An auditory training technique
to improve dichotic listening

By Kris English, Jennifer Martonik, and Laura Moir

Formal auditory training (AT) has been recommended to improve auditory processing skills in order to capitalize on the neural plasticity of the central nervous system. When the listener receives appropriately designed sensory stimulation, neural changes should occur, including enhanced myelin development and transmissions across synapses. Yet, despite these recommendations, with few exceptions (e.g., Musiek, 1999), little information has been made available regarding the effectiveness of AT procedures. The following study describes one treatment designed for children with deficits in dichotic listening skills. Dichotic listening tasks require listeners to attend to different words, phrases, or short sentences presented simultaneously to each ear. For example, a listener under headphones may be presented the double-pair digits “6-2” in the left ear and, at the same time, “4-1” in the right. The ability to process both inputs improves with age, reaching 90%-96% accuracy by age 12.

Musiek, Gollegly, and Baran hypothesized that when children demonstrate difficulties in this area (particularly with input presented to the left ear), the poor transfer of auditory input across hemispheres may be due to delays in the myelination of the corpus callosum. Hence, appropriate auditory training would be expected to stimulate this myelin development and improve interhemispheric transfer. Our study tests the hypothesis that providing left-ear auditory stimulation improves dichotic listening skills in typically developing children.

METHODS

Subjects

EXPERIMENT 1: Ten children (8 males and 2 females) with reduced left-ear Dichotic Digit Test—Double Pair scores were recruited as subjects for the experimental treatment. All the subjects attended a university speech-language-hearing clinic. Their average age was 8 years, 2 months, and their ages ranged from 5 years, 10 months to 10 years, 9 months. The children all had normal hearing levels and middle ear function bilaterally.

When available, teacher reports indicated strong concern about the classroom listening behaviors of most subjects (see Table 1). Table 2 provides language development information for each subject, collected by school...
personnel or by university student clinicians. Only three of the subjects (Subjects 2, 6, and 7) demonstrated typical language development across all subtests.

In addition to dichotic listening deficits, subjects presented with problems in auditory discrimination, auditory sequential memory, and temporal resolution. Table 3 depicts the range of auditory problems presented by each subject (as determined by a test battery described below). Pertinent to this investigation, the Dichotic Digit (DD) test revealed that eight subjects had right-ear scores within normal limits (WNL), but left-ear scores from 2.5 SDs to 7.8 SDs below normal (relative to mean for age). Two subjects (3 and 5) had below-average scores in both ears.

EXPERIMENT 2: Since all subjects above presented with two or more auditory processing problems (per Table 2), they received additional AT in conjunction with the left-ear-only stimulation. To determine the effects of left-ear AT independent of other treatments, the second author recruited Subject 11 (male, 7:6 years) for a thesis project. His DD score for the left ear was four standard deviations (SD) below the mean for his age; the right-ear score was age-appropriate. No information was collected regarding other auditory processing skills or language development and, despite several attempts, no teacher reports could be obtained.

Materials

A book on tape (Arthur's Chapter Books, Vol. 1) was used as the stimulus for auditory training. We selected this title because its language level, designed for a pre-school audience, would present limited if any linguistic demands. In addition, its chapter-book format allowed for a continuity of story line over several sessions.

To deliver the stimulus to the left ear only, we used the following equipment:

- a CD/tape player (either RCA RP 8000 or Aiwa CSD-A120)
- audiometric headphones for the subject (Maico TDH 39), to deliver an auditory stimulus to the left ear only
- a set of monitor headphones for the clinician (either Sony MDR 101 or Aiwa HP-A091)
- a headphone cable Y-adapter (Radio Shack 42-2570) to allow both subject and clinician to listen to the stimulus
- a 1/4-inch-to-1/8-inch stereo headphone adapter (Radio Shack 274-366C) to couple the left-ear (blue) audiometric headphone jack to the Y-adapter.

To measure changes in dichotic listening abilities, we re-administered the Dichotic Digits Test-Double Pairs after treatment and again 4 to 6 weeks later. Because three of the subjects were 5 to 6 years of age, we used Rosenberg’s normative data for all subjects.

Procedures

EXPERIMENT 1: We evaluated the subjects with an assessment battery involving five behavioral tests (see Figure 1). This battery was designed for school-based audiologists and other professionals (speech-language pathologists, psychologists) to obtain behavioral information about a child’s auditory processing abilities. The tests in this battery were selected because they can be administered in a school environment without specialized (audiometric) equipment, they make few or no linguistic or memory demands, they employ simple response modes, and they do not require audiologic equipment or expertise.

All subjects were enrolled in a 1-semester program of auditory training (AT) for 10 to 13 weeks (mean = 11.2 weeks) to receive 1 hour a week of individualized AT in a university clinic, provided by a student clinician.

To improve dichotic listening skills, each subject was instructed to listen carefully to the book on tape for 2 minutes. Headphones were placed on the subject, the tape was played, and the subject listened to the story delivered to the left ear only.

The clinician monitored the story with his or her own headphones. After 2 min-

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Table 3. Auditory processing problems across subjects (2.5+ SD below mean).

<table>
<thead>
<tr>
<th>Subject</th>
<th>Dichotic Listening</th>
<th>Auditory Discrim</th>
<th>Aud. Seq. Memory</th>
<th>Temporal Resolution</th>
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<td>Left</td>
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</tbody>
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Figure 1. APD behavioral assessment matrix.

1. Dichotic Digits, Double Pairs (Mesin, 1983)
2. Lindamood Auditory Cenesthesia Test (Lindamood & Lindamood, 1979)
4. Auditory Fusion Test, Revised (McCreery & Keith, 1996)
5. “Auditory Sequential Memory-Digit Span” subtest, Illinois Test of Psycholinguistic Abilities (Kirk, McCarthy, & Kirk, 1966)
utes, the clinician removed the headphones and asked three simple questions, such as “What color was Arthur’s shirt?” These “attending questions,” which served to focus attention on the auditory stimulus, were designed to make as little linguistic demand as possible and to be answerable in one or two words.

This process was repeated three times, continuing the story through its chapters, for a total of 8 minutes left-ear-only stimulation and 12 “attending questions.” The remaining time in the 1-hour session was used to address other auditory processing problems.

At the midpoint of the AT program (5 to 7 weeks), we re-administered the Dichotic Digits test. If scores were within normal limits at that time, we discontinued left-ear stimulation and addressed other auditory processing problems. If DD scores were not within normal limits, left-ear stimulation was continued. At the end of the semester (10 to 13 weeks), we again administered the DD test to measure the progress during the second half of treatment (specifically, for Subjects 3, 5 and 9) or to determine the stability of the normal DD scores obtained earlier.

EXPERIMENT 2: Subject 11 received the same left-ear stimulation treatment at an after-school program, twice a week for 1 month, for a total of eight 20-minute sessions. The same procedures were used, with no other auditory training provided. The DD test was administered at the end of AT, and also 4 and 8 weeks later.

RESULTS

EXPERIMENT 1: Figure 2 shows left-ear Dichotic Digit test scores before and after AT. Relative to the mean by age, all 10 subjects had improved their left-ear scores by at least 1.5 standard deviations (SDs), and some by as much as 8 SDs (Table 4). Nine subjects (90%) achieved age-appropriate DD scores after receiving left-ear-only auditory training.

Figure 3 shows how subjects reached age norms over time. Seven of the 10 subjects (70%) reached or exceeded the mean score for their age within 5 to 7 weeks. Subjects 3 and 9 reached age-appropriate scores after 13 weeks of treatment. Subject 5 showed the least improvement (1.5 SD) at the midpoint, and no change at the end of the training sessions. It is interesting to note that, unlike the other subjects, Subjects 3 and 5 presented with reduced DD scores in both ears.

When age-appropriate scores were achieved, treatment was withheld, and the DD test was administered 4 to 6 weeks later. All nine subjects who had achieved normal scores were found to maintain them (Figure 4).

EXPERIMENT 2: The thesis subject demonstrated one SD improvement immediately after 4 weeks of auditory training. To verify the stability of the score, he was retested 4 weeks later. At that time, his score improved another 2 SDs (Table 4). He was tested again 4 weeks later, and his score remained stable (Figure 5).

DISCUSSION

It appears that for most subjects, providing auditory stimulation to the left ear only improved left-ear dichotic deficits as measured by the Dichotic Digits Test. Analogous to the ophthalmologic practice of covering a strong eye to train a “lazy eye” to focus and track, providing auditory input only to the left ear may “train” the auditory cortex in the right hemisphere to process auditory input with more accuracy and efficiency.

Clearly, much remains to be investigated. For instance, it is not known why some subjects responded to this AT faster than others or why Subject 5 did not...
achieve normal test scores after 12 sessions. Nor is it known why the thesis subject (#11) showed marked improvement 1 month after treatment was withheld compared with the subjects in Experiment 1, whose scores had not changed. And it remains to be determined if improvements in dichotic listening skills affect other auditory processing skills or academic success.

Future studies should include randomized assignments to treatment/different-treatment/no-treatment groups. In addition, a multiple baseline design would allow each subject to serve as its own control against the possibility of maturation effects. Other auditory training procedures and outcomes also need to be reported for our field to advance in these areas.

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REFERENCES


Figure 3. Baseline and post-AT DD scores, LE.

Figure 4. LE DD scores post-AT and at 4-6-week recheck.

Figure 5. Left- and right-ear DD improvement (SDs).