Home-Use of Roger Technology by Children with Hearing Loss

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Remote microphone system (RM System)

- Hearing assistance technology

**Diagram:**
- Microphone
- Transmitter
- Receiver
SHOULD CHILDREN WITH HEARING LOSS USE RM SYSTEMS CONSISTENTLY AT HOME?
“ANSI standards recommend a signal-to-noise ratio (the difference between the teacher's voice and the background noise) of at least +15 dB at the child's ears for appropriate speech perception in the classroom setting.”

American National Standard Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools
Children spend 60% of their time at home...

(Silvers et al., 1994)
(Hofferth & Sandberg, 2001)
How noisy are the homes of children with hearing loss?

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Children learn from language coming from a distance
Overhearing is especially important for word learning by 2 ½ years of age
“With few exceptions, the more parents talked to their children, the faster the children’s vocabularies were growing and the higher the children’s IQ test scores at age 3 and later. The most important aspect of children’s language experience is its amount.”

Quantity

Hart & Risley, 1995
“Our results confirm that both the quantity of language input and the quality of parental sensitivity affected language outcomes. Research spotlights the powerful contribution of the quality of the communication foundation co-constructed by the caregiver and the child”

Hirsh-Pasek et al, 2015
Therefore...

When used in the home, RM systems might increase opportunities for children with hearing loss to access quantity and quality language.

Language Development
RM system use in homes of children with hearing Loss

- Impact on Caregiver Talk
  - Quantity
- Impact on Child-Directed Speech
  - Quality
- Impact on Child Responsiveness & Engagement
- Caregiver Perceptions
Data collection

• LENA: Digital Language Processor

• RM System (Phonak ROGER)

• RM System Caregiver Survey
Data collection

NO-RM System WEEKEND

RM System WEEKEND

RM System Caregivers Survey
STUDY 1

Remote Microphone System Use at Home: Impact on Caregiver Talk
Carlos R. Benitez-Barrera,* Gina P. Angley, and Anne Marie Tharpe

Purpose: The purpose of this study was to investigate the effects of home use of a remote microphone system (RMS) on the spoken language production of caregivers with young children who have hearing loss.

Method: Language Environment Analysis (LENA) recorders were used with 16 families during 2 consecutive weekends (RMS weekend and no-RMS weekend). The amount of talk from a single caregiver that could be made accessible to children with hearing loss was measured using an RMS was estimated using Language Environment Analysis software. The total amount of caregiver talk (close and far talk) was also compared across both weekends. In addition, caregivers' perceptions of RMS use were gathered.

Results: Children, with the use of RMSs, could potentially have access to approximately 45% more words per day. In addition, although caregivers produced an equivalent number of words on both weekends, they tended to talk more from a distance when using the RMS than when not. Finally, caregivers reported positive perceived communication benefits of RMS use.

Conclusions: Findings from this investigation suggest that children with hearing loss have increased access to caregiver talk when using an RMS in the home environment. Clinical implications and future directions for research are discussed.

STUDY 2

Remote Microphone System Use at Home: Impact on Child-Directed Speech
Carlos R. Benitez-Barrera,* Emily C. Thompson,* Gina P. Angley,*
Tiffany Wynn Roski,* and Anne Marie Tharpe

Purpose: The impact of home use of a remote microphone system (RMS) on the caregiver production of, and child access to, child-directed speech (CDSS) in families with a young child with hearing loss was investigated.

Method: We drew upon extant data that were collected via Language Environment Analysis (LENA) recorders used with 9 families during 2 consecutive weekends (RMS weekend and no-RMS weekend). Audio recordings of primary caregivers and their children with hearing loss obtained while wearing and not wearing an RMS were manually coded to estimate the amount of CDSS produced. The proportion of CDSS that was likely accessible to children with hearing loss under both conditions was determined.

Results: Caregivers produced the same amount of CDSS when using and when not using the RMS. However, it was concluded that children with hearing loss, on average, could potentially access 12% more CDSS if caregivers used an RMS because of their distance from their children when talking to them.

Conclusions: Given our understanding of typical child language development, findings from this investigation suggest that children with hearing loss could receive auditory, speech, and language benefits from the use of an RMS in the home environment.

Quantity
& Caregiver perceptions

Quality
**STUDY 3**


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Child responsiveness & engagement
RQ1. Does an RM system provide a child with more access to caregiver talk as well as CDS in the home than when not using an RM system?

**Quantity**
- 5300 words/day
- 42% caregiver talk
- 11 words/min

**Quality**
- 12% CDS
RQ2. Is there a difference between the **number of words** as well as the **amount of CDS** caregivers produce when using and when not using an RM system?

**Quantity**

**Quality**
RQ3. Do caregivers produce a greater proportion of words as well as a greater proportion of CDS from a distance when using an RM system than when not?

**Quantity**

**Quality**

10% more words
RQ. Do caregivers reduce the **number of repetitions** and **alerting phrases** they use when talking from a **distance** when using the RM system in the home?

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1. Under what circumstances did the RMS work best?
   - Talking from distance
   - Noisy environments
   - Face-to-face interactions
   - Conversations
   - Always

2. Did you notice any communication difference in your child when using the RMS?
   - Increased responsiveness
   - Increased speech clarity
   - Increased communication
   - Increased attention
   - More talkative
   - Increased responsiveness
   - Increased attention
   - Confusion
   - Surprise
   - Better communication
   - No particular reaction
   - Less frustration
   - More talkative
   - More confident
   - Happier
   - More responsive
   - No change
   - Yes
   - No

3. How did your child react when listening to sound coming from a distance?
   - Talking from a distance
   - Very Confident
   - Very Positive
   - Experience

4. Were there any changes in your child’s behavior when using the RMS?
   - Yes
   - No

5. Did you find any difficulties when using the RMS?
   - (Very) Confident
   - (Very) Easy to use

6. How confident were you with the technology?
   - Yes
   - No

7. In general, how would you rate your experience using the RMS during the weekend? (1 = very poor, 5 = very positive)
   - (Very) Positive
   - (Very) Negative

Note: RMS = remote microphone system.

*Difficulties with the RMS reported by families included equipment being uncomfortable for the child to wear, difficulty remembering when to mute and unmute the equipment, inconvenience of wearing the extra device (neckloop for bone-anchored and cochlear implant), and siblings wanting to play with the transmitter.
Clinical Implications

When not using the RM system in the home...

Children:
- **Might miss** a significant amount of caregiver talk (~5300 words/day – 42% of caregiver talk)
- **Might miss** a significant amount of child-directed speech (12%)
- This language could potentially be accessible through the use of an RM system, thereby promoting language learning
Clinical Implications

When using the RM System in the home...

Caregivers:
- Produced the same amount of talk as well as the same amount of CDS than when not using an RM system
- Produced higher amount of talk from a distance than when not using the RM system
- Produced the same amount of CDS from a distance than when not using the RM system
- Reduced the number of repetitions and alerting phrases they used from a distance
- Indicated high levels of acceptance towards the technology and reported auditory and communication benefits in their children with hearing loss
Conclusion

- The use of an RM system in the home could provide access to more language to children with hearing loss.

- Exposure to more language quantity and quality is associated with better language skills later in life (Hart & Risley, 1995; Hirshek-Pasek et al., 2015).

- Early access to language is associated with an improved neural language processing as well as the development of cognitive and academic skills (Romeo et al., 2018).

- The use of an RM system in the home could provide auditory, language and communication benefits for children with hearing loss (Curran et al., 2019).
SHOULD CHILDREN WITH HEARING LOSS USE RM SYSTEMS CONSISTENTLY AT HOME?
Caution

• Limited access to speech from other speakers

• Reduced access to visual cues

• Reduced access to auditory distance and localization cues

• Access to excessive or inappropriate speech - Disruptive?
Looking into the future...
Impact of RM System use at the brain level
PRACTICE vs CLARITY
Naïve Brain
Experienced Brain
Connectome Model

Kral et al., (2016)
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Families and Children