

Applied Behavior Analysis is a Science and, Therefore, Progressive

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Abstract Applied behavior analysis (ABA) is a science and, therefore, involves progressive approaches and outcomes. In this commentary we argue that the spirit and the method of science should be maintained in order to avoid reductionist procedures, stifled innovation, and rote, unresponsive protocols that become increasingly removed from meaningful progress for individuals diagnosed with autism spectrum disorder (ASD). We describe this approach as progressive. In a progressive approach to ABA, the therapist employs a structured yet flexible process, which is contingent upon and responsive to child progress. We will describe progressive ABA, contrast it to reductionist ABA, and provide rationales for both the substance and intent of ABA as a progressive scientific method for improving conditions of social relevance for individuals with ASD.

Keywords Applied behavior analysis · Behavioral intervention · Discrete trial teaching · Functional analysis

The first group are the first four authors who appear in alphabetical order by their last name. The second group are the fifth through eight author and they also appear in alphabetical order by their last name.

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The number of children being diagnosed with autism spectrum disorder (ASD) continues to rise (Matson and Kozlowski 2011). For children to make the most meaningful gains both early and intensive behavioral intervention (EIBI) is required (Lovaas 1987). The most commonly implemented and empirically supported interventions for individuals diagnosed with ASD are models based on the procedures developed and evaluated within the field of Applied Behavior Analysis (ABA) (Reichow 2012). Researchers have repeatedly shown that when children receive EIBI that they make meaningful gains and a certain percentage are able to become indistinguishable from their peers (Lovaas 1987; McEachin et al. 1993). Researchers have also stated that when children receive EIBI that it has the potential to save both the state and federal government hundreds of thousands of dollars per individual (Chasson et al. 2007; Jacobson et al. 1998). EIBI is both efficient and effective.

EIBI is most effective when certain parameters are in place. First, the intervention must be implemented with the correct dosage (intensity), with current consensus being that formal intervention should occur 25–40 h per week (Lovaas 1987; Reichow 2012). Second, it requires that the treatment be comprehensive (Lovaas 1987). Researchers have evaluated components of comprehensive treatments in various studies to increase language development (e.g., Sundberg 2008), social skills development (e.g., Laugeson et al. 2014; Leaf et al. 2012a), self-help skills (e.g., Flynn and Healy 2012), academics (Akmanoglu and Batu 2004), and leisure and play skills (Koegel et al. 2005; Oppenheim-Leaf et al. 2012). Third, it requires that staff are adequately trained to implement the procedures with a high degree of fidelity and quality (Bibby et al. 2001; Green 1996). Furthermore, long-time experts in the field of EIBI have delineated the necessary skill sets and processes believed to

be needed in order to achieve the outcomes seen in the research (e.g., Ala'i-Rosales and Zeug 2010; Eikeseth 2010; Taylor and Fisher 2010; Vets and Green 2010; Weiss and Zane 2010). When these components are all present, the results can be life altering for individuals diagnosed with ASD (Lovaas 1987; Schreibman 2000; Smith 1999; Weiss 1999).

The research in EIBI has largely grown out of the conceptual and scientific discipline of Applied Behavior Analysis (ABA). The increase in research and practice within this discipline has led to an increase in ABA services and behavior analytic professional training programs. Most of the professionals entering the field of behavior analysis (BACB Newsletter 2013) work with individuals diagnosed with ASD (Green 2010). Recent data shows that there are now over 17,000 certified behavior analysts and between 3000 and 5000 registered behavioral technicians (Carr et al. 2015). This data does not include the numerous professionals who are not certified in ABA but who have been implementing ABA based procedures for numerous years; nor does the data include those professionals who have been well trained in ABA (e.g., teachers) who are not necessarily certified. Today, there are both more individuals diagnosed with ASD and more professionals attempting to implement interventions based upon the principles and science of ABA than ever before.

A potential danger inherent in any field growing so rapidly and without advanced technology is that the fidelity of interventions can be compromised, not just the fidelity of particular procedures, but the fidelity of the overall approach (Solcum et al. 2014). Lack of fidelity to the process and boundaries of ABA is likely to result in an unsophisticated recipe based approach that is probably not sufficient to produce the outcomes seen in the EIBI research literature. Fortunately, there are many quality programs implementing EIBI intervention for individuals diagnosed with ASD. Such programs allow us to analyze and describe the necessary components to effectively implement ABA based programs. Such large scale programs can be found in university settings (Handleman and Harris 2005), private clinics (Leaf et al. 2011), and schools (Kamps et al. 1992). There are also many quality university based training programs that turn out well trained behavior analysts (Bernstein and Dotson 2010). Unfortunately, if rise of large scale implementation of ABA for individuals diagnosed with ASD and training do not advance at equal rates, there may be a trend towards incomplete manualization of procedures, rigid adherence to decontextualized protocols, and a potential of lack of understanding, or even worse, misunderstanding of the basic principles behind the procedures and interventions (Smith 2013). Losing the “analysis” in applied behavior analysis may be a danger.

Several of the present authors participated as designers and or implementers of the groundbreaking EIBI studies (e.g., Lovaas 1987; McEachin et al. 1993; Smith et al. 2000; Weiss 1999). Given the conditions and dangers of rapid growth, we would like to offer suggestions that seem critical in order to maintain fidelity and aid our ability to help children with autism progress. The suggestions here are all given in the spirit of science. That is, our hope is that all interventions will look very different over time. As we learn more, we will get better. Our technologies will change. Our scientific method will help us change. The suggestions here focus on methods to retain the analytical and responsive nature of a science based therapy.

In our collective clinical experience, research experience, and based upon our study of the empirical research, we argue that the best implementation of intervention based upon ABA occurs when the interventionist is skilled in analysis. Clinicians who are most effective learn to continually examine the impact of their interventions. Expert clinicians utilize a structured, yet flexible approach that is contingent and responsive to the child and to the environment. Highly trained interventionists are well versed in basic principles of behavior and scientific method, fully understand how to best arrange the elements of a protocol, and know how to alter and individualize curriculum and treatment strategies. The decisions of well-trained interventionists are based upon numerous factors that are often only recognizable once the intervention has commenced and child responding is observed. Furthermore, well trained interventionists are less likely to rely on decontextualized, recipe-based procedures (Roll-Pettersson et al. 2010). Appropriately trained behavior interventionists are truly *analysts*; rather than merely carrying out a protocol, they must analyze behavior and environment interactions moment by moment (Shook et al. 2002). Analysts take into account critical learning variables, such as the child's current motivation, responsiveness, and behaviors that may signal emotional states and contingencies (Leaf and McEachin 1999). They assess the current functions of behavior and determine if disruptive behaviors are potentially operant or respondent. They identify the optimal shaping and prompting strategies based upon past and present performance as well as the importance and difficulty of the tasks (Green 2010; Soluaga et al. 2008). Critical factors also include the child's nonverbal behaviors (e.g., facial expressions and body language) and the child's physical state. In effect, during intervention they are shaped by clear goal specification, knowledge of principles, scientific method, and current environmental contingencies, instead of rigid adherence to unresponsive protocols. They are able to achieve more rapid change in behavior by following the *intent* of the protocol rather than being bound to the *letter* of the protocol. These skills are

more complex than they appear at first glance. Perhaps the challenge to us as a field is to examine and identify training procedures that produce analysts. If we produce only interventionists, we are failing in our mission. The field requires professionals who can assess, adjust, and continually examine the effectiveness of their instructions.

In the early days of ABA, professionals in the field were fewer and often had significantly more extensive behavior analytic training (Lovaas 2002). These individuals typically employed an adaptable, analytic approach (Phillips et al. 1971; Wolf et al. 1995, 1964). The pioneers in the field were goal and science driven, innovative and nimble, stressed the analysis in clinical intervention, and were not protocol driven. They continually evaluated the effectiveness of intervention and made rapid changes in curriculum and intervention strategies as necessary. They employed the scientific method in their everyday practice. Lovaas was often quoted as saying, “If a child cannot learn in the way we teach, then we must teach in the way the child can learn.” This structured yet flexible approach was implemented during the UCLA Young Autism Project (Lovaas et al. 1973; Lovaas 1987; Leaf et al. 2008; Leaf 2015) and was utilized in many of the other groundbreaking, comprehensive ABA programs such as the Teaching Family Project (Phillips et al. 1971, 1974) and the Douglas Developmental Disabilities Center (Handleman and Harris 2005). Because it is an approach that promotes fluid and dynamic practice, it was productive in stimulating the development of many of the specific procedures in the field of ABA (e.g., shaping of vocal responses, prompting and prompt fading for motor imitation, teaching interactions for social behavior, the time-out ribbon for self-injurious behavior, and the token economy for self-help skills). Video recordings of behavioral artists, such as Ivar Lovaas shaping vocalizations (Lovaas and Leaf 1981) and Richard Foxx transforming self-injury into playing catch (Foxx and Gregorich 1980), exemplify the analytical approach. It is critical to note that development of such techniques went hand in hand with evaluation of the techniques (Baer et al. 1968).

As more professionals enter the field of ABA and implement these procedures with individuals diagnosed with ASD, it is important for them to be faithful to the science-based, progressive approach, which has always been the hallmark of ABA. Clinicians should be able to make responsive decisions, as opposed to rigidly adhering to a set protocol or following a manual without understanding the basic and advanced principles behind those procedures. It is not clear that current training programs are adequate for this task. It is possible, and it is our view, that trends in the field regarding how and under what conditions staff should be trained to implement ABA based interventions has changed (Lovaas 2002). It is our view that

rigid, non-responsive therapist behavior may result in lower quality services for children with ASD (Leaf et al. 2008). Non-responsive therapist behavior is not behavior analytic (Baer et al. 1968; Solcum et al. 2014). Additionally, reductionistic, ritualistic, non-responsive therapist behavior might contribute to outside professionals and parents misunderstanding ABA or having a negative view of ABA (Gernsbacher 2003, 2006). Unfortunately, much of the general public believes that ABA procedures are rigid and cannot be used to teach complex behaviors and that practitioners are merely technicians, lacking clinical sensitivity and prowess (e.g., Autism Treatment Center 2015; Winner 2007).

The purpose of this paper is to help identify some of the factors associated with the implementation of quality ABA, which takes a structured, responsive, and flexible approach using continual on-going analysis of the effectiveness of teaching and suggest that training programs be revised to focus on these factors. Here we describe several components of this approach and provide practitioners with rationales for why they should implement a flexible model. It is hoped that identification of these variables can be useful in supporting training programs to adopt a focus in these areas.

Components of a Comprehensive, Flexible and Progressive Approach

Not Just One Procedure

Today, the field of ASD intervention is comprised of several different treatment approaches (models of intervention). It is not uncommon to hear that a child is receiving intervention based upon the Lovaas Model (Lovaas 1987; Sallows and Graupner 2005), Skinner’s Analysis of Verbal Behavior (Applied Verbal Behavior) (Sundberg 2001), Pivotal Response Training (Koegel et al. 2014), or the Early Start Denver Model (Rogers et al. 2012). When professionals are saying that they are trained under a certain model it usually means that they are trained and following certain procedures that are conceptually systematic with beliefs of that model.

Although many models are useful under some conditions, we believe that quality EIBI intervention should not adhere to just one set of static procedures; instead, therapists should be able to implement a wide variety of procedures, all of which are based upon the principles and process of ABA (Baer et al. 1968). For individuals diagnosed with ASD to make the most meaningful gains they have to receive a comprehensive treatment approach where a variety of operant and respondent based procedures are implemented on a daily basis (Harris and Handleman 2000;

Lovaas 1987; Sallows and Graupner 2005). For example, to teach social skills or play skills, a therapist should know when and how to implement script fading (Krantz and McClannahan 1993), video modeling (Charlop-Christy et al. 2000), and role-playing (Leaf et al. 2012). To teach daily living skills a therapist should be able to task analyze the behavior to be taught (Parker and Kamps 2011) as well as implement shaping (Azrin and Foxx 1971), various prompting procedures (Graves et al. 2005), and various chaining procedures (Jerome et al. 2007). To decrease aberrant behavior a therapist should know how to conduct a functional assessment (Iwata et al. 1994) as well as implement time-out (Wolf et al. 1964), punishment procedures (Lerman and Vorndran 2002), extinction procedures (Iwata et al. 1994), various differential reinforcement procedures, and respondent procedures such as systematic desensitization (Koegel et al. 2004).

Based upon the empirical evidence, quality intervention is most likely to occur when therapists are well versed and able to implement a wide variety of procedures with a high degree of fidelity. Therapists should be able to implement more than one set of procedures (e.g., errorless learning) and they also need to understand the theoretical underpinnings of these procedures. They need to know why they work when they do and why they do not when they don't. This requires an understanding of the basic principles on which the procedures are based. Not all staff will be experts in all interventions that are conceptually derived from with ABA, but at least they should be trained on the procedures they are to implement and the conditions under which the procedures should be modified (Green 1996). If a therapist is only able to implement one specific procedure in a fixed way (e.g., errorless prompting), and is unable to effectively implement other important ABA procedures, usually fault lies in the quality of training they received. A well-trained behavior analyst should have the skills to understand under what conditions one would use or not use the different interventions and variants of the intervention. Training students of behavior analysis to be able to check off a list of procedures they have implemented is not the same as teaching them to be able to modify the procedures when a learner is failing to make progress despite the correct implementation of that procedure.

Instructional Arrangements

Procedures based upon the principles of ABA can be implemented in a variety of different instructional formats, which are on a continuum ranging from one-to-one instruction to large group instruction (Anderson and Romanczyk 1999). The majority of research, however, has been conducted in one-to-one instructional formats (Stahmer et al. 2005). It is not uncommon to hear

professionals state that ABA based procedures, especially discrete trial teaching, should occur primarily in a one-to-one instructional format (for example, see Texas Statewide Leaders for Autism Training, 2015).

Quality behavioral intervention should be implemented in a variety of instructional formats. Group instruction is essential for individuals diagnosed with ASD for several reasons. First, researchers have continually demonstrated that group instructional formats can lead to skill acquisition across a variety of skills, including language (Ledford et al. 2008), academic (Ledford et al. 2008), and social skills (Laugeson et al. 2014). Second, group instruction provides the opportunity for observational learning to occur (Charlop et al. 1983). This is a tremendous advantage because there are simply too many programs to teach an individual diagnosed with ASD. When children are learning through observation, the process is more efficient and children can learn continuously without the need for direct instruction (e.g., Ledford et al. 2008). Third, research has demonstrated that group instruction can sometimes be more efficient than one-to-one teaching (Leaf et al. 2012b). Fourth, group instruction is a closer approximation to teaching that occurs in school settings, which may lead to better generalization in their future settings and environments (Stokes and Baer 1977). Finally, group instruction may provide more social opportunities for the student.

Far more research is needed to demonstrate the benefits, conditions, and timing of various instructional formats. At this time, however, a well-trained therapist implementing quality ABA should have the skills to understand, for a given child, under what conditions one would arrange instruction individually and under what conditions one would arrange instruction in a group format. Until there is more data, there should be individualized assessment to determine when and how group instructional format can be introduced to a child. Once a student is learning effectively in a one-to-one instructional format, the therapist(s) should be well trained enough to know that shaping participation in small group instruction can and should begin. Thus, our training programs need to ensure that we train clinicians to implement intervention in both one-to-one instructional format as well as small and large group instructional formats.

Reinforcement

The provision of reinforcement is a core component of ABA-based procedures and it is one of the key components for increasing and maintaining desired behaviors (Cooper et al. 2007). It is important that a therapist who is implementing quality ABA be able to identify potential reinforcers (Fisher et al. 1992), condition items to be reinforcing (Singer-Dudek et al. 2011), and implement

reinforcement procedures on an appropriate schedule (Cooper et al. 2007). Today, there are several methods that have been developed by researchers to identify potential reinforcers, including the paired stimulus preference assessment (Fisher et al. 1992), the multiple stimulus without replacement (Restar and Noell 2008), and the multiple stimulus with replacement (DeLeon and Iwata 1996). There have been hundreds of studies that have evaluated formal preference assessments and they are widely used in clinical practice by behavior analysts (Graff and Karsten 2012). A recent survey by Graff and Karsten (2012) found that a majority of responders implement these formal preference assessments within their clinical practice on a regular basis, with a small percentage implementing them on a daily basis. Formal preference assessments are generally considered the “gold standard” in identifying potential reinforcers.

Although the use of formal preference assessments may be considered the “gold standard” it is critical to note that these procedures identify items selected from a narrow field and represent only the most often selected from the presented field, and not necessarily an effective reinforcer. Reinforcement is a term applied post hoc for a stimulus that has been shown to increase rates of responding. Unthoughtful delivery of stimuli selected often can result in poor learning outcomes. There are clear student behavioral indicators that the stimuli being delivered as a consequence for correct responding functions as a reinforcer. These behaviors include orienting to the instructor (both physically and visually), reaching for the stimulus, initiating responding, etc. Based upon recent empirical evidence we would argue that a quality ABA program and/or therapist should also use in-the-moment analysis (Leaf et al. 2015) of these behavioral indicators for effective use of reinforcers as opposed to relying exclusively on formal preference assessments as having identified stimuli that will function as reinforcers.

In-the-moment reinforcer analysis requires a therapist to make ongoing decisions about what stimuli are appropriate to the task and whether a stimulus is likely to function as a reinforcer, and make continuous observations regarding reinforcer effectiveness throughout teaching. This is in contrast to having a priori determination of stimuli that are restricted by a periodic assessment and limited to items that lend themselves to the specific researched protocols (e.g., eight items on a table top). There are multiple, observable factors (e.g., learner affect, learner interaction with the stimulus, previous history with the stimulus, and motivating operations) that impact reinforcer effectiveness; these variables are constantly changing and the behavior of the learner must be observed and analyzed on an ongoing basis in order to determine which potential stimulus will function best as a reinforcer at any given point in time. This

approach requires a therapist to engage in critical thinking (Green 2010), in-the-moment decision making (Soluaga et al. 2008), flexibility (Soluaga et al. 2008), direct observation and frequent probing to determine which stimuli to utilize. While this level of observation and analysis can be challenging, there are significant potential benefits.

Recent research has shown that reinforcers determined via in-the-moment reinforcer analysis versus paired stimulus preference assessment result in comparable rates of responding; however, the in-the-moment reinforcer analysis was significantly more efficient as there was no need to conduct formal preference assessments prior to teaching (Leaf et al. 2015). The amount of time saved by not conducting a formal preference assessment can be used to maximize teaching trials and may lead to quicker skill acquisition of new tasks. Incidentally, the in-the-moment reinforcer analysis is not incompatible with the occasional use of a formal preference assessment, nor is it conceptually inconsistent. There are certainly conditions where formal preference assessment may be needed; however, in a quality ABA program the use of in-the-moment reinforcer analysis may often be the best way to determine the current effects of potential reinforcers.

Another potential concern is the use of edibles as reinforcers in comprehensive ABA programs. These are commonly used as the reinforcer for increasing adaptive behaviors (ABA autism training-Chapter 2-Reinforcement, 2015). There are a number of reasons to find the use of edibles as reinforcers problematic, as they can contribute to unhealthy eating habits (Cohen and Babey 2012), they are unnatural in a majority of educational environments, and they may result in lost opportunities to expand social interaction skills, appropriate play skills, and social interest (all hallmark characteristics of individuals diagnosed with ASD). As long as there is heavy reliance on food reinforcement, therapists may overlook other potential reinforcers and the possibility of conditioning other stimuli to become sufficiently motivating reinforcers (Singer-Dudek et al. 2011). Quality ABA programs use a variety of reinforcers, including tangible items (Cooper et al. 2007), token economies (Ayllon and Azrin 1965), social interaction and increased privileges. The use of multiple reinforcers decreases the likelihood of satiation (Cooper et al. 2007) and mitigates the negative side effects created by the sole use of edible reinforcers.

To establish a variety of reinforcers that can be utilized, however, can be difficult as individuals diagnosed with ASD typically have limited or restricted interests (American Psychiatric Association 2013). Therefore, in a quality ABA program, therapists should be always attempting to expand and condition new items to be reinforcing (e.g., Singer-Dudek et al. 2011). Professionals have stated that reinforcement should not only motivate the student, but

also bring the student under the control of a variety of natural consequences, such as social affiliation, recognition, approval, play activities, special opportunities, privileges, and, most importantly, internalized motivation functioning as reinforcement (Leaf and McEachin 1999). This may be one of our most important outcomes, as entrance into the natural community of reinforcement is our goal (Baer and Wolf 1970). The natural communities often involve complex and nuanced reinforcers, not just skittles and slinkies. In a quality behavior analysis training program there should be a strong focus on teaching potential therapists to be able to establish a wide range of conditioned reinforcers and to be able to effectively and efficiently assess if something is or is not functioning as a reinforcer. Effectively establishing this repertoire would, in our view, go a long way towards improving the quality of interventions for individuals receiving services as well as the reputation of behavior analysts outside of our field.

Functional Analysis and Aberrant Behavior

One of the most researched (Beavers et al. 2013) and biggest contributions to the field of ABA and ASD has been the formalization of functional analysis (Iwata et al. 1994). Today, most of the research on functional analysis occurs in an analogue setting (e.g., hospital setting) as opposed to an individual's natural environment (Hanley et al. 2003). A fair criticism is that an analogue functional analysis often does not provide an evaluation of the client's behavior in his or her natural environment. A functional analysis or functional behavioral assessment that is conducted within the natural environment, would allow for better evaluation of how the individual's environment affects his or her behavior. Thus, a hallmark of quality ABA is evaluating functions of behavior within natural environments and only in unusual cases would an analogue functional analysis be necessary.

A second hallmark of a quality program is ensuring that therapists are using a knowledge of the function of aberrant behavior to prevent the behaviors from occurring. This is done by altering antecedent conditions to make the reinforcer more available on a predictable basis and by teaching alternative behavior to access the identified reinforcer. The last part of the process should be ensuring that the reinforcer maintaining the aberrant behavior is not available contingent upon engaging in the aberrant behavior. We are concerned that many training programs focus on the last part (extinction) and not on the proactive and instructional components.

That said, identifying the consequence maintaining the problem behavior can often be done without the use of a formal structural functional analysis. The over reliance on collecting objective data only (and not using or drawing

conclusions from subjective data) seems to be the norm in our field. Information regarding reinforcers maintaining problem behavior should be able to be identified by directly observing the changes in the post problem behavior environment. It is from there that the reinforcer emanates. Yet, antecedent analyses seem to dominate conversations about function. Without facts about consequences, there is little that can be done to prevent challenging behavior; quality ABA interventions should always aim to make identification of actual consequences that function to increase rates of responding (both for adaptive and maladaptive behavior) a priority. If attention is identified as functioning to reinforce behavior, then we need to ensure it is available on a regular and predictable basis for adaptive behavior (or even on a time based schedule); then we can also ensure that all therapists avoid providing attention contingent upon disruptive behaviors. If we truly believe that escape is maintaining a problem behavior, then we need to both limit escape following problem behavior (nearly impossible in many settings) and systematically develop tolerance for increasing response effort and duration. This can best be done when we have truly effective reinforcers.

A well trained therapist should know when he or she can evaluate the function of the behavior with standard functional assessment methodology (e.g., observations, informal interviews, and structured interviews) and in what conditions a functional experimental analysis is needed. A well trained therapist will be able to identify the standard four functions (Iwata et al. 1994) as well as other important variables (e.g., control or emotional release) which can be occurring in the natural environment. Additionally, a therapist should be trained in how to implement functional assessments within the client's natural setting. This is most effectively done by a therapist who is trained not only in the implementation of procedures, but in the theoretical underpinnings of a procedure or set of procedures. How to critically evaluate data from the use of such procedures is an essential skill of the well trained therapist.

Discrete Trial Teaching (DTT)

One of the most commonly implemented procedures for individuals diagnosed with ASD is DTT (Ghezzi 2007). DTT incorporates a basic three term contingency (antecedent-behavior-consequence), with the motivating operation being a possible fourth term, and an optional step of prompting (Leaf and McEachin 1999). When the procedure was first described by Lovaas et al. (1973), it was expected that therapists would implement the procedure with a great deal of flexibility (Leaf 2015); however, the procedure has drifted far away from how it was originally developed. DTT has, unfortunately, become heavily protocol driven with therapists often strictly following these

protocols; examples of protocol driven DTT include counterbalancing (Grow et al. 2011), or using simple instructions (Green 2001). We are concerned that protocol driven intervention is easy to train yet may limit some children from making the most progress. When DTT is implemented in a structured yet flexible approach (Leaf et al. 2015), the learner benefits from naturalized presentation of instruction due to the therapist making dynamic and variable choices in their implementation of the various aspects of intervention (e.g., varied instructions and prompts) based upon learner responding during instruction. This is the level of analysis that is ideal in instruction.

DTT begins with the teacher providing the learner with a discriminative stimulus (instruction), which informs the learner of what behavior he or she should display and that the opportunity for reinforcement is available. It is often the case that therapists today primarily use one topographical instruction per task (e.g., “Do This”) as opposed to utilizing varied topographies (e.g., “Do This”, “Copy Me”, “Follow Me.”) (Green 2001). It is also a common recommendation from professionals to use as few words as possible (e.g., “Touch nose”) as opposed to more natural wording (e.g., “Where’s your nose?”) (Green 2001).

In a quality program, during the implementation of DTT the instructor should make in-the-moment decisions on a case-by-case basis (or even trial-by-trial basis) as to the variability and complexity of instructions utilized. These decisions are based upon such factors as the criterion stimulus conditions (goal environments), the child’s language level, history with the task, and correctness of responding within a session. A progressive ABA approach is a dynamic process in which the instructor is continually fine tuning teaching strategies based on the goal behaviors, the child’s current repertoire, and what the child is doing at the moment of the teaching interactions. Thus, the instructor will vary the type of instruction based upon an evaluation and analysis of many factors, rather than complete a predetermined set of trials using stimuli that are not functioning as reinforcers currently and procedures that are resulting in continued errors.

An optional component of a DTT trial is the teacher providing a prompt to the student, which increases the likelihood of the student displaying the correct response (Wolery et al. 1992). There are many different prompt types that can be used, including physical guidance, gestural, positional, and verbal prompting (Wolery et al. 1992). There are also many different prompting systems that can be used, including least-to-most prompting (Heckaman et al. 1998), most-to-least prompting (Libby et al. 2008), progressive time delay (Heckaman et al. 1998), constant time delay (Knight et al. 2003), and no-no-prompt (Fentress and Lerman 2012). As with other areas of DTT, we would like to see training focus more on effective

analyses and protocol modification rather than therapists completely relying on protocols to make decisions. A goal for the profession would be to teach implementers the analytic skills that would enable natural variability in how such instruction is implemented.

Although under certain conditions (staff with limited training) it may be advantageous to strictly follow prompting protocols, a therapist who completed a quality training program should have the skills to modify prompting and fade prompts flexibly; this approach has been termed Flexible Prompt Fading (Soluaga et al. 2008). Flexible prompt fading has been described in curriculum manuals (Leaf and McEachin 1999) as well as research articles (e.g., Leaf et al. 2014). Recent research shows that it may be more efficacious than simple error correction procedures (Leaf et al. 2014), time delay prompting systems (Soluaga et al. 2008), and most-to-least prompting (Leaf et al. in press).

Therapists implementing a flexible prompt fading procedure can utilize any prompt type. The goal of the therapist is to keep the participant responding correctly at 80 % or above (prompted correct plus independent correct) across all trials. Prior to every trial, the therapist assesses the probability of the student responding correctly as well the potential detrimental effect of an error occurring. If the therapist judges that the student is likely to respond correctly on the trial, then the therapist should not provide a prompt; if the therapist judges that the student is likely to respond incorrectly, then the therapist should provide a prompt. The therapist also has to decide what level and type of prompt will generate a correct response without providing unnecessary assistance. There are multiple factors the therapist must evaluate on a trial by trial basis, including attending, the child’s responding on previous trials, novelty of the task, difficulty of the task, occurrence of off-task behavior, and history of prompt dependency (Soluaga et al. 2008). Incorporating training and competency assessments of these skills as part of the formal training of behavior analysts would be a welcome improvement.

In addition to the implementation of the discriminative stimulus and prompts, researchers and professionals have created several other rules about the implementation of DTT, including prescriptive counterbalancing (Grow et al. 2011), not providing corrective feedback (Gast 2012), interspersing maintenance tasks at a high rate to novel tasks (Benavides and Poulson 2009), and providing DTT in a distraction free environment (Green 2001). The “rules” surrounding DTT should in reality be *guidelines*, with each guideline being on a continuum, and applied based on in-the-moment assessment of a variety of relevant determinative factors and variables. Again, professionals would analyze the extent to which such factors could be altered or relaxed for individual learners.

For example, there are times when corrective feedback is clearly unnecessary or ineffective (e.g., if a student does not understand the boundaries of correct responding) (Gast 2012) and there are times when it is advantageous (e.g., if the student will alter his or her response based solely upon the feedback) (Leaf et al. 2014). There are times when work should occur in distraction-free environments (e.g., during frustration tolerance programs) and periods of time when a more chaotic learning environment is desirable (e.g., school readiness programs). In summary, in a quality ABA approach, a therapist should be able to implement DTT along every dimension on the guideline continuum and make in-the-moment assessments regarding procedural variations and applications throughout intervention.

The field appears to be moving in the direction of individualized application. This is consistent with the message of this article- application of the science should be individually tailored to the unique characteristics and needs of each learner.

Data Collection

What separates ABA from other psychological and educational approaches is reliance on objective data measuring observable events (Baer et al. 1968). When implementing procedures based upon the principles of ABA a therapist should take data to track a student's progress. Data should be useful, be worth the time taken away from other activities, not interfere with teachable moments, provide an accurate assessment, and not compete with social interactions (especially during reinforcer delivery).

Rather than a "one size fits all" data collection system, a variety of measurement systems can be used (Taubman et al. 2013), which include trial by trial data (Cummings and Carr 2009), time sampling (Meany-Daboul et al. 2007), probe trial data (Cummings and Carr 2009), and retrospective summary/estimation data (e.g., Lerman et al. 2011; Fiske and Delmolino 2012; Taubman et al. 2013). If, for example, the purpose of the data is to better understand the nuanced variations in a student's problem behavior or to track the acquisition characteristics of a rapid learner, then continuous data is indicated. However, if the purpose is to track a child's progress or determine mastery for community based intervention services (rather than research), then probe data may be the better option (see Taubman et al. 2013). Finally, if data are taken during a group instructional format then a combination of momentary time sampling and estimation data would likely be most appropriate (Taubman et al. 2013). A critically thinking and analytical therapist should be able to articulate the conditions under which they would select one data collection protocol over another. We believe this decision

should be made based upon data rather than rigid philosophy that precludes critical thinking about the impact on learners. The purpose of collecting data and a thoughtful understanding of the logistical considerations should drive data collection decisions. Therapists need to collect meaningful yet practical data that adequately measures progress, is usable, is doable, and does not interfere with the learning process.

Curriculum

Individuals diagnosed with ASD may have multiple deficits (e.g., social deficits, language deficits, behavioral deficits, and academic deficits); therefore, curriculum must be comprehensive to address these deficits. This necessitates therapists knowing how to implement a wide range of curricular targets. Therapists with limited curriculum knowledge often focus primarily on decreasing aberrant behaviors or increasing language or academic skills. Children diagnosed with ASD typically have several deficits and, therefore, the curriculum should address reducing aberrant behavior as well as teaching learning-how-to-learn skills, social skills, language, play, self-help skills, community skills, and academics. The curricular choices a therapist makes should be individualized and do not neatly fall into set phases. Curriculum books, such as *The Me Book* (Lovaas 1981) or *A Work In Progress* (Leaf and McEachin 1999), and curriculum assessments, such as the *VB MAPP* (Sundberg 2008), should be used as guidelines about what to teach rather than a cookbook of recipes to follow to the exclusion of knowledge of the core deficits of children on the autism spectrum.

It is not only sensible for an interventionist to utilize multiple curriculum books/assessments as *guidelines* but for curriculum to be individualized; that is, therapists should create their own curriculum based on students' unique individual needs. Curriculum targets should have meaning and value for the student, and be readily generalizable to everyday usage in the natural environment. For example, a curriculum addressing imitation (Leaf and McEachin 1999) is not just about learning to "tap head" or "clap", but rather about producing generalized imitation under relevant and generalizable conditions and then intertwining those stimuli and responses with other programs, such as play and conversation that may have importance in a particular child's life. A well-trained therapist should have the analytical skills and the applied understanding to implement a wide variety of meaningful programs, ensure that multiple areas (e.g., play, social, language, academics, etc.) are being addressed, individualize curriculum, and create their own programs to meet the unique needs of their clients.

Applied Significance

A danger inherent in any large scale, quickly growing area is a loss of focus on meaningful purpose, process, and outcomes. In the field of ABA, this might translate into dogmatic lack of attention to clinical significance, selection of impractical procedures, ritualistic data-collection, over-abundant usage of off-putting, dehumanizing terminology, disregard of logistical realities, and insensitivity to consumer issues. These are all characteristics of a reductionist approach, not a science-based progressive approach. A tradition of applied significance and prioritization of social considerations (e.g., Fawcett 1991; Wolf 1978) may be dismissed in favor of analogue, colonial, and unidirectional approaches. This could produce a lack of significant outcomes for children and only serve to further disenfranchise ABA from the general public. Balancing the “Applied” with the “Analytic” in ABA results in greater consumer satisfaction, more consistent utilization of procedures, embracing of ABA concepts and cultural adoption, and ultimately greater and more widespread interventional effectiveness. Doing so puts a more humane, acceptable, and attractive face on ABA, a discipline that was designed to move efforts from the lab to the amelioration of the problems of human behavior in everyday life (Wolf 1978).

Staff Training

To implement a quality ABA based program, therapists must utilize the scientific essence of ABA, have knowledge of a wide range of ABA principles, and demonstrate skill in implementation of procedures, as well as engage in a great deal of critical thinking (Green 2010), flexibility (Leaf 2015), in-the-moment analysis (Soluaga et al. 2008), clinical insight, and sensitivity to the clients and their families. Ultimately, therapists under this model are not implementing static ABA, but are combining science and care to create complex, dynamic, and effective intervention. Since a great deal of clinical judgment needs to be utilized in this approach it requires a great deal of training. Training to become a competent therapist takes a good deal of time. Researchers have shown that proficiently learning just one procedure within the realm of ABA intervention (e.g., functional analysis or discrete trial teaching), takes a good amount of time (Au et al. 2015; Whang 1982). Thus, being able to implement a variety of behavior analytic procedures, evaluate learning progress during those procedure, especially those requiring problems solving, and effectively being able to modify the intervention while instruction is underway will require intensive training.

Questions surrounding training, such as how much training is necessary, how it is best accomplished, and how to achieve clinical decision making skills in trainees,

urgently need to be addressed by researchers. Children diagnosed with ASD and their families not only deserve, but require, therapists who are well trained and are able to adjust their teaching strategies based upon the ever-changing environment and the child with whom they are working (Shook et al. 2002).

Conclusion

The purpose of this paper was to highlight areas of skill a quality ABA therapist must possess to develop and implement effective programming for individuals diagnosed with ASD. Research, as well as clinical experience, has shown that when EIBI is implemented with a high degree of quality that children can have meaningful outcomes (Reichow 2012). Both clinical experience and empirical evidence have shown that children who were unable to communicate have developed conversational language be able to speak after quality ABA has been implemented. We have seen children who engaged in high rates of aggression no longer engage in aberrant behavior when they are upset. Children who are lonely or depressed develop meaningful relationships after intervention. And we have seen children become indistinguishable from their peers. All of which resulted from the implementation of a quality ABA program.

Today, there are many programs that are implementing quality ABA on a continual basis and that are producing meaningful outcomes. We applaud the work that they continue to do. In addition, more and more professionals are coming into the field of ABA (Carr et al. 2015); although some of them will receive training in academic and clinical settings where quality ABA is provided, there will be some who will be trained by newer or less skilled/experienced professionals who, in our view, have not been adequately trained in ABA. Thus, the purpose of this paper was to provide a clearer view of areas where training programs need to better prepare new staff entering the field. It is our hope that clarifying the skills necessary to provide quality ABA may result in a refocusing of training in these programs. The paper may also provide parents with some guidance regarding parameters that they should look for within their children’s ABA based programs.

In this paper we suggest an approach that is conceptually consistent with Baer et al.’s (1968) description of ABA, has a long history and tradition within our science (Cooper et al. 2007), and has shown robust results (Reichow 2012). Our hope is that this commentary will bring about a fuller appreciation of a quality ABA approach, and will serve as a catalyst for reflection and dialogue amongst professionals and parents.

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References

- ABA Autism Training-Chapter 2-Reinforcement. (2015). Retrieved from: <https://www.youtube.com/watch?v=crFjZiWWZo0>.
- Akmanoglu, N., & Batu, S. (2004). Teaching pointing to numerals to individuals with autism using simultaneous prompting. *Education and Training in Developmental Disabilities, 39*, 326–336.
- Ala'i-Rosales, S., & Zeug, N. (2010). Three important things to consider when starting intervention for a child diagnosed with autism. *Behavior Analysis in Practice, 3*, 54–55.
- American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders: DSM-5*. Washington, D.C: American Psychiatric Association.
- Anderson, S. R., & Romanczyck, R. G. (1999). Early intervention for young children with autism: Continuum-based behavioural models. *Journal of the Association for Persons with Severe Handicaps, 24*, 162–173.
- Au, A. H. C., Mountjoy, T. J., Man, K. L. P., Leaf, J. B., Leaf, R. B., Taubman, M., et al. (2015). A programmatic description of an international private behaviorally orientated autism school. *Education and Treatment of Children, 38*, 121–144.
- Autism Treatment Center. (2015). *Joining-autism treatment-ABA vs the son-rise program*. Retrieved: http://www.autismtreatmentcenter.org/contents/other_sections/aba-vs-son-rise-program.php.
- Ayllon, T., & Azrin, N. (1965). *The token economy: A motivational system for therapy and rehabilitation*. New York, New York: Appleton-Century-Crofts.
- Azrin, N. H., & Foxx, R. M. (1971). A rapid method of toilet training the institutionalized retarded. *Journal of Applied Behavior Analysis, 4*, 88–99.
- BACB Newsletter. (2013). *BACB certificants now exceed 13,000 worldwide*. Retrieved from http://www.bacb.com/newsletter/BACB_Newsletter_5-13.pdf.
- Baer, D. M., & Wolf, M. M. (1970). The entry into natural communities of reinforcement. In R. Ulrich, H. H. Sachnik, & J. Mabry (Eds.), *Control of human behavior* (pp. 319–324). Glenville, IL: Scott, Foresman.
- Baer, D. M., Wolf, M. M., & Risley, T. R. (1968). Some current dimensions of applied behavior analysis. *Journal of Applied Behavior Analysis, 1*, 91–97.
- Beavers, G. A., Iwata, B. A., & Lerman, D. C. (2013). Thirty years of research on the functional analysis of problem behavior. *Journal of Applied Behavior Analysis, 46*, 1–21.
- Benavides, C. A., & Poulson, C. L. (2009). Task interspersal and performance of matching tasks by preschoolers with autism. *Research in Autism Spectrum Disorders, 3*, 619–629.
- Bernstein, D., & Dotson, W. (2010). Promoting teaching excellence in professional education of behavior analysts. *European Journal of Behavior Analysis, 11*, 277–288.
- Bibby, P., Eikeseth, S., Martin, N. T., Mudford, O. C., & Reeves, D. (2001). Progress and outcomes for children with autism receiving parent-managed intensive interventions. *Research in Developmental Disabilities, 22*, 425–447.
- Carr, J. E., Howard, J. S., & Martin, N. T. (2015). An update on the behavior analyst certification board. In *Panel discussion presented at the Association for Behavior Analysis International 41st annual convention*. San Antonio, Texas.
- Charlop, M. H., Schreibman, L., & Tryon, A. S. (1983). Learning through observation: The effects of peer modeling on acquisition and generalization in autistic children. *Journal of Abnormal Child Psychology, 11*(3), 355–366.
- Charlop-Christy, M. H., Le, L., & Freeman, K. A. (2000). A comparison of video modeling with in vivo modeling for teaching children with autism. *Journal of Autism and Developmental Disorders, 30*, 537–552.
- Chasson, G. S., Harris, G. E., & Neely, W. J. (2007). Cost comparison of early intensive behavioral intervention and special education for children with autism. *Journal of Child and Family Studies, 16*, 401–413.
- Cohen, D. A., & Babey, S. H. (2012). Candy at the cash register-A risk factor for obesity and chronic disease. *The New England Journal of Medicine, 367*, 1381–1383.
- Cooper, J. O., Heron, T. E., & Heward, W. L. (2007). *Applied behavior analysis* (2nd ed.). Upper Saddle River, NJ: Pearson Education Inc.
- Cummings, A. R., & Carr, J. E. (2009). Evaluating progress in behavioral programs for children with autism spectrum disorders via continuous and discontinuous measurement. *Journal of Applied Behavior Analysis, 42*, 57–71.
- DeLeon, I. G., & Iwata, B. A. (1996). Evaluation of a multiple-stimulus presentation format for assessing reinforcer preferences. *Journal of Applied Behavior Analysis, 29*, 519–533.
- Eikeseth, S. (2010). Examination of qualifications required of an EIBI professional. *European Journal of Behavior Analysis, 2*, 239–246.
- Fawcett, S. B. (1991). Social validity: A note on methodology. *Journal of Applied Behavior Analysis, 24*, 235–239.
- Fentress, G. M., & Lerman, D. C. (2012). A comparison of two prompting procedures for teaching basic skills to children with autism. *Research in Autism Spectrum Disorders, 6*, 1083–1090.
- Fisher, W., Piazza, C. C., Bowman, L. G., Hagopian, L. P., Owens, J. C., & Slevin, I. (1992). A comparison of two approaches for identifying reinforcers for persons with severe and profound disabilities. *Journal of Applied Behavior Analysis, 25*, 491–498.
- Fiske, K., & Delmolino, L. (2012). Use of discontinuous methods of data collection in behavioral intervention: Guidelines for Practitioners. *Behavior Analysis in Practice, 5*, 77–81.
- Flynn, L., & Healy, O. (2012). A review of treatments for deficits in social skills and self-help skills in autism spectrum disorder. *Research in Autism Spectrum Disorders, 6*, 431–441.
- Foxx, R. M., & Gregorich, D. M. (1980). *Harry, behavioral treatment of self abuse. Analysis and intervention in developmental disabilities*. Champaign, IL: Research Press Company, H.E.L.P Inc.
- Gast, D. L. (2012). An experimental approach for selecting a prompting strategy for children with developmental disabilities. *Evidence-Based Communication Assessment and Intervention, 5*, 149–155.
- Gernsbacher, M. A. (2003). Is one style of early behavioral intervention “scientifically proven?”. *Journal of Developmental and Learning Disorders, 7*, 19–25.
- Gernsbacher, M. A. (2006). The Science of autism: Beyond the myths and misconceptions. In *Paper presented at the meeting of the national autism committee*, Nashua, NH.
- Ghezzi, P. M. (2007). Discrete trials teaching. *Psychology in the Schools, 44*, 667–679.
- Graff, R. B., & Karsten, A. M. (2012). Assessing preference of individuals with developmental disabilities: A survey of current practices. *Behavior Analysis in Practice, 5*, 37.
- Graves, T. B., Collins, B. C., Schuster, J. W., & Kleinert, H. (2005). Using video prompting to teach cooking skills to secondary students with moderate disabilities. *Education and Training in Developmental Disabilities, 40*, 34–46.
- Green, G. (1996). Early behavioral intervention for autism: What does research tell us? In C. Maurice, G. Green, & S. C. Luce (Eds.),

- Behavioral intervention for young children with autism: A manual for parents and professionals.* Pro-Ed: Austin, Texas.
- Green, G. (2001). Behavior analytic instruction for learners with autism: Advances in stimulus control technology. *Focus on Autism and Other Developmental Disabilities, 16*, 72–85.
- Green, G. (2010). Training practitioners to evaluate evidence about interventions. *European Journal of Behavior Analysis, 11*, 223–228.
- Grow, L. L., Carr, J. E., Kodak, T. M., Jostad, C. M., & Kisamore, A. N. (2011). A comparison of methods for teaching receptive labeling to children with autism spectrum disorders. *Journal of Applied Behavior Analysis, 44*, 475–498.
- Handleman, J. S., & Harris, S. L. (2005). Douglass developmental disabilities center: An ABA program for children and adults with autism spectrum disorders. *International Journal of Behavioral Consultation and Therapy, 1*, 301–311.
- Hanley, G. P., Iwata, B. A., & McCord, B. E. (2003). Functional analysis of problem behavior: A review. *Journal of Applied Behavior Analysis, 36*, 147–185.
- Harris, S. L., & Handleman, J. S. (2000). Age and IQ at intake as predictors of placement for young children with autism: A four-to-six year follow-up. *Journal of Autism and Developmental Disorders, 30*, 137–142.
- Heckaman, K. A., Alber, S., Hooper, S., & Heward, W. L. (1998). A comparison of least-to-most prompts and progress time delay on the disruptive behavior of students with autism. *Journal of Behavioral Education, 8*, 171–201.
- Iwata, B. A., Pace, G. M., Cowdery, G. E., & Miltengberger, R. G. (1994a). What makes extinction work: An analysis of procedural form and function. *Journal of Applied Behavior Analysis, 27*, 131–144.
- Iwata, B. A., Pace, G. M., Dorsey, M. F., Zarcone, J. R., Vollmer, T. R., Smith, R. G., et al. (1994b). The functions of self-injurious behavior: An experimental-epidemiological analysis. *Journal of Applied Behavior Analysis, 27*, 215–240.
- Jacobson, J. W., Mulick, J. A., & Green, G. (1998). Cost-benefit estimates for early intensive behavioral intervention for young children with autism: General model and a single state case. *Behavioral Interventions, 13*, 201–226.
- Jerome, J., Frantino, E. P., & Sturmey, P. (2007). The effects of errorless learning and backward chaining on the acquisition of internet skills in adults with developmental disabilities. *Journal of Applied Behavior Analysis, 40*, 185–189.
- Kamps, D. M., Leonard, B. R., Vernon, S., Dugan, E. P., Delquardi, J., Gershon, B., et al. (1992). Teaching social skills to students with autism to increase peer interactions in an integrated first-grade classroom. *Journal of Applied Behavior Analysis, 25*, 281–288.
- Knight, M. G., Ross, D. E., Taylor, R. L., & Ramasamy, R. (2003). Constant time delay and interspersal of known items to teach sight words to students with mental retardation and learning disabilities. *Education and Training in Developmental Disabilities, 38*, 179–191.
- Koegel, R. L., Bradshaw, J. L., Ashbaugh, K., & Koegel, L. K. (2014). Improving question-asking initiations in young children with autism using pivotal response treatment. *Journal of Autism and Developmental Disorders, 44*, 816–827.
- Koegel, R. L., Openden, D., & Koegel, L. K. (2004). A systematic desensitization paradigm to treat hypersensitivity to auditory stimuli in children with autism in family contexts. *Research and Practice for Persons with Severe Disabilities, 29*, 122–134.
- Koegel, R. L., Werner, G. A., Vismara, L. A., & Koegel, L. K. (2005). The effectiveness of contextually supported play date interactions between children with autism and typically developing peers. *Research and Practice for Persons with Severe Disabilities, 30*, 93–102.
- Krantz, P. J., & McClannahan, L. E. (1993). Teaching children with autism to initiate to peers: Effects of a script-fading procedure. *Journal of Applied Behavior Analysis, 26*, 121–132.
- Laugeson, E. A., Ellingsen, R., Sanderson, J., Tucci, K., & Bates, S. (2014). The ABC's of teaching social skills to adolescents with autism spectrum disorder in the classroom: The UCLA PEERS program. *Journal of Autism and Developmental Disorders, 44*, 2244–2256.
- Leaf, R. B. (2015). *The Lovaas model: Love it or hate it, but at least understand it!* In Presented at evidence based autism spectrum disorder intervention CAS and autism partnership conference. Las Vegas, NV.
- Leaf, J. B., Leaf, R., Alacalay, A., Leaf, J. A., Ravid, D., Dale, S., et al. (2015). Utility of formal preference assessments for individuals diagnosed with autism spectrum disorder. *Education and Training in Autism and Developmental Disabilities, 50*, 119–212.
- Leaf, J. B., Leaf, J. A., Alacalay, A., Kassardjian, A., Tsuji, K., Dale, S., et al. (in press). Comparison of most-to-least prompting to flexible prompt fading for children with autism spectrum disorder. *Exceptionality*.
- Leaf, J. B., Leaf, R., Taubman, M., McEachin, J., & Delmolino, L. (2014). Comparison of flexible prompt fading to error correction for children with autism spectrum disorders. *Journal of Developmental and Physical Disabilities, 26*, 203–224.
- Leaf, R. B., & McEachin, J. J. (1999). *A work in progress: Behavior management strategies and a curriculum for intensive behavioral treatment of autism*. New York, NY: Different Roads to Learning.
- Leaf, R. B., McEachin, J. J., & Taubman, M. (2008). *Sense and nonsense in the behavioral treatment of autism: It has to be said*. New York, NY: Different Roads to Learning.
- Leaf, J. B., Oppenheim-Leaf, M. L., Call, N. A., Sheldon, J. B., Sherman, J. A., Taubman, M., et al. (2012a). Comparing the teaching interaction procedure to social stories for people with autism. *Journal of Applied Behavior Analysis, 45*, 281–298.
- Leaf, R. B., Taubman, M. T., McEachin, J., Leaf, J. B., & Tsuji, K. H. (2011). A program description of a community-based intensive behavioral intervention program for individuals with autism spectrum disorders. *Education and Treatment of Children, 34*, 259–285.
- Leaf, J. B., Tsuji, K. H., Lentell, A. E., Dale, S. E., Kassardjian, A., Taubman, M., et al. (2012b). A comparison of discrete trial teaching implemented in a one-to-one instructional format and in a group instructional format. *Behavioral Interventions, 28*, 82–106.
- Ledford, J. R., Gast, D. L., Luscre, D., & Ayres, K. M. (2008). Observational and incidental learning by children with autism during small group instruction. *Journal of Autism and Developmental Disabilities, 38*, 86–103.
- Lerman, D. C., Dittlinger, L. H., Fentress, G., & Lanagan, T. (2011). A comparison of methods for collecting data on performance during discrete trial teaching. *Behavior Analysis in Practice, 4*, 53–62.
- Lerman, D. C., & Vorndran, C. M. (2002). On the status of knowledge for using punishment: Implications for treating behavior disorders. *Journal of Applied Behavior Analysis, 35*, 431–464.
- Libby, M. E., Weiss, J. S., Bancroft, S., & Ahearn, W. H. (2008). A comparison of most-to-least and least-to-most prompting on the acquisition of solitary play skills. *Behavior Analysis in Practice, 1*, 37–43.
- Lovaas, O. I. (1981). *Teaching developmentally disabled children: The Me book*. Austin, TX: PRO-ED Books.
- Lovaas, O. I. (1987). Behavioral treatment and normal educational and intellectual functioning in young autistic children. *Journal of Consulting and Clinical Psychology, 55*, 3–9.

- Lovaas, O. I. (2002). *Celebration of Donald M. Baer*. In Paper presented at the Celebration of Donald M. Baer, Lawrence, Kansas.
- Lovaas, O. I., Koegel, R., Simmons, J. Q., & Long, J. S. (1973). Some generalization and follow-up measures on autistic children in behavior therapy. *Journal of Applied Behavior Analysis, 6*, 131–166.
- Lovaas, O. I., & Leaf, R. B. (1981). *Teaching developmentally disabled children: The Me book video tapes*. Baltimore: University Park Press.
- Matson, J. L., & Kozlowski, A. M. (2011). The increasing prevalence of autism spectrum disorders. *Research in Autism Spectrum Disorders, 5*, 418–425.
- McEachin, J. J., Smith, T., & Lovaas, O. I. (1993). Long-term outcome for children with autism who received early intensive behavioral treatment. *American Journal on Mental Retardation, 97*, 359–372.
- Meany-Daboul, M. G., Roscoe, E. M., Bourret, J. C., & Ahearn, W. H. (2007). A comparison of momentary time sampling and partial-interval recording for evaluating functional relations. *Journal of Applied Behavior Analysis, 40*, 501–514.
- Oppenheim-Leaf, M. L., Leaf, J. B., & Call, N. A. (2012). Teaching board games to two children with an autism spectrum disorder. *Journal of Developmental and Physical Disabilities, 24*, 347–358.
- Parker, D., & Kamps, D. (2011). Effects of task analysis and self-monitoring for children with autism in multiple social settings. *Focus on Autism and Other Developmental Disabilities, 26*, 131–142.
- Phillips, E. L., Phillips, E. A., Fixsen, D. L., & Wolf, M. M. (1971). Achievement place: Modification of the behaviors of pre-delinquent boys within a token economy. *Journal of Applied Behavior Analysis, 4*, 45–59.
- Phillips, E. L., Phillips, E. A., Fixsen, D. L., & Wolf, M. M. (1974). *The teaching-family handbook* (2nd ed.). Lawrence, KS: University Press of Kansas.
- Reichow, B. (2012). Overview of meta-analyses on early intensive behavioral intervention for young children with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 42*, 512–520.
- Restar, J. L., & Noell, G. H. (2008). Evaluating preference assessment for use in the general education population. *Journal of Applied Behavior Analysis, 41*, 447–451.
- Rogers, S. J., Estes, A., Lord, C., Vismara, L., Winter, J., Fitzpatrick, A., et al. (2012). Effects of a brief Early Start Denver Model (ESDM)-based parent intervention on toddlers at risk for autism spectrum disorders: A randomized controlled trial. *Journal of the American Academy of Child and Adolescent Psychiatry, 51*, 1052–1065.
- Roll-Pettersson, L., Alai-Rosales, S., Keenan, M., & Dillenburger, K. (2010). Teaching and learning technologies in higher education: Applied behaviour analysis and autism; “Necessity is the mother of invention”. *European Journal of Behavior Analysis, 11*, 247–259.
- Sallows, G. O., & Graupner, T. D. (2005). Intensive behavioral treatment for children with autism: Four-year outcome and predictors. *American Journal on Mental Retardation, 6*, 417–438.
- Schreibman, L. (2000). Intensive behavioral/psychoeducational treatments for autism: Research needs and future directions. *Journal of Autism and Developmental Disorders, 30*, 373–378.
- Shook, G. L., Ala'i-Rosales, S., & Glenn, S. (2002). Certification and training of behavior analyst professionals. *Behavior Modification, 26*(1), 27–48.
- Singer-Dudek, J., Oblak, M., & Greer, R. D. (2011). Establishing books as conditioned reinforcers for preschool children as a function of an observational intervention. *Journal of Applied Behavior Analysis, 44*, 421–434.
- Smith, T. (1999). Outcome of early intervention for children with autism. *Clinical Psychology: Science and Practice, 6*, 33–49.
- Smith, T. (2013). What is evidence-based behavior analysis? *The Behavior Analyst, 36*, 7–33.
- Smith, T., Groen, A. D., & Wynn, J. W. (2000). Randomized trials of intensive early intervention for children with pervasive developmental disorders. *American Journal of Mental Retardation, 105*, 269–285.
- Solcum, T. A., Detrich, R., Wilczynski, S. M., Spencer, T. D., Lewis, T., & Wolfe, K. (2014). The evidence-based practice of applied behavior analysis. *The Behavior Analyst, 37*, 41–56.
- Soluaga, D., Leaf, J. B., Taubman, M., McEachin, J., & Leaf, R. (2008). A comparison of flexible prompt fading and constant time delay for five children with autism. *Research in Autism Spectrum Disorders, 2*, 753–765.
- Stahmer, A. C., Collings, N. M., & Palinkas, L. A. (2005). Early intervention practices for children with autism: Descriptions from rom community providers. *Focus on Autism and Other Developmental Disabilities, 20*, 66–79.
- Stokes, T. F., & Baer, D. M. (1977). An implicit technology of generalization. *Journal of Applied Behavior Analysis, 10*, 349–367.
- Sundberg, M. L. (2001). The benefits of Skinner’s analysis of verbal behavior for children with autism. *Behavior Modification, 25*, 698–724.
- Sundberg, M. L. (2008). *Verbal behavioral milestones assessment and placement program: the VB-MAPP*. Concord: AVB Press.
- Taubman, M. T., Leaf, R., McEachin, J., Papovich, S., & Leaf, J. B. (2013). A comparison of data collection techniques used with discrete trial teaching. *Research in Autism Spectrum Disorders, 7*, 1026–1034.
- Taylor, B. A., & Fisher, J. (2010). Three important things to consider when starting intervention for a child diagnosed with autism. *Behavior Analysis in Practice, 3*, 52–53.
- Texas Statewide Leaders for Autism Training. (2015). Retrieved from <http://www.txautism.net/target-texas-autism-resource-guide-for-effective-teaching>.
- Vets, T. L., & Green, G. (2010). Three important things to consider when starting interventions for a child diagnosed with autism. *Behavior Analysis in Practice, 3*, 56–57.
- Weiss, M. J. (1999). Differential rates of skill acquisition and outcomes of early intensive behavioral interventions for autism. *Behavioral Interventions, 14*, 3–22.
- Weiss, M. J., & Zane, T. (2010). Three important things to consider when starting intervention for a child diagnosed with autism. *Behavior Analysis in Practice, 3*, 58–60.
- Whang, P. L., Fletcher, K. R., & Fawcett, S. B. (1982). Training counseling skills: An experimental analysis and social validation. *Journal of Applied Behavior Analysis, 15*, 325–334.
- Winner, M. G. (2007). *Thinking about you thinking about me*. San Jose, CA: Think Social Publishing INC.
- Wolery, M., Ault, J. M., & Doyle, P. (1992). *Teaching students with moderate to severe disabilities. Use of response prompting strategies*. New York: Longman.
- Wolf, M. M. (1978). Social validity: The case for subjective measurement or how applied behavior analysis is finding its heart. *Journal of Applied Behavior Analysis, 11*, 203–214.
- Wolf, M. M., Kirigin, K. A., Fixsen, D. L., Blasé, K. A., & Braukmann, C. J. (1995). The teaching family model: A case study in data-based program development and refinement (and dragon wrestling). *Journal of Organizational Behavior Management, 15*, 11–68.
- Wolf, M. M., Risley, T. R., & Mees, H. (1964). Application of operant conditioning procedures to the behavioral problems of an autistic child. *Behaviour Research and Therapy, 1*, 305–312.