Discovering New Educational Trends (V3)

Discovering New Educational Trends (V3):

A Symposium in Belize, Central America

Edited by

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Many thanks to the Belizean, Ministry of Education (MoE) for their continued support in sending representatives each year to the International Symposium in Belize, Central America. There is much appreciation for the presentations provided from the MoE; which add an array of information to be discussed regarding the plight for continued educational growth and development in the surrounding Districts of Belize and the Caribbean.

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INTRODUCTION

Travel for me has been both educational and personal. A lifestyle, for most researchers and professors which is on-going and quite stringent. To most it is an academic obligation to attend lectures, conferences, round tables and, a symposium from time-to-time; which will meet the high-level demands of professionalising their university profile. Additionally, there is an array and assortment of academic duties in the field which require much research and writing.

Therefore, it is my desire to bring a research and writing opportunity for many educationalists that have attended the most current and previous; *Belizean International Symposium on Education* (BISE). The International Symposium has been meeting annually in the month of January, in Belize, Central America for a decade. All of the author's research is educational, professional and scholarly while written in the format of an article, essay or narrative response to their current research.

The International Symposium also offers to academics a way to accomplish yearly continuing professional development (CPD) requirements, including hours of educational learning and networking. This event allows academic professionals to present from a national and international venue while being given an opportunity to passionately share their love of current research projects and studies with other fellow academics. We welcome all of these latest thoughts and ideas in a new collection of; '*Discovering New Educational Trends' (V3): A Symposium in Belize, Central America'*.

For personal reasons… I have been blessed to have this opportunity to travel which allows me to, 'fall back in love with learning' so to speak; as I become more and more intrigued with diverse cultures and different places of the world. I am completely amazed to see the many ways that I can share my educational background with one culture to another and from one venue to another. I am forever grateful for the many opportunities that have come along my way as I am able to meet people from all walks of life. As they say in Iceland, "Takk", which means, "Thank-you" in English; is simply how very blessed I feel.

In the first volume of, '*Educational Trends: A Symposium in Belize, Central America';* contributors discussed a variety of topics pertaining to the educational trends of diverse learning in Belize and other locations. These articles consisted of topics that primarily related to: the Belizean

educational system; preschool education; historical literature; the language of Kriol; reading specifics; methods of constructivism; preparing quality teachers and, virtual learning and study abroad responses from participating university students. This Textbook provides administrators, educators and students a look into cultures and society.

In volume two, '*An Exploration of Educational Trends (V2)';* several different viewpoints were taken from diverse educational trends which discuss: culture and diversity; the educational and historical perspectives of Belize; childhood holocaust art; national educational research and political trends; STEM research; the educational effects of incarceration; bilingual majors; communication including reading and writing; building peace; new school initiatives and, study abroad responses from participating universities.

In volume three, '*Discovering New Educational Trends (V3)';* additional perspectives were written to encompass a variety of educational trends which address: educational and psychological assessments; behavioural challenges; diverse cultures; health and nutritional sciences; innovative teaching techniques; philosophies and history in mathematics; social and emotional challenges; technology; a private school initiative, professional development with teacher responses and, educational thoughts in the 21st century. A final chapter provides new and trendy responses from two separate university groups of students sharing transformational experiences from their own personal research and cross-cultural learning experiences.

As for all those college and university students that read this textbook, my only hope is that you will glean a variety of information from these articles that will assist you with your own educational careers. I also trust that you will continue to stimulate your own thinking and become energised about new learning experiences in research, study and travel.

My desire is for all readers to choose to use this textbook as a valuable resource tool and or supplemental source of information. The contents of this book are filled with current and up-to-date educational topics and relevant information from a diverse group of highly qualified educators and professionals. I also trust this textbook may become an additional resource for other educators, students and teachers, globally.

I especially encourage each of you to enjoy this text as it is used to enhance your careers, expand your research, and further your ventures to strengthen your own education and knowledge base. Continue to use this material as a way to enrich yourself from a culturally diverse and emotionally uplifting viewpoint of learning.

I hope to see many of you with a smile on your face in sunny, Belize, in January!

With many kind thoughts,

Pamela R. Cook, Ph.D., Editor
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CHAPTER ONE:

EDUCATIONAL TRENDS IN NEW ASSESSMENTS

1.1

IDENTIFYING AUDITORY AND VISUAL PROCESSING DIFFICULTIES IN SCHOOL-AGED CHILDREN WITH ADHD

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Introduction

In 2012, the total costs to the United States (U.S.) economy of Attention Deficit/Hyperactivity Disorder (ADHD) was estimated to be between $143 billion and $266 billion (Doshi, Hodgkins, Kahle, et al. 2012). The estimated costs of ADHD to the U.S. healthcare system was between $21 Billion and $44 Billion, on children alone; and the estimated costs to the educational system reached between $15 Billion and $25 Billion (Doshi et al. 2012). Additional financial costs borne by the families of children diagnosed with ADHD reached between $33 Billion and $43 Billion (Doshi et al. 2012).

Beyond the financial costs of ADHD to the economy, healthcare and educational systems, lies the collateral effects of ADHD on the children

themselves. Children with a history of ADHD are six times as likely as those without ADHD to have significant levels of problems that include difficulty with their emotions, conduct problems, and impaired peer relationships (Strine et al. 2006). In addition, they are nine times as likely to manifest a high level of impairment that interferes with their activities of daily living including difficulties with their home life, strife in their friendships, diminished classroom learning, and poor outcomes with leisure activities (Strine et al. 2006).

About 11% of children, or some 6.4 million school-aged children (i.e., >1 in 10), in the U.S. have been diagnosed with ADHD (Visser, Zablotsky, Holbrook, Danielson & Bitsko, 2015). Of concurrent concern is the significant increase in the diagnosis of ADHD in children, which has risen 42% between the years 2003 to 2012 (Visser et al. 2015). Therefore, identifying efficacious interventions is paramount to assisting children who are struggling with symptoms of ADHD.

Traditional School-based Interventions

School systems in the U.S., generally use tiered levels of interventions to encourage school-aged children to demonstrate positive behavioral, social-emotional, and academic readiness. School districts typically strive to minimize achievement gaps and improve emotional and behavioral difficulties by using a Multi-Tier Systems of Supports (MTSS) intervention model (Dowdy, Ritchey & Kamphaus, 2010) that is generally implemented through the process of Positive Behavioral Interventions and Supports (PBIS). The goal of school-based interventions is to strengthen the skills and competencies of school-aged children yielding greater success in the academic setting.

MTSS is an evidence-based model integrating problem-solving techniques into academic and behavioral instruction and is used in the development of interventions (Gamm et al. 2012). MTSS is typically conceptualized as the umbrella under which both academic and behavioral interventions reside and is delivered through three levels of support (Gamm et al. 2015). Tier 1 is described as Core Universal Instruction and Supports, and Tier 2 is labeled as Targeted Supplemental Interventions and Supports; Tier 3 is designed to provide Intensive Individualized Instruction and Support (Gamm et al. 2015).

Positive Behavioral Interventions and Support

PBIS is an evidence-based practice designed to assist students in developing effective social-emotional, academic, and behavioral skills. Educators integrate the PBIS approach by using multiple strategies designed to support the needs of students who are struggling with inappropriate behavior, social skills development, and academic confidence. Schools that have adopted the PBIS model have reported improved social, emotional, and academic outcomes for all students (Nelson, Martella, & Marchand-Martella, 2002).

Academic Interventions. The integration of multi-tiered systems of instruction supports and enhances student engagement in learning through differentiation of the rigorous Common Core State Standards (Gamm et al. 2012). MTSS functions as a preventative approach providing a mechanism for earlier identification of students who are struggling academically, as well as social-emotionally and behaviorally. Specifically, academic interventions are provided to support students in becoming proficient in the areas of math, reading, and writing (Nelson, Martella, & Marchand-Martella, 2002). When a student is identified as being significantly delayed in basic academic areas, interventions are designed and integrated into the student's daily academic program. Integration allows for a higher quality of instruction and development of academic readiness across the targeted areas (Gamm et al. 2012).

Behavioral Interventions. Alternatively, some school-based interventionists implement Applied Behavioral Analysis (ABA) approaches, which are classical forms of conditioning with the express goal of altering behaviors or introducing an alternative appropriate behavior (Fisher, Piazza & Roane, 2011). ABA interventions are implemented to support the behavioral intervention goals for students who are struggling in a general education setting. ABA, which is based on the work of Skinner (1938, 1953); is implemented to identify and modify behaviors deemed unsuitable, inappropriate, or disadvantageous to the student in the school setting. By providing the student with guidance to engage in alternative behaviors, the goal of the behavior change intervention is to eliminate the undesired behavior. Through the establishment of a state of intrinsic motivation, versus extrinsic motivators such as rewards and punishments, alternative behaviors may be accepted and integrated into the student's behavioral skill repertoire (Geller 1989).

Social-Emotional Interventions. As a means of providing support to students who are struggling with social-emotional development, school systems provide school-based counseling designed to strengthen student

coping skills and enhance social-emotional readiness, which is necessary in the development of positive peer relationships. Whether students are diagnosed or displaying symptoms and characteristics of the DSM-5 (APA, 2013); school systems are implementing supports that are accessible to all students. The goal of the Social Emotional Learning (SEL) model is to assist in the identification and subsequent regulation of emotions, the development of positive relationships, and strengthening decision-making skills of students (Durlak, Weissberg, Dymnicki, Taylor & Schellinger, 2011).

Limitations of Traditional School-based Interventions. Although there is a movement to provide differentiated learning across school districts, a lack of evidence in the literature exists on whether these forms of interventions are truly individualized to fit student needs. As noted by McReynolds, Villalpando and Britt (2018), many traditional classroom interventions use visual and auditory stimuli to encourage student engagement and enhance learning. Effectiveness of these types of interventions is severely limited when applied to children diagnosed with ADHD.

The hallmark traits of ADHD (i.e., inattentiveness, hyperactivity, and impulsivity), impede a student's ability to fully comprehend instructions that are presented in a verbal and/or written manner. Notably, these are also traits of many children who have been identified with auditory and visual processing disorders (McReynolds et al. 2018). When a child is experiencing auditory and/or visual processing difficulties, interventions that rely on conveying information through auditory and/or visual approaches may not succeed, regardless of the presumed effectiveness of the intervention.

The manner in which mainstream classrooms are organized is based upon the assumption that children have the capacity to pay attention and inhibit impulsive behaviors. When a child is unable to follow classroom rules, the 'misbehavior' can be deemed deliberate and/or intentional (Waschbusch et al. 2015). Viewing the behavioral wrongdoings as a willful act, or that the child is just needing to pay better attention, needs to listen better, or sit still is likely the reason classroom behavioral interventions are aimed at reducing the misbehavior (e.g., excessive talking, constant movement, speaking out of turn, getting out of their seat). However, using a different lens of perception to better understand the meaning behind the behaviors leads to the possibility of identifying alternative interventions that may yield improved outcomes.

Structuring a treatment plan designed specifically to support the way a child processes information lays the foundation for improving self-

confidence, social skills, empathy, and attention (Wilson & Lipsey, 2007). Furthermore, proper development of social-emotional learning can facilitate a child's academic engagement, work ethic, commitment, and school success (Durlak et al. 2011).

Neurofeedback Outcomes for Children. Common outcomes of neurofeedback training for ADHD result in decreased impulsiveness and hyperactivity, increased mood stability, improved sleep patterns, increased attention span and concentration, improved academic performance, increased retention and memory, and a much lower rate of medication side effects (Hammond 2011). Beginning by identifying auditory and/or visual processing difficulties in children who are struggling in school provides the foundation to implement a relatively short-term, computer-based training program. The positive outcome by using neurofeedback has been documented in reducing or eliminating auditory and/or visual processing difficulties in school-aged children (McReynolds et al. 2018).

Using the Integrated Visual and Auditory Continuous Performance Test (IVA-2 CPT) assessment assists in identifying the driving force behind specific behaviors, reveals what those behaviors are communicating, and provides useful information in the development of individualized neurofeedback treatment plans. The IVA2 assesses auditory and visual processing across 37 different aspects of brain processing providing insight into the behavioral symptoms manifested by many children who are struggling in school (McReynolds et al. 2018).

Attention/Inattention

An inability to attend results in significant difficulties for children that often lead to behavioral reactions. Children with auditory and visual processing difficulties often appear disorganized, exhibit an inability to follow through on assignments and tasks, do not listen when spoken to directly, daydream, are often forgetful, frequently lose things, can be easily distracted, display a lack of focus, or exhibit behaviors that can be diagnosed as oppositional deviant disorder. All of which are common descriptors for children diagnosed with ADHD (McReynolds et al. 2018).

In order to understand information, one must be able to *pay attention* to be able to respond appropriately to one's environment (Norman 1982). Processing information is necessary in order to understand and retain information and is a function of attention and memory (Norman 1982). Psychological processing, memory, learning and perception are all linked to attention, and therefore, a child must be able to *process* information in order to extract meaning (Norman 1982). Children who are unable to *pay*

attention are therefore unable to respond appropriately to their world (McReynolds et al. 2018). As previously noted in McReynolds (et al. 2018), **"**limited processing capacity invariably implies a competition for attention…The term *inattention* usually implies that, at a given moment, the thing being attended to is either not what it was intended to be or not what adaptively it ought to be. If a single definition could be derived… it would refer…to the state of the individual through which learning takes place. It [attention] makes heavy demands upon the brain's processing capacity" (McCallum 2015, pp 15-16).

Auditory Processing Difficulties (APD)

When discussing the concept of auditory processing difficulties (APD), it is an important distinction to note that the APD described herein is not about hearing loss, generally identified by audiological assessments. Rather, APD focuses on how the brain is *processing* auditory stimuli. APD is distinguished from Central Auditory Processing Disorder (CAPD) in that CAPD is an *input* disorder that impedes selective and divided auditory attention (Chermak & Musiek, 1997). Auditory processing problems can be thought of as an *output* disorder (Chermak & Musiek, 1997) and can cause sustained attention deficits across modalities (McReynolds et al. 2018). Simply assessing central auditory processing, language and reading disorders does not provide a full explanation of auditory processing difficulties (Sharma, Purdy & Kelley (2009).

A need exists to identify assessment measures that are more sensitive in ferreting out APD and cognitive limitations in children when attempting to determine causality of ADHD (Tomlin, Dillon, Sharma & Rance, 2015). This is especially needed for children with APD (McReynolds et al. 2018) who display behaviors mimicking behavioral symptoms of ADHD (Gyldenkærne, Dillon, Sharma & Purdy, 2014), which further complicates accurate diagnosis.

One of the unfortunate outcomes of misdiagnosis is establishing and implementing an intervention plan that may not be targeting the correct condition. McReynolds, et al. (2018) noted that symptoms of APD can include the following; many of which are also factors in determining a diagnosis of ADHD (see Table 1.1.):

Table 1.1. Auditory Processing Difficulties

- Difficulty hearing in noisy environments
- Difficulty following long conversations
- Problems with reading comprehension
- Trouble understanding verbal math problems
- Difficulty remembering spoken information (i.e., auditory memory deficits)
- Difficulty taking notes
- Difficulty maintaining focus on an activity if other sounds are present
- Easily distracted by other sounds in the environment
- Difficulty with organizational skills
- Difficulty following multi-step directions
- Difficulty in directing, sustaining, or dividing attention
- Difficulty with reading and/or spelling
- Difficulty processing nonverbal information
- Anxiety, which might lead to illnesses such as irritable bowel syndrome or panic attacks (American Academy of Audiology 2010).

Of concern is that children with APD may have difficulty learning when they are being taught in a noisy classroom environment with multiple types of auditory and visual distractions (Behavioural Neurotherapy Clinic 2016; Moore, Ferguson, Edmondson-Jones, Ratib & Riley 2010). Children with APD may be unable to follow along in a conversation or remember what is said to them when asked to perform multi-stepped tasks (McReynolds et al. 2018). Instructions must be repeated multiple times and still the child does not follow through with the requested tasks in home and school environments (McReynolds et al. 2018). Because of APD, children may define themselves as less intelligent and lose confidence in themselves (McReynolds et al. 2018). Children with APD may engage in disruptive behaviors (Woliver & Ibrahim, 2012), and some may find it better to be labeled a, ‘problem child’ (Swingle 2015, p 106) than incapable or of being, ‘slow’ (McReynolds et al. 2018).

Visual Processing Difficulties (VPD)

When discussing the concept of visual processing difficulties (VPD); VPD is not about vision, nearsightedness or farsightedness, but rather speaks to how a child’s brain processes visual information (Epstein 2015).

Children who have VPD may have difficulties remaining attentive to visual tasks (McReynolds et al. 2018). Farrar Call and Maples (2001) discovered that children diagnosed with ADHD have problems with visual memory and spatial orientation.

Children who have trouble with visual skills have difficulty with attention, which interferes with executive brain functioning, and can mimic ADHD symptoms (Hagen, Moore, Wickham & Maples, 2008) and may be easily distracted by too much visual stimulation (McReynolds et al. 2018). Children who have VPD may struggle with remembering letters and numbers, as if they have short or long-term memory problems (Epstein 2015), and may have difficulty recalling information that has been visually presented to them. Some of the identified VPD symptoms include those noted in Table 1.2. (McReynolds et al. 2018).

Table 1.2. Visual Processing Difficulties

• May exhibit difficulty with tasks that require copying (e.g., taking notes from a whiteboard) • Written copies may be missing words • Often cannot remember even basic facts about material read silently • Complains of eye strain or frequently rubs eyes despite no presence of poor eye sight • Below average reading or writing level coupled with high oral comprehension and verbal skills • Math skills may be demonstrated below average, may ignore function signs, omit steps or confuse visually similar formulae • Routinely fails to observe or recognize changes in bulletin-board displays, signs, or posted notices (New Brunswick Department of Education 1999)

Integrated Visual and Auditory Continuous Performance Test (IVA2)

The IVA2 provides an efficient and effective approach to identifying strengths and weaknesses in visual and auditory processing (Sandford & Sandford, 2015). As discussed by McReynolds, et al. (2018), although the ability to discriminate between APD and ADHD has yet to be fully established in the treatment of ADHD. Gyldenkærne, et al. (2014) uncovered some degree of correlation between APD and ADHD measures. Gyldenkærne, et al. (2014) stated that, “even though deficits in both APD

and maintained attention co-occur in more children than would be expected from chance alone, the two conditions are separate and largely independent conditions, even though they may have similar symptoms" (p 676). Further exploration is warranted in identifying whether auditory and visual processing difficulties are a function of ADHD, or if the diagnosis of ADHD has become a catchment category for a wide variety of conditions including auditory and visual processing difficulties (McReynolds et al. 2018).

When a child cannot process what is being said regardless of the number of times the information is repeated, something is interfering with the child's ability to do so regardless of how auditory and visual processing difficulties are categorized, (McReynolds et al. 2018). Children want to have positive relationships with their parents, peers and teachers; they want to succeed in school, and they want to do well (McReynolds et al. 2018). Yet, despite their best efforts many are unable to achieve these goals. Identifying and strengthening APD and VPD processes in children has been found to lead to a reduction in problematic behaviors yielding improvements both at home and at school (McReynolds et al. 2018). Table 1.3. lists some of the behavioral symptoms identified with the IVA-2 assessment in children who have auditory/visual attentional difficulties (McReynolds et al. 2018).

Table 1.3. Symptoms of Auditory/Visual Processing Deficits Identified via IVA-2

- significant problems remaining alert, i.e., likely to tune out
- problems shifting sets, i.e., likely to drift off
- difficulty getting back on track when distracted by auditory or visual stimuli
- deficits in auditory or visual working memory
- difficulty in maintaining focus to auditory or visual stimuli
- difficulty following directions accurately
- misunderstanding verbal instructions
- problems with self-esteem or self-confidence
- erratic responses to auditory and/or visual stimuli, i.e., makes more errors when high demand to perform
- frequent lapses in visual or auditory attention
- rushes through written work resulting in careless errors
- attention problems related to slow mental processing
- problems with response inhibition and impulse control tendencies reflecting carelessness, thoughtlessness, or over-reactivity

- problems regulating and directing actions when stressed or tired, i.e., gives up
- acting out, irritability, and negative verbalizations
- impaired social interactions with peers
- trouble with self-direction and completing necessary work
- tendencies reflecting distractible, divergent or variable-attention processing when given a repetitive, demanding, structured, non-entertaining task
- difficulties learning new tasks in the school environment
- slow mental processing speed
- problems sustaining attention and responding in a consistent manner when asked questions verbally or given written tests
- starts tasks then quickly runs out of steam; may be very slow in getting the work done that needs to be completed
- impulsive, agitated, chaotic, over-excited, and turbulent
- significant problems with self-control
- difficulty listening, remembering, or following rules
- agitated, confused or excessively impulsive response pattern
- internally distracted to the point there is difficulty concentrating and performing meaningful mental activities
- significant trouble with test performance (IVA2 Sandford & Sandford 2015).

Traditional Interventions for ADHD

Typically, treatment approaches fall into one of two categories to reduce the behavioral symptoms of ADHD in children, either behavior modification and/or medication (McReynolds et al. 2018). Results of behavior modification and/or medication interventions have been noted to have positive outcomes for some children [e.g., Fabiano et al. (2009)]; however, others have not found substantive positive treatment effects in addressing ADHD [e.g., Sonuga-Barke et al. (2013)]. Although, Fabiano et al. (2009) reported support for behavioral interventions, long-term effects of the treatment intervention were not evaluated. Daley et al. (2014) noted behavioral interventions were associated with positive benefits that included enhancing empowerment of parents and reducing conduct problems of children diagnosed with ADHD. However, positive outcomes for academic

achievements and social skills were not substantiated (McReynolds et al. 2018).

For treatments based on the medication approach, several studies have identified concerns regarding the side-effects of some of the typical prescription-drug regimens. Ellis (2016) reported medication side-effects include the risk of bone loss (i.e., osteopenia), with nearly 25% of the reviewed children exhibiting lower bone-mineral density in the femur, femoral neck and lumbar spine. These were compared to children who had not taken methylphenidate (Ritalin), dexmethylphenidate (Focalin), dextroamphetamine (Dexedrine), atomoxetine (Strattera), and lisdexamfetamine (Vyvanse) medications, along with gastrointestinal problems of decreased appetite and an upset stomach potentially worsening nutrition and diminishing normal calcium intake.

A 60% higher risk of sleep problems, along with nearly a 300% greater risk of decreased appetite, was reported following the use of methylphenidate (e.g., Ritalin, Concerta, Medikinet, Equasym), (Brazier 2015). Height suppression of between 1 to 1.5 inches has been associated with long-term use of ADHD medication (Poulton et al. 2013), including a long term follow up study in young adults following consistent use of medication from childhood to adulthood (Swanson et al. 2017). Furthermore, physical growth (height and weight) were reported as diminished in children following 14 months of intensive medication treatment in the MTA study (2004).

In a study of 41 students with ADHD, fewer than 50% of the children remained consistent with their prescribed dosage over a six-month time frame (Steiner, Sheldrick, Gotthelf, & Perrin, 2011) while Swanson et al. (2017) noted that, consistent use of medication from childhood to adulthood occurred in <10% of ADHD cases. Importantly, long-term use of medication was not associated with a reduction in symptom severity in adulthood (Swanson et al. 2017).

Not-with-standing initial indications of a long-term benefit during the first two treatment years of using stimulants to treat symptoms of ADHD; additional analyses following three treatment years did not document any long-term relative advantages of the on-going treatment (Swanson & Volkow, 2009).

A systematic review and meta-analysis conducted by, Prasad et al. (2013) of 43 studies involving a pooled-subject total of 2,110 children reported that drug treatment benefited a child's school performance by maximum of 15%, with only 14% of children viewed as being more on-task. It was discovered that, nearly 90% of the 186 children investigated continued to struggle with ADHD symptoms after 6 years of drug treatment.

Riddle, et al. (2013) reported that long-term use of ADHD medications did not result in reduced symptoms in the children who had taken medications. Instead, they were found to have symptoms as severe as children who had not participated in medication interventions (Riddle et al. 2013). Investigating the incongruity associated with ADHD pharmacological interventions and limited outcomes of a subset of children for whom medications provide little or no improvement in their behavioral functioning (Gleason 2013; Prasad et al. 2013) is worthy of continued exploration (Gleason 2013).

Alternative Intervention

ADHD medication is prescribed to reduce the symptoms of ADHD, but it does not generally address the underlying causes of the behaviors (McReynolds et al., 2018). Extraordinarily, children are being prescribed medication as early as pre-school age (APA, DSM5). For children diagnosed with ADHD, the use of stimulant medication may be too simplistic of an approach that does not address the complex and multiple types of factors contributing to a child's emotional and unregulated behavioral difficulties (Dunlop & Newman, 2016).

Neurofeedback Intervention Outcomes. Following is the archival study reporting on the results of neurofeedback treatment with children who were initially identified with significant auditory and visual processing difficulties often associated with an ADHD diagnosis (McReynolds et al. 2018). As conducted by McReynolds, et al. (2018), neurofeedback treatment was provided for 51 children (N = 35 males, N = 16 females; ages 6 to 17), who completed a total of 40 half-hour sessions of neurofeedback treatment (EEG biofeedback). The study participants were randomly drawn from an archival database of children who had previously received individualized neurofeedback training. Only children who completed 40 neurofeedback treatment sessions and were identified by IVA-2 CPT with significant ADHD symptomatology were selected for the study (McReynolds et al. 2018).

Auditory and Visual Assessment Measure. The IVA-2 CPT is a valid and reliable measure of both visual and auditory attention functioning for children providing assessment of attentional functioning of auditory and visual processing abilities across 37 different aspects of brain processing (Sandford & Sandford, 2015). The IVA2 provides clinical information on the quantified measures of auditory and visual processing abilities in both graph and text formatting. The following is a description of each of the

global and standard measures of attention as described in the IVA2 manual (Sandford & Sandford, 2015).

The Auditory Attention Quotient (AAQ) is a global measure of attention comprised of three primary visual and auditory scales: Vigilance, Speed, and Focus. Vigilance measures errors of omission and Speed provides a measure of the response time in milliseconds to visual and auditory stimuli targets. Focus is a measure of the variability of response time to auditory test targets. The Visual Attention Quotient (VAQ) is based on the exact same scales as the AAQ but differs in that it assesses visual test responses to the same measures of attention. The FAQ is a global composite scale comprised of the AAQ and VAQ scales, which are used in equal weights (not an average) to determine the FAQ (Sandford & Sandford, 2015).

The Auditory Response Control Quotient (ARCQ) is a global measure comprised of the Prudence, Consistency, and Stamina response control scales. Prudence measures impulsivity and response inhibition as evidenced by three different types of errors of commission. Consistency measures the general variability of response times ignoring outliers and is a measure of the ability to stay on task. Stamina compares the mean reaction times of correct responses between the first and last half of the IVA-2 test and is used to identify an individual's problems related to fatigue in mental processing speed over time. The Visual Response Control Quotient (VRCQ) has the exact same component scales as ARCQ but differs in that it specifically assesses visual test responses. The FRCQ is a composite scale comprised of the ARCQ and VRCQ scales, which are used in equal weights (not an average) in computing the FRCQ (Sandford & Sandford, 2015).

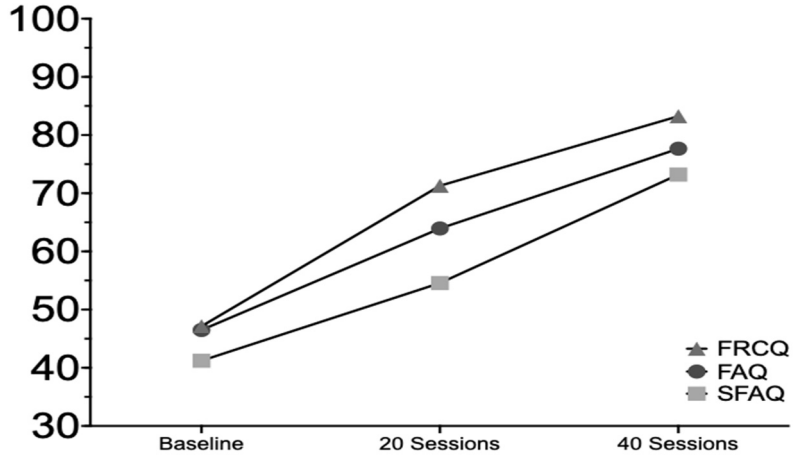
The Sustained Auditory Attention Quotient (SAAQ) provides a global measure of a person's ability to respond to auditory stimuli under low demand conditions accurately, quickly, and reliably and it is combined with an assessment of the person's ability to sustain attention and be flexible under high demand conditions when auditory stimuli change frequently. It is comprised of the Acuity, Dependability, Elasticity, Reliability, Steadiness and Swiftness scales. Acuity measures errors of omission under low demand conditions, Dependability reflects the variability of reaction times under low demand conditions and Elasticity reflects the ability to be flexible when faced with changing conditions. Reliability measures idiopathic errors of commission, Steadiness is a measure of accuracy under high demand conditions, and Swiftness measures response times under low demand conditions when the targets are rare (Sandford & Sandford 2015). The Sustained Visual Attention Quotient (SVAQ) measures the exact same type of factors as SAAQ, but specifically for visual attention. The Sustained Full-

Scale Attention Quotient (SFAQ) is the combined weighted global measure of the SAAQ and SVAQ global scales (Sandford & Sandford 2015).

Neurofeedback Treatment Protocol. Children were administered the IVA-2 CPT before beginning their first neurofeedback session. Testing was individually administered and scored in accordance with the specified test guidelines. The assessment results for children who were unable to appropriately respond to either visual or auditory IVA-2 test stimuli due to their extreme deficits in attentional functioning were scored as zero in accordance with the recommended test interpretive procedures for 'invalid' scores (Sandford & Sandford, 2015). After the completion of both 20 and 40 neurofeedback sessions, the IVA-2 was re-administered and the data were analyzed comparing baseline test scores and the scores obtained after the 20th and 40th neurofeedback sessions were completed (McReynolds, et al. 2018).

As conducted in McReynolds, Bell and Lincourt (2017) and in McReynolds et al. (2018) studies, neurofeedback exercises were provided in game-like format utilizing both visual and auditory reinforcement, as well as, graphs and numerical scores to provide positive reinforcement. Based upon each individual's performance, they were provided clinically relevant feedback and adjustments were made to the training protocol to optimize their performance. All EEG data was automatically de-artifacted and recorded by the SmartMind 3 software.

Outcome Measures of Neurofeedback Intervention. Auditory and visual processing plays an integral role in how children interact with their world. Impairments in auditory and visual processing can affect the manner in which they are able to respond to instructions, follow through on tasks, remain attentive in the classroom, and enjoy success in their life. The following section provides a review of the research findings as reported by McReynolds et al. (2018).



X axis: ***Fig. 1.1.*** IVA-2 Global Combined Scale Score Changes During Training for FRCQ (Full-scale Response Control Quotient, 20 Sessions, p<.0001, Cohen's *d* = .61, 20-40 Sessions p<.01, Cohen's *d* = .33); FAQ (Full Scale Attention Quotient, 20 Sessions, p<.001, Cohen's *d* = .45, 20-40 Sessions p<.01, Cohen's *d* = .37; SFAQ (Sustained Full-scale Attention Quotient, 20 Sessions, p<.001, Cohen's *d* = .34, 20-40 Sessions p<.001, Cohen's *d* = .48). *(See Tables 4, 5, 6).* **Y axis:** Standard Score (M=100, SD = 15).

As indicated in (*Fig*.1.1.), (McReynolds et al. 2018), the baseline at which children were initially assessed prior to neurofeedback intervention reflects significant impairment across the Full-Scale Response Control Quotient measure (FRCQ), the Full-Scale Attention Quotient (FAQ) and the Sustained Full-Scale Attention Quotient (SFAQ) for combined auditory and visual processing difficulties. Overall, children's FRCQ, FAQ, and SFAQ scores improved at 20 sessions with small to medium size effects and continued to significantly improve after an additional 20 sessions of training resulting in neurofeedback treatment significantly improving attention and self-control with large size effects (see Appendix B for statistical tables).

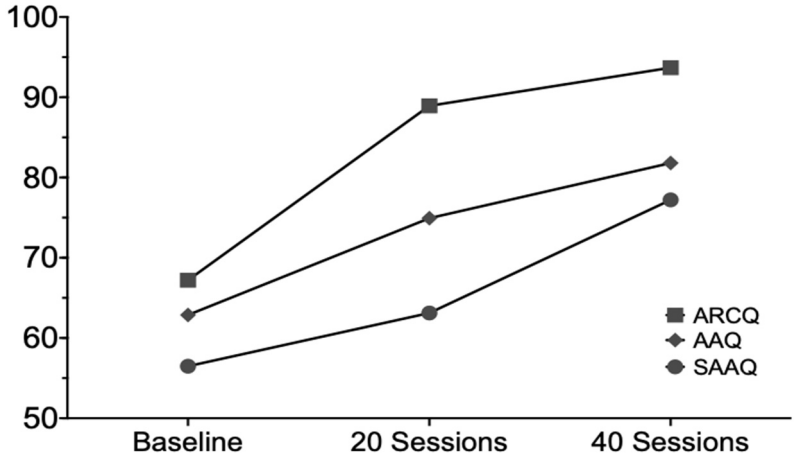
The FRCQ scale measures the child's impulsivity, the ability of the child to stay on-task, and the ability to sustain attention and effort over time (Sandford & Sandford, 2015). Following 20 sessions of neurofeedback, children reduced their impulsivity, increased their ability to stay on task, and increased their ability to sustain attention and effort over time. FRCQ scores were significantly higher after 20 sessions of treatment from a mean of 47 (Extremely Impaired) to 71 (Moderately to Severely Impaired); a 24-

point increase. Following an additional 20 sessions of treatment, FRCQ scores significantly improved from a mean of 71 (Moderately to Severely Impaired) to 83 (Mildly Impaired); a 12-point increase. Overall, FRCQ scores between baseline and 40 sessions reflected a significant improvement from a mean of 47 (Extremely Impaired) to 83 (Mildly Impaired), a 36-point improvement, resulting in an overall significant improvement in being able to inhibit impulsivity, remain on-task, and sustain attention and effort over time (McReynolds et al. 2018), (see Appendix B for statistical tables).

The FAQ scale measures a child's inattentiveness, mental processing speed, and helps to identify attention reaction times for both auditory and visual processing difficulties (Sandford & Sandford, 2015). Accurately identifying auditory and visual processing speed is of paramount importance as misattribution of processing speed can lead to a misdiagnosis of the child. For example, slow mental processing speed is often mistakenly attributed to lowered cognitive abilities, identified as a developmental delay, or an intellectual limitation when, in fact, this may inaccurate.

Following 20 sessions of neurofeedback, children significantly reduced their inattentiveness, increased their mental processing speed, and increased their attention reaction times. FAQ scores were significantly higher increasing from a mean of 47 (Extremely Impaired) to 64 (Severely Impaired); a 17-point increase. FAQ scores continued to improve from a mean of 64 (Severely Impaired) to 78 (Mildly to Moderately Impaired); a 4-point increase, following an additional 20 sessions. Overall, FAQ scores between baseline and 40 sessions reflected a significant improvement from a mean of 47 (Severely Impaired) to 78 (Mildly to Moderately Impaired); a 31-point improvement (McReynolds et al. 2018), (see Appendix B for statistical tables).

The SFAQ measures the child's ability to remain attentive to both auditory and visual information when encountering information considered boring, non-engaging, or non-interesting (Sandford & Sandford, 2015). Initially, children initially scored the lowest on this measure with a mean of 41 (Extremely Impaired). Following 20 sessions of treatment, children improved from a mean of 41 (Extremely Impaired) to 55 (Extremely Impaired); a 14-point increase. Following an additional 20 sessions of treatment, SFAQ scores significantly improved from a mean of 55 (Extremely Impaired) to 73 (Moderately Impaired); an 18-point increase. Overall, children's SFAQ scores reflected a significant improvement between baseline and 40 sessions from a mean of 41 (Extremely Impaired) to 73 (Moderately Impaired); a 32-point improvement (McReynolds, et al. 2018), (see Appendix B for statistical tables).



X axis: ***Fig. 1.2.*** IVA-2 Auditory Scale Score Changes During Training for ARCQ (Auditory Response Control Quotient, 20 Sessions, $p<.001$, Cohen's $d = .73$, 20-40 Sessions $p>.10$, Cohen's $d = .21$); AAQ (Auditory Attention Quotient, 20 Sessions, $p<.01$, Cohen's $d = .37$, 20-40 Sessions $p<.05$, Cohen's $d = .23$); SAAQ (Sustained Auditory Attention Quotient, 20 Sessions, $p>.10$, Cohen's $d = .18$, 20-40 Sessions $p<.01$, Cohen's $d = .40$) *(See Tables 7, 8, 9).* **Y axis:** Standard Score (M=100, SD = 15).

To further understand the auditory and visual processing changes in this sample of children treated with neurofeedback, additional analyses were conducted separately on the auditory and visual scales, as reflected in Fig. 1.2. (auditory) and Fig. 1.3. (visual). As indicated in Fig. 1.2., the baseline at which children were initially assessed prior to neurofeedback intervention reflects significant impairment across the Auditory Response Control Quotient measure (ARCQ), the Auditory Attention Quotient (AAQ) and the Sustained Auditory Attention Quotient (SAAQ) scales (McReynolds et al. 2018).

The ARCQ scale measures impulsivity, the ability to stay on task, and the child's ability to sustain attention and effort over time related to auditory functions via the Prudence, Consistency, and Stamina measures (Sandford & Sandford, 2015). Initially, ARCQ scores were in the Severely Impaired range at baseline and then normalized to the Average range following 40 sessions of treatment. ARCQ scores were found to be significantly higher after 20 sessions of treatment from a mean of 67 (Severely Impaired) to 89 (Slightly Impaired); a 22-point increase. ARCQ scores then normalized from a mean of 89 (Slightly Impaired) to 94 (Average), a 5-point increase,