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A Pilot Investigation of the Relationship Between Derived Relational Responding and Challenging Behavior Function

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A PILOT INVESTIGATION OF THE RELATIONSHIP BETWEEN DERIVED RELATIONAL RESPONDING AND CHALLENGING BEHAVIOR FUNCTION

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Master of Science, Applied Behavior Analysis

By

Kaitlin Nichole Beason

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ABSTRACT

The study evaluated the relationship between participants derived relational responding across arbitrary stimuli and parent or teacher endorsed functions of challenging behavior as assessed on the *Questions About Behavior Function* (QABF). Supplemental analyses were conducted to directly observe the frequency and intensity of challenging behavior using the *Challenging Behavior Index* (CBI), as week as direct observation of presenting autism symptoms in session using the *PEAK Autism Symptoms and Behavioral Observation Summary* (PAS-BOS). Derived relational responding was assessed using the *Promoting the Emergence of Advanced Knowledge Equivalence Pre-Assessment* (PEAK-E-PA) and the *Promoting the Emergence of Advanced Knowledge Transformation Pre-Assessment* (PEAK-T-PA) taking from the PEAK Comprehensive Assessment (Dixon, 2019). Assessments were conducted across 34 individuals with autism or another intellectual disability. Relations between participants who can derive relations (ME+) and participants who cannot derive relations (ME-) and the ability of the QABF to identify a single function of behavior were significant $\chi_2 (1, N = 34) = 4.9$, $p = 0.026$. When evaluating the relationship between PEAK Total Scores and the CBI Total Scores, results suggest there was a moderate negative relationship between the two $r = -0.35$, $p \leq 0.05$. There was no relationship observed between measure of derived relational responding and autism symptom severity on the PAS-BOS $r = -0.12$, $p \geq 0.28$. Results from this pilot investigation could be used to inform future research on the topic of derived relational responding and how it pertains to an individual's scores on both indirect and direct challenging behavior assessments.

KEYWORDS: arbitrary stimuli, autism, relational responding, PEAK, CBI, PAS-BOS, challenging behavior

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INTRODUCTION

Prevalence of Autism and Challenging Behavior Function

Autism Spectrum Disorder (ASD) is becoming more prevalent in children today (Healy, Brett, & Leader, 2013). Pennington, Cullinan, & Southern (2014, p.1) stated "ASD refers to a group of pervasive neurodevelopmental disorders that involve moderately to severely disrupted functioning in regard to social skills and socialization, expressive and receptive communication, and repetitive or stereotyped behavior and interests." Most signs of ASD become apparent in the early stages of development, but behavior patterns, language and social deficits might not become present until the individual has aged (Healy, Brett, & Leader, 2013). According to Pennington, Cullinan, & Southern (2014), 1 in 88 have a diagnosis of ASD, meaning that over 800,000 individuals under the age of 20 in the United States alone have ASD. Challenging behaviors often provide another obstacle when interacting with children with ASD. Behaviors such as ones that are not socially acceptable, ones that can harm oneself or another, and can affect learning or where a child lives (Matson, Mahan, Hess, Fodstad, & Neal, 2010). Aggression, destruction, self-injury, and elopement are common challenging behaviors. Matson & Reed (2009, p.400) stated "Up to 94.3% of children and adolescents with ASD display at least one challenging behavior." Dawson, Matson, & Cherry (1998) found that a child diagnosed with ASD was an automatic predictor of engagement in challenging behaviors. The presence of these behaviors is correlated with fewer adaptive behaviors (Matson et al., 1997).

The function of challenging behaviors in children with autism can be assessed in a variety of different ways. Behavioral antecedents and consequences in a person's environment are the

result of behavior function. “The gold standard” when attempting to identify the function of challenging behaviors is the use of a functional assessment (Healy, Brett, & Leader, 2013). Experimental functional analysis (EFA) occur when environmental events are systematically manipulated to test hypotheses of behavior function (Iwata, Vollmer, & Zarcone, 1990). EFA’s can be conducted in an individual’s natural environment, but the majority of the time, they are not, rather conditions are manipulated by implementers (Healy, Brett, & Leader, 2013). An EFA is conducted by trained behavior analysts who implement specific procedures. The most commonly used assessment conditions are attention, demand, and play when conducting functional analyses that involve the manipulation of antecedents and consequences associated with challenging behaviors (Iwata et al., 2000). In a study conducted by Iwata et al. (2000), skill acquisition in implementing functional analyses was examined. Eleven undergraduate students were participants. The attention condition consisted of the participant being given free access to multiple preferred items throughout the session. The therapist ignored the participant throughout the session unless attention was being delivered in the form on a statement or physical contact following each occurrence of challenging behavior (Iwata et al. 2000). The demand condition consisted of the therapist presenting learning trials to the participant, initiated at 30 second intervals. Praise was delivered to the participant if they complied. Prompting was continued if the participant did not comply, and the session was terminated if the participant engaged in any target behaviors during the session (Iwata et al., 2000). During the play condition, the participant again had access to preferred items. The therapist delivered attention on a fixed-time 30 second schedule and responded to appropriate interactions from the participant. Inappropriate behavior, whether target or nontarget behaviors, were ignored. Delivery of attention was delayed inappropriate behavior had discontinued for 5 seconds if attention was supposed to be initiated at

the time of inappropriate behavior (Iwata et al., 2000). The purpose of an EFA is to determine which condition produces the highest frequency and duration of challenging behavior (Healy, Brett, & Leader, 2013). The condition with the highest frequency represents the likely maintaining antecedent (Healy, Brett, & Leader, 2013) or consequential (Healy, Brett, & Leader, 2013) condition that maintain challenging behavior in the natural environment. The study conducted by Iwata, Dorsey, Slifer, Bauman, & Richman (1994) is perhaps the most influential study conducted to date on the effectiveness of functional analyses. Both physical and social manipulations that differentially affect occurrences of self-injury was evaluated. Nine subjects, all showing developmental delay of some degree were included in the study. Subjects were allowed to engage in self-injurious behavior with a prior medical examinations and specific criterion put in place by the subject's physician (Iwata, Dorsey, Slifer, Bauman, & Richman, 1994). All but one of the subjects were exposed to the four conditions (Academic, Alone, Social Disapproval, and Play). Results of the study showed that there were higher levels of self-injury associated with one specific condition (Iwata, Dorsey, Slifer, Bauman, & Richman, 1994). These results suggest that self-injury may indeed be a function of different types of reinforcement and add to the degree of direct empirical evidence (Iwata, Dorsey, Slifer, Bauman, & Richman, 1994).

The QABF is a commonly used behavior scale that consists of a 25-item scale assessing the function of a single challenging behavior. Five possible functions: attention, escape, tangible, non-social, and physical are assessed (Healy, Brett, & Leader, 2013). Matson, Bamburg, Cherry, & Pac (1999) found that the QABF successfully identified functions of behavior for 84% of participants in the study and treatments based on the results of the QABF led to more improvement in participant behavior than those treatments that were not based on the functions

of challenging behavior identified on the QABF. Another study by Matson & Boisjoli (2007) evaluated the use of the QABF when developing future assessments and treatment plans for individuals who have a history of maladaptive behaviors. Results showed that for the majority of the participants, behaviors were maintained by multiple functions of behavior and reliability was higher when the QABF identified a single function of challenging behavior (Matson & Boisjoli, 2007). The CBI and PAS-BOS are other assessments that are related to behavior function as defined above. A child might engage in challenging behaviors to escape a task, maintain attention, etc. The CBI measures the frequency and intensity of challenging behaviors, therefore, using the CBI, QABF, and EFA together, a specific function of behavior can be identified. The CBI does not identify the function of behavior by itself but is a valid supplemental tool. The PAS-BOS measures autism symptom severity, meaning it does not identify a function of behavior. Rather it measures the frequency and intensity of symptoms a child with autism might have. Just as the CBI can be used as an additional assessment, the PAS-BOS can as well, but cannot be used when attempting to identify the function of challenging behavior.

The CBI is part of the PEAK comprehensive assessment. It composed of 10 questions, each based on challenging behaviors that the child might engage in. A Likert-type scale is used to record the frequency and intensity of the behavior on a 0-2 rating scale (0=never/no intensity, 1=sometimes/minimal intensity, 2=frequently/high intensity). Frequency and intensity of behavior are totaled with a maximum of 20 points possible for both sections. The CBI is completed by the implementer during the first session. It is a useful supplement to the QABF in that it examines the frequency and intensity of challenging behavior rather than solely the function. Based on its results, the CBI can give the implementer an idea of how often and how severe challenging behavior can get. The PAS-BOS is also part of the PEAK comprehensive

assessment. It consists of 30 questions regarding a child's social interactions, communication, and repetitive behaviors are assessed. The PAS-BOS is completed by the implementer throughout the first session. Unlike the QABF and CBI, the PAS-BOS does not necessarily aim to evaluate the relationship between function of behavior and the frequency and intensity. Rather the PAS-BOS is a measure of autism symptom severity. A child can have autism without engaging in challenging behavior. A Likert-type scale identical to the one used to identify frequency and intensity of behaviors on the CBI is used for the PAS-BOS. The QABF is used in hopes of identifying a single function of challenging behavior, the CBI is used as a supplement to the QABF in that it measures the frequency and intensity of the behavior, and the PAS-BOS is used to determine the extent to which a child shows autism related symptoms.

Studies correlating the PEAK-CA assessment with the *Questions About Behavior Function* (QABF) assessment have been conducted and have produced significant results. One study conducted by Belisle, Stanley, & Dixon (2017) where researchers evaluated the relationship between an individual's ability to derive mutually entailed relations and their function of challenging behavior indicated on the QABF. I discuss the specifics of the PEAK-CA below as derived relational responding but note here that results reported by Belisle, Stanley, & Dixon (2017) suggest that identification of a single function of challenging behavior may be less probable for individuals who can derive relations. In the above study, 47 individuals with autism or other intellectual disabilities were included. Those individuals whose assessment results identified more than one single function of behavior made it difficult for the researchers to develop successful treatment programs. Belisle and colleagues found that an individual's potential to derive relations was not due to any specific topography of challenging behavior. The results of the overall study suggested that participants who could derive mutual relations on the

PEAK-CA had lower scores on the QABF (Belisle, Stanley, & Dixon, 2017). The results of this study cohere with a behavioral interpretation of behavior function within the framework of rule-governed behavior as described below, along with the potentially necessary condition on derived relational responding contributing to the development of rule-governed- rather than contingency shaped-challenging behavior.

Rule-Governed Behavior and Derived Relational Responding

Rule-governed behavior (RGB) is rule-following behavior that allows an individual to interpret a contingency before coming in contact with it (Skinner, 1969). For example, rule-governed behavior often associated with daily life are ingredient labels on products. A bottle of cleaning spray containing bleach may have a warning label stating not to drink the bleach, as it is toxic. By following this rule, we are able to understand the contingency of drinking bleach without having to drink it and ultimately contact sickness or death. Skinner (1969) stated that RGB is essential to human survival, as it allows us to interpret contingencies without putting our species at risk or harm. Therefore, RGB is a key component when developing an effective treatment plan for children with autism who engage in challenging behaviors. Hayes, Brownstein, Haas, & Greenway (1986) states that human behavior is notably influenced by verbal instructions. RGB is distinct due to behavior occurring because of contact with rules that describe contingencies, rather than prior contact with the contingencies that may immediately follow behavior (Tarbox, Zuckerman, Bishop, Olive, & O'Hora, 2011). Undoubtedly, a sufficient verbal repertoire is necessary for the formation of rule-governed behavior that may lead us away from a direct contingency account. That is, the probability that behavior is contingency shaped may be greater for children who lack a sufficient verbal repertoire to derive

rules about their environment; whereas children who can derive relations may show less contingency-shaped behavior. Such an outcome could explain the results achieved by Belisle, Stanley, & Dixon (2017), in that fewer items on the QABF-a tool used to identify immediate contingencies controlling behavior-are endorsed as a function of a person's rate of derived relational responding. The potential application of this can be found in basic experimental research on contingency sensitivity when exposed to accurate verses inaccurate rules. Schedule insensitivity can be the result of socially mediated consequences occurring due to opposition to operant consequences (Cerutti, 1991). Compliance that is schedule insensitive with instructions sometimes continues after exposure to incompatible events (Cerutti, 1991). Cerutti (1991) conducted a study on whether or not insensitivity may be determined by discriminative properties of contingencies instead of the reinforcing properties. Participants consisted of 31 undergraduate students. Participants were assigned to a condition where tones were presented based on a mixed random, mixed- fixed, or fixed-time schedule for button pressing. Insensitivity was measured by participants' compliance with instruction to press or avoid tones, their shaped guesses to press fast and slow, and post session reports that described an avoidance contingency (Cerutti, 1991). Results show that those participants who responded superstitiously revealed schedule insensitivity was present due to continuously pressing panels in an extinction operation (Cerutti, 1991). Instructed insensitivity typically involves two sets of contingencies (Otto et al., 1999). Otto and colleagues developed a study evaluating whether participant responses were controlled by accurate "Go Fast, Go Slow" instructions and were randomly assigned to four conditions. Two experiments were conducted to test for schedule insensitivity. Results of both experiments provide evidence that operant blocking plays a role in some instructed insensitivity (Otto, Torgrud, & Holborn, 1999).

Behavior analysts focus on assessing and treating the function of a problem behavior that a child might be engaging in rather than just the topography. In applied behavior analysis, behavior analysts work toward determining what the antecedents and consequences of challenging behavior might be. Human development is contingent on an individual being able to derive relations between stimuli that are arbitrarily related (Belisle, Stanley, & Dixon, 2017). A study conducted by Catania, Shimoff, & Matthews (1989) promoted that once under the control of rules, behavior shows an insensitivity to change in a reinforcement contingency. Children and individuals with autism can also show an insensitivity to direct acting contingences when they begin to develop meaningful language. Deriving rules can be understood in the context of derived relational responding.

Hayes et al. (2001, p.21) stated "Derived relational responding presents itself as a kind of kernel or seed from which a behavioral analysis of language and cognition may grow." Derived relational responding is not based solely on physical properties of stimuli being related, but by any stimuli that has been encountered in a specific relational context (Hayes et al., 2001). Relational repertoires are eventually well established through contingencies put in place by the trainer. Verbal rules then become the source of verbal relations for young children (Hayes et al., 2001). Stimulus equivalence is the result of a learned frame of sameness to the stimuli in an arbitrary match-to-sample procedure (Steele & Hayes, 1991). Stimulus equivalence transpires when stimuli have identical functions as a result of deriving direct relations, symmetrical and transitive relations (Dixon et al., 2016a). Equivalence can be the outcome of history relating to the frame of coordination, opposition, or distinction, all of which would establish a variety of relational systems (Steele & Hayes, 1991). Sidman & Tailby (1982) suggest that equivalence is the relation of sharing the properties of reflexivity, transitivity, and symmetry.

Relational frame theory (RFT; Hughes & Barnes-Holmes, 2016) describes derived relational responding and resulting transformations of stimulus function. RFT is the idea that relational responding is the main process that drives language development as well as cognitive abilities in humans. Barnes-Holmes, T., Barnes-Holmes, D., & McHugh (2004) argue that RFT and relational responding not only aid in the development of behavior and language, they also help through using teaching programs for individuals with language and cognition deficits. Deriving a relation between two things or events is controlled by the formal properties of a stimuli. RFT says that relational responses that are arbitrarily applicable can be brought upon any stimuli as long as it is in the appropriate context. By using relational responding and RFT, bidirectional relations can be derived which in turn build a larger language/cognitive repertoire (Barnes-Holmes, T., Barnes-Holmes, D., & McHugh, 2004).

Performance on equivalence tests can be a result of previous learning history. In this case, RFT can be used to directly train each of these relations to increase language and other necessary skills (Jackson, Williams, & Biesbrouck, 2006). Though many children with autism cannot derive mutually entailed relations, some children with autism can. Barnes-Holmes, T., Barnes-Holmes, D., & McHugh (2004) conducted a study on derived relational responding using sixteen children, eleven of which did not demonstrate derived relational responding on their first attempt at a symmetry test. A multiple baseline design was used to do specific training for the eleven children who did not reach the performance levels which included training of the symmetrical object-action relations. Some of the children were introduced to multiple sessions of conditional discrimination training before beginning the symmetry training. All eleven children who initially failed the first symmetry test were able to establish derived transformations of function upon the completion of explicit symmetry training (Barnes-Holmes, T., Barnes-Holmes, D., & McHugh,

2004). The results showed that with the inclusion of more training, the majority of children required only one exemplar of training to increase their derived performance levels (Barnes-Holmes, T., Barnes-Holmes, D., McHugh, 2004).

RFT aids in the development of different types of relational frames as well. Some of these are: coordination, opposition, distinction, comparison, hierarchy, and perspective-taking (Barnes-Holmes, T., Barnes-Holmes, D., & McHugh, 2004). Coordination involves the relations of sameness, which is the most common pattern of all the types of relational frames. Opposition refers to stimuli being distinguished in equal ways from a particular starting point. The relational frame of distinction is simply being able to respond to differences in stimuli. Comparison relational frames are present when responding occurs in terms of a quantitative or qualitative relation. Lastly, perspective-taking includes three deictic frames which are "I", "here", "there", "now" and "then". When using RFT, responding in accordance to the correct deictic relation is present when language development occurs (Barnes-Holmes, T., Barnes-Holmes, D., & McHugh, 2004).

Another form of relational responding is arbitrarily applicable relational responding (AARR). RFT states that AARR is developed based off of a unique history of reinforcement (McHugh & Reed, 2009). A first study showing AARRing in a disability sample was conducted by Sidman (1971). Participants with a learning disability were taught to form three-member equivalence relations using pictures, objects, and words. The results of the training were promising due to a significant increase in their vocabulary and reading ability. Equivalence classes were then developed by the participants.

Dixon et al. (2016b) conducted a study using PEAK-Equivalence (PEAK-E). PEAK-E is based on the use of equivalence sources to promote the emergence of simple and complex

categorical classes. The curriculum that makes up PEAK-E has demonstrated efficacy in using stimulus equivalence formation in children with disabilities (Daar, Negrelli, & Dixon, 2015; Dixon et al., 2016b). The efficacy of one of the programs from the PEAK-E program was evaluated. Three participants with disabilities were included in the study where their potential to form equivalence relations was tested. Dixon et al. (2016b, p.5) stated "A multiple probe across participants design was used to evaluate the efficacy of the PEAK-E curriculum on trained relations, categorical relations, and on the emergence of intraverbal responding during test probes." Results suggest that training was effective in teaching all participants to engage in derived categorical responding and receptive categorical responding (Dixon et al., 2016b). Another study directed by Belisle, Dixon, Stanley, Munoz, & Daar (2016) taught three children with autism perspective-taking tasks while evaluating their ability to derive single-reversal deictic relations of their newly leaned perspective-taking skills. The purpose of the study was to analyze the efficacy of a relational training program in teaching single-reversal deictic relational responding (Belisle, Dixon, Stanley, Munoz, & Daar, 2016). Only one relation was directly taught, and the inverse relations was tested intermittently tested for untrained emergence. Single-Reversal (You) Deictic Training and Mixed-Single (I and You) Reversal Deictic Training was tested with all participants. The results of this study indicate that some individuals with autism derive bidirectional single-reversal deictic frames after direct training of a single relation has occurred (Belisle, Dixon, Stanley, Munoz, & Daar, 2016).

Assessing Derived Relational Responding in Children with Autism

Language skills are a leading deficit in children diagnosed with autism, therefore, an abundance of research has been conducted on how to measure derived relational responding in

this population. Relating simply means to respond to one event due to another event (Hayes et al. 2001). An individual's ability to respond to nonarbitrary stimuli is not considered to be derived relational responding, but when an individual can respond to stimuli in the appropriate relational context, it is arbitrarily applicable (Hayes et al., 2001). A relationship between stimuli might be more complex, but due to the ongoing interactions with the procedure, the existence of derived relational responding is directly observable (Sidman & Tailby, 1982). Derived relational responding is believed to be reached when an individual can respond correctly to a specific number of trials all while being tested on untrained relations (Dymond & Rehfeldt, 2001). Research on technologies to assess and promote the emergence of derived relational responding in children is becoming increasingly prevalent. Belisle, Paliliunas, Lauer, Giamanco, & Sickman (2019) conducted a citation analysis on DRR and transformations of function in children. They reviewed several ABA journals, identifying a total of 123 empirical articles pertaining to derived relational responding in children. Of these articles, researchers found several ways that multiple authors use different technologies for children with disabilities and without disabilities to use when attempting to increase their derived relational responding skills.

In 1988, Wulfert & Hayes conducted another study on DRR. They studied response latencies during baseline, symmetry, transitivity, and equivalence trials. Their research showed that response latencies on both sets of trials varied significantly from each other even though accuracy was the same across all trials. It is important to use a variety of procedures when evaluating derived relational responding. Both stimulus sorting and stimulus recall play a key part in derived relational responding. There is evidence supporting that once equivalence has been demonstrated, participants are able to engage in class-consistent sorting as well. Stimulus sorting and stimulus recall in themselves acquire validity within other measures of DRR

(Dymond & Rehfeldt, 2001). One of the smallest, yet most important aspects of derived relational responding is being specific when giving instructions. The outcome of the measures can be affected if specific and direct instructions are not delivered. It is said that once derived relational stimuli have been tested and equivalence relations have been acquired, they remain stable over time. Pre-training may also be relevant. Steele & Hayes in (1991) conducted multiple experiments to look at the difference in pre-trained participants who were exposed to same and opposite pre-training and those exposed to same and different pre-training differed in terms of relational responding. Pre-training consisted of same/different control, arbitrary matching-to-sample training, and testing blocks using probes (Steele & Hayes, 1991). Results support those of previous equivalence studies in which the establishment of classes can emerge.

The majority of research done on effective methods for attempting to change the behavior of a client has been conducted directly with participants or organizations that have focused mainly on changing the performance of individual staff so that they can attempt to change the behavior of the client. Instead, Dixon, Belisle, & Stanley, (2018a) ran a yearlong study on implementation of the PEAK curriculum. The purpose of the study was to evaluate the effectiveness of the PEAK-DT over the course of a year in which it is conducted by school staff, both direct care staff and teachers. They found that their study replicates previous research in terms of the PEAK-DT curriculum is effective when training targeted skills. They found that about 16 new skills were acquired over the course of the year as well as several response topographies within each of the skills (Dixon, Belisle, & Stanley, 2018a).

Perspective-taking skills are often lacking in children with autism, therefore, Belisle, Dixon, Stanley, Munoz, & Daar (2016) ran a study based on the PEAK-T curriculum testing children on their perspective taking skills along with their ability to derive single-reversal I

relations based on training of single-reversal You relations. Both children with autism and typically developing children participated in the study. The procedures used to gauge the effectiveness of teaching single-reversal deictic responding were based off of the PEAK-T curriculum. The PEAK-T curriculum gives instruction on how to properly teach deictic skills (Belisle, Dixon, Stanley, Munoz, & Daar, 2016). Overall, the study again supported that the PEAK-T can be an effective and useful tool for staff when working to support children with autism.

The *Promoting the Emergence of Advanced Knowledge Equivalence Pre-Assessment* (PEAK-PA) is an assessment used to evaluate an individual's ability to make relations between stimuli and how those complex relations may play a part in the function of challenging behavior (Belisle, Stanley, & Dixon, 2017). The results from the PEAK-PA are then used to create targets for language programing.

The PEAK-E-PA was created to evaluate a child's ability to draw relations between stimuli and to provide a measure that can appropriately determine the development of complex relations that may be related to the function of the problem behavior (Belisle, Stanley, & Dixon, 2017). PEAK allows behavior analysts to determine the relationship between stimuli and whether or not the relationship is of mutual entailment or combinatorial entailment. Mutual entailment and combinatorial entailment involve reflexivity, symmetry, transitivity and equivalence all of which link back to the idea behind rule-governed behavior and being able to determine relationships between stimuli. Dixon, Belisle & Stanley (2018a) conducted a study comparing the results on participants IQ tests and assessing derived relational responding using the PEAK-E-PA. Skinner developed the idea that verbal behavior is brought under the control based on the behavior of the speaker who serves as the mediator of reinforcement and

punishment. Skinner's main focus is on how direct contingencies influence the development of verbal behavior. Individuals are said to derive certain relations because of the history of reinforcement that is paired with that stimuli. The purpose of their study was to determine whether or not participants' scores on their IQ test would result in them performing better on the PEAK-E-PA. This particular study by Dixon, Belisle, & Stanley (2018a) was the first of its kind to assess the relationship between participants derived relational responding and their IQ test scores. Overall, results showed that the two are related in that the participants who could to derive relations also performed better on their IQ tests. One limitation of the study is that the behaviors being evaluated during the IQ tests may not have a history of reinforcement due to not occurring outside of testing. Therefore, a study on derived relational responding without the possibility of direct reinforcement might yield different results considering the relations assessed in this study are only those of equivalence.

Equivalence based instruction has been used to teach both typically developing children academic skills as well as children with intellectual disabilities (Dixon, Belisle, Stanley, Daar, & Williams, 2016a). Another study done by Dixon et al., (2016b) supported previous research conducted on the effectiveness of PEAK-E and stimulus equivalence. Three participants were tested on their ability to form equivalence relations using PEAK-E. The purpose of the study was to establish a procedure that tests derived categorical responding and to assess the emergence of untrained categorical responses (Dixon et al., 2016b). Results indicated that training put in place to teach participants to engage in derived categorical responding and receptive categorical responding were effective for all participants (Dixon et al., 2016b). The overall goal of using PEAK-E is to create the formation of both simple and elaborate categorical classes (Dixon et al., 2016b). The results from the PEAK-E assessment can be of help when creating

treatment/learning plans for a child with autism. Often times treatment plans are created to reduce challenging behavior. PEAK-E provides the behavior analyst with an idea of whether or not the individual can derive mutually entailed relations and what trainings need to be put in place to teach this skill. For example, if the function of behavior is to escape from a task simply because the individual cannot properly communicate with the implementer, then those rule-governed behaviors and derived relations of asking for a break need to be taught.

Derived relational responding and rule-governed behavior interlace in the concept that an individual who can derive relations more than likely can follow rules without coming in contact with them due to an interpreted contingency: rule-governed behavior (Skinner, 1969). It might be expected that participants in the ME+ group (participants who can derive relations based on the scores on PEAK-E-PA and PEAK-T-PA) show lower indications of a single function of challenging behavior on the QABF as well as lower overall scores on the CBI. This is due to those participants engaging in a variety of functions of behavior because they are able to discriminate, and rule-governed behavior is established. If access to reinforcement was gained before for engaging in a specific behavior, they might gain access again. For example, if a child is screaming because they want a toy during a session trial and the implementer gives them the toy so that they stop screaming, the child will likely scream again once the toy is removed due to a history of reinforcement for screaming.

Purpose of the Present Study

The purpose of the present study is to test for derived relational responding and stimulus equivalence using various assessment methods such as the PEAK Equivalence Pre-Assessment and the PEAK Transformation Pre-Assessment. The QAFB was used as a measure to test for the

isolation of a single function of challenging behavior. The CBI was used to measure the frequency and intensity of challenging behavior the child engages in, and PAS-BOS was used to identify the frequency and intensity of autism symptoms that might be correlated with the participant's behavior, but not necessarily with challenging behavior. All data used in the present study were secondary data that were de-identified and coded from prior research conducted by the HUB Lab at Missouri State University. Hypotheses indicated that those participants who cannot derive mutually entailed relations as indicated on the PEAK-E-PA and the PEAK-T-PA will score higher on the CBI and PAS-BOS, and their QABF scores will lead to the identification of a single function of behavior.

METHODS

Participants

Participants in the obtained dataset included 34 children, 28 males and 6 females. Six of the participants were from waiting lists at autism clinics across the Springfield, Missouri. Ten participants were from a midwestern special education classroom. The other eighteen were from a specialized classroom located in St. Louis, Missouri where they provide services to children with autism and other intellectual disabilities. Participants' ages ranged from 3 to 9 years (M = 4.9, SD = 1.7). In the Belisle et al. (2017) study, participants' ages ranged from 5 to 19 (M = 13.4, SD = 4.2) years. Challenging behaviors examined on the QABF were consistent with aggression, elopement, tantrums, and refusal. Score deviations on PEAK, CBI, QABF, and PAS-BOS were as follows: PEAK-E-PA (M = 2.1, SD = 3.6), PEAK-T-PA (M = 6.7, SD = 13.0), CBI (M = 11, SD = 9), QABF (M= 35.6, SD = 14.4), and PAS-BOS (M = 36.7, SD = 17.5). Note, we used the Short Form version of the PEAK-E-PA, therefore scores should be multiplied by 2 when comparing to prior PEAK research, representing a mean of 5. Belisle et al. (2017) used the Long Form assessment. IQ was estimated using the equation IQ = 1.24 * PEAK-E + 49.13. Results suggested that IQ scores were low across participants (M = 54.4, SD = 8.9) with the lowest score being 49.13 and the highest score being 88.8. An average range of IQ is 90-110. A low range of IQ is 70-55 or even lower. It is difficult to determine the IQ of a child below the age of 4. This should be taken into consideration due to some of the participants in the current study being 3 years of age. Because the data were deidentified secondary data, IRB approval was not

required for the below analyses. Procedures describe those carried out by the original implementers of the studies that this work directly extends.

Settings and Materials

PEAK-E-PA and PEAK-T-PA scores were recorded for each participant to provide a measure of participants ability to derive relations using arbitrary stimuli. Participants scores on the PEAK-E-PA ranged from 0 to 16 (maximum score of 48). Participants scores on the PEAK-T-PA ranged from 0 to 60 (maximum score of 96). These scores alone show that participants in the study vary in terms of their cognitive functioning.

In the original study, PEAK assessments were conducted in a room at PCOB located on the Missouri State University campus or at sites conducting PEAK as part of their regular programming. The Questions About Behavior Function (QABF) measure was completed by the parents/guardians of the participants. The QABF is an indirect assessment used to assess the function of challenging behaviors in individuals diagnosed with autism or other developmental disabilities. The measure consists of 25 items, each of which asks a question pertaining to the child's behavior on a 0-3 Likert-type scale (ranging from never to often). Certain numbers correspond to functions of behavior in the attempt identify a single function of challenging behavior. The categories of behavior function are as follows: Attention, Escape, Physical, Tangible, and Nonsocial.

The Challenging Behavior Index was used to determine the participant's frequency and intensity of behavior. The implementer filled out the CBI during the first session for participants from the Missouri State University clinic and the specialized classroom for children with autism. A CBI assessment was not completed for participants from the midwestern special education

classroom. It consists of ten questions based on how frequent the behavior might be and how intense the behavior might get. Frequency and intensity are measured on a Likert-type of scale from 0-2 (0=never/none, 1=sometimes/minimal intensity, 2= frequently/high intensity). Both frequency and intensity results were combined for a total of 20 points possible in each category.

The PAS-BOS was completed by the implementer within the first session for participants from the Missouri State University clinic and the specialized classroom for children with autism. A PAS-BOS assessment was not completed for participants from the midwestern special education classroom. It consists of 3 sections: social interactions, communication, and repetitive behaviors. Each of these are scored on a Likert-type of scale for the frequency of behavior and the intensity of behavior identical to the CBI. Both frequency and intensity of behavior results are based off 20 possible points for each of the three sections.

The PEAK Equivalence Pre-Assessment (short form) was used to test the participants' ability to derive relations between stimuli (reflexive, symmetrical, transitive, and equivalence). Materials needed for this part of the study include the stimuli flip book, the implementers' script for delivering the assessment, a timer for breaks and reinforcement for the participant, data sheets and a pencil to collect data. The stimuli book was laid on the table directly in front of the participant and contains the stimuli needed for the participant to give a correct response to all questions on the assessment. The script provides them with the correct instructions for them to deliver the assessment to the participant and gives the implementer the answers to each question. The script along with the data sheets were out of the participants sight. A paper scoring sheet was used to score each question. Under each question there is a spot where the implementer marked whether the participant answered the question correctly or incorrectly. This data was then be transferred to an Excel document where each participants data is pooled.

The PEAK Equivalence and PEAK Transformation Pre-Assessment materials are very similar in terms of utility and the actual materials being used. Another stimulus book, a script, data sheets to collect data, a timer to time breaks and reinforcement periods, and reinforcers were present in the room during the PEAK Transitivity Pre-Assessment.

Procedure

PEAK Assessment Battery, CBI, and PAS-BOS Direct Assessments. The PEAK Equivalence Pre-Assessment contains 48 items that assess reflexive, symmetrical, transitive, and equivalence responding. Each of the four types of responding has a subtest that consists of 12 items. Scores range from 0-12 for each of the subtests and these scores are combined for a total PEAK Equivalence score ranging from 0-48. The subtests contain six skills labeled one of the following: "basic", "intermediate", or "advanced" that are each tested one time during the assessment. The participant's score is then multiplied by two to create a maximum score of 12. To evaluate derived relations, both visual and auditory stimuli are included in the assessment. Visual stimuli used are arbitrary pictures and arbitrary text, whereas auditory stimuli used are arbitrary vocal words.

Data collectors followed a script for each item on the assessment. The participant was shown relations and then tested using sequential presentation or match-to-sample. For the sequential presentation segment, the participant was presented with a comparison stimulus, then a different comparison stimulus followed. Next, the implementer gave a verbal prompt indicating whether the sample stimulus was the same or different than the comparison stimulus. The same stimulus was presented again to the participant. A different comparison stimulus followed sequentially. The implementer then provided another verbal prompt asking the participant whether

the sample stimuli was the same or different than the comparison stimuli. After, the implementer presented a prior comparison stimulus as a sample stimulus along with a corresponding comparison stimulus. The implementer asked the participant, "Were those the same?" A correct response from the participant would be "yes" if a corresponding stimulus were presented. If unrelated stimuli are presented to the participant, he/she would respond with "no" for a correct response. A sample stimulus, and two comparison stimuli were presented for match-to-sample tasks. The implementer said "This is the same as this" while pointing to the sample stimulus and then to the comparison stimulus. The implementer then presented one of the previously presented comparison stimuli as a sample stimulus along with two comparison stimuli. While saying, "Find the same," the implementer pointed to the sample stimulus. A correct response was recorded if the participant pointed to the comparison stimulus that corresponded to the sample stimulus.

The stimuli that are related are formally identical when testing for reflexivity. For each of the other tests, stimuli being used are considered arbitrary which means that it is unlikely that the stimuli being used have a reinforcement history with those particular stimuli. Tasks relevant in the reflexivity subtest are matching identical stimuli. The implementer presented two relations to the participant to test for transitivity relations. A third derived relation is tested then after. The participant would be told that stimuli A-B is the same as stimuli B-C. Stimulus A would be presented and if the participant selects stimulus C, a correct response would be scored based on the participant being able to recognize a relation between the two stimuli. Reinforcement was not provided to the participant during this portion of the PEAK Equivalence Pre-Assessment.

The PEAK Transformation Pre-Assessment receptive subtest was also be conducted. This subtest consists of 6 relational frames that each have 16 items. No reinforcers or consequences for participant responses were provided during the assessment. The implementer can offer breaks to

the participant during the assessment to maintain attention after the completion of any number of items. Increasingly difficult questions were presented within each frame during the PEAK Transformation Pre-Assessment receptive subtest. This subtest was centered on selection-based responses to the questions presented to the participants. The implementer had a specific script to follow to deliver the assessment correctly. If the participant delivered three consecutive incorrect responses, the implementer moved to the next relation. Each item in the subtest has only one correct response (item is scored as 0 or 1). A data sheet and pencil were used by the implementer to record the participant's responses. Practice and instructional items are included in the subtest. Practice items are used to aid in the familiarity of the assessment layout and expected ways of responding. During the practice questions, the implementer could provide the participant with feedback and error correction. Practice questions were included at the beginning of each subtest. Instructional items provided the learner with information needed to complete test items. Each of these items were presented multiple times in a row. The participant was not required to provide a response for the instructional items. Thus, the instructional items were not included in scoring.

The QABF measure consists of 25 items, each of which asks a question pertaining to the child's behavior on a 0-3 Likert-type scale (ranging from never to often). Certain numbers correspond to functions of behavior to try and identify the function of the challenging behavior. The categories of functions are as follows: Attention, Escape, Physical, Tangible, and Nonsocial. The QABF was completed by the parent/guardian of the participant. Results of the measure were then analyzed to determine the function of challenging behavior for each participant (if applicable). A single function of behavior was confirmed if there was a two-point difference between the highest subscale score and the second highest subscale score (Attention, Escape, Physical, Tangible, and Nonsocial). For example, if the participant scored 10 on the Attention

subscale (highest) and 8 on the Tangible subscale (second highest), then the QABF identified a single function of challenging behavior.

The Challenging Behavior Index consists of ten questions where the frequency and intensity of the behavior is measured based on a Likert-type of scale from 0-2 (0=never/none, 1=sometimes/minimal intensity, 2=frequently/high intensity). Both frequency and intensity have a total of 20 points possible. The lower the score, the less frequent and intense the challenging behavior. It was filled out by the implementer within the first session. The PAS-BOS was completed by the implementer within the first session. It consists of 3 sections: social interactions, communication, and repetitive behaviors. Each of these are scored on a Likert-type of scale for the frequency of behavior and the intensity of behavior identical to the CBI. Both frequency and intensity of behavior results will be out of 20 possible points for each of the three sections.

Interobserver agreement were also made available in the data. Measures of reliability were run for the PEAK assessments by having a second independent observer record data on participant responses during the assessment for 44% of the assessments. Agreement occurred when the second observer and implementer calculated the same final score on the PEAK assessment. Interobserver agreement was calculated by dividing the number of agreements by the total number of agreements plus the total number of disagreements and multiplying by 100. IOA was 92.4% resulting in a high rate of agreement among observers.

RESULTS

Mutual Entailment and Behavior Function

Out of the 34 total participants, 10 could derive relations on the PEAK Equivalence Pre-Assessment and PEAK Transformation Pre-Assessment. The QABF was used to determine a single function of challenging behavior for each of the participants. A single function was identified if there was a two-point difference in the highest subscale score and the second highest subscale score (Attention, Escape, Physical, Tangible, and Nonsocial). Of 10 participants who were able to derive relations, 4 of them had a single function of the challenging behavior they engage in and 6 did not. Therefore, on only 40% of occasions was the QABF able to isolate a single function with this group. This is similar to results reported by Belisle et al. (2017) who reported 33.3% single identified function for ME+ participants Participant PEAK-E-PA, PEAK-T-PA, and QABF scores are shown in Table 1.

The analyses of participants' abilities to derive relations and QABF Total Scores are summarized in Figure 1 using a simple bar graph. Figure 1 shows the percentage of participants whose QABF Total Scores identified a single function of behavior across the ME+ (N = 10, 11.76%) and ME- groups (N = 24, 55.88%). Table 2 also shows the percentage of participants whose QABF Total Scores identified a single function of behavior across ME+ and ME- groups. The results suggest the QABF failed to identify a single function of challenging behavior for the majority of participants who could derive relations (ME+). Data suggest that the QABF was successful in identifying a single function of challenging behavior for those participants who could not derive mutually entailed relations (ME-). Prior research conducted by Belisle et al.

(2017) found similar results suggesting that the QABF failed to produce a single function of challenging behavior for almost all participants in the ME+ group and was successful at identifying a single function of challenging behavior for participants in the ME- group.

A chi-square test of independence was performed to examine the relations between the ME+ (participants who can derive relations based on PEAK total scores) and ME- (participants who cannot derive relations) groups and the ability of the QABF to identify a single function of behavior. Table 3 and 4 show the results of the chi-square test and Table 2 represents percentage totals for PEAK Total Scores and QABF Total Scores. The results suggested that these variables were significant $\chi_2 (1, N = 34) = 4.9, p \leq 0.05$. There is a strong relationship between PEAK Total Scores and the function of challenging behavior.

PEAK Total Scores and Challenging Behavior Index Total Scores

The analyses of participants' total scores on the CBI and PEAK assessments are summarized in Figure 2. Figure 2 shows a scatter plot of participant CBI Total Scores and PEAK Total Scores. A Pearson correlation test was run to evaluate the relationship further. The findings of the Pearson correlation test suggest that there is a negative relationship between CBI Total Scores and PEAK Total Scores ($r = -0.35, p < 0.05$). These results relate to the QABF findings above in the sense that for participants who were not able to derive mutually entailed relations on the PEAK assessments, the QABF identified a single function of challenging behavior. Similar results were recorded when comparing PEAK Total Scores and CBI Total Scores. Those participants who scored lower (could not derive relations) on the PEAK assessments, scored high on the CBI. Those participants who scored higher (could derive relations) on the PEAK assessments, scored low on the CBI. Essentially, there was a higher endorsement for immediate

consequential functions in session for participants with lower derived relational responding skills.

PEAK Total Scores and PAS-BOS Total Scores

The analyses of participants' PEAK Total Scores and PAS-BOS Total Scores are summarized in Figure 3. Figure 3 shows a scatter plot of participant PEAK Total Scores and PAS-BOS Total Scores. A Pearson correlation test was run to evaluate the relationship between the two variables. The Pearson correlation test suggests there is a negative relationship between PEAK Total Scores and PAS-BOS Total Scores ($r = -0.12$, $p > 0.05$). These results show that there is not a relationship between a participant's PEAK Total Score and PAS-BOS Total Score. Therefore, whereas derived relational responding likely influences the function of challenging behavior of children with autism, we did not see this same relationship in terms of autism severity symptoms.

DISCUSSION

Results from the pilot study provide data suggesting that a participant's ability to derive relations influenced the results obtained on the QABF in the attempt to identify a single function of challenging behavior. The QABF identified a single function of behavior for the majority of participants in the ME- group and failed to identify a single function of behavior for participants in the ME+ group. In terms of rule-governed behavior, these results indicate that those participants in the ME- group do not engage in rule-governed behavior due to their inability to derive mutually entailed relations. Those participants in the ME+ group can derive relations and can engage in rule-governed behavior. Significance is also seen between PEAK Total Scores and CBI Total scores through a small negative relationship. When evaluating the relationship between PEAK Total Scores and QABF Total Scores, the variables were significant and had a large effect size meaning there is a strong relationship between scores. No correlation was found between PEAK Total Scores and PAS-BOS Total Scores. These findings suggest that a participant's ability to use derived relational responding was not related to their score on the PAS-BOS due to the PAS-BOS being a measure of autism symptoms on the basis of frequency and intensity while PEAK tests for derived relational responding and stimulus equivalence. These results support prior research conducted by Belisle, Stanley, & Dixon (2017) where researchers found that for participants who could derive mutually entailed relations (ME+), the QABF failed to produce a single function of challenging behavior. For participants who could not derive mutually entailed relations (ME-), the QABF was generally successful in identifying a single function of behavior.

According the Bentall, Lowe & Beasty (1985), schedule insensitivity due to the control of rules becomes apparent in typically developing children around the age of five. With this, the development of language also begins to emerge. Participants in the above study are between the ages of 3 and 9. The average age of participants in the ME+ group is (M = 5.1). Rule-governed behavior might be present if the child is old enough and they can derive mutually entailed relations. The majority of children in the current study are so young (ages 3-5), especially those participants from the specialized classroom for children with autism. Most of these children had language deficits, if any language skills at all, resulting in the inability to derive relations.

There are a few implications to be discussed. This study is a pilot study that supports further exploration into the areas of indirect and direct assessments, derived relational responding, and rule-governed behavior. All of which are important when testing a child's ability to derive relations and the effect those skills have on challenging behavior. Future studies can replicate the current study by using better control and varying participant pools. This can be done by having a larger sample size, perhaps including participants with autism with a wider age range than the ones in the current study.

Another implication is to use another type of direct assessment such as conducting an experimental functional analysis to identify the function of challenging behavior. EFA is often used along with other indirect and direct assessments such as the ones in the present study. Multiple studies conducted by Iwata, Dorsey, Slifer, Bauman, & Richman (1994) found that EFA generated consistent results over 95% of the time. Using EFA along with assessment such as PEAK, QABF, CBI, and PAS-BOS adds to the reliability and validly that a single function of challenging behavior can be identified for participants who can derive mutually entailed relations and those who cannot.

There were some differences between this study and the study conducted by Belisle, Stanley, & Dixon (2017). Participants in the current study were relatively young (3-9 years old) compared to the participants' in other studies such as the one conducted by Belisle, Stanley, & Dixon (2017), where the participants were between the ages of 5 and 15 years. PEAK-E and estimated IQ scores also suggest that the current sample was more severely impacted. The differences in the scores on the two studies alone show that overall, the participants in the present study had a significantly lower ability to derive mutually entailed relations than those in the Belisle, Stanley, & Dixon (2017) study. This itself might have influenced the results of the overall study due to the lack of language and cognitive skills present in most participants, thus lacking derived relational responding and rule-governed behavior. In a more robust evaluation, older participants or even participants who are less severely impacted might be a better population to analyze in terms of derived relational responding and how the ability to derive mutually entailed relations impacts scores on the QABF in particular.

Due to the nature of the study, there are several limitations to be considered. The first limitation is that only 10 participants could derive relations. This means that the sample used in the current study is representative only of young children who are severely impacted. These children are not at risk for rule-governed behavior influencing their challenging behavior. Another limitation with using the QABF to determine function of challenging behavior was when it indicated multiple functions of behavior. This can be an issue in when it comes to reliability. When multiple functions of behavior are present according to the completed QABF, it can be hard to pinpoint an exact function to focus on in treatment. Other functional assessments should be conducted in case this does happen such as an EFA. Studies comparing the QABF to the EFA have shown that both are reliable when identifying a single function of behavior, but the

biggest limitation of the EFA is that it has limited utility in real world settings (Matson, Tureck, & Rieske, 2012). Of all the research conducted on different standardized tests to measure behavior function, the QABF has the psychometrics (Matson, Tureck, & Rieske, 2012). Neither one nor the other have been proven to be more effective than the other, but the QABF is a good starting point when conducting a functional analysis (Matson, Tureck, & Rieske, 2012). In addition, there are not psychometric studies on the CBI and PAS-BOS, so these should be treated as supplemental measures.

A third limitation is that the QABF for half of the participants was filled out by their teacher instead of their parent/guardian. The children who's QABF was completed by their teacher were from a specialized classroom for children with autism and the midwestern special education classroom. This potentially limits the reliability of the QABF considering the teacher only witnesses the behaviors that occur in the classroom instead of those that occur in several different environmental settings. This could be controlled in the future by having the QABF emailed out or handed out to the parents of the participant directly. Another way to control this is to have the parent fill out a parent report on the behaviors engaged in at home and in other settings where they are present and look for correspondence between the parent report and a report filled out by the teacher. Due to only 10 families volunteering for the on-campus PEAK training at Missouri State University, children from the specialized classroom and children for a midwestern special education classroom were included to increase the sample size.

The study was originally designed to include twelve full weeks of treatment, but due to increased concerns of the health and well-being of not only the participants in the study, but that of the implementer, treatment programs were cut to eight weeks in duration. As we know, children with autism experience deficits in their language and cognitive skills, so the loss of

treatment on their half is significant. Those participant's in the study who engaged in more severe challenging behavior suffer the most from this unexpected change. The challenging behavior is likely due to the lack of cognitive and social function of those participants. For them especially, the longer the treatment, the more skills they could have acquired. This is why additional data from sites with existing PEAK and QABF scores were obtained. The additional data was used to supplement the chi-square analysis above.

The results of this pilot study inform future research on derived relations and treatment of challenging behaviors engaged in by children with autism. Future research should increase the length of treatment in weeks, as well as include more participants who engage in severe challenging behavior. By doing so, it will become clearer as to how accurate the functional assessment strategies are and how well programs such as PEAK can increase their language and cognitive skills. Future research should include interventions designed to address RGB. Rule-governed behavior is an essential part of an individual's verbal repertoire. Individuals with autism who lack rule-governed behavior might also struggle to derive mutually entailed relations. PEAK addressed the issue of derived relational responding, so interventions addressing rule-governed behavior could be put in place. An example intervention might look as follows: begin by teaching the child different rules such as "when I play nicely with my friends, it is fun for everyone" or "when I do not talk when the teacher is talking, I am better at doing my school work." Once the child understands those examples of rule-governed behavior, then incorporate more complex rules, test their ability to use rule-governed behavior without modelling the answers or giving prompts, and record the correct and incorrect responses. Multiple trials should be conducted until the child reaches 100% criterion. One last area for future research is to conduct further assessments for determining the function of challenging behavior. These

assessments might include some or all of the following: parent surveys, direct observations of challenging behavior (EFA), and other experimental approaches. The QABF is great until it shows multiple functions upon completion. This can pose a problem when going to plan a treatment program for the participant. Other assessments can aid in the understanding of relational responding and challenging behavior.

In summary, several interventions have been successful when developed to decrease both the intensity and frequency of challenging behavior in individuals with autism. The effectiveness of these interventions can be hindered by an individual's ability to engage in meaningful language, which in return often means they lack in the area of being able to derive mutually entailed relations when arbitrary stimuli are present. Thus, the results of the above study add to the body of literature regarding an individual's ability to derive relations and how that is linked to the identification of a single function of challenging behavior using various indirect and direct assessments. These findings suggest that a variety of ABA treatments for individuals with autism need to continue to emerge as long as our knowledge of human language continues to grow as well.

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TABLES

Table 1. Participant total scores on PEAK-E-PA, PEAK-T-PA, QABF, CBI, and PAS-BOS

Participant	PEAK Total Score	QABF Total Score	CBI Total Score	PAS-BOS Total Score
1	28	35	4	62
2	72	71	2	38
3	4	58	17	64
4	3	58	19	42
5	32	53	23	67
6	32	4	0	0
7	4	26	0	19
8	22	36	10	22
9	0	33	9	44
10	3	26	22	45
11	0	33	6	23
12	0	33	29	40
13	41	26	1	10
14	3	35	3	21
15	7	40	7	24
16	0	19	11	49
17	1	24	7	33
18	0	31	10	42
19	3	32	5	40
20	1	30	26	66
21	5	49	6	25
22	0	37	27	45
23	0	32	7	27
24	2	35	14	32
25	2	58		
26	2	37		
27	3	53		
28	1	32		
29	3	7		
30	3	37		
31	4	34		
32	2	17		
33	11	28		
34	6	50		

Table 2. Chi-square percentage totals for PEAK Total Scores and QABF Total Scores

Percentage of row total	Single Function	No Single Function
ME+	40.00%	60.00%
ME-	79.17%	20.83%
Percentage of column total	**Single Function**	**No Single Function**
ME+	17.39%	54.55%
ME-	82.61%	45.45%
Percentage of grand total	**Single Function**	**No Single Function**
ME+	11.76%	17.65%
ME-	55.88%	14.71%

Table 3. The results of a chi-square comparing PEAK Total Scores and QABF Total Scores

Analysis	Results
Table Analyzed	Chi-square
P value and statistical significance test	Chi-square
Chi-square, df	4.948, 1
z	2.224
P value	0.0261
P value summary	*
One- or two-sided	Two-sided
Statistically significant ($P < 0.05$)?	Yes

Table 4. The chi-square analysis for PEAK Total Scores and QABF Total Scores

Data analyzed	Single Function	No Single Function	Total
ME+	4	6	10
ME-	19	5	24
Total	23	11	34

FIGURES

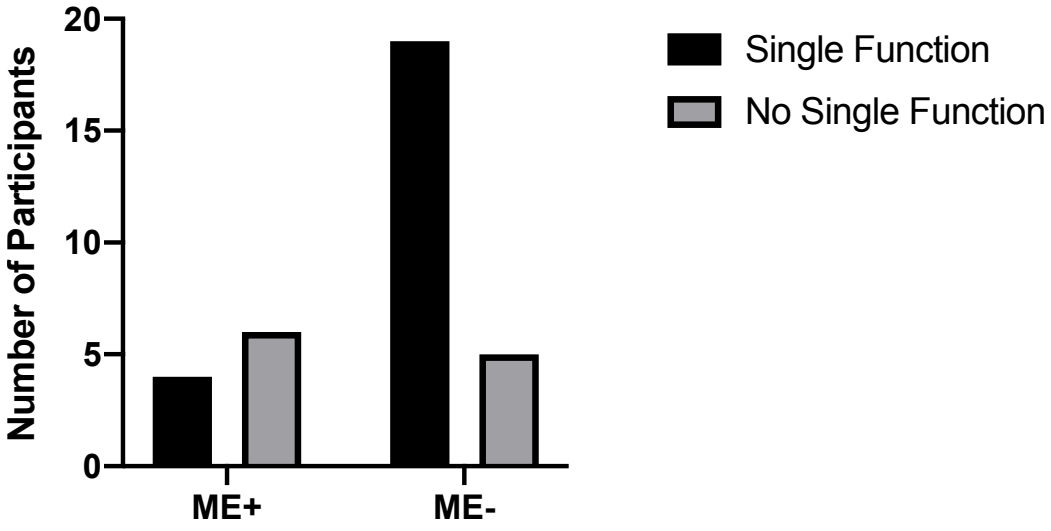

Figure 1. Contingency analysis of the proportion of QABF results that identified a single function of challenging behavior for ME+ and ME- participants

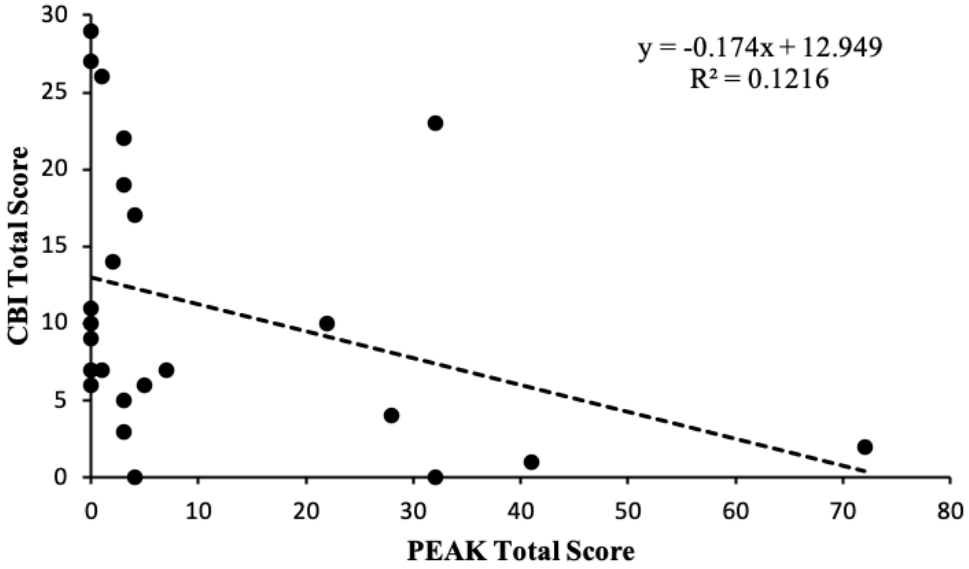

Figure 2. Scatter plot indicating the correlation between PEAK Total Scores and CBI Total Scores, as well as the R_2 value.

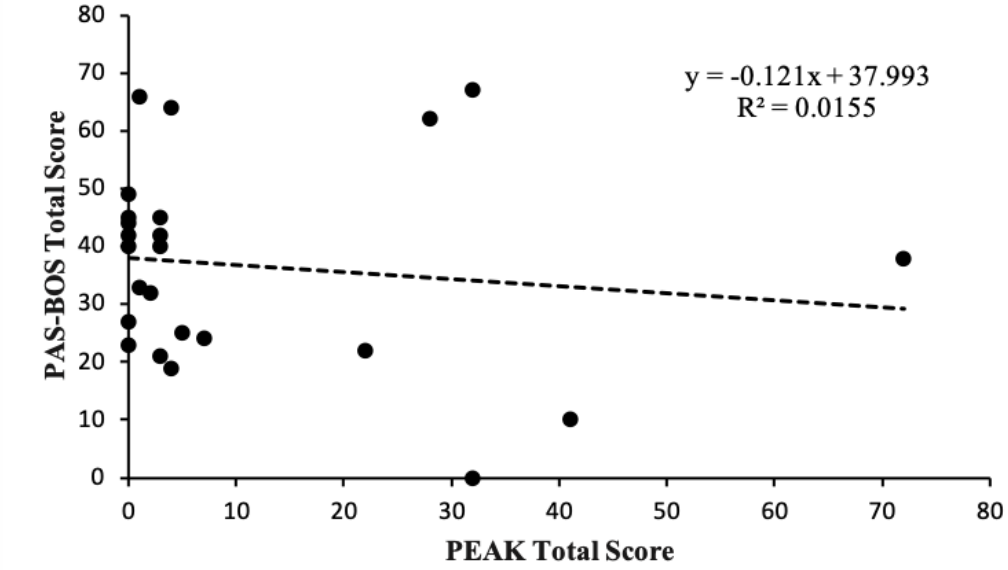

Figure 3. Scatter plot indicating the correlation between PEAK Total Scores and PAS-BOS Total Scores, as well as the R_2 value.