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THE EFFECTIVENESS OF THE PEAK RELATIONAL TRAINING SYSTEM AND CORRESPONDING CHANGES ON THE VB-MAPP FOR YOUNG ADULTS WITH AUTISM

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The current investigation sought to extend prior research evaluating the use of the PEAK Relational Training System as a comprehensive treatment model in improving language skills demonstrated by individuals with autism. Baseline PEAK-Direct Training and Verbal Behavior Milestone Assessment and Placement Program (VB-MAPP) assessments were conducted across 3 adult male participants, and scores on the PEAK-Direct Training assessment were used to select targets for intervention. Language instruction guided by the PEAK-Direct Training module was implemented for 45 to 69 days across participants. Results suggest that participants mastered target skills throughout the training phase, and VB-MAPP test probes showed an increasing trend. Follow-up probes suggested that scores on the VB-MAPP maintained when training was discontinued. In addition, participants demonstrated an increase in assessment scores on the PEAK-Direct Training assessment in the follow-up phase, including the mastery of untargeted verbal skills.

Key words: autism, language, PEAK, VB-MAPP, verbal behavior

Applied behavior analytic (ABA) approaches to decreasing challenging behavior and promoting skill acquisition are the most implemented and empirically supported treatment for children with autism (Reichow, 2012), and when intervention is early and intensive, can lead to clinically significant increases in intelligence, language, daily living skills, and social skills (Virués-Ortega, 2010). Although ABA approaches are most frequently researched when conducted with children (Peters-Scheffer, Didden, Korzilius, & Sturmey, 2011), there are examples of research supporting applications with adult learners with autism (Baker, Valenzuela, & Wieseler, 2005; Rehfeldt & Chambers, 2003). Challenges experienced by adults with autism differ somewhat topographically from the challenges experienced by children (Matson, Benavidez, Compton, Paclawskyj, & Baglio, 1996) but are nonetheless socially valid targets for behavioral intervention. Given the rise in prevalence of autism over the past decade (Elsabbagh et al., 2012), it follows that there will be a corresponding increase in the number of adults with autism that require ABA services. With increased demand, there is a need to ensure ABA approaches are accessible and target common deficits experienced by this population (i.e., social communication deficits and restricted/repetitive behaviors; American Psychiatric Association, 2013). Packaged comprehensive treatment models (CTMs) may have utility in serving a greater demand for autism intervention with adult clients. CTMs are often published as "branded" protocols (Odom, Boyd, Hall, & Hume, 2014; Rogers & Vismara, 2008) that target a broad skill area (e.g., language, adaptive behavior), in contrast to focused intervention strategies that target only a single skill (e.g., tacting, functional

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communication; Odom, Boyd, Hall, & Hume, 2010; Odom, Collet-Klingenberg, Rogers, & Hatton, 2010). Currently, there are several publicly available ABA-based CTMs, and empirical data supporting the effectiveness of CTMs in developing broader skill domains are starting to emerge (Dawson et al., 2012; Fulton, Eapen, Crncec, Walter, & Rogers, 2014).

Treatment models that target language and communication skills often use an assessment-to-treatment approach (Gould, Dixon, Najdowski, Smith, & Tarbox, 2011), and both single-case and between-group research have established that this approach can lead to targeted skill acquisition (Lorah et al., 2013; McKeel, Dixon, Daar, Rowsey, & Szekely, 2015). In this approach, assessments are used to identify specific skill-deficient areas (e.g., tacting colors, receptively labeling animals), and ABA approaches are prescribed (e.g., discrete trial training [DTT], incidental teaching) that directly target identified skill deficits. In single-case evaluations, successful outcomes are demonstrated when participants demonstrate mastery of the target skill or several target skills. In between-group evaluations, successful outcomes are demonstrated when participants master several target skills relative to a control group or condition (e.g., McKeel, Dixon, et al., 2015). Both single-case and between-group evaluations have limitations. Single-case research often lacks the appropriate sample size to describe the generality of obtained outcomes; this, however, may be achieved when relatively larger groups are used in between-group research. Between-group research often reports only group averages and thus fails to account for changes over time; by contrast these changes are revealed in studies relying on single-case designs (O'Donohue & Ferguson, 2006; Perone, 1999). Both single-case and between-group evaluations are likely necessary to account for the limitations of each.

Several language assessments and curricula are available for ABA service providers and consumers that are theoretically grounded in a Skinnerian approach to language development (e.g., Assessment of Basic Language and Learning Skills – Revised, ABLLS-R, Partington, 2006; Verbal Behavior Milestones Assessment and Placement Program, VB-MAPP, Sundberg, 2008; PEAK Direct Training Module, PEAK-DT, Dixon, 2014a) first described in Skinner's book, *Verbal Behavior* (1957). Research on the use of Skinner's approach to develop elementary forms of verbal operant behavior is considerable (Dixon, Small, & Rosales, 2007; Dymond, O'Hora, Whelan, & O'Donovan, 2006), and research into the development of more complex verbal behavior is starting to emerge (McKeel, Rowsey, Belisle, Dixon, & Szekely, 2015; Ribeiro, Miguel, & Goyos, 2015); however, most of this research has implemented focused intervention strategies, and although this research may serve as the evidence-basis for CTMs, research on CTMs as comprehensive protocols must be conducted for the CTMs to be considered evidence-based.

One CTM that is grounded in Skinner's verbal behavior theory and has gained preliminary empirical support is the PEAK-DT (Dixon, 2014a). This module contains a 184-item criterion-referenced assessment (PEAK-DTA; Dixon, 2014a) of participants' abilities across several topographies of elementary as well as complex forms of verbal operant behavior (Dixon, Whiting, & Daar, 2014). A caregiver familiar with the learner can indirectly conduct the assessment, or a caregiver or other assessor can directly conduct the assessment by delivering discriminative stimuli consistent with each item and recording the participant's response. Initial items are designed to assess prelearning skills, such as maintaining eye contact, minimizing gross-motor movement, and displaying behavior consistent with object permanence. Subsequent items emphasize receptive and expressive forms of elementary verbal operant responses, such as tacts and mands. Finally, assessment items at the end of the assessment

provide a measure of more complex verbal operant behavior, such as autoclitics, metonymical tacts, and displays of audience control. The topographies of operant skills across all assessment items include socially valid intervention targets (e.g., tacting community helpers, manding for preferred items), which were guided by the Common Core State Standards in the United States (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). Research following the publication of the PEAK-DTA has supported the construct validity of the assessment (Dixon, Belisle, Whiting, & Rowsey, 2014; Dixon, Stanley, Belisle, & Rowsey, 2016; Rowsey, Belisle, & Dixon, 2015), and correlations have been reported between the PEAK-DTA and measures of school readiness (Dixon, Carman, et al., 2014), vocabulary (McKeel, Rowsey, Dixon, & Daar, 2015), and intelligence (Dixon, Whiting, Rowsey, & Belisle, 2014). In addition to the PEAK-DTA, PEAK-DT contains a 184-program curriculum that directly targets skills identified in the PEAK-DTA (Dixon, Whiting, & Daar, 2014).

The instructions of the PEAK-DT prescribe a DTT approach, in which the instructor delivers one or multiple discriminative stimuli and, contingent upon the appropriateness of the participant response, provides reinforcement or implements individualized prompting strategies. This approach is considered a *Direct Training* approach because target skills are directly reinforced when emitted, and training is conducted until a mastery criterion is achieved. Through PEAK-DT, learners progress through increasingly complex verbal operant skills guided by the PEAK-DTA. Prior research has supported the effectiveness of the procedures described in PEAK-DT in teaching target skills in single-case evaluations (Dixon, Belisle, Munoz, Stanley, & Rowsey, 2017; McKeel, Rowsey, Belisle, et al., 2015) as well as in a randomized controlled evaluation (McKeel, Dixon, et al., 2015). Results reported by McKeel, Rowsey, Belisle, et al. (2015) showed that the procedures described in PEAK-DT were efficacious in teaching two children with autism to correctly demonstrate basic autoclitics, receptive metonymical tacting, and expressive identification of planet names, and one child with autism receptive metonymical tacting, expressive metonymical tacting, and guessing. Dixon et al. (2017) extended upon these findings by showing that participants can also learn to tact the private events of others metaphorically by observing a rival-model undergoing PEAK-DT instruction. Although these studies support the use of procedures described in PEAK-DT to establish these seven skills, support of PEAK-DT as a CTM would require that: (a) the entire assessment-to-treatment model prescribed in PEAK-DT was implemented (i.e., the assessment is used to select target skills for intervention), and (b) broader domains of skill acquisition were demonstrated, rather than merely the acquisition of single skill targets. A first evaluation of PEAK-DT as a comprehensive assessment-to-treatment package was conducted by McKeel, Dixon, et al. (2015) who used a randomized controlled trial experimental design. Following 1 month of PEAK-DT training, participants in the experimental group (N = 14) demonstrated significantly greater skill acquisition compared to that of a randomized control group (N = 13), as measured using pre- and posttest evaluations of performance on the PEAK-DTA. A first limitation in this study is common among RCTs in general, in that baseline performance was not evaluated using repeated measures, and naturally occurring skill acquisition trends could not be ascertained. A second limitation specific to the McKeel, Dixon et al. study was that only the PEAK-DTA was used as a measure of treatment outcome. Although psychometric evaluations of the PEAK-DTA support its validity as a measure of comprehensive language development, and test–retest evaluations absent intervention suggest that scores are unlikely to

increase within 1 month (Dixon et al., 2016), PEAK-DT instruction is designed to train to the PEAK-DTA. Increases in other measures of verbal operant development would provide greater confidence in the comprehensive effectiveness of PEAK-DT as a CTM for individuals with autism. A final limitation to both single-case evaluations as well as the RCT is that these studies were conducted either exclusively with children with autism (Dixon, Belisle, Munoz et al., 2017; McKeel, Rowsey, Belisle, et al., 2015), or with both children and young adults aggregated into the sample (McKeel, Dixon, et al., 2015), so the degree to which the obtained results are generalizable in application with adult learners is not well known.

An alternative to the PEAK-DTA as a measure of treatment outcomes is the *Verbal Behavior Milestones Assessment and Placement Program* (VB-MAPP; Sundberg, 2008). Like the PEAK-DTA, the VB-MAPP is a criterion-referenced assessment of participants' verbal operant development from a Skinnerian framework. The assessment contains 170 items and is frequently used to assess the language skills of participants in behavior analytic research prior to intervention (e.g., Geiger, LeBlanc, Dillon, & Bates, 2010; Lorah et al., 2013). Each of the items are categorized based on the (a) verbal operant category (e.g., tacts, mands) and (b) level of complexity (Sundberg, 2008). For example, Level 1 Tact items involve tacting up to 10 items, and Level 2 Tact items involve tacting up to 200 nouns and/or verbs. Unlike the PEAK-DTA, the VB-MAPP does not specify socially relevant topographies of verbal responding, rather provides a metric of the overall number of responses that a learner can emit. Prior research in which the PEAK-DTA and VB-MAPP were conducted with both children and adults with autism has suggested that there is a strong, significant correlation between participant scores on the PEAK-DTA and scores on the VB-MAPP (Dixon et al., 2015). Because of the conceptual similarities between these two assessments and their strong relationship, improvements in participant scores on the VB-MAPP as an ancillary measure to improvements on the PEAK-DTA following PEAK-DT instruction may provide greater confidence in the use of PEAK-DT as a CTM with this population.

Therefore, the purpose of the current investigation was to extend the results of previous research supporting the use of PEAK-DT as a CTM in application with individuals with autism. There were two primary goals in the investigation. First, using a single-case experimental design, we sought to replicate the results reported by McKeel, Dixon, et al. (2015) in application with adults with autism. The ages of the participants in the McKeel, Dixon, et al. study ranged from 7 to 21, whereas the current sample was composed of a more age-homogenous adult sample. In addition, replication in a single-case design may increase confidence in the findings reported by McKeel, Dixon, et al. due to limitations in group-design research. Specifically, the single-case experimental design in the current study that allowed for an analysis of how skills were mastered throughout the study over time, and staggering the introduction of PEAK instruction which reduced the possibility that confounding variables co-occur with the introduction of training, had an influence on the obtained results. Second, we sought to extend prior research by periodically probing participant performance on the VB-MAPP throughout the investigation to evaluate the degree to which mastery of target skills corresponded with changes in participant scores on the VB-MAPP. The VB-MAPP, like the PEAK-DTA, provides a metric of verbal operant development, but differences in the construction and delivery of the assessment allow for a greater demonstration of comprehensive language learning if ancillary increases in VB-MAPP scores are observed along with increases in PEAK-DTA scores.

METHOD

Participants and Setting

Three adult male participants with autism who attended a specialized day program in the Midwestern United States took part in the study. Ronald was 19 years of age, Frank was 21 years of age, and Bernard was 21 years of age. Each participant attended the specialized day program due to frequent and intense challenging behaviors as well as impaired intellectual and adaptive functioning. Challenging behavior frequently emitted by the participants included: self-injurious behavior (Ronald), elopement (Frank), and verbal outbursts (Bernard). Challenging-behavior reduction strategies were being implemented with the participants; however, these strategies were not directly implemented during assessment or training sessions. PEAK-DTA scores were obtained for Ronald, Frank, and Bernard, who achieved scores of 4 (e.g., holding hands still on command, modeling play), 15 (e.g., vocal imitation, following two-step directions), and 18 (e.g., vocally imitating words, simple drawing imitation), respectively. Each of these scores fell within assessment performance expected of a typically developing 3-4-year-old according to normative data reported by Dixon, Belisle, et al. (2014). The estimated age range for all participants was consistent with the recommended typical-age language functioning suggested for the application of the VB-MAPP (Sundberg, 2008). None of the participants were receiving ABA services guided by the PEAK Relational Training System, nor any other behavioral language training CTM at the time of the study.

Assessments and PEAK-DT training sessions were conducted at the day program that the participants attended. The study was conducted each day that the participants attended, and session duration ranged from 30 min to 1 hr each day. Assessment and training sessions were conducted in a classroom at the agency. The classroom was 3.7 m x 3.7 m and contained 4 tables and 12 chairs. No other participants, clients, or staff were in the classroom during assessment or training sessions. For all assessment and training sessions, the experimenter sat at a table directly across from the participant.

Materials

PEAK Direct Training Assessment (PEAK-DTA). The PEAK-DTA is a 184-item criterion referenced assessment of elementary as well as complex forms of verbal operant behavior. The assessment provides a list of each of the 184 items, as well as a description of the target skill. The direct assessment provides an evaluation of the participant's ability to demonstrate the target skill under direct testing conditions. Each skill is directly assessed in 10-trial blocks, during which the assessor presents the target conditional discriminative stimuli (e.g., the assessor shows the participant a picture of a bird, and asks, "What animal is this?") and then provides 3 to 5 s for a participant response. No prompts or preferred items are provided contingent on correct responding during the assessment. If the participant demonstrates 80% or greater correct responding in a trial block, then the skill is considered mastered. For both assessment methods, mastered skills are summed for a PEAK-DTA Total Score, ranging from 0 to 184. Correct skills are indicated in descending alphanumeric order on the PEAK-DT performance matrix (see Supporting Information) and used to select programs for instruction using the PEAK-DT curriculum.

Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP). The VB-MAPP Milestones assessment is a 170-item criterion-referenced assessment of elementary forms of verbal operant behavior. The assessment is subdivided based on the type of elementary verbal operant behavior (e.g., tacts and mands) as well as levels denoting the complexity of target behaviors within each level (i.e., Levels 1, 2, and 3). The verbal operant

categories within each level contain five items, and the categories and items increase in complexity within and across levels. Participants can achieve a score of 0 (unable to demonstrate mastery), ½ (partially demonstrates mastery), or 1 (able to demonstrate mastery) on each assessment item as indicated by the scoring guidelines provided for each item in the assessment. There are four assessment methods used in conducting the VB-MAPP, including formal testing (i.e., direct testing), observation, a combination of observation and formal testing, or timed observation. Suggested materials for each item on the VB-MAPP are provided in the instructions section, and include common stimuli available in agencies serving individuals with disabilities.

PEAK Direct Training. The PEAK-DT curriculum guided training contains 184 programs, each corresponding directly to a skill on the PEAK-DTA. Programs selected from the curriculum are individualized for each participant, as guided by the PEAK-DT performance matrix. In the performance matrix, earlier developmental skills are located at the top of the triangle (see Supporting Information), and programs increase in complexity in descending alphanumeric order (e.g., 1A, 1B, 2A, … 14Z). Based on the performance matrix, unmastered programs are added to a participants' curriculum in increasing complexity. Each program contains a description of the target skill (corresponding to the description in the PEAK-DTA), a list of required materials, instructions for implementers describing how to conduct the program, and a list of typical stimuli used for each program. Specific stimuli are recommended rather than required so that stimuli can be individually selected for each participant. In addition, each program provides implementers with space to record the stimuli used in training, as well as the option to introduce new stimuli when skills are mastered. An example of the description, materials, instructions, and typical stimuli used to guide training is provided in Supporting Information. The experimenter kept preferred stimuli on the table adjacent the experimenter. The primary caregiver of each participant identified the preferred stimuli prior to the study.

Design and Procedure

A multiple-baseline across participants was conducted with embedded assessment probes. The PEAK-DTA and VB-MAPP assessments were conducted at the onset of the investigation, and the assessments were staggered across the three participants. The VB-MAPP was conducted repeatedly with two of the participants, and the PEAK-DTA was conducted repeatedly with a single participant, to evaluate the stability of these measures prior to PEAK-DT. In the PEAK-DT phase, participants were continuously assessed on the target skills as part of the program, and once participants mastered a given program, the program was added to their PEAK-DTA Total Score. Following a number of days established a priori (Ronald = 69 days, Frank = 57 days, Bernard = 45 days), differing depending on the length of the pretest phase, posttest assessments were conducted with the PEAK-DTA and the VB-MAPP. The VB-MAPP assessment was conducted twice during the posttest phase to determine the stability of the measures, and the PEAK-DTA was conducted once following 23 days to evaluate if the target skills were maintained following the conclusion of training. The authors implemented all procedures in the current study.

Pretest and Posttest Assessment Probes. Pretest assessment probes for the PEAK-DTA and the VB-MAPP were conducted with each of the participants to determine their scores prior to the PEAK-DT training phase. Both assessments were conducted using exclusively direct assessment methods, and no common stimuli were used across the two assessments. No feedback or prompts were delivered following participant responses on each skill, and this was consistent

across both assessments. For the PEAK-DTA, assessment skills were tested in 10-trial blocks, and a skill was considered mastered if the participant demonstrated 80% accuracy or greater. The assessment was discontinued once the participant received a score of 0 for five consecutive programs. The scores for each assessed skill were summed to arrive at a PEAK-DTA total score, ranging from 0 to 184.

For the VB-MAPP, assessment items were directly assessed in trial blocks that varied based on the length of the assessment item. For example, if the item tested the ability of the participant to demonstrate 25 mand responses, then a trial block consisted of 25 trials. Items were scored based on the scoring instructions for each item, and we summed all item scores to determine the VB-MAPP total score for each assessment across participants. The experimenter discontinued the assessment for a given category once a participant received a score of 0 for three consecutive programs within that category. If the participant received a score of 3 or less in the same category from a previous level, then the subsequent level was not assessed, and a score of 0 was assumed.

PEAK Direct Training. PEAK-DT was conducted based on the guidelines provided by Dixon, Whiting, and Daar (2014), and direct-care staff who were trained by the investigators of the current experiment implemented the procedures. First, target programs were selected based on the participants' results on the PEAK-DTA as well as targets specified in their individualized support plans. For example, a PEAK-DT program may have been selected because the target skill was specified in an individualized support plan at the agency even if the skill was not the next skill on the PEAK-DT performance matrix. Otherwise, programs were selected in descending order on the PEAK-DT performance matrix. For each participant, 10 programs were conducted concurrently, such that 10-trial blocks were conducted for each target program each day the participants attended the agency, and training sessions lasted 45 to 60 min (100 trials, 10 per block, each day). The procedures for conducting training were guided by the PEAK-DT curriculum, which provides instructions for how to conduct training. Each program in the PEAK-DT curriculum was conducted in a DTT format (see Supporting Information), in which the experimenter delivered conditional discriminative stimuli consistent with target skills (e.g., the experimenter provided an array of colored pictured cards and asked, "Which is red?"). If the participant demonstrated the target response (e.g., touching the red card), the experimenter provided contingent access to a preferred stimulus suggested by the participant's primary caregiver. If the participant failed to demonstrate the target response within 3 to 5 s, the experimenter provided prompts using a least-to-most hierarchy until the participant demonstrated the target response. When the target response was a motor movement, the prompt hierarchy included the experimenter saying, "Try again"; modelling the correct response; reducing the array or lightly physically prompting the correct response; then physically prompting the correct response. When the target response was a vocal utterance, the prompt hierarchy included the experimenter saying, "Try again"; modelling part of the correct response; modelling the full response; then saying, "Do the same as me," followed by modelling the correct response. Prompts were conducted within the same trial. Once participants demonstrated three consecutive trial blocks with 80% independent accuracy or greater, the skill was considered mastered, and another program replaced the mastered program.

Dependent Variables and Interobserver Agreement

There were two dependent variables in the investigation: PEAK-DTA total score and

Table 1
Summary of Skills on the PEAK-DT Assessment that Participants Demonstrated at Pretest, Mastered during Training, and Demonstrated at Posttest

Participant	Pretest PEAK-DT skills mastered	PEAK-DT skills mastered in training	Posttest PEAK-DT skills mastered
Ronald	1A, 2A, 3B, 4B	1B, 2B, 3A, 3C, 5F, 4E, 5G, 5H, 6A, 6J, 8C, 8D, 9C, 9B, 9D, 10E, 13Q, 13V, 13X	4A, 13T
Frank	1A, 1B, 2A, 2B, 3A, 3B, 3C, 4A, 4B, 4C, 5E, 5H, 6A, 7A, 9A	3D, 4D, 4E, 4F, 5A, 5B, 5F, 5B, 5C, 5D, 5G, 6D, 6E, 6F, 6I, 6J, 7B, 7E, 8A, 8B, 8C, 8D, 8I, 8J, 8L, 8M, 8J, 9B, 9C, 9D, 9G, 9K, 9L, 9M, 9P, 10E, 10G, 10O, 11A, 12C, 12D, 13D, 13E, 13Q, 13V	6B, 9P, 13B, 13T
Bernard	1A, 1B, 2A, 2B, 3A, 3B, 3C, 4A, 4B, 4C, 5H, 6A, 6D, 6E, 6F, 8C, 9A, 9C	4B, 4D, 4E, 4F, 5D, 5E, 5G, 6C, 6I, 7B, 7E, 7L, 8A, 8B, 8D, 8E, 8J, 9B, 9D, 9K, 9M, 10C, 10E, 11A, 11E, 12C, 13S	5B, 7A, 13Q, 13R, 13T, 13X

VB-MAPP total score. In the pretest and posttest phases, scores directly obtained from each assessment were used. Scores on the PEAK-DTA ranged from 0 to 184, and scores on the VB-MAPP ranged from 0 to 170. In the PEAK-DT phase, scores on the PEAK-DTA were obtained by adding mastered programs to the participants' PEAK-DTA total score. The rationale for adding this score was that the participants demonstrated mastery of the skill under conditions that were like the conditions in the PEAK-DTA, except that they received differential reinforcement and prompting during the PEAK-DT training-trial blocks. Interobserver reliability (IOR) was evaluated for both assessments by having a second assessor directly implement a second assessment on the same day. A total of 20% of the assessments were conducted on a second occasion (5/25). Agreement for each skill was compared across the two observers as a measure of reliability, and IOR was 87% (range, 85%-89%). Interobserver agreement (IOA) was not assessed for the number of mastered skills during the PEAK-DT phase.

RESULTS

The results of the current investigation are summarized in Figure 1. Participant scores on the PEAK-DTA prior to intervention were low across the three participants. Ronald had a score of 4, Frank had a score of 15, and Bernard had a score of 18; Bernard's assessment results were also stable across the two PEAK-DTA pretest probes. The participants also demonstrated low scores across the VB-MAPP pretest probes—Ronald had a score of 14, Frank had a mean score of 29, and Bernard had a mean score of 25. Stability was observed across Frank's and Bernard's pretest VB-MAPP assessment results. The specific PEAK-DTA skills that the participants demonstrated in the pretest phase, mastered in the training phase, and demonstrated in the posttest phase, are summarized in Table 1. The PEAK-DT phase was first conducted with Ronald, and Figure 1 shows a cumulative record of mastered programs throughout the training phase. Ronald began mastering programs on the fourth day and continued to master programs at a steady rate. By the end of the training phase, Ronald had mastered 19 skills (total skills mastered in PEAK-DT phase – baseline skills mastered), resulting in a mean rate of program mastery of 0.28 programs per day. Ronald's VB-MAPP assessment scores increased throughout the training phase, with a mean VB-MAPP score of 22 (range, 20-24). During the posttest, Ronald's PEAK-DTA total score increased to 25, and his VB-MAPP total score increased to 30, which was stable across two assessments.

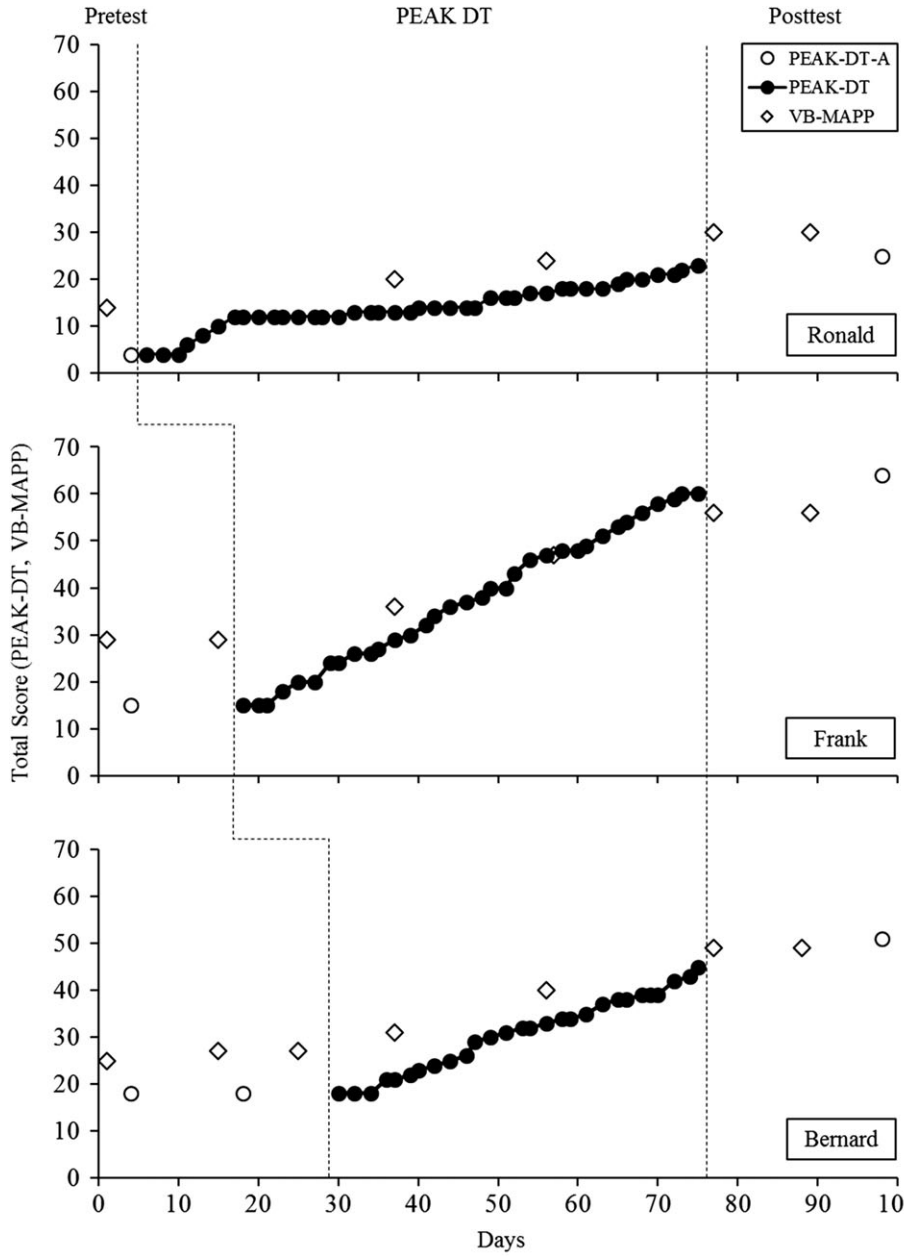

Figure 1. Figure 1. Multiple-baseline across participants with an embedded multiple probe of assessment results. Open data points show total scores during assessments, and closed data points show PEAK-DTA assessment results given mastery of target programs.

The PEAK training phase was conducted second with Frank. Frank began mastering PEAK-DT programs in the fourth trial block and continued to master programs at a steady rate. By the end of the training phase, Frank had mastered 45 additional programs, resulting in a mean rate of program mastery of 0.79 per day. Frank's scores on the VB-MAPP increased

to a mean of 41.5 (range, 36-47). By the posttest Frank's PEAK-DTA total score had increased to a score of 64, and his VB-MAPP total score increased to a score of 56, which was stable across the two assessments. Finally, PEAK-DT was conducted with Bernard, who also began mastering programs in the fourth trial block and continued to master programs at a steady rate. By the end of the training phase, Bernard had mastered 27 programs, resulting in a mean rate of program mastery of 0.6 programs per day. Bernard's scores on the VB-MAPP increased to a mean score of 37 (range, 31-40) during training. By the posttest, Bernard's PEAK-DTA total score had increased to a score of 51, and his VB-MAPP total score had increased to a score of 49, which was stable across the two assessments.

DISCUSSION

The results reported in the current investigation support the effectiveness of the procedures described in PEAK-DT in increasing target verbal operant skills of adults with autism, as well as improving participant scores on the VB-MAPP. These results are consistent with the results reported by McKeel, Dixon, et al. (2015), and extend those results in several ways. The treatment dosage in the current investigation (i.e., 45-60 min per session) was higher than the treatment dosage reported by McKeel, Dixon, et al., who reported sessions averaging 25 min. Participants in the McKeel, Dixon, et al. study acquired an average of 0.52 skills per day (skills mastered / total length of treatment), which was similar to the average of skills acquired per day in the current investigation (M = 0.55; range, 0.28-0.79). One consideration is that the average number of skills acquired per day reported in the current investigation is based on the PEAK-DT total scores at the end of the PEAK-DT phase, so additional mastered skills were not included. If new skills mastered on the PEAK-DTA in the posttest were substituted for scores at the end of the PEAK-DT phase, then the mean rate of program mastery would be 0.63 programs per day (range, 0.3-0.86). The latter average would account for the greater dosage reported in the current investigation, corresponding with greater program mastery. Additional analyses were conducted to evaluate the rate of program mastery throughout the PEAK-DT phase. The data appear to suggest that skill acquisition for each of the three participants was linear, rather than exponential or logarithmic in nature. This finding is potentially important because, despite the increasing complexity of the target skills over the course of the study (i.e., once skills were mastered, the skills were replaced with more complex skills), participants continued to master skills at a consistent rate. An additional limitation common in prior investigations (e.g., Dixon et al., 2017; McKeel, Dixon, et al.) that was addressed in the current investigation was the inclusion of a maintenance probe following training. Furthermore, the results suggest that each of the participants not only maintained the target skills following 23 days without exposure to PEAK-DT, but also demonstrated the acquisition of skills that were not directly targeted.

Perhaps the more important contribution of the current investigation, however, was that participant scores on the VB-MAPP also increased throughout the PEAK-DT phase and remained stable following the removal of the intervention. Prior research established the relationship between the PEAK-DTA and scores on the VB-MAPP (Dixon et al., 2015), a result that was consistent with the theoretical approach underlying both assessments; specifically, Skinner's verbal operant theory. Although these two assessments appear to be both statistically and conceptually related, the assessments do assess verbal operant skills differently, in that skills on the VB-MAPP appear to assess more topographical variations of the elementary verbal operants (Dixon et al., 2015). This result

provides support for the effectiveness of PEAK-DT in promoting the development of language and communication skills as a broader skill domain.

The procedures described in the current investigation were not guided by the VB-MAPP assessment, and participant performance improvement on the assessment was replicated across each of the participants. Increases on the VB-MAPP corresponding with PEAK-DT training suggest that the functional operant skills acquired during training may have transferred to the discriminative stimuli presented during the VB-MAPP assessment, as the discriminative stimuli on the two assessments are topographically distinct yet functionally similar. Also worth noting is that for each of the three participants, results on the VB-MAPP remained stable once PEAK-DT training was removed, providing further support for a functional relation between PEAK-DT training and participant results on these two assessments.

Although the results of the investigation suggest that the procedures described in PEAK-DT may have been effective in promoting the development of target skills with corresponding improvements in participant scores on the VB-MAPP, there are several limitations that may be addressed in future research. First, the PEAK-DT total score values presented in the pre- and posttest phases were not obtained in the same manner as the scores reported in the PEAK-DT phase. Repeatedly conducting the PEAK-DTA throughout the training phase would have provided information regarding how novel untrained skills emerged and would have provided more information regarding the skills that the participants had acquired in the posttest phase that were not directly trained. How repeated measurements influence participant performance on the PEAK-DTA has not yet been evaluated, however, so conducting assessment probes rather than continuous assessments as in the current investigation was appropriate. In addition, mastery of a skill on the PEAK-DTA in the current investigation involved responding with greater than 80% accuracy in a 10-trial block, and mastery of a program in the PEAK-DT phase involved this same criterion. The distinction between these two measurements was the inclusion of prompts or feedback contingent on participant responses, which is a limitation in the investigation. Because of this limitation, we do not know if low PEAK-DTA scores in baseline were an artifact of lower overall rates of reinforcement relative to the training condition. It should be noted that posttraining PEAK-DTA probes in the maintenance phase were conducted in the same manner as in baseline, suggesting that when reinforcement was removed, assessment scores on the PEAK-DTA remained high. In addition, participant scores on the VB-MAPP also increased despite these skills never contacting reinforcement across any of the test probes.

A second limitation was that stability in the pretest phase for the PEAK-DTA assessment was not evaluated, as the assessment was only conducted on a single occasion for two of the participants. Repeated measures on the PEAK-DTA were not obtained to avoid testing effects, and because the test–retest reliability of the assessment has been reported in prior research (Dixon et al., 2016). A final limitation was the homogeneity of the participants in the investigation. Participants were between 19 and 21 years of age, were male, and had low PEAK-DA pretest scores relative to prior investigations on PEAK-DT (e.g., Dixon et al., 2017; McKeel, Rowsey, Belisle, et al., 2015). It remains to be seen if the results would be replicated with participants who have higher preinstructional language and communication skills or are older than those in the current study. A final limitation was that IOA and procedural fidelity assessments were not conducted during PEAK-DT training. Collecting procedural fidelity data would have provided confidence that the independent variable was conducted as

intended. IOA was, however, evaluated in terms of the primary dependent variable, scores on the PEAK-DTA and the VB-MAPP.

In addition to addressing the limitations in the current investigation, future research may continue to evaluate how the use of CTMs such as PEAK lead to improvements across several domains of adaptive behavior, and in application with adults with autism. Prior research has established a relationship between the PEAK-DTA and the PPVT as a vocabulary measure (Dixon, Carman, et al., 2014) and IQ as a measure of intellectual functioning (Dixon, Whiting, et al., 2014). It remains to be seen if changes in participants' performance on the PEAK-DTA following PEAK-DT, as demonstrated in the current investigation, lead to meaningful increases in other related measures. Evaluating the relationship between PEAK-DT training and scores on the VB-MAPP was a logical first step given the conceptual and statistical relationship between these two measures, however, evaluating changes in these other measures would add to the external validity of the data supporting the application of the PEAK-DT curriculum with children and adults with autism. Future research may also evaluate how the remaining PEAK modules affect assessments that are related to those measures (Dixon 2014b, 2015; 2016). The PEAK-Generalization assessment has also shown a strong relationship with the VB-MAPP (Dixon et al., 2015), and assessments and instructional protocols in the PEAK Equivalence and Transformation modules provide even greater complexity (Dixon, 2015, 2016) by incorporating advances in stimulus equivalence (Sidman, 1971; Sidman & Tailby, 1982) and Relational Frame Theory (Hayes, Barnes-Holmes, & Roche, 2001). Ultimately, the purpose of conducting CMTs such as PEAK are to improve the adaptive behavior and ultimately the life quality of individuals with disabilities, making the evaluation of increases in untargeted adaptive behavior domains (e.g., intelligence, autism severity) corresponding with the implementation of CTMs a necessary avenue for future research.

In summary, prior research has supported the application of the PEAK-DT curriculum in terms of increasing children's performance on skills that are directly targeted. The results of the present study extend upon this existing literature by demonstrating that the procedures are also effective in application with adults with autism, and that increases may also co-occur in a related assessment of language and communication skills. The current investigation should be considered a first step in evaluating the degree to which conducting CTMs over an extended period leads to changes in adaptive behavior more globally, an avenue of research that could improve the language and cognitive skills of children and adults with autism and other disabilities.

REFERENCES

American Psychiatric Association (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC. Author.

Baker, D. J., Valenzuela, S., & Wieseler, N. A. (2005). Naturalistic inquiry and treatment of coprophagia in one individual. *Journal of Developmental and Physical Disabilities, 17*, 361-367. https://doi.org/10.1007/s10882-005-6619-2

Dawson, G., Jones, E. J., Merkle, K., Venema, K., Lowy, R., Faja, S., … Smith, M. (2012). Early behavioral intervention is associated with normalized brain activity in young children with autism. *Journal of the American Academy of Child & Adolescent Psychiatry, 51*, 1150-1159. https://doi.org/10.1016/j.jaac.2012.08.018

Dixon, M. R. (2014a). *PEAK Relational Training System: Direct Training Module*. Carbondale, IL: Shawnee Scientific Press.

Dixon, M. R. (2014b). *PEAK Relational Training System: Generalization Module*. Carbondale, IL: Shawnee Scientific Press.

Dixon, M. R. (2015). *PEAK Relational Training System: Equivalence Module*. Carbondale, IL: Shawnee Scientific Press.

Dixon, M. R. (2016). *PEAK Relational Training System: Transformation Module*. Carbondale, IL: Shawnee Scientific Press.

Dixon, M. R., Belisle, J., Munoz, B. E., Stanley, C. R., & Rowsey, K. E. (2017). Teaching metaphorical extensions of private events through rival-model observation to children with autism. *Journal of Applied Behavior Analysis, 50*, 744-749. https://doi.org/10.1002/jaba.418

Dixon, M. R., Belisle, J., Stanley, C. R., Rowsey, K., Daar, J. H., & Szekely, S. (2015). Toward a behavior analysis of complex language for children with autism: Evaluating the relationship between PEAK and the VB-MAPP. *Journal of Developmental and Physical Disabilities, 27*, 223-233. https://doi.org/10.1007/s10882-014-9410-4

Dixon, M. R., Belisle, J., Whiting, S. W., & Rowsey, K. E. (2014). Normative sample of the PEAK relational training system: Direct training module and subsequent comparisons to individuals with autism. *Research in Autism Spectrum Disorders, 8,* 1597-1606. https://doi.org/10.1016/j.rasd.2014.07.020

Dixon, M. R., Carman, J., Tyler, P. A., Whiting, S. W., Enoch, M. R., & Daar, J. H. (2014). PEAK relational training system for children with autism and developmental disabilities: Correlations with Peabody picture vocabulary test and assessment reliability. *Journal of Developmental and Physical Disabilities, 26,* 603-614. https://doi.org/10.1007/s10882-014-9384-

Dixon, M. R., Small, S. L., & Rosales, R. (2007). Extended analysis of empirical citations with Skinner's *Verbal Behavior:* 1984-2004. *The Behavior Analyst, 30*, 197-209.

Dixon, M. R., Stanley, C. R., Belisle, J., & Rowsey, K. E. (2016). The test-retest and interrater reliability of the Promoting the Emergence of Advanced Knowledge-Direct Training assessment for use with individuals with autism and related disabilities. *Behavior Analysis: Research and Practice, 16*, 34-40. https://doi.org/10.1037/bar0000027

Dixon, M. R., Whiting, S., & Daar, J. (2014). Implementing the direct training module. In M. R. Dixon (Ed.), *PEAK Relational Training System: Direct Training Module*. Carbondale, IL: Shawnee Scientific Press.

Dixon, M. R., Whiting, S. W., Rowsey, K., & Belisle, J. (2014). Assessing the relationship between intelligence and the PEAK relational training system. *Research in Autism Spectrum Disorders, 8,* 1208-1213. https://doi.org/10.1016/j.rasd.2014.05.005

Dymond, S., O'Hora, D., Whelan, R., & O'Donovan, A. (2006). Citation analysis of Skinner's *Verbal Behavior*: 1984–2004. *The Behavior Analyst, 29*, 75-88

Elsabbagh, M., Divan, G., Koh, Y. J., Kim, Y. S., Kauchali, S., Marcín, C., ... Yasamy, M. T. (2012). Global prevalence of autism and other pervasive developmental disorders. *Autism Research, 5*, 160-179. https://doi.org/10.1002/aur.239

Fulton, E., Eapen, V., Crncec, R., Walter, A., & Rogers, S. (2014). Reducing maladaptive behaviors in preschool-aged children with autism spectrum disorder using the Early Start Denver Model. *Frontiers in Pediatrics, 2*, 71-80. https://doi.org/10.3389/fped.2014.00040

Geiger, K. B., LeBlanc, L. A., Dillon, C. M., & Bates, S. L. (2010). An evaluation of preference for video and in vivo modeling. *Journal of Applied Behavior Analysis, 43*, 279-283. https://doi.org/10.1901/jaba.2010.43-279

Gould, E., Dixon, D. R., Najdowski, A. C., Smith, M. N., & Tarbox, J. (2011). A review of assessments for determining the content of early intensive behavioral intervention programs for autism spectrum disorders. *Research in Autism Spectrum Disorders, 5*, 990-1002. https://doi.org/10.1016/j.rasd.2011.01.012

Hayes, S. C., Barnes-Holmes, D., & Roche, B. (2001). *Relational frame theory: A post-Skinnerian account of human language and cognition*. New York, NY: Kluwer Academic/Plenum Publishers.

Lorah, E. R., Tincani, M., Dodge, J., Gilroy, S., Hickey, A., & Hantula, D. (2013). Evaluating picture exchange and the iPad™ as a speech generating device to teach communication to young children with autism. *Journal of Developmental and Physical Disabilities, 25*, 637-649. https://doi.org/10.1007/s10882-013-9337-1

Matson, J. L., Benavidez, D. A., Compton, L. S., Paclawskyj, T., & Baglio, C. (1996). Behavioral treatment of autistic persons: A review of research from 1980 to the present. *Research in Developmental Disabilities, 17*, 433-465. https://doi.org/10.1016/S0891-4222(96)00030-3

McKeel, A. N., Dixon, M. R., Daar, J. H., Rowsey, K. E., & Szekely, S. (2015). Evaluating the efficacy of the PEAK relational training system using a randomized controlled trial of children with autism. *Journal of Behavioral Education, 24*, 230-241. https://doi.org/10.1007/s10864-015-9219-y

McKeel, A. N., Rowsey, K. E., Belisle, J., Dixon, M. R., & Szekely, S. (2015). Teaching complex verbal operants with the PEAK relational training system. *Behavior Analysis in Practice, 8*, 241-244. https://doi.org/10.1007/s40617-015-0067-y

McKeel, A., Rowsey, K., Dixon, M. R., & Daar, J. H. (2015). Correlation between PEAK relational training system and one-word picture vocabulary tests. *Research in Autism Spectrum Disorders, 12*, 34-39. https://doi.org/10.1016/j.rasd.2014.12.007

National Governors Association Center for Best Practices & Council of Chief State School Officers (2010). *Common Core State Standards*. Washington, DC: Authors.

Odom, S. L., Boyd, B. A., Hall, L. J., & Hume, K. (2010). Evaluation of comprehensive treatment models for individuals with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 40*, 425-436. https://doi.org/10.1007/s10803-009-0825-1.

Odom, S. L., Boyd, B. A., Hall, L. J., & Hume, K. A. (2014). Comprehensive treatment models for children and youth with autism spectrum disorders. In F. R. Volkmar, R. Paul, S.J. Rogers, & K.A. Pelphrey (Eds.), *Handbook of autism and pervasive developmental disorders,* 4th ed. Hoboken, NJ: John Wiley & Sons.

Odom, S. L., Collet-Klingenberg, L., Rogers, S. J., & Hatton, D. D. (2010). Evidence-based practices in interventions for children and youth with autism spectrum disorders. *Preventing School Failure, 54*, 275-282. https://doi.org/10.1080/10459881003785506.

O'Donohue, W., & Ferguson, K. E. (2006). Evidence-based practice in psychology and behavior analysis. *The Behavior Analyst Today, 7*, 335-349.

Partington, J. (2006). *Assessment of basic language and learning skills-revised (The ABLLS-R)*. Pleasant Hill, CA: Behavior Analysts.

Perone, M. (1999). Statistical inference in behavior analysis: Experimental control is better. *The Behavior Analyst, 22*, 109-116.

Peters-Scheffer, N., Didden, R., Korzilius, H., & Sturmey, P. (2011). A meta-analytic study on the effectiveness of comprehensive ABA-based early intervention programs for children with autism spectrum disorders. *Research in Autism Spectrum Disorders, 5*, 60-69. https://doi.org/10.1016/j.rasd.2010.03.011

Rehfeldt, R. A., & Chambers, M. R. (2003). Functional analysis and treatment of verbal perseverations displayed by an adult with autism. *Journal of Applied Behavior Analysis, 36*, 259-261. https://doi.org/10.1901/jaba.2003.36-259

Reichow, B. (2012). Overview of meta-analyses on early intensive behavioral intervention for young children with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 42*, 512-520. https://doi.org/10.1007/s10803-011-1218-9

Ribeiro, D. M., Miguel, C. F., & Goyos, C. (2015). The effects of listener training on discriminative control by elements of compound stimuli in children with disabilities. *Journal of the Experimental Analysis of Behavior, 104*, 48-62. https://doi.org/10.1002/jeab.161

Rogers, S. J., & Vismara, L. A. (2008). Evidence-based comprehensive treatments for early autism. *Journal of Clinical Child & Adolescent Psychology, 37*, 8-38. https://doi.org/10.1080/15374410701817808

Rowsey, K. E., Belisle, J., & Dixon, M. R. (2015). Principal component analysis of the PEAK relational training system. *Journal of Developmental and Physical Disabilities, 27*, 15-23. https://doi.org/10.1007/s10882-014-9398-9

Sidman, M. (1971). Reading and auditory-visual equivalences. *Journal of Speech and Hearing Research, 14*, 5-13.

Sidman, M., & Tailby, W. (1982). Conditional discrimination vs. matching to sample: An expansion of the testing paradigm. *Journal of the Experimental Analysis of Behavior, 37*, 5-22. https://doi.org/10.1901/jeab.1982.37-5

Skinner, B. F. (1957). *Verbal behavior*. Englewood Cliffs, NJ: Prentice Hall.

Sundberg, M. L. (2008). *VB-MAPP: Verbal behavior milestones assessment and placement program*. Concord, CA: AVB Press.

Virués-Ortega, J. (2010). Applied behavior analytic intervention for autism in early childhood: Meta-analysis, meta-regression and dose–response meta-analysis of multiple outcomes. *Clinical Psychology Review, 30*, 387-399. https://doi.org/10.1016/j.cpr.2010.01.008

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