



Applied Behavior Analysis as Treatment for Autism Spectrum Disorder

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EDITOR'S NOTE: As the incidence of autism spectrum disorder (ASD) has increased, it has become clear that there is substantial variability of the children affected by this neurodevelopmental disorder. Likewise, there are a wide range of educational and medical therapies for ASD. Early intensive behavioral and developmental interventions, such as applied behavior analysis treatment addressed in this Medical Progress, have shown benefits in some children with ASD. Nonetheless, the increased awareness of ASD and the screening of a wider range of children for ASD have both resulted in an increasingly heterogeneous population of children with ASD. One treatment may not be appropriate for all children diagnosed with ASD. An increasing range of treatment approaches is on the horizon, and these will require rigorous study across the heterogeneous population of children with ASD.

With an increase in the number of children diagnosed with autism spectrum disorder (ASD)¹ to 1 in 68, family demand for insurance coverage of evidence-based treatments for ASD has increased. To date, 43 states have reformed insurance coverage.² The majority of the approved statutes explicitly mandate coverage of treatments based on the principles of applied behavior analysis (ABA). In addition, 24 states have now passed legislation to establish professional regulation of ABA providers, known as behavior analysts.³ The purpose of the present review is to provide information on: (1) basic principles and procedures of ABA treatments; (2) the body of evidence and strength of studies that support the efficacy of ABA treatments; (3) the matching of these procedures to patients with specific characteristics (eg, toddlers) or symptoms (eg, minimal vocal skills); and (4) the assessment of appropriately trained and credentialed behavior analysts.

Given the inclusion of ABA treatments in insurance reform mandates for ASD along with the increasing impact of ASD on the health care system,⁴⁻⁶ pediatricians should be familiar with the basic principles and procedures of ABA. This knowledge is particularly important in light of research suggesting that physicians report that familiarity with ABA is associated with increased competency for providing primary care to children with ASD.⁷ Pediatricians also should be aware that ABA is a field of study and not just a single treatment for ASD. The principles and procedures of ABA have been used to treat a wide va-

riety of socially important problems, such as academic delays and addiction.⁸ For the purposes of this discussion, we will delineate between the field of ABA (henceforth ABA) and the application of behavioral principles to the treatment of disorders such as ASD (henceforth ABA treatments). Finally, it should be noted that this review is not intended to be a comprehensive review of ASD treatments or other evidence-based practices for ASD but is instead a primer on the topic.

The core symptoms of ASD include persistent impairments in reciprocal social interaction and communication and restricted and repetitive behaviors. For example, one area of social communication that is particularly problematic in children with ASD is joint attention.

Joint attention involves the shared focus of 2 individuals on a common object or event.⁹ Whereas typically developing children will often look at an interesting object, point at it, and then look at their parent to share the experience, children with ASD are much less likely to engage in such forms of joint attention.

Other areas of impairment include difficulties in expressing and interpreting nonverbal communication, poor eye contact, and difficulties in initiating and maintaining relationships. Restricted and repetitive behaviors seen in children with ASD include repetitive motor movements such as hand flapping, restricted use of objects such as lining up toys, and/or stereotypic speech such as echolalia. Interestingly, the majority of children with ASD do not present with intellectual disability.¹ Therefore, manifestations of ASD symptoms vary widely, leading to a clinical heterogeneity of ASD. For example, one child with ASD may have well-developed verbal skills, no intellectual impairment, and relatively mild forms

ABA	Applied behavior analysis
ASD	Autism spectrum disorder
BACB	Behavior Analyst Certification Board
BCBA	Board-Certified Behavior Analyst
DTT	Discrete-trial teaching
EIBI	Early and intensive behavioral intervention
ESDM	Early Start Denver Model
FBA	Functional behavior assessment
NLP	Natural language paradigm
PECS	Picture Exchange Communication System
PRT	Pivotal Response Training
RCT	Randomized clinical trial

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of repetitive behavior, whereas another might be “nonverbal” with severe intellectual disabilities and persistent stereotyped behavior patterns. When interviewing caregivers regarding their child’s development, pediatricians should proactively inquire about eye contact, joint attention, imitation, gesturing, repetitive behavior, and language, among other developmental milestones.¹⁰ There are a number of available screening procedures (eg, Modified Checklist for Autism in Toddlers)¹¹ for this purpose. In addition, the nature of any deficits as well as the age of the child are important considerations for determining the appropriate course of treatment.

Theory of ABA and Treatments

The basic principles underlying ABA arose from the research of B. F. Skinner,¹² who posited and later confirmed that behavior was determined through a process called selection by consequences, which is analogous to Darwin’s process of natural selection. That is, Skinner demonstrated that in a given environmental context, behaviors that produce favorable outcomes will continue to occur through the process of reinforcement and those behaviors that do not produce favorable consequences will decrease over time, or extinguish. Skinner demonstrated how responses could be developed or changed over time by providing reinforcing consequences for successive approximations (eg, saying a single phoneme) of the final target response (eg, saying a target word), a process called shaping. Other important operant procedures used to establish new responses include prompting and modeling, among others.⁸

Ivar Lovaas developed the first intensive ABA treatment for ASD, which is commonly referred to as early and intensive behavioral intervention (EIBI). As originally conceived, EIBI is a comprehensive treatment model often conducted 5-7 days per week, several hours per day for up to 40 hours per week. Initially, the treatment is delivered in a one-to-one format with focus on the elimination of atypical behavior and the establishment of learning skills. Thereafter, the treatment may become more group oriented and less structured while focusing on more complex cognitive and social skills.^{13,14}

The EIBI model developed by Lovaas relied heavily on discrete-trial teaching (DTT), which focuses on teaching skills in a repeated and brief fashion with a specific instruction (the “discriminative stimulus”) while minimizing extraneous details, thereby making the instruction “discrete.” For example, a child who is being taught to differentiate among 3 shapes might be presented with the brief, specific instruction, “Touch the circle.” Correct responses would be reinforced through praise, whereas incorrect responses would produce no such positive reaction or would be correlated with a form of correction, such as the therapist pointing to the correct shape while repeating the instruction. The final and perhaps most critical component of DTT is ongoing data collection and data analysis. Within DTT, data are collected on a trial-by-trial basis or on a subset of trials.^{15,16} These data are used to determine the child’s rate of progress and

whether procedural modifications are warranted. Generally speaking, DTT and other, more naturalistic forms of ABA (described herein) often are applied to children around age 2 years for 25 or more hours per week to target basic skills such as joint attention, play, or imitation.¹⁷ As children progress in skill development, this model typically is applied for a shorter duration (eg, 15 hours per week) to address more complex social behavior (eg, perspective taking).¹⁸

Smith and Iadarola¹⁴ reviewed recent evidence on EIBI and other ABA treatments for children 5 years of age and younger with ASD and concluded that 2 interventions met Chambless and Hollon’s¹⁹ criteria for a “well-established” treatment, defined as 2 or more well-conducted group-design studies from different research labs: (1) individual, comprehensive ABA (ie, EIBI); and (2) teacher-implemented, focused ABA/developmental approach. Additional support for ABA treatments has come from multiple meta-analyses and systematic reviews,^{20,21} which have found that ABA treatment has strong empirical support.

It should be noted, however, that the evidence supporting many focused ABA procedures has come primarily from small-sample studies that use within-subject experimental designs, which are sometimes excluded from meta analyses, rather than randomized clinical trials (RCTs).^{21,22} Consequently, the strength of evidence regarding ABA treatments has been the topic of some debate. Generally speaking, the strength of evidence varies according to how one reviews the data (eg, random assignment, use of treatment manuals). For example, if evaluation criteria place an emphasis on RCTs, then ABA treatments might be deemed to have low-to-moderate evidence.^{23,24} By contrast, reviews that include studies that use within-subject experimental analyses are more likely to conclude that there is strong evidence supporting ABA treatment.^{21,25} As previously noted, however, the lack of RCTs of ABA treatments has limited the conclusions that can be drawn about the efficacy of these approaches²³ and has led to calls for additional RCTs in this area.²⁶ In addition, the extant ABA treatment literature tends to focus on broad skills among younger children (eg, imitation behavior among toddlers with ASD)²⁷ or specific behaviors among older individuals (eg, aggression among adolescents with ASD and intellectual disability). Nevertheless, like all sciences, ABA is a continually evolving field in terms of breadth of approaches used²⁸ and problems addressed.²⁹ In fact, in the years since Lovaas et al³⁰ described the outcomes for their first cohort of children with ASD who received EIBI, several ABA treatment approaches have been developed as alternatives or adjuncts to the Lovaas model.

One of the first alternative forms of ABA treatment for ASD was the natural language paradigm (NLP), one of the first of the naturalistic language training strategies.³¹ NLP is implemented in a naturalistic, play-based context. The therapist delivers reinforcement for all verbal attempts, even those that are less accurate than those the child has previously displayed. The therapist and the child take turns with the toys during the treatment, thus allowing the therapist to model appropriate toy play and relevant speech in a

structured context. The therapist uses a variety of examples to demonstrate the meaning of various words and activities. Finally, control of the therapeutic activities is shared between the therapist and the child by periodically allowing the child to select new toys and activities. Thus, a primary advantage of NLP is the incorporation of therapy into natural, ongoing social and play activities.

The naturalistic language strategies with the most empirical evidence supporting their effectiveness are called Pivotal Response Training (PRT)³² and the Early Start Denver Model (ESDM), an interdisciplinary treatment approach that recently has incorporated ABA procedures.³³ Other ABA treatment models that combine DTT with naturalistic strategies include the verbal behavior approach,³⁴ which focuses on teaching language in accord with social events that precede and follow each unit of communication, and the Picture Exchange Communication System (PECS),³⁵ which focuses on teaching nonspeaking children with ASD to request preferred activities by handing specific picture cards to others.

As an extension of NLP, PRT uses similar procedures but also focuses on targeting “pivotal” areas, including (1) motivation to interact with others, (2) self-management, (3) self-initiation, and (4) responsiveness to multiple cues. The effectiveness of PRT is supported mostly by small sample-size studies, with more recent RCTs.³⁶ For example, a matched-control design comparing children who received community-based EIBI using PRT vs the verbal behavior approach found that both groups showed significant but equivalent improvements in IQ, improvements in receptive and expressive language, and reductions in problem behavior.³⁷ Another RCT³⁸ compared PRT with PECS on acquisition of spoken language in children ages 2–4 years with fewer than 10 spoken words. Both groups showed significant and equivalent increases in spoken language after 23 weeks of treatment. Finally, a comparison of DTT and PRT in an RCT,³⁹ also with minimally verbal children, found that both treatments produced equivalent improvements in spoken language, and showed that children with lower receptive-language skills responded better to DTT, whereas those with higher receptive skills responded better to PRT.

ESDM integrates several interdisciplinary models with the training methods of ABA and relies heavily on PRT. The ESDM model follows a developmental progression such that goals chosen for the child are connected to the developmental skills of early childhood (eg, social interaction, joint attention). ESDM targets toddlers as young as 12 months; as such, this model has the strongest evidence for use with very young children identified with ASD. The ESDM curriculum is implemented by an interdisciplinary team and focuses on multiple areas of development, but stresses 5 essential components: imitation, nonverbal communication (eg, joint attention), verbal communication, social development, emotion sharing, and play. Similar to PRT, there is a strong emphasis on sharing control of the materials, interactions, and activities during therapy sessions.

Dawson et al⁴⁰ evaluated the effects of ESDM in an RCT in which 48 toddlers were assigned randomly to either receive

ESDM or standard community-based treatments. Children assigned to ESDM received approximately 25 hours per week of one-on-one therapy during a 2-year period. The children receiving ESDM showed an average gain of 19 points on the IQ—equivalent score of the Mullen Scales of Early Learning in comparison with a gain of 7 points for the control group. Although the results of some pilot studies suggested that short-term (eg, 12 weeks) parent training in ESDM may improve language development for children with ASD,^{41,42} a large RCT found no differences between the ESDM parent intervention and the treatment-as-usual control group.⁴³ Taken together, these results suggest that: (1) intensive ESDM has considerably better outcomes on child behavior than the less intensive, parent-mediated ESDM approach; and (2) intensity of intervention is an important predictor of outcomes across EIBI models.

Because of the numerous ABA treatments and their generally positive empirical support, many treatment approaches blend DTT with more naturalistic ABA treatments and aforementioned developmental-based models of goal selection. Sundberg and Partington⁴⁴ suggested that naturalistic ABA treatments are superior to DTT for the development of early requesting behavior and compliance, whereas DTT is superior for the development of very specific skills and preacademic activities. Likewise, PECS might be useful for a child to communicate basic wants and needs, but it is unclear whether this approach produces sustained, independent speech.⁴⁵ There have been some specific recommendations provided for how DTT and naturalistic ABA treatments can be successfully blended on the basis of the extant literature^{46,47} and, ultimately, comparisons among various ABA treatments have not shown clear differences between approaches, suggesting that a variety of procedures might be effective depending on patient characteristics and treatment targets. Indeed, future research should examine why specific procedures are effective, and for whom a given procedure will be most effective. Overall, there is a trend toward treatment approaches that combine multiple strategies. This trend has led to a recent suggestion to change the nomenclature of ABA and related treatments to reflect the more varied nature of ABA treatments; however, this suggestion has not yet been incorporated into health plans, legislation, and the literature at large.²⁸

ABA Treatments for Atypical Behavior Seen with ASD

Dominick et al⁴⁸ surveyed the presence of atypical eating, atypical sleeping, aggression, self-injury, and tantrums in a sample of 67 children with ASD and found that 98% of the sample reported at least 1 type of problem. Thus, although such behaviors are not diagnostic features of ASD, they commonly occur in this population. One of the most notable applications of ABA methods to atypical behavior is commonly referred to as a functional behavior assessment (FBA). A FBA is a hypothesis-testing model used to assess the relation between contextual factors (eg, attention from others, escape from instruction) and atypical behavior,

thereby producing information about the effects that social reactions may have on inadvertently increasing (or reinforcing) the occurrence of these behaviors. In their simplest form, FBAs involve interviews and informal observations, which often are conducted by school personnel. By contrast, experimental FBAs⁴⁹ are those that systematically manipulate events that precede and follow behavior and are the most effective at identifying the reinforcers that lead to the ongoing occurrence of atypical behavior.^{50,51} An FBA provides clinicians with information about what reinforcers, or contextual variables, to change to reduce atypical behavior through an individualized treatment (called a behavior intervention plan in educational settings). A range of FBA-based treatments has been described in the literature.⁵²

Existing meta-analyses and hundreds of studies have demonstrated FBAs to be effective in identifying the reinforcers that maintain atypical behavior,^{53,54} and application of FBAs has been extended to other pediatric conditions (eg, food avoidance⁵⁵). Also, research has demonstrated that treatments based on an FBA: (1) are more effective at reducing atypical behavior than are non-FBA based interventions^{50,51}; and (2) lead to the use of more reinforcement-based procedures as a means for treating atypical behavior among the population with ASD.⁵³ Thus, the use of FBAs has been recommended as a “best practice” by the American Academy of Pediatrics.¹⁷

Professional Credentialing of ABA Practitioners

A range of professionals including psychologists, special educators, speech therapists, and occupational therapists are capable of delivering interventions for ASD; however, since 1998, most practitioners of ABA have been credentialed by the nonprofit Behavior Analyst Certification Board (BACB).⁵⁶ The BACB’s credentials were designed to promote consistency of ABA training and practical experience as well as the assessment of competency through standardized examination. Credentials are offered at 2 levels: the Board-Certified Behavior Analyst (BCBA; graduate level) and Board-Certified Assistant Behavior Analyst (undergraduate level). Although individuals who hold the BCBA credential may practice independently, Board-Certified Assistant Behavior Analysts must receive ongoing supervision by a BCBA. The primary eligibility requirements for each credential include a university degree from predefined academic areas, a specified number of hours of university coursework in behavior analysis, and a defined field experience supervised by a professional who has met the necessary training requirements.

Applicants who meet these criteria are permitted to sit for a BACB examination. The BACB adheres to established testing and legal standards for boards that grant professional credentials,⁵⁷ and its certification programs are accredited by the National Commission for Certifying Agencies.⁵⁸ After passing the examination, all BACB certificants enter an ongoing cycle during which they must actively maintain their credential through continuing education. In addition, the BACB

maintains an ethics code (*Professional and Ethical Compliance Code for Behavior Analysts*) that serves as the foundation of a professional disciplinary system for its certificants.

Almost all of the 24 states that regulate the practice of ABA rely heavily on BACB credentials or standards.³ These ABA certification and licensure credentials are the basis of the consumer guidelines published by the Association for Behavior Analysis International,⁵⁹ which provides explicit guidance for consumers on selecting service providers who are competent to deliver ABA treatment for ASD.

Conclusion

The increasing number of children diagnosed with ASD¹ has increased the role of pediatricians in the management of this disorder. Given the importance of early identification and treatment of ASD,^{10,17} pediatricians should be familiar with the basic tenets and applications of ABA. In general, children who show behavior problems and skill deficits in multiple areas are candidates for immersive ABA treatments (ie, EIBI) that might be conducted 25 or more hours weekly in an effort to address the core symptoms and behavioral correlates of ASD through the implementation of a comprehensive treatment curriculum.^{17,59,60} Children who have a relatively mild expression of ASD might be candidates for more time-limited or focused ABA treatments (eg, 10 hours per week).⁶¹ In addition, some methods are useful for treating associated behavior disorders,⁵³ whereas others target core social-communication deficits like problems with joint attention.⁶² Pediatricians should familiarize themselves with local ABA providers and the behaviorally based interventions that may help their patients with ASD.

There are a number of methods for identifying ABA treatment service providers, including searching directories of treatment centers,⁶³ behavior analyst professional organizations (both US and worldwide),⁶⁴ and individual providers.⁶⁵ This information is intended to assist pediatricians in identifying and making appropriate referrals for ABA-based care for patients with ASD. ■

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