

Evolution of Research on Interventions for Individuals with Autism Spectrum Disorder: Implications for Behavior Analysts

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The extraordinary success of behavior-analytic interventions for individuals with autism spectrum disorder (ASD) has fueled the rapid growth of behavior analysis as a profession. One reason for this success is that for many years behavior analysts were virtually alone in conducting programmatic ASD intervention research. However, that era has ended. Many investigators from other disciplines are now carrying out large-scale intervention studies and beginning to report successes of their own. The increasing number and range of studies has the potential to improve services for individuals with ASD, and it challenges behavior analysts to intensify their research efforts.

Key words: autism, pervasive developmental disorder, behavior analysis, behavior modification, treatment effectiveness research

For nearly half a century, behavior analysts were virtually alone in conducting programmatic studies on interventions for individuals with autism spectrum disorders (ASD) (Smith, 2008). During this time, behavior analysts published many hundreds of peer-refereed, data-based investigations documenting that applied behavior-analytic (ABA) interventions help many individuals with ASD communicate with others, engage in play and leisure activities with peers and caregivers, carry out self-care activities such as toileting and dressing, acquire academic and vocational skills, and manage disruptive behaviors such as tantrums (National Autism Center, 2009). One exemplary achievement has been early intensive ABA, which involves 20 to 40 hr per week of individualized instruction for 2 to 3 years beginning in the toddler and preschool years. Numer-

ous studies indicate that this approach enables some children with ASD to catch up to their peers in developmental domains such as cognitive skills, academics, and adaptive behavior (Eldevik et al., 2009). These successes have brought much public attention to ABA interventions, contributed to the growth of ABA as a profession, and led many reviewers to designate ABA approaches as the only empirically supported interventions for individuals with ASD (Lilienfeld, 2005; Rogers & Vismara, 2008).

However, research on ASD interventions is currently undergoing a dramatic transformation that appears to have attracted little notice from behavior analysts. Research by investigators from other disciplines has accelerated rapidly (Interagency Autism Coordinating Committee [IACC], 2011) and is beginning to yield reports of successes comparable to those in the ABA literature (Dawson et al., 2010; Kasari, Paparella, Freeman, & Jahromi, 2008). Although such results are encouraging for individuals with ASD and their families, they are also a sign that the time has come for behavior analysts to start paying attention to what is

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happening and reinvigorate their own research efforts.

EVOLUTION OF ASD INTERVENTION RESEARCH

As prevalence estimates for ASD rise and the burden that ASD places on affected individuals, families, and society is documented with ever greater precision, ASD has emerged as a major public health issue (IACC, 2011). For example, the Combating Autism Act (2006), “considered by some to be the most comprehensive piece of single-disease legislation ever passed by the United States Congress” (Autism Speaks, 2011), was essentially a declaration of war on ASD by the federal government, akin to those declared in the past against conditions such as human immunodeficiency virus, cancer, and drug abuse. This act authorized funding of hundreds of millions of dollars for research on ASD, much of it focused on intervention studies. Grants to support ASD intervention research are now available from large private foundations (notably Autism Speaks) and many federal agencies in the United States, including the National Institute of Mental Health (NIMH), Institute of Education Sciences, Maternal and Child Health Bureau, and even the Department of Defense (in keeping with the “war” theme). The public health concerns and burgeoning opportunities for funding attract new investigators as well as established investigators who formerly specialized in other kinds of ASD research (e.g., early signs of ASD) or in intervention research with other clinical populations.

Funders give priority to randomized clinical trials (RCTs), which assign large numbers of participants by chance to intervention and control groups. Until recently, RCTs of ASD interventions were rare. In 2005, an NIMH working group (Lord et al., 2005) identified only one published RCT of a comprehensive intervention program (Smith, Groen, & Wynn,

2000) and a handful of RCTs on other interventions. However, this situation has changed with the increase in funding and accompanying emphasis on RCTs. Several types of RCT, along with examples of specific studies and their sample sizes, illustrate the extent to which RCTs have proliferated.

Psychotropic Medication

Two RCTs (Marcus et al., 2009, $N = 218$; Owen et al., 2009, $N = 98$) indicated that a second generation antipsychotic (SGA) medication, aripiprazole (Abilify), markedly reduced irritable behavior such as tantrums and aggression in children with ASD who displayed high levels of such behavior. This finding led to approval from the United States Food and Drug Administration (FDA) for aripiprazole as a treatment for individuals with ASD accompanied by intense irritability. Another SGA, risperidone (Risperdal), previously received FDA approval for this use, based on support from RCTs (e.g., McCracken et al., 2002, $N = 101$).

Focused ABA Interventions Packaged for Implementation by Nonspecialists

Johnson et al. (2007) developed a detailed manual for training parents to use ABA interventions to prevent or reduce problem behavior. The training is time limited (approximately 11 sessions, each lasting 1 to 1.5 hr) and can be delivered by a range of masters-level practitioners. Aman et al. (2009, $N = 125$) found that this training augmented the benefits of risperidone. Other RCTs have evaluated the picture exchange communication system (PECS) as delivered by nonspecialists. For example, Howlin, Gordon, Pasco, Wade, and Charman (2007, $N = 84$) and Yoder and Stone (2006, $N = 24$) taught educators and parents, respectively, to implement PECS, and children in both studies showed gains in communication skills.

Clinical Behavior Therapy and Cognitive Behavioral Therapy

Investigators have created and tested several different models of clinical or cognitive behavioral therapy. Examples include (a) social skills training programs that involve 12 to 16 weeks of outpatient sessions for children and adolescents with high-functioning ASD (HFASD) (e.g., Begeer et al., 2011, $N = 40$; Lauge-son, Frankel, Mogil, & Dillon, 2009, $N = 33$); (b) a 16-session anxiety-reduction program for children with HFASD (Wood et al., 2009, $N = 40$); (c) computer software, accompanied by systematic token reinforcement, to teach children with HFASD to identify physical features of faces, expressions of affect, and direction of eye gaze (Tanaka et al., 2010, $N = 117$); and (d) intensive summer camp programs that involve contingency management and skills training for children with HFASD (Lopata et al., 2010, $N = 36$).

Developmental Interventions

The distinction between developmental interventions and less structured ABA interventions (e.g., incidental teaching) is somewhat murky. Developmental interventions provide instruction in the context of naturally occurring, child-led play activities, as occurs in many ABA procedures (e.g., Koegel & Koegel, 2006). However, developmental interventions aim for a continuous flow of back-and-forth social communication rather than the discrete trials or separate learning units that comprise most ABA interventions (Prizant & Wetherby, 2005). They also focus on encouraging this communication by imitating and systematically expanding on the child's actions and verbalizations (Rogers & Dawson, 2010). Although these strategies can be explained from an ABA perspective (e.g., Dube, MacDonald, Mansfield, Holcomb, & Ahearn, 2004) and operationalized for use in ABA interventions (e.g., Ingersoll &

Schreibman, 2006; Whalen & Schreibman, 2003), they are not a standard part of published ABA curricula (e.g., Koegel & Koegel, 2006; Lovaas, 2003). Numerous published RCTs center on training parents to implement developmental interventions for their children with ASD (e.g., Aldred, Green, & Adams, 2004, $N = 28$; Carter et al., 2011, $N = 62$; Drew et al., 2002, $N = 24$; J. Green et al., 2010, $N = 152$; Kasari, Gulsrud, Wong, Kwon, & Locke, 2010, $N = 38$; Oosterling et al., 2010, $N = 75$). An interim report of an RCT that focuses on parent training in the developmental individual-difference relationship-based model (often called floortime) indicated that this model was associated with improved social interaction, although scores on standardized tests of language did not change ($N = 51$; Casenhiser, Shanker, & Stieben, in press). In addition, Kasari and colleagues ($N = 58$; Kasari, Freeman, & Paparella, 2006; Kasari et al., 2008) found gains in nonverbal communication, pretend play, and tests of IQ and language skills from approximately 12 hr of developmental intervention, combined with ABA approaches, delivered by study clinicians. Dawson et al. (2010, $N = 48$) reported gains in IQ and reduction in autistic behaviors following a comprehensive home-based program that combined developmental approaches with an ABA intervention (pivotal response treatment). Landa, Holman, O'Neill, and Stuart (2011, $N = 60$) described positive outcomes from a comprehensive, center-based developmental program.

IMPLICATIONS

Behavior analysts probably will have strong reservations about the research summarized in the preceding section. RCTs have limitations that are well known in our profession, especially a focus on the average change within an intervention group instead of the more clinically relevant

analysis of change made by each individual participant (G. Green, 2008; Johnston, 1988; Keenan & Dillenburger, 2011). Many RCTs for individuals with ASD are open to criticism on other grounds, such as relying on ratings by parents or clinicians as opposed to direct observation of the behaviors targeted in the intervention (Singh, Matson, Cooper, Dixon, & Sturmey, 2005).

However, rejecting RCTs outright is unjustifiable because, even when criticizing them as a methodology, we behavior analysts routinely cite them as evidence to support our own interventions, such as early intensive ABA for individuals with ASD (G. Green, 2008; Keenan & Dillenburger, 2011). Furthermore, such citations are entirely consistent with long-held views within our profession. Skinner (1968) commented, "We still use group comparisons to test different kinds of therapies" and added that such comparisons "roughly correspond to those in the field of public health" (p. 249). Similarly, Johnston and Pennypacker (1993) observed that group comparisons are "valid" for "actuarial" purposes such as performing "large-scale educational evaluation" or contrasting different interventions (p. 96) and are "quite appropriate" (p. 190) in that context. As previously noted, "public health" and "actuarial" concerns are precisely the factors that drive the upsurge in funding for ASD intervention research. Such concerns are amply justified, given the heavy burden (financial and otherwise) associated with ASD. Therefore, RCTs are pertinent, and behavior analysts will need to take a more nuanced view about them (discussed further in the next sections).

Behavior analysts also may doubt whether the benefits reported in recent RCTs are sufficiently large or consistent to deserve serious consideration. To be sure, RCTs do indicate that some developmental interventions for individuals with ASD may be ineffective (Carter et al., 2011) or produce only circumscribed gains (J.

Green et al., 2010). In addition, with the exception of RCTs on medications, most RCTs that yielded favorable findings have yet to be replicated by independent investigators. In addition, although most RCTs measure outcomes in key domains such as social communication, they seldom assess other domains that are also vital (e.g., self-help skills or restricted or repetitive behavior).

Nevertheless, the studies have led to two FDA-approved medications (risperidone and aripiprazole) and one clinical behavior therapy identified as "evidence based" in a systematic review (outpatient treatment for anxiety displayed by individuals with HFASD; Lang, Regeister, Lauderdale, Ashbaugh, & Haring, 2010). Studies also have produced promising reports of gains in IQ and reductions in ASD behaviors measured from direct observation (e.g., Dawson et al., 2010; Kasari et al., 2006, 2008; Landa et al., 2011). In some instances, improvements on these variables have been detected after only a few hours of intervention (e.g., 30 min per day for 5 to 6 weeks in Kasari et al., 2006, 2008). Moreover, these studies are just the beginning. A search for *autism intervention* or *autism treatment* on a grants database such as enGrant (search.engrant.com/Default.aspx) reveals that scores of additional, large-scale intervention trials are underway, mostly led by investigators outside behavior analysis. Some of the studies are multicenter RCTs to test the replicability of interventions that have fared well in initial RCTs (e.g., Aman et al., 2009; Dawson et al., 2010; Kasari et al., 2006, 2008), whereas others are tests of novel interventions. Because intervention research is a slow process with uncertain outcomes, no one knows whether or when any of these interventions will amass robust empirical support. However, there is a real possibility that several could do so over the next 5 to 10 years as the numerous ongoing replication studies are completed.

In sum, the volume of ASD intervention research by investigators in disciplines outside behavior analysis has become substantial; the relevance of this research to the needs of the ASD community and the general public is undeniable; and some findings are auspicious. Investigators who have reported the most favorable outcomes often make extensive use of ABA intervention procedures (Dawson et al., 2010; Kasari et al., 2008). Behavior analysts cannot afford to ignore these reports, given that ASD interventions are a mainstay of our profession.

How, then, should behavior analysts proceed? The remainder of this article will focus on our role as consumers and producers of research. Admittedly, there are other valuable contributions we can make, such as commenting on the ideas and policies that have spurred the expansion of ASD intervention studies (e.g., examining the validity of the diagnostic category of ASD or the merits of declaring war on ASD). However, in this author's opinion, enhancing our own work should be the centerpiece of our efforts because it is the best way for behavior analysts to stay at the forefront of ASD intervention research and practice, to augment the existing evidence base for ABA interventions, and to improve upon these interventions. Accordingly, the next sections outline a framework for research and an agenda stemming from this framework.

A FRAMEWORK FOR ASD INTERVENTION RESEARCH

As a starting point, it may be helpful to clarify the place of RCTs in relation to other research methods. Two limitations of RCTs have already been mentioned: the difficulty of generalizing from group findings to any individual within the group and the tendency to resort to indirect measures such as ratings instead of direct observations. Another limita-

tion is that RCTs usually involve testing intervention packages or programs that are comprised of many different procedures. Although this approach may seem efficient, the opposite is often true because investigators are likely to need to take a step back and analyze the individual procedures in the package in order to make sense of the results from RCTs (Birnbrauer, 1979). Rather than "putting the cart before the horse" by conducting RCTs from the outset, a more logical approach is to conduct careful tests of the effects of individual procedures on behavior and only later package these procedures for evaluation in RCTs. Thus, RCTs "should be the very last type of investigation that a procedure encounters" (Johnston, 1988, p. 91).

From this perspective, some RCTs of ASD interventions may be premature. For example, if a combined developmental ABA approach produces benefits (as reported by Dawson et al., 2010, for the Early Start Denver model, and Kasari et al., 2006, 2008, for an intervention that targets social communication and play), the question arises as to how different these approaches actually are and what the relative contribution of each is to the eventual outcome. If a developmental approach is ineffective (as reported by Carter et al., 2011, for the Hanen model), it is unclear whether all the procedures that make up the approach are ineffective, whether some are effective while others are not, whether the approach as a whole would be effective if given at a different dose, and so on. These issues matter because they hinder efforts to translate research findings into practice, especially pinpointing what elements of study interventions to carry over to clinical settings.

On the other hand, RCTs of some ABA interventions for ASD seem overdue. Although research on ABA interventions has been ongoing since the early 1960s, RCTs have been

conducted only for early intensive ABA (Smith et al., 2000) and for a few ABA interventions that focus on specific skills (e.g., PECS for increasing communication, Howlin et al., 2007; and parent training for reducing problem behavior, Aman et al., 2009). No published RCTs or other group studies are available for any comprehensive ABA intervention for school-age children, youth, or adults with ASD (Smith, Mruzek, Mazingo, & Zarcone, 2007). After decades of ABA research involving these individuals, one might hope and expect that more ABA interventions would be ready for “the last type of investigation.”

ABA research that does exist on interventions for older individuals with ASD consists mainly of studies with single-case experimental designs. These studies have allowed investigators to create and refine a wide array of procedures that can be used to teach specific skills (National Autism Center, 2009). However, the studies provide little information on whether such procedures address public health and actuarial concerns. For example, it is unclear whether programs that implement ABA procedures enable individuals with ASD to increase their independence, become gainfully employed, form a network of social relationships, join in community activities, or enhance their general quality of life. Single-case studies are poorly suited for exploring these kinds of long-term global outcomes because they are designed to detect changes that occur as soon as an intervention begins. Indeed, most single-case studies aim to analyze the immediate effects of a specific intervention technique on a particular target behavior. Unlike single-case studies, group studies such as RCTs can test long-term outcomes by comparing individuals with ASD who complete an intervention package to similar individuals who receive a different intervention

(or no intervention) and following both sets of individuals over time.

Whereas behavior analysts sometimes characterize single-case studies and group studies as two distinct research traditions (Johnston, 1988), the foregoing considerations suggest that the traditions are more accurately viewed as complementary. Single-case studies are especially useful for innovation (Skinner, 1968; i.e., the initial formulation and subsequent improvement of a new procedure), but group studies such as RCTs are required for large-scale testing of overall outcomes from established intervention packages. Accordingly, the process of developing and validating interventions should begin with single-case studies and progress to group studies.

Applying this line of reasoning to ASD intervention research, Smith, Scahill, et al. (2007) outlined a sequence of four stages: (a) performing initial efficacy studies on intervention procedures, usually with single-case designs; (b) packaging procedures into an intervention manual and testing whether varying clinicians can implement the intervention with fidelity and whether the intervention is acceptable to the clinicians and consumers (e.g., individuals with ASD); (c) conducting RCTs to test the efficacy of the intervention in university settings; and (d) carrying out RCTs to evaluate the intervention as deployed in community settings.

Smith, Scahill, et al. (2007) provided details about methodological issues that arise at each of these stages. They also cautioned that the model was an ideal, not a sequence that always can or should be followed. For the present discussion, four complexities are worth noting. First, single-case studies may be sufficient by themselves to validate some interventions, especially those that focus on a circumscribed set of skills. For example, there may be little reason to conduct RCTs of procedures to teach a particular self-help skill if

the procedures quickly and reliably establish the skill and if there are no other validated procedures against which to compare them. Second, because findings from group studies may not generalize to any one person, single-case studies may continue to be important after RCTs, as a way to determine the relevance of study findings to an individual participant in the intervention (Barlow & Nock, 2009). Third, RCTs may not be feasible under some circumstances. For example, families may refuse to enroll in an RCT that compares early intensive ABA to community treatment, or they may drop out if assigned to community treatment and seek early intensive ABA elsewhere. Quasiexperimental studies, in which treatment and control groups are matched on participant characteristics but are assigned nonrandomly (e.g., according to the availability of providers to deliver the experimental treatment), often minimize this problem and thus are preferable under some circumstances.

Finally, the model does not address the customary differences in measurement between single-case and group designs (direct observation vs. indirect measures such as ratings). These differences may appropriately reflect the differing goals of these approaches, namely analyzing the effects of a procedure on a specific behavior and examining overall outcomes, respectively. Also, in ABA terminology, indirect measures may be considered to be assessments of social validity (raters' satisfaction with the intervention procedures and their effects; Wolf, 1978). Still, investigations of the concordance between direct and indirect measures would assist in interpreting the results of indirect measures (e.g., Zarccone et al., 2001).

A RESEARCH AGENDA

Despite the complexities inherent in ASD intervention studies, the four-stage model described above offers

some guidance to behavior analysts on responding to and initiating such research. Regarding research by other investigators, behavior analysts can advocate for single-case studies to develop new interventions before undertaking RCTs. They also can seek collaborations that would allow them to lend their expertise in designing these studies. When multiple RCTs consistently indicate that an intervention is efficacious (as has happened already for some medications and can be expected to occur in the near future for some developmental approaches), behavior analysts can again recommend single-case studies to test the effects of these interventions for particular individuals. If the RCTs were performed without prior development in single-case studies, behavior analysts can urge such studies to isolate the effects of individual procedures that are contained in the intervention package.

Although behavior analysts are not in a position to administer medications, we probably can implement clinical behavior therapy and developmental approaches, with training from the originators of these approaches. Once trained, we can conduct single-case studies of these approaches ourselves, potentially adopting approaches whose utility is confirmed by these studies and exploring ways to reinterpret the approaches in terms of learning theory (e.g., examining the role of stimulus control and reinforcement contingencies in these approaches). Thus, just as other investigators have sought to incorporate ABA approaches into their interventions, behavior analysts could incorporate interventions that were conceived by other investigators into our own research and practice. Doing so would be in keeping with the initial definition of ABA (Baer, Wolf, & Risley, 1968) as a technology for identifying and delivering effective interventions rather than as a predetermined set of intervention techniques.

More generally, ABA offers a system for analyzing any behavior

change in terms of learning theory (Skinner, 1953). For example, medication may function as an establishing operation (e.g., Dicesare, McAdam, Toner, & Varrell, 2005). Also, despite differences in terminology, developmental interventions essentially involve learning, as is true of ABA interventions, and thus can be investigated with ABA methodologies. In principle, therefore, behavior analysts can contribute to understanding and testing any ASD intervention regardless of its provenance.

For research initiated by behavior analysts, the four-stage model shows that behavior analysts need to proceed to larger scale studies in order to take on the many needs of the ASD community that remain unmet, notwithstanding the successes of existing ABA interventions. Moreover, the model helps to identify which interventions are ready for such studies and which are not. As an illustration, research has barely begun on interventions for some defining features of ASD (e.g., excessive repetitive behavior and routines, limited pretend play, and difficulties with perspective taking). In the area of repetitive behavior, behavior analysts have documented short-term, situation-specific improvements from interventions to reduce stereotyped motor actions displayed by individuals with ASD (Ahearn, Clark, MacDonald, & Chung, 2007) but have not shown more generalized effects, nor have they validated interventions for more complex rituals or routines such as intense preoccupations with a particular topic (Bodfish, 2004). To improve play, behavior analysts have successfully taught functional play skills (e.g., Coe, Matson, Fee, Manikam, & Linarello, 1990), but studies on teaching pretend play are sparse. Similarly, although behavior analysts have effectively trained some perspective-taking skills (e.g., identifying what another person sees; Gould, Tarbox, O'Hora, Noone, & Bergstrom, 2011), they have not examined

how to increase other such skills (e.g., recognizing when two people have access to different information). Because ABA interventions for these problems are incompletely formulated, further development in single-case studies is a prerequisite for RCTs.

For other problems displayed by individuals with ASD, an extensive literature of single-case studies already exists. Smith, Scahill, et al. (2007) suggested that research on interventions is ready to go beyond single-case studies when there are multiple independent single-case studies that replicate intervention effects (e.g., five such studies with a total of 20 or more participants across studies, a standard for classifying an intervention as evidence based proposed by the Council on Exceptional Children; Horner et al., 2005). An alternate criterion might be that the intervention has been tested experimentally under well-controlled conditions, and then implemented successfully in real-world settings (Johnston, 1996). Research on some ABA intervention procedures has far exceeded either of these thresholds. For example, Machalicek et al. (2008) identified 45 single-case studies of intervention techniques for supporting school-age children and adolescents with ASD in classroom settings, and Iovannone, Dunlap, Huber, and Kincaid (2003) derived a set of best practices from this literature. It seems appropriate to go to the next stage of crafting intervention manuals that package these practices in preparation for RCTs. Other examples of interventions that likewise appear ready to go to the next level include (a) techniques for feeding problems (tested in 48 single-case studies of children with a range of medical or behavioral concerns, including ASD; Sharp, Jacquess, Morton, & Herzinger, 2010), (b) techniques to improve social communication and peer interaction (e.g., a package combining procedures such as peer-mediated social skills training, which has been tested in 45 single-case studies, Zhang

& Wheeler, 2011; and video modeling, which has been tested in 23 studies, Bellini & Akullian, 2007), and (c) incidental teaching procedures such as pivotal response treatment to increase a child's rate and complexity of communication (tested in 21 studies; Koegel, Koegel, Vernon, & Brookman-Fraze, 2010).

The strategies that manuals encompass for delivering intervention packages are apt to vary considerably. For example, intervention packages for feeding problems could involve a limited number of parent training sessions, similar to sessions developed for managing other behavior problems (Johnson et al., 2007). (However, children with more severe feeding problems that pose urgent health concerns probably demand more intensive intervention.) Manuals for classroom-based interventions and interventions for social communication might take the form of curricula in which students must master each step before proceeding to the next one. Regardless of the format, manuals must provide enough standardization to ensure that clinicians implement the intervention uniformly yet be flexible enough to allow for tailoring the intervention to meet the needs of an individual with ASD or caregiver. For standardization, the manual should outline a typical progression of treatment and step-by-step instructions at each stage, as well as problems that are likely to occur and strategies for addressing them (Hibbs et al., 1997). For individualization, the manual may itemize acceptable variations in the intervention, such as decision rules for deciding which components of the intervention to implement, modifications of how a component of the intervention is implemented, and ways to incorporate participants' interests into sessions (Smith, Scahill, et al., 2007).

Some ABA interventions, especially models of early intensive ABA and some other models for young or minimally verbal children such as PECS, have already been detailed in

manuals and evaluated in group studies such as RCTs. These interventions are sufficiently well established to scale up and test in region-wide programs (Perry et al., 2008) or to be implemented by teachers in public schools (Strain & Bovey, 2011). Further, such interventions are ready to be extended to (and assessed with) subgroups of individuals with ASD who have usually been excluded from treatment studies (e.g., adults with ASD and intellectual disability). In addition, now that plausible alternatives to existing ABA interventions are emerging, comparative effectiveness studies can be carried out to provide a direct test of the relative merits of different interventions.

Another promising direction for research on established ABA models is to update or revise the models, allowing comparisons of the original and revised models. Notably, Lovaas's (1987) finding that a significant minority of children with ASD catch up to their peers after early intensive ABA remains unsurpassed a quarter of century later, even though the technology of instructional procedures and the identification of key features of ASD have advanced considerably (Mayville & Mulick, 2011). Subsequent studies have modified or elaborated on Lovaas's intervention in some respects (e.g., Smith et al., 2000), and Lovaas (2003) published a new edition of the intervention manual. Studies also have documented success with early intensive ABA models other than Lovaas's approach (e.g., Howard, Sparkman, Cohen, Green, & Stanislaw, 2005). However, it is worth evaluating whether a more thorough revision or different ABA model would increase rates of success, as some investigators have proposed but not demonstrated (discussed by Smith, 2011).

In summary, this application of the four-step model to ABA interventions reveals three main areas of need:

1. Effective ABA interventions have not yet been found for many key features of ASD (e.g., difficulties

in social communication and intense repetitive behaviors or routines). Single-case studies to develop interventions for these underresearched problems are needed.

2. Many ABA intervention procedures have been examined thoroughly in single-case studies but have not yet been combined into intervention packages and tested to see whether they add up to produce life-changing improvements for individuals with ASD. A crucial next step, therefore, is to prepare for testing of overall outcomes by creating manuals that integrate these procedures and provide a model for implementing them.

3. A few ABA interventions have already been operationalized in manuals and evaluated in RCTs. Additional RCTs would be valuable in testing outcomes (a) in community settings, (b) across different subgroups of individuals with ASD, (c) compared to alternative interventions, and (d) for revisions of existing ABA models.

CONCLUDING COMMENTS

As remarked earlier, the emphasis in this article on boosting our own research efforts and the recommendations on how to do so reflects the author's own outlook on the state of ASD intervention research. Hence, they are open to debate. For instance, some behavior analysts might disagree with the proposals to start conducting more RCTs and to consider adopting interventions that emanate from research by investigators from other disciplines. Scrutiny of these proposals is welcome because it may well yield a better plan for moving forward. What is indisputable, however, is that the field of ASD intervention research is expanding rapidly and that behavior analysts will need to adapt to this reality.

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