

## UNILATERAL HEARING LOSS: AMPLIFICATION AND ACOUSTICS

REFERENCE	DESIGN	RECRUIT- MENT	CASE DEFINITION	SUBJECTS	ASSESSMENT TOOLS	RESULTS	AUTHOR'S CONCLUSIONS
Kenworthy OT, Klee T, Tharpe AM. Speech recognition ability of children with unilateral sensorineural hearing loss as a function of amplification, speech stimuli and listening condition. Ear Hear. 1990;11(4):264-70.	<p>Repeated Measures (2 x 3 x 3): 2 types of speech materials, 3 listening conditions, 3 audiological recommendations using multiple analysis of variance</p> <p>Compared 3 audiological recommendations: (1) Unaided (2) CROS* (3) Personal FM* system</p> <p>3 listening conditions: (1) MD* (2) MI* (3) MS/ON*</p>	Not reported.	<p>PTA* .25-8 kHz.*</p> <p>Unaffected ear: 0-15 dB* HL.*</p> <p>Affected ear: 56-120+ dB HL.</p> <p>UHL* for minimum of 4 years</p> <p>No recurrent otitis media</p> <p>Normal tympanograms</p>	<p>Total: N = 6</p> <p>Aged 8-12 years</p> <p>3 boys, 3 girls</p> <p>With hearing loss: N = 6</p> <p>Controls: N/A</p> <p>Flat UHL 56-120 dB HL (5 subjects right ear affected).</p> <p>No prior experience with amplification.</p> <p>5 subjects at grade level, but 4 had behavioral or academic difficulties; 1 had repeated a grade.</p> <p>All scored above 10<sup>th</sup> percentile on receptive and expressive subscales of a language screening test.</p>	<p>NST* &amp; BKB* lists</p> <p>Recorded on audio tape (in acoustically untreated classroom and recorded at a manikin's head) simulating 3 listening conditions encountered in a classroom—MD, MI, and MS/ON, with the 3 audiological recommendations (unaided, CROS, and FM).</p> <p>Tapes presented to children seated in sound-treated booth via headphones.</p>	<p>3-way interaction was significant.</p> <p>Simple main effects and individual analyses performed.</p> <p>5 of the 6 children showed statistically significant gains in speech recognition scores with the FM system for the BKB lists as compared to the unaided condition (6th child had the least severe loss: 56 dB therefore, might not have needed the FM system).</p>	<p>Children with severe-profound unilateral sensorineural hearing loss experienced a significant improvement in speech recognition ability under some listening conditions as a result of listening to speech through an FM system.</p> <p>The findings of this study provide some justification for recommending use of an FM system in the academic setting for children with severe-profound UHL who are experiencing academic difficulty.</p> <p>Field studies are needed.</p>

\* CROS = contralateral routing of signal; FM = frequency modulated; MD = monaural direct; MI = monaural indirect; MS/ON = midline signal/omni-directional noise; PTA = pure tone average; kHz = kilohertz; dB = decibel; HL = hearing level; UHL = unilateral hearing loss; NST = Nonsense Syllable Test; BKB = Bench Standard Sentence lists

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Kopun JG, Stelmachowicz PG, Carney E, Schulte L. Coupling of FM systems to individuals with unilateral hearing loss. J Speech Hear Res. 1992;35(1):201 -7.	<p>Purpose: To examine the attenuation characteristics of sound delivery options that provide different degrees of ear canal occlusion in adults and school-aged children.</p> <p>5 coupling devices were tested: (1) Nonoccluding lightweight headphones, (2) tube-fitting, (3) CROS* earmold with tubing, (4) snap-ring earmold with a vent, and (5) CROS earmold with a snap-ring.</p> <p>All 5 tested with children; first 4 also tested in adults</p> <p>Attenuation measured from coupling devices at 17 frequencies presented at 45° azimuth in free-field.</p>	Not reported	Not reported	<p>Total: N = 25</p> <p>Adults: N = 10</p> <p>Children: N = 15</p> <p>Controls: N/A</p> <p>10 adults (aged 20–50 years)</p> <p>15 children (aged 5–13 years) with normal pinna and middle ear function</p> <p>Children divided into 3 groups: 5–7 years, 8–10 years, and 11–13 years</p>	<p>Probe-microphone used to measure attenuation from coupling devices.</p> <p>17 frequencies sequentially spaced from .2 to 6 kHz* presented at 45° azimuth in free-field.</p> <p>Ear canal size was measured by taking cross-section of the earmold impression 5 millimeters medial to the point corresponding to the entrance of the ear canal.</p>	<p>No significant difference in attenuation between any age groups in the study.</p> <p>Tube fitting provided &lt;5 dB* of attenuation at all frequencies tested.</p> <p>Headphones provided &lt;5 dB of attenuation below 4 kHz and up to 10 dB at high frequencies.</p> <p>CROS and snap-ring with vent ear molds provided significant attenuation at the higher frequencies with the greatest attenuation (20–30 dB) at 3 kHz.</p> <p>Frequencies of 2.4 to 4.2 kHz were affected most by occlusion.</p>	<p>Only CROS, non occluding ear molds should be used with unilateral hearing loss.</p> <p>Non-occluding is defined as no greater than 30% of the ear canal as measured in the study.</p>

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<p>McKay S. To aid or not to aid: children with unilateral hearing loss. <i>Healthy Hearing</i>. 2002. <a href="http://www.hearthyhearing.com/library/article_content.asp?article_id=163">http://www.hearthyhearing.com/library/article_content.asp?article_id=163</a></p>	<p>Questionnaire, retrospective, descriptive.</p>	<p>Audiology department at the Children's Hospital of Philadelphia.</p> <p>(20 of 28 completed the questionnaire).</p>	<p>UHL* = 25–65 dB* (Hz* not reported)</p>	<p>Total: N = 20</p> <p>With UHL: N = 20</p> <p>Controls: N/A</p> <p>2–17 years.</p> <p>Degree of hearing loss ranged from mild–moderately severe.</p>	<p>Children fitted with a HA* then parents completed a survey that evaluated:</p> <ul style="list-style-type: none"> <li>-attention span,</li> <li>-ability to follow directions,</li> <li>-frustration level,</li> <li>-ability to understand TV,</li> <li>-response to being called from another room,</li> <li>-ability to understand speech in noise,</li> <li>-confidence level,</li> <li>-child's enjoyment of the device, and</li> <li>-the parents' satisfaction with their decision to aid the child.</li> </ul> <p>Used Lickert scale from survey results.</p>	<p>Responses to each of the questions were generally neutral or positive.</p>	<p>In this study, children seem to respond well to HA amplification in the affected ear.</p> <p>According to the survey, parents reported their children were hearing better, and were showing improvement in academic and social situations.</p> <p>Overall there appeared to be a benefit from amplification and this study recommended fitting for this mild–moderate UHL population on a trial basis.</p>

\* UHL = unilateral hearing loss; dB = decibel; Hz = hertz; HA = hearing aid

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Updike CD. Comparison of FM auditory trainers, CROS aids, and personal amplification in unilaterally hearing impaired children. J Am Acad Audiol. 1994;5(3):204-9.	Individual subject analyses and group comparisons across conditions.	Not reported.	PTA* = .25-4 kHz*  Normal: $\leq 25$ dB* HL*  Hearing loss = at least 3 threshold levels $> 25$ dB HL  UHL*: Normal hearing in one ear and mild-profound loss in contralateral ear  Mild: PTA 37 dB (N = 1) Moderate: PTA 42 dB (N = 1) Moderate-Severe: PTA 63 dB (N = 1) Severe: PTA 85 dB (N = 1) Profound: PTA 110+ dB (N = 2)  All had normal tympanograms.	Total: N = 6  With UHL: N = 6  Controls: N = 0  3 male; 3 female  Aged 5 years, 10 months - 12 years, 11 months.  4 children performing at grade level, although 2 were reported to have behavior difficulties.  2 children had repeated a grade.	Goldman-Fristoe Woodcock Test of Auditory Discrimination was used to evaluate speech and sound discrimination.  Children selected 1 of 4 pictures after listening to the auditory stimulus.  3 tape players were used to present the speech signal at 77 dB SPL* and speech noise at 71 dB SPL creating a SNR* of +6 to simulate a classroom noise situation.	HA* use, FM* trainers, and CROS* hearing aids showed improvement in quiet conditions (ambient room noise about 25 dB SPL).  CROS aids and conventional HA showed either no difference or a decrease in performance with the signal in noise condition.  Only FM trainer showed improvement for all conditions and levels of hearing impairment.  Benefit of FM in noise increased as degree of UHL increased.  Subject with mild UHL showed improvement with the FM trainer.	FM trainers might provide benefit for children with all levels of UHL.  FM trainers provided better benefit than CROS or conventional HAs for subjects with UHL.  The benefit of FM over HAs and CROS aids became greater in the presence of background noise or low SNRs.  The finding regarding benefit of FM for children with mild UHL was contrary to that reported in Kenworthy et al (1990). However, the discrepancy might have been due to different test materials used in each study.

\* PTA = pure tone average; kHz = kilohertz; dB = decibel; HL = hearing level; UHL = unilateral hearing loss; SPL = sound pressure level; SNR = signal-to-noise ratio; HA = hearing aid; FM = frequency modulated; CROS = contralateral routing of signal