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Evaluating Correlations between the PEAK Equivalence and Transformation Assessments with Intelligence Quotient Scores and the Relational Acquisition of Skills in Children with Autism

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EVALUATING CORRELATIONS BETWEEN THE PEAK EQUIVALENCE AND TRANSFORMATION ASSESSMENTS WITH INTELLIGENCE QUOTIENT SCORES AND THE RELATIONAL ACQUISITION OF SKILLS IN CHILDREN WITH AUTISM

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Master of Science, Psychology

By

Hannah Lauren Wallace

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ABSTRACT

The purpose of the present study was to evaluate correlations between PEAK Equivalence and Transformation assessment scores to Intelligence Quotient (IQ) scores in children with autism. An assessment called the Relational Acquisition of Skills in Children with autism (RASC) was created as a pilot test. This method was used to test relational responding in young children with autism. The scores of this assessment were correlated with scores obtained using PEAK Equivalence and Transformation assessments and IQ. It was found that PEAK Equivalence and Transformation assessments had a strong positive correlation with IQ. No significant relationship between the Relational Acquisition of Skills in Children with autism and the PEAK Equivalence and Transformation assessments or IQ was found.

KEYWORDS: autism, derived relational responding, match to sample, PEAK, RASC, stimulus pairing observation procedure

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INTRODUCTION

Language and Cognitive Deficits in Children with Autism

Individuals with autism share common deficits in language and cognitive development (Kelley, Paul, Fein, & Naigles, 2006; Yeung, Han, Sze, & Chan, 2016). A defining feature of this disorder is diminished communication, including both vocal and non-vocal communication (American Psychiatric Association, 2000; Kelley et al., 2006). The Wisconsin Card Sorting Test was created to measure cognitive flexibility. Using this test, many researchers found that children with autism spectrum disorder (ASD) demonstrate greater perseveration than their typically developing peers (Goldstein, Johnson, & Minshew, 2002; Lopez, Lincoln, Ozonoff, & Lai, 2005; Minshew, Meyer, & Goldstein, 2002; Shu, Lung, Tien, & Chen, 2001; Tsuchiya, Oki, Yahara, & Fujieda, 2005; Van Eylen, Boets, Steyaert, Evers, Wagemans, & Noens, 2011; Verté, Geurts, Roeyers, Oosterlaan, & Sergeant, 2006; Williams & Jarrold, 2013; Kaland, Smith, & Mortensen, 2007). Researchers who have used other measurement tools found that individuals with ASD show difficulty with tasks involving shifting conceptual sets (shape to line), even though their ability to shift perceptual sets (shape to shape) was intact (Brady, Schwean, Saklofske, McCrimmon, Montgomery, & Thorne, 2013; Hughes, Russell, & Robbins, 1994; Ozonoff, Cook, Coon, Dawson, Joseph, Klin, McMahon, Minshew, Munson, Pennington, Rogers, Spense, Tager-Flusburg, Volkmar, & Wrathall, 2004). Yeung, Han, Sze, and Chan have found that children with ASD have less complex shifting skills, specifically shifting conceptual sets, compared to neurotypical children due to deficits in cognitive flexibility (2016). According to Pennington & Ozonoff (1996), these skills enable a child to complete tasks efficiently.

Individuals with autism also show more global deficits in cognitive functioning and executive functioning (Barkley, 1997a; Barkley 1997b; Pennington & Ozonoff, 1996; Russell, 1997). Executive functions have many different definitions but are most commonly described processes that are necessary in maintaining problem solving and enable self-control (Denckla, 1996; Lezak, 1995; Pennington & Ozonoff, 1996; Welsh & Pennington, 1988). Encompassed in executive functions are metacognitive domains that include cognitive flexibility, fluency, planning, response inhibition, and working memory (Ozonoff, 1997; Pennington & Ozonoff, 1996; Reader, Harris, Schuerholz, & Denckla, 1994; Tranel, Anderson, & Benton, 1994). Deficits in cognitive flexibility are thought to be a fundamental distinguishing feature of ASD (Yeung et al., 2016). The frontal lobe is the primary mediator of cognitive flexibility (Stuss & Knight, 2013). Abnormalities in the frontal lobe have consistently been found in children with ASD (Chan, Cheung, Han, Sze, Leung, Man, & To, 2009; Chan, Han, Leung, Wong, & Cheung, 2011). Similar abnormalities are found in patients who have damage to their frontal lobe (Damasio & Maurer, 1978; Stuss & Benson, 1984). Barkley (1997a, b) and Russell (1997) found executive functioning deficits to be perhaps the core deficit associated with ASD. With that being said, there are differing kinds of deficits and differing profoundness of deficits within certain executive functioning domains. When the brain damage occurred, where the brain damage occurred, and the severity of the damage could account for the differences. It was thought that an executive functioning profile could be used to distinguish different childhood disorders (Pennington & Ozonoff, 1996). However, research conducted by Geurts, Verté, Oosterlaan, Roeyers, & Sergeant (2004) found that creating executive functioning profiles, due to measurement complexity, would be more complicated than originally thought.

A potential solution to the language and cognitive deficits in children with autism is intensive language training. According to the American Psychiatric Association (2013), delays in language development is an early indicator of ASD. Early intensive interventions based on the principles of Applied Behavior Analysis have been shown to improve common autism deficits (Kelley et al., 2006). Included in these are reduced problem behaviors, increased language skills, increased cognitive skills, and increased social interactive skills (Harris & Handleman, 2000; Jocelyn, Casiro, Beattie, Bow, & Kneisz, 1998; Lord, 1996). Programs for these children should address the unique deficits of the individual, have low ratios between implementors and students, include the student's family, be in session for more than 20 hours per week, and provide up to date assessments and treatment goals according to *Educating Children with Autism* (2001).

Research conducted by Lovaas (1987) showed differences in young children with autism between those who received intensive behavioral interventions and those who did not. Lovaas (1987) hypothesized that by creating and intensive learning environment, the individuals involved in this research study would be able to generalize treatment environments and be better able to maintain gains made. Thus, allowing some of the participants to catch up to their neurotypical peers academically by first grade. Subjects involved in this study showed similar scoring on pretreatment assessments. Lovaas (1987) found that children with autism who were involved in intensive behavioral treatments scored significantly better on the follow up assessments than the children with autism who did not. An average difference of 31 points was found between the 2 groups. Lovaas (1987) also found that 47% of the individuals receiving intensive treatment "achieved recovery", meaning that their post-intervention IQ scores fell in the normal range and they successfully completed first grade in regular education settings.

Since then, many researchers have tried to replicate these findings. Studies conducted by Birnbraurer & Leach (1993) attempted to address the criticisms against the study conducted by Lovaas (1987) by creating the Murdoch Early Intervention Program. The participants in this study made significant progress over two years. Anderson, Avery, DiPietro, Edwards, and Christian (1987) evaluated home-based treatment for children with autism, supporting the efficacy of this model as well. Important features of this model include training conducted in the participant's home, the use of systematic behavioral teaching techniques and procedures, and in-depth training for parents. Anderson et al. (1987) found that a high percentage of children involved in this study made gains in language, social, self-care, and academic development. These researchers also found a change in the ability of the parents to teach their children with autism (Anderson et al., 1987). According to Reichow and Wolery (2008) other replication studies have incorporated methods including random assignment, meaning participants are assigned to a control or an experimental group (Sallows & Graupner, 2005; Smith, Groen, & Wynn, 2000a). Different variations of the intervention protocol have also been studied. These variations include home-based (Sheinkopf & Siegel, 1998), community-based (Maigiati, Charman, & Howlin, 2007), school-based (Eikeseth, Smith, Jahr, & Eldevik, 2007; Eldevik, Eikeseth, Jahr, & Smith, 2006), and parent managed early intensive behavioral interventions (Bibby, Eikeseth, Martin, Mudford, & Reeves, 2001; Sallows & Graupner, 2005; Smith, Buch, & Gamby, 2000b).

Other researchers who investigated language deficits in children with autism, Kelley, Paul, Fein, and Naigles (2006) studied children who were described as "optimal-outcome", meaning that these children were diagnosed with ASD in early childhood, all but one were involved in programs such as Applied Behavior Analysis, and all were in age-appropriate regular

education classes receiving no special educational services. In this study, participants were tested for syntactic, lexical semantic, morphological, and pragmatic ability with multiple standardized tasks. The researchers conducting this study found that children with autism preformed as well as the control group on standardized vocabulary assessments. Children with autism preformed less well on other standardized subtests but still scored within the normal range for their chronological age. Children with autism also scored more poorly than the control group on Verb Argument Structure task, the Categorical Induction task target questions, the Theory of Mind task, the Mental Verb task, and certain parts of the Narrative task dealing with pragmatics (Kelley et al., 2006).

Language and executive functioning skills are important for the progress of individuals with autism. Traditional ABA approaches using direct contingency learning have been effective in teaching these skills. However, these core deficits may run deeper. More contemporary approaches involving learning in the absence of direct reinforcement need to be incorporated in teaching. Methods such as stimulus equivalence and Relational Frame Theory provide this type of learning.

Many traditional Applied Behavior Analysis (ABA) programs use the Verbal Behavior Milestones and Placement Program (VB-MAPP; Sundberg, 2008) as a tool to identify the deficits in language in children with autism. The VB-MAPP was created around the core principles of Skinner's verbal behavior (Skinner, 1957). The VB-MAPP assesses an individual's verbal skills across three developmental milestones (0-18 months, 18-30 month, and 30-48 months). The skills assessed increase in difficulty across the milestones. This assessment has been commonly used to measure the verbal repertoire in individuals with autism (Dixon, Belisle, Stanley, Rowsey, Daar, Szekely, 2014a).

More recently, ABA programs have used different technologies to assess language development in children with autism. The Promoting the Emergence of Advanced Knowledge Relational Training System (PEAK; Dixon, 2014a; Dixon, 2014b) sets out to improve language and cognition deficits experienced in many special populations (Dixon, Belisle, Stanley, Rowsey, Darr, & Szekely, 2014a). The PEAK Direct Training (PEAK-DT) and Generalization (PEAK-G) modules include curriculums that are also based on Skinner's verbal behavior model (Dixon et al., 2014a).

Dixon, Belisle, Stanley, Rowsey, Daar, and Szekely evaluated the relationship between PEAK and the VB-MAPP (2014a). These researchers found a strong correlation between the VB-MAPP and PEAK-DT ($r = .932$, $p < .0001$) and that total scores on PEAK-DT can be predicted by total scores on the VB-MAPP. These researchers also found that a moderate correlation existed between PEAK-G and the VB-MAPP ($r = .577$, $p < .0001$) and that PEAK-G assessment scores could not be predicted by scores of the VB-MAPP (Dixon et al, 2014a). The data collected by these researchers suggest that PEAK targets more advanced skills and can be used with a larger population of individuals with autism (Dixon et al., 2014a)

As additional assessments that measure the development of language in individuals with autism are created, it is important to compare and contrast the assessment tools to confirm that appropriate assessments are being used. This will not only determine the utility of the tool but also ensure that effective treatment is being provided to clients (Dixon et al., 2014a).

Derived Relational Responding and Human Language Learning

One of the main concentrations of behavioral analytic researchers in the last 50 years has been developing different methods of teaching language skills to children with autism (Stewart,

McElwee, & Ming, 2013). Considerable progress has been made in developing successful programs that teach these skills (Stewart et al., 2013). Outcome studies involving these new programs have shown that participants have gained language skills and earned higher IQ scores (Lovaas, 1987; McEachin, Smith, & Lovaas, 1993). In the area of language generativity, however, success has been described as subtle (Stewart et al., 2013). Skinner's *Verbal Behavior* (1957) has gained attention in the field of behavior analysis and beyond for over 50 years (Dymond, O'Hora, Whelan, & O'Donovan, 2006; Petursdottir & Devine; 2017). Dixon, Small, & Rosales (2007) stated that it is imperative for the field of Applied Behavior Analysis to move past the studies of verbal operants and create innovative methods in which to do so. Although direct contingency has been successful in directly teaching skills in children with autism, we as a field, could be missing the mark when it comes to teaching executive functioning skills.

Language generativity has been defined as the ability to generate sentences that have never been said previously and to understand the meaning of those sentences that have never been heard previously (Hayes, Barnes-Holmes, & Roche, 2001a). Language generativity has been shown to be major part of the development of functional communication. Establishing this generative language in children with language deficits has been shown to be a challenge. In children with autism, for example, responding is said to be memorized and inflexible even with involvement in early intensive behavioral interventions (EIBI; Greer & Ross, 2008; Lord & McGee, 2001). Novel responding is credited to generalization. Lovaas (1981) explained that generalization skills are imperative for successful teaching because all behaviors cannot be built in every situation. Williams and Williams (2010) also suggested that every response in every circumstance does not have to be taught to humans because of response generalization. Language generativity involves responding that has never been trained. Because of this, language

generativity has been linked specifically with response generalization. Untrained responding is used as a progress marker and is acknowledged within assessment tools including the VB-MAPP (Sundberg, 2008) and the Assessment of Basic Language and Learning Skills (ABLLS; Sundberg & Partington, 1998). However, generalization may not account for all or even most of the generative language skills that people typically demonstrate (Hayes et al., 2001a). For example, if a person is taught that a CUG is the same as a dolphin, the person may also describe CUG as an aquatic animal that is highly intelligent. The person may request to travel to see a CUG, tact CUG, or if asked "what is something else you can call a dolphin," engage in the intraverbal "Cug." It is unlikely, however, that the person has obtained direct reinforcement for any of these responses, and the word CUG does not contain formal similarity to the word "dolphin," which is requisite for stimulus generalization. Therefore, an alternative account may be needed for generative verbal behavior that is referential or symbolic in nature (Critchfield, Barnes-Holmes, & Dougher, 2018).

Relational responding is the main process involved in human abilities involving language and cognition according to Relational Frame Theory (RFT; Hayes et al., 2001a). These abilities range from something as simple as naming a favorite object to understanding more complex processes such involving abstract dimensions such as those found in oppositional frames (Barnes-Holmes, Barnes-Holmes, & Mchugh, 2004). Hayes, Barnes-Holmes, and Roche (2001a) have found that RFT offers an account of verbal and cognitive processes, in humans, that is both behavioral and functional and provides the possibility of connecting these processes with programs designed to teach individuals with language and cognition deficits (Barnes-Holmes, Barnes-Holmes, & Cullinan, 2001). Programs designed using nonarbitrary relational responding and arbitrary relational responding have the potential to increase both language and cognitive

skills in individuals with these deficits. Relating can be defined as the process of responding to one stimulus in terms of another stimulus. Nonarbitrary relational responding, according to RFT, is controlled by formal properties of the specific stimulus. Because of this, it is not considered a verbal process. However, RFT argues that applicable arbitrary relational responding is considered a verbal process. This is because formal properties of the stimulus become under the control of different contextual features. RFT also argues that arbitrary relational responses could influence responding on other stimuli when presented appropriately (Hayes, Fox, Gifford, Wilson, Barnes-Holmes, & Healy, 2001b). In language interactions, children are exposed to several examplars of name- object relations. An example of this would be when a child is shown the object doll, the word “doll” will be said by the caregiver. Reinforcement occurs when the child turns toward the doll. For the reverse, the caregiver might ask “Where’s the doll?”. When the child turns towards the doll, reinforcement will be given. Object-name and name-object relations are trained in young children, but many other bidirectional relations emerge without specific training. This form of naming history, according to RFT, establishes that bidirectional relations (name-object relations) accurately predict the emergence of both object-name and name-object relations. Therefore, the skill that arises is said to be generalized and can be applied to many names and objects. According to RFT’s training history, if a child has mastered a specific name-object relation, the result will likely be that the child will also learn the derived relation object-name (Barnes-Holmes et al., 2004).

Two defining features of relational responding are mutual entailment and combinatorial entailment. These features explain relations that have been derived between no less than 2 stimuli. A third feature is needed to explain the changes that happen in the function of a particular stimulus because of its involvement in relations derived with other stimuli. RFT refers

to this as the transformation of functions. An example of this would be if a child was shown two identical containers and told that container B was better than container A, the child will most likely be more excited about being given container B. The child still derived better-worse relations between the two containers even without having experience with either one (Roche & Barnes, 1997; Roche, Barnes-Holmes, Barnes-Holmes, Smeets, & McGeady, 2000). The function of container B was transformed by the better-than relation with container A. This means that container B will produce more approach functions than container A (Barnes-Holmes et al., 2004).

There are several reasons to believe that language and cognitive training developed from an RFT account may serve to reinforce or strengthen language and executive functioning deficits observed in children with autism. First, neurological research comparing children with autism to typically developing peers during executive functioning tasks suggests that involvement of frontal lobe and the parietal lobe may be impacted in children with autism. Second, research evaluating neural activity during stimulus equivalence tasks using an fMRI show that the frontal lobe and parietal lobe are active; however, these same areas are not active throughout direct contingency learning (Laurer & Belisle, 2019).

Behavioral research has demonstrated a relationship between intelligence and derived relational responding using verbal behavior models. This suggests that the same skills suspected in higher cognitive function are assessed by PEAK as well as IQ and that similar results will be consistent across implementers (Dixon, Whiting, Rowsey, & Belisle, 2014b). Dixon, Whiting, Rowsey, and Belisle evaluated the relationship between PEAK-DT, which is based on a verbal behavior model, and intelligence (2014b). These researchers found that participant age did not correlate with PEAK-DT scores or IQ scores. They did find, however, that although a strong

positive correlation was observed, the relationship appeared curvilinear wherein extreme high and low scores on the verbal behavior assessment could account entirely for the strong positive relation of the correlation ($r = .759$, $p < .01$) (Dixon et al., 2014b).

In another study, members of this same team (Dixon, Belisle, & Stanley, 2018) examined the relationship between derived relational responding using the PEAK Equivalence Pre-Assessment and IQ, obtaining a stronger correlation coefficient and a strong fit for the linear model ($r = .887$, $p < .01$). These researchers found a strong significant correlation between both the PEAK-E-PA total scores and raw IQ scores, and the PEAK-E-PA total scores and full-scale IQ (Dixon et al., 2018). Further, although verbal operants may be correlated with intelligence test scores, a hierarchical multiple regression conducted by Belisle, Dixon, and Stanley (2018) suggests that this relationship is moderated, or accounted for, by the ability of participants to derive relations. Meaning individuals who are able to make derived relations perform better on standardized IQ tests (Belisle et al., 2018).

Treatment effectiveness research is also starting to highlight the potential utility of RFT treatment models to promote gains in executive functioning. Research conducted by Cassidy, Roche, and Hayes (2011) set out to test the effectiveness of multiple-exemplar relational training and raising children's IQ. In the first experiment, four neurotypical children were subjected to multiple exemplar training and the relational frames of more than, less than, opposite, and same. The Wechsler Intelligence Scale for Children (WISC-IIIUK; Wechsler, 1992) was measured at baseline, after stimulus equivalence training, and after relational frame training. The participants in the experimental group showed a rise in Full Scale IQ, Verbal IQ, and Performance IQ after stimulus equivalence training and another significant rise after training relational frames when compared to the control group. These researchers found that 12 of 12 participants improved at

least 1 standard deviation, 11 of 12 improved more than two standard deviations, and 7 of 12 scores improved more than three standard deviations. In the second experiment, eight children with different educational and behavioral issues were introduced to multiple exemplar-based training of relational frames. IQ was tested using the WISC (IV-UK). Researchers found that IQ scores rose by one standard deviation for seven of the eight participants showing statistically significant improvement for the group, suggesting important implications for intellectual skills and support the idea of RFT that derived relational responding fluency is, in fact, related to IQ (Cassidy et al., 2011).

PEAK Equivalence and Transformation Assessments

The ability of humans to make equivalence relations is embedded in language (Dixon, 2015). Many researchers view equivalence relations as the essential element of language. Relating stimuli in ways including verbally, vocally, and symbolically is the core of real language. Manding, tacting, and responding intraverbally are not a part of fully functional language. They are, however, the start of skills that grow into skills that are more complex (Dixon, 2015). It has been said that humans are the only organism on the earth that can make these equivalent type of relations. Children, at a very young age, begin to make these relations, but nonhumans do not (Dixon, 2015). PEAK was created as a tool for consumers, allowing them to train relations with children in a systematic way.

There are four main stimulus relation components in the Equivalence Module of PEAK. They are reflexivity, transitivity, symmetry, and equivalence. These relations are presented to the learner in varying levels difficulty. This is said to establish strong and flexible responses that are

not tied to specific stimuli involved in a program. The main goal is not to teach what to relate, it is to teach how to respond relationally. PEAK includes a pre-assessment and an assessment to test a child's ability to derive equivalence relations. The Stimulus Equivalence Pre-Assessment was designed with skills to focus on during the PEAK Equivalence Assessment. The Pre-Assessment was not designed to replace the full assessment, but rather gauge the child's existing repertoire of relational skills. The Pre-Assessment assesses the child's ability to derive relations across four different types of relations and three difficulty levels. The Pre-Assessment is made up of two test programs for each of the four different types of relations. Each program includes arbitrary stimuli to test if the child is able to derive relational responding to any stimuli presented, even if the child has never interacted with such stimuli before (Dixon 2015).

Dixon, Belisle, and Stanley (2018) found a positive correlation between the PEAK-E pre-assessment and IQ (raw and full scale) scores in children with autism and other related disabilities in which higher IQ scores result in higher PEAK-E-PA scores. These results support relational accounts of language and cognition and suggest a relationship between intelligence and derived relational responding (Dixon et al., 2018). Training guided by PEAK-E may also be efficacious in establishing more complex forms of behavior than traditionally targeted within applied behavior analytic research. Dixon, Belisle, Stanley, Speelman, Rowsey, Kime, and Daar (2016) evaluated the efficacy of one of the programs of PEAK- E in supporting the development of untrained responding skills in intraverbals and labeling. The results showed that training put in place was effective for teaching the participants to respond receptively and engage in derived categorical responding. The data gathered are consistent with research suggesting that discrete trial training is an effective way to teach individuals to respond categorically (e.g. Braam & Poling, 1983; Luciano, 1986; Partington & Bailey, 1993).

Belisle, Dixon, and Stanley (2018) found a significant relationship between intelligence and derived relational responding in children with autism. These results were extended by testing the degree to which results on the PEAK Equivalence Pre-assessment mediated the relationship between IQ and the PEAK Direct Training Assessment, suggesting that the PEAK Equivalence Pre-Assessment had greater predictive utility of IQ scores (Belisle et al., 2018). They found positive correlations between the PEAK Direct Training Assessment and IQ (full scale IQ $r = .66$, $p < .01$; raw IQ $r = .80$, $p < .01$) and the PEAK Equivalence Pre-Assessment and IQ (full scale $r = .85$, $p < .01$; raw IQ $r = .89$, $p < .01$). However, the PEAK Equivalence Pre-assessment results could explain this relationship. These findings suggest that derived responding provides a behavioral explanation of intelligence and Skinner's elementary operants (Belisle et al., 2018). In a study conducted by McKeel and Matas (2017) the PEAK equivalence module was used to teach relations between stimuli to adults with autism. A gustatory sensory modality program was implemented. Different stimuli were selected to be probed before the initial training. Gustatory stimuli were first trained to a picture. Then, a picture was trained to a spoken word. Once a participant reached mastery criteria, responding was examined to determine if relations were derived after training. These researchers found that the participants obtained mastery criterion during training sessions. The participants were also able to relate stimuli without being directly trained. The results of this study are important for demonstrating the usefulness of the PEAK equivalence module in teaching relations in individuals with developmental disabilities as well as support the notion that equivalence relations could be trained outside of using the typical visual to visual or verbal to visual stimuli (Rehfeldt, 2011).

The ultimate goal of the Transformation Module of PEAK is to transform the language and cognitive skills of the child beyond what was possible with the previous PEAK modules

(Dixon, 2016). This PEAK module targets relational learning to complete the child's repertoire. Relational responding allows individuals to derive meaning from the different stimuli that are interacted with. Skills taught in this module include concept formation, problem solving, and perspective taking. These skills are considered to be absent from other ABA programs focused on language training (Dixon, 2016). Another goal included in the Transformation Module in PEAK is to test the relational complexity exhibited by the child. This module will increase the complexity of the skills using the PEAK-T curriculum. Research has exposed that relational skills in children can positively effect intelligence scores, school performance, and social-emotional success (Dixon, 2016). PEAK includes a pre-assessment for transformation. The Transformation Pre-Assessment consists of two subtest, expressive and receptive. These evaluations will allow the thorough consideration of verbal and selection abilities the child possesses in isolation. This provides an assessment of the strength of the child's repertoire. Also, the pre-assessment gauges the child's complexity skills. This information will help the clinician know where to begin in future programming (Dixon, 2016). The assessment included in the PEAK Transformation Module is the Language and Cognition Comprehensive Assessment Version 1.0 (LCCA1). This assessment is used as an information summary of the current skills the child possesses across all PEAK modules. This is an important document and should be referenced when putting together insurance authorizations, medical reports, Individualized Education Plans (IEP), and progress reports. The LCCA1 shows the current skills of the child as well as provides a comparison of that child to a group of neurotypical peers for the first two modules of PEAK (Dixon, 2016). Research conducted by Belisle, Dixon, Stanley, Munoz, and Darr (2016) set out to gauge the effectiveness of relational training procedures in teaching children with autism single reversal deictic responding. Deictic relational responding occurs

when a relationship is formed in the perspective of the speaker (Montoya-Rodríguez, Molina, and McHugh, 2016), such as I-you, now-then, and here-there. This study targeted I-You relations. This is because skills in perspective-taking appear to develop first (Howlin Baron-Cohen, & Hadwin, 1999). In the study, researchers directly taught a single relation. The opposite relation was tested periodically for untrained development. To test transfer of function, test probes were conducted similarly with a second set stimuli. This research was the first to show relations, derivations, and transfers in adolescents with autism. The researchers of this study found that single-reversal bidirectional frames, after the direct training of one relation, can be derived. All three participants involved in this study exhibited a transfer of stimulus function after the You and I relations were mastered (Belisle et al., 2016).

Dixon, Paliliunas, Barron, Schmick, and Stanley (2019) studied the effects of traditional ABA therapy and post -Skinnerian techniques on IQ scores in children with autism. Traditional ABA therapy has been shown to be effective in improving intelligence, verbal behavior, and language repertoires by using direct contingency-based training. Also, RFT has been shown to lead to IQ gains in children with autism (Dixon et al., 2019). RFT uses derived relational responding instead of the antecedent-behavior-consequence model when teaching novel skills. For this study, researchers used a randomized control trial to compare verbal behavior techniques involved in traditional ABA therapy, post-Skinnerian techniques that were added to comprehensive ABA methods, and a control group (Dixon et al., 2019). These researchers found that acquisition of skills improved across both experimental groups when compared to the control group. The highest IQ gains were found in the comprehensive ABA group. The data suggest that ABA providers could have an advantage by adding nontraditional techniques into teaching language and cognitive skills (Dixon et al., 2019).

There is substantial empirical evidence that support PEAK as being a successful tool for teaching children with ASD language and cognitive skills. For example, Reed and Luiselli (2016) called PEAK "…conceptually sound, psychometrically robust, and an innovative advancement of conventional ABA tactics…" (p. 210). One potential advantage of the PEAK-E and PEAK-T pre-assessments is that they can provide a measure of growth in derived relational responding as a higher-order operant behavior (Healy, Barnes-Holmes, & Smeets, 2000). As learners progress though PEAK programming, improvements in derived relational responding may be observed as improved scores within the pre-assessments. Currently, PEAK-E and PEAK-T provide the only systematic and standardized measure of derived relational responding. Limitations of the PEAK-E and PEAK-T pre-assessments include pre-assessments possibly leading to training to the test and pre-assessments not being direct measures of performance. For example, a learner may achieve a score of 4/6 for the Symmetry subtest of the PEAK-E assessment, but "4" is not a direct measure of behavior. We can infer the 4 is greater than 3 and less than 5, but what precisely 4 refers to is unknown. Traditional approaches to behavior analysis emphasize measuring directly the behavior of interest, such as time spent on a task or frequency of self-injury. Currently, there are no quantitative methods to measure derived relational responding as a generalized operant directly. Obtaining a direct measure that correlates with the PEAK could provide a valid estimate for use as a predictor or outcome measure within stimulus equivalence and RFT research. Creating this measure is of interest to current researchers.

Piloting an Additional Measure of Coordinated Responding

One approach could be to obtain "relational deceleration," or the weakening of derived relational responding as a function of class size. Belisle & Dixon (2020) provided a model of relational deceleration as: Rp = Rm / Rv, where Rp represents the strength of relations contained within a class, Rm represents mass or resistance, and Rv are the number of nodes. Without knowledge of Rm, we can infer from this equation that as Rv increases (i.e., additional nodes), the overall strength of the class decreases (Rp). Although individuals with autism have shown deficits in derived relational responding in general, these deficits appear to become more pronounced within larger classes. And, this finding corresponds with neurological research suggesting primary differences may occur when tasks become more complex. Belisle and Dixon (2020) demonstrated in a basic experiment with college student participants that nodal distance was inversely related to response accuracy as a measure of response strength, corresponding with prior research stemming from a stimulus equivalence account (Belisle & Dixon, 2020). Although these authors elected to use response accuracy, neurological research suggests that a decrease in fluency as a function of task complexity may be more sensitive to detecting differences, and therefore may be more appropriate as a measure of relational deceleration.

The Relational Acquisition of Skills in Children with autism (RASC) assessment was created to show the decay of relating across nodal distance. We expected that as nodes increase, the ability to derive relations decreases. Directly trained relations will first be established using a stimulus pairing observation procedure (SPOP). After the relation has been directly trained, a match to sample (MTS) procedure will be used to test the participant on the symmetrical relation. This procedure will continue for three classes of stimuli with three members in each class. Fluency was recorded for participants who mastered a relation. This new measure will be pilot

tested with children who have autism. The scores obtained from this new measure were compared against PEAK E, PEAK T, and IQ scores.

SPOP has received attention form behavior analytic research in past years (e.g. Leader & Barnes-Holmes, 2001; Leader, Barnes-Holmes, & Smeets, 1996; Smyth, Barnes-Holmes, & Forsyth, 2006). Recently, SPOP has been examined in the development of language skills (e.g. Byrne, Rehfeldt, & Aguirre, 2014; Rosales, Rehfeldt, & Huffman, 2012; Vallinger-Brown & Rosales, 2014). In the study conducted by Solares and Fryling (2018) three children with ASD were exposed to SPOP instructions. These researchers found that after SPOP instructions, the participant's scores for tact and listener responses increased and remained increased during maintenance. These results were inconsistent with the study conducted by Byrne, Rehfeldt, and Aguirre (2014), in which the participants did not master the criteria after being exposed to SPOP instruction (Solares & Fryling, 2018).

MTS testing involves relating different stimuli together because of previous environmental reinforcement. Matching stimuli such as a picture of an item with the written word (Sidman & Tailby, 1982). Researchers have found that children with ASD are successful at learning stimuli relations after MTS training. It has also shown that receptive and expressive language skills emerge for some participants who undergo MTS training (Carr, Wilkinson, Blackman, & McIlvane, 2000; McLay, Sutherland, Church, & Tyler-Merrick, 2013). There are, however, variations in the results of these research studies. Some researchers have found that children with ASD who have higher verbal skills before MTS training acquire untrained relations more quickly compared to children with lower verbal skills (O'Conner, Rafferty, Barnes-Holmes, & Barnes-Holmes, 2009). Some children who have autism need modifications to the

teaching conditions to be able to develop relations. In these situations, the extent of training is highly variable (Cuvo & Riva, 1980; Murphy & Barnes-Holmes, 2010).

Bejno, Johansson, Ramnero, Gimaldi, & Cepeda (2018) examined the effects of MTS training on verbal responding. The participants were 6 children who have been diagnosed with autism. These children had varying levels of skills. The purpose of the study was to investigate if MTS training would improve in the development of untrained receptive and expressive language responses, and also to determine if previous verbal skills influence learning and retention. These researchers found that all participants involved increased their matching skills to some degree during the study. Participants with higher verbal skills at the beginning of the study developed responses more quickly than other participants. This lends support that MTS training can be helpful for children with autism in acquiring untrained language responses (Bejno et al., 2018). Clayton and Hayes (2004) also found that exposure to MTS training resulted in a higher number of correct responses while testing derived relations (Clayton & Hayes, 2004). The RASC assessment uses an MTS procedure to test a symmetrical relation that has previously been trained.

Fluency has been said to lead to the successful generalization of skills that are more complex (O'Brien, Tiernan, & Holloway, 2017). Strength of relating will be measured as fluency. It has been hypothesized that fluency decays over nodal distance.

Purpose of the Present Study

The present study (a) extended previous research by evaluating the relationship between PEAK Equivalence and PEAK Transformation with IQ scores in children who have autism and (b) created and pilot tested the RASC with the same pool of participants. The PEAK assessment

battery has been correlated positively with several constructs related to executive functioning and language supporting the empirical and clinical utility of this tool. An additional advantage of the PEAK assessment battery is that curricular programming can be developed directly from this tool. Deficits in IQ are common in children with autism, so we compared the accuracy of full scale IQ estimates to total PEAK scores. We anticipated strong, positive correlation between PEAK and IQ scores since, although these measures are different, they are of the same general concept. The scores of the piloted RASC assessment were correlated with both PEAK and IQ scores to determine the validity of this new measure.

METHOD

Participants

Twenty-one children between the ages of two years and six years with a diagnosis of autism were recruited from ABA service providers in Missouri. Of the 21 participants, six were female and 15 were male. The average age of the participants included in this study was 3.95 years with a standard deviation of 0.97.

Most of the children recruited were already receiving ABA services, however, some were on the waitlists to get into those services. Out of the 21 participants included in this study, 18 attended an ABA preschool class. This classroom had a morning session and an afternoon session. The morning session had ten children in attendance. The afternoon session had eight children in attendance. Both sessions were led by one teacher and three classroom aids. The classroom incorporated natural environment teaching and group activities. Each child in the program was pulled aside one at a time to work with a staff member on discrete trial targets. The remaining three participants were not receiving ABA services.

Each child involved in this study had a diagnosis of autism. Additional diagnoses of Down syndrome, Oppositional defiant disorder, sensory processing disorder, developmental delays, and speech delays were reported. Children with all behavior ranges were included in this study. Behaviors including physical refusal, physical aggression, verbal refusal, screaming, and elopement were also reported. However, if behaviors became severe, the assessments were discontinued. Assessments were discontinued if the participant engaged in physical aggression towards self or implementor or if discontinue criteria was met for the specific assessment.

The average IQ score for the participants included in this study was 54 with a standard deviation of 19.26. The average PEAK E score for these participants was 3 with a standard deviation of 4.39. The average PEAK T score for the participants included in this study was 8 with a standard deviation of 15.77.

Other studies that have compared the relationship between IQ and PEAK have used children who have ASD as well as other forms of disabilities. However, studies conducted by Dixon, Whiting, Rowsey, and Belisle (2014b) and Dixon, Belisle, and Stanley (2018) used a much larger number of participants (64) as well as higher age ranges (five years to 22 years and four years to 16 years).

Settings and Materials

The WPPSI-IV subtests, PEAK Equivalence Pre-Assessment, PEAK Transformation Pre-Assessment, and the RASC assessment were either conducted at Missouri State University in a 2.44 m x 1.22 m treatment room in Hill Hall or in a quiet 0.61 m x 0.91 m corner of a classroom that was separated from the rest of class by dividers. The treatment room at Missouri State University was able to be viewed through a two-way mirror in an adjoining room. Present in the treatment room was a table and two chairs positioned across from each other. A shelf with an array of reinforcers (toys, edibles, iPad mini) was also present in the room. The participants assessed at Missouri State University were allowed to bring highly reinforcing items from home to work for. An iPad mini was mounted on the wall positioned to view the top of the table. This iPad recorded the session through zoom to be viewed on a computer located in the adjoining room. Parents of the participants, as well as other graduate students were seated in the adjoining room and watched the session. Items included in the corner of the classroom included a table,

three chairs, and a Mac Book. Edible reinforcers and age appropriate toys were also available for the participant to work for.

The Wechsler Preschool and Primary Scale of Intelligence (WPPSI-IV) short form was used to test intelligence. Assessors used the WPPSI-IV for all participants. These participants were tested using the Information, Matrix Reasoning, and Picture Memory subtests of the WPPSI-IV. These subtests were administered in the treatment room or in a secluded corner of the classroom. The materials needed for the WPPSI-VI included picture stimuli for the participant's to be able to select a correct response, scoring sheets for all subtests, and a writing utensil to score participant responses.

The Information subtest of the WPPSI-IV is included in the Verbal Comprehension Index. This subtest measures a participant's capacity to acquire information, retain information, and retrieve information. The participant either selected a picture in an array of 4 that best answered a question or answered a question verbally about a variety of topics. For the questions that needed picture stimuli, the assessor used the stimuli book for the information subtest. The page that corresponded to the item number on the data sheet was presented to the participant.

The Matrix Reasoning subtest of the WPPSI-IV is included in the Fluid Reasoning Index. This subtest measures a participant's broad visual intelligence, fluid intelligence, perceptual organization, knowledge of part-whole relations, classification and special capacity, and processing. In this subtest, the participant was asked to select one of four possible stimuli that completed the unfinished matrix that was presented. The stimuli book for this subtest was used to present the unfinished matrices, as well as the four possible stimuli choices to the participant. The assessor presented the page that corresponded to the item number on the data sheet.

The Picture Memory subtest of the WPPSI-IV is included in the Working Memory Index. This subtest measures visual working memory. In this subtest, a participant viewed a page of stimuli for a specified amount of time. The participant then selected the pictures he previously viewed from a number of options provided on a response page. The assessor used the stimuli book from this subtest to present the page that corresponded to the item number on the data sheet.

The PEAK Equivalence Pre-assessment was used to test derived equivalence relations (reflexive, symmetrical, transitive, and equivalence) between stimuli. The short form version of this pre-assessment was used for this study. Materials needed for the implementation of the PEAK Equivalence Pre-Assessment included the stimuli flip book, the assessor's script, and data sheets. The stimuli flip book contains the stimuli needed for the participant to give a correct response to any given question. This book was placed on the table, directly in front of the participant. The assessor's script provided the assessor with the correct verbal instructions to give to the participant for every question on the PEAK Equivalence Pre-Assessment. The script was followed verbatim by the assessor. The script also provided the assessor with the correct answer. Space was provided on the scoring sheet for the assessor to mark if the participant answered the question correctly or incorrectly. The assessor's script as well as the data sheet were hidden from the view of the participant. Other materials needed for this assessment included a timer for the assessor to time participant breaks and a variety or reinforcers for the child to work for (edibles, toys in the treatment room, or toys brought by the child).

The materials needed for the PEAK Transformation Pre-Assessment were similar to the materials above. A stimulus book that included the stimuli needed for the child to give a correct response to any given question was sitting on the table directly in front of the participant. A

script for the assessor to follow was also present in the room but hidden from the participant's view. Other materials present in the room for this assessment included a timer to time breaks taken by the participant and reinforcers for the child to work for.

The materials needed for the method to measure fluency and obtain the deceleration coefficient included a Surface Pro for the participant to view the stimuli, a printed data sheet, and a writing utensil for the assessor to record participant responses as correct or incorrect. The data sheet that was created for this method is shown in Appendix 2. This assessment had three classes of stimuli with three members in each class. Class A stimuli consisted of pictures of merged animals (two different animals merged together), the class B stimuli consisted of arbitrary consonant vowel consonant (CVC) words, and the class C stimuli consisted of non-primary colors. These stimuli were presented using a Microsoft PowerPoint presentation on a Surface Pro. Various reinforcers were present in the room and available for the participant.

Interobserver Agreement

IOA was calculated for 67% (42 out of 63) of all assessments implemented. Agreement occurred when the observer and the assessor both marked a correct or incorrect response for assessment items. The percent agreement for all assessments was calculated by taking the total number of agreements (694) and dividing by the total number of agreements plus the total number of disagreements (702) and multiplying by 100. The total percent agreement for all assessments implemented was 99%. These results were then broken down by assessment type. IOA was calculated for 76% (16 out of 21) of IQ assessments. Percent agreement was calculated by taking the total number of agreements (317) and dividing by the total number of agreements plus the total number of disagreements (317) and multiplying by 100. The percent of agreement

for the IQ assessments was 100%. Next, IOA was calculated for 29% (6 out of 21) of the PEAK assessments. Percent agreement was calculated by taking the total number of agreements (169) and dividing by the total number of agreements plus disagreements (175) and multiplying by 100. The percent agreement for the PEAK assessments was 97%. Then, IOA was calculated for 95% (20 out of 21) of the RASC assessments. Percent agreement was calculated by taking the total number of agreements (208) and dividing by the total number of agreements plus the total number of disagreement (210) and multiplying by 100. The percent agreement for the RASC assessment was 99%.

Procedure

Prior to the start of assessing the participants, the study was approved by Missouri State University's institutional review board, IRB-FY2020-33, on August 29, 2019 (Appendix A). Each of these assessments were conducted by graduate level students who were trained to criterion by Dr. Jordan Belisle, PhD, BCBA. Before a participant could be assessed, an intake packet was given to the parents. Included in the packet was a consent form, an informational sheet, PEAK Direct Training indirect assessment, PEAK Generalization indirect assessment, and a Questions About Behavioral Function (QABF) indirect assessment. The assessments could not begin until the consent form was signed. Once consent was obtained, an observational preference assessment was conducted for each participant to determine reinforcers for the participants to work for. Once the reinforcers were identified, the assessor began implementing the assessments in a randomized order. Breaks were given to the participants periodically through the two-hour session. During the session, participants would complete the WPPSI-IV Information, Matrix

Reasoning, and Picture Memory subtests, the PEAK Equivalence Pre-assessment, and the Transformation Pre-assessment receptive subtest, and the RASC assessment.

The WPPSI-IV Information, Matrix Reasoning, and Picture Memory subtests were used for all participants. For the Information subtest, the assessor was positioned directly in front of the participant. Participants were presented with picture stimuli. A piece of paper with four different stimuli printed on it was presented to the participant. The assessor would then ask a question about one of the pictures presented. For example, the assessor would present the pictures of a sandwich, a doll, a ball, and a house. The assessor would then say, “Show me what you can eat.” This process continued for three more trials. After these trials, only verbal items were used. For example, the assessor would ask the participant a question like “Show me your knee? Touch it.” or “How many eyes do you have?”. Each item on this subtest was scored a 0 or a 1 depending on participant responses. If the participant scored a 0 on three consecutive trials, the subtest was discontinued.

For the Matrix Reasoning subtest, the assessor stayed positioned directly in front of the participant. The assessor presented an incomplete matrix to the participant. Stimuli to complete the matrix were also presented. The assessor would then say, “Look at these pictures”. The assessor then pointed to the response options and then to the incomplete matrix while saying “Which one here goes here.” The participant selected a correct response by touching or pointing to the stimulus that completed the matrix. This subtest began with three sample items. For the sample items, the assessor provided feedback for the participant responses. If the participant selected an incorrect response on a sample question, the assessor corrected the participant and showed the correct response. Participant responses were scored either a 0 or 1. The assessor no longer provided feedback after the sample questions. The items in this subtest became more

difficult as the test continued. If the child selected three incorrect responses in a row, the assessment was discontinued.

For the Picture Memory subtest, the assessor stayed positioned directly in front of the participant. The assessor would present a page to the participant. The page would have one or more items printed on it. The assessor would wait three seconds and then turn the page. The second page would have two or more items presented on it, including the items from the first page. Once the second page was presented, the assessor would say “What did you see?”. The participant would touch or point to the correct item or items in the array. This subtest began with a sample question. The assessor could provide the participant feedback on the sample question only. Six items were to follow in the same manner as the first sample question. After the six items, another sample question would be presented. For this sample item the assessor would present the stimuli to the participant and wait five seconds. The assessor used the same procedure as the previous items by turning the page to the array of stimuli and asking, “What did you see?”. Each item in this subtest would either be scored a 1 for correct responses or a 0 for incorrect responses. The participants must select all correct stimuli for an item to be scored as correct. This assessment was discontinued after three consecutive scores of 0.

The PEAK Equivalence Pre-Assessment contains 48 items that assess the four different types of derived responding (reflexive, symmetrical, transitive, and equivalence). Each type of responding has a subtest that includes 12 items. Participant’s scores could range from 0-12 for each of the subtests. The scores for the four different subtests were combined for a total PEAK Equivalence Pre-Assessment score ranging from 0-48. Each subtest contains six skills that are labeled “basic”, “intermediate” or “advanced” based on complexity. These six skills were tested one time. The score was then multiplied by two to create a maximum score of 12. Visual and

auditory stimuli were included in the assessment to evaluate derived relations. Visual stimuli included arbitrary pictures and arbitrary text. Auditory stimuli included arbitrary vocal words. For each item on the assessment, the assessor followed a script verbatim. Relations were shown to the participant and then tested using sequential presentation or match-to-sample. During a sequential presentation arrangement, the participant was presented with a comparison stimulus. A different comparison stimulus was followed sequentially. The assessor then provided a verbal statement indicating whether the sample stimulus was the same as the comparison stimulus or not. The same stimulus was presented again by the assessor. This was followed sequentially by a different comparison stimulus. The assessor provided another verbal statement that indicated whether the sample stimulus was the same as the comparison stimulus or not. Following this, a prior comparison stimulus was presented as a sample stimulus as well as a corresponding comparison stimulus by the assessor. The assessor then asked, "Were those the same?" If corresponding stimuli were presented, the participant would respond with "yes" for a correct response. If unrelated stimuli are presented, the participant would respond with "no" for a correct response. For match-to-sample tasks, a sample stimulus, as well as two comparison stimuli, were presented. The assessor pointed to the sample stimulus and then to the comparison stimulus and said, "This is the same as this". The assessor would then present one of the previously presented comparison stimuli as a sample stimulus. Two comparison stimuli were also presented. The assessor would then point to the sample stimulus while saying "Find the same." If the participant pointed to the comparison stimulus that corresponds to the sample stimulus, a correct response would have been recorded.

For reflexivity testing, the stimuli that were related are formally identical. For all other relational tests, the related stimuli were arbitrary. This means that the stimuli used had no formal

similarities and it was very unlikely that the participants would have had a reinforcement history with those specific stimuli. Tasks included in the reflexivity subtest of the PEAK Equivalence Pre-assessment were matching identical stimuli. Tasks included in the symmetry subtest involved the participant making a correct bidirectional response after being presented with a relation between two stimuli. For example, the participant was told that stimulus A was the same as stimulus B. The participant was then tested to see if stimulus A was selected when presented with stimulus B. For testing transitivity relations, the assessor presented two relations to the participant. A third derived relations would then be tested. For example, the participant was told that stimuli A-B and stimuli B-C are the same. Stimulus A was then presented, and a correct response was scored if the participant selected stimulus C demonstrating the relation between the two stimuli. For testing equivalence relations, the participant was presented with three relations. A fourth derived relation would be tested. For example, a participant was told that A-B, B-C, and A-C. Stimulus C was then presented. A correct response was scored if the participant selected stimulus A. If the participant earned a score of 0 for two consecutive items, the participant would move on to the next relation type. The assessor would not provide reinforcement or feedback to the participant throughout this assessment.

The PEAK Transformation Pre-assessment receptive subtest was also used in this study. This subtest includes six relational frames that have 16 items each. Any reinforcers, such as feedback, praise, or tangibles, were not provided to the participant during this assessment. This assessment was conducted with no consequences for participant responses. To help maintain the attention of the participants, the assessor could have offered the participant a break or a snack after the completion of a certain number of items.

The receptive subtest of the PEAK Transformation Pre-assessment follows a structure of presenting increasingly difficult questions within each frame. In this subtest, the participant used selection-based responses to answer the questions presented. The assessor delivered instructions to the participant verbatim from the assessor's script. If the participant answered three consecutive questions incorrectly, the assessor moved on to the next frame. The items in this subtest had only one correct response. This means the items were scored as 0 or 1. The assessor used data sheets and a writing utensil to record participant responses. Also, included in this subtest were practice and instructional items. The practice items helped familiarize the participant to the layout of the assessment, as well as, the expected method of responding. Providing the learner with feedback and correcting errors, if any, made by the participant was appropriate for the assessor to provide during practice questions. This occurred at the beginning of each section included in the subtest. Instructional items provided the learner with information needed for test items. These items were presented several times in a row to the participant. The participant would not make a response for the instructional items, and therefore, these items were not included in the participant score.

The RASC assessment consisted of 3 classes of stimuli. Each class contained 3 members (A 1-3, B 1-3, and C1-3). A Surface Pro was used to train and test relations. To train A to B, a SPOP procedure was used. A picture of the A1 animal combination stimulus was presented to the participant. While the stimulus was presented, an audio recording of the corresponding CVC B1 stimulus was played. For example, the participant was shown a picture of the cow baby drawing (A1) while the audio recording said "RUQ" (B1). Next, a picture of the A2 animal combination stimulus was presented to the participant and the corresponding CVC B2 audio

recording was played. Then, a picture of the A3 animal combination stimulus was presented to the participant and the corresponding CVC B3 audio recording was played.

After each A to B relation has been trained once, the participant was tested on relating B1 to A1 using an MTS procedure. For this test, stimuli A1, A2, and A3 were presented to the participant simultaneously. While these stimuli were presented an audio recording that stated "find RUQ" (B1) was played. The participant made a selection by touching or pointing to one of the stimuli presented. If the participant touched multiple stimuli, the assessor said, "pick one". This test repeated for two more trials. In each trial, the A stimuli were presented in a random order. If the participant selected the correct response for all three trials, the participant moved on in the assessment. If the participant did not select the correct response, the participant went back to the A-B training. This process could have occurred up to two more times. If the participant was unable to relate B1 to A1 after the third A to B training, the assessment was discontinued.

If the participant was able to relate B1-A1, the participant was represented with the SPOP procedure to train A-B stimuli relations before moving on to the B2&3 to A2&3 test. For this test, a MTS procedure was used. The participant was presented with the A1, A2, and A3 stimuli simultaneously. An audio recording of the directive "Find WEX" (B2) or "Find SAZ" (B3) was played in a random order (three trials of B2-A2 and three trials of B3-A3). The participant selected a response by touching or pointing to an A stimulus. If the participant touched multiple stimuli, the assessor could have said "pick one". If the participant selected the correct response for all six trials, the assessment continued. If the participant did not select the correct response for all six trials, the assessment was discontinued.

In the next section of this assessment, the participant was trained to relate the C stimuli to the corresponding B stimuli using a SPOP procedure. To do this, the participant was presented

with the non-primary color C1 stimulus. While the stimulus was presented, an audio recording of the corresponding CVC B1 stimulus was played. For example, the participant was shown the non-primary color magenta (C1) while an audio recording saying “RUQ” (B1) was played. Next, the non-primary color C2 stimulus was presented to the participant while an audio recording of the CVC B2 stimulus was played. Then, the participant was presented with the non-primary color C3 stimulus while an audio recording of the CVC B3 stimulus was played. After training the C stimuli to the B stimuli, the participant was tested on the B1 to C1 relation. For this test, the participant was presented with the C1, C2, and C3 stimuli simultaneously while an audio recording that stated “Find RUQ” (B1) was played. The participant made a selection by touching or pointing to a picture of a C stimulus. If the participant touched multiple stimuli, the assessor could have said “pick one”. This test repeated for two more trials. In each trial, the C stimuli were presented in a random order. If the participant did not select the correct response for all three trials, the participant went back to the training of C-B. This process could have occurred up to two more times. If the participant did not select the correct response for all three trials of the B1-C1 test after the C-B relation has been trained three times, the assessment was discontinued.

If the participant was able to select the correct response for all three trials after the B1-C1 relation had been tested one to three times, the participant was represented with the SPOP training of the C-B stimuli relations before moving on to the B2&3 to C2&3 test. For this test, a MTS procedure was used. The participant was presented with the C1, C2, and C3 stimuli simultaneously. An audio recording of the directive “Find WEX” (B2) or “Find SAZ” (B3) was played in a random order (three trials of B2-C2 and three trials of B3-C3). The participant selected a response by touching or pointing to a C stimulus. If the participant touched multiple stimuli, the assessor could have said “pick one”. If the participant selected the correct response

for all six trials, the assessment continued. If the participant did not select the correct response for all six trials, the assessment was discontinued.

For the next section of the assessment, the participant was represented with the SPOP procedure to train A-B and B-C relations. To do this, the participant was presented with a picture of an animal combination A stimulus or a picture of a non-primary color C stimulus in a random order. While the participant was presented with a stimulus, an audio recording of the corresponding CVC B stimulus was played. For example, the participant was shown a picture of an elephant butterfly (A2) or a picture of teal (C2) while the corresponding CVC audio recording of "WEX" (B2) was played. After the training, the participant moved on to a transitivity test which determined if a relation could be made for the A1 stimulus to the C1 stimulus. For this test, a MTS procedure was used. The participant was presented with the C1, C2, and C3 stimuli simultaneously. These stimuli appeared at the bottom of the screen. An audio recording of the directive "find" was played followed by the timed appearance and disappearance of the A1 stimulus. The participant was presented with three trials of this test. In each trial the C stimuli were presented in a random order. The participant made a selection by touching or pointing to the correct C stimulus. If the participant selected multiple stimuli, the assessor could have said "pick one". If the participant selected the correct response for all three trials the assessment continued. If the participant did not pick the correct response for all three trials the assessment was discontinued.

If the participant was able to move on in the assessment, another MTS transitivity test was presented. This tested the relation between the A2&3 stimuli to the C2&3 stimuli. For this test, the participant was presented with the C1, C2, and C3 stimuli simultaneously. These stimuli appeared at the bottom of the screen. An audio recording of the directive "find" was played

followed by the timed appearance and disappearance of the A2 or A3 stimuli. The participant was presented with six trials of this test. In each trial the C stimuli were presented in a random order at the bottom of the screen. The A stimuli also appeared and disappeared in a random order. The participant made a selection by touching or pointing to the correct C stimulus. If the participant selected multiple stimuli, the assessor could have said “pick one”. If the participant selected the correct response for all six trials the assessment continued. If the participant did not pick the correct response for all six trials the assessment was discontinued.

If the participant was able move on to the last section of the assessment, the C2&3 to A2&3 relations were tested using a MTS procedure. For this test, the participant was presented with the A1, A2, and A3 stimuli simultaneously. These stimuli appeared at the bottom of the screen. An audio recording of the directive “find” was played followed by the timed appearance and disappearance of the C2 or C3 stimuli. The participant was presented with 6 trials of this test. In each trial the A stimuli were presented in a random order at the bottom of the screen. The C stimuli also appeared and disappeared in a random order. The participant made a selection by touching or pointing to the correct C stimulus. If the participant selected multiple stimuli, the assessor could have said “pick one”.

Participant responses were recorded as correct or incorrect on the data sheet shown in Appendix B. Total fluency of a relation was also recorded on the data sheet. To record fluency, the implementation of the RASC assessment was recorded with an iPad through Zoom. The assessor watched the video to record the amount of time that passed from the end of the Sd to the participant response. This time was recorded on the participant data sheet. If the participant was able to derive a relation after being tested, the time it took for the participant to master that

specific relation was calculated and recorded as the total fluency for that relation. It was hypothesized that this will show the decay of fluency across nodal distance for each participant.

RESULTS

Intelligence Quotient Results

The participants' scores for each assessment can be found in Table 1. To calculate IQ scores for the participants in this study, researchers used three of the subtests included in the WPPSI-IV. The three subtests were Information, Matrix Reasoning, and Picture Memory. The raw scores for the Information subtest ranged from 0 to 23. The mean score for this subtest was 5 and the standard deviation was 6.97 across the participants included in this study. The raw scores for the Matrix Reasoning subtest ranged from 0 to 15. The mean score for this subtest was 2 and the standard deviation was 4.44 across the participants included in this study. The raw scores for the Picture Memory subtest ranged from 0 to 14. The mean score for this subtest was 2 and the standard deviation was 3.89 across the participants included in this study. The raw scores for these subtests were converted into scaled scores for each participant. The scaled scores for the Information subtest ranged from 1 to 15 across the participants included in this study. The mean score for this subtest was 3 with a standard deviation of 4.11. The scaled scores for the Matrix Reasoning subtest ranged from 1 to 12 across the participants included in this study. The mean score for this subtest was 3 and the standard deviation was 3.88. The scaled scores for the Picture Memory subtest ranged from 1 to 10 across the participants included in this study. The mean score for this subtest was 2 and the standard deviation was 2.63. Once the scaled scores were calculated, the scaled scores of each subtest were added together for each participant. The assessor then used a conversion table to convert the sum of the scaled scores to calculate a full scale IQ estimate for each participant (Sattler, Dumont, & Coalson, 2016). The full scale IQ estimates ranged from 43 to 108. Due to time constraints, participant 19 was unable to receive an

IQ score. For this participant, IQ was calculated using the PEAK Equivalence score. An equation used by Dixon, Belisle, & Stanley (2018) was used to calculate this full scale IQ score ($y = 1.2436x + 49.131$. Given that $x = 8$, total full scale estimated IQ for that participant was 59. The mean total IQ estimate for the participants included in the study was 54. The standard deviation for these participants was 19.26.

PEAK Equivalence and Transformation Results

To calculate scores for PEAK Equivalence and PEAK Transformation the assessor added the participant's correct number of responses. Because only the receptive PEAK Transformation pre-assessment was implemented, the assessor added the participant's correct number of responses and multiplied that total by two. The PEAK E scores ranged from 0 to16 for the participants included in this study. The participants' mean score for PEAK E was 3 and the standard deviation was 4.39. The PEAK T scores ranged from 0 to 60 for the participants included in this study. Their mean PEAK T score was 8 and the standard deviation was 15.77. Total PEAK scores were calculated for each participant by adding their PEAK E and PEAK T scores together. Total PEAK scores ranged from 0 to 72 for the participants included in this study. The mean total PEAK score was 11 with a standard deviation of 18.77. Many of the participants included in this study were able to derive reflexive relations but were unable to derive symmetrical relations.

Relational Acquisition of Skills in Children with Autism Results

For the RASC assessment, seven out of 21 participants (33%) mastered the B1-A1 relation when tested after being trained on the A-B relation. Of these seven participants, four

(57%) mastered the relation after being trained once, two (29%) mastered the relation after being trained twice, and one (14%) mastered the relation after being trained a third time. Out of the seven participants who moved on to the second relation, three (43%) mastered the B2 & 3 to A2 &3 relation after being represented with the A1-B1 training. Out of the three participants who moved on to the next relation, two (67%) mastered the B1-C1 relation after being trained on the C-B relation. Both participants (100%) mastered the relation after being trained one time. Of the two remaining participants, only one (50%) mastered the B2 & 3 to C2 & 3 relation after being represented with the C-B training. This participant also mastered the A1-C1 relation after being trained on the C-A relation, the A2 & 3- C2-3 after being represented with the C-A relation, and the C2 &3-A2 & 3 relation. Therefore, only one participant was able to complete the entire assessment such that obtaining a difference between the symmetry and transitivity rate was not possible for most subjects. These data were therefore omitted from the remainder of the analyses. The data from this participant are however described below to aid in the development of future testing models because this was a pilot evaluation of this method.

To measure fluency for the RASC assessment, the time between the end of the Sd and the participant's response (latency) was measured. For the B1-A1 relation, there were three trials in which the participant had to respond correctly to master the relation. If the participant mastered the B1-A1 relation the three latency times were added together to measure the total fluency of that relation. If the participant mastered multiple relations, the latency times were added for each relation that was mastered. That number was then divided by the number of relations that the participant mastered. For example, participant 2 mastered three relations. The first relation took the participant 30.66 seconds to master. The second relation took the participant 15.78 seconds to master. The third relation took the participant 17.8 seconds to master. These three times were

then added together to show that the participant mastered three relations in 64.24 seconds. This time was then divided by the number of relations the participant mastered (3), to get an average fluency score. This participant's average fluency was calculated as 21.41 seconds. The participants included in this study who were unable to master the first relation, thus discontinuing this assessment, scored a 0 for average fluency. Average fluency for all participants in this study ranged from 0 to 54.05 seconds.

Statistical Analyses

A Pearson correlation measures the statistical relationship between two variables. Values .70 and above are said to have strong positive correlations and values .29 and below are said to have weak positive correlations. A Pearson correlation matrix was created for the scores of the assessments implemented in this study. Figure 1 shows this Matrix. Correlations between the assessments ranged from $r = .16$ to $r = .95$. For the Information subtest, a strong positive correlation was found with the total IQ estimate ($r = .95$) and a moderate positive correlation was found with the Picture Memory subtest ($r = .59$). For Matrix Reasoning, a strong positive correlation was found with the total IQ estimate ($r = .88$) and a moderate correlation was found with Picture Memory ($r = .44$). A strong positive correlation was found between Picture Memory and the total estimated IQ ($r = .70$). A moderate positive correlation was found between Picture Memory and Matrix Reasoning ($r = .44$). For total estimated 1Q, a strong positive correlation was found with Information ($r = .95$) and a strong positive correlation was with Picture Memory ($r = .70$). A strong positive correlation was found between PEAK total score and total estimated IQ ($r = .94$) and a moderate positive correlation was found between PEAK total score and Picture Memory ($r = .66$). When RASC scores were added to the correlation matrix, it showed

that the RASC had a strong positive correlation with Matrix Reasoning (r = .78), moderate correlations with Information (r = .54), total IQ estimates (r = .49), and total PEAK score estimates (r = .57), and a weak positive correlation with Picture Memory. A Pearson correlation matrix was also created to correlate total estimated IQ scores and PEAK Equivalence scores (Figure 2) and to correlate total estimated IQ scores and PEAK Transformation scores (Figure 3). These matrices' indicate a moderate positive correlation of 0.68 between total estimated IQ scores and PEAK Equivalence scores and a strong positive correlation of 0.93 between total estimated IQ scores and PEAK Transformation scores.

Linear regressions were ran between the participants' total PEAK scores and total estimated IQ scores (Table 2), the total estimated IQ scores and the PEAK Equivalence scores (Table 3), and the total estimated IQ scores and the PEAK Transformation scores (Table 4). An equation for a linear regression was calculated and graphed. For total PEAK scores and total estimated IQ the equation was y= 1.013*x + 43.62 (Figure 4). For total estimated IQ scores and PEAK Equivalence scores the equation was y= 3.061*x + 45.90 (Figure 5). For total estimated IQ scores and PEAK Transformation scores the equation was y= 1.202*x + 44.78 (Figure 6). Data were then graphed using these equations. We found that PEAK Equivalence had the strongest correlation with total estimated IQ scores while PEAK Transformation had the weakest correlation with total estimated IQ scores. These equations help determine the relationship between the assessments being correlated. A positive relationship will produce a line that slopes upward, a negative relationship will produce a line that slopes downward, and if no relationship is found, a flat line will be produced.

The r-squared values were calculated for each correlation. The r-squared values range from 0 to 1. The r-squared value for the correlation between total PEAK scores and total

estimated IQ scores was $r = .88$. The r-squared value for the correlation between total estimated IQ scores and PEAK E scores was $r = .47$. The r-squared value for the correlation between total estimated IQ scores and PEAK T scores was $r = .86$. High r-squared values account for more variance in the data. A visual display of high r-squared values will show data points that are closer to the line of regression than low r-squared values.

According to these data presented, researchers found strong correlations between PEAK scores and total estimated IQ, thus agreeing with extensive research that had been conducted on the relationship between PEAK and IQ. It was also found that the RASC assessment was not a sensitive enough measure to correlate with PEAK scores or total IQ estimates.

Secondary Analysis with Strong Performers Removed

Upon further investigation of these data, data points belonging to the strongest performers were eliminated. Additional analyses were ran on the new data set. Table 5 shows a Pearson Matrix Correlation between total estimated IQ scores and total PEAK scores minus the top five scores. A weak positive correlation between these assessments was found. A linear regression was then run on these data. The equation of a line that was calculated from these data is shown in Figure 7. The equation $Y = 0.08696*X + 44.22$ was used to graph this correlation (Figure 8). The P value for this correlation was $p = .691$. The r-squared value for this correlation was $r = .01$.

When the top 5 performers' scores were eliminated from the data set, correlations between total estimated IQ and total PEAK scores weakened. Total PEAK scores for these learners had a higher variance than their IQ scores, thus showing differences between learners. It has been discussed that the WPPSI-IV might not be appropriate for those early learners who are

highly impacted by ASD due to the restricted range of IQ scores and the high estimation of total IQ. Research conducted by Scattone, Raggio, and May discusses the importance of using multiple assessments when trying to calculate IQ for individuals with autism (2012).

DISCUSSION

Summary of Results

Total PEAK scores and total estimated IQ scores were shown to be related by strong positive correlations. The highest positive relationship was found between total PEAK scores and total estimated IQ scores (r = .94). A moderate positive relationship was found between total estimated IQ scores and PEAK E scores (r = .68). A high positive relationship was found between total estimated IQ scores and PEAK T scores (r = .93). These results extend previous research that has been conducted on the relationship between PEAK and IQ. However, when the top 5 performers' scores were eliminated from the data set, the relationship between total estimated IQ and total PEAK scores changed significantly (r = .11). For these participants, total PEAK scores had a higher variance than their IQ scores. This shows the differences between learners at a lower level. For the WPPSI-IV a participant who has a total raw score of 0 across the three subtest used in this study and a participant who has a total raw score of 5 across the three subtest used in this study both receive a total estimated IQ of 43. A more sensitive measure of intelligence would be beneficial for children with more severe intellectual disabilities.

After the pilot test of the RASC assessment, it was determined that it was not sensitive enough to show a correlation with PEAK and IQ. More research needs to be conducted on the RASC assessment to create a more reliable assessment procedure.

Implications

This study found that total estimated IQ scores have a strong positive correlation with PEAK scores. This finding replicates findings in previous studies that have evaluated the

correlation between PEAK and IQ. Researchers such as Dixon, Whiting, Rowsey, and Belisle (2014b) have suggested that the PEAK assessment and IQ test target several of the same skills. This means that these assessments will consistently yield similar results (Dixon et al., 2014b). Dixon, Belisle, and Stanley (2018) suggest that IQ and derived relational responding are related. They propose that IQ and derived relational responding are rooted in human language and cognition. The results of their study showed that individuals who performed better on IQ assessments also demonstrated higher levels of derived relational responding (Dixon et al., 2018).

When these data from the present study were visually inspected, it was noticed that the top five participant scores were outliers. When the top five performers scores were eliminated from the data, the correlations between total PEAK scores and total IQ estimates significantly weakened. This result shows that the IQ and PEAK still correlate. The participant scores that were included after the top five scores were eliminated showed low scores on PEAK E, PEAK T, and the IQ subtests. This further supports the research suggesting IQ and PEAK are related constructs.

Differences in intelligence and derived relational responding were difficult to detect in lower scores on the IQ and PEAK E and PEAK T assessments. Because of this, more sensitive measures are needed. Scattone, Raggio, and May (2012) discuss using multiple assessments when trying to calculate IQ for individuals with autism. In doing so, a more sensitive measure of IQ can be determined. This is especially beneficial for individuals who score low on IQ or other assessments. The RASC assessment was created to be a more sensitive measure of derived relational responding.

The RASC assessment was initially created to become a quantitative method to directly measure derived relational responding as a generalized operant. It was our goal for this measure to correlate with PEAK. If this method correlated with PEAK, it could be used to guide PEAK implementers on what the ability level of a particular child is, as well as, where to start the child in PEAK programming. It was thought that the RASC assessment would be a faster assessment tool that would be as reliable as the PEAK E and PEAK T preassessments at scoring a child's ability to derive relations.

The RASC assessment, however, seemed to be a less sensitive measure of derived relational responding. A floor effect was found in the scores for this assessment. A floor effect occurs when the questions are too difficult for the population of individuals being assessed. In this study, 18 of the 21 participants scored a 0 on this assessment. Two participants scored a 1 on this assessment. One participant scored a 4 on this assessment. Changes could be made on the RASC assessment to make it a more sensitive measure. Changing the stimuli that was used could be a possible solution. For example, complex animal combination stimuli could be changed to a basic symbol (i.e. @, #, or %). or a shape (i.e. trapezoid, pentagon, or chevron). Different procedures to train and test relations could also be used. Using the SPOP procedure to train relations and the MTS procedure to test relations could occur more times before discontinuing a relation, however, this will take more time to assess individuals.

Limitations

Although this study agrees with previous research conducted on the correlation between the PEAK Relational Training System and IQ, many limitations were found. One limitation of this present study was the number of participants assessed. In this study, the minimum number of

participants were assessed. Although we did assess the minimum number of participants, having a larger number of participants would better support the correlation between total estimated IQ scores, PEAK E, and PEAK T scores.

The second limitation of the present study was the age range of the participants. This study included participants between the ages of two years to six years. Some of these learners lacked prerequisite skills, such as sitting in a chair, attending to different materials, and pointing, that are required for the completion of these assessments. Assessing more participants who are above the age of six could potentially show correlations between total estimated IQ scores, PEAK E scores, and PEAK T scores for participants who receive higher scores on the assessments. Assessing children who score higher on PEAK and IQ using the RASC, could potentially show a positive correlation between these three assessments. This data would further support the idea to research and expand upon the method of obtaining the *d* coefficient.

The third limitation of the present study were the unwanted behaviors exhibited by the participants. Data from the participants who showed unwanted behaviors were included in this study. Final scores on the assessments might not accurately reflect the ability of the participant if the assessment was discontinued due to unwanted behavior instead of inaccurate responding.

The fourth limitation of the present study was that the IQ tests were implemented by trained graduate students. IQ test are usually only administered by licensed psychologists, however the results of the IQ tests were not disclosed to participant's family or used for any other purpose other than obtaining correlations between total estimated IQ scores, PEAK E scores, and PEAK T scores.

The fifth limitation of this present study in the high minimum IQ score for the participants. The WPPSI-IV subtests of Information, Matrix Reasoning, and Picture Memory

were used for all participants regardless of age. As discussed previously, a participant that scored a total of 0 for all three subtests used in this study and a participant that scored a total of 5 for all three subtest used in this study both received the same estimated IQ score of 43. This could be due to the subtests used, however, it still shows that the WPPSI-IV might not be an accurate measure for the participants included in this study.

The final limitation of the present study was the floor effect of the scores obtained on the RASC assessment. A floor effect occurs when most of the participants' scores fall near the bottom. This suggests that the directives could have been too difficult for the group of participants we assessed. Fluency as a measure included in the RASC assessment was unable to be graphed. This occurred because not enough of the participants mastered relations, causing a low number of data points. Because of this, we were unable to measure the decay of fluency across nodal distance.

Future Avenues of Research

Future avenues of research could include replicating the study with a larger and a higher age range of participants to determine if the assessment correlations would correspond to the correlations found in this study. Age classifications such as early learners, school aged, adolescents, etc. could be used to compare the correlations between IQ and PEAK assessments. This could show if stronger correlations occur within a particular age group. These data could also be displayed by looking at ranges of test scores. Researchers determine if there is a specific point in which the correlation between derived relational responding and IQ begin to deteriorate. These participants could also be assessed using the RASC assessment. Researchers could compare the results of the RASC in the same manner, looking to see if RASC scores show an

increasing correlation with IQ and PEAK as the age of the participants increase or as scores on the IQ and PEAK assessments increase.

A second avenue of future research could include replicating the study with participants who do not display unwanted behavior during testing and compare it to participant who do display unwanted behaviors during testing. Researchers determine if the correlations between IQ and PEAK differ between the two groups, potentially showing the negative affect unwanted behavior has on assessment scores.

A third avenue of future research could examine the differences in IQ scores using different tools that measure intelligence. Researchers could then determine the most sensitive measure of IQ and if different methods of determining IQ are more beneficial in certain populations.

Future research could also include creating a more sensitive version of the RASC assessment by creating different stimuli or using alternative procedures to implement the assessment. Scores from the new RASC assessment can be correlated with IQ and PEAK scores to determine if the new RASC assessment has a strong positive correlation with IQ and PEAK scores. This could help create a better assessment while combating floor effects found in the present study. These different research opportunities will better strengthen the hypothesis presented in this study.

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WPPSI (4-7)			WPPSI (4-7) scaled scores			Estimated IQ	PEAK		
Information	Matrix Reasoning	Picture Memory	Information	Matrix Reasoning	Picture Memory		Equivalence	Transformation	TOTAL
4	0	4	1	1	3	47	0	4	4
8	6	14	1	6	10	72	16	6	22
0	1	1	1	3	1	47	0	0	0
0	0	0	1	1	1	43	2	1	3
6	0	0	1	1	1	43	0	0	0
0	0	2	1	1	1	43	0	0	0
16	15	0	7	12	1	79	9	32	41
3	0	2	1	1	1	43	0	3	3
5	0	1	2	1	1	45	1	6	7
0	0	0	1	1	1	43	0	0	0
2	1	1	1	3	1	47	0	1	1
0	0	0	1	1	1	43	0	0	0
0	1	2	1	3	1	47	3	0	3
0	0	0	1	1	1	43	1	0	1
0	0	2	1	1	1	43	2	3	5
0	0	2	1	1	2	45	0	0	0
5	0	1	2	1	1	45	0	0	0
3	0	1	1	1	1	43	2	0	2
						59*	4	28	32
23	8	12	15	11	8	108	12	60	72
20	12	6	13	12	6	102	2	30	32

Table 1. Participant information and assessment scores

Participant	Age (years)	Gender	RASC							
			B1-A1	B2,3-A2,3	B1-C1	B2,3-C2,3	A1-C1	A2,3-C2,3	C2,3-A2,3	TOTAL	Average Fluency
1	4	M	0	0	0	0	0	0	0	0	0
2	5	M	2	1	1	0	0	0	0	1	21.41s
3	3	M	0	0	0	0	0	0	0	0	0
4	6	M	3	0	0	0	0	0	0	0	54.05s
5	5	M	1	0	0	0	0	0	0	0	8.00s
6	4	F	0	0	0	0	0	0	0	0	0
7	5	F	1	1	1	1	1	1	1	4	11.39s
8	5	M	0	0	0	0	0	0	0	0	0
9	4	M	1	0	0	0	0	0	0	0	23.90s
10	3	M	0	0	0	0	0	0	0	0	0
11	4	M	0	0	0	0	0	0	0	0	0
12	4	M	0	0	0	0	0	0	0	0	0
13	4	M	0	0	0	0	0	0	0	0	0
14	4	F	0	0	0	0	0	0	0	0	0
15	5	M	2	0	0	0	0	0	0	0	32.10s
16	3	F	0	0	0	0	0	0	0	0	0
17	3	M	0	0	0	0	0	0	0	0	0
18	3	M	0	0	0	0	0	0	0	0	0
19	3	M	0	0	0	0	0	0	0	0	0
20	4	F	1	1	0	0	0	0	0	1	7.36s
21	2	F	0	0	0	0	0	0	0	0	0

*This score was obtained using the PEAK Equivalence score

Table 2. Linear regression of total PEAK scores and total IQ scores

Best-fit values	
Slope	1.013
Y-intercept	43.62
X-intercept	-43.07
1/slope	0.9872
Std. Error	
Slope	0.08943
Y-intercept	1.843
95% Confidence Intervals	
Slope	0.8250 to 1.201
Y-intercept	39.75 to 47.50
X-intercept	-55.67 to -34.23
Goodness of Fit	
R squared	0.8769
Sy.x	7.252
Is slope significantly non-zero?	
F	128.3
DFn, DFd	1, 18
P value	<0.0001
Deviation from zero?	Significant
Equation	Y = 1.013*X + 43.62
Data	
Number of X values	21
Maximum number of Y replicates	1
Total number of values	20
Number of missing values	1

Table 3. Linear regression of total IQ scores and PEAK E scores

Best-fit values	
Slope	3.061
Y-intercept	45.9
X-intercept	-14.99
1/slope	0.3267
Std. Error	
Slope	0.7715
Y-intercept	3.888
95% Confidence Intervals	
Slope	1.440 to 4.682
Y-intercept	37.73 to 54.07
X-intercept	-34.96 to -8.650
Goodness of Fit	
R squared	0.4666
Sy.x	15.1
Is slope significantly non-zero?	
F	15.75
DFn, DFd	1, 18
P value	0.0009
Deviation from zero?	Significant
Equation	Y=3.061*X + 45.90
Data	
Number of X values	21
Maximum number of Y replicates	1
Total number of values	20
Number of missing values	1

Table 4. Linear regression of total IQ scores and PEAK T scores

Best-fit values	
Slope	1.202
Y-intercept	44.78
X-intercept	-37.26
1/slope	0.8321
Std. Error	
Slope	0.1156
Y-intercept	1.939
95% Confidence Intervals	
Slope	0.9590 to 1.445
Y-intercept	40.70 to 48.85
X-intercept	-49.04 to -29.26
Goodness of Fit	
R squared	0.8573
Sy.x	7.809
Is slope significantly non-zero?	
F	108.1
DFn, DFd	1, 18
P value	<0.0001
Deviation from zero?	Significant
Equation	Y = 1.202*X + 44.78
Data	
Number of X values	21
Maximum number of Y replicates	1
Total number of values	20
Number of missing values	1

Table 5. Linear regression of IQ scores and PEAK scores minus the top 5 scores

Best-fit values	
Slope	0.08696
Y-intercept	44.22
X-intercept	-508.5
1/slope	11.5
Std. Error	
Slope	0.2141
Y-intercept	5.937
95% Confidence Intervals	
Slope	-0.3723 to 0.5462
Y-intercept	42.94 to 45.49
X-intercept	-infinity to -79.40
Goodness of Fit	
R squared	0.0100
Sy.x	1.797
Is slope significantly non-zero?	
F	0.16
DFn, DFd	1, 14
P value	0.6908
Deviation from zero?	Not Significant
Equation	Y = 0.08696*X + 44.22
Data	
Number of X values	17
Maximum number of Y replicates	1
Total number of values	16
Number of missing values	1

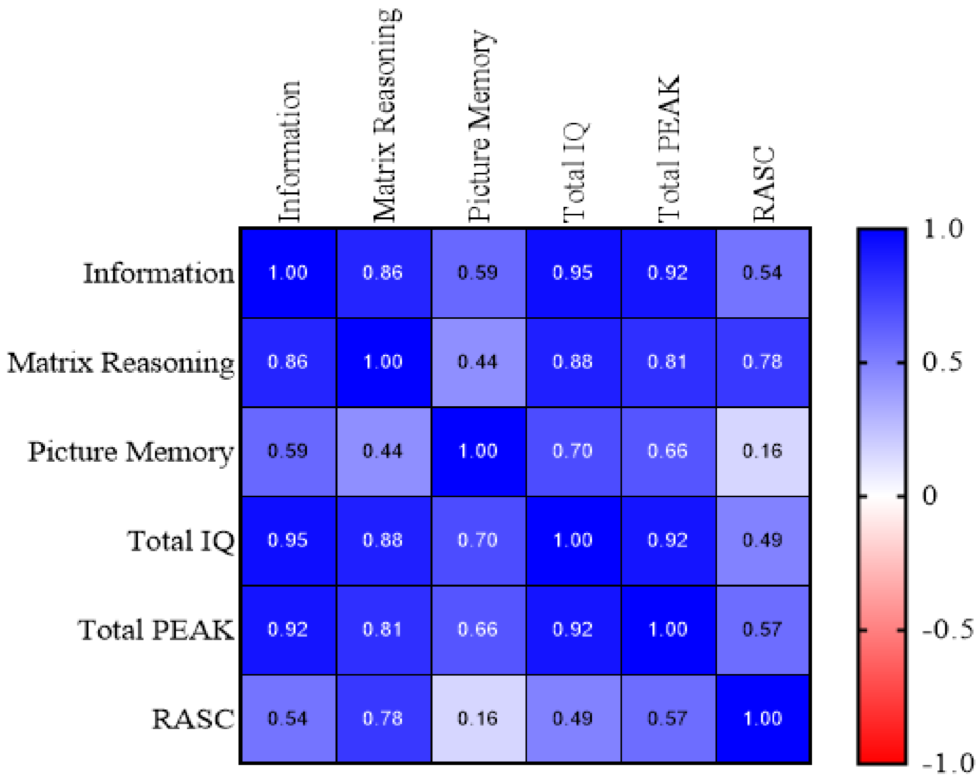

Figure 1. Pearson correlation matrix between all assessments

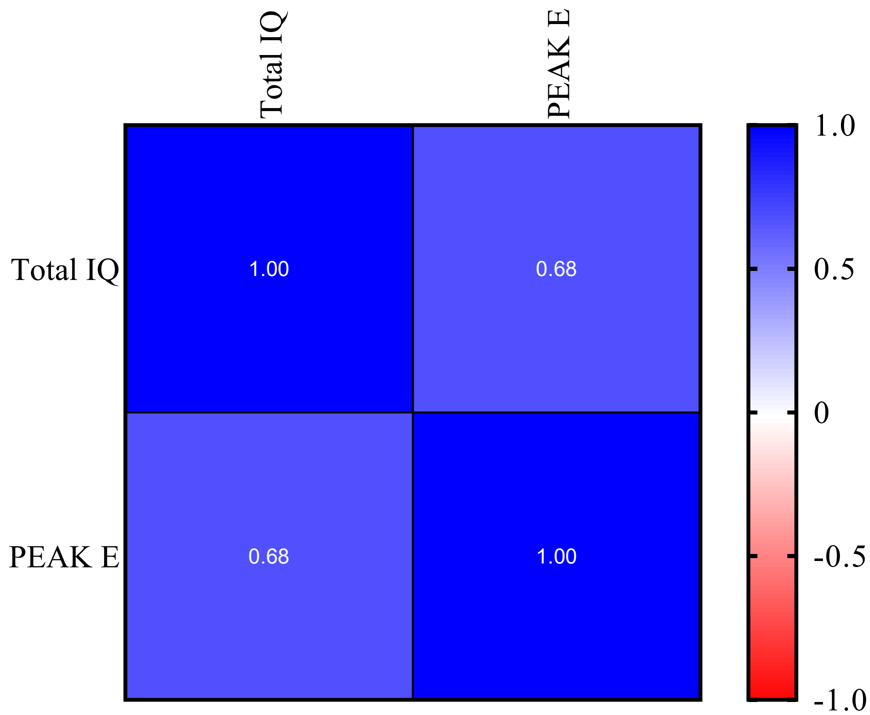

Figure 2. Pearson correlation matrix between total IQ and PEAK E

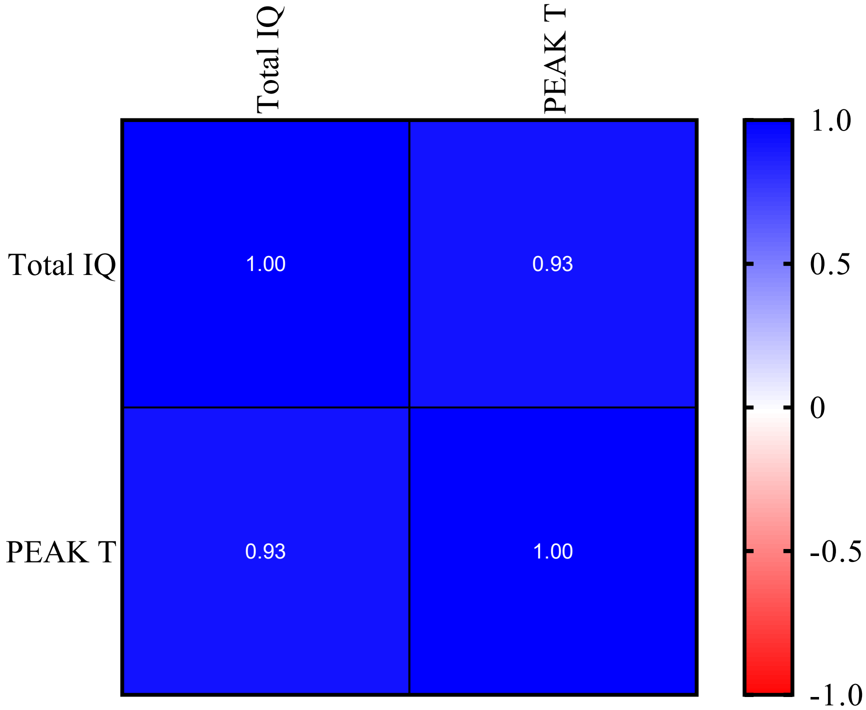

Figure 3. Pearson correlation matrix between total IQ and PEAK T

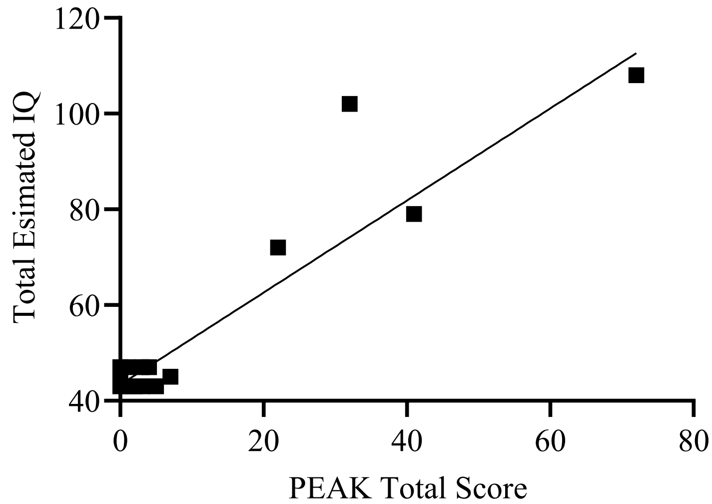

Figure 4. Graph of correlations between IQ and PEAK

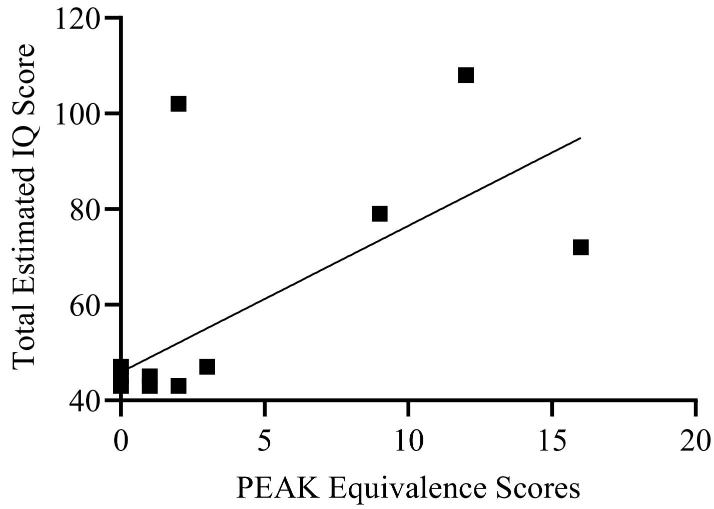

Figure 5. Graph of correlations between IQ and PEAK E

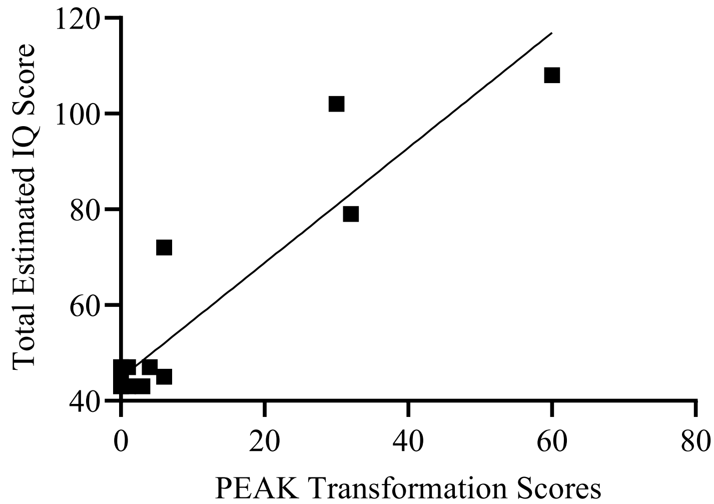

Figure 6. Graph of correlations between IQ and PEAK T

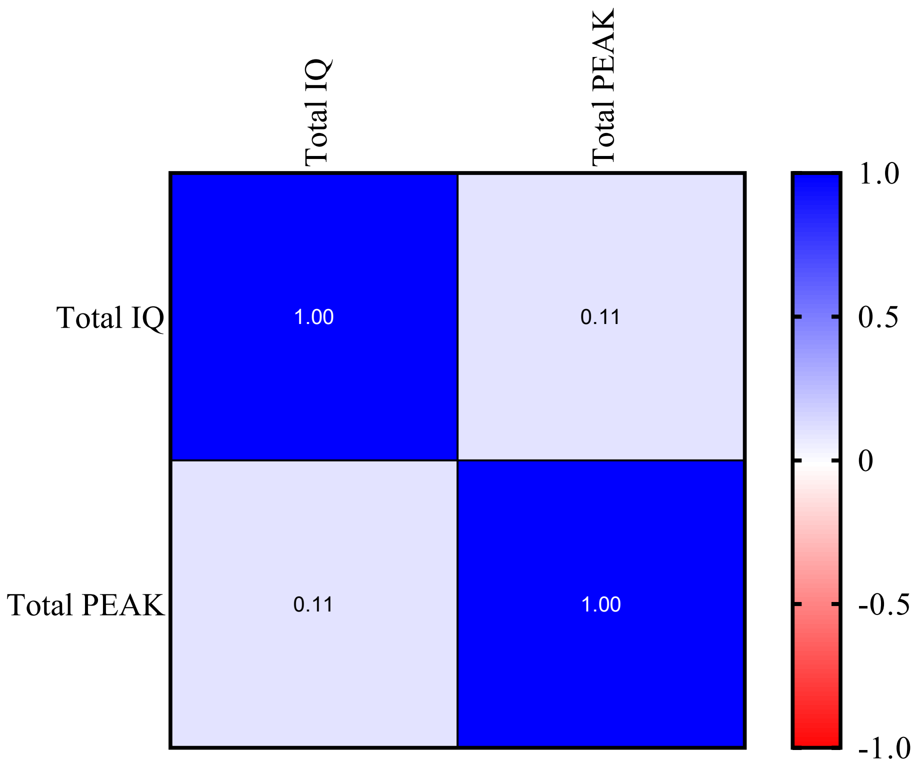

Figure 7. Pearson correlation matrix between IQ and PEAK minus the top 5 scores

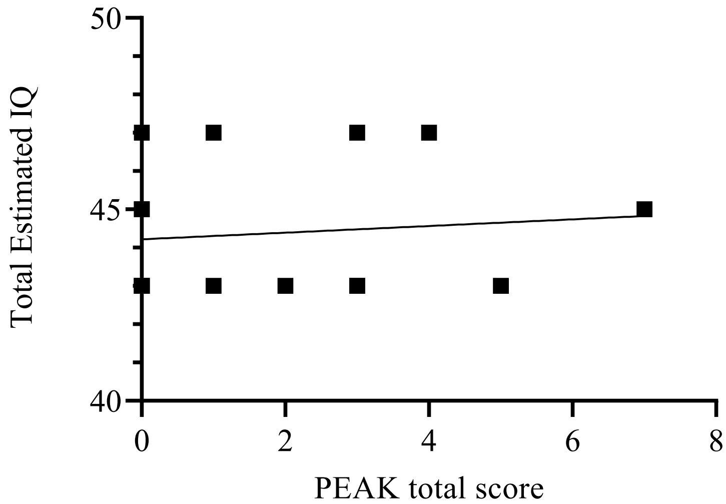

Figure 8. Graph of correlations between IQ and PEAK minus the top 5 scores

APPENDICES

Appendix A: Institutional Review Board Approval

Date: 4-29-2020

IRB #: IRB-FY2020-33
Title: Teaching Language and Cognition Skills to Children and Adolescents
Creation Date: 7-29-2019
End Date:
Status: Approved
Principal Investigator: Jordan Belisle
Review Board: MSU
Sponsor:

Study History

Submission Type	Initial	Review Type	Expedited	Decision	Approved
Submission Type	Modification	Review Type	Expedited	Decision	Approved
Submission Type	Modification	Review Type	Expedited	Decision	Approved
Submission Type	Modification	Review Type	Unassigned	Decision	

Key Study Contacts

Member	Jordan Belisle	Role	Principal Investigator	Contact jbelisle@missouristate.edu
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Initial Submission

Investigative Team

Who is the Principal Investigator?

1 *This individual will be required to certify the protocol for submission and will be responsible for the overall project and* ***MUST be a faculty or staff*** *member.*

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Who is the Primary Study Contact?

2 *This person, in addition to the Principal Investigator, will be included on all correspondence related to this project. This person may be the Principal Investigator or someone else* ***(faculty, staff, or student)****.*

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Will there be any Co-Principal Investigators participating in this study?

3. *Co-Principal Investigators will also be required to certify the protocol for submission and share overall responsibility with the Principal Investigator for the study. Co-Principal Investigators MUST be faculty or staff members.*

Yes

✓ No

Will there be any other individuals participating with the investigation?

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4 *These individuals will be participating as part of the research team, but will not need to certify the protocol submissions, or be included in any correspondence regarding the study. Typically these individuals will be students or individuals from other institutions. Investigators may be faculty, staff, students, or unaffiliated individuals.*

✓ Yes

Select the Investigator(s)

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No

General Information

1 What is the full title of the research protocol?

Teaching Language and Cognition Skills to Children and Adolescents

Abstract/Summary

Please provide a brief description of the project.

2 The purpose of the study is to evaluate instructional procedures designed to teach language and cognition skills to children and adolescents.
These procedures include the *Promoting the Emergence of Advanced Knowledge (PEAK): Relational Training System*, which is an assessment and curriculum that uses behavioral principles and techniques to teach basic to advanced language skills, and *Acceptance and Commitment Therapy (ACT) for Children with Autism and Emotional Challenges*, which is a language and cognition based therapeutic intervention incorporating mindfulness and behavior change techniques to help individuals learn how to stay in the present moment and identify as well as prioritize their values.

3 Are you requesting Single IRB Review

Single IRB Review is applicable to a study that is being reviewed by another Institution's IRB, in which you wish to rely on the external IRB for review, approval, and oversight.

Yes

✓ No

4 Does the study require review and oversight of the IRB?

Regardless of how these questions are answered, the determination of IRB review and oversight is made by the IRB and this study will still need to be submitted for preliminary review.

4A

Is this study a systematic investigation, following a predetermined plan, for looking at a particular issue, testing a hypothesis or research question, or developing a new theory that includes any of the following:

- Collection or analysis of quantitative or qualitative data
- Collection of data using surveys, testing or evaluation procedures, interviews, or focus groups
- Collection of data using experimental designs such as clinical trials
- Observation of individual or group behavior

✓ Yes

No

4B

Will this study contribute to generalizable knowledge, in that the purpose or intent of the project is to test or to develop scientific theories or hypotheses, or to draw conclusions that are intended to be applicable and/or shared beyond the populations or situations being studied? This may include one or more of the following:

- Presentation of the data at meetings, conferences, seminars, poster presentations, etc.
- The knowledge contributes to an already established body of knowledge
- Other investigators, scholars, and practitioners may benefit from this knowledge
- Publications including journals, papers, dissertations, and theses

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✓ Yes

No

4C

Will this study require obtaining information or biospecimens, through intervention or interaction with an individual that will be used, studied, or analyzed by the investigative team?

✓ Yes

No

Will you be requesting an Exempt Review for this study?

5

In order to qualify for review via exempt procedures, the research must not be greater than minimal risk and must fall into at least one of the exempt categories defined by federal regulations.

Yes

✓ No

6 Is this study receiving internal or external funding?

Yes

✓ No

Does this study contain protected health information (PHI)?

7

PHI is any information in a medical record or designated record set that can be used to identify an individual and that was created, used, or disclosed in the course of providing a health care service, such as a diagnosis or treatment.

Yes

✓ No

8 Has all IRB Human Research training been taken through CITI under Missouri State University?

✓ Yes

No

Research Protocol

Describe the proposed project in a manner that allows the IRB to gain a sense of the project including:

- The research questions and objectives,
- Key background literature (supportive and contradictory) with references, and
- The manner in which the proposed project will improve the understanding of the chosen topic.

1 The purpose of the study is to evaluate instructional procedures designed to teach language and cognition skills to children and adolescents.
These procedures include the *Promoting the Emergence of Advanced Knowledge (PEAK; Dixon, 2016): Relational Training System*, which is an assessment and curriculum that uses behavioral principles and techniques to teach basic to advanced language skills, and *Acceptance and Commitment Therapy (ACT) for Children with Autism and Emotional Challenges (Dixon & Paliliunas, 2018)*, which is a language and cognition based therapeutic intervention incorporating mindfulness and behavior change techniques to help individuals learn how to stay in the present moment and identify as well as prioritize their values. Both approaches seek to understand how language develops, and once developed, how language can influence behavioral flexibility. Research will take place on campus within research space dedicated to the primary investigator. Prior research on PEAK has demonstrated that the assessment tools contain convergent validity with measures of language and intellectual functioning (Dixon et al., 2014; Dixon, Belisle, et al., 2015), and that training guided by PEAK can lead to the acquisition of skills such as perspective taking (Belisle et al., 2016) and categorization (Dixon, Belisle, Stanley, et al., 2015). This research extends upon this work by evaluating PEAK in a better controlled laboratory setting on campus that contains on-going data monitoring and feedback, digital data recording, video monitoring, and physiological measures including heart rate and skin conductance during assessment and training. Research on ACT has also begun to show that this approach can intervene on the relationship between language and present moment awareness and values with children (Coyne et al., 2011). We are seeking to again extend this work by implementing ACT in a more rigorously controlled laboratory setting on campus.

2 Check all research activities that apply:

✓ Audio, video, digital, or image recordings

Biohazards (e.g., rDNA, infectious agents, select agents, toxins)

Biological sampling (other than blood)

Blood drawing

Class Protocol (or Program or Umbrella Protocol)

✓ Data, not publicly available

Data, publicly available

Deception

✓ Devices

Diet, exercise, or sleep modifications

Drugs or biologics

Focus groups

Intenet or email data collection

Materials that may be considered sensitive, offensive, threatening, or degrading

Non-invasive medical procedures

✓ Observation of participants

Oral history

Placebo

Record review

Specimen research

Surgical procedures

✓ Surveys, questionnaires, or interviews (one-on-one)

Surveys, questionnaires, or interviews (group)

Other

Describe the procedures and methods planned for carrying out the study. Make sure to include the following:

- Site selection,
- The procedures used to gain permission to carry out research at the selected sites(s),
- Data collection procedures, and
- An overview of the manner in which data will be analyzed.

Provide all information necessary for the IRB to be clear about all of the contact human participants will have with the project.

Subjects will be asked to participate in various language- and cognitive-based training/instructional activities and therapeutic exercises included in their instructional/treatment plans, as well as engage in preferred activities as a reward for doing so. As well, depending upon their age/ability level, they may be asked to complete surveys/questionnaires related to their instruction (attached).

3 Measurement will consist of standardized language assessments, data related to language and cognition skill acquisition, standardized measures of psychological health/flexibility and mindfulness, and any permanent products produced by participants' during their instruction. Language skill acquisition data typically involves daily or trial based recordings of response accuracy and prompt levels required. Language skills will be assessed both directly, using discrete trial training (presenting the individual with an instruction or question, providing praise/rewards for correct responses, and prompting incorrect responses), and indirectly, by having an adult familiar with the child/adolescent complete a checklist. Other measures will be gathered via questionnaires and surveys. (See attached for measurement instruments).

Direct observation/data collection will be collected during sessions by the behavior therapist/researcher working with the subject, and at some times, by a second researcher observing the session through a one-way mirror built in to the therapy room. Parent(s)/guardian(s) will be able to view the results of assessments by request.

Video/Audio taping will be used for treatment integrity and professional presentation. Separate written consent from subjects' guardians (see Request for Video/Audio Recording and Release of video recordings) will be obtained. The disposition of such recordings will include only the participant and instructor during applications of treatment materials or procedures. This will be done in order to allow for the review of procedural fidelity and reliability of recorded data. In some cases, audio/video recordings may be used in the professional presentations, such as training workshops or research symposiums. Only participants who have provided the additional consents (see audio/video consent and release) will be included in such presentations.

Attach tests, surveys, questionnaires, and other social-behavioral measurement tools, if applicable.

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4 Exemplar Survey Documents.pdf

PARTICIPANT INTAKE SURVEY.docx

5 Attach documentation of site permission, if applicable.

Participants

1 Specify the participant population(s).

Check all that apply.

- Adults
- ✓ Children (<18 years of age)
- Adults with decisional impairment
- Non-English speaking
- Student research pools (e.g. psychology)
- Pregnant women or fetuses
- Prisoners
- Unknown (e.g., secondary use of data/specimens, non-targeted surveys, program/class/umbrella protocols)

2 Specify the age(s) of the individuals who may participate in the research.

1 year through 17 years

3 Describe the characteristics of the proposed participants, and explain how the nature of the research requires/justifies their inclusion.

Children and adolescents (ages 1 through 17) whose parents and/or guardians have determined they would benefit from language and cognition based instructional procedures to develop or enhance their skills will be included in this study.

4 Provide the total number of participants (or number of participant records, specimens, etc.) for whom you are seeking IRB approval.

100

5 Describe what time commitment will be required from each participant, including individual interactions, total time commitment, and long-term follow-up, if any.

Participation in the study will take place for 1-2 hours / day and 2-5 days / week. The total length of intervention will vary across subjects, ranging from 1-week to 12-weeks depending on the intervention package developed to meet the specific needs of the subject.

6 Describe how potential participants will be identified (e.g., advertising, individuals known to investigator, record review, etc.). Explain how investigator(s) will gain access to this population, as applicable.

Subjects will be recruited from schools, ABA therapy providers, and parent referrals to a behavior analysis and therapy clinic operated by the Applied Behavior Analysis program within the Psychology Department at Missouri State University. Sites that work with potential participants will be contacted by the Primary Investigator via email (see Email Script) about the study. If the site responds to the email indicating their interest in providing information about the study to parents, then the site will be provided paper copies of the recruitment flyer (see Flyer) to provide directly to families. The flyer contains the contact information for the research team. Once contacted, the research team will set up an appointment on campus to discuss the research study with parents and complete and obtain informed consent from parents / guardians. Potential participants may be excluded if assessment results suggest participants may not benefit from participation in the study or if challenging behavior during the assessment or reported at intake indicates that the participant may fail to complete training sessions.

7 Describe the recruitment process; including the setting in which recruitment will take place.

Sites are encouraged to physically provide the recruitment flyer to families at the location where the families are receiving ABA services.

Attach recruitment materials (ads, flyers, website postings, recruitment letters, and oral/written scripts), if applicable .

Email Script - Agency.docx

FlyerPEAK.docx

8 Will participants receive compensation or other incentives (e.g., free services, cash payments, gift certificates, parking, classroom credit, travel reimbursement, etc.) to participate in the research study?

✓ Yes

Describe the incentive, including the amount and timing of all payments.

Participants may receive financial compensation for participating in the study. The compensated amount will be $10 per session to cover travel and parking expenses at the university. Therefore, the total compensation amount will be equal to $10 x number of sessions (e.g., 8 sessions = $80.00). We will track the number of sessions throughout the participation in the study. Participants will receive payment either at the end of the final session or after every 10 sessions (i.e., once compensation equals $100.00) if participation exceeds 10 sessions. There is no limit to the total number of sessions, as this will vary across potential participants. All potential participants will also receive a list of community resources that can provide further clinical services to the participants.

No

Risks and Benefits

1 Describe all reasonably expected risks, harms, and/or discomforts that may apply to the research. Discuss severity and likelihood of occurrence.

Consider the range of risks - physical, psychological, social, legal, and economic.

No risks are expected as a result of participation in this study.

2 Discuss the steps that will be taken to minimize risks and the likelihood of harm.

Consent from potential subject will be given before the start of the study. Subjects will be monitored while participating in the study to ensure that potential subjects are not exposed to any unnecessary risks. All procedures will take place in a private location within the therapeutic setting. Personal information will not be shared with anyone outside of the research team.

3 Describe the potential benefits that participants may expect as a result of this research study. State if there are no direct benefits to individual participants.

Participant may benefit from the study in a number of ways. First, all potential participants will be given a list of community resources at the intake session, even if they elect not to participate in the research study. This list may help families to contact services for their children. Second, by participating in the study, participants may acquire new language and cognitive skills or learn to contact the present moment and improve psychological health. Research suggests that improvement in these areas can lead to reductions in challenging behavior and overall gains in life quality.

4 Discuss any potential indirect benefits to future subjects, science, and society.

Indirect benefits include an improved understanding of assessment and treatment for children with- and without-disabilities. Results may guide the development of programming within applied settings (e.g., schools, health providers, ABA clinics).

Describe how risks to participants are reasonable when compared to the anticipated benefits to participants (if any) and teh importance of the knowledge that may
5 reasonably be expected to result.

Because there are no known risks and several potential benefits to the participant and society, risks are considered reasonable.

Informed Consent

1 From the list below, indicate how consent will be obtained for this study.

Check all that apply.

- Written/signed consent by the subject
- ✓ Written/signed consent (permission) for a minor by a Parent or Legal Guardian
- Written/signed consent by a Legally Authorized Representative (for adults incapable of consenting)
- Request for waiver of documentation of consent (verbal consent, anonymous surveys, etc.)
- Waiver of parental permission
- Waiver of consent (consent will not be obtained from subjects)

2 Describe the consent process including where and by whom the subjects will be approached, the plans to ensure the privacy of the subjects and the measures to ensure that subjects understand the nature of the study, its procedures, risks and benefits and that they freely grant their consent.

Once a potential subject has been identified, a solicitation letter will be given to the parent(s)/guardian(s) (see Research Information Letter) along with the Intake survey and other documents. If the guardian signs the letter with an indication that they would like to participate in the study, the researcher will then seek informed consent from the parent or guardian of the potential participant.

At that time, the consent form and aspects of the study will be reviewed with parent(s)/guardian(s).

Assent will also be obtained from any participant above the age of 5. Assent will be gained by approaching the participant with their instructor, therapist, or guardian, and explaining to them what the purpose of the study is. Expectations of participation (see assent form) will be explained and the participant will be told that they will be allowed to quit if they so choose.

Attach all consent and assent documents here:

[Consent for Video Release.docx]

Consent Video Recordings.docx

Research Letter.docx

Release of Liability Form.docx

Service Agreement Form.docx

Parent Guardian Consent Form.docx

Assent to Participate.docx

Data Collection

Missouri State University is committed to keeping data and information secure. Please review the Missouri Ste University Information Security Policies. Discuss you project with the MSU Information Security Office or your College's IT support staff if you have questions about how to handle your data appropriately.

1 **Statement of Principal Investigator Responsibility for Data**
The principal investigator of this study is responsible for the storage, oversight, and disposal of all data associated with this study. Data will not be disseminated without the explicit approval of the principal investigator, and identifying information associated with the data will not be shared.

✓ By checking this box, all personnel associated with this study understand and agree to the Statement of Principal Investigator Responsibility for Data.

2 How will the data for this study be collected/stored?

Check all that apply.

✓ Electronic storage format

On paper

Describe where the data will be stored (e.g., paper forms, flash drives or removable media, desktop or laptop computer, server, research storage area network, external

source) and describe the plan to ensure the security and confidentiality of the records (e.g., locked office, locked file cabinet, password-protected computer or files, encrypted data files, database limited to coded data, master list stored in separate location).

3

At minimum, physical data should always be secured by lock and key when stored. Electronic data should be stored on University secure servers whenever possible (Office 365 or other secure campus server). If data has to be stored off campus, the file should be encrypted and the device password protected. Additionally, any data to be shared outside the University network will require a SUDERS request be filed and approved. See https://mis.missouristate.edu/Central/suders/create

All data collected during the study will be stored on University secured servers (Office 365; Microsoft SharePoint). Paper documents will be scanned and secured on the secured server within 48 hours and will subsequently be destroyed. Only researchers affiliated with this project will have access to the server.

Describe how data will be disposed of and when disposal will occur.

4

At minimum, Federal regulations require research records to be retained for at least 3 years after the completion of the research (45 CFR 46). Research that involves identifiable health information is subject to HIPAA regulations, which require records to be retained for at least 6 years after a participant has signed an authorization. Finally, funded research projects may require longer retention periods, you may need to follow the sponsoring agency guidelines.

Paper documents will be shredded within 48 hours. All data contained on the server will be kept for 7 years, after which point it will be deleted from the server.

Additional Information

1 Please include any additional information about the study below.

N/A

2 Please include any additional documents that aren't covered within the application.

Appendix B: RASC Data Sheet

				%	Time
Test B1-A1 (up to 3 times, must get all 3 to move on)					
Test B1-A1					
Test B1-A1					
Test B2 & 3-A2 & 3					
Test B1-C1 (up to 3 times, must get all 3 to move on)					
Test B1-C1					
Test B1-C1					
Test B2 & 3-C2 &3					
Test A1-C1					
Test A2 & 3-C2 & 3					
Test C2 &3-A2 & 3					