Effects of Applied Behavior Analysis on individuals with Autism

ABSTRACT: Autism spectrum disorder impacts individuals through a wide range of physical, verbal and social behaviors. Presented with these challenges, individuals with ASD and their caregivers frequently seek out evidence-based practices to help with developing new skills and reduce inappropriate behaviors while promoting independence. Although consumers have many options when it comes to ASD interventions, one of the most researched evidence-based practice is applied behavior analysis (ABA). ABA is the professional use of behavior science principles based on the work of B.F. Skinner, J. B. Watson and others to teach and reinforce the acquisition of socially significant adaptive behaviors. The ultimate goal of ABA is that learners will be able to generalize functional skills and live independent lives to best of their abilities. In an effort to educate consumers of therapies for ASD, this paper provides a brief history of behavior analysis, an explanation of what constitutes evidence-based practice and focuses on describing a few of the most readily available ABA therapies that are recognized as evidence–based practices for the effects they have in the treatment of ASD.

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Introduction

The purpose of this paper is to identify the most current effects of applied behavior analysis on the process of teaching new skills as well as reducing problem behaviors that may be exhibited by individuals with autism spectrum disorder. A quick internet search results in over sixteen million resources related to applied behavior analysis and the positive effects this science has on the treatment of ASD (Smith, 2013). Applied behavior analysis is a science that is practiced by credentialed professionals who follow "the process of systematically applying interventions based upon the principles of learning theory to improve socially significant behaviors to a meaningful degree, and to demonstrate that the interventions employed are responsible for the improvement in behavior" (Baer, Wolf and Risley, 1968). Based on this methodology, ABA is a discipline that includes many different specific strategies.

Description of Autism Spectrum Disorder

In 1942, child psychiatrist Leo Kanner wrote a paper describing eleven children who demonstrated no apparent affect and who seemed drawn into a shell and lived within themselves. He chose to describe these individuals as having autism which means "self" in Greek (Matson and Neal 2009). Kanner's paper opened a door to providing supports, services and treatment for individuals with autism. As defined by the Individuals with Disabilities Education Act (IDEA, 2004), Autism is a developmental disability that significantly affects verbal and nonverbal social interactions and may include issues with executive processing and stereotypic/repetitive behaviors.

Newly defined in 2013 by the American Psychiatric Association (DSM-5), Autism spectrum disorder incorporates the following diagnoses into one: autism, autistic disorder, Asperger's, childhood disintegrative disorder, and pervasive developmental disorder (not otherwise specified) (Herold et al. 2012). ASD may be evident before the age of three (Educator Guidelines, 2009). According to the CDC, within the last decade, the incidence of autism have increased from 4 to 5 children per 10,000 to 6-7 children per 1000 (Rice, 2007). 1 in 68 children are currently being diagnosed with ASD. There is no definitive consensus within the professional community (CDC, 2015) to explain the increasing incidence of individuals diagnosed with ASD but there is naturally a skyrocketing interest in providing evidence-based educational supports and services. One of the most researched sciences that produces effective evidence-based interventions for the treatment of ASD is applied behavior analysis.

Description of Applied Behavior Analysis (ABA)

As described by the national science and advocacy organization Autism Speaks, applied behavior analysis is based on the science of learning and behavior, and utilizes general "laws" pertaining to how behavior works and how learning takes place in an environment. Furthermore the Autism Speaks publication: Applied Behavior Analysis: A Parent's guide, (2012) stated "ABA therapy applies these laws to behavioral treatments in a way that helps to increase useful or desired behavior. ABA applies these laws to help reduce behaviors that may interfere with learning or behaviors that may be harmful. ABA is used to increase language, communication skills, improve attention, focus, social skills, memory and academics as well as to decrease problem behaviors."

Many consumers are surprised to hear that ABA is based on a psychological science that is over 100 years old. The modern field of applied behavior analysis traces its beginning to 1968 with the publication of the first copy of the *Journal of Applied behavior Analysis* and specifically the article "Some Current dimensions of Applied Behavior Analysis" by Baer, Wolf, and Risley (1968). This paper briefly describes the seven principles that guide all evidence-based applied behavior analysis practices. These core guidelines include: *applied, behavioral, analytic, technological, conceptually systematic, effective,* and *generalized outcomes.*

Seven dimensions of Applied Behavior Analysis

Applied	The work conducted must have social significance
Behavioral	Precise and reliable measurement of behavior should be attainable
Analytic	It must be shown that the treatment led to behavior change, and not something else, such as chance
Technological	Procedures used should be clearly described and identified
Conceptually systematic	Procedures should be described in terms of their principles
Effective	Procedures should improve the behaviors being addressed to a practical degree
Generalized	Positive changes should extend over time, environments, and behaviors

Source: T. Meadows 2011

The first principle described by Baer, Wolf, and Risley (1968) that guides the practice of applied behavior analysis is that interventions are *applied* to solve real life, socially significant issues and promote independence for the consumer. The second principle is that interventions are based on *observable behavior.* Within ABA, behavior is considered to be anything that humans do. This idea includes thoughts, feelings and, of course, actions. Applied behavior analysis is concerned about the specific observable behavior that is highlighted for change and behavior that can be measured by an observer through evidence. Careful measurement is arguably the main focus of behavior analysis and the reason why ABA interventions involve taking large amounts of data.

The next principle of evidence-based behavior analysis is the idea that interventions are *analytic.* This very scientific sounding word means that the professional who uses an ABA intervention can prove through experimentation that what they say is causing a change in behavior is actually doing so. In other words, that there is enough evidence that a particular ABA based intervention works and that change in behavior happened as a direct result of the intervention and not something else. Another core guideline of the science of ABA is that it is *technological.* This does not mean that those who practice ABA interventions always use computers or IPads but rather that interventions are designed in such a way that any other ABA professional can repeat it and get the same or nearly the same results. *Conceptually systematic* is the idea that to make an intervention meet the criteria of ABA it must be based on the psychology of behaviorism.

The final two guidelines for the practice of ABA include that interventions are *effective* and can be *generalized.* Of course, consumers of treatments for ASD want these interventions to work but ABA requires observable evidence that there has been a socially significant change in behavior before an intervention can be called a success. *Generality* is the idea that although skills may be successfully taught to an individual with ASD in one setting (such as washing their hands in their home or saying "hi" to a friend), an intervention is only truly successful when the same individual can use the skill in many different settings or with many different social interactions (such as washing their hands at school and a restaurant, and saying "hi" to many friends and relatives.). This is the ultimate goal of all evidence-based ABA interventions for individuals with ASD.

Applied behavior analysis has many specific treatment effects and can be implemented to increase language, functional communication skills, improve attention, social skills, memory and well as specific academic skills as well as to decrease problem behaviors (Autism Treatment Network, 2012). ABA interventions are not limited to individuals with Autism spectrum disorders. "ABA has become recognized as the treatment of choice for behavior problems associated with mental retardation (*intellectual disability*), brain injury, and other disorders" (Axlerod, McElrath and Wine, 2012). ABA services are flexible

and are not limited to one format or age group. They may be used by highly trained professionals in various environments including classrooms, homes, community centers, group homes, and employment settings among others.

Although practice of ABA is a specifically trained science, practitioners regularly enlist and train parents and caregivers to actively participate in interventions. With specific training, parents and caregivers frequently help with collecting data or even administer interventions directly. With fifty years of research behind it, and comprehensive training protocols for practitioners, the science of ABA is widely recognized as an effective evidence-based practice by the Centers for Medicare and Medicaid Services (CMS), the National Autism Center (NAC), and the National Professional Development center on ASD (NPDC) for the treatment of individuals with ASD.

What are Evidence-Based Interventions?

There are many different types of interventions that are based on the principles of applied behavior analysis which use the concept of understanding and modifying behavior in the context of the environment. In order to determine which approach or intervention is considered evidence-based it is important to define exactly what evidence-based means.   The Ohio Employment First, *Evidence-based Practices for Transition Youth* (2015) defined evidence-based practice to be:

- "Instructional methods and strategies proven through research to be effective".

- "Use in a variety of settings, such as classrooms, work sites, community environments, social settings, etc."

- "Useful to teach a variety of skills, such as those associated with employment, daily living, communication, academics, job-routines and tasks, independence, and workplace behavior."

Additional criteria for what constitutes evidence-based interventions is described by the University of North Carolina, Autism Evidence-Based Practice Review Group (Wong et al., 2014) and are consistent with the criteria described by the National Professional Developmental Center on Autism Spectrum Disorder (NPDC), and the National Autism Center (NAC):

- "At least two high quality experimental or quasi-experimental group design articles."

- "Be conducted by at least two different researchers or research groups."

- "Or at least give high quality single case design articles conducted by at least three different researchers or research groups and having a total of at least 20 participants across studies."

- "Or it could have a combination of at least one high quality experimental or quasi-experimental group design article and at least three high quality single case design articles conducted by at least two different research groups".

Finally, as described by the Missouri Autism Guidelines Initiative, 2012: "evidence-based practice includes consideration of the best available research evidence in the context of individual characteristics and professional expertise" as shown in the following graphic.
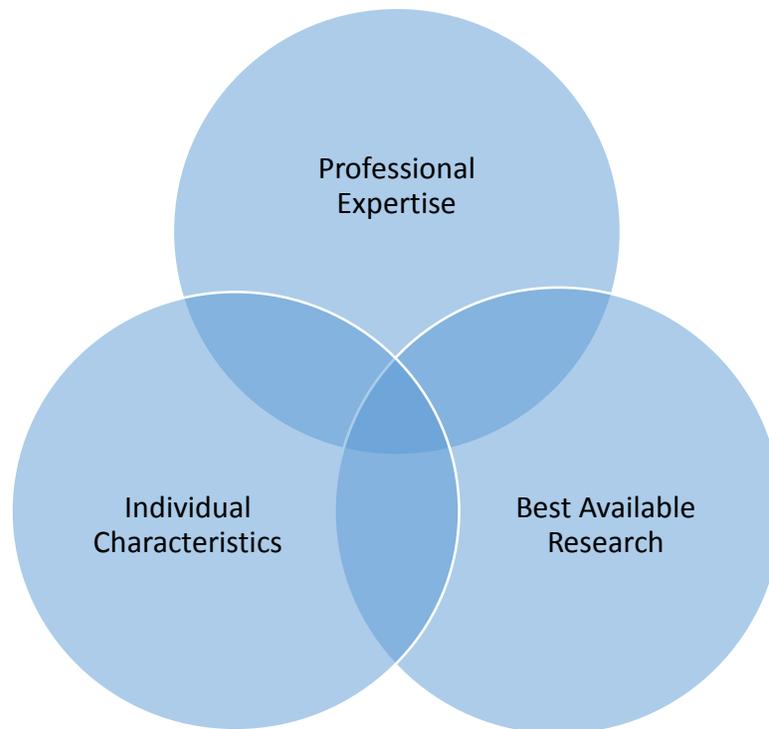
Source: Missouri Autism Guidelines Initiative, 2012

Evidence-Based ABA Interventions

The focus of this report is to inform consumers on evidence-based ABA interventions. Based on information gathered from the NPDC, NAC, and CMS reports there are over 36 identified types of approaches, treatments, or

interventions that are considered as having ABA modality. There is no single intervention that is effective for every individual diagnosed with ASD. Each intervention is fundamentally based on the needs of an individual consumer, their caregivers, and their family. Evidence-based interventions are mandated by law in educational settings (IDEA 2004), however, the interventions identified here have been shown to be effective in many settings, including schools, homes, and the community at large. This paper focuses on describing the following common evidenced-based ABA practices: antecedent interventions (including: prompting, and environmental antecedent modifications, and time delay), behavior interventions (including: visual schedules, differential reinforcement, discrete trial training, extinction, and task analysis) as well as pivotal response training, functional communication and self-management. In addition, this report briefly describes the following core practices of ABA: Stimulus Control (Sds), Positive Reinforcement (R+), the three term contingency (Antecedent, Behavior, and Consequence), and Functional Behavior Assessment (FBA).

Comprehensive ABA interventions focus on teaching (reinforcing) individuals to react to stimuli in an environment in a way that has functional, productive meaning for the individual and society (Schoen, 2003). The environment refers to everything observable through the senses that is present in given place and time. A stimulus is something particular that is present in the environment that causes a reaction in the senses (Kearney, 2015). Stimulus control refers to a change in the environment that consistently produces specific behavior. In other words, it is the signal to a learner that a particular behavior should be performed at a given place and time. This concept is crucial to ABA interventions and learning in general. For example, stimulus control is the idea that a student is taught to raise their hand. The student does this only in the presence of a teacher and is reinforced socially for doing so. The student will not be reinforced for raising their hand in environments and situations where there is no instructor (i.e. no opportunity to be called on by an adult) nor will they be reinforced for talking before raising their hand (blurting out answers, shouting, etc.). When the learner can consistently identify that they should raise their hand to get a teacher's attention (to ask for help, or answer a question) hand raising is said to be under stimulus control.

The concept of positive reinforcement is also at the core of all ABA practices. As described by the NPDC: "Reinforcement is a foundational practice that is used with other evidence-based practices. Reinforcement describes the relationship between learner behavior and a consequence that follows the behavior. This relationship is reinforcing only if the consequence increases the likelihood the learner will perform the skill or behavior in the future" (AFIRM, 2015). Positive reinforcement of correct responses is what the practitioner (or teacher, or parent) does to "teach". Behavior or "learning" happens when correct responses are reinforced and incorrect responses are not. For example, a student who consistently tantrums and refuses to complete an acceptable task may be taught the replacement behavior of asking for a break.

Asking for a break serves the same function as shouting and throwing an assignment on the floor (escaping the task) but in a manner that is socially acceptable. The student is then positively reinforced for asking for a break appropriately using the mode of communication that works best with the current abilities of the student (e.g. verbally stating: "break", pointing to or retrieving a "break" card or icon) and not reinforced for engaging in tantrums. There are many ways to go about teaching communication depending on the needs of the individual student but the contingency is usually the same processes and the skills can be shaped over time to be as effective as possible in all settings.

ABA interventions incorporate what is referred to as the three term contingency, which is described as the ABC's of behavior. When practitioners talk about the three term contingency they are referring to an environmental antecedent (A), an observable behavior (B), and an environmental change or consequence (C). An antecedent (A) refers to what is present or has occurred in the environment immediately before a behavior. (In our asking for a break example, a teacher gave the student a worksheet or wrote the problem on a board). Observable behavior (B) seems like an easy concept but it is one that is frequently confused and when inaccurately described weakens interventions. Remember that practitioners of applied behavior analysis are concerned with behavior that we can directly observe and measure. In our example the observable behavior of the student exhibited a tantrum as soon as the task was presented. The tantrum may have included shouting, throwing materials, etc. and this specific behavior is what is recorded exactly as it was observed. Finally, a consequence (C) refers to what happened in the environment immediately after the behavior. In our example, the teacher may have withdrawn the task completely or presented it again and the student's behavior might have correspondingly ended or restarted depending on its function. It is important to note that within ABA terminology, consequence does not automatically refer to punishment.

	Setting event →	Antecedent stimulus →	Behavior →	Consequence
Definition	Anything that increases the likelihood that the interfering behavior will occur	Events or conditions that are present right before the interfering behavior occurs	Interfering behavior	The events or conditions that are present right after the interfering behavior occurs
Example	Not getting enough sleep, noisy activity, lights too bright, working with a certain person	Bell rings to change classes, teacher asks learner to do something, peer says, "hello"	Screaming, flapping hands, hitting, body rocking	Learner is told to leave activity, learner gets a break, teacher says, "no hitting"

Source: Neitzel, 2010

Many individuals with autism spectrum disorder exhibit challenging behaviors. A core component of ABA practices is to try and find the function of problem behavior (i.e. what someone wants to get or get out of) and develop an intervention based on that function. There are four generally accepted functions of behavior described in ABA research: social attention, escape from a task or stimulus, access to a tangible, and automatic reinforcement (reinforcement that is not mediated by another person) (Carr and Durand, 1985). Practitioners of ABA frequently use a Functional Behavior Assessment (FBA) to determine what an individual wants or wants to get out of. Conducting a FBA is a crucial step in the process of developing effective interventions replace the function of challenging behavior with appropriate alternatives. The focus of an FBA is to look at the contingencies maintaining a given behavior.

Once the contingencies that maintain a behavior have been identified and function of a behavior has been assessed, specific evidence-based interventions can be utilized to teach and reinforce replacement behaviors that serve the same function as the problem behavior. These interventions may benefit Individuals with ASD in the following ways (ABA Resources: What is ABA, 2000):

- Increase behaviors (e.g. reinforcement procedures increase on –task behavior, or social interactions).

- Teach new skills (e.g. systematic instruction and reinforcement procedures teach functional life skills, communication skills, or social skills).

- Maintain behaviors (e.g. teaching self-control and self-monitoring procedures to maintain and generalize job related social skills).

- Generalize or to transfer behavior from one situation or response to another (e.g. from completing assignments in the resource room to performing as well in the mainstream classroom).

- Restrict or narrow conditions under which interfering behaviors occur (e.g. modify).

- Reduce interfering behaviors (e.g. self-injury or stereotypy).

Evidence-based ABA practices highlighted in this report were included based on their prominence in literature and are likely to be encountered by consumers seeking ABA. The following interventions have been subjected to peer review and were identified as being evidence-based by four main agencies including: National Professional Development Center (NPDC), Centers for Medicare and Medicaid Services (CMS), National Standards Project (NSP), and the Agency for Healthcare Research and Quality (AHRQ):

1) Antecedent Interventions which include the following:

    a. Prompting

    b. Environmental Modification

    c. Task Analysis (TA) and Chaining

    d. Time Delay (TD)

2) Behavior Interventions which include the following:

    a. Differential Reinforcement

    b. Discrete Trial Training (DTT)

    c. Extinction (EXT)

    d. Functional Communication Training (FCT)

Also included in this report are the evidence-based practices of:

    e. Pivotal Response Training (PRT)

    f. Visual Supports (VS)

    g. Self-Management

Antecedent Interventions

According to Matson and Neal (2009) in their paper, *Applied Behavior Analysis for Children with Autism Spectrum Disorders,* antecedent intervention is used to shift from a focus on response-reinforcement relationships to approaches that focus on manipulating the antecedents relevant to target behavior. In other words, changes to the environment change behavior. Wong et al (2014) stated that an antecedent package is an intervention that includes a variety of modifications that are made to the environment/context in an attempt to change or shape a student's behavior. Types of modifications to the environment include the schedule, activities, access to additional instruction or materials, and can be used effectively to address social, communication, behavior, play, school-readiness, academic, motor, and adaptive skills. Intervention techniques include prompting, environmental modification, time delay and visual schedules.

- Prompting: A procedure that includes any help given to learners that assists them in using a specific skill. Prompts are verbal, gestural, or physical assistance to the learner to support them in acquiring or engaging in a targeted behavior or skill. This can also involve a delay as to when providing a prompt to the learner (Wong et al., 2014).

- Environmental Modification: As stated by Baily (2011), a modification is an actual change in how the school work is completed. Examples of how to modify a child's environment in the classroom would be to use visual or written daily schedules of what will occur that day, have classroom aids that can assist with supporting desired behaviors and/or assisting in developing communication, provide instructions orally as well as written, allow extra time for student to respond to directions, instructions or questions, provide pictures that the student can point to for communication purposes, repeat or rephrase questions, model tasks, posting rules of classroom, provide social skills support, have the teacher incorporate visual components, break assignments into smaller parts, allow student to move around when needed, provide visual or verbal cues when transitioning from one activity to another, minimize distractions, give students extended time for taking tests or completing assignments, allow student to pair up with another student to help when interacting with others, offer alternative activities when an activity is high sensory, and let the student use a stress ball to rub to help improve focus and reduce anxiety.

- Time Delay (TD): This is a practice used to fade the use of prompts during instructional activities, a brief delay is provided between the initial instruction and any additional instructions or prompts. There are two types of time delays; progressive and constant. Progressive time delay uses increased waiting time between the instruction and any prompts that might be used to evoke a response from a learner. In a constant time delay, a fixed amount of time is always used between the instruction and the prompt as the learner becomes more proficient at using the new skill (Wong et al., 2014).

- Task Analysis and Chaining: A process in which an activity or behavior is divided into small, manageable steps in order to assess and teach the skill. Other practices, such as reinforcement, video modeling, or time delay, are often used to facilitate acquisition of the smaller steps (Wong et al., 2014).

- Visual Schedules (VS): Is a visual support to the individual that represents their complex physical world. It is a tool that translates a person's schedule for the day, week or month. It involves having

pictures or photographs, icons, drawings, written words, objects that arrange a script of the person's life. It organizes the individual's thinking by establishing a visual routine (Wong et al., 2014).

Behavior Interventions

As identified by the National Autism Center (NAC) National Standards Project, behavioral package interventions "are designed to reduce problem behavior and teach functional alternative behaviors or skills through the application of basic principles of behavior change" (p.12). The following practices have been identified by the NAC, NPDC, and Wong et al. 2014 as being evidenced based ABA interventions (Wong et al., 2014).

- Differential Reinforcement: Provision of positive/desirable consequences for behaviors or their absence that reduce the occurrence of an undesirable behavior. Reinforcement provided: a) when the learner is engaging in a specific desired behavior other than the inappropriate behavior (DRA), b) when the learner is engaging in a behavior that is physically impossible to do while exhibiting the inappropriate behavior (DRI), or c) when the learner is not engaging in the interfering behavior (DRO).

- Discrete Trial Training (DTT): Instructional process usually involving one teacher/service provider and one student/client and designed to teach appropriate behavior or skill. Instruction usually involves trials. Each trial consists of the teacher's instruction/presentation, the child's response, a carefully planned consequence, and a pause prior to presenting the next instruction.

- Extinction (EXT): Withdraw or removal of reinforcers of interfering behavior in order to reduce the occurrence of that behavior. Although sometimes used as a single intervention practice, extinction often occurs in combination with functional behavior assessment, functional communication training, and differential reinforcement.

- Functional Communication Training (FCT): "Replacement of interfering behavior that has a communication function with more appropriate communication that accomplishes the same function. FCT usually includes FBA, DRA, and/or EX".

Other Common Evidence-Based ABA Practices

There are many other evidence-based practices that have empirical roots in the principles of applied behavior analysis. Pivotal response training (PRT), Visual Supports (VS) and Self-Management are three interventions that have been identified by the NAC, NPDC, among others as being empirically supported practices (Wong et al., 2014):

- Pivotal Response Training (PRT): PRT works with the individual's interest, drive and motivation in which effective communication is established. This creates a connection to self-control in the person's social, academic, play, and communication environment. PRT intervention builds on the individual's self-initiations towards their natural world, using the idea of pivotal tools within the person to create change".

- Visual Supports (VS): Any visual display that supports the learner engaging in a desired behavior or skills independent of prompts. Examples of visual supports include pictures, written words, objects within the environment, arrangement of the environment or visual boundaries, schedules, maps, labels, organization systems, and timelines.

- Self-Management (SM): Instruction focusing on learners discriminating between appropriate and inappropriate behaviors, accurately monitoring and recording their own behaviors, and rewarding themselves for behaving appropriately.

Evidence of ABA Effectiveness

Various institutions have reviewed the research on evidence-based ABA practices (Missouri Autism Guidelines Initiative, National Autism Center, National Professional Development center on Autism Spectrum Disorders, Centers for Medicare and Medicaid Services, the Agency for Health Care research and Quality and the Autism Evidence-based Practice Review Group). According to these reviews, the research indicated that the effects of the ABA interventions on individuals with ASD vary across age groups. The effects of the ABA practices identified in this paper are highlighted below (Wong et al 2014):

1) Antecedent Packages include some or all of the interventions listed below and is effective for toddlers (0-2 years) to young adults (19-22 years) with Autism Spectrum Disorder (ASD). It is effective to address

social, communication, and behavior, play, school-readiness, academic, motor, adaptive, and vocational skills.

2)

    a. Prompting is identified as being effective for toddlers (0-2 years) to young adults (19-22) with ASD in the areas of school readiness, academic and adaptive skills development. It is also effective in addressing social, communication, play and motor skills in students aged 0-14. High-school and middle school age students may benefit from prompting in the areas of behavior and vocational skills.

    b. Environmental Modification: The National Autism Center identified 99 studies that involved environmental enrichment or environmental modification of task demands have shown to be effective for individuals from the ages of three to eighteen years of age. It can be used to increase skills in the area of communication, interpersonal skills, learning readiness, personal responsibility, play and self-regulation. Environmental modifications can also be effective in decreasing behaviors such as problem behaviors or SER (Sensory or Emotional regulation) (Green, 2009).

    c. Time Delay (TD) has been shown to be effective in addressing social, communication, behavior, joint attention, play, cognitive, school readiness and academic skills in student's age 0-14. Research also confirms effect in the areas of motor and adaptive skills for pre-school age individuals with ASD (Wong et al. 2014).

3) As identified in the Wong et al. (2014) publication, behavior packages are used to address social, communication, behavior, joint attention, play, cognitive, school-readiness, academic, motor, and vocational skills in individuals with ASD.

    a. Differential Reinforcement is effective for preschoolers (3-5 years) to improve social, communication, behavior, and school readiness skills. It is shown to be effective in addressing social, communication, and behavior, joint attention, and play, and school readiness, academic, motor, and adaptive skills for middle school aged students (6-14 years). It is also beneficial for young adults (19-22 years) in terms of addressing behavior and adaptive skills.

    b. Discrete Trial training (DDT) has been shown to be effective for preschoolers (3-5 years to elementary school-age learners (6-11 years) with ASD in addressing social, communication, joint

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attention, academic, and adaptive skills. It was shown to be effective in increasing school readiness skills in preschool students as well as behavior and vocational skills in middle-school age students with ASD.

    c. Extinction (EXT) is a practice that shows effectiveness for addressing communication and behavior skills in ages 0-22 years. It is also effective with middle-school age students in the areas of social, joint attention, academic, adaptive, and vocational skills. It is also effectively used to teach adaptive skills in pre-school age students.

    d. Task Analysis (TA) and Chaining is identified as being effective for preschoolers (3-5 years) when addressing communication and joint attention skills and middle school-age learners (12-14 years) to address social, communication, and joint attention, academic, motor, and adaptive skills.

4) Pivotal Response Training (PRT) is effective for toddlers (0-2 years) to middle school-age learners (12-14 years) with ASD, "and is used to address social, communication, joint attention, and play skills" (Wong et al. 2014).

5) Functional Communication (FCT) has been shown to be effective in ages 0-16 for social and play skills development, 0-age 22 for developing communication and behavior and adaptive skills

6) Visual Supports (VS) were identified as being effective for social skills development in ages 0-22 and communication, behavioral, play, school readiness, and academic skills development for ages 0-14. VS were also effective in middle-school aged students for increasing motor and adaptive skills as well as being effective for 0-5 year olds in developing cognitive skills.

7) Self-management has been shown to be effective in increasing school readiness skills for ages 0-22 and social, communication, and play skills for students age 6-14. Self-management was also shown to be effective for addressing behavior skills in students aged 6-22. It was also effective for teaching vocational skills for high-school aged students age 15-22.

Limitations of Research

Information clearing houses such as the NAC, NPDC, and acknowledge variations in the criteria used to identify evidence-based practices for the

treatment of ASD (NAC identifies eleven EBP and the NPDC identifies twenty-seven). Furthermore, the NPDC study reviewed literature published from 1990-2011. As previously discussed, ABA is fundamentally based on ongoing research and thus new publications are continuously being presented in professional journals to support the use of ABA interventions. The NPDC review also acknowledge that their review focused on interventions for school aged individuals only (early intervention – age 22). The review makes no claim that ABA interventions are not viable to treat adults with ASD but it is beyond the scope of this work. This is an important point to make as rates of the incidence of 8 year olds with ASD has increased from 1 in 150 in the year 2000 to 1 in 68 in 2012 (CDC 2015). Individuals identified a decade ago are fast approaching adulthood and will soon be in need of effective adult interventions (Gray and et al, 2014).

There is limited literature on the long term effects of the use of ABA interventions on young children and their progression into adulthood. Sallows and Graupner (2005) demonstrated the positive impacts that ABA based early intensive behavioral interventions (EIBI) have on the development of young children over four consecutive years while Healy, O'Conner, Leader, and Kenny (2008) used similar interventions over the course of three years. EIBI interventions are built upon the pioneering work of Ole Ivar Lovaas at the University of California Los Angeles in the 1960's. Researchers such as Schreibman (2000) have called for specific research in the core ABA areas of generality and maintenance of behaviors in an effort to bolster the long term impact of ABA based therapies.

Conclusion

With over thirty years of accumulated literature, applied behavior analysis interventions are at the forefront of evidence-based practices to support the needs of individuals with ASD (Healy at al. 2008; Virués-Ortega 2010; Slocum et al. 2014; Smith 2013; Wacker et al. 2011). Interventions based on the behavioral concepts of stimulus control (Sds), positive reinforcement (R+), the three term contingency (Antecedent, Behavior, and Consequence), and Functional Behavior Assessment (FBA) form the core of most effective ASD interventions (Schreibman, 2000). Despite the overwhelming evidence for the efficacy of ABA, concerns and misconceptions persist in the eyes of consumers (Schoen, 2003). The NPDC, NAC, CMS and various current articles recommend that consumers of ABA educate themselves on the "practice" of ABA and what constitutes effective service delivery of evidence-based interventions.

Schoen (2003) highlighted and addressed historical comments and criticism of ABA interventions:

1) "ABA is very intense and intrusive in its format and delivery. Stressful reactions by the recipient of the procedure should be carefully monitored. Sensitive and knowledgeable interventionist are essential in observing adverse treatment outcomes.

2) "Setting results may occur, with individuals with autism responding to stimuli in one environment, but are unable to generalize the learning to other contexts. Care needs to be taken in selecting natural environments for instruction in order to promote skills in real world situations."

3) "The spectrum of difficulties, range of abilities, age of the child, culture of the family, and characteristics of the individual combine to suggest that the use of a single treatment would be a problem. Many particular variables complicate the treatment selection process. Treatments must be tailored to meet specific consideration."

These concerns may be discussed with consumers and alleviated by direct service providers reflecting their practice with basic behavioral principles that are the foundation of ABA (Slocum et al. 2014)

The evidence-based practices listed in this paper have been identified as being supported by research as to their effect on treating various symptoms associated with autism spectrum disorder for individuals aged birth to 22. In order to address the concerns of consumers pertaining to the delivery of evidence-based ABA services, The Behavior Analyst Certification Board provides the following core characteristics of ABA in their publication: *Applied Behavior Analysis Treatment of Autism Spectrum Disorder: Practice Guidelines for Healthcare Funders and Managers* (2014).

BACB Core Characteristics of ABA (2014):

1. An objective assessment and analysis of the client's condition by observing how the environment affects the client's behavior, as evidenced through appropriate data collection

2. Importance given to understanding the context of the behavior and the behavior's value to the individual, the family, and the community

3. Utilization of the principles and procedures of behavior analysis such that the client's health, independence, and quality of life are improved

4. Consistent, ongoing, objective assessment and data analysis to inform clinical decision-making

Source: BACB, 2014

According to the UC Davis Medical Center, servicing the needs of individuals with ASD will cost the United States upwards of 500 billion dollars by 2025 (Autism costs, 2015). Kimball (2002) stated that estimates show that ABA interventions such as early, intensive behavioral interventions (EIBI) may save hundreds of thousands of dollars in public funds for individuals with ASD over the period of time that they are eligible for services under IDEA (ages 3 to 22). It is important that research continues to support what are considered to be evidence-based practices. As described in this review, behavioral interventions based on applied behavior analysis form the majority of current evidence-based practices in the treatment of ASD. Consistent with the scientific doctrines of ABA these interventions need to be evaluated in the context of the unique setting and needs of the individual recipient (Slocum et al. 2014). These interventions may be applied in educational or community settings with the goal of developing functional skills that afford as much independence as possible for individuals with ASD to live fulfilling lives.

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