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Auditory Integration Training Using Bourdin Auditory Bio-Feedback System for Remediation of ADD/ADHD and Central Auditory Processing Disorder.

Abstract.

This study examines auditory integration training (AIT) as a method for improving both visual and auditory responses in the areas of control, concentration and attention in individuals with a primary or secondary diagnosis of ADD/ADHD. Twenty-two participants between the ages of 7-25 with a primary or secondary diagnosis of ADD/ADHD were tested through an electronically administered audiometric assessment, and subsequently listened to individually adjusted filtered music for 60 minutes sessions at a typical frequency rate of five sessions a week. The number of sessions between pre- and post-test ranged from 9 hours to 23 hours. Subjects were administered the Integrated Visual and Auditory Continuous Performance Test (IVA) pre- and post- AIT treatment and measured on variables associated with visual and auditory attention, impulse control and mental concentration. Overall, subjects performed significantly better on tests measuring full scale response control and attention, with auditory response control and both visual and auditory attention showing significant improvements from pre-test to post-test. There was also a significant improvement in overall consistency, auditory speed, "balance", auditory sensory motor competence and in visual focus. The results of our study suggest that AIT may be especially helpful to individuals who have difficulties with impulsivity, attention, and auditory processing, and should be further investigated to determine if clinicians should suggest AIT as an alternative treatment to the traditional psycho-stimulant medications.

Keywords.

ADHD, Attention-Deficit Hyperactivity Disorder, Central Auditory Processing Disorder, CAPD, Auditory Integration Training, AIT, treatment, assessment, Integrated Visual and Auditory Continuous Performance Test, IVA

Introduction

Attention-Deficit/Hyperactivity disorder is a significantly disabling disorder affecting more than 7.8 of the US population, according to the 2004 census. It is a disorder commonly treated with medications, specifically the psycho-stimulants. Recent concerns have been raised about the long-term effects of psycho-stimulants and other drugs on the developing brain. In 1996 the FDA alerted the health care community that an animal study on Ritalin had shown a "weak signal" indicating that the drug may produce an increased risk of malignant liver tumors with long-term use (news release FDA, 1996).

More recently, the FDA has recommended a new "black box" warning for amphetamine-based drugs for ADHD, such as Adderall and Dexedrine, citing increased risk of sudden death in patients with heart problems (news release, FDA August 2006). The short-term side effects alone are cause for concern. According to the Physician's Desk Reference 2006 the side effects of Ritalin can include: nervousness and insomnia, hypersensitivity; anorexia; nausea; dizziness; palpitations; headache; dyskinesia; drowsiness; blood pressure and pulse changes; tachycardia; angina; cardiac arrhythmia; abdominal pain; and weight loss during prolonged therapy. There have been reports of Tourette's syndrome, toxic psychosis, abnormal liver function, cases of cerebral arteritis and/or occlusion; leukopenia and/or anemia; transient depressed mood and scalp hair loss. With these side-effects and the unknown long-term side-effects, it is critical for clinicians to be able to offer safe, effective alternative therapies to aid in the treatment of individuals diagnosed with ADD/ADHD.

Among these alternative methods is auditory integration training (AIT), a form of therapy using modulated and/or filtered music to enhance and synchronize left/right brain function in order to establish right ear dominance and improve auditory processing. Peer-reviewed, data-based reports of research in the area of AIT have focused on its effects in population groups other than ADD/ADHD individuals, finding mixed results with individuals diagnosed with autism, CAPD and "multiple handicaps" (Edelson and Rimland, 2001). Those few studies that have been done to evaluate the effectiveness of AIT in the treatment of ADD/ADHD have been limited, non-persuasive and anecdotal (eg., Kirby, 2000), with most studies investigating AIT's effects on selective attention, sound blending scales, and tolerance for tones and speech, but not on variables relevant to the symptoms of ADHD. The need for research in the area of AIT's effects on ADD/ADHD's debilitating symptoms is clearly needed before we can unequivocally recommend AIT to treat the symptoms of inattention, impulsivity and hyperactivity known to impair learning and social interactions in the ADHD individual.

Our treatment clinic, The Attention and Achievement Center in Walnut Creek, CA, specializes in the assessment and treatment of attention problems using neurofeedback, auditory integration training, sensory integration training and other non-medical treatments. Clinically, we have seen many individuals with normal hearing who present with symptoms of ADHD who also perform poorly on tests for auditory integration and tests for central auditory processing disorder. Our experience is that individuals with auditory integration difficulties who receive auditory integration training also show improvements in attention and concentration. We decided to test our theory that auditory integration training for individuals with ADHD can also produce significant changes on tests of attention, concentration and impulsivity when there is a concomitant problem with auditory integration, thus providing many ADHD individuals with an effective, alternative treatment for ameliorating their symptoms.

Methods

Participants

Clients who came to our clinic for help with attention and impulse control problems and who came from a variety of referral sources were selected for the study. Subjects at our clinic are routinely tested for auditory processing disorder, since we find that the vast majority of clients presenting with attention and impulse control problems also have auditory integration difficulties. Clients whose audiometric tests indicated the presence of problems with auditory integration were recommended to participate in auditory integration training. Our subjects were selected from these clients. The criteria for inclusion in the study were: 1) the subjects had completed initial and post-treatment assessments that included an Integrated Visual and Auditory Continuous Performance Test 2) the subjects completed one or more sessions of auditory integration training 3) the subjects completed fewer than 10 hours of any other type of treatment at our clinic. Thirty-one clients met our initial screening criteria. Of these, 9 were excluded for invalid, missing or unavailable data. The remaining 22 subjects consisted of 7 females and 15 males ranging in age from 7 to 25 with mean age of 12.8. The vast majority of our clients had received a primary diagnosis of ADHD either by one of our psychologists or by a clinician prior to coming to the clinic; two subjects received a primary diagnosis of Learning Disability, with ADHD as a secondary or tertiary diagnosis.

Measures

The Integrated Visual and Auditory Continuous Performance Test (IVA), developed by J.A. Sandford is a normed, computerized tool that assesses many variables associated with visual and auditory attention, impulse control and mental concentration. Research has demonstrated that comparisons of pre- and post- IVA scores can be reliably interpreted to reflect possible medication, treatment or environmental effects. (Seckler, P. et. al., 1995). The IVA presents subjects with a random series of 1's and 2's that are either flashed on the computer screen or spoken aloud to the subject through a set of headphones. The rate of presentation and form of presentation (whether visual or oral) varies throughout the 13 minute test in a pseudorandom pattern, with a 1500 ms ISI for 500 trials. (Sandford & Turner, 1995) Subjects are asked to click a computer mouse when they hear or see a "1" but to refrain from responding when they see or hear a "2". Response patterns, reaction time and errors are tabulated to arrive at a full diagnostic picture of a subjects' ability to maintain mental concentration, focus and sustain attention when material is presented orally or verbally. The resulting test scores range from 40 to 140 with a mean of 100 and SD of 15 for each of the subscales of the IVA.

Scores generated by the test fall into four general categories: Response Control Primary Scales, Attention Primary Scales, Attribute Scales and Symptomatic scales. The Response Control Primary Scales include Prudence (a measure of impulsivity defined roughly as errors of commission), Consistency (a measure of ability to respond reliably based on reaction time), and Stamina (a measure of ability to sustain speed of response time over the course of the test). The Attention Primary Scales include Vigilance (a measure of attentional functioning calculated from errors of omission), Focus (a measure of frequency of slow response times to test stimuli) and Speed (a measure of mean recognition time for all correct responses). The Attribute scales are scales that are used to provide insight into characteristics of a test-taker's functioning. These scales include Balance (a measure of relative differences between auditory and visual reaction times), and Readiness (a measure of the test-taker's mean recognition reaction time under high vs. low demand conditions). The Symptomatic Scales are thought to be useful in identifying factors that might impact performance, such as the test-taker's comprehension of the instructions, his motivation towards taking and understanding the IVA test, mental fatigue and other underlying attitudinal or behavioral characteristics that might be revealed in extremes of carelessness and inattention. These include Comprehension (a measure of the ability to follow the rules of the test defined as idiopathic errors of commission), Persistence (a measure comparing the simple reaction time at the beginning of the test to that measured at the end of the test), Sensory Motor (a measure of simple reaction time thought to aid in identifying problems related to emotional, psychological, neurological or learning problems) and Fine Motor Regulation/Hyperactivity (a measure of "fidgetiness" and "restlessness" defined as off-task, spurious, impulsive and inappropriate fine motor activity using the mouse input device). Scores from these various scales and categories are used to tabulate scores for Full Scale Response Control (a measure of overall ability to regulate responses and respond appropriately), and Full Scale Attention (a measure of overall ability to make accurate responses, stay focused and sustain attention).

Treatment

Auditory Integration Training (AIT) is an invention that uses specially modulated and filtered music to retrain an individual's ability to process sound input. Sounds are presented through a set of headphones, enabling clinicians to prescribe a particular set of sound frequencies to each ear. The treatments are individualized, and the particular sound frequencies are based on the degree and type of auditory integration problems a patient manifests. Patients listen to a favorite audio or video recording during the course of the session, while the audio portion is manipulated to stimulate under-active areas of the brain and calm over-active areas.

Auditory integration training at our clinic is based on the methods developed by Dr. Dominique Bourdin whose methods in turn were based on the better known methods developed by Guy Berard (Berard 1993). We use Dr Bourdin's AudioBioColor Program which is a PC based unit running Windows XP platform with an independent unit connected to the computer via USB port. This unit contains hardware which receives and amplifies auditory information and is capable of delivering treatment to four clients simultaneously, with two separate auditory channels per client. Audiograms and setting are obtained through a propriety software program running in the PC environment. The system permits us to measure auditory processing by measuring the hearing threshold of a series of frequencies; the frequency ranges we use range from 250 Hz through 8000Hz.

Assessment Procedures

The patient wears special sound reducing headphones that are connected to the apparatus and faces away from the computer. During the testing, the patient hears a series of sounds, first in the left and then in the right ear, beginning with the lower register frequencies and moving systematically to the highest level frequencies. We test each ear at 250Hz, 500 Hz, 750 Hz, 1000 Hz, 1500 Hz, 2000 Hz, 3000 Hz, 4000 Hz, 6000 Hz and 8000Hz. The patient is asked to quickly raise his hand as soon as he hears each sound. When the first frequency for the left ear is presented the therapist presses the up arrow on a joystick to regulate the force of the sound until the hearing threshold is reached. Once it is reached, the therapist releases the arrow and presses a button on the joystick which permits the computer to record the corresponding value for that sound. The therapist and patient continue in this manner with each frequency in turn, from lowest to highest frequency register, until all frequencies have been heard. The therapist then proceeds to test thresholds for the right ear. The therapist may make several recordings of the same frequency to achieve an average value; however, in our experience and in the experience of Dr. Bourdin (personal communication), the values are the same if the frequencies are presented in the same order.

Treatment Procedures

Once all values are measured and recorded, the computer traces a curve specific to the patient for each ear, which is then compared to the normal statistical curve for each ear. Points of hypersensitivity ("peaks") and hyposensitivity ("troughs") at certain frequencies are then apparent. A special music CD, based on the patient's unique curve, is then created for treatment. Through filtering sounds during recording, the therapist can modify the lower register and higher register frequencies heard by each ear, with the goal of either increasing or decreasing hearing capabilities (eliminating the peaks and troughs) in order to produce two smooth congruent curves at post-test. *This filters the music to the third of octaves. Filtering occurs by varying between 30 Hz and 11,500 Hz per frequency.* This modification is unsynchronized between ears, meaning that during the treatment the music playing switches between the ears in an unidentifiable and untraceable pattern. Thus, the ear does not know what to expect and must work harder to clearly hear the music.

After the completed test, each patient's settings are recorded in the computer. The therapist can print out a graph of the results which becomes the measurement tool for monitoring auditory integration changes during treatment.

During the training, patients listen to preselected songs for 60 minutes per session. After completing ten sessions, a second audio test is performed, and based on the new curve, the patient's settings are adjusted. After another five to ten 60 minute sessions, the patient has a final audio test, allowing the therapist to monitor progress. In our experience, many of the initial curves are filled with peaks and troughs, are not smooth, and differ from ear to ear. However, as the treatment progresses, the curves become smoother and more identical for each ear.

Results

A one-tailed T-test for dependent measures was performed on each of the various subtests of the IVA; our results are summarized in Tables 1 - 4. Overall, subjects performed significantly better on tests measuring full scale response control and attention, with auditory response control and both visual and auditory attention showing significant improvements from pre-test to post-test. There was also a significant improvement in overall consistency, whether material was presented visually or aurally. Not surprisingly, many more subtests measuring aspects of auditory attention and concentration showed improvements as opposed to subtests of visual attention and concentration. Significant improvements were noted in auditory speed, “balance”, and in auditory sensory motor competence. Measures of auditory and visual vigilance approached significance, as did measures of visual prudence (reduction of impulsivity). Interestingly, a significant improvement was also noted in visual focus, although there were no changes in auditory focus. There were also no changes noted in tests of hyperactivity, auditory impulsiveness (prudence), stamina, readiness or persistence; our readiness measures, in fact, show a non-significant *decrease* from pre-test to post-test, with auditory readiness showing a strong trend in the non-predicted direction.

Discussion

Our findings suggest that, in individuals with auditory integration problems and attention deficit/ hyperactivity problems, auditory integration training can improve an individual’s overall ability to pay attention and exercise self-control. Our subjects who were treated with auditory integration training as the primary treatment modality appeared to significantly improve their overall ability to make accurate responses, to stay focused and to sustain attention. There was improved ability to recognize when a response was appropriate, to inhibit responses to irrelevant signals and to maintain overall processing speed. These individuals also showed improved overall ability to maintain attention and respond appropriately under high demand conditions, to remain focused and stay “on task”, and to respond more quickly when appropriate. Moreover, the results on various subtests suggested that our subjects had a specific reduction in their tendency towards uneven performance, demonstrating an improved ability to be reliable, consistent and ignore distractions. There are also strong suggestions that they may have had a reduction in their tendency to be neglectful as well, becoming less likely to make errors of omission.

An examination of the results on our subtest scores suggests, not surprisingly, that AIT resulted in improved auditory as opposed to visual response control and attention on many variables. For example, improvement on our measure of auditory speed appears to be attributable to the specific effects of auditory integration training on enhancing the performance of the auditory system. These individuals demonstrated an improved ability to process information and make decisions when material was presented aurally - factors which are likely to impact performance in school settings with respect to getting work done in a reasonable time frame and with an acceptable degree of accuracy with verbal instruction. Improvements were not noted in their ability to do so when material was presented visually, however. We looked at the mean differences on the speed scales to assist us with interpreting this finding, and noted that our subjects performed in the average range on pre-test for both visual and auditory speed. The significant difference we obtained on post-test appears to be the result of even better performance post-test on auditory speed. This would seem to indicate that, on average, our subjects were not significantly impaired in their ability to process information and make decisions prior to AIT; nevertheless, they experienced enhanced auditory performance after AIT.

Similarly, our significant findings on our balance scale are likely indicative of a positive response to AIT training on the auditory system. Balance refers to the relative differences between auditory and visual reaction times. The balance scale in particular reveals whether person is likely to learn better visually or aurally. This is relative to the individual himself or herself rather than to a normative sample. Our findings indicated that individuals treated with AIT improved in their ability to process auditory information which accounted for the significant shift in balance scores on post-test. This indicates that these individuals are likely to learn better through aural instruction than previously.

Our subjects' performance in high vs. low demand conditions did not improve with AIT, however, as reflected in our non-significant findings on our readiness scale, a scale which is used to compare an individual's recognition reaction time under high and low demand conditions. We did, however, obtain a strong trend on our measure of auditory readiness although in the non-predicted direction. Like the balance scale, the readiness scale is a measure of a person's differences in functioning relative to himself or herself, rather than a comparison with a normative sample. Generally, most individuals react somewhat slower under low demand conditions and are relatively faster under high demand conditions, unless performance anxiety or other factors interfere with performance under high demand conditions. In the normal population, we would therefore expect to see a mean readiness score below 100. In our clinical experience, individuals with ADHD appear to respond considerably better under the stimulating challenge of high demand conditions and tend to lose focus and interest under the low demand conditions. In a sample of ADHD individuals, we would therefore expect to find an average readiness score of well under 100 on pre-test, with a movement towards the mean on post- test. We observed that on pre-test, however, our subjects were on average evenly balanced with respect to performance under low vs. high demand conditions, suggesting poorer than expected performance under high demand conditions, and especially so for a population of ADHD individuals. Our strong trend on auditory readiness measures seems to suggest that our subjects experienced enhanced auditory performance under high demand conditions, resulting on post-test in a scoring pattern that more closely resembles that which we would expect in a normal population.

Our results on our symptomatic scales indicated that our sample of subjects were less careless, less inattentive and had a greater ability to follow test rules when material was presented aurally, and performed better on tests of auditory sensory motor competence on post-test, suggesting that these subjects were more able to process information quickly under both simple and demanding conditions when material is presented aurally. There did not appear to be any effect of AIT on measures of test-taking visual comprehension or visual sensory motor competence, again suggesting that AIT, as expected, strengthens the functioning of the auditory system, thereby improving overall attention and self-control. Interestingly, we found no effect of AIT on reducing mental fatigue as measured by auditory or visual persistence, a finding which was corroborated by the non-significant effect of AIT on auditory and visual stamina. Again, our examination of our means on pre-test suggested to us that our subjects were on average close to the mean on both of these scales, suggesting that problems with mental fatigue were not, on average, among the more debilitating difficulties our subjects were presenting at evaluation.

One of our more interesting findings is that of improved visual focus on post-test. Our results indicate that individuals receiving AIT have an improved ability to sustain attention and not “drift off” or “tune out” due to momentary lapses in attention, confusion caused by deficits in working visual memory, episodic mental fatigue or gross problems sustaining visual attention. They appear to cope better with visual distractions and to stay focused visually. More surprising to us was the discovery of no specific improvement in auditory focus with AIT. Since auditory focus on pre-test fell, on average, in the borderline range for our sample of subjects, we interpret this non-significant finding as most likely due to absence of treatment effect on auditory focus in particular. One possible explanation is that auditory focus is less easily remediated with 23 sessions or less of AIT in individuals diagnosed with both ADHD and auditory processing disorder. Such individuals may require more AIT treatment sessions to improve auditory focus, or may need to supplement AIT with another treatment modality when auditory focus presents clinically as requiring special remedial attention.

The weak results we obtained on scales measuring hyperactivity and impulsivity, where we saw only a trend in the general direction of improvements in visual prudence, might suggest that auditory integration training does not provide much remedial benefit to the hyperactive or impulsive symptoms of ADHD. This might suggest that individuals who are primarily hyperactive and impulsive, in contrast to those who meet criteria for the inattentive and combined subtype of ADHD, are less likely to benefit from auditory integration training. Recent critiques of the DSM-IV sub-typing distinctions for ADHD suggests that the hyperactive-impulsive subtypes are often younger children, who will present as combined types as they grow older and as the social environment provides more opportunities to observe the deficits in attention associated with the disorder (Barkley, presentation, 2006). As our sample of ADHD individuals were somewhat older than the young children who often present for a first evaluation, it may very well be that our sample did not include many individuals whose hyperactive and impulsive behavior as contrasted to inattentive behavior brought them for treatment. We found some corroborating evidence for this by examining our mean test scores. These show that the average pre-test score for our sample fell in the average range on our measures of auditory prudence, and that our subjects scored on the lower end of the hyperactivity scale on both pre-test and post-test; this would seem to support the conclusion that our overall sample did not consist of particularly impulsive or hyperactive individuals which left little room for a demonstration of improvement.

Conclusion

Our preliminary examination of the effects of auditory integration training on symptoms relevant to the problems experienced by ADHD individuals suggests to us the beneficial effect of auditory integration training on symptoms of inattention and response dyscontrol when individuals present with ADHD and auditory processing disorder. Clearly, it will be important to conduct further research randomizing subject assignment and controlling for obvious extraneous effects, such as test-retest effects or the effects of listening to music without frequency manipulation before we can confidently recommend auditory integration training for the treatment of ADHD symptoms in affected individuals. This is particularly so for the primarily impulsive, hyperactive individuals or for those who present with specific problems with auditory focus. An additional, interesting experimental variant would include a group of ADHD individuals presenting without a concomitant auditory processing disorder. Further research aimed at examining the effects of age and symptoms at presentation on auditory integration training's effectiveness should begin answer questions concerning auditory integration training's potential to treat symptoms of impulsivity and hyperactivity, while research designed to specifically address problems with auditory focus should begin to answer others. In particular, we would suggest the value of a study varying the length of auditory integration training treatment to determine if auditory focus can be improved in ADHD individuals by increasing the frequency or the duration of auditory integration training treatment.

The clinical implications of our initial research are enormous. The need to include comprehensive auditory testing when diagnosing ADHD to rule out a concomitant central processing disorder in ADHD individuals, as well as the importance of treating the central auditory processing disorder in order to ameliorate ADHD symptoms is strongly suggested by our preliminary findings. Moreover, our findings of a more generalized effect of auditory integration training on improving auditory attention and response control as opposed to visual attention and visual response control would suggest to us that comprehensive visual testing and treatment to remedy imbalances in visual processing may also provide a profitable approach to treating the symptoms of ADHD when a visual processing disorder is in evidence. In short, we believe the potential for alternative treatments such as auditory integration training to safely improve the lives of many ADHD individuals is promising, and we invite others to engage in further investigation of the benefits and limitations of auditory integration training for the improvement of attention, concentration and self-control in ADHD individuals.

		Mean	Variance	Pearson Correlation	df	t Stat	P(T<=t) one-tail
Full Scale Response Control							
	Pre-test	86.5	482.16667	0.8212353	21	-2.3181898	0.015305895
	Post-test	92.909091	456.94372				
Auditory Response Control							
	Pre-test	88.636364	396.90909	0.752827368	21	-2.222637	0.018677638
	Post-test	95.363636	417.671				
Visual Response Control							
	Pre-test	88.454545	492.25974	0.674486606	21	-1.2365973	0.11494435
	Post-test	92.863636	336.21861				

TABLE 1 - Response Control

Response Control Primary Scales

		Mean	Variance	Pearson Correlation	df	t Stat	P(T<=t) one-tail
Prudence Auditory							
	Pre-test	95.272727	489.63636	0.741513575	21	-0.7603756	0.227741558
	Post-test	97.818182	463.10823				
Consistency Auditory							
	Pre-test	80.636364	322.62338	0.686590182	21	-2.5326177	0.009680656
	Post-test	89.045455	433.37879				
Stamina Auditory							
	Pre-test	102.04545	436.33117	0.142829998	21	-0.4419023	0.331538554
	Post-test	104.31818	237.56061				
Prudence Visual							
	Pre-test	90.409091	600.91991	0.754147525	21	-1.5142006	0.072440831
	Post-test	95.636364	280.4329				
Consistency Visual							
	Pre-test	87.454545	635.11688	0.617885538	21	-1.6985414	0.052087389
	Post-test	94.818182	405.48918				
Stamina Visual							
	Pre-test	100.86364	266.21861	0.137306576	21	1.1509829	0.131338277
	Post-test	95.727273	241.54113				

TABLE 2 - Attention Scales

		Mean	Variance	Pearson Correlation	df	t Stat	P(T<=t) one-tail
Full Scale Attention							
	Pre-test	72.681818	925.27489	0.801465045	21	-2.8787204	0.004493571
	Post-test	84.045455	774.33117				
Auditory Attention							
	Pre-test	74.181818	915.67965	0.754630347	21	-2.1766731	0.020530091
	Post-test	83.5	667.02381				
Visual Attention							
	Pre-test	76.772727	775.89827	0.671705033	21	-2.1839966	0.020224172
	Post-test	87.136364	731.74242				

Attention Primary Scales

		Mean	Variance	Pearson Correlation	df	t Stat	P(T<=t) one-tail
Vigilance Auditory							
	Pre-test	66.090909	1456.8485	0.627235838	21	-1.5546403	0.067487061
	Post-test	76.5	1160.6429				
Focus Auditory							
	Pre-test	84.227273	490.94589	0.543406938	21	-0.2533511	0.40123033
	Post-test	85.272727	302.49351				
Speed Auditory							
	Pre-test	97.363636	463.671	0.771362442	21	-2.6389613	0.007672813
	Post-test	105.27273	389.82684				
Vigilance Visual							
	Pre-test	77.136364	793.36147	0.569135874	21	-1.495023	0.074892479
	Post-test	85.954545	971.18831				
Focus Visual							
	Pre-test	84.636364	655.57576	0.687293276	21	-2.0288742	0.027669582
	Post-test	92.681818	301.84632				
Speed Visual							
	Pre-test	92.818182	268.91775	0.630435376	21	-0.9405667	0.178810629
	Post-test	95.545455	228.83117				

TABLE 3 - Attribute Scales

		Mean	Variance	Pearson Correlation	df	t Stat	P(T<=t) one-tail
Balance							
	Pre-test	108.18182	364.5368	0.623182339	21	-2.2617887	0.017221409
	Post-test	116.5	421.69048				
Readiness Auditory							
	Pre-test	98.090909	260.84848	0.374273315	21	1.5754422	0.065050207
	Post-test	91.909091	280.27706				
Readiness Visual							
	Pre-test	101.95455	510.52165	-0.029904773	21	0.5058907	0.309101353
	Post-test	99.136364	155.36147				

TABLE 4 - Symptomatic Scales

		Mean	Variance	Pearson Correlation	df	t Stat	P(T<=t) one-tail
Comprehension Auditory	Pre-test	64.227273	1691.3268	0.848277738	21	-3.2803932	0.00178473
	Post-test	79.5	1331.7857				
Persistence Auditory							
	Pre-test	98.954545	301.85498	0.100989475	21	-1.1212152	0.137427201
	Post-test	104.18182	229.48918				
Sensory Motor Auditory							
	Pre-test	110.63636	32.337662	0.386071388	21	-2.4011016	0.012844108
	Post-test	114.04545	39.664502				
Comprehension Visual							
	Pre-test	79.590909	1001.7771	0.719865629	21	-0.3141435	0.37825578
	Post-test	81.136364	890.50433				
Persistence Visual							
	Pre-test	96.454545	74.450216	0.349960222	21	-1.1114379	0.1394716
	Post-test	98.954545	96.045455				
Sensory Motor Visual							
	Pre-test	101.45455	211.97403	0.559866211	21	0.507807	0.308440505
	Post-test	100.04545	169.95022				
Hyperactivity							
	Pre-test	93.772727	631.51732	0.892209841	21	0.1387335	0.445491269
	Post-test	93.318182	1074.7035				

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