT represents proportion of far key caregiver talk, KCRec represents the mean number of key caregiver words produced per minute as estimated from the key caregiver's recorder, and KCHRec represents mean number of key caregiver words produced per minute as estimated from the child's recorder:

$$\text{FarKCT} = \frac{\text{KCRec} - \text{KCHR}}{\text{KCRec}} \times 100$$

As seen in Figure 2, on average, key caregivers produced a higher proportion of far talk when using the RMS (47% of words) than when not using the RMS (37% of words), $t(8) = 2.47$, $p < .05$ ($d = 0.82$).

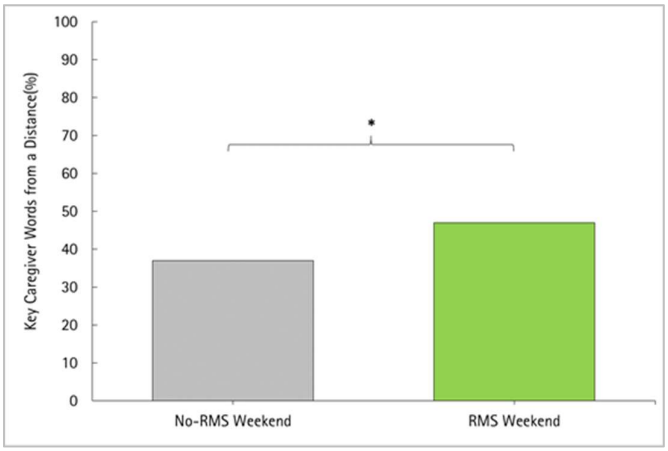

Figure 2: The percentage of caregiver words recorded from a distance, for both the No-RMS and the RMS weekend.
***= significant difference**

Discussion

This study examined the influence of RMS usage in the homes of children with hearing loss on caregiver talk. It was expected that caregivers talk more to their child while using an RMS due to the learned expectation that their children could hear them even under adverse acoustic conditions. However, caregivers did not talk more when using an RMS, but they did talk more from a farther distance. It is possible that caregivers understood they could communicate effectively with their children from a distance and, as a result, did not feel the need to be as close when talking to their child as they were when not using an RMS. It is reasonable to view this change in caregiver behavior as being more naturalistic for communication or, perhaps, detrimental as the child could be missing important visual cues for communication.

Another important finding of this study suggests that children with hearing loss could miss a significant amount of caregiver talk during a typical weekend at home when not using an RMS. That is, based on average data from this study, children lack access to as many as almost 5,300 words per day from a single caregiver (assuming eight hours use time) when not using an RMS. However, given the variability in amount of caregiver talk across families, a median percentage might be more informative. For this cohort, 42% of total caregiver talk in the home represents the median percentage of caregiver talk that could be missed by the child (i.e., caregiver talk produced from a distance).

Factors such as child's degree of hearing loss, whether or not visual cues are present, and attention and motivation to listen can influence a child's perception of caregiver talk generated from a distance with or without an RMS. Likewise, because of transmitter capability, caregiver words produced farther than about 20 feet from children would not be accessible even with the use of an RMS. For purposes of this study, it was assumed that children with hearing loss have access to all caregiver talk produced in close proximity to them (< 8 feet) even without an RMS. However, it is likely that audibility can be limited somewhat for children with hearing loss even with well-fit hearing technology and that access to caregiver talk that is produced in close proximity to the child might be diminished in some instances (e.g., when visual cues are not available). Nonetheless, based on the current results, it is reasonable to assume that children with hearing loss have access to significantly more caregiver talk in the home environment when they use an RMS than when they do not. In addition, if two caregivers are using the transmitter it is reasonable to expect even more access to distant caregiver talk.

Conclusions

This study was conducted in the homes of children with hearing loss and explored the effects of RMS caregiver talk. Using 'real' home environments produced high ecological validity of results. Key results include (1) caregivers did not talk more when using an RMS in the home than when not using an RMS; (2) on average, it was estimated that RMS use in the home provided children with access to approximately 5,300 more key caregiver words during an eight-hour day; and (3) caregivers spoke more from a distance while using the RMS than when not using an RMS. Additional work is needed to determine the quality of the extra caregiver talk made available by an RMS.

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