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Evaluating the Maintenance of Verbal Relational Operants Following PEAK Programming

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EVALUATING THE MAINTENANCE OF VERBAL RELATIONAL OPERANTS FOLLOWING PEAK PROGRAMMING

A Master's Thesis

Presented to

The Graduate College of

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In Partial Fulfillment

Of the Requirements for the Degree

Master of Science, Behavior Analysis and Therapy

By

Jenna Huskey

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ABSTRACT

The Promoting the Emergence of Advanced Knowledge (PEAK) Relational Training System is an assessment and curriculum tool developed for basic and advanced language skills using behavior analytic approaches (Dixon, 2016). Maintenance describes the retention of performance following the progression of time. In the present study, the purpose was to determine if maintenance was achieved on previously mastered PEAK programs, both in terms of the content and the verbal relational operant (i.e., generalization to new, untrained content). De-identified data were analyzed for five autistic learners (six to fourteen years old) receiving ABA services at a Midwestern clinic. Programs were selected from the previous two months from when probes began. First, a mastery probe was conducted on the mastered stimuli from an initial program. Second, a probe with a novel set of stimuli was conducted. In cases where the participants did not show mastery of the content or the operant, relational training was conducted with the novel stimuli followed by testing with the novel and the original stimuli. Results showed that maintenance of program content was inconsistent and generalization to novel stimuli was not observed. However, faster acquisition rates were observed for retraining and reinstatement of prior learning was observed in some cases.

KEYWORDS: maintenance, generalization, verbal relational operants, PEAK relational training system, autism, renewal, probes, mastery criteria

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INTRODUCTION

Overview of Maintenance and Generalization

Maintenance refers to the continued ability of the learner to perform a behavior even after part or all an intervention has been removed (Cooper, Heron, & Heward, 2019). According to Cooper, Heron, & Howard (2019), maintenance in behavior analytic treatment is important for many reasons. First, maintenance is important in behavior analytic treatment because it indicates that the intervention or training has been effective not in just the short-term, but also the long-term. Next, maintenance is also important because it ensures that the behavior continues beyond the specific circumstances in which it was initially trained. Maintenance demonstrates that the behavior was generalized across different situations, settings, and times. Lastly, maintenance provides evidence that the individual has acquired the necessary skills to continue the behavior independently without the need for constant prompting or reinforcement.

Generalization in behavior analysis refers to the process by which a behavior learned in one situation or context occurs in other similar situations or contexts without direct training or intervention. There are several types of generalization: stimulus generalization, response generalization, setting generalization, and temporal generalization. Generalization of behavior change was included as one of the field's defining characteristics (Baer, Wolf, & Risley, 1968). Behavior change was said to have generalized if it lasted over time, occurred in many environments, or spread to related behaviors (Arnold-Saritepe et al., 2009). Therefore, maintenance can also be conceptualized as generalization across the dimension of time, or temporal generalization.

To test for maintenance of adaptive skills, skills must first be in a learner's repertoire at a given point in time that can be confirmed when a learner achieves a pre-established mastery criterion. The term "mastery criterion" refers to the predetermined level of proficiency that an individual must attain to demonstrate competence in a particular skill. Accuracy-based mastery criteria can be conceptualized as containing at least two dimensions: level of performance and frequency of observations at that level (Fuller & Fienup, 2017). Mastery criterion is determined by the clinician, practitioner, Board Certified Behavior Analyst (BCBA), or the appropriate individual. A mastery criterion based on accuracy is associated with several dimensions including the level of performance, such as a certain percentage correct, and the number of observations across which this level must be achieved, such as multiple sessions or days (Fuller & Fienup, 2017). Upon achieving "mastery", a period of "maintenance" ensues, which maybe involve: no further teaching, teaching less frequently, or conducting maintenance probes at various intervals to determine if additional teaching is necessary (McDougale et al., 2019). One study conducted by Love et al. (2009) sought to identify common practices of clinicians within the field of ABA. Researchers of the study distributed a 43-question internet survey to professional supervisors working in early intensive behavioral intervention programs with individuals diagnosed with autism. Researchers included several questions regarding strategies to promote skill acquisition, maintenance, and generalization. Results indicated that 98% of respondents reported including strategies to promote the maintenance and generalization of skills, which most often (50% of reported) consisted of reintroducing mastered targets in isolation or interspersed with other programs daily.

Richling et al. (2019) conducted an evaluation of maintenance following skill acquisition when applying different mastery criteria (i.e., 80%, 90%, and 100% correct across three sessions)

across skills with several individuals diagnosed with intellectual disabilities. Results showed that a mastery criterion of 80% correct across three sessions was not sufficient to promote maintenance. Additionally, a criterion of 90% correct across three sessions did not produce consistent maintenance. By contrast, results showed that a criterion of 100% accuracy across three sessions was the most effective for promoting maintenance following skill acquisition. Longino et al. (2021) replicated the Richling et al. (2019) study by evaluating the effects of three mastery criteria (80%, 90%, and 100% accuracy across three sessions) on maintenance of skills taught within a combined most-to-least and time-delay prompting hierarchy. Their findings replicated the results by demonstrating high levels of maintenance for skills assigned to the 100% accuracy across mastery criterion condition.

Another study did a systematic review over recent applied behavior-analytic research to identify commonly used mastery criteria, and the associated maintenance reported by investigators conducting skill-acquisition research (McDougale et al., 2019). Of the articles that included maintenance probes, 61% (n = 39) reported successful maintenance of the target skill at some point following mastery. While these articles focused on mastery criteria, it is important to understand which criterion is most effective to achieve maintenance. These articles suggest that having a mastery criterion of 90 percent or higher is most effective. This is only one of multiple possible forms of maintenance. Other forms of maintenance include maintenance of the skill, generalization of the skill, and maintenance of the operant. Evaluating these additional forms of maintenance was the primary purpose of the present study with respect to the PEAK relational training system.

PEAK Relational Training System

Verbal behavior and relational learning are examples of behaviors that are particularly important to maintain, especially in autistic learners. Promoting the Emergence of Advanced Knowledge (PEAK; Dixon 2014-2016) is a technology designed to promote verbal behavior and relational learning. PEAK consists of four modules, each including a separate 184-item referenced assessment and corresponding curriculum programs. The four PEAK modules are Direct Training, Generalization, Equivalence, and Transformation. PEAK Direct Training (PEAK-DT; Dixon, 2014a) teaches foundational language skills (i.e., tacts, echoics, mands, object permanence) like Skinner's (1957) verbal operants using direct reinforcement (Dixon et al., 2017a). PEAK Generalization (PEAK-G; Dixon, 2014b) uses a train-test methodology in which novel untrained stimuli are presented within embedded blocks of directly trained stimuli. This module is designed to promote stimulus and response generalization as an active process to establish and maintain skills in new and novel contexts (Dixon et al., 2017a). Lastly, PEAK Equivalence (PEAK-E; Dixon, 2015) and PEAK Transformation (PEAK-T; Dixon, 2016) offer a conceptually systematic approach that capitalizes on behavioral technologies derived from stimulus equivalence (Sidman, 1971) and Relational Frame Theory (Barnes-Holmes et al., 2001). The Equivalence module consists of four relations: reflexivity, symmetry, equivalence, and transformation. Transformation consists of six relational frames: coordination, comparison, discrimination, opposition, hierarchical, and deictic.

For individuals to master PEAK programs, they must meet a mastery criterion for each program. The PEAK books suggest a mastery criterion for programs. For PEAK programs, individuals need to meet a mastery criterion of 90 percent accuracy across three consecutive sessions. Other considerations can be made as well when determining mastery criteria based on clinical judgement. For PEAK-E and PEAK-T programs, individuals must meet mastery criteria

on each step of the program. Reed and Luiselli (2016) analyzed the extant literature on the PEAK-DTM. They state there is substantive research to support the PEAK-DTM and the relational training system's underlying constructs, psychometric properties, and intervention effectiveness. The authors state that the growing empirical support for PEAK's efficacy, usability, and psychometrics is impressive and provides a robust empirical basis for the system that is not described within the pages of the manual. The existing research on PEAK, however, is not without limitations. For example, Witts (2018) reviews the conclusions made by Reed and Luiselli (2016) and contend that many overrate the research that backs them. Witts advocates for skepticism of this research due to methodological shortcomings, hyperclaiming of results, and inappropriate statistical testing procedures. Belisle and Dixon (2019) identified 30 criticisms in Witts' review, responded to each, and argue that all but 2 (7%) contain untrue assumptions, (7, 23%), are not novel (5, 17%) are logically invalid (7, 23%), or are more appropriately framed as criticisms of applied behavior analytic research more generally (9, 30%). Lastly, they discussed all of Witts' criticism both specifically and broadly to illustrate that most of his suggestions about applied behavior analytic research may serve to hinder progress in a discipline moving toward larger-scale research. Since there is limited research on maintenance of PEAK outcomes, more research is needed.

While Reed and Luiselli (2016) and Witts (2018) focus only on the PEAK-DT module, Dixon et al. (2017a) focuses on the overall state of the PEAK research currently. Dixon et al. (2017a) conducted an internal and critical review of the PEAK Relational Training System for children with autism. The paper provides a comprehensive and critical review of peer-reviewed publications based on the entire PEAK system. The authors describe both psychometric and outcome research and indicate positive features and limitations. Overall, the findings support the

proposition that PEAK is worth considering as an alternative to autism intervention packages that have been available for longer and may be better known. Some of the packages have passionate adherents but little in the way of empirical support. Lastly, some studies have included individuals with more issues than autism. This further suggests that PEAK's utility may not be limited to one clinical population.

Ackley et al. (2019) sought to examine contemporary applied behavior analytic-based assessment and curriculum protocols for teaching language skills to children with autism and evaluate the evidence supporting their reliability, validity, and effectiveness. The authors looked at curriculums such as Early Start Denver Model, ABBLS-R, and PEAK to name a few. Results of the literature search reveled the existence of 18 ABA educational assessments and curriculum protocols. Only four of the protocols had any supporting the reliability and validity of their assessment tools, one of them being PEAK. Further research should look at examining the content validity of their assessment tools.

Padilla et al. (2022) presents the findings from a systematic review of the available reliability and validity evidence supporting the use of criterion-referenced assessments based on the applied behavior analysis framework. The authors also identified PEAK as one of the curriculums that identified reliability and validity. Seven PEAK studies presented reliability with four reporting inter-rater reliability alone, one reporting interrater reliability and internal consistency, and one reporting inter-rater reliability and test-retest reliability.

Rowsey, Belisle, and Dixon (2014) conducted a principal component analysis after administering the PEAK-DTM to 98 children with autism and other developmental disabilities. Results indicated that the PEAK-DTM represents four factors related to language and learning abilities: foundational learning skills; perceptual learning skills; verbal comprehensive skills; and

verbal reasoning, memory and mathematical skills. The authors viewed these findings as further empirical validation of an ABA-based instructional protocol.

Another study conducted by Rowsey et al. (2017) assessed the content validity and internal consistency of the PEAK Generalization Module (Dixon, 2014b). Eighty-four children with autism were evaluated using the PEAK Generalization Assessment to ascertain the presence or absence of 184 language and learning skills within the child's repertoire. Following the assessment, a principal component analysis was run yielding a four-component model of the PEAK Generalization Module. After all the analyses, the four components identified include the constructs of Foundational Learning and Basic Social Skills, Basic Verbal Comprehension, Memory, and Advanced Social Skills, Advanced Verbal Comprehension, Reading and Writing, and Basic Problem-Solving Skills, and Verbal Reasoning, Problem Solving, Logic, and Mathematical Skills. The present data provides support for a conceptually systematic behavior analytic approach to the treatment of children with autism.

One study looked at evaluating the efficacy of the PEAK relational training system using a randomized controlled trial of children with autism (McKeel et al., 2015a). They compared the pre and posttreatment PEAK assessment scores of children who received training using the PEAK curriculum versus the same scores obtained from a treatment-as-usual control group. Participants in the experimental group received additional language instruction derived from the curriculum programs of the PEAK-DT module. Participants in the control group received treatment as usual. Results indicate that a significant effect was observed between experimental groups on the change from pre to posttreatment. However, participants in the control group did not demonstrate significant gains. Some participants scored lower in the posttreatment. The data

supports the assertion that exposure to the curriculum portion of the PEAK-DT is functionally related to gains on the PEAK-DT assessment.

Additionally, Sutton et al. (2021) examined the relationships between the standardized applied behavior analysis (ABA) direct assessment, the PEAK Comprehensive Assessment (PCA), and established assessments commonly used in educational and clinical settings, including the Children Autism Rating Scale – Third Edition (CARS-3), the PDD Behavior Inventory (PDDBI), the Vineland Adaptive Behavior Scale – Second Edition (VABS-2), and intelligence, including the Wechsler Preschool and Primary Scale of Intelligence (WPPSI-IV), and the Wechsler Intelligence Scale for Children (WISC-V). The study found the PCA to be significantly correlated with the established measure. The results suggest evidence of convergent validity of the PCA, and internal consistency among its subtests.

Welch (2022) conducted a study creating programming using computerized discrete trial training programs on commonly used software. The purpose was to examine the relationship between pre and posttest scores of the PEAK Comprehensive Assessment (PCA) after the decrease in instructional time during the COVID-19 shutdown. Results from the PCA from before COVID-19 closures to those after the closure were analyzed to determine if students could continue to learn and improve in areas of language and academics. During the shutdown, students had a drastic decrease in instructional time as well as changes in implementation of programs. Therefore, only mastered programs were run with students instead of introducing new concepts to promote maintenance of learning outcomes.

Another study evaluated the effectiveness of five packaged protocols from the PEAK curriculum (McKeel et al., 2015b). The skills targeted included complex verbal operants such as autoclitics, metonymical tacts, tacting planet names, and guessing. Results suggest that the

PEAK methodology was effective in teaching each of the targeted skills to a mastery criterion, as well as maintenance of those skills at a 2-week follow-up phase.

Dixon et al. (2016) evaluated the efficacy of equivalence-based instruction (EBI) as described in the PEAK-E curriculum for promoting the emergence of derived geometry skills. Mastery criterion consisted of a minimum of five sessions at 100% correct responding. Results suggested that direct training of shape name (A) to shape property (B) was effect for the two participants. Following A-B training, both participants demonstrated emergent relations that are consistent with symmetry (B-A), as well as transitivity (A-C). The results also indicate that the mastery criterion picked for the intervention fit the skill and the purpose of the study.

Furthermore, another study taught basic perspective-taking tasks to children with autism and evaluated their ability to derive mutually entailed single-reversal deictic relations of the newly established perspective-taking skills (Belisle et al., 2016). The methods of the study were taken from the PEAK-T training curriculum, and results yielded positive gains for all 3 children to learn basic perspective taking as well as for 2 of the 3 to derive untrained single-reversal I relations following direct training of single-reversal You relations. Furthermore, all participants demonstrated a transfer of stimulus function to untrained stimuli after the single-reversal deictic relations had been mastered.

While these studies all suggest that PEAK instruction can lead to the mastery of target skills, and mastery is consistent with recommendations by Richling et al. (2019) and Longino et al. (2021) that 100% independent correct responding should be achieved, maintenance was not directly evaluated in these and several other studies. A limitation of the PEAK literature is that there are not many studies on maintenance of PEAK programming. Maintenance on PEAK literature is very important because the treatment should be effective for learners not just in the

short-term, but in the long-term. Maintenance on PEAK is also important because it ensures that the behavior continues beyond the circumstances in which it is initially trained.

Conceptualizing Skill Maintenance within PEAK Programming

Content Maintenance

Maintenance can be thought of as generalization across time or the resistance to change of behavior over time. The dimension of behavior most interested in maintaining is the resistance to change over time. This allows for generalization to occur across settings, people, and time without further training. In other words, maintenance of the operant allows for learning similar content over a shorter amount of time. One could consider it in terms of maintaining the content. One study conducted by Dixon et al. (2017b) explored the efficacy of three PEAK instructional protocols to produce response generalization across these verbal operant topographies. Specifically, it evaluated the feasibility of the PEAK Relational Training System's Generalization module (Dixon, 2014b) to teach and establish generalization of autoclitic mands, distorted tacts, and creative path finding in three children diagnosed with autism. Using a multiple-baseline design across behaviors, each participant was provided with differential reinforcement and a least-to-most prompting hierarchy for correct responses to a subset of stimuli, and responses to other similar stimulus sets were probed for emergent generalization. Following training, each participant successfully acquired the directly trained behaviors and demonstrated generalization to the nonreinforced test exemplars. This suggests that a manualized curriculum such as PEAK may have utility for promoting skill development and generalization for front line staff and caregivers of children with autism.

Generalized Maintenance

Maintenance can be thought of in terms of generalizing the content, or maintenance of learning as a process. One study conducted a time-delay procedure to teach three children with autism to ask the question "What's that?" when novel stimuli was presented during an instructional task (Taylor & Harris, 1995). Once the ability to ask the question was acquired, the children's ability to learn novel information by asking the question was assessed. The children were then taught to ask the question within a less structured context. Generalization was assessed in a different room, to a new person, and to novel stimuli. All the children learned to ask the question within the instructional context, while on a walk in the school building, and to request information about 3-D objects. This study indicates that children with autism can be taught to ask questions that lead to the acquisition of new information.

The testing strategy in the PEAK Generalization (PEAK-G; Dixon 2014b) is especially useful here. This module uses a train-test methodology in which novel untrained stimuli are presented within embedded blocks of directly trained stimuli.

Operant Maintenance

Maintenance can be thought of in terms of maintenance of the specific operant (i.e., learning similar content faster over time). A generalized operant refers to the behavior that has been learned in one situation or context but is then demonstrated in a different, but similar situation or context. Understanding generalized operants helps in studying how behaviors are learned, maintained, and spread across different contexts. Learning novel tasks more quickly would suggest the general operant maintained, even if the specific content did not.

Relational Frame Theory (RFT) offers one account of derived relational responding (Healy et al., 2000). A study conducted by Barnes-Holmes et al. (2004) constitutes the first attempt to generate repertoires of relational responding, as generalized operant behaviors, using interventions suggested by RFT. Three children (4-6 years old) were exposed to a basic problem-solving task that involved two or three identically sized paper coins to test and train patterns of relational responding in accordance with more-than and less-than. Interventions suggested by RFT, including training and testing across stimulus sets, were then successfully used to establish increasingly complex patters of relational responding in all three children. Generalization tests demonstrated that the relational responding successfully generalized to novel stimuli and to a novel experimenter. Additionally, the use of a non-contingent reinforcement condition for one participant, during which no improvement was made, together with contingency reversals for all children, indicated that the trained and test relational responding may be considered a form of generalized operant behavior. These finding lend positive support to RFT's approach to derived relational responding, and to the functional analysis of human language and cognition.

Dixon et al. (2021) conducted an empirical examination of derived relational responding as a generalized operant and concurrently evaluated the validity and efficacy of programs contained in the PEAK-Equivalence curriculum, replicated across 11 children with autism. A first study utilized a multiple-baseline across-skills experimental arrangement to determine the efficacy of equivalence-based instruction guided by PEAK-E. A total of 33 individualized skills were taught, and the subsequent emergence of untrained relations were tested. Mastery criterion was achieved for 29 of the 33 instructional targets. For 3 participants, results were again replicated with a novel set of stimuli. The second study evaluated the degree to which multiple-exemplar equivalence-based instruction led to the emergence of derived relational responding as

a generalized operant. Increases in derived relational responding using novel, untrained stimuli were only observed when multiple-exemplar equivalence-based instruction was introduced. These results provide support for derived relational responding as a generalized operant.

In terms of PEAK, maintenance of the specific operant is more important than maintaining the content. Maintenance of the skill may be achieved due to coincidence, or simply the memorization of the content without it being learned. Maintenance of the content may not always generalize across settings, which indicates further training needs to be conducted. Learning is the operant, and so it should strengthen as the learner progresses through PEAK. In other words, the learner is learning how to learn. Learning a novel set of stimuli should occur more quickly (i.e., in fewer trial blocks).

Renewal Maintenance

Behavioral Momentum Theory (BMT) is a concept within behavioral psychology that originated with Donald L. Thomas and others in the 1970s. BMT suggests that the effects of a history of reinforcement in a distinctive stimulus context are expressed as the behavioral equivalent of inertial mass, and are evident in resistance to disruption in that stimulus context rather than the ongoing rate of responding before disruption (Nevin, Mandell, & Atak, 1983). Basic research has also demonstrated that resistance to disruption can be increased by presenting reinforcers independently of the target response (Mace & Nevin, 2017). BMT is also concerned with the persistence of reinforced behavior during disruptions that reduce target responding, such as maintenance after treatment is discontinued or generalization to a new treatment setting (Mace & Nevin, 2017). Overall, BMT provides insights into how reinforcement history shapes the persistence and resistance to change of behaviors.

Renewal refers to a reappearance of extinguished responding that occurs with a change in the context in which extinction took place (Podlesnik & Shahan, 2009). In this case, new stimuli are introduced, so reinforcement is now made available again for the previous response, so the response renews in the repertoire without need for additional training or relearning.

Podlesnik et al. (2017) examined the relevance of basic and translational research to understanding the failures to maintain treatment gains across settings. The findings suggest treatment effects can become specific to the context in which the treatment was delivered. This also offers promising methods for systematically assessing the factors contributing to treatment maintenance and improving generalization of treatment gains across contexts.

By understanding these principles, behavior analysts can design more effective interventions to promote desired behaviors and reduce undesired ones in both clinical and everyday settings. These concepts would be important for skills within PEAK. It would not only promote a more effective intervention, but also would increase learning and desired behaviors and decrease the undesired behaviors. Additionally, content could potentially be learned faster and maintained for longer without further training.

The Present Study

The purpose of the present study was to evaluate the maintenance of verbal relational operants following mastered PEAK programs. This was achieved by analyzing if the skill was maintained, the operant was maintained, generalization of stimuli, and renewal on each mastered PEAK program for each participant. This study also determined which form of maintenance was most important when learning new skills in interventions, specifically the PEAK relational training system. This study could expand the literature on maintenance by bridging the gaps in

existing literature and pave avenues for future research. This study also adds to the importance of effective treatment in behavior analytic interventions. Final analyses for this study were conducted from de-identified data collected through the Institute for Dynamic Behavior Science and Missouri State University made available by the primary investigator of those studies (Appendix A).

METHODS

Participants and Setting

Final analyses for this study were conducted from de-identified data collected through the Institute for Dynamic Behavior Science and Missouri State University made available by the primary investigator of those studies (Appendix A). Data were analyzed across 5 children diagnosed with autism, each receiving ABA services at a Midwestern clinic. Harry was a seven-year-old boy and has received ABA services for 2 years and 11 months. He received 11.5 hours of services per week (4 sessions a week). On Harry's most recent PCA, he scored 40 out of 64 points on the Direct Training module. On the Generalization module, Harry scored 29 out of 64 points. Harry scored 2 points out of 24 on the Equivalence module. On the Transformation-Receptive subtest, he scored 11 out of 96 points. Lastly, on the Transformation-Expressive subtest, Harry scored 7 out of 96 points. His total score on the PCA was 89 out of 344 points. These scores indicates that training is recommended on each PEAK module. In addition, The PAS-BOS is used to help understand possible barriers to treatment regarding maladaptive behaviors. He scored 17 out of 60 points on both Autism Symptomology and Scale of Intervention on the PAS-BOS Summary. This indicates that Harry shows some characteristics of autism, and a moderate amount of ABA treatment is recommended.

Harrison was a six-year-old boy and has received ABA services for 1 year and 10 months. He received 6 hours of services per week (2 sessions a week). On Harrison's most recent PCA, he scored 37 out of 64 points on the Direct Training module. On the Generalization module, Harrison scored 22 out of 64 points. He scored 3 points out of 24 points on the Equivalence module. On the Transformation-Receptive subtest, Harrison scored 6 out of 96 points. Lastly, he

scored 7 out of 96 points on the Transformation-Receptive module. Harrison scored a total of 75 points out of 344 total points. Harrison's scores indicates that training is needed on all PEAK modules. Additionally, on the PAS-BOS his Total Frequency Score was 17 out of 60 points on Autism Symptomology. His Total Intensity Score was 7 out of 60 points on the Scale of Intervention. This indicates that Harrison shows some characteristics of autism, and an intensive amount of ABA treatment is recommended.

James was an eight-year-old boy and received ABA services for 2 years and 2 months. He received 15 hours of services per week (5 days a week; 4 at center and 1 in home). On James' most recent PCA, he scored 58 out of 64 points on the Direct Training module. James scored 51 out of 64 points on the Generalization module. On the Equivalence module, he scored 11 out of 24 points. James scored 68 out of 96 points on the Transformation-Receptive module. Lastly, he scored 58 out of 96 points on the Transformation-Expressive module. James scored 246 out of 344 points on the PCA. James' scores indicates that training on higher level PEAK programs is recommended. James' PAS-BOS summary indicates a Total Frequency Score of 21 out of 60 on Autism Symptomology. This indicates that James shows some characteristics of autism. He scored 21 out of 60 points on the Total Intensity Score for Scale of Intervention. This also indicates that a moderate amount of ABA treatment is recommended.

Liam was an eleven-year-old boy and has received ABA services for 1 year and four months. He received 15 hours of services per week (5 sessions a week). On Liam's most recent PCA, he scored 57 out of 64 points on the Direct Training module. He scored 40 out of 64 points on the Generalization module. On the Equivalence module, Liam scored 9 out of 24 points. He scored 30 out of 96 points on the Transformation-Receptive subtest. Lastly, he scored 15 out of 96 points on the Transformation-Expressive subtest. Liam scored 151 out of 344 points total on

the PCA. These scores indicate that minimal training is recommended on the Direct Training module. Moderate training is recommended on the Generalization module. Lastly, training is recommended on the Equivalence and Transformation modules.

Noah was a fourteen-year-old boy and has received ABA services for 2 years and five months. He also received 15 hours of services per week (5 sessions a week). On Noah's most recent PCA, he scored 60 out of 64 points on the Direct Training module. He scored 57 out of 64 points on the Generalization module. On the Equivalence module, Noah scored 20 out of 24 points. He scored 46 out of 96 points on the Transformation-Receptive subtest. Lastly, Noah scored 44 out of 96 points on the Transformation-Expressive subtest. In total, he scored 227 out of 344 points. This indicates that training is recommended on higher level PEAK programming. On the PAS-BOS, Noah scored 12 out of 60 points on the Total Frequency Score for Autism Symptomology. This indicates that Noah shows some characteristics of autism. He also scored 12 out of 60 points on the Total Intensity Score for Scale of Intervention, which indicates a moderate amount of ABA treatment is recommended. Each participant already had a research release form in their intake packets upon inclusion of the study.

This study took place at the Midwestern autism clinic. Each participant received ABA services at this clinic. All probes were run during their sessions in center. The maintenance probes were run additionally to their normal programming during their weekly sessions. This study took place over a six-month period. For the first three months, probes were conducted only with Harry. This was to modify procedures as needed before including more participants to the study. The following three months all five participants participated in the study. Four Registered Behavior Technicians (RBT) that worked at the clinic were also trained on the study to run probes with participants.

PEAK Materials

Mastered PEAK programs were selected from the previous two months when probes were run. Programs were selected from each PEAK module. Participants varied on what level of PEAK programming they were on, so some participants did not have mastered programs from each module. The previously mastered stimuli were pulled from the stimuli library at the center. New, novel stimuli was made in addition to each program. Programs sheets were printed, and the mastered and novel stimuli were written on each one. Stimuli cards were numbered according to the program sheet.

Dependent Variables

Maintaining the skill was measured by the total number of trials blocks to mastery. Generalization was determined by whether training was needed on the novel probes. Maintaining the operant was determined by if the novel stimuli was mastered more quickly than the initial mastered stimuli. Lastly, renewal was measured by whether the score improved.

Procedure

First, two mastered programs were randomly selected for each participant at a time. A mastery probe was run on the initial mastered stimuli of the mastered program. The participant scored a 10 if answered correctly, or a 0 if incorrect. A score was collected, and no further training was done on the mastered stimuli, even if the score did not meet mastery criterion.

Following the mastery probe, a novel probe was run on the new, novel stimuli. If the participant scored 90 percent or greater, the program was considered mastered again, and no further training was conducted. If the participant scored less than 90 percent, training was then

conducted on the novel stimuli. The program was trained per the program sheet until mastery criteria was met (90 percent accuracy across three consecutive sessions). Scores had to meet mastery criterion on each step if the program had multiple steps. Once mastery was met, the old set was tested, or a second mastery probe, was run again to test for renewal by seeing if they score improved from the initial mastery probe. Only two programs were trained at a time so that the participant's regular programming was still being conducted during their session. Once a program was mastered, it was removed from the participant's binder and replaced with the next probe.

The goal was to run both probes and train, if necessary, in every session the participant's had each week. If both probes could not be conducted due to problem behaviors, time, or other goals that needed attention, technicians would make time for them in the next session.

Data Analysis

Maintenance of the skill was determined by the mastery probe percentages and if the scores met mastery criteria. Generalization was determined if training was conducted on the novel stimuli. Maintenance of the operant was determined if the time it took to train the novel stimuli was shorter than the initial set. Finally, renewal was determined if the score improved on the mastery probes. To understand each component of maintenance, scores and the number of trial blocks to mastery were considered for each program. The first question asked was did they maintain the skill? If the participant scored 90 percent or greater, the answer was yes. If the participant scored lower than 90, the answer was no. The second question asked was did the participant do it without any training, or did it generalize? If the novel stimuli needed training, the answer was no. If the participant met mastery criteria on the novel probe, the answer was yes.

The third question was did the participants maintain the operant, or did they master the novel stimuli more quickly than the mastered stimuli. If the participants mastered the novel stimuli more quickly, the answer was yes. If they took longer to master the novel stimuli, the answer was no. Finally, the last question was once they learned the new stimuli, did they then show renewal? This was determined by comparing the initial mastery probe to the second mastery probe. The design used in this study was a multiple baseline across participants with embedded probes.

A chi-square was conducted to determine if two categorical variables were related or independent of each other. This helps to understand if the observed data differs significantly from the expected data. By comparing the two datasets, conclusions can be drawn about whether the variables have a meaningful association. Final analyses for this study were conducted from de-identified data collected through the Institute for Dynamic Behavior Science and Missouri State University made available by the primary investigator of those studies (Appendix A).

RESULTS

Final analyses for this study were conducted from de-identified data collected through the Institute for Dynamic Behavior Science and Missouri State University made available by the primary investigator of those studies (Appendix A). The results of the study are shown in Table 1 and Figures 1 and 2. There were a total of 42 mastered programs that were probed. Appendix B shows the PEAK programs that were probed and separated by participant. Harry had 15 programs probed, Harrison had 2 programs probed, James and Noah had 11 programs probed, and Liam had 3 programs probed. For maintenance of the skill, Harry maintained 6 of his programs, while 9 of them were not maintained. Harrison maintained both of his programs that were probed. James maintained 8 of his programs, and 3 of them were not maintained. Liam maintained 2 programs, and 1 was not maintained. Lastly, Noah maintained 4 of his programs, and 7 of his programs were not maintained. In total, 22 programs were maintained for the skill across participants, and 20 programs were not maintained.

For generalization, Harry generalized 3 of his programs, and 12 of them were not generalized. Harrison had no generalized programs, resulting in 2 programs that did not generalize. James had 6 generalized programs and 5 programs that did not generalize. Liam generalized 1 program, and 2 programs were not generalized. Noah had 5 programs generalized, and 6 were not generalized. For the programs that did not generalize, that mean that further training was conducted on those programs. In total, 15 programs were generalized across participants, and 27 programs were not generalized.

For maintenance of the operant, Harry maintained 8 programs and did not maintain 7 programs. Harrison maintained 1 program and did not maintain 1 program. James and Noah both

maintained 10 programs, while not maintaining 1 program. Liam maintained 3 programs and had 0 programs for not maintained. In total, 32 programs were maintained across participants, and 10 were not maintained.

Lastly, for renewal, Harry showed renewal on 11 programs and 1 program did not show renewal. Harrison and Liam both showed renewal on 1 program, and then 0 programs did not show renewal. James did not show renewal on any of his programs. Noah showed renewal on 3 programs and 0 programs did not show renewal. In total, 16 programs showed renewal and 1 program did not show renewal. Programs that were either generalized or mastered again indicated not applicable (N/A) and was deducted from the total number of programs for renewal.

Figure 1 displays the components of maintenance for each participant, and then the aggregate numbers. This is where the questions previously mentioned were answered as a yes or no. When applicable, the question of renewal was answered as not applicable (N/A) due to the programs being mastered again or they were generalized. The Y-axis represents the total number of yes and nos. In this analysis, it was determined that maintenance of the operant and renewal were the top two in importance. For each participant, maintenance of the operant was more apparent than not maintaining the operant. Every participant apart from James showed renewal as well. While maintenance of the skill and generalization varied with each participant, the aggregate number indicates a higher level of maintenance of the skill, and a lower level of generalization. The results indicate a chi-square score of 24.0421 and a p-value of 0.000024, suggesting statistically significant results.

According to Figure 2, the average number of trial blocks to mastery decreased from the initial to novel set. The average initial mastery trial blocks were 15.772 and the novel mastery trial blocks had a mean of 7.214. Each participant also showed a decrease in average trial blocks

from the initial set to novel set. For Harry, the average mastery trials decreased from 21.5 to 8.8 trial blocks. To make note, one program specifically (T4A) went from 135 trial blocks on the initial mastered set to 1 trial block on the novel set (mastered the novel probe). Harrison's averages decreased from 16.5 to 8.5 trial blocks. James's averages decreased from 6.36 to 3.27 trial blocks. For Liam, there was a decrease in average trial blocks from 24 to 11.7. Lastly, for Noah, he had a decrease in average trial blocks from 10.5 to 3.8 trial blocks. Although some programs required further training, the average number of trials blocks decreased from the total number of trial blocks to each participant. A paired sample t-test was conducted for the average trial blocks to mastery. The results of the t-test for the five participants were $p = .008947$, suggesting statistically significant results.

Table 1 displays each maintenance component for each PEAK program for all five participants. There are several important things to note. For maintenance of the skill, only 52% of programs were maintained. 36% of the programs showed generalization. For maintenance of the operant, 76% of programs were maintained. Lastly, 70% of programs showed renewal. Note: if programs displayed N/A, those programs were subtracted from the total number of mastered programs. Programs that did not show renewal may be due to several factors. First, renewal scores did not improve from the initial mastery probe to the final mastery probe after training of the novel stimuli. Some scores were either equivalent or decreased, or programs were mastered on the novel probe, therefore no further training was conducted. Programs that were not generalized were due to those programs needing further training. If the skill was not maintained, that was due to the participant scoring lower than 90% on the mastery probe. If the operant was maintained, that indicates that the program was trained in a shorter amount of time than the initial set.

DISCUSSION

Final analyses for this study were conducted from de-identified data collected through the Institute for Dynamic Behavior Science and Missouri State University made available by the primary investigator of those studies (Appendix A). The purpose of the present study was to evaluate the maintenance of verbal relational operants following mastered PEAK programs. The study looked at four types of maintenance: skill, generalization, operant, and renewal. The results display a high percentage of greater than 70 percent on maintenance of the operant and renewal in total. Four of the five participants had high scores in renewal. Additionally, all five participants had high numbers in operant maintenance. This supports that maintenance of programming is important in behavior analytic procedures and that it is effective.

These results extend on the kinds of maintenance shown in prior PEAK studies (Welch, 2022; McKeel, 2015b; Dixon, 2017b). It not only extends on the maintenance of content, but it also further extends to operant maintenance, generalization, and renewal as well.

The results of this study also show support for the concepts of relational responding as a generalized operant and for response renewal as a behavioral principle. Relational responding as a generalized operant refers to the ability to respond to stimuli based on their relationships with other stimuli. There is evidence of this in the results of the study with all five participants. This is evident due to the 32 of the 42 programs maintained. Response renewal, again, is when the behavior reappears in a different context or after a period. This was evident as well with four participants. This contributes to how to better understand how behaviors are learned, maintained, and reappear in different contexts or settings.

Implications of the study shows strengths of PEAK interventions and directions for next targets. This supports several reviews done on the PEAK curriculum (Dixon et al., 2017a; Reed & Luiselli, 2016; Witts, 2018; Belisle & Dixon, 2019). Additionally, the study displays the importance of testing for maintenance. Maintenance supports the validity of treatment interventions such as PEAK. This is evident that 76% of programs showed operant maintenance. This also extends the literature on derived relational responding as a generalized operant (Barnes-Holmes et al., 2004; Dixon et al., 2021). Another implication of the study is that this introduces new, and potentially more important ways to test skill maintenance. Sometimes, the content is not what is more important. Other times, it might be expected that the skill generalizes and expand without additional training. Sometimes, learning as an operant is more important. Lastly, one might want the behavior to occur at one point in time and renew when necessary.

There are a few limitations of the study. First, the sample size was small. Only 5 participants were included in the study. Ideally, every client who uses PEAK at this Midwestern clinic should have been included. While data did show statistical significance for only having 5 participants, having more participants included in the study would have stronger data. Additionally, the outcomes are variable across participants. This suggests that it likely varies from subject to subject. More participants in the study would also give more conclusive data on the outcomes.

Secondly, was there was no experimental manipulation. Since this was an active service setting, it is unknown what conditions would better support the different types of maintenance. Additionally, since there was no control group, it is also unknown if the initial training was needed to meet the mastery and generalization criteria.

Another limitation of the study is the number of sessions per week. Harrison had the least number of sessions per week with only two sessions a week, each 2 hours long. This makes it more difficult to train programming and see stronger results. Harrison also had the most cancelled sessions out of the rest of the participants. Furthermore, another limitation is the time between programming. For reference, Harry had programs pulled from the initial two months at the beginning of the study, but no more programs were probed for previous months due to the time it took to train programs. Additionally, not every mastered program in the participant's repertoire was not including in the study.

Future research should go beyond these extensions. Future research should look at each form of generalization and how they should be better operationalized. This could be done by using a different procedure to test for maintenance. This could also be done by creating an intervention with new data and not using only preexisting data. Future research should compare how different training strategies and probe strategies support different forms of generalization. To do this, programs could be set up and use different training strategies to test the different types of maintenance. Then, if different types of training strategies are being used, new probe strategies can also be made that fits them. Additionally, future research should determine if those different forms of generalization are interdependent or dependent. In other words, does supporting one form also support the other. To test for these different types of generalization, testing could be conducted one form without the other and compare results. The types of generalization could be interchanged with one another and once again, compare results. Lastly, future research could determine how to streamline testing for this type of generalization at an organizational level. This could be done by creating a technology that flags programs that need

to be tested for maintenance. Additionally, the program could flag programs after a certain about of time (i.e., every 2 months).

In summary, this study looked at the four types of maintenance using previously mastered PEAK programs with 5 autistic children. This was done by running mastery and novel probes on the mastered PEAK programs across all modules. Although results were variable across participants, results support the need for maintenance and the importance of testing for maintenance in behavior analytic interventions. The current study adds to the body of literature aimed to examine maintenance and the validity of PEAK interventions on those diagnosed with autism.

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Table

Table 1. Complete Maintenance Components Across All Participants

Program	Maintain Skill	Generalization	Maintain Operant	Renewal
DT9A	YES	NO	NO	YES
DT10D	YES	NO	NO	YES
DT10G	YES	NO	NO	YES
DT10Q	NO	NO	YES	YES
DT11F	YES	YES	YES	N/A
DT11J	NO	NO	YES	YES
DT11K	NO	NO	NO	YES
DT11M	NO	NO	NO	YES
DT12S	NO	NO	YES	YES
DT12V	YES	NO	YES	NO
DT14F	NO	NO	YES	NO
DT14V	YES	YES	YES	N/A
G6J	YES	YES	YES	N/A
G8N	YES	NO	YES	N/A
G10I	YES	NO	NO	NO
G11B	YES	YES	YES	N/A
G12J	NO	NO	NO	YES
G12L	YES	YES	YES	N/A
G12Q	YES	NO	YES	N/A
G12S	NO	NO	YES	N/A

Table 1. Complete Maintenance Components Across All Participants Continued

Program	Maintain Skill	Generalization	Maintain Operant	Renewal
G13N	NO	NO	YES	N/A
E6C	YES	NO	YES	YES
E7B	YES	NO	NO	NA
E8A	NO	NO	YES	YES
E10L	NO	NO	YES	NO
E10R	YES	NO	YES	NO
E11A	NO	NO	YES	YES
E11B	NO	NO	NO	NA
E11F	YES	YES	YES	N/A
E11H	NO	NO	YES	YES
E11I	YES	NO	YES	YES
E11J	NO	NO	YES	YES
E11K	YES	NO	NO	YES
E12B	NO	YES	YES	N/A
T4A	NO	YES	YES	N/A
T5D	YES	YES	YES	N/A
T7A	YES	YES	YES	N/A
T7L	NO	YES	YES	N/A
T8H	NO	YES	YES	N/A
T9E	NO	YES	YES	N/A
T9J	YES	YES	YES	N/A

Table 1. Complete Maintenance Components Across All Participants Continued

Program	Maintain Skill	Generalization	Maintain Operant	Renewal
T10O	YES	YES	YES	N/A

Figures

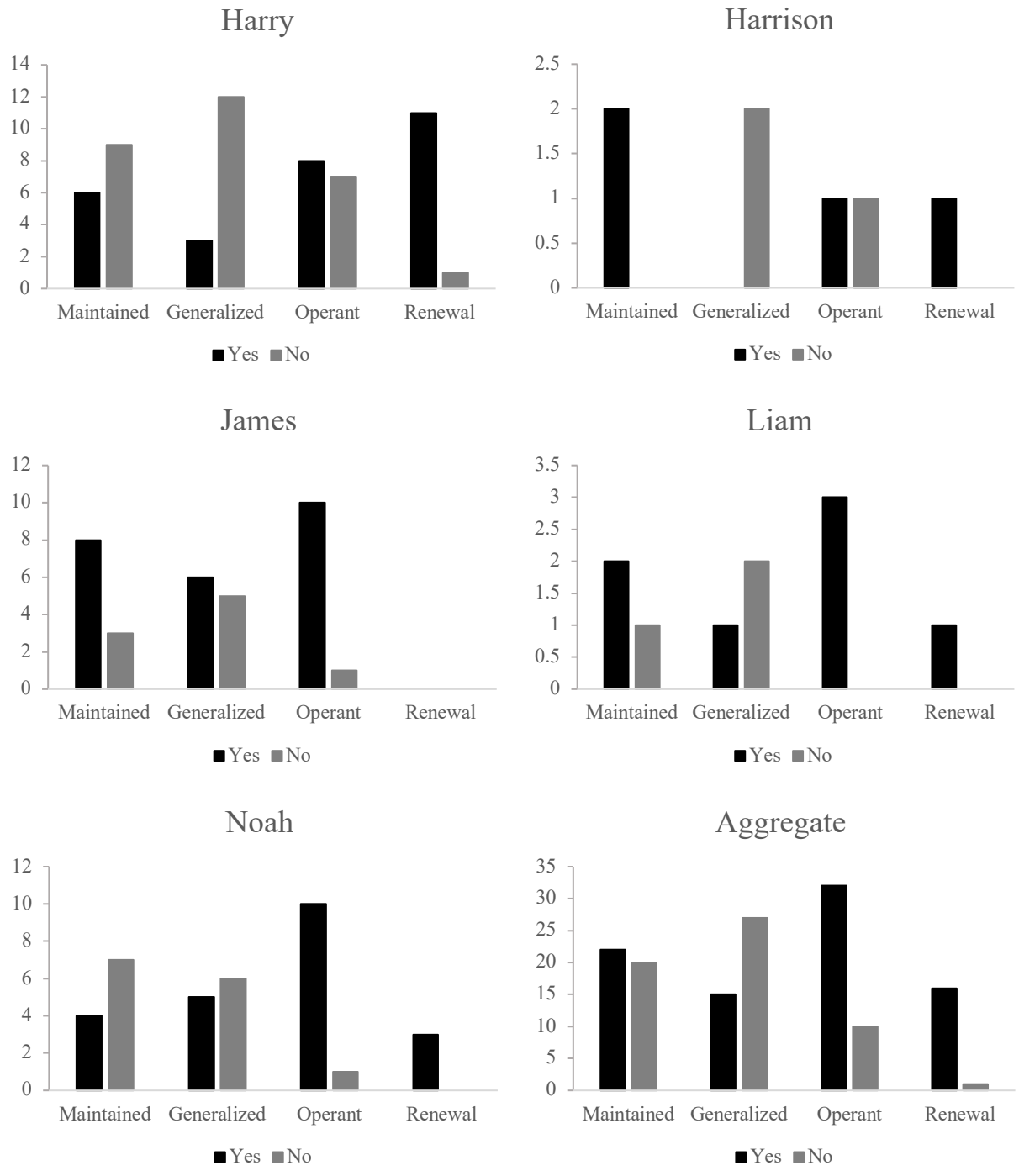

Figure 1. Analysis of Maintenance Components

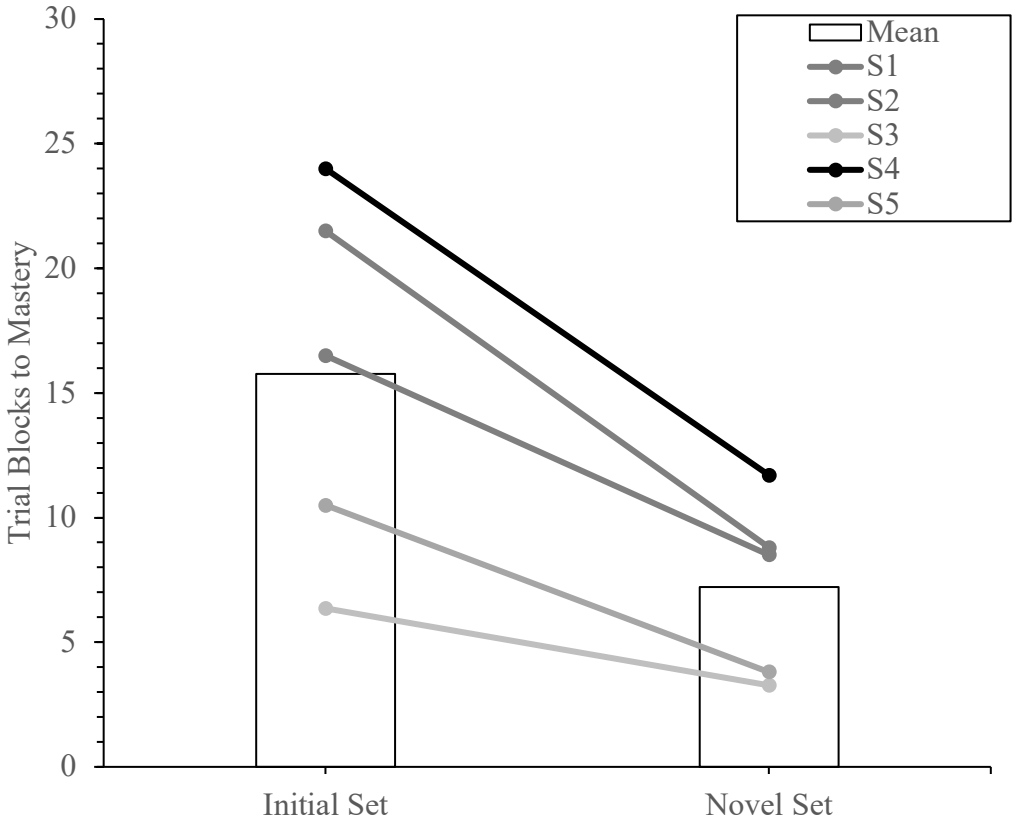

Figure 2. Average Trial Blocks to Mastery

APPENDICES

Appendix A. IRB Approval

The studies were conducted consistent with the below IRB approval:

To:
Jordan Belisle
Psychology

RE: Notice of IRB Approval
Submission Type: Initial
Study #: IRB-FY2019-576
Study Title: Evaluating the Efficacy of the PEAK Relational Training System in Active Clinical Settings - Existing Data
Decision: Approved

Approval Date: March 18, 2019
Expiration Date: --

This submission has been approved by the Missouri State University Institutional Review Board (IRB) for the period indicated.

Federal regulations require that all research be reviewed at least annually. It is the Principal Investigator's responsibility to submit for renewal and obtain approval before the expiration date. You may not continue any research activity beyond the expiration date without IRB approval. Failure to receive approval for continuation before the expiration date will result in automatic termination of the approval for this study on the expiration date.

You are required to obtain IRB approval for any changes to any aspect of this study before they can be implemented. Should any adverse event or unanticipated problem involving risks to subjects or others occur it must be reported immediately to the IRB.

This study was reviewed in accordance with federal regulations governing human subjects research, including those found at 45 CFR 46 (Common Rule), 45 CFR 164 (HIPAA), 21 CFR 50 & 56 (FDA), and 40 CFR 26 (EPA), where applicable.

Appendix B. PEAK Maintenance Probes

Table 1: Maintenance Probes for Harry

Direct Training	Generalization	Equivalence	Transformation
DT9A: Receptively Label Body Parts DT10D: Receptively Label Toy Functions DT10G: Receptively Label Community Helpers DT10Q: Tact Community Helpers DT11J: Intraverbal: Functions DT11K: Intraverbal: Class DT11M: Tact Values of Coins DT12S: Tact Item Class	G12J: Tact Seasons by Activity G12S: Exclusion: Function	E11F: Equivalence: Letter Case & Sounds E11J: Equivalence: Seasons Information E11K: Equivalence: Seasons Information	T4A: DIS: Textual Discrimination T5D: DIS: Differing Quantities

Table 2: Maintenance Probes for Harrison

Direct Training	Generalization	Equivalence	Transformation
N/A	N/A	E6C: Symmetry: Clothing Names E7B: Symmetry: Cause and Effect	N/A

Table 3: Participant 3 Maintenance Probes

Direct Training	Generalization	Equivalence	Transformation
DT12V: Tact Community Signs DT14F: Math Intraverbals DT14V: Collateral Responses	G6J: Identifying Solecistic Tacts G10I: Basic Punctuation G11B: Picture Sequences with Delay	E10L: Equivalence: Feature Rules E10R: Equivalence: Symbolism	T7A: HIR: Two Properties T7L: OPP: Cultural to Non-Arbitrary (Nouns) T10O: DIS: Exclusion by Function

Table 4: Participant 4 Maintenance Probes

Direct Training	Generalization	Equivalence	Transformation
DT11F: Delayed Picture Identification	G8N: Letter Sounds in Words	E8A: Symmetry: Stimulus Abstraction	N/A

Table 5: Participant 5 Maintenance Probes

Direct Training	Generalization	Equivalence	Transformation
N/A	G12L: Delayed Receptive Picture ID G12Q: Textual: Picture Puzzles G13N: Logic Problems and Riddles	E11A: Equivalence: Metaphorical Emotions E11B: Equivalence: Telling Time E11H: Equivalence: Days of the Week E11I: Equivalence: Months E12B: Equivalence: Addition	T8H: DIS: Cultural to Non-Arbitrary (Function) T9E: DIS: Cultural to Non-Arbitrary (Space) T9J: COR: Favorite Seasons