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Moving toward complexity: Introduction to the special issue on derived relational responding

Behavior analysis is characterized by a conservative, inductive, ground-up approach to research. From the very beginning, the consensus was to study the simplest behaviors first and to only study more complex behaviors when simpler behaviors were believed to be well-understood (Catania, 1998). The logic went something like this: you do not research gravity by studying a falling leaf on a windy day. The early decades of behavior analytic research, therefore, were characterized by painstakingly careful research on the minutia of how simple behaviors, such as lever pressing, were affected by environmental manipulations, such as the amount, type, frequency, and timing of positive reinforcement. Research began with studying such behavior in the simplest possible conditions: one organism in a small box with one lever to be pressed. Complexity was very slowly increased by adding a second lever and/or adding a light or tone as a discriminative stimulus.

The assumption of the importance of starting with the simple before moving to the more complex has tended to be borne out. Most small, controlled extensions from simple laboratory preparations with animals to simple laboratory or applied preparations with humans have produced orderly data that confirm the basic functional relations originally observed. For example, carefully controlled research in analog settings on the functional analysis and treatment of self-injurious behavior in individuals with developmental disabilities and minimal verbal repertoires has produced large volumes of very orderly data (Hanley, Iwata, & McCord, 2003). Similarly, research on the simpler of Skinner's (1957) verbal operants (e.g., the mand, tact, and echoic) have produced orderly data that show that many basic verbal operants are readily teachable to individuals with severe disabilities (Sautter & LeBlanc, 2006).

In the domain of outcome-level research on early intensive behavioral intervention (EIBI) for autism spectrum disorder (ASD), however, things have seemed different in certain respects. Rather than very carefully and precisely demonstrating a change in one or two behaviors over a short time (e.g., a few weeks or months), outcome research on EIBI has attempted to change entire human repertoires of behavior over the course of 2 or more years (Granpeesheh, Tarbox, & Dixon, 2009). In addition, studies have often produced robust effects on global, standardized measures of language and intelligence. The latter of course most certainly requires changes in complex behavioral repertoires; however, such changes were rarely, if ever, directly measured in EIBI research.

Out of EIBI outcome research has sprung a cottage industry of ASD service providers whose intensive, global services attempt to teach all skills required to allow a child to catch up to his/her typically developing peers. Of course, typically developing children of school age engage in extremely complex repertoires of behavior on a daily basis and so service providers have had to improvise methods for teaching complex skills, despite a lack of behavioral research on how to do so. Thus, on one hand, there was the cannon of behavioral research, which had studied relatively simple behaviors, and on the other hand, were practitioners who were busy teaching relatively complex behaviors, with a significant disconnect between the two. In particular, until the last 10 or so years, relatively little research had been done on improving relatively more advanced but nevertheless crucial aspects of language and cognition in children with ASD, including linguistic generativity, the ability to produce sentences never before said, and to understand sentences never before heard, as well as complex verbal skills including abstract problem solving, perspective taking, and analogical reasoning, to name a few (see e.g., Stewart, McElwee, & Ming, 2013).

In the meantime, however, underlining once again the importance of the conservative movement from simple to complex, results from the world of basic research have identified an important empirical phenomenon that seems to be very relevant for understanding and promoting advanced performances including generativity. This phenomenon is derived relational responding (DRR).

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Sidman (1971) reported the first empirical example of arbitrary derived relations. After training a minimally verbal participant in a set of related conditional discriminative performances between pictures, text, and spoken words, the participant derived several further responses in the absence of training, effectively responding as if particular sets of spoken words, pictures, and printed words were the same as or equivalent to each other. Sidman termed this pattern stimulus equivalence, and over ensuing decades, he and other behavior analysts conducted substantial empirical investigation into it.

A key motivator and emergent theme of this research was the link between derived equivalence and language. For example, derived equivalence responding exhibits key features of language including bi-directionality and generativity (Fields, Verhave, & Fath, 1984). Furthermore, empirical findings have shown that it develops in parallel with language in typically developing children (e.g., Lipkens, Hayes, & Hayes, 1993); that nonhumans and nonverbal humans seem unable to show it (e.g., Devany, Hayes, & Nelson, 1986; Dugdale & Lowe, 2000); and that equivalence and language tasks produce functionally similar outcomes (e.g., Dickins et al., 2001; Ogawa, Yamazaki, Ueno, Cheng, & Iriki, 2010). This link was intriguing and exciting for behavior analysts for both theoretical and practical reasons, and hence, a number of theories were advanced in an attempt to explain it. These have included relational frame theory (RFT; e.g., Hayes, Barnes-Holmes, & Roche, 2001), naming theory (e.g., Horne & Lowe, 1996), joint control (e.g., Lowenkron, 2006), and the basic stimulus account (e.g., Sidman, 2000). At this point, the account provided by RFT stands out from the others in terms of the amount of empirical evidence that has accumulated in its favor. As an example, although the call for papers for this special issue explicitly welcomed research from all of the above empirical traditions, 89% of the manuscripts submitted were informed primarily by RFT.

RFT suggests that the empirical association between derived equivalence and language comes about because they are essentially the same phenomenon, namely generalized contextually controlled relational responding or relational framing. Stimulus equivalence is seen as a case in which the context cues a generalized pattern of sameness. However, this is only one type of generalized relational responding, and language and cognition are thought to consist of many others. Existing research has provided evidence for multiple other patterns of generalized derived relations such as distinction (e.g., Roche & Barnes, 1997), comparison (e.g., Berens & Hayes, 2007), opposition (Barnes-Holmes, Barnes-Holmes, & Smeets, 2004), analogy (e.g., Persicke, Tarbox, Ranick, & St. Clair, 2013; Stewart, Barnes-Holmes, & Roche, 2004), temporality (O'Hora, Barnes-Holmes, Roche, & Smeets, 2004) and deixis (McHugh, Barnes-Holmes, & Barnes-Holmes, 2004) (see Dymond & Roche, 2013, for an overview of recent research).

Two characteristics of DRR or relational framing that seem particularly important are: (1) that it is extremely generative and (2) that it can be trained. Evidence for the generativity of this behavior has been provided by many of the RFT studies published thus far, though a few in particular deliberately highlight this characteristic (e.g., O'Hora et al., 2004; Stewart et al., 2004; Wulfert & Hayes, 1988).

There is also increasing evidence that DRR/relational framing can be trained. A number of studies have provided empirical demonstrations of the use of multiple exemplar training (MET) as a means of deliberately training DRR repertoires in young children for whom they are deficient or absent. For example, Greer, Stolfi, and Pistoljevic (2007) used MET to establish generalized derived mutual entailment of coordination (aka generalized symmetry) in preschool children; Barnes-Holmes et al. (2004a) and Barnes-Holmes, Barnes-Holmes, Smeets, Strand, and Friman (2004b) trained repertoires of more than/less than and opposite relational framing, respectively, in young children between the ages of 4 and 6 after such repertoires were found to be absent; Luciano, Becerra, and Valverde (2007) trained equivalence relations in a young infant whose age ranged from 15 to 23 months during the study; and Berens and Hayes (2007) as well as Weil, Hayes, and Capurro (2011) conducted a well-controlled multiple baseline demonstration of the training of comparative and deictic frames, respectively, in 4–5 year olds.

According to RFT, DRR or relational framing is a generalized operant class generated by a history of reinforcement across multiple exemplars, and its establishment underlies the development of language and cognitive skills. In terms of this special issue, of course, a key focus is the application of DRR and RFT to teaching children with ASD or other developmental delays as a means of improving their repertoire of generative language and cognitive ability.

Many children with ASD have at least a basic repertoire of DRR ability, which, though perhaps not as well practiced or advanced as that of typically developing children, nevertheless can be used and built upon in order to expand their repertoire of skills and responses more rapidly and efficiently than would be possible through more conventional training. The educational relevance of this approach is significant and it offers substantial benefits. In the case of other individuals with ASD, their relational framing/DRR repertoires, including sometimes even the most basic such as equivalence, are either markedly deficient or absent (e.g., Devany et al., 1986; McLay, Church, & Sutherland, 2013). In such cases, establishing DRR skills is critical in order to establish generative verbal behavior.

The majority of empirical work on DRR, and especially RFT, conducted so far has involved typically developing participants. However, in recent years, there have been an increasing number of studies, including RFT studies, that have involved the application of DRR with participants with ASD and other forms of developmental delay (e.g., see Ming, Moran, & Stewart, 2014; Rehfeldt & Barnes-Holmes, 2009). For instance, a series of studies between 2005 and 2010 examined how a basic manding repertoire might be combined with a repertoire of DRR to augment both and boost generative skills (see Murphy & Barnes-Holmes, 2009a,b, 2010a,b; Murphy, Barnes-Holmes, & Barnes-Holmes, 2005; Rehfeldt & Root, 2005). In addition, a series of studies by Greer and colleagues have documented how MET can be used to establish naming or generalized derived symmetry in preschool-aged children with and without disabilities (e.g., Greer, Stolfi, Chavez-Brown, & Rivera-Valdes, 2005; Greer et al., 2007). Other studies have begun to assess and train perspective taking (e.g., Weil et al.,

2011). Work such as this is beginning to suggest the potential and promise of DRR and RFT for remediating the absence of linguistic generativity and advanced cognitive skills in the ASD population. The purpose of this special issue is to provide an up-to-date sampling of some of the most recent such work.

1. In this issue

The collection of papers in this issue touch on a diverse range of topics relevant to DRR in the ASD population, including methodological and procedural refinements, technology applications, challenging behavior, and methods for teaching particular relational frames.

1.1. Procedural refinements

Although typically developing children learn to derive relations by pure exposure to the unplanned contingencies involved in language interactions in the natural environment, many children with ASD do not (Rehfeldt & Barnes-Holmes, 2009). Procedural refinements involve methods used to facilitate the emergence of DRR in such individuals who demonstrate difficulty establishing DRR repertoires via traditional behavior analytic teaching methods. The article by Ming, Stewart, McElwee, and Bynum (2015) provides a well-controlled demonstration of using an influential animal context during teaching in order to enhance acquisition of DRR. Using a reversal design, this study evaluated the difference in the emergence of DRR when teaching was done in a neutral context ("Which one does ___ go with?") versus an animal context ("Which one is called ___?"/"Which one says ___?") and found that the participant performed better in the animal context. These results are noteworthy, as they suggest that tailoring teaching material to a learner's interests facilitates DRR. Future research may discover that using preferred contexts may initially be helpful for establishing DRR, and via MET, it may become possible for learners to eventually respond appropriately using neutral contexts. This would be an exciting discovery, and it's possible other types of influential contexts could be tailored for individual learners with unique preferences.

1.2. Challenging behavior

One of the defining features of ASD (APA, 2013) is the presence of repetitive and restrictive behaviors oftentimes presenting as ritualistic routines (i.e., needing to do things a specific way). A common treatment has involved exposure and response prevention or interruption; however, interrupting or preventing the behavior may result in tantrums, aggression, and other challenging behavior. The study by Eilers and Hayes (2015) presents the application of a cognitive defusion intervention to the treatment of repetitive and restrictive behavior in children with ASD. The first experiment employed a multiple baseline across participants design to assess the effects of a cognitive defusion exercise, consisting of word repetition, and exposure on challenging behavior associated with repetitive and restrictive behavior. Results demonstrated a decrease in challenging behavior subsequent to the defusion intervention and the gains were maintained at a 3-month follow-up. The second experiment compared the cognitive defusion exercise combined with exposure intervention to a control intervention with exposure and found that the defusion combined with exposure intervention produced more rapid effects in the reduction of challenging behavior. This study is quite novel, as it is the first of which we are aware, to attempt to identify a procedure influenced by the RFT literature for addressing challenging behavior in individuals with ASD.

1.3. Assessment

Given the evidence that DRR is a key repertoire comprising language, there is a growing need for tools that allow assessment and systematic evaluations of DRR in individuals with ASD. One such tool is the Training and Assessment of Relational Precursors and Abilities (TARPA; Moran, Stewart, McElwee, & Ming, 2010). Moran, Walsh, Stewart, McElwee, and Ming (2015) conducted an evaluation of the TARPA that extended all previous evaluations of the TARPA and found: (a) differences in performance across visual and auditory tasks in children with ASD, (b) that the TARPA correlated with other standardized assessments such as the Vineland Adaptive Behavior Scales (VABS), Preschool Language Scale 4th Edition (PLS-4), Gilliam Autism Rating Scale, and the Stanford-Binet 5, and (c) that the TARPA had relatively high test-retest reliability. Psychometric research on behavior analytic assessments is uncommon, yet needed, in order for them to be regarded highly by those outside the field of ABA. Thus, this study provides an important contribution to the field.

1.4. Technology

Technology currently plays an integral role in behavioral intervention for children with ASD. For example, it is relevant for teaching skills, providing reinforcement, and most importantly, allowing nonvocal individuals with ASD to communicate with others. Speech-generating devices using communication applications have largely supplanted the need to create communication books with laminated picture icons. Still, May, Rehfeldt, Whelan, and Dymond (2015) were the first to investigate the use of a touchscreen tablet for facilitating derived mands in children with ASD. Using a touchscreen tablet, this study started by teaching participants to mand for missing items needed for toy play by exchanging pictures of items for the actual items. Then, participants were taught to relate dictated items both to pictures and to text representing the items.

Following training, test probes found that all but one of the participants demonstrated derived mands for missing items using text exchange (derived requesting) and could, without training, match pictures to text and text to pictures as well as label pictures and read text (derived stimulus relations). These results are exciting as they suggest that technology synthesized with DRR can effectively facilitate independent communication in nonvocal children with ASD.

1.5. Methods for teaching particular relational frames

Deficits in social communication are a defining feature of ASD (APA, 2013), and thus, language is often a major focus of behavioral intervention. An emphasis on teaching generative repertoires is preferable to the alternative of teaching language skills one response at a time, wherein children would need to be taught rote memorization of thousands of responses to individual stimuli. The latter method of teaching is simply impractical, inefficient, and inflexible, and is not likely to result in the learner using their acquired language in novel ways in the natural environment when opportunities arise. Teaching generalized operant repertoires, through the use of training DRR, on the other hand, likely allows individuals with ASD to apply their language abilities to novel situations. According to RFT, there are many different types of relations that individuals make when using and understanding language. Two types that were investigated in the studies herein include coordination and deictic relations.

Coordinate relations. Relations of coordination refer to relations of sameness or equivalence. Lessons that teach "receptive" and "expressive" names (symmetrical relations), such as body parts, objects, people, colors, numbers, letters, and so on, are generally teaching frames of coordination. Thus, relations of coordination are at the heart of behavioral intervention for learners with ASD.

Wh- questions. Responding to wh- questions is a difficult skill for many children with ASD, and little research has evaluated techniques for teaching such skills. Of the research that has been conducted, evaluations for teaching emergent responding in this area are lacking. In the study by Daar, Negrelli, and Dixon (2015), teaching children with ASD to respond appropriately to wh- questions was addressed using a multi-stage intervention to facilitate derived equivalence relations between community helper stimuli (doctor, police officer, and teacher), noun-class stimuli ("person," "place," "activity"), and wh- words (e.g., "who," "where," "what"). A concurrent multiple baseline across participants and behaviors demonstrated emergence of responding to untrained wh- questions in two of three participants.

Sorting by category. Sorting objects by category is another difficult skill for many children with ASD to which training resulting in DRR would be beneficial. Lee, Miguel, Darcey, and Jennings (2015) tested the effects of listener training on emergent speaker (tact) and categorization (visual-visual matching/sorting) repertoires. Results demonstrated that two participants passed speaker (tact) and categorization testing following listener training, while two did not pass and required tact training before passing categorization testing. Results were interpreted to suggest that naming repertoires (listener and speaker) are needed in order for children to demonstrate emergent categorization repertoires. This topic is interesting and worthwhile in that it is important to determine what training is necessary to produce emergent repertoires.

Deictic relations. Deictic relations refer to those associated with perspective taking (i.e., I/you [identity], here/there [location], now/then [temporality]). Perspective taking is a common area of deficit for children with ASD, and given its importance to effective social functioning (being able to identify and predict others' thoughts, feelings, preferences, intentions, etc.), this area is also often a major focus during behavioral intervention. Gilroy, Lorah, Dodge, and Fiorello (2015) evaluated the effects of a story-telling procedure on establishing deictic relational frames in children with ASD. Results found the procedure to be effective across three levels (i.e., simple, reversed, double reversed) of deictic relations and to maintain when the treatment was withheld and in the presence of a novel person. These results are promising in that this is only the second study to train deictic relations to children with ASD and the first to use this teaching approach specifically. It also used a more naturalistic teaching procedure than previously used with DRR research with this population.

1.6. Peer review process

The research articles contained in this special issue underwent a rigorous process of peer review. Each article was reviewed by a minimum of three experts in ASD and DRR research. Of the articles submitted, 56% were rejected, all due to limitations in experimental methodology. All manuscripts which were eventually accepted underwent multiple rounds of back-and-forth revisions between the authors and guest editors. Finally, all articles that evaluated procedures, books, tools, or technology that were named or could be branded contain statements at the end of the article that disclose any potential conflict of interest the authors might have.

2. Conclusion

Although ABA-based intervention for children with ASD has become widely known for being effective and evidence-based, the common misconception still remains that ABA is only effective for teaching basic key skills and ignores advanced language and cognition. Even at the most basic theoretical and philosophical levels, this myth is untrue. However, it is not enough to state that a science can be applied to complex skills and behaviors; a robust program of research must also bear this out. More and more research is being published on teaching higher-order skills and emergent repertoires in the ASD population but much more is still needed. Indeed, we believe that the field of ABA is at a critical cusp. Crucial early research

on DRR and ASD has been published but vast opportunities for expansion of research in this area still exist. Recent books, such as *Derived Relational Responding: Applications for Individuals with Autism and Related Disorders* (Rehfeldt & Barnes-Holmes, 2009), and forthcoming books, such as *PEAK Relational Training System: Equivalence Module* (Dixon, in press), and *PEAK Relational Training System: Transformation of Function Module* (Dixon, in press) are landmark publications that have and will continue to usher in advances in research and practical application of DRR to ASD treatment.

This special issue was intended to bring attention to the use of behavior analytic procedures to promote the emergence of derived repertoires in individuals with ASD. Research that addresses DRR in the ASD population is growing increasingly, yet a small population of researchers conducts most of the research in this area, and the application of procedures for promoting DRR is still lacking. It is our hope that bringing attention to research on assessment and treatment related to DRR will contribute to more widespread clinical use of procedures for promoting DRR as well as aid in the development and design of future research investigations studying this phenomenon.

Author note

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