The Use of FM Systems for Children with Attention Deficit Disorder

Claudia D. Updike
Ball State University
Muncie, IN

This research study was undertaken to evaluate the effects of using FM systems with children having attention deficit disorder. Word recognition ability, attention and listening skills, and academic scores were compared for pre-versus post-FM fitting. Implications of these findings and suggestions for further research are presented.

Attention deficit (hyperactivity) disorder (ADD/ADHD) is one of the most common problems of elementary school children. Estimates of its prevalence vary, but according to Obrien and Obrzut (1986) and Barkley (1982), AD(H)D is present in about 4 to 5% of school-age children. According to the American Psychiatric Association (1994), the essential diagnostic characteristics of AD(H)D are the inability to sustain attention and effort, impulsivity, and possible accompanying hyperactivity. AD(H)D is ten times more common in boys than in girls and appears to be more common in family members than in the general population (American Psychiatric Association, 1994; Obrien and Obrzut, 1986).

Numerous intervention strategies have been utilized, including behavioral and cognitive behavioral techniques, family counseling, and psychotherapy, diet modification. However stimulant medication appears to be the most common treatment choice in the United States (Obrien and Obrzut, 1986). Dietary intervention has been found to be effective in 30 to 50% of hyperactive children, but many hyperactive children respond due to the psychological reasons of suggestion and family concern, while only a few children show a genuine, physiological, idiosyncratic response (Taylor, 1985). Behavior therapy has been found to be effective for the short-term period, and may be more effective than drug intervention for the long-term period in the management of defiance and antisocial behavior, which have been found not to be very sensitive to stimulants (Taylor, 1985; Brown, 1986). Brown (1986) observed that in many instances, behavior therapy can be very effective, but that behavior therapy in conjunction with pharmaco-therapy was better than either alone in mild to moderate cases. He also stated that pharmaco-therapy was effective in more severe cases. Cognitive behavior modification, which combines manipulation of environmental contingencies with self-control processes (e.g. self instruction, self-monitoring, and self-reinforcement), has also been investigated as a possible intervention strategy. Brown, Wynne, and Medenis (1985) compared the effects of cognitive training, stimulant drug therapy, and the two treatments combined with ADHD boys with learning disabilities. They observed that the combination of both intervention programs resulted in significant improvement in attention and behavior. They observed no improvement in academic achievement by any of the treatments. Numerous medications, including Strattera, Ritalin, Aderall, appear to be effective to varying degrees with many AD(H)D children. Medications reportedly improve subjective reports of lowered anxiety and restlessness, and improve attention and performance on cognitive tasks. It would seem logical that as attention improves, learning would also improve. Unfortunately, Taylor (1985) found that stimulants did not yield any long-term benefit on academic learning. Obrien and Obrzut (1986) suggested that achievement measures used in the studies may not have been sensitive to the actual learning taking place. They also point out that many students with AD(H)D have learning disabilities which may be impacted, even though medication may improve attention span and behavior symptoms. Another issue with pharmacological intervention is that it controls for only some of the symptoms of AD(H)D while the child is taking the medication. Should the child cease the medication, the problem behaviors and inability to pay attention remain.

Numerous studies have investigated the impact of AD(H)D on academic achievement. In general, the research indicates that children with AD(H)D are more likely than children without disabilities to receive lower grades in academic subjects and lower scores on standardized tests of reading and math (Barkley, Fischer, Edelbrock and Smallish, 1990; Wener, 1990). Anderson, Williams, McGee, and Silva (1987) found that 80% of 11-year olds with AD(H)D were behind at least two academic years in math, reading, written language and spelling. Barkley et al (1990) and Brown and Borden (1986) observed that children with ADHD will experience failure of at least one grade by the time they are adolescents, and over one third will not complete high school (Weiss and Hechtman, 1986).

Perhaps the main difficulty for children with AD(H)D with respect to academic issues, is that they have attentional issues: they have difficulty focusing on the relevant auditory stimuli, (the teacher's instruction), particularly if there is background noise in the classroom. Furthermore, they fail to sustain attention to the pertinent auditory stimuli when other "more interesting" auditory and/or visual stimuli are present, e.g. other students whispering, movement in the room (Zentall, 1993). It is estimated that about 75% of the school day is spent in listening activities. Without focusing and sustaining attention, the AD(H)D student misses much classroom instruction and becomes at-risk for academic failure.

The listening difficulties of the AD(H)D student are compounded by the fact that typical classrooms in the United States are not acoustically conducive to listening and learning. Numerous studies have investigated the background noise levels of American classrooms, (Sanders, 1965, Finitzo-Hieber (1988), Updike and Conner, 2004, Crandell and Smaldino, 1994) and have determined that they typically exceed the ASHA (2002) and ANSI (2002) recommended levels. The impact of background noise on listening skills of school-age children has been well documented. Updike and Conner (2004) determined that word recognition scores of first, second and third graders decreased significantly by an average of 35% when noise was in the classroom. Listening skills of second and third graders likewise decreased significantly. Given the definition of AD(H)D, it is assumed that the listening skills of AD(H)D children would be similarly impacted, if not more so.

The key to helping the student with AD(H)D is to gain and sustain his/her attention during classroom instruction. Personal FM technology has provided a means to help the student with listening difficulties in the classroom. The system functions like a miniature public address system within a school classroom. It consists of several portable parts, including a small, teacher-worn microphone/transmitter and a receiver worn by the student. As the teacher talks, his/her voice is transmitted via FM waves to the student's receiver where the signal may be amplified more than slightly if it is sent directly to his/her ear. In this way, there is a direct link from the teacher to the student. The enhancement in the signal to noise ratio (S/N) occurs as a result of the teacher's voice being at the child's ear and is not traveling across space with opportunity for noise and reverberation to interfere with signal clarity. The student is able to focus and concentrate more easily on the teacher's voice and instruction. He/she is less likely to be distracted by other background noise since the teacher's voice is the "foremost" or predominant sound in his/her ear. Blake et al (1991) investigated the effect of FM systems on the attending behaviors of learning disabled (LD) children. They observed improved attending behaviors in group activities, specifically in a) motivation to participate; b) eye contact with the teacher; c) response time; d) appropriateness of verbal response; e) quality of spoken language, and f) ability to follow directions. To date, there has been no follow-up study on the effects of FM systems on attending behaviors of AD(H)D children.

Purpose:

The purpose of this study was to evaluate the effectiveness of mild gain personal FM systems as a tool to enhance the speech discrimination skills, classroom behavior, and academic performance of AD(H)D children.

Method:

Participants:

There were 31 children, ages 7 to 9 years, (9 girls, 22 boys) who were referred by their school speech-language clinicians to participate in this study. All were enrolled in first through third grades (first grade: 7 students; second grade: 14 students; third grade: 10 students) in 10 schools in the Muncie Community School System. All were previously medically diagnosed as ADD/ADHD, with 24 of the children on medication (23 students were on Ritalin, 1 was on Cyclert). For the remaining 7 students, medication for ADD/ADHD was recommended by their physicians, but their parents chose for personal reasons to not have their children take medication. Nine of these students were enrolled in speech and language therapy at school, two were receiving tutoring services, and one was receiving occupational and physical therapy. Participants' characteristics are presented in Table 1.

To participate in this study, all participants had to have normal hearing and no middle ear issues (see the next section).

Table 1. Characteristics of the Participants in This Study

Subject	Gender	Age	Medicated	Special Services
1	F	7-9	Yes	Speech/Language
2	F	7-3	No	Tutoring
3	F	6-11	Yes	
4	F	8-8	Yes	
5	M	7-6	Yes	
6	M	9-2	Yes	
7	M	7-9	Yes	
8	M	9-5	Yes	Speech/Language
9	M	9-10	No	Speech/Language
10	M	7-0	Yes	Speech/Language
11	M	8-5	Yes	Occupational and Physical Therapy
12	M	9-6	Yes	Speech/Language
13	M	10-2	No	
14	M	8-7	Yes	Speech/Language
15	M	8-1	No	
16	F	8-0	Yes	Speech/Language
17	F	8-11	No	
18	M	8-2	Yes	
19	M	9-5	No	
20	M	8-0	Yes	Speech/Language
21	M	7-10	Yes	
22	M		Yes	
23	M		Yes	
24	F	8-7	Yes	
25	M		Yes	
26	F	9-0	Yes	
27	M	8-6	No	
28	M	7-0	Yes	Speech/Language Tutoring
29	M	6-10	Yes	
30	F	9-6	Yes	
31	M	6-11	Yes	

Normal hearing was defined as hearing threshold levels < 15 dB HL at all of the following frequencies: 500 Hz, 1000 Hz, 2000 Hz, 3000 Hz, 4000 Hz and 8000 Hz. Normal middle ear function was defined as having Type A tympanograms in each ear.

Equipment:

Hearing testing of each student was performed using the Beltone 2000 audiometer in an IAC sound treated booth at Ball State University. Immittance testing was performed during the initial hearing evaluation with the GSI-61 tympanometer.

The test battery consisted of the following tests: *Goldman-Fristoe-Woodcock Test of Auditory Discrimination-Modified version* (modified GFWTAD), *Observation Profile of Classroom Communication (Profile)*, and the *Children's Attention and Adjustment Survey (CAAS)*. To further evaluate the effectiveness of the FM systems from the teacher's perspective, an appraisal form was developed: *FM Appraisal Form* (Appendix A). To evaluate academic performance, grades achieved by each child were recorded on class tests at mid-school year (pre¬- FM) and at the end of the school year (post-FM) in the following subject areas: reading, language arts, spelling, math, social studies, and science.

The modified *GFWTAD*: Four versions of the *GFWTAD* (1970) were developed so that word recognition ability could be evaluated under four different listening conditions: in quiet and in noise, with and without the FM system. The original *GFWTAD* was developed as a test of speech discrimination ability for children as young as 4 years of age. The test has three parts: a training section, a quiet subtest, which provides a measure of auditory discrimination in the absence of background noise, and a noise subtest, which evaluates auditory discrimination in the presence of distracting background noise. Test items are presented via picture plates and a cassette tape with the pre-recorded test stimuli. Each picture plate contains four line drawings representing words that sound similar except for a single phoneme. The student is asked to point to the picture representing the stimulus word. The *GFWTAD* was selected for use since its test items are highly familiar to children as young as 4 years old. Because it utilizes a picture pointing (nonverbal) response, there is no need to "interpret" verbal responses. The revised test forms used in this study consisted of the same test items, with the same contrasts, but in different orders from the original *GFWTAD* quiet subtest. The words were randomly selected to determine the test item order in each revised list. These lists were recorded by a typical English-speaking American female speaker on a compact disc (CD) for ease of administration and sound quality control. The recording was developed professionally at the Ball State University (BSU) media center. For word recognition testing purposes, a Sony CFD-110 portable CD radio cassette player was used to present the modified *GFWTAD* in a Ball State University classroom (see Test Environments section).

Three noise tapes were created, using white noise generated by a Beltone 2000 clinical audiometer interfaced with a Technics RS-T11 tape recorder. White noise was chosen since the ventilation systems in each classroom were considered to be major sources of background noise, and the noise was judged to be best described as approximating white noise. Other types of noise, such as speech-weighted noise or pink noise would have also been good choices. For the purposes of presenting the noise tapes, three Panasonic RQ 2739 audio-cassette players were used.

The *Profile* was used both pre-and post-one month trial fitting to evaluate any changes in classroom attending and behavior skills as a result of wearing an FM system. The *Profile* is a 31-item checklist that examines ongoing communication in a classroom setting. The authors developed this non-standardized checklist to identify students exhibiting auditory language processing difficulties in the context of their class environment where there are interfering distractions of background noise. While the *Profile* is designed to help identify children with auditory language processing issues, it contains items that specifically evaluate behaviors that are observed in children with AD(H)D, such as auditory attending skills (e.g. distractibility), inconsistent responses to auditory stimuli, and problems recalling previous events in the correct order. The authors of the *Profile* concluded that the *Observational Profile of Classroom Communication (Profile)* is an effective procedure for teachers to systematically observe and document communicative behaviors in the context of the classroom. This questionnaire asks about the signal, the presentation, the environment, the response of the child, and the learning strategies used by the child. The classroom teacher observes the child for at least two weeks, and then answers "yes" or "no" to the statements describing the student's communication skills in the classroom context. A student who scores 16 or more points on this questionnaire is considered to be at risk for academic issues (Sanger, Keith, and Maher, 1987). In order to conduct the most valid evaluation, a person very familiar with observing the child's behavior throughout the day is needed. The ideal evaluator is therefore the classroom teacher(s) who has had the student in the class for at least 2 weeks (Sanger et al, 1987).

The Children's Attention and Adjustment Survey (*CAAS*; Lambert, Hartsough, and Sandoval, 1990) was also used to evaluate the listening and attending skills of the students with AD(H)D in this study. The *CAAS* is a 31-item rating scale system designed to evaluate behaviors related to AD(H)D. The behaviors evaluated consist of short attention span, impulsivity, distractibility, and motor restlessness. It is composed of two forms: the Home Form and the School Form. Each measures four symptoms on the basis of ratings by parents or teachers. The School Form was used in this study. This is a normed test with a scoring grid.

There were 31 FM systems available, but specifically, the Phonic Ear Easy Listener system (transmitter: PE 300T and headset receiver: PE 300R) was utilized in this study to enhance the listening skills of the AD(H)D students. This system was used since it was developed for use by people with auditory attention deficit for use in classrooms. The specifications for this system were as follows: HF average SSPL 90: 111 dB SPL; HF average full-on gain: 37 dB; frequency response: 125-9000 Hz. The volume controls were set initially at approximately one half of maximum output. This level was chosen since it represented the preferred volume for most of the participants. Although the classroom teachers were requested to monitor the settings on the systems, there was no protocol in place to assure consistent monitoring of the receiver/headset volume control.

Procedure:

Institutional Review Board (IRB) approval as well as parental and school consent were obtained in order for each child to participate in this study. The purpose and procedure of the study, the concept of FM systems and their potential benefits, maintenance, care and troubleshooting were explained to each parent, teacher, child, and speech-language pathologist (when one was involved with the child). Each child's hearing was evaluated at the Ball State University Audiology Clinic, using standardized audiometric procedures. Each FM system was then provided to each child to be used during class instruction time.

Periodic weekly unannounced visits were made to each child/teacher in the study to monitor the functioning of the child and equipment. Troubleshooting of equipment was provided as needed.

Test Environments:

Dimensions were taken of each of the participants' classrooms, as well as the test environment (classroom at Ball State University) for word recognition testing. Reverberation times (RTs) were estimated for each of the classrooms, using the Sabine formula (2006): $RT = .05V/A$, where .05 is a constant, V is the volume of the room in cubic meters, and A is the total absorption of surfaces in the room. The Sabine formula is based on room dimensions and absorption co-efficients of the walls, ceiling and floor. Sound level measurements of the background noise in each of the unoccupied classrooms were also recorded (see Table 2). The background noise level in each classroom was determined using the method described by Smaldino, Crandell, and Kreisman (2005). The sound level meter (SLM) was positioned approximately at the center of each participant's head while seated at this/her desk. The SLM was placed so that it pointed toward the teacher's position at the front of the room. The sound levels were measured additionally at all four corners, the middle, and middle back of the classroom.

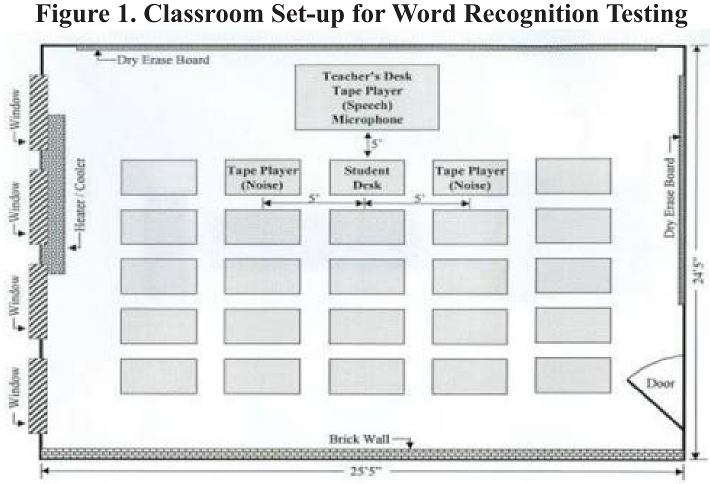
For practical reasons, speech recognition skills were assessed in a classroom at Ball State University (BSU). Word recognition testing was conducted for each participant individually. In order to simulate a typical classroom, a compact disc player was placed 5 feet from the dry erase board at the front of the classroom, approximately 3 ½ feet from the floor and on top of a teacher's desk. For testing purposes, the CD player presented the test stimuli from the front center of the classroom at the teacher's desk. The presentation level of the test stimuli for each condition was 70 dBA since that level closely represents average conversational speech (50 dB HL). The microphone of the Easy Listener system was located six inches from and facing the speaker of the CD player. This distance was chosen because that represents the typical distance clip-on microphones are worn from the teacher's mouth (Rosenberg, Blake-Rahter, Heavner, Allen, Redmond, Phillips, & Stiger, (1999). The participants were seated five feet from and directly in front of the speaker of the CD player (zero degrees azimuth). For future reference, masking tape was put on the floor directly below the participant's seat and on the floor directly below the CD player. The three Panasonic RQ 2739 tape players which presented the speech noise were arranged around the student in the classroom, 5 feet on either side and from the back, at a 180 degree azimuth. For the word recognition testing conditions in noise, the level of the noise arriving from the 3 tape recorders at the student's location was approximately 66 dBA so that the signal to noise ratio (S/N) would be +4 dB. This S/N was used in this study because it corresponds to the typical classroom S/N (Finitzo-Hieber, 1988). Figure 1 illustrates the classroom set-up for this study.

Table 2. Classroom Noise Levels and Reverberation Times

School	Classroom	Participants	Noise Levels in Unoccupied Classrooms (dBA)	Dimensions of Classroom	Reverberation Time in Classroom
School 1	Classroom 1-A	5	52	25' x 28' x 9'	.44
	Classroom 1-B	7	50	26' x 28' x 9'	.44
	Classroom 1-C	6	53	31' x 30' x 9'	.46
School 2	Classroom 2-A	20	51	31' x 30' x 9'	.46
	Classroom 2-B	21 22	52	38' x 24' x 9'	.45
	Classroom 2-C	19 23	52	24' x 38' x 9'	.45
School 3	Classroom 3-A	10 31	51	30' x 28' x 9'	.45
School 4	Classroom 4-A	28	53	28' x 30' x 9'	.45
School 5	Classroom 5-A	15	56	37' x 24' x 9'	.45
School 6	Classroom 6-A	27 29	54	28' x 30' x 9'	.45
	Classroom 6-B	14	53	37' x 24' x 9'	.45
	Classroom 6-C	13	54	28' x 34' x 9'	.46
School 7	Classroom 7-A	2 3	55	38' x 24' x 9'	.46
	Classroom 7-B	1 4 25	53	28' x 34' x 9'	.46
School 8	Classroom 8-A	16 18	49	35' x 25' x 10'	.49
	Classroom 8-B	17 26	50	24' x 35' x 9'	.45
School 9	Classroom 9-A	11 12	54	35' x 24' x 9'	.45
	Classroom 9-B	30	56	33' x 27' x 9'	.45
School 10	Classroom 10-A	24	55	25' x 25' x 10	.45
BSU	Classroom	All Participants	47	34' x 17' x 8'	.38

For each student, the word recognition scores in quiet and noise were obtained using the modified *GFWTAD*, without and then with the FM system. For each condition, the presentation of the modified *GFWTAD* lists was randomized in an attempt to avoid order and list effects.

Figure 1. Classroom Set-up for Word Recognition Testing



The *Profile* and *CAAS* were used to evaluate classroom listening and attending behavior. The classroom teacher for each student filled in each questionnaire twice: pre-FM fitting and post-FM fitting one month after the student had been fitted with the FM system. Comparisons of the pre-and post-FM system *Profile* and *CAAS* scores were made for each participant. Ideally, if there had been a teacher and teacher aide in the class, both persons would have filled in both the *Profile* and *CAAS*, and interpretation of the results would have been based on both sets of data. In this particular study, there was only one teacher per class who answered the *Profile* and *CAAS*. *Profiles* and *CAAS*s were recorded for 28 of the 31 students. *Profiles* and *CAAS*s for the remaining three students were not returned by their teachers.

To evaluate academic performance, the grades achieved by each child on class tests at mid-school year (pre-FM) and at the end of the school year (post-FM) were utilized in the following subject areas: reading, language arts, spelling, math, social studies, and science. It should be noted that 14 of the students in this study were receiving special education services, and their academic progress was not recorded using the traditional grade system. Their academic status was noted as either unsatisfactory or satisfactory. The academic scores were converted from letter grades to numerical grades, based on a 4.0 grading system. Statistical analyses were based on the academic scores of the 17 AD(H)D participants.

Results

Classroom noise levels were determined for each of the classrooms wherein each of the AD(H)D students was located, and it was determined that the unoccupied classroom noise levels ranged from 47 dB to 58 dB SPL (Table 2). In all situations, the classroom noise levels in the participants' own unoccupied classrooms, as well as the classroom used in this study, exceeded the recommended maximum classroom sound levels, as proposed by ANSI (2002) and ASHA (2002). It should be noted that the unoccupied background noise level for the BSU classroom where the word recognition testing was performed was less than that of the participants' own classrooms. The word recognition scores obtained in this testing situation in quiet would therefore most likely be an overestimate of what the participants' word recognition scores would be in their typical classrooms. The RTs, estimated from the Sabine formula, (Sabine, n.d.) indicated that the BSU classroom and six of the ten classrooms had RTs within the acceptable limits (ANSI, 2002).

The average pre-and post-scores obtained by all 31 subjects on the modified *GFWTAD* tests are presented in Figure 2. Analysis of variance with the results indicated that when scores for quiet versus noise backgrounds were compared, all 31 subjects experienced difficulty with word recognition in the presence of noise ($p < .001$). The average word recognition score decreased significantly ($p < .001$) when noise was present in the background (Table 3). This significant decrease in scores was observed only when the FM system was not used. A significant increase in word recognition was evidenced when the FM system was utilized in both quiet and noisy backgrounds. While the increase in scores was not significant in the quiet background, it was significant in the noise background ($p < .001$). There was a 34% increase in scores with the use of the FM system under the noisy background situation.

Attending skills were also evaluated in quiet and in noisy backgrounds without, as well as with, the use of the FM systems

Figure 2. Recognition Scores in Quiet and Noisy Backgrounds, With and Without FM Systems

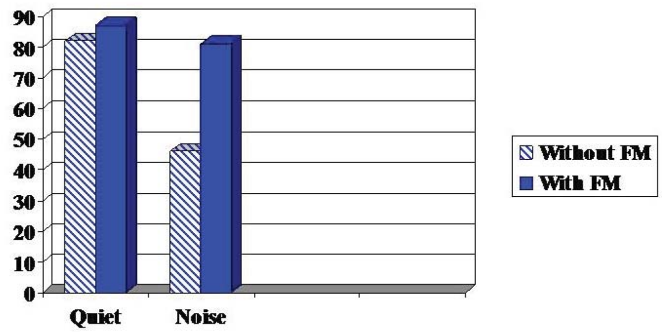


Table 3. Analysis of Variance Word Recognition Scores in Quiet and Noise Without and With the FM Systems

	Df	Mean Square	F	Significance
Word Recognition Quiet & Noise, Without FM vs With FM	1,31	17246.166	40.205	.001
Quiet vs Noise	1,31	1194.832	60.113	.001
Without FM vs With FM	1,31	12933.511	30.778	.001
Quiet Without FM vs Quiet With FM	1,31	175.105	1.195	NS
Noise Without Vs Noise With FM	1,31	10098.819	75.275	.001

(Figures 3 and 4, Table 4). Decreases in scores on the *Profile* and *CAAS* were noted, which, on these surveys, would indicate an improvement in attention. Two way analysis of variance results indicated that the improvement in listening and attending, as noted on both scales, was significant at the .01 level. This would suggest that the use of the personal FM systems significantly improved the attention and listening skills of the children with ADD in this study. Figure 3 illustrates the pre-and post-subtest scores on the *Profile* for each child. The pre-fitting Profile scores indicated that all 28 children were at risk for having difficulty within the classroom (scores higher than 16 are interpreted as "at risk"). Comparison of the pre-and post-scores on the *Profile* indicated a significant decrease (improvement) for all children ($p < .01$). It was noted that while there was an improvement in listening skills with FM use on the *Profile*, the participants are still at risk for academic issues, since as a group, their mean scores exceed the criterion. Closer examination of the pre-FM fitting individual scores reveals that only one participant had a "passing score". In the post-FM fitting scores, only 3 participants passed. While no data on non-AD(H)D children was collected, the results of this study would suggest that the FM equipment appears to help improve this study's participants' listening skills. It also suggested that they still require support to develop strategies to cope with their issues in the classroom.

Examination of the results obtained on the *CAAS* revealed that there was a substantial improvement (decrease in scores) for

Figure 3. Observation Profile of Classroom Behavior (Profile) Without versus With FM Systems

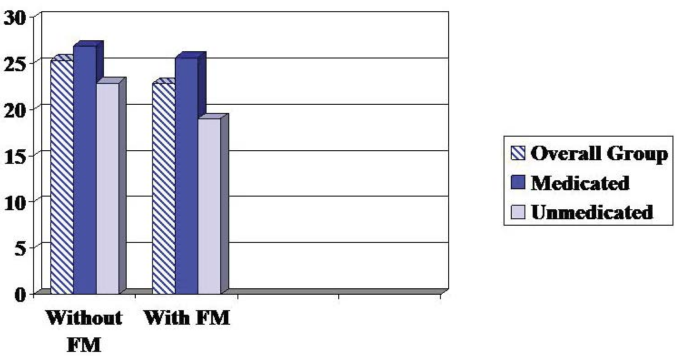


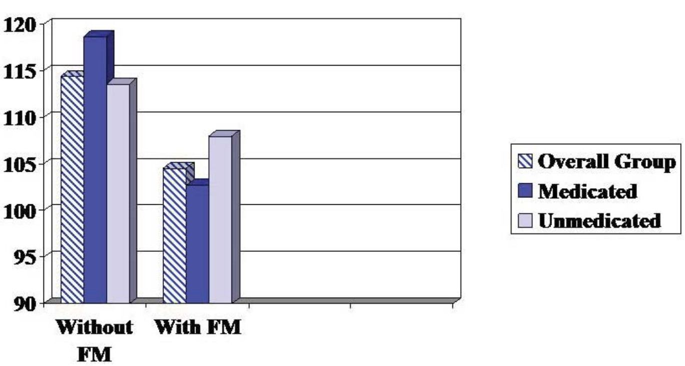
Table 4. Two Way Analysis of Variance (ANOVA) Attending and Listening Skills Without FM vs With FM: Profile and Survey

	Df	Mean Squares	F	Significance
Profile	1,27	288.478	27.364	.01
CAAS	1,27	3740.065	24.369	.01

the pre-and post-FM fitting conditions. The decrease in attending difficulties was statistically significant ($p < .01$ level). Closer examination of these results revealed an interesting trend for the children with AD(H)D medicated versus unmedicated: both groups experienced a decrease in attending difficulties, and it appeared that the children with AD(H)D who were medicated experienced greater improvement (Figure 4).

It was earlier hypothesized that improvement in listening and discrimination could result in improved performance in academic areas. Figure 5 illustrates the mid year and final year mean academic scores of the 17 children with AD(H)D. The other 14 participants did not have grade scores, and were not included in these analyses. Multivariate T analysis of variance (Table 5) indicated a significant improvement in academic scores. The academic scores of the 17 children with AD(H)D in this study were then examined. It was determined that their average overall grade at mid year was 1.6, which was equivalent to a letter grade of D+. This performance was then improved by the end of the year to an overall mean grade of 2.1, which translates to a letter grade of C. Univariate analysis of variance indicated that this improvement was significant at the .05 level (Table 5). The reading scores improved significantly (p <. 5), by the end of the academic year. The spelling scores improved significantly ($p < .01$); the math scores improved significantly ($p < .05$); and the social studies scores improved significantly ($p < .05$). There was improvement in language and science, but the increase in scores did not prove to be statistically significant for this population of students, although the trend for improvement was evidenced. A limitation of this data is that the students and teachers in this study were from 10 schools, with no standardized tests and grading system in use to evaluate the students' progress.

Figure 4. Classroom Attention and Adjustment Survey (CAAS) Without versus With FM Systems



Closer examination of the data revealed that the participants with AD(H)D medicated and AD(H)D unmedicated both experienced increases in academic scores. The participants with ADD medicated achieved at higher academic levels for all subject areas, both pre-and post-FM fitting. It could be hypothesized that since they are currently receiving medication for their AD(H)D, they may be better able to attend to class instruction and discussion and, therefore, learn at a better rate than the students with AD(H)D who are not medicated. When degree of change (improvement) was compared for each group (Figure 6), it can be seen that both subgroups improved by approximately the same degree in all subjects.

Figure 5. Academic Scores Without versus With FM Systems

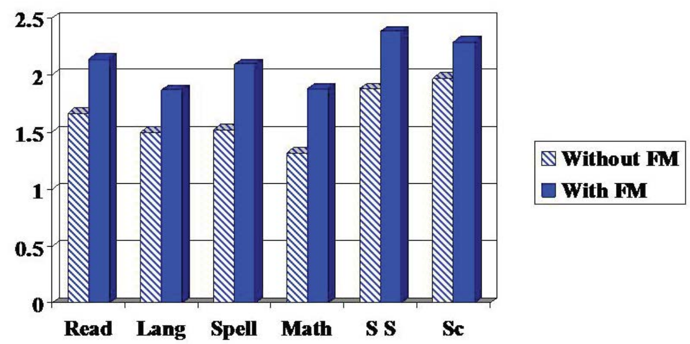
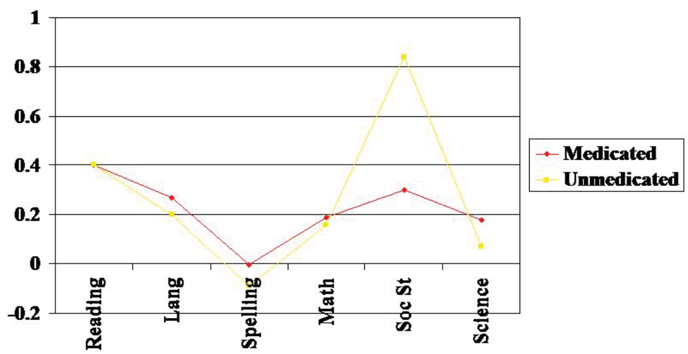


Table 5. Multivariate T Analysis of Variance (ANOVA) Univariate Tests Academic Scores, Without FM vs With FM

	Df	Pillai's Trace Value	F	Significance
Overall Academics	6,11	.686	4.007	.05
Post Hoc Univariate Analysis of Variance Tests				
Reading	1,16	2.051	4.585	.05
Language	1,16	1.149	3.477	NS
Spelling	1,16	2.382	9.656	.01
Math	1,16	2.654	5.731	.05
Social Studies	1,16	1.441	6.135	.05
Science	1,16	.403	1.501	NS

Each teacher was also requested to fill in a teacher appraisal form to indicate how well the student was performing with the FM system. Of the 31 forms distributed, 26 forms were returned to the author. The total number of points possible was 13, and the teachers rated their students' use of the FM systems at 11.50 (Figure 7). Interesting results were obtained when the results for the students were subdivided into the AD(H)D with medication (n = 16) versus AD(H)D unmedicated (n = 10). There was a tendency for the teachers to rate the usefulness of the FM system more highly for the participants who were currently receiving medication for their AD(H)D.

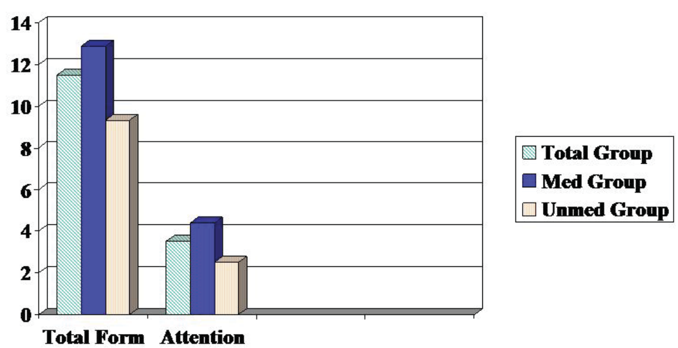
Figure 6. Increase/Decrease in Academic Scores with the FM Systems



Summary and Conclusions:

There are numerous suggested solutions to help children with AD(H)D, including stimulant medication, cognitive behavior techniques, family counseling, diet modification and psychotherapy. This current research suggests yet another possible alternative to help the child with AD(H)D. The results of this study clearly suggest that the fitting of an FM system may help a child with AD(H)D overcome some of his/her listening and attending problems in a classroom environment. The improved academic performance was perhaps as a result of the students' improved attention during class instruction and discussion.

Figure 7 Teacher Appraisal of the FM System



In addition to the successes achieved in this study, there are some additional comments. During the weekly unannounced follow-up visits to the participating students and their teachers, it was noted that there was a continuing issue with broken cords on the students' headsets. This may be just another sign that the participants in this study were AD(H)D students with typical distractibility. While some of the children did well with the equipment, other children had difficulty getting used to wearing it. Some children had a tendency to manipulate or play with the cords. This was particularly true for the students who were not medicated. The equipment is a good concept, but possibly only for those children who can "leave it alone" once it is in place. In spite of the numerous equipment repairs, the participants with AD(H)D did perform significantly better academically once they were consistently listening with an enhanced signal to noise ratio.

The FM system, however, does not resolve all of the listening and attending issues which plague the child with AD(H)D. He/she is still at risk for learning problems in class, as suggested by the results of this study. The child with AD(H)D needs to learn strategies to help him/her cope in the classroom. No one technique alone will resolve all of the issues for a child with AD(H)D. This research provides another alternative that should be considered and incorporated into the well-rounded educational intervention program for the child with AD(H)D.

Acknowledgements

The author wishes to express her gratitude to the Muncie Kiwanis Club for their financial support for this project. All of the equipment was donated to the Muncie Community Schools at the end of this project.

The author also wishes to thank all of the students who participated in this study, as well their teachers and parents, who gave of their time to support this project.

A very special thank you also goes to Dr. James Jones, who provided his expertise with the statistical analyses and the graphics.

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