

Children

Chapter 4

Multiple Benefits of Phonak EduLink use by Children with Auditory Processing Disorder (APD)

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Children with Auditory Processing Disorder (APD)

Benefit from Phonak EduLink Use

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Abstract

Children with APD were fitted with Phonak EduLink FM devices for home and classroom use. Repeated measures during the school year demonstrated speech perception improvement in noisy classroom environments and significant psychosocial benefits. Compared with a control group, the APD group showed greater speech perception advantage with FM technology compared to unaided conditions.

Introduction

Children diagnosed with auditory processing disorder (APD) experience significant listening difficulties in classroom environments, which are typically noisy, reverberant, and distracting in multiple modalities (Crandell, Smaldino, and Flexer, 2005). Common educational sequelae of untreated APD include poor speech perception, decreased on-task behavior, poorer relationships with peers and teachers, and diminished academic performance, potentially resulting in negative psychosocial effects such as anxiety, loss of self esteem, and depression (Crandell, 1999; Kreisman, 2007; Smaldino and Crandell, 2004). Use of personal frequency-modulation (FM) amplification devices has been proposed as a remediation strategy to overcome these difficulties (ASHA, 2005; Crandell and Smaldino, 2002; Stach et al, 1987). However, limited data exist to support the positive anecdotal reports on utilization of FM technology for children with APD in the classroom.

The present study evaluated the potential long-term benefits in speech perception and psychosocial function of the Phonak EduLink personal FM system used in mainstream classroom environments by children with APD. The Phonak EduLink is a compact behind-the-ear FM device appropriate for children

with mild hearing loss, APD, attention deficit hyperactivity disorder (ADHD), and/or learning disabilities. The EduLink ear-piece is minimally visible and does not occlude the ear, allowing the wearer access to environmental sound in addition to the FM signal.

Methods

Ten children (8 male, 2 female) with a positive diagnosis of APD were recruited as participants. All participants were evaluated at the University of Florida Speech and Hearing Clinic (UFSHC). Audiologic findings confirmed normal hearing sensitivity, normal middle-ear function, and a positive diagnosis of APD. Criteria for APD were consistent with accepted recommendations (e.g., ASHA, 2005) and included performance more than 2 standard deviations below normal for at least one ear on multiple measures of dichotic listening, auditory sequencing, and/or auditory figure-ground (speech-in-noise). Participants ranged in age from 8 years 2 months to 15 years 7 months with a mean age of 11 years 8 months. A second group of thirteen children (nine male, four female) was recruited as a control group. Children in this group ranged in age from 8 years 2 months to 13 years 2 months with mean age 10 years 6 months. Control subjects had normal hearing sensitivity, normal middle-ear function, and normal auditory processing function by formal assessment. Participants for the control group were recruited from a North Florida K-12 school that included a geographically and socio-economically diverse student population.

FM Amplification System

Following a diagnosis of APD, participants in the experimental group were fit bilaterally with Phonak EduLink FM systems. The

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Phonak EduLink system is a non-occluding ear-level style FM system appropriate for classroom use by children with normal hearing sensitivity or mild hearing loss, as well as children with APD. The Campus S FM transmitter with Miniboom microphone (worn on the face and over the ear) was provided for use by teachers in the classroom and by parents at home. Participants and parents were instructed in the use of the FM system at the initial fitting and follow-up in-service education was available for participants' teachers.

Speech perception

Speech perception assessment was conducted using the Hearing \$In Noise Test (HINT; Nilsson, Soli, & Sullivan, 1994). The HINT consists of 25 lists of 10 phonemically-balanced sentences spoken by a male voice. The lists are recorded to CD with speech spectrum noise matched to the long-term spectrum of the sentences serving as noise competition. Reception thresholds for sentences (RTS) in quiet and in noise, both with and without using the EduLink system, were obtained using an adaptive procedure.

Testing was conducted using a five-speaker array surrounding the seated participant in a double-walled sound-treated booth. The sentences were delivered from one speaker (Tannoy System 600), located at 0 degrees azimuth, 1 meter from the participant. The noise competition was delivered using four speakers (Definitive BP-2X bipolar) located at 45, 135, 225, and 315 degrees azimuth (in the corners of the booth), 1 meter from the participant. This speaker array was arranged to simulate listening to a single talker within a diffuse noise field, which is typical of everyday listening environments.

Continuous speech-spectrum noise served as the noise competition for HINT testing.

To simulate the distance from the mouth of a teacher utilizing the microphone/transmitter system, the aided conditions of testing were completed with the microphone transmitter assembly

placed at 0 degrees azimuth and approximately 3 inches from the diaphragm of the speaker delivering the speech material. In the aided conditions, participants wore the EduLink receivers binaurally. In the unaided conditions, all FM system equipment was powered off and no receivers were worn by the participant.

Academic Status

Academic performance was assessed using two rating instruments commonly used to evaluate learning difficulties and success of classroom interventions for children with auditory disorders – the Screening Instrument for Targeting Educational Risk (SIFTER; Anderson, 1989) and the Listening Inventory for Education (LIFE; Anderson and Smaldino, 1998). The SIFTER allows the teacher to assess a student's performance in the following five areas: Academics, Attention, Communication, Class Participation, and School Behavior. The LIFE, actually developed as an extension of the SIFTER, allows children to provide direct input on the listening problems they are experiencing through the use of self-report scales. Previous research has established the efficacy of the SIFTER and LIFE in pre-test/post-test evaluation of intervention utilizing classroom listening devices (see Crandell, Smaldino, and Flexer, 2005 for a review).

Psychosocial Function

Psychosocial function was evaluated using the Behavior Assessment System for Children – Second Edition (BASC-2; Reynolds and Kamphaus, 2004). The questions in the BASC-2 are used to create a profile of adaptive and maladaptive behaviors and emotions exhibited by children and adolescents. Each administration of the BASC-2 in the current investigation study included forms completed independently by the student and by a parent. The Parent Rating Scale (PRS) is used to quantify positive and negative behaviors in home and community settings. The PRS covers 14 sub-categories including adaptability, anxiety, depression, functional communication, and withdrawal. The student Self-Report

of Personality (SRP) is used to quantify the child’s own feelings and thoughts as they relate to 16 sub-categories of attitudes and emotions including attitude toward school, locus of control, interpersonal relations, and self esteem. Prior investigations have demonstrated the validity of these instruments for use with children who have hearing loss or other communication disorders (Kreisman et al, 2004; Kreisman, 2007).

Testing Interval

For the participants in the experimental group, speech-perception and psychosocial measures were administered prior to and during the school year after a period of at least five months of FM system use in the classroom. Speech-perception testing (HINT) and selected academic (SIFTER, LIFE) and psychosocial (COOP, BASC-2) measures were repeated at the follow-up visit. For all participants and parents, results of initial measures were not made available to participants during the return visit. All assessments of participants in the control group were completed in one visit.

Table 1. Summary of significant findings (p < 0.05)

Domain	Test material	Condition or test item	Findings of group comparisons
Speech perception	HINT	aided in noise	Figure 1: Comparison of HINT reception thresholds for sentences among the control group, indicating APD greatly more perceived benefit for individuals with APD. Children in the experimental group also showed significant improvement with prolonged FM system use.
Academic status	SIFTER	academics	In the post-FM use condition, children with APD showed significant improvement from measures prior to FM system use.
	LIFE	questions 1 & 9	In the pre-FM use condition, children with APD were significantly more at risk for problems than peers in control group.
		question 6 & 9	In the post-FM use condition, children with APD were still significantly more at risk for problems than peers in control group.
		question 5	In the post-FM use condition, children with APD were significantly less at risk for problems than peers in control group.
		questions 1, 3, & 5	In the post-FM use condition, children with APD were significantly less at risk for problems than prior to FM system use.
Psychosocial status	BASC-2 (parent)	functional communication, leadership, attention problems	In the pre-FM use condition, children with APD were found to be more at risk in these areas than peers in the control group. With the exception of attention problems, the children with APD were found to be no longer any more at risk in these areas than peers in the control group following prolonged FM system use.
	BASC-2 (student)	interpersonal relationships, attention problems, depression, anxiety, locus of control	In the pre-FM use condition, children with APD were found to be more at risk in these areas than peers in the control group. With the exception of attention problems, the children with APD were found to be no longer any more at risk in these areas than peers in the control group following prolonged FM system use.

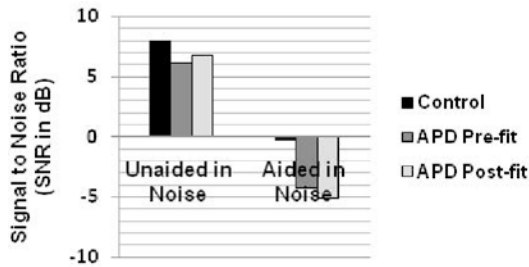


Figure 1. Speech perception performance using HINT (see Table 1 for significant findings)

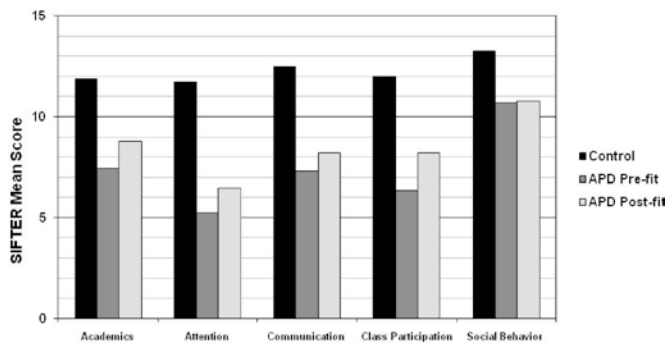


Figure 2. CSIFTER mean scores (see Table 1 for significant findings)

Results

All significant findings are summarized in Table 1 and are based on an alpha level of 0.05.

Speech Perception

Group speech perception data are presented in Figure 1. Comparisons among performance of the control group and experimental group (prior to and following FM system use) revealed significant differences for aided performance in noise. The children with APD in particular showed significantly greater benefit of FM use when listening in quiet and in noise after long-term use of the EduLink

system. Benefit of FM use was calculated as the difference between performance SNR with and without FM use in noise.

No significant differences were apparent between the control and experimental groups in unaided performance in noise either before or after use of the EduLink system by the children in the experimental group. Due to a greater benefit of FM use seen in the APD group, aided thresholds in noise were significantly better than control group thresholds both prior to and following prolonged use of the FM system. Interestingly, prior to FM use, the children with APD had significantly poorer group thresholds in quiet than control group thresholds in both aided and unaided conditions. However, baseline-to-post-fit comparisons indicated the children with APD improved significantly in listening in quiet both with and without the FM system following prolonged FM use and were no longer significantly different in comparison to control group thresholds.

Academic Status

Analysis of SIFTER ratings by parents of children in both groups revealed significant differences between the control group and experimental group (Figure 2). Mean ratings by the parents of the children in the control group resulted in responses within the “pass” range for all categories of the SIFTER. Prior to FM use by the children with APD, mean ratings by parents resulted in responses in the “fail” range for the following SIFTER categories: academics, communication, and class participation. For each of these categories, however, ratings improved from the “fail” to “marginal” range after prolonged use of the FM system. In other words, the children with APD were found to be at reduced risk for academic failure by their parents after prolonged use of the EduLink system.

Student self-rating scores on the LIFE revealed that, prior to use of the EduLink system, children with APD rated themselves more at risk than did participants in the control group on all of the items used, however, significant differences were noted specifically

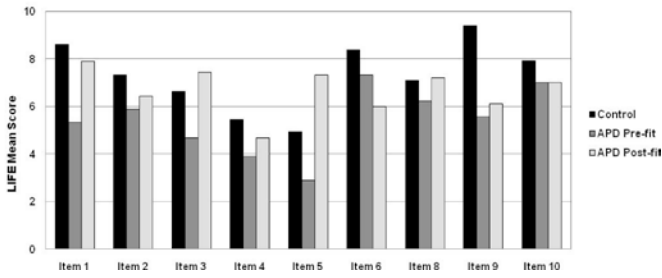


Figure 3. LIFE mean scores (see Table 1 for significant findings)

for two situations (Figure 3). Following use of the FM system, children with APD rated themselves significantly worse than control on only two items (students answering during discussion, word recognition during test directions). Additionally, scores had improved in the APD group on eight of the nine items. Compared to pre-fit scores, significant improvement was seen in the APD group following EduLink system use for three listening situations (teacher talking in front of room, teacher talking with back turned, other students making noise). Following use of the FM system, children with APD were still at increased risk than peers in the control group for problems when listening to a student answer during a discussion and for problems with word recognition during a test or directions. In addition, comparison of control and APD post-fit scores revealed that students with APD using the EduLink reported a significant advantage over control-group peers while listening when other students are making noise.

Psychosocial Function

A summary of BASC-2 parent report differences is displayed in Table 1. Prior to use of the EduLink system, significantly more parents of APD group participants rated their children outside of the normal range in three domains: functional communication, leadership, and attention problems. After using the EduLink system, significant group differences disappeared for all but the

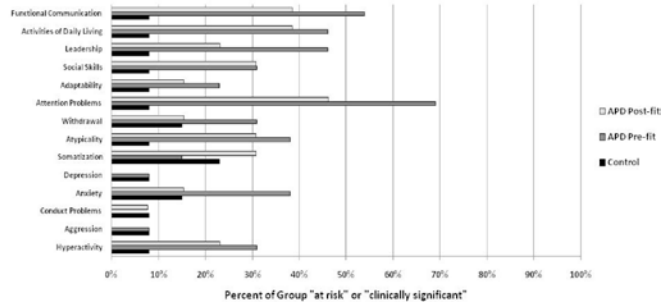


Figure 4. Psychosocial function as reported by parents on BASC-2 (see Table 1 for significant findings)

attention problems domain, a similar finding to that which was seen in student self-report comparison. Although parent ratings improved on almost all of the BASC-2 categories, no significant differences were seen for the children with APD for ratings completed prior to and following FM system use.

Table 1 displays a summary of comparisons between the control and experimental groups in terms of the number of participants who rated themselves “at-risk” or “clinically significant” on the fourteen domains of the BASC-2 student report. Prior to use of the EduLink system, significantly more participants in the APD group compared to the control group rated themselves outside of the normal range on the BASC-2 domains of interpersonal relationships, attention problems, depression, anxiety, locus of control. After using the EduLink system, significant group differences disappeared for all but the attention problems domain. A comparison of ratings prior to and following FM system use revealed significant improvement in two domains: locus of control and depression. In summary, ratings in the student self report for the BASC-2 indicate perceived improvements in the following domains for the children with APD after prolonged use of the FM system: locus of control, anxiety, depression, and interpersonal relationships.

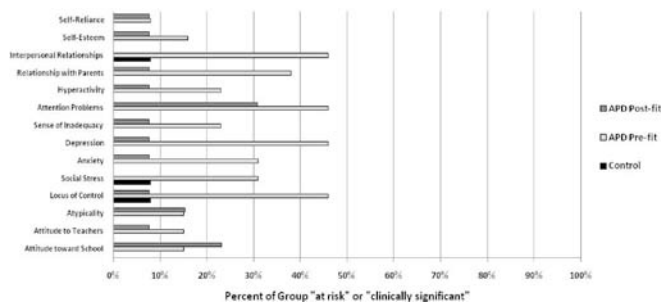


Figure 5. Psychosocial function as reported by students on BASC-2 (see Table 1 for significant findings)

Discussion

Following long-term use of the EduLink personal FM system, a group of 10 children with APD showed improvement in nearly every academic performance, speech perception, and psychosocial function measure administered. Laboratory speech perception testing as well as both parent and student anecdotal reports confirmed the significant benefit in signal-to-noise ratio provided by the FM system in the classroom. This benefit was evident immediately following fitting with the FM system, and was maintained during the study period. Even with the small sample examined, statistically significant improvements were evident in several domains measured, including improved ability to understand the teacher's voice in class, improved communication ability, and lower levels of stress and depression. These data provide strong evidence for the benefit of personal FM use in the classroom by children with APD.

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