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S:I AUTISM IN REVIEW: 1980-2020: 40 YEARS AFTER DSM-III

Advances in Our Understanding of Behavioral Intervention: 1980 to 2020 for Individuals Diagnosed with Autism Spectrum Disorder

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Abstract

There are three branches of science of behavior analysis [i.e., experimental analysis of behavior, behavior analysis, and applied behavior analysis (ABA)]. ABA can be defined as a systematic approach to understanding behavior of social interest. For the past 40 plus years, researchers have evaluated ABA and ABA based procedures (e.g., behavioral intervention) as they relate to individuals diagnosed with autism spectrum disorder (ASD) and have implemented behavioral intervention in clinical settings for individuals diagnosed with ASD. In this paper, we discuss some of the pivotal contributions in the field of ABA in research and clinical practice. Additionally, we provide recommendations for the science and clinical practice of behavioral intervention in the next 40 years.

Keywords Applied behavior analysis · Behavior analysis · Behavioral intervention · Certification · Intensive behavioral intervention

Applied behavior analysis (ABA) is rooted in the science and philosophy of behavior analysis (Cooper et al. 2020). ABA can be referred to as a science or practice, and as a practice it is commonly referred to as behavioral intervention, both of which have a central focus on manipulating environmental variables to improve socially significant behavior. The history of behavioral intervention can be traced back to the groundbreaking work of Ivan Pavlov, John B. Watson, Rosalie Rayner, Mary Cover Jones, Edward Thorndike, Joseph Wolpe, Burrhus Frederic Skinner, Barbara Etzel, Sidney Bijou, and Judy Favell, among others. The contributions of these and other professionals culminated in the seminal article by Baer et al. (1968). Although there are many examples of ABA prior to Baer and colleagues' (1968) article (e.g., Allen et al. 1964; Ayllon 1963; Ayllon and Azrin 1965; Ayllon and Michael 1959; Etzel and Gerwitz 1967; Sherman 1963; Wolf et al. 1963), its publication and the establishment of the *Journal of Applied Behavior Analysis* are commonly cited as the birth of ABA. In their article, Baer et al. described *some* current dimensions of ABA which were applied, behavioral, analytic, technological, conceptually systematic, effective, and generality.

Although the field of ABA has been around for over 50 years; the purpose of this paper is to provide a commentary on the past 40 years of behavioral intervention as it relates to individuals diagnosed with autism spectrum disorder (ASD). We highlight some pivotal contributions in the field of ABA as they relate to research and clinical practice. Additionally, we provide recommendations for the next steps in the evolutionary process of ABA in the next 40 years.

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Seminal Contributions

Outcome Studies

Perhaps one of the most significant contributions in the past 40 years was the experimental demonstration of the outcomes of comprehensive behavioral intervention for children diagnosed with ASD. With the most notable being Lovaas (1987), who compared an intensive ABA only model of intervention (i.e., an average of 40 h of direct behavioral intervention per week) to a non-intensive (i.e., an average of 10 h of direct intervention per week) eclectic model. Thirty-eight children participated in this study and were quasi-randomly assigned into the two treatment groups. Each participant received 2 or more years of intervention. Lovaas divided outcomes into three broad categories (i.e., recovered, aphasic, autistic/retarded) based upon IQ, school placement, and diagnosis. We will refer to these outcome groups as best, fair, and poor, respectively. The results demonstrated that 47%, 42%, and 10% in the intensive group reached best, fair, and poor outcome, respectively. This compared to 0%, 42%, and 58% in the non-intensive group that reached best, fair, and poor outcome, respectively. This study clearly demonstrated that intensive, comprehensive, behavioral intervention can make life altering, positive changes for individuals diagnosed with ASD and their families. Furthermore, McEachin et al. (1993) conducted a 6 year follow-up on the participants in the Lovaas (1987) outcome study. Specifically, McEachin et al. ascertained current school placement and conducted three standardized assessments with the participants from Lovaas' (1987) study. The results indicated that eight of the nine children who reached best outcome maintained that status 6 years later (the one who did not maintain was not due to a diagnosis of ASD, but a comorbid diagnosis), thereby demonstrating that not only can best outcome be achieved, but also that these gains can maintain overtime.

Lovaas (1987) changed the face of behavioral intervention as it relates to individuals diagnosed with ASD, which also may be a reason some regard the name "Lovaas" as synonymous with ABA (Smith and Eikeseth 2011). Prior to this and other studies in the 1980s, ASD was largely viewed as untreatable (Cohen et al. 2006). As a result, Lovaas' work brought hope to many families of individuals diagnosed with ASD. Lovaas also inspired replication (e.g., Smith et al. 2000) and clinical outcome studies (e.g., Howard et al. 2005) which have continued to demonstrate the effectiveness of early intensive behavioral intervention with individuals diagnosed with ASD.

Smith et al. (2000) as well as Sallows and Graupner (2005) are just two examples of studies that have evaluated the role of parents in behavioral intervention for individuals diagnosed with ASD. Smith et al. (2000) compared two treatment models. In one model, referred to as the intensive treatment group, treatment was provided by individuals/staff who had been trained to meet the criteria and qualifications outlined by Lovaas (1987). In the other model, referred to as the parent training group, treatment was provided by parents who received two sessions of parent training per week, for a total of 5 h of training per week, for 3 to 9 months. The results demonstrated that participants in the intensive treatment group outperformed participants in the parent training group on measures of intelligence, visual-spatial skills, language skills, and academic skills. Sallows and Graupner (2005) compared an intensive clinic-based model to a parent directed group for 24 children diagnosed with ASD. Participants in both groups received treatment from similarly trained and supervised therapists following the procedures outlined by Lovaas (1987). The results demonstrated that both treatment groups significantly improved their scores on formal cognitive, language, and adaptive assessments.

Howard et al. (2005) compared a behavior analytic treatment approach to an eclectic treatment approach for individuals diagnosed with ASD. Twenty-nine children received intensive behavior analytic intervention resembling the treatment provided in Lovaas (1987). Two comparison groups of 16 children received either an eclectic intervention in an autism educational program (i.e., a combination of methods, 1:1 or 1:2 ratio, 30 h per week) or a non-intensive public early intervention program (i.e., a combination of methods, small groups, 15 h per week). The children assigned to the intensive behavior analytic condition outperformed children in the comparison conditions on virtually every measure after 14 months of treatment. Howard et al. (2014) conducted a follow-up of the participants in the Howard et al. (2005) study and found the results maintained throughout the second and third years of treatment.

Leaf et al. (2011) published a description of a community-based intensive behavioral intervention program and outcome data for 64 individuals diagnosed with ASD across four different sites. Leaf et al. grouped their outcome data using the same definitions provided by Lovaas (1987) as well as an expanded definition of best outcome to include clients who have IQs of 85 or higher, completing grade level work in general education classes, but may have received minimal supports at the time of follow up (e.g., consultation to the classroom teacher, weekly participation in social skills group). Twenty-five of the participants met the criteria for best outcome based on the definition provided by Lovaas (1987), while an additional 20 participants met the new expanded definition of best outcome.

These and additional outcome studies (e.g., Cohen et al. 2006; Harris and Handleman 2000; Harris et al. 1991) have advanced our understanding of the power behavioral

intervention has for individuals diagnosed with ASD. Research has shown that for individuals with ASD to achieve best outcomes, it requires early intensive behavioral intervention that includes numerous hours of intervention per week, implemented by well-trained interventionists, and comprehensive programming on a wide array of behaviors and skills (e.g., language, social, adaptive, cognitive, reduction of aberrant behavior). The aforementioned studies as well as hundreds of others are responsible for ABA having one of the strongest bodies of empirical evidence demonstrating its effectiveness for individuals diagnosed with ASD (Smith and Iadarola 2015).

Clinical Practice

One of the biggest advancements in the field of behavior analysis is the increase of behavior analysis in clinical practice as it relates to individuals diagnosed with ASD. From 1980 to 1994 there were numerous group studies demonstrating the effectiveness of comprehensive behavioral intervention for individuals diagnosed with ASD (e.g., Harris et al. 1991; Lovaas 1987; McEachin et al. 1993) as well single subject studies demonstrating the effectiveness of individual procedures (e.g., Dunlap and Koegel 1980; Harris et al. 1981; McEvoy et al. 1988). Additionally, there were numerous centers (e.g., Early Childhood Partial Hospitalization Program) providing behavioral intervention for individuals diagnosed with ASD during this time period. However, it was not until 1994 that the increase of behavior analysis in clinical practice occurred. This coincided with publication of Catherine Maurice's (1994) book entitled *Let Me Hear Your Voice.* In this book, Maurice describes the meaningful changes two of her children made as a result of quality behavioral intervention.

This book brought the attention of parents to the effectiveness of ABA and the demand from better-informed parents spurred growth in the availability of behavioral intervention for individuals diagnosed with ASD. This growth is evident in the number of behavior analytic certifying bodies (e.g., Behavior Analyst Certification Board, Behavioral Intervention Certification Council) who oversee the minimum standards for behavior analysts and a number of different behavior analytic certifications (e.g., Board Certified Behavior Analyst, Registered Behavior Technician™, Certified Autism Specialist, Board Certified Autism Professional, Board Certified Autism Technician) available today. Although these certifications were not directly created with behavioral intervention as it applies to individuals diagnosed with ASD in mind, these certifications did set standards in the field of behavior analysis and act as a means to protect consumers (Shook et al. 2002). For example, in 1999 there were only 30 Board Certified Behavior Analysts (BCBAs) and Board-Certified assistant Behavior Analysts (BCaBAs) in the world; as of October 2019 there are over 39,000. In 2013, the Behavior Analyst Certification Board created the Registered Behavior Technician™ (RBT®) as an entry level certification. In just 7 years, there are now over 50,000 RBTs®. The majority of these certificants are involved in delivery of behavioral intervention to individuals diagnosed with ASD (Carr and Nosik 2017). It should also be noted there are an unknown number of additional professionals who are implementing behavior intervention, that are not certified.

Parallel to the growth in the number of individuals who are certified as behavior analysts there was also a growth in the number of states that passed laws mandating coverage of ABA intervention under private insurance policies. From 1980 to 2000 no state had mandated coverage for behavioral intervention. In 2001, Indiana passed the first law mandating insurance coverage of ABA services. By 2010, 23 states had passed insurance laws. By 2015 the number grew to 43, and as of 2019 all 50 states have mandated insurance coverage for ABA intervention (Autism Speaks 2019a, b). Thus, current data indicate that applied behavior analysis is a booming field.

Progressive ABA

A progressive approach to ABA requires constant in-the-moment assessment to inform changes to a systematic plan. This is commonly referred to as clinical judgment (Leaf et al. 2018, b; Redelmeier et al. 2011). Clinical judgment has been described as a decision-making model derived from the medical field that "combines scientific theory, personal experience, patient perspectives and other insights" (Redelmeier et al. 2011, p. 358). There are many variables that could contribute to decision making using clinical judgment which include, but are not limited to, (a) moment-to-moment changes in the function of the client's behavior, (b) interfering or aberrant behaviors, (c) determination of whether behavior is primarily operant or respondent, (d) current levels of engagement, (e) the client's receptivity to learning, (f) the emotional state of the client, (g) current and past performance, (h) ongoing evaluation of reinforcer effectiveness, and (i) the physical health of the client.

Recent research has demonstrated the effectiveness of interventions and procedures using a progressive approach across a wide variety of behavior analytic procedures including: expanding preferences (e.g., Leaf et al. 2012a, b), contingency systems (e.g., Cihon et al. 2019a, b, c), reinforcer identification (e.g., Alcalay et al. 2019), prompting (e.g., Soluaga et al. 2008), DTT (e.g., Leaf et al. 2017a, b, 2018a, b), staff training (e.g., Green et al. 2019), data collection (e.g., Ferguson et al. 2020a, b; Taubman et al. 2013), social skills groups (e.g., Leaf et al. 2017a, b), and functional analysis (e.g., Ala'i-Rosales et al. 2019). However, it should be

noted that while recent research has continually documented the effectiveness of a progressive approach, this approach has been present in the field of ABA for some time now. Components of a progressive approach can be found in the seminal works of Lovaas (e.g., Lovaas 1987), Jones (e.g., Jones 1924), Azrin (e.g., Ayllon and Azrin 1965), Hart (e.g., Hart et al. 1964), and Bijou (e.g., Bijou 1965) to name a few. Nonetheless, the shift away from a conventional approach back to a progressive approach marks an important recent advancement in behavioral intervention.

Functional Analysis

It has been well documented that individuals diagnosed with ASD engage in problem behavior including, but not limited to, stereotypic behavior (Petrongolo et al. 2015), self-injury (Coman and Houghton 1991), aggression (Roscoe et al. 2010), elopement (Boyle et al. 2019), and pica (Ledford et al. 2019). One of the biggest advancements in the last 40 years in the field of behavioral intervention for individuals diagnosed with ASD is the development and evolution of functional analyses. The purpose of a functional analysis is to determine the conditions under which problem behavior occurs (e.g., to obtain teacher attention) and inform intervention to teach a function-based replacement behavior (e.g., teaching the individual to gain attention appropriately).

Standard Functional Analysis

The procedures outlined by Iwata et al. (1982/1994a) have become most associated with the term functional analysis (e.g., Cooper et al. 2007; Fisher et al. 2011) despite many examples of functional analyses of problem behavior demonstrated before the seminal publication in 1982 (e.g., Carr et al. 1976; Lovaas and Simmons 1969; Lovaas et al. 1965; Pinkston et al. 1973; Sailor et al. 1968; Thomas et al. 1968). Iwata et al. (1982/1994) exposed nine participants to four different conditions to evaluate the conditions under which the individuals engaged in self-injurious behavior. In the social disproval condition, the experimenter instructed the participant to go play while they did some work. The experimenter only provided attention (i.e., statements of concern and disapproval) contingent upon self-injury. In the academic demand condition, the experimenter provided an instruction to engage in a task. The experimenter ended the trial and turned away from the participant for 30 s contingent upon any instance of self-injury. The unstructured play condition consisted of the experimenter providing praise and physical contact contingent on the absence of self-injury for at least 30 s and all instances of self-injury were ignored. During the alone condition, the participants were placed in the room by themselves without access to attention, toys, or other external sources of stimulation. Four of the participants engaged in more self-injury in the alone condition, suggesting self-injury was likely maintained by non-socially mediated consequences. Two participants engaged in more self-injury during the academic demand condition, suggesting self-injury was likely maintained by delaying or escaping demands. One participant engaged in more self-injury in the social disapproval condition, suggesting their self-injury was maintained by attention in the form of statements of concern and disapproval. The remaining three participants had undifferentiated patterns of self-injury or engaged in high levels self-injury across all conditions.

Iwata et al. (1994) expanded upon the results of the original Iwata et al. (1982) study in which the data from 152 functional analyses for participants were summarized. The participants included individuals diagnosed with developmental disabilities who were referred for assessment and/or treatment across an 11-year period. The results showed that for the majority of the participants (i.e., 145) differential or uniformly high responding was observed. Overall, the self-injurious behavior of the participants was accounted for by escape from task demands or other aversive stimulation for 58 participants, attention or access to food or materials for 40 participants, automatic reinforcement for 39 participants, and multiple controlling variables for 8 participants. Seven participants displayed cyclical or inconsistent patterns of responding that the researchers deemed as uninterpretable.

Evolution of Functional Analysis

Since Iwata et al. (1982/1994), there have been several variations to the standard functional analysis. One of these variations is known as the brief functional analysis (Northup et al. 1991). In a brief functional analysis, conditions last approximately 5 to 10 min as opposed to the 15 min usually required in the standard functional analysis (e.g., Wallace and Iwata 1999) and only one or two sessions are conducted for each condition. This differs from a standard functional analysis in which many sessions are conducted over a longer duration of time (Northup et al. 1991). Another variation of the standard functional analysis is a trial-based functional analysis (Rispoli et al. 2014). Within a trial-based functional analysis the functional analysis is usually conducted within the confines of discrete trials with each condition lasting one minute. The conditions include a test condition and a control condition in which the evocative event is presented in the test condition, and continuous access to the reinforcer is available in the control condition (Cooper et al. 2020). Trial-based functional analyses can be performed by teachers within their classroom during naturally occurring activities (Bloom et al. 2011). In addition to the brief and trial-based functional analysis there are other variations which

include a latency-based functional analysis (Neidert et al. 2013) and a functional analysis based on precursor behavior (Heath and Smith 2019).

One of the newest variations on the standard functional analysis is a procedure known as the synthesized functional analysis or practical functional assessment (Hanley et al. 2014). The practical functional assessment (PFA) process starts with the interventionist conducting an interview with people who are familiar with the client engaging in problem behavior. During this interview, the interventionist asks questions about when and why problem behavior occurs. Based upon this interview, the interventionist then conducts a brief functional analysis during which the control condition is compared to a condition in which multiple contingencies can be combined, or synthesized (e.g., escape to attention as opposed to escape or attention alone). Research has shown that the PFA is less time consuming than the standard functional analysis (Jessel et al. 2019). In a synthesized functional analysis, precursor behavior is reinforced during the test condition, making it a more efficient process for interventionists and avoiding the dangers associated with long functional analyses of problem behavior (e.g., reinforcing dangerous problem behavior for client or staff; Hanley 2012). The methods and approach employed in the PFA also allows for the evaluation of functions not commonly assessed, such as control (sometimes referred to as mand compliance; Eluri et al. 2016). In addition to the methodological improvements that have led to efficient and effective treatment, the practical functional assessment has also been documented to be a highly acceptable, socially valid approach to the assessment and treatment of problem behavior (Ferguson 2020a, b; Hanley et al. 2014). Although the majority of research on the PFA has been conducted by one research group (e.g., Jessel et al. 2016) there are several studies which have been published outside of this research group (e.g., Ferguson 2020a, b; Strand and Eldevik 2018).

Another very recent approach to functional analysis is known as the Big Four (Ala'i-Rosales et al. 2019). In this commentary, Ala'i-Rosales et al. extrapolate the wealth of knowledge collected from research on functional analyses to recommend prevention practices for individuals at risk for developing problem behavior. Specifically, the research on standard functional analyses has demonstrated that there are four common conditions under which problem behavior typically occurs (i.e., access to attention, escape from task demands, access to tangibles, and alone). This knowledge, informed by decades of research, paves the way for a preventative approach: identifying individuals at risk for developing problem behavior and then proactively teaching the skills necessary for navigating those specific conditions. Ala'i-Rosales et al. (2019) termed these skills, or repertoires, as the Big Four which include:

1. Safely, effectively, and respectfully communicating wants, needs, likes, and dislikes in ways that are understood by others and do not result in harm to self or others;
2. Safely, effectively, and pleasantly gaining the attention and affection of others in ways that are understood by others and do not offend or hurt others;
3. Joyfully engaging in activities alone and with others in ways that increase in number, duration, and complexity and do not cause harm to self or others; and
4. Safely, effectively, and diplomatically, coping with, tolerating, and accommodating adversity in situations that are in the child's best interests over the long term. (p. 226)

Several benefits to adopting this preventative approach to problem behavior were identified. The main benefit is the potential to completely prevent the development of problem behavior in populations with whom problem behavior is common (e.g., ASD; Kanne and Mazurek 2011). Another benefit provided by this approach is decreasing the potential harm to clients involved in the intentional evocation of problem behavior in a standard experimental functional analysis. Ala'i-Rosales et al. also discussed how this approach welcomes the conceptualization of problem behavior including multiple and/or changing contingences as a benefit. The possibility of synthesizing the information from decades of research on the experimental functional analysis of problem behavior to develop a preventative approach represents a substantial progression in behavioral intervention. In fact, "if problem behavior is prevented, then the need to conduct a [standard] functional analysis of behavior might be eliminated" (Ala'i-Rosales et al. 2019, p. 225).

Functional Analysis in Clinical Practice

Functional analysis remains one of the most common topics of behavior analytic research (Beavers et al. 2013; Hanley et al. 2003). More specifically, Hanley et al. (2003) found 277 studies published from 1961 to 2000 on the topic of functional analysis and Beavers et al. (2013) found an additional 158 articles published from 2001 to 2012 on functional analysis. The abundance of research on functional analyses also closely aligns with the use of functional analyses in clinical practice. That is, Oliver et al. (2015) found that although descriptive functional behavior assessment methods were the most commonly used clinically, 36% of respondents indicated almost always or always using experimental functional analyses. Furthermore, functional behavioral assessment, which can include experimental functional analyses, has become part of educational law in that it is an established part of the Individuals with Disabilities Education Act (1997, 2004).

Teaching Social Behavior

A third advancement in behavioral intervention as it relates to individuals diagnosed with ASD is the teaching of social behavior. Since Leo Kanner first described autism (Kanner 1943) to the DSM-III (American Psychiatric Association 1980) to the DSM-V (American Psychiatric Association 2013), deficits in social behavior has always been a defining characteristic of ASD. Over the past 40 years, numerous behaviorally based interventions have been empirically evaluated and implemented to improve social behaviors for individuals diagnosed with ASD (Leaf 2017).

Video Modeling

One intervention used to teach social behavior that consists of teacher demonstration and commonly includes role-playing is video modeling. Bellini and Akullian (2007) defined video modeling as "…a technique that involves demonstration of desired behaviors through video representation of the behavior" (p. 266). In other words, a video is created displaying the desired social behavior and then the learner watches the video. After the learner watches the video demonstration, an opportunity to role-play the targeted behavior with the interventionist can be provided (Taylor et al. 1999).

Charlop and Milstein (1989) were one of the first to evaluate the effectiveness of video modeling for three children diagnosed with ASD. Each of the participants viewed videotaped conversations between a therapist and a child and were given the opportunity to engage in the video modeled conversation after viewing the video model. Reinforcement was provided contingent upon sitting still, attending, and talking. The results showed that video modeling was effective for all three participants and the conversation skills generalized across settings, stimuli, and topics. Since the 1990s, there have been numerous studies that have evaluated the effectiveness of video modeling with individuals diagnosed with ASD (Banda et al. 2011). In addition to the number of studies evaluating the effectiveness of video modeling, procedural variations in video modeling have also been developed. Some of these variations include who is the model: an adult (MacDonald et al. 2005), a known peer (Nikopoulus and Keenan 2003), or the learner themselves (Norman et al. 2001). Another variation is the perspective of the video, either first person (Shipley-Benamou et al. 2002) or third person (Ayres and Langone 2007). Finally, with the advances in technology since the first evaluations of video modeling, videos now can be viewed almost anywhere and no longer requires the use of cumbersome items such as a VCR, DVD player, or a television.

Teaching Interaction Procedure

Another procedure involving demonstration and role-playing to teach social skills is the teaching interaction procedure (TIP), which first appeared in print in 1968 (Phillips 1968). The TIP is a multicomponent, systematic procedure consisting of: (1) labeling and identifying the target behavior, (2) providing a meaningful rationale for engaging in the target behavior, (3) describing the target behavior, (4) demonstrating the target behavior, (5) the learner role-playing the target behavior, and (6) providing feedback throughout.

Leaf et al. (2009a, b) were the first to evaluate the effectiveness of the TIP to teach social skills for individuals diagnosed with ASD. In this study three children diagnosed with ASD were taught social skills including following a peer, greeting a peer, including a peer in an activity, choosing a peer partner, changing the topic during a conversation, going with the flow of a conversation or game, giving a compliment, sharing, and making on-topic statements. The results of a multiple baseline design across skills demonstrated that the TIP was effective for teaching all social skills to all three participants. Since Leaf et al. (2009a, b), there have been several more studies documenting the effectiveness of the TIP for teaching social skills for individuals diagnosed with ASD. For example, research has documented the effectiveness of the TIP for young children diagnosed with ASD (e.g., Leaf et al. 2009a, b, 2010), adolescents and adults with ASD (e.g., Dotson et al. 2010; Ng et al. 2016), in one-to-one instructional formats (e.g., Kassardjian et al. 2013; Leaf et al. 2012a, b), in group instructional formats (e.g., Dotson et al. 2010; Peters et al. 2016), for children with high levels of expressive language (e.g., Leaf et al. 2010), and for children with low levels of expressive language (e.g., Ng et al. 2016). Additionally, researchers have compared the relative effectiveness of the TIP to other commonly used social skills interventions (e.g., social stories; Kassardjian et al. 2014; Leaf et al. 2012a, b). These comparisons have demonstrated the advantages of implementing the TIP to teach social skills for individuals diagnosed with ASD over social stories (Kassardjian et al. 2014; Leaf et al. 2012a, b).

The TIP is similar to behavioral skills training (BST; Miltenberger 2008), which has also been demonstrated to be an effective teaching strategy for teaching social skills to individuals diagnosed with ASD. However, there are at least two components of the TIP that distinguish the TIP from BST. First, the TIP *always* includes the provision of a meaningful rationale. Second, the TIP includes a demonstration of the appropriate and *inappropriate* way to engage in the targeted skill. In comparison, BST typically only includes an appropriate demonstration and an optional component of BST is the provision of a rationale.

Social Skills Groups

Another advancement in behavioral intervention as it relates to social skills is the documentation of the effectiveness of behaviorally based social skill groups for individuals diagnosed with ASD (e.g., Miller et al. 2014). Social skills groups have been described as "groups contain[ing] two or more like-aged individuals (with and/or without disabilities) meeting in a group instructional format…" (Reichow and Volkmar 2010, p. 152). Adding the use of only behavior analytic principles and procedures to this description is what makes a social skills group a behaviorally based social skills group (Ellingsen et al. 2017).

For example, Kamps et al. (1992) evaluated the effectiveness of a behaviorally based social skills group to improve social interaction skills with peers for three children diagnosed with ASD. The behaviorally based social skills group occurred during the first 10 min of a 20 min session with typically developing peers. Social skills training included typical peer models, repeated systematic practice, and feedback on specific skills from published curricula (i.e., McGinnis and Goldstein 1984; Walker et al. 1988). Feedback was also provided during a 20 min free play. The results indicated improvements in a variety of social skills (e.g., accepting compliments, initiation, and asking for help) for the three participants and improved social performance for the participants and their peers.

More recently, Leaf et al. (2017a, b) demonstrated the effectiveness of a behaviorally based social skills group using a progressive approach to behavior analytic intervention for young children diagnosed with ASD. Fifteen children were randomly assigned to an immediate treatment group (n = 8) or a delayed treatment group (n = 7). The behaviorally based social skills group consisted of 32 sessions, each lasting 2 h, during which the interventionists implemented a variety of behavior analytic procedures within a progressive behavior analytic framework (e.g., shaping, differential reinforcement, TIP). The interventionists individualized each session's curriculum based on individual participant skill deficits, skill deficits as a group, information obtained on assessments, and caregiver concerns. The results demonstrated that the behaviorally based social skills group resulted in a significant improvement in social behavior for the 15 participants. Furthermore, the improvements maintained, and parents were satisfied with the procedures and the improvements in their child's social behavior.

The advances achieved through the literature base on behaviorally based social skills groups have provided important information on the components required for behaviorally based social skills groups to be the most effective. First, interventionists implementing the behaviorally based social skills group need to be well trained in the principles of behavior analysis and not just trained on how to follow a cookbook of procedures. Second, the behaviorally based social skills group should include a wide variety of behavior analytic procedures (e.g., behavioral skills training, shaping, prompting, discrete trial teaching), and not rely on just one procedure for all targeted skills. Relatedly, these procedures should be empirically based and conceptually systematic with behavior analysis. As such, procedures such as Social Thinking™, social narratives, Son-Rise, and facilitated communication should not be included. Third, behaviorally based social skills groups should include the use of a reinforcement system. The reinforcement system could be individual (e.g., each participant has their own token board) or group (e.g., a level system), but should be tailored to individual and group needs. For example, more impacted individuals may require an individual token system, while self-monitoring systems may be more appropriate and effective for individuals with more advanced skills. Regardless, reinforcement should be designed so that eventually behaviors are maintained by naturally occurring contingencies. Fourth, a variety of skills should be targeted during each session of the behaviorally based social skills group. When all of these components are in place, behaviorally based social skills groups can result in life altering changes for individuals diagnosed with ASD.

Stimulus Control Technology

It has been well established that stimuli that precede a response that is reinforced come to exert some level of control over the probability of the reinforced response. This is commonly referred to as stimulus control which has been defined as situations "in which the frequency, latency, duration, or amplitude of a behavior is altered by the presence or absence of an antecedent stimulus" (Cooper et al. 2007, p. 705). An example of stimulus control is giving a hug in the presence of a family member but not in the presence of a stranger. Across the last 40 years there have been several advances in stimulus control technology that have resulted in more effective and efficient intervention approaches for individuals diagnosed with ASD. These advances are perhaps most evident within discrete trial teaching (DTT).

Discrete Trial Teaching

Discrete trial teaching (DTT) is a commonly implemented procedure implemented with individuals diagnosed with ASD. DTT consists of three main components: (a) an instruction from the interventionist; (b) the response from the learner; and (c) feedback from the interventionist. There have been numerous recommendations of how to implement DTT; some of which may contradict each other (e.g., Ghezzi 2007; Gongola and Sweeney 2012; Green 2001; Grow and LeBlanc 2013; Leaf et al. 2016a, b; Smith 2001). Green

(2001), Grow and LeBlanc (2013), and Leaf et al. (2016a, b) provide three representative samples of recommendations of differing ways DTT can be implemented.

Green (2001) The first suggestion in Green (2001) was to use a different sample stimulus on each trial while ensuring the same comparisons are used on every trial across a trial block. Within this recommendation Green also noted that each comparison should serve as a sample and should be an incorrect comparison (i.e., S-delta) an equal number of times with the other samples. The second recommendation provided was to use three comparison stimuli in the array on every trial. The third recommendation provided by Green (2001) was that each sample should be presented an equal number of times across a trial block or session. Green further suggested the same sample stimulus should not be presented on more than two consecutive trials. Relatedly, the fourth recommendation was to systematically vary the position of the comparison stimuli from trial to trial. This was followed by a rule of thumb that the correct comparison should not be presented in the same location on more than two consecutive trials. Green's fifth recommendation was for the learner to make an observing response to the sample on each trial. Her sixth recommendation, related to the use of an auditory sample (e.g., receptive language tasks), was to clearly present a simple instruction of the sample (e.g., "ball" as opposed to "Touch the ball") when the comparisons are displayed and continue to issue the instruction every 2 s until the learner responds. The seventh recommendation was to arrange the comparison stimuli prior to each trial out of view of the learner. Green's eighth recommendation was to teach the learner the pre-requisite skills for match-to-sample tasks prior to using them to teach conditional discriminations using match-to-sample tasks. The final recommendation was to use errorless learning strategies as opposed to trial-and-error methods to teach conditional discriminations.

Grow and LeBlanc (2013) Grow and LeBlanc (2013) expanded upon Green's (2001) recommendations and provided, "five overarching best practice recommendations for receptive language instruction" (p. 58). The best practice recommendations Grow and LeBlanc (2013) provided had several areas of overlap with Green's recommendations with some additions and refinements. The first recommendation was to require an observing response on or before each trial. Grow and LeBlanc's second recommendation was to minimize inadvertent instructor cues (e.g., eye movement, gaze, voice modulation). The third recommendation involved several suggestions related to the "instructor's selection of the antecedent stimuli and required responses" (Grow and LeBlanc 2013, p. 62). These suggestions included planning the targeted responses, introducing multiple targets simultaneously, using simple auditory instructions, and counterbalancing the location of stimuli in the array. Grow and LeBlanc's fourth recommendation included suggestions relating to prompting and differential reinforcement. These suggestions included identifying effective prompts and prompt fading strategies, regularly conducting formal preference assessments, and providing differential reinforcement for independent correct responses. Grow and Leblanc's final recommendation involved suggestions for how to proceed when undesired stimulus control is developed including, but not limited to, increasing the size of the array, eliminating inadvertent cues, separating targets into different sets, and blocking responding prior to the instruction being provided.

Leaf, Cihon et al. (2016) The first guideline Leaf et al. (2016a, b) provided was to select the target for each trial and the arrangement of the comparisons based on learner responding and not as a predetermined rule. Thus, not engaging in a strict counterbalance approach. Research has shown that interventionist clinical judgment was just as effective as strict counterbalancing of target placement or just placing the stimuli on the table in a fixed location (Leaf et al. 2018a, b). The second guideline provided by Leaf et al. (2016a, b) was to move toward natural language instructions as quickly as possible. Furthermore, the complexity of the instruction should be determined based upon learner behavior as opposed to a rule. For instance, simple instructions (e.g., "ball") may be selected initially for younger learners that are new to intervention while more complex instructions may be used later into intervention. Relatedly, Leaf et al. third guideline was to vary the topography of instructions as quickly as possible.

Leaf et al. (2016, b) suggested the use of flexible prompt fading (FPF) as their fourth guideline. Within FPF, an interventionist identifies and responds to the conditions under which a learner is more or less likely to respond correctly with or without a prompt, and then provides or does not provide a prompt accordingly. This guideline is supported by research evaluating the effectiveness of FPF as well as comparisons to other prompting and error correction methods (Cihon et al. 2019a, b, c; Leaf et al. 2014, 2019a, b; Soluaga et al. 2008). The fifth guideline Leaf et al. provided was to use consequences to teach additional skills that do not require direct teaching. That is, as opposed to simply referring to consequences as serving as reinforcement or punishment, they can also function as informative feedback. This is commonly referred to as instructive feedback and is supported by a robust literature base (e.g., Leaf et al. 2017a, b; Grow et al. 2017; Reichow and Wolery 2011; Werts et al. 1995). The seventh guideline Leaf et al. provided was to take data on a sliding scale. That is, data should only be collected when it is informing decisions and not interfering with intervention. In some instances, trial-by-trial may

be required, while in other instances estimation data can also be accurate and sufficient (e.g., Ferguson et al. 2020a, b; Taubman et al. 2013). Finally, Leaf et al. eighth guideline suggested allowing graduated levels of distraction during instruction as opposed to artificially and automatically minimizing distractions. Similar to all of the guidelines provided by Leaf et al. this should be assessed and determined based on learner behavior. In some instances, minimizing distractions may be necessary, but as intervention continues instructors should work toward teaching in an environment more closely resembling the terminal criterion environment (i.e., the real world).

Preference Assessments

Identifying consequent events that serve as effective reinforcers is paramount in teaching skills and decreasing problem behavior for individuals diagnosed with ASD (Chappell et al. 2009; Ciccone et al. 2015; Graff and Karsten 2012). Specifically, individuals diagnosed with ASD have restricted interests (DSM-5; American Psychiatric Association 2013), and, as a result, may have a limited pool of reinforcers. Therefore, it can be difficult to identify reinforcing events for use during the course of the behavioral treatment of ASD (Chappell et al. 2009; Lanner et al. 2010; Sautter et al. 2008). Fortunately, considerable efforts have been made within the literature examining effective means to assess preference and identify potential reinforcers through the use of formal preference assessments (Reid et al. 2003).

Preference assessments can be implemented directly or indirectly to help identify potential reinforcers. Indirect assessments typically involve a parent or professional ranking items on a list, based on their knowledge of the individual and knowledge of the individual's preference for the various items (e.g., Matson et al. 1999). Direct assessments often involve directly observing the individual in the natural environment or in a setting where the availability of items is systematically manipulated. Several different direct assessments of preference have been developed and evaluated including single-stimulus (SS; Pace et al. 1985), paired-stimulus (PS; Fisher et al. 1992), multiple-stimulus with or without replacement (MS, MSWO; DeLeon and Iwata 1996), and free-operant (FO; Roane et al. 1998).

There have been recent studies which have documented the benefits of the use of in-the-moment reinforcer analysis (IMRA) compared to formal preference assessments (Alcalay et al. 2019; Leaf et al. 2015, 2016a, b). IMRA consists of assessing a variety of variables to make decisions relating to preference including, but not limited to, learner affect, learner interaction with an item, frequency of selection, an item's similarities to other known reinforcing items, targeted behavior change, and overall treatment goals. Each of these variables comes to be the main sources of control for the interventionist's behavior with respect to the selection of potentially reinforcing items. For instance, a child displaying favorable affect while interacting with an item may set the occasion for the interventionist selecting that item to provide contingent upon the child engaging in a targeted behavior. Conversely, a child displaying neutral affect and not interacting with an item may set the occasion for the interventionist not selecting to use that item contingent upon the child engaging in a targeted behavior.

The documented effectiveness of the aforementioned formal preference assessments may have contributed to their common use among behavior analysts within clinical settings. In a survey, Graff and Karsten (2012) noted "[t]he majority of behavior analysts who participated in the survey reported using at least one published SPA [stimulus preference assessment] procedure (89%)" (p. 44). Furthermore, 26.7% of Board Certified Behavior Analysts included in the survey reported conducting a formal preference assessment more than once a month.

The Future

The past 40 years has been a time of tremendous growth and discovery for the field of ABA as it relates to intervention for individuals diagnosed with ASD. During this time researchers have continually demonstrated the lifelong benefits of comprehensive behavioral intervention as well as refinements in intervention leading to greater gains. Although there have been exceptional advances, ABA is a science and should not remain stagnant. That is, ABA should continually progress and improve. With this in mind, we provide recommendations of future areas to research to ensure that behavioral intervention will continue in a positive direction.

Outcome Studies

There continues to be an increase in the number of interventions and/or treatments claiming effectiveness, and, in some cases, a cure (Goin-Kochel et al. 2007; Jacobson et al. 2005) for individuals diagnosed with ASD. While some interventions have a plethora of research (e.g., Early Start Denver Model), many interventions are unsubstantiated, lack empirical support for their effectiveness (Schreck and Miller 2010), and would be considered non-evidence based, pseudoscientific, and/or antiscientific (Green 1996). Despite the amount of literature behind these interventions, it is critical to compare comprehensive behavioral intervention to other models to ensure individuals diagnosed with ASD receive effective, efficient, and evidence-based interventions. To continue to advance our understanding of behavioral intervention, these comparisons should be done via large scale group studies (e.g.,

randomized control or clinical trials) using a comprehensive battery of assessments as well as blind evaluators. The results of these studies could inform the most effective and efficient interventions, policy change, and result in meaningful changes for individuals diagnosed with ASD.

Progressive ABA

Given the progressive nature of science, another area of research that will continually be necessary relates to progressive ABA. That is, our field will constantly be evolving which will, in turn, require continual research. While some components of a progressive approach to behavioral intervention have been evaluated, future research will be necessary to evaluate other components in comparison to a conventional approach to ABA (e.g., curriculum development, establishing an orientating response, data collection). In addition to evaluating components, large scale randomized control trials comparing progressive approaches to ABA to conventional approaches to ABA on overall outcomes with respect to language development, social development, cognitive development, and overall development are needed. More research is also needed on a progressive approach to ABA conducted by different research labs, given that the majority of the current research has been conducted by the same group of researchers. Finally, research evaluating effective training methods are necessary to identify effective methods to train individuals in a progressive approach to behavioral intervention as it applies to individuals with ASD.

Functional Analysis

An area in need of continued research is functional analysis. Standard functional analyses based upon the initial work of Iwata et al. (1982/1994) have been well established in the research. However, more research is necessary with respect to progressions in functional analysis technology such as the PFA (Hanley et al. 2014) and The Big Four (Ala'i-Rosales et al. 2019). Although the research on the use of the PFA has grown considerably since its conception, more research remains necessary (e.g., different contexts, varied change agents, group designs). Similarly, while The Big Four was offered as a means to prevent the development of problem behavior based upon the functional analysis literature, research is necessary to document that this approach does in fact prevent the development of problem behavior. Finally, given that The Big Four and the PFA open the door to functions not originally assessed by Iwata et al. (1982/1994), such as control, the opportunity to use these models to explore this possibility is ripe.

Adolescents and Adults

There is a paucity of research on effective behavior intervention as it relates to adolescents and adults diagnosed with ASD. The overwhelming majority of research within this area includes younger children as participants. Therefore, more research is needed that includes adolescents and adults diagnosed with ASD as participants in research studies. This includes evaluating the conditions under which current evidenced-based procedures are effective for adolescents and adults as well as group outcome studies when the onset of intensive treatment occurs later in life. The results of these studies should be used to help develop more guidelines, trainings, and a focused emphasis on how to effectively support and teach adolescents and adults in clinical settings.

Clinical Evaluation

Finally, as a field we need to continually evaluate what is occurring in clinical practice. We need to come up with a standardized measure to evaluate the quality of intervention that is occurring in clinical settings. This would mean creating an assessment where we can evaluate direct line therapists, supervisors, and organizations on the intervention that is being delivered to individuals diagnosed with ASD. This would enable consumers to make better informed decisions about the choice of the practitioners providing services to their children. Second, we think that the field would benefit by agreeing upon a comprehensive battery of assessments that can be used for individuals diagnosed with ASD. These assessments should include language assessments, social assessments, adaptive assessments, play assessments, self-help assessments, and cognitive assessments. Having a more standardized approach to assessments will let us evaluate what types of outcomes are being achieved in clinical settings and help differentiate effective vs noneffective approaches to ASD treatment.

Along these lines, there needs to be better guidelines for practitioners and consumers. Areas in need of guidelines include definition of quality intervention, definition of quality outcomes, how intervention should be implemented in home or clinic settings, how interventions should be implemented in school settings, and what constitutes a quality school, school district, and teacher. These guidelines will be helpful as the business of behavioral intervention continues to grow, where companies are merging together, and where private equity is playing a role in the formation of behavior analytic enterprises. Having these guidelines will help consumers and outside evaluators better determine what companies are providing quality intervention.

Social Validity and Consumer Input

Finally, input from consumers such as individuals diagnosed with ASD and their caregivers needs to be obtained and incorporated into behavioral intervention. There have been numerous complaints about ABA within the ASD community (e.g., Kupferstein 2018). These complaints range from the alleged abusiveness of behavioral intervention to negative side effects of behavioral intervention (e.g., PTSD). As a field we need to recognize there is a number of individuals who are not happy with the past or current state of behavioral intervention, regardless of whether the criticism deserved or undeserved. One future step would be to include more measures of social validity within our research. Recent reviews have found that only 12% of articles within the *Journal of Applied Behavior Analysis* from the years of 1999 to 2016 collected social validity data (Ferguson et al. 2019). Without obtaining consumer input, it will be impossible to address their concerns and modify our interventions and procedures to more closely align with their goals. More broadly, we have to start listening and responding with compassion; which has been a notable deficit of behavior analysts (e.g., Callahan et al. 2019). In doing so, we might be able to better improve the acceptability of intervention which can have positive life altering changes for the clients we serve.

Certification

Certification of behavior analysts has become common for those providing behavioral intervention for individuals diagnosed with ASD. However, there is little research related to certification and its implications for this intervention. Therefore, another area of expanded research relates to certifying behavior analysts. Specifically, research using performance-based assessments is necessary to determine if certification processes differentiate competency in the areas on the task lists associated with various certifications; which would be legally defensible. Relatedly, research is necessary to determine the number of hours of training that is necessary to achieve competency in the areas on task lists. For example, 40 h of training is required as a component to obtain the RBT® certification; however, it remains unknown if 40 h is enough time to train an individual to display all the skills on the RBT® task list with competency. Third, expanding upon current task lists to include many more principles and commonly used procedures is desperately needed. Finally, and perhaps most importantly, research is necessary to determine if intervention provided by those with certifications results in improved outcomes for individuals diagnosed with ASD. To date, no research exists that has empirically documented the benefits of certification as it relates to outcomes for individuals diagnosed with ASD.

Conclusions

The purpose of this paper was to highlight and discuss some pivotal contributions in the field of ABA and evolutions of these contributions in research and clinical practice in the past 40 years. This was by no means a comprehensive list of all the minor or major advancements during that time span. It has been a tremendous time for ABA as our technology has been established and evolved over the past 40 years. These improvements have resulted in behavioral intervention becoming the most widely adopted intervention and the one with the strongest empirical base for individuals diagnosed with ASD (Smith 2012). This has also resulted in countless individuals diagnosed with ASD reaching their fullest potential as a result of quality behavioral intervention.

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Conflict of interest None of the authors have any conflict of interests with this commentary.

Ethical Approval All procedures performed in studies involving human participants were in accordance with ethical standards of the institutional research committee and with 1964 Helsinki decoration and its later amendments or comparable ethical standards.

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