Applied Behavior Analysis: Its Application in the Treatment of Autism and Related Disorders in Young Children

The techniques of applied behavior analysis (ABA) are effective in altering the developmental trajectory of some very young children with autism. This research suggests that early, intensive treatment using the methods of ABA enables a significant number of children to enter the educational mainstream and achieve normal intellectual functioning. Both home-based and center- or school-based models have been used to deliver these services. Although discrete trial instruction is one of the most potent tools of early ABA teaching, a number of variations on this theme—the initial teaching of mands (requests), the use of an enriched environment with many items attractive to the child, and a focus on teaching the child to be highly skilled (fluent) in a behavior—all have the potential to be valuable teaching approaches. Key words: *ABA, autism, early intervention*

Sandra L. Harris, PhD
Professor of Clinical Psychology
Graduate School of Applied and Professional Psychology

Lara Delmolino, PhD
Research Assistant Professor
Douglass Developmental Disabilities Center
Rutgers, The State University of New Jersey
New Brunswick, New Jersey

IT IS POSSIBLE to impact the development of some young children with autism more today than at any other time in history. The shift in our understanding and treatment of autism began around 1960 with the publication of two important works. One of these, a book by Bernard Rimland,[1] offered the first plausible biologic theory of infantile autism. His book cast doubt on the then widespread notion that a defective parent-child relationship caused autism.[2] The data in this debate are now clearly on the side of biology; in the past 40 years a substantial body of research has emerged suggesting that multiple biologic causes may be involved. The second major event occurred in 1966 when an article by Lovaas and colleagues[3] in *Science* demonstrated that the principles of learning could be used to teach speech to young children with autism. Subsequent research using these principles of applied behavior analysis (ABA) has transformed our treatment of children with autism and enabled a significant number of them to enter the educational mainstream, in some cases with minimal extra support.

In this article we review the research on the benefits of ABA for the education of children with autism up to 5 or 6 years of age. We present the

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most common models for service delivery and discuss a few recent treatment innovations.

THE RESEARCH

From the 1960s to the 1980s a major body of research emerged exploring the use of ABA methods to educate children with autism. From this work we learned the importance of including parents as partners in the educational process[4,5]; the need to plan for generalization of responding[6]; and the power of the tools for teaching speech and language,[7] self-help skills, prevocational and vocational skills, and some social skills.

In 1987, Lovaas[8] published an article that was the impetus for significant progress with preschool children. He reported on the behavioral treatment of 38 young children with autism. One group of 19 children, the intensive-experimental group, received 40 hours a week of one-to-one treatment for at least 2 years. Another group, the minimal-treatment control group, had no more than 10 hours a week of one-to-one instruction during the 2 years. A second control group consisted of 21 children who had no behavioral intervention. He found that nearly half (47%) of the children in the intensive treatment condition were functioning at a normal level intellectually and were in regular education classes at 6 to 7 years of age. Only one child in the minimal-treatment control group made those kinds of gains in intelligence and educational achievement. A long-term follow-up of the children from the intensive treatment group[9] revealed that at 13 years of age, those who made early gains continued to hold their own. Eight of them were described as "indistinguishable" from other children their age on measures of intelligence and adaptive skills.

Following Lovaas'[8] study, a number of other investigators examined the power of ABA to alter the developmental trajectory of preschool-age children. Although these studies vary in experimental rigor, they produced similar outcomes to the Lovaas study. For example, Anderson and his colleagues[10] at the May Center for Early Childhood Education provided a blend of intensive home-based and center-based teaching for preschool children with autism. Among the first 26 children who participated for at least 1 year, 14 (54%) went to a regular kindergarten, 2 (8%) were enrolled in resource rooms in their home school district, and 10 (38%) went to segregated classes. Anderson et al noted that many of the children in the regular kindergarten classes needed extra support such as an instructional aide. Similar findings were reported by Birnbrauer and Leach,[11] who provided intensive early behavioral intervention for nine children; four children were described as approaching normal functioning after 2 years of treatment, while only one of five control children made significant progress.

The best replication of Lovaas' work was by Smith and colleagues,[12] who compared 15 children receiving an average of 24.52 hours of intensive treatment a week for 2 to 3 years by student therapists under intensive supervision with 13 children whose parents were given 5 hours a week of training in ABA for 3 to 9 months. These parents were asked to work with their child an additional 5 hours a week and children were in special education classes 10 to 15 hours a week. The two groups did not differ on intake measures. At follow-up the intensive treatment group was superior to the parent group on intelligence quotient (IQ), language, and academic skills, but the groups did not differ on adaptive functioning or behavior problems. Four intensive treatment children were in regular education classes without support, and 24 were in regular classes with support. In the parent group none were in regular classes without support, and three were there with support. This study provides additional evidence that intensive treatment can have major benefits for some children and that the parent training model that is so common in early intervention literature for a range of disabilities may not be as effective as the intensive treatment model. However, the gains by these children were less than those reported in the Lovaas[8] study and we do not yet know why. One reason may be because the number of hours of treatment was less in the Smith

et al study; another may be that the children in that study did not have as high an IQ at intake as did those in the Lovaas study.

In the lead author's work at Rutgers University, the extent to which IQ and age at admission might be related to a child's progress was of interest.[13] Among 14 children who had an IQ of 52 or less when they came to Rutgers, 1 was in a regular education class at follow-up and 13 in segregated classes. By contrast, for 13 children with an initial IQ of 59 or more, 10 were in regular education classes and 3 in segregated classes. Among 13 children who began before 48 months, all but 3 were in regular education settings; among 14 who started at 50 months or older, only 1was in a regular class.

Taken as a whole, these studies suggest that early intensive intervention for some young children with autism can alter their developmental trajectory. In the best outcomes roughly half the children become capable of benefiting from the curriculum in a typical classroom although many of them continue to need special support, especially socially and emotionally.

These findings, although impressive, still leave many questions. For example, we know that 40 hours a week of intensive treatment can be very beneficial and 10 hours are not.[8] We do not have good data on the extent to which 20, 25, or 30 hours might achieve a similar outcome. Several studies[12,14] have found various degrees of benefit with between 20 and 30 hours, but differences in characteristics of the children studied, the duration of the treatment, and other important factors make it hard to draw comparisons across projects. Such comparative research has important implications for social policy because the 40-hour-a-week standard is very costly.

We also do not yet have many data enabling us to predict who will benefit the most from ABA treatment. The work by Harris and Handleman[13] suggests that age at intervention and IQ may be predictors of outcome, but these findings need to be replicated in other settings before we can put much faith in them. We also do not have data showing that children with Rett's disorder or childhood disintegrative disorder will make gains by virtue of this intensive treatment.

MODELS OF SERVICE DELIVERY

There are two general approaches to providing ABA services to young children with autism and their families. Lovaas'[8] study was done in a home-based model where staff came to the home, worked with the child, and taught the families the ABA skills they needed to carry out instructional programs. This model has become common for preschool-age children. The alternative is a center- or school-based model in which one or more children are seen in a special program for children with autism, or in a special education or regular education classroom. Each of these approaches has advantages and limitations.

One of the strengths of the home-based model is that parents have full control over their child's education. They know all the details of the curriculum being used, often they are the ones who hired the staff members who carry out the programs, and nothing is done without their engagement. This strength is also a potential problem because many families lack the time to maintain that level of involvement in the details of their child's education. In a center- or school-based program a professional staff member has responsibility for coordination and, while parents are encouraged to become involved, they do not need to master all of the technology needed to offer leadership in shaping their child's treatment. A center- or school-based program also offers easy access to a multidisciplinary team with teachers, speech therapists, occupational therapists, and physical therapists readily available to provide treatment as needed.

Young children often spend much of their day at home with a parent. In this respect the home-based program matches the normative model. Another advantage of a home-based program is that it minimizes a child's travel time. The treatment staff come to the child rather than vice versa. This time saved can be spent learning. In addition to travel,

children in school- or center-based programs often have to spend some time in required activities including lunch, lining up to go outside, fire drills, and so forth. Similarly, the presence of other children in a school or center initially creates some visual and auditory distractions that may lead a child off task. One clear advantage to a school setting is the ready availability of typical peers, whereas in home programs special arrangements must be made to create this opportunity.

Clearly, there are advantages and disadvantages to any educational setting. We have few data to guide us in making a choice between home-based and center-based programs for young children with autism. Although the work by Lovaas[8] was done in a home-based context others, including Anderson et al[10] and Harris and Handleman,[13] worked in center-based settings with significant home involvement. The center-based setting probably offers economic advantages because specialists can see many children over the course of the day, and staffing patterns may be more efficient. However, the home-based setting, when properly done, promises the greatest intensity of treatment. We need additional research to guide these decisions, and given the lack of data, there will continue to be wide variation in service delivery settings.

INNOVATIONS IN TREATMENT METHODS

The term ABA encompasses many variations on the basic theme. Although discrete trial instruction (DTI) is sometimes erroneously equated with ABA, it is only one teaching tool available to practitioners of ABA. In this section we review the basic features of DTI and then look at mand training, natural environment training, and fluency as important recent contributions to the ABA literature.

DTI

DTI is widely used in the education of individuals with autism and has been shown to be an effective teaching approach.[8,9,14] Although this method can be implemented across all ages, it is most commonly associated with the instruction of young children with autism who are receiving intensive early intervention.

DTI is derived from the assumption that behavior is learned and that the science and laws of learning theory can be applied systematically in the education of young children with autism. The goal of DTI is to present information to the child in a clear, concise, and consistent way because research shows that children with autism acquire information most readily when it is presented in a structured format. In addition, the structure inherent in DTI helps the child isolate the key components of the learning situation.

DTI is characterized by a careful, deliberate, and specific organization of antecedent and consequent stimuli. The behavior of interest (what is being taught), the antecedent (what comes before this behavior), and the consequence (what comes after the behavior) are the essential components. In DTI, the primary antecedent stimulus is called the discriminative stimulus (S^D). This is the instruction, direction, or cue that is presented to the child. For example, if the teacher asks the child to "Throw me the ball," that command is a discriminative stimulus. After this, the behavior that the child engages in is the response. For example, the child might throw the ball. Following a child's response, the instructor delivers a consequence. In this illustration the teacher might say,"Great throw!" Each sequence of S^D, response, and consequence is called a trial.

Consequences following a child's response may be categorized as either reinforcement or punishment. These categories are defined by their effect on the behavior that precedes them. A consequence can be considered reinforcement if it increases the likelihood of the response it follows. In our example, if the teacher's praise is a reinforcement, then the child will likely throw the ball again. Likewise, a consequence is said to be a punishment if it decreases the frequency of the response it follows. Within DTI, consequences for correct responses often consist of social praise, smiles, tickles, treats, or favored toys and objects. Incorrect responses are followed by a correction, along with

an opportunity to demonstrate the corrected skill, with help if needed. It is important not to equate the technical term "punishment" with an implication of a harsh or painful consequence. A neutral "no" or the brief withdrawal of attention is an example of punishment, as that term is used in ABA.

Prompts are used to help students acquire new skills within the DTI model of instruction. Prompts are supplemental antecedent stimuli that coincide with the presentation of the S^D and are designed to ensure that the child answers correctly. When a new skill is being taught, a number of prompts are provided and then systematically faded (reduced) as the child begins to demonstrate the correct response independently. Prompts also are delivered in the event of an incorrect response to ensure success on a follow-up trial. Prompts include physical assistance and guidance, proximity, written or pictorial cues, additional verbal cues, gestures, or arrangement of materials.

DTI is characterized by data collection. The child's performance on each trial, or on a sample of trials (called a probe), is recorded and summarized to monitor progress. Programming decisions are made on the basis of these data. Clear performance objectives are established in the beginning of instruction, and the child's progress is measured against these objectives. Similarly, the specific S^Ds and responses are clearly specified at the outset of the intervention to ensure reliability in administration and data collection.

Mand training

Skinner, in his book *Verbal Behavior,*[15] referred to the concepts of the mand and the tact. Technically, a *mand* is a behavior that specifies its reinforcer. That is, a mand is a request, demand, or command that identifies the consequence that would increase its use. For example, asking for a glass of water, pointing to a water fountain, or reaching for a bottle of water are all mands that specify obtaining water as their reinforcer. Receiving a glass of water after asking serves to increase the likelihood of asking for a glass of water the next time one is wanted. A *tact* is a term that refers to the act of labeling or making contact with some aspect of the environment. The goal of a tact differs from a mand in that it is not intended to acquire the item, but rather to identify, point out, or comment on the item.

Sundberg and Partington[16] used Skinner's[15] principles of verbal behavior in the development of their approach to teaching language to children with autism. In this model, language is conceptualized using verbal behavior concepts, and children are taught these verbal behaviors systematically. The first step in this process is typically mand training in order to increase a child's frequency and range of mands. This is often a critical part of the early education of youngsters with autism because of its emphasis on increasing spontaneous and functional communication. Mand training involves exposing the child to an environment that is rich with preferred stimuli and providing frequent reinforcement for communicative behavior. Requests (mands) are shaped, beginning with behaviors that are in the child's repertoire. Prompting and modeling can be used to increase the frequency and complexity of mands. Progress is documented by recording the nature and frequency of mands within specific time intervals. After establishing a strong range of mands that is used regularly, instruction can focus on other language functions such as tacting.

Natural environment training

Natural environment training (NET) refers to the structure and context within which verbal behavior language instruction takes place. NET, which is described by Sundberg and Partington,[16] is based on the natural language paradigm (NLP).[17] Both NLP and NET focus on the context within which learning and instruction takes place. In these interventions, the stimulus items are chosen primarily by the child, are varied frequently, and are functionally relevant to the interaction.[17] In this way, the teaching exchanges happen within naturally occurring interactions and take advantage of a child's interest and momentary motivation. Research[16,18,19] indicates that children are able to acquire language and communication skills using this model and that

use of a natural environment may reduce disruptive behavior.

Mand training and NET are sometimes contrasted with DTI, which is typically conceptualized as instructor directed, more repetitive, and involving fewer natural contingencies and reinforcements. However, DTI can be included within more natural environments and teaching interactions. The structured sequence of S^D, response, and consequence may be readily embedded within child-directed activities and include varied materials and relevant, functional consequences.

Fluency

Behavioral fluency is a concept that is derived from the principles of learning and conditioning. Binder defines fluency as the "combination of accuracy plus speed that enables competent individuals to function efficiently and effectively in their natural environments."[20(p163)] The premise of fluency-based instruction is that a skill is mastered when it is produced accurately, automatically, and can be done in a variety of situations, in the face of distraction, and after long periods of time. That is, a fluent skill can be characterized by showing retention, endurance, and application.[20] Fluency is a key concept in the model of precision teaching,[20] a method of instruction and decision making that relies on the measurement of response rates. Precision teaching is used across a variety of environments with a range of learners, including typically developing students, adults, employees, and so forth.

One of the fundamental characteristics of this teaching approach is the emphasis on rate of a particular behavior or its occurrence in time. For example, in fluency-based instruction, it would be important to know if a student labeled 10 pictures correctly in 20 seconds as compared with 10 pictures in 60 seconds. For both examples, a student may have gotten 100% of the pictures correct, but the first instance (10 correct in 20 seconds) is an example of a more fluent behavior. In order to reflect this difference, programming and data collection in fluency programs involve the concepts of both accuracy and speed.

The data that are collected in fluency-based teaching differ from traditional data collection (which often relies solely on percentage correct) in that they are graphed on a "standard celeration chart"—a graphical display that represents the rate of a behavior in addition to the proportion of accuracy. In addition, teaching within a fluency-based paradigm involves the use of fluency aims. Data from specific populations, such as typical 3 year olds, are compiled to indicate rates of specific behaviors that are associated with fluent expression of behavior. That is, when an individual is able to name a specified number of pictures in a specified number of seconds, that behavior is typically associated with retention, endurance, and application. Teaching is then systematically guided in order to help the student attain the identified goal or fluency aim. The student's starting point and goal are connected visually on the celeration chart to create a trajectory, and teaching is systematically modified when the student's progress does not follow the trajectory.

Because fluent demonstration of skills and generalization are such fundamental challenges in teaching children with autism, the incorporation of fluency-based instructional practices addresses an important need. Fluency-based instruction offers a model that focuses on teaching skills to levels of mastery that are associated with long-term gains and effortless performance.

SUMMARY

The teaching methods of ABA have been demonstrated to have a significant impact on the learning of young children with autism. Over the past 30 years the application of the principles of ABA to meet the needs of children with autism has been subjected to hundreds of meticulous studies of specific mechanisms of change. In addition, it has been examined through a handful of global out-

come studies showing that some children make major developmental gains following this treatment during the preschool years. The teaching technology of ABA has continued to evolve with such techniques as mand training, NET, and fluency, all showing some usefulness in some children. It will be important to subject these methods to the kinds of longer-term outcome studies that have documented the benefits of discrete trial teaching in its more traditional context.

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