PEAK Relational Training System: A Novel Approach for Autism Language Disorder Rehabilitation

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Abstract

The PEAK (Promoting the Emergence of Advanced Knowledge) relational training system represents the world' s first language behavior assessment and training system that simultaneously integrates Skinner' s Verbal Behavior and post-Skinnerian Relational Frame Theory to facilitate the development of core skills—including language, learning, and social interaction—in individuals with Autism Spectrum Disorders (ASD). As of the end of 2018, the PEAK relational training system consists of four modules: Direct Training Module, Generalization Module, Equivalence Relations Module, and Transformation of Functions Module. Each module comprises 184 assessment methods and training curricula for target abilities, sequenced according to difficulty level. Multiple published empirical studies have demonstrated that the PEAK relational training system overcomes the ceiling effect observed during milestone assessment of individuals with ASD using the Verbal Behavior Milestones and Placement Program (VB-MAPP), and promises to deliver a more comprehensive and advanced language behavior assessment framework than VB-MAPP, extending the scope of improvement in language, learning, and social abilities for individuals with ASD from early childhood (18 months) to adulthood (18 years). Furthermore, characteristics such as robust reliability and validity of the assessment tools, significant findings from multiple effectiveness studies, and ease of practical implementation render the PEAK relational training system not only suitable for professional instruction but also potentially valuable for future family intervention models for individuals with ASD.

Full Text

PEAK Relational Training System: A Novel Approach for Autism Language Disorder Rehabilitation

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Abstract

The Promoting the Emergence of Advanced Knowledge (PEAK) Relational Training System represents the world' s first language behavior assessment and training protocol to integrate Skinner' s *Verbal Behavior* with post-Skinnerian Relational Frame Theory (RFT), designed to foster core skill development in language, learning, and social interaction among individuals with Autism Spectrum Disorder (ASD). By the end of 2018, the PEAK Relational Training System comprised four modules: Direct Training, Generalization, Equivalence Relations, and Transformation of Functions. Each module contains 184 assessment protocols and training curricula for target skills, sequenced by difficulty level. Multiple empirical studies have demonstrated that PEAK overcomes the "ceiling effect" observed when using the Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP) for milestone evaluation in ASD patients, offering a more comprehensive and advanced language behavior assessment system that extends skill development from early childhood (18 months) through adulthood (18 years). Furthermore, PEAK exhibits strong psychometric properties, significant efficacy in multiple outcome studies, and practical operability, making it suitable not only for professional implementation but also holding potential value for family-based intervention models for ASD.

Keywords: Autism Spectrum Disorder; Relational Frame Theory; PEAK; Verbal Behavior; VB-MAPP
Classification Codes: B842.5; R749.94

1. Introduction

Autism Spectrum Disorder (ASD) constitutes a group of neurodevelopmental conditions with onset in early childhood, characterized by two core symptom domains: (1) persistent deficits in social communication and interaction across multiple contexts, and (2) restricted, repetitive patterns of behavior and interests. Research indicates that language impairment is common among individuals with ASD and represents a significant contributor to their core social communication deficits (Simms & Jin, 2015). Language impairment refers to difficulties in comprehending and using spoken language, written language, and

other signaling systems (Mao, Wang, & Du, 2017). Individuals with ASD exhibit varying degrees of language impairment across age groups: some children remain nonverbal until ages 2–3 or experience language regression after typical development, while others demonstrate excessive but non-communicative language characterized by meaningless, repetitive, and stereotyped utterances. Consequently, early assessment and effective training of communication skills constitute the most critical component of any rehabilitation program for ASD patients, directly promoting recovery from core deficits (Niu & Xu, 2016).

Verbal Behavior Analysis, rooted in Skinner' s 1957 publication *Verbal Behavior* and typically classified under Applied Behavior Analysis (ABA), has been recognized by the National Autism Center as an evidence-based intervention for language deficits in ASD. Implementing verbal behavior analysis to enhance functional language in children with ASD requires accurate assessment of current language abilities to identify unique strengths and weaknesses, which forms the basis for developing Individualized Educational Plans (IEPs). Currently, the primary assessment and training systems based on Skinner' s *Verbal Behavior* for children with ASD or other language delays are the Assessment of Basic Language and Learning Skills-Revised (ABLLS-R) and the Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP). VB-MAPP has gained widespread adoption in U.S. rehabilitation facilities due to its developmentally normed assessment system and clear articulation of progression within skill domains (referred to as "milestones"), providing operators with explicit training objectives (Sundberg, 2008). Following its translation into Chinese by Huang Weihe, Li Dan, and colleagues in 2014, VB-MAPP has become increasingly popular in Chinese ASD rehabilitation settings (Sundberg, 2014). While ABLLS-R and VB-MAPP successfully translated Skinner' s theoretical framework into systematic practice, recent empirical research has identified limitations and areas needing improvement when relying exclusively on these tools for enhancing communicative abilities in ASD patients.

First, Dixon and colleagues argue that language behavior assessment methods such as VB-MAPP and ABLLS-R have not maximally utilized concepts from Skinner' s *Verbal Behavior*, remaining focused on training basic verbal operants such as manding, tacting, listener responding, echoic behavior, motor imitation, copying, dictation, textual reading, and simple intraverbals. Although mastery of these fundamental elements produces significant short-term language development gains for minimally verbal ASD patients, meaningful long-term effects on core deficits require incorporation of more complex, advanced, and functionally relevant communication skills for adulthood; otherwise, interventions inevitably encounter a "ceiling effect" after initial training phases (Dixon et al., 2014). Furthermore, even when maximizing application of Skinner' s theory, ongoing research debates whether *Verbal Behavior* provides a complete account, focusing on two primary controversies (Gross & Fox, 2009; Reed & Luiselli, 2016; Stewart, Mcelwee, & Ming, 2017): (1) Skinner conceptualized verbal behavior as an operant but failed to adequately address derived relational responding, particularly arbitrarily applicable derived relational responses (AADRR) essen-

tial for complex language construction. This limitation explains why Skinner' s framework cannot account for the spontaneous language explosion observed in typically developing children at ages 3–4, who produce countless novel utterances beyond their limited input, prompting Chomsky' s vigorous critique. (2) Skinner' s preliminary definition— "verbal behavior is behavior reinforced through the mediation of other persons" (Skinner, 1957, p. 2)—has been criticized as overly broad, including trivial behaviors and failing to distinguish human from nonhuman behavior. For instance, under this definition, a laboratory rat' s lever-pressing for food could be considered verbal behavior, as it is mediated by an experimenter who functions as a "listener" within a verbal community (Hayes, Barnes-Holmes, & Roche, 2001). Skinner himself considered such "nonhuman behavior" appropriate for study, noting that "the animal and experimenter constitute a small but genuine verbal community" (Skinner, 1957, p. 225).

Consequently, exclusive adherence to Skinner' s operational definition yields effective promotion of basic language skills in early stages but ultimately limits advanced language acquisition due to inadequate AADRR training. This results in rigid, inflexible language skills that fail to adapt to varying contexts, perpetuating communication difficulties in complex situations rather than enabling functional, contextually flexible language use.

Post-Skinnerian developments in verbal behavior analysis, particularly Relational Frame Theory (RFT), address these unresolved issues by elucidating the nature of derived relational responding and refining core concepts from *Verbal Behavior* (Wang & Zhu, 2017). Integrating Skinner' s principles with post-Skinnerian RFT to develop a novel assessment and training system could potentially resolve current limitations in ASD language rehabilitation, overcome ceiling effects of existing tools like VB-MAPP (which primarily assesses skills through age 4), and provide higher-order language and social communication training. The following review of PEAK's theoretical foundations, structural features, applications, advantages, and limitations in ASD rehabilitation addresses these questions.

2. Overview of the PEAK Relational Training System

In 2014, American psychologist Mark Dixon (BCBA-D) established PEAK, a system applicable for assessing language, cognitive, and social deficits in individuals with ASD or other developmental disabilities and for developing IEPs to enhance these skills. PEAK' s theoretical foundation integrates core concepts from Skinner' s *Verbal Behavior* with post-Skinnerian Relational Frame Theory (RFT). Structurally, PEAK comprises four modules [Figure 1: see original paper]: Direct Training (PEAK-DT), Generalization (PEAK-G), Equivalence (PEAK-E), and Transformation (PEAK-T). Together, these modules encompass 736 skill targets, with each module containing 184 sequenced training skills to achieve module-specific objectives.

Figure 1. Framework of PEAK Relational Training System Modules

In 2015, Dixon and colleagues conducted a comparative study using both VB-MAPP and PEAK to assess language, learning, and social skills in 40 randomly selected individuals with ASD (ages 5–21, mean 12.62 years) (Dixon, Belisle, Stanley, Rowsey, Daar, & Szekely, 2015). Results revealed that VB-MAPP milestone scores correlated significantly with combined scores from PEAK' s first two modules ($r=0.8266$, $p<0.0001$), with an even stronger correlation with PEAK-DT alone ($r=0.9322$, $p<0.0001$). Regression analysis indicated that PEAK scores positively predicted VB-MAPP scores, with a nonlinear logarithmic relationship ($R^2=0.9598$). As PEAK scores increased, VB-MAPP scores rapidly approached the milestone maximum (170 points), demonstrating a clear ceiling effect. Notably, individuals who achieved perfect VB-MAPP scores continued to show varying ability levels on PEAK, with scores ranging from 138 to 368. Overall, 50% of participants (20/40) reached VB-MAPP ceiling, precluding further IEP development using that tool, whereas only 5% (2/40) reached PEAK' s maximum, leaving 38 individuals who could benefit from continued skill development based on PEAK assessment results.

Dixon concluded that PEAK provides a more comprehensive and advanced language assessment system than VB-MAPP, which evaluates skills only through approximately age 4. PEAK can assess and train more complex, higher-order language, learning, and social abilities. VB-MAPP' s founder Sundberg validated these findings, citing the study as evidence for VB-MAPP' s external validity (Sundberg, 2018). Since PEAK' s inception through April 2018, Dixon and his team have published 29 peer-reviewed articles. Research demonstrates that PEAK-DT alone extends assessment and training of language, learning, and social skills from 18 months to 9 years of developmental age, while PEAK-G further extends this range to 11 years. The latter modules, PEAK-E and PEAK-T, focus on training derived relational responding through Sidman' s stimulus equivalence and Hayes' s RFT to establish relational frames essential for complex language and advanced cognition (Dixon et al., 2017).

PEAK' s superiority stems from its integration of traditional Skinnerian verbal operant training (VOP) with post-Skinnerian derived relational responding (DRR). Hayes and Barnes-Holmes' s 2001 publication of *Relational Frame Theory: A Post-Skinnerian Account of Human Language and Cognition* marked RFT's maturation. RFT's core concept is DRR or relational framing—the behavior of relating one stimulus to another across multiple relation types (Hayes et al., 2001). Sidman' s 1971 work on stimulus equivalence initially explored DRR, which comprises reflexive and symmetrical relations, though RFT expanded DRR beyond equivalence to include coordination, opposition, comparison, temporal, spatial, hierarchical, and deictic relations. These can be categorized as non-arbitrary (physically based) or arbitrarily applicable derived relational responses. Three core features define relational framing: mutual entailment, combinatorial entailment, and transformation of stimulus function. Human language development emerges from establishing relational frames through these processes, creating complex networks from limited trained relations and generating novel, untrained responses (Wang, Zhang, & Zhu, 2012).

RFT addresses Skinner' s two major omissions: (1) It clarifies the nature of derived relational responding, explaining spontaneous language generation and why 3–4-year-old children produce novel utterances beyond their input (Hayes et al., 2001). Research by Zhu and Zhu (2017) assessing 230 typically developing Chinese children aged 2–7 found age 4 to be a critical inflection point: before 4 years, children construct language through simple relations (coordination, opposition, comparison, non-arbitrary DRR), while after 4 years they master complex relations (temporal, spatial, hierarchical, deictic, arbitrarily applicable DRR), enabling flexible relational networks and spontaneous advanced language. (2) Skinner' s definition inadequately explains human-exclusive language acquisition and overemphasizes external mediation while neglecting internal contexts where relational frames generate language through derived relations (Niklas & Hayes, 2010). Relational frames are contextually controlled rather than physically determined, with contextual cues defining both relational and functional properties. This RFT perspective clarifies language as contextually controlled derived relational responding, addressing Chomsky's critique and enabling training that overcomes operant conditioning limitations while enhancing functional language flexibility.

By integrating Skinner' s *Verbal Behavior* with post-Skinnerian RFT, PEAK breaks through VB-MAPP' s ceiling effect, promising a more advanced and comprehensive language behavior assessment and training system extending from early childhood through adulthood.

3.1 Psychometric Validation of PEAK as an Assessment Tool

Through April 2018, eight peer-reviewed articles examined PEAK' s psychometric properties as a verbal behavior assessment instrument. Results demonstrated high reliability coefficients: test-retest reliability (ICC: 0.987), inter-observer reliability (IOR: 85%–99.1%), and internal consistency (Cronbach' s : 0.981). PEAK scores correlated significantly with established measures: ABLLS-R ($r=0.951$, $p<0.05$), VB-MAPP ($r=0.932$, $p<0.05$), Peabody Picture Vocabulary Test (PPVT) ($r=0.908$, $p<0.05$), Vineland Adaptive Behavior Scales-II (VABS-II) ($r=0.453$, $p<0.05$), and Wechsler Intelligence Scale for Children ($r=0.759$, $p<0.05$), demonstrating strong criterion validity (median $r=0.908$). Logical and factor analyses of all items confirmed adequate content and construct validity. Dixon concluded that PEAK functions as a psychometrically sound assessment tool, contrasting with other ABA-based instruments like VB-MAPP and ABLLS-R that lack comprehensive reliability and validity research (Dixon et al., 2017).

3.2 Intervention Outcomes of PEAK for Individuals with ASD

Unlike existing language training curricula primarily targeting young children with ASD, PEAK applies across a broad age range (18 months–21 years). Through April 2018, 21 peer-reviewed studies examined PEAK' s effectiveness, with 14 focusing on children, 4 on adolescents, and 1 on adults.

The PEAK-DT module directly trains language and learning skills (18 months–9 years) through four domains: basic learning, perceptual skills, language comprehension, and metaphorical reasoning/mathematics. Its 184 sequenced skills begin with Skinnerian verbal operants (manding, tacting, listener responding, echoics, imitation, copying, dictation, matching) using concrete stimuli, then progress to abstract stimuli while incorporating derived relational responding for elementary metaphorical reasoning and mathematical skills (Reed & Luiselli, 2016).

McKeel and colleagues randomly assigned 27 ASD students (ages 5–21) from a specialized school, all PEAK-naïve, to PEAK-DT training (n=14) or treatment-as-usual control (n=13) groups. The control group received standard comprehensive programming (speech therapy, art/music therapy, social games, math practice, behavior reduction) without Discrete Trial Training (DTT). The PEAK-DT group received identical programming plus twice-weekly 10–20 minute PEAK-DT sessions using DTT. After one month, PEAK-DT scores increased by a mean of 15.79 points while control scores decreased by 2.66 points, a significant difference ($F(1, 22)=9.684$, $p<0.01$), demonstrating PEAK-DT' s efficacy even with minimal dosage (McKeel, Dixon, Daar, Rowsey, & Szekely, 2015).

Dixon and colleagues extended this work with 34 ASD students (ages 5–15) across three schools, with 15 controls receiving comprehensive IEPs (including ABA, speech therapy, art/music therapy, social games, math) without PEAK, and 19 receiving identical programming plus PEAK-DT (10–60 minutes daily, individualized by skill acquisition). After one year, the PEAK-DT group mastered a mean of 16 new target skills with a 16.0-point score increase, while controls regressed by 6.1 points without acquiring new PEAK-DT skills, a significant difference ($F(1, 33)=10.66$, $p<0.05$). This confirms PEAK-DT' s effectiveness and feasibility when implemented by frontline special educators within existing ABA-based programs (Dixon, Belisle, Stanley, & Rowsey, 2018).

The PEAK-G module promotes generalization of PEAK-DT skills to novel, similar contexts without direct training. Its 184 skills span four categories: basic learning/social skills, language comprehension/memory/advanced social skills, advanced language comprehension/problem-solving/mathematics, and advanced problem-solving/reading/writing. Dixon and colleagues used a multiple-baseline design with three children (ages 4–5) who had mastered at least 30 PEAK-DT skills but no PEAK-G training. Using train-test trials (not DTT), they taught complex verbal operants including creativity (pathfinding tasks), automatic mands, and distorted tacts under specific conditions. After 4–12 training sessions, all three children demonstrated correct responses to untrained stimuli in new contexts, confirming PEAK-G' s generalization effectiveness (Dixon, Peach, Daar, & Penrod, 2017).

The PEAK-E module trains stimulus equivalence relations (reflexive, symmetrical, transitive) through 184 skills, using mutual entailment, combinatorial entailment, and transformation of stimulus function to establish equivalence rela-

tional frames. PEAK-T extends DRR beyond equivalence to diverse relations: non-arbitrary coordination, comparison, difference, opposition, deixis, and hierarchy; culturally-based relations; and simple to complex arbitrarily applicable relations across these types.

In eight multiple-baseline case studies, Dixon and colleagues demonstrated that after training ASD children and adolescents to relate taste names (A) to taste pictures (B) and taste pictures (B) to oral taste names (C), participants derived untrained relations between oral names (C) and pictures (B). This derived performance generalized across 22 novel stimulus sets (chemical properties, historical events, animal categories, geometric shapes) with a mean Percentage of Non-overlapping Data (PND) of 96.3%, indicating robust training effects (Dixon et al., 2017).

Belisle and colleagues examined whether three ASD adolescents (ages 12–18) could acquire perspective-taking skills through PEAK-T' s deictic "I-You" relations training. At baseline, participants showed 0% accuracy on reversed perspective questions (e.g., "If you were me and I were you, what would you see now?") when viewing three double-sided picture cards. After training to criterion on direct perspective questions, two participants demonstrated derived reversed perspective responding at 100% accuracy without direct training, and generalized this performance to novel picture sets at >80% initial accuracy, reaching 100% across three consecutive trials. This demonstrated mutual entailment, combinatorial entailment, and transformation of stimulus function. The third participant required additional training but ultimately showed similar generalization. The researchers distinguished transformation of stimulus function (novel stimuli differing in form but sharing functional relations) from stimulus generalization (novel stimuli similar in form to training stimuli). These findings confirm PEAK-E and PEAK-T' s effectiveness in establishing relational framing capabilities and promoting perspective-taking development (Belisle, Dixon, Stanley, Munoz, & Daar, 2016).

4. Limitations and Future Directions

As the first manualized system integrating Skinner' s *Verbal Behavior* with post-Skinnerian RFT, PEAK has proven effective in overcoming VB-MAPP' s ceiling effect (18 months–4 years) and offers a more advanced, comprehensive approach. However, several limitations remain:

First, PEAK modules focus primarily on language, learning, and social skills, with minimal attention to daily living skills, problem behavior reduction, or adaptive behavior establishment, rendering it an incomplete rehabilitation system.

Second, while neuroimaging research reveals ASD pathophysiology involving brain structure, neural pathways, and neuronal excitability (e.g., corpus callosum abnormalities, white matter disruptions), and studies show that relational training (equivalence, reflexivity) activates hippocampal regions asso-

ciated with relational framing and memory flexibility (Dickins et al., 2001; Schlund, Cataldo, & Hoehn-Saric, 2008), longitudinal PEAK intervention studies examining biological-level neural changes are lacking. Founder Mark Dixon emphasizes that elucidating PEAK' s neuroimaging mechanisms is essential for optimizing the system based on objective evidence.

Third, although PEAK' s four modules progress in difficulty from PEAK-DT to PEAK-T, implementation need not follow this sequence rigidly. IEPs should select skills across modules based on individual assessment results to maximize benefit (Dixon et al., 2017). However, questions remain regarding whether all 184 skills per module are essential for every individual and how to optimally select and sequence skills. Ten ongoing studies are investigating optimal inter-module coordination and skill selection protocols.

Future PEAK development should address these limitations while advancing ASD rehabilitation in China:

First, PEAK holds promise for family-based implementation in China, where qualified ABA professionals are severely limited, particularly in second- and third-tier cities. Unlike VB-MAPP, which requires extensive ABA expertise, PEAK's manual is highly readable with detailed guidelines, primarily using DTT methodology that parents with high school education can implement (Dixon, 2016). However, prior to widespread family implementation, PEAK requires Chinese translation, cultural adaptation, and psychometric validation, followed by parent training and integration into online intervention platforms using intelligent technologies (VR, AR) to benefit families in remote areas.

Second, PEAK can upgrade institutional rehabilitation methods in China. Research demonstrates that frontline special educators can effectively implement PEAK within existing ABA programs, significantly accelerating skill acquisition across a broad age range (18 months–21 years), thus addressing the current homogeneity of interventions limited to young children. Urgent priorities include Chinese translation, localization of training materials, psychometric validation, and efficacy studies to establish PEAK as an evidence-based IEP component for older individuals with ASD. Greater professional involvement in PEAK' s adaptation and scientific validation will advance Chinese ASD rehabilitation and benefit more patients.

References

[The references section contains both Chinese and English references which should be preserved as in the original. For brevity in this translation, they are maintained in their original format.]

PEAK Relational Training System for Children with Autism: A Novel Application Based on Relational Frame Theory

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Abstract

The Promoting the Emergence of Advanced Knowledge (PEAK) Relational Training System is the first verbal behavior assessment instrument and treatment protocol that integrates Skinner' s "Verbal Behavior" and Post-Skinnerian analysis of human language and cognition, "Relational Frame Theory". It aims to address the language and cognitive deficits in children with autism. By the end of 2018, the PEAK system has published four modules: PEAK-Direct Training module (PEAK-DT), PEAK-Generalization module (PEAK-G), PEAK Equivalence module (PEAK-E) and PEAK-Transformation module (PEAK-T). Each of the modules contains a direct pre-assessment, a full 184-itemized skill assessment, and a 184 item curriculum. Based on the previous literature, PEAK-DT has broken the ceiling effect of the VB-MAPP milestone evaluation in patients with ASD, and the entirety PEAK system is prospected to provide a more advanced and comprehensive verbal behavior assessment and training system than VB-MAPP. Since the establishment of the PEAK system in 2014, many published empirical studies indicated that some properties of the PEAK system are: good reliability and validity as an assessment tool, effective treatment for the patients with ASD, and an easily-mastered operation in practice; which makes the PEAK system owning potential application value in the intervention delivered from behavioral analysists as well as autistic parents in the future.

Key words: Autism Spectrum Disorders; Relational Frame Theory; PEAK; Verbal Behavior; VB-MAPP

Note: Figure translations are in progress. See original paper for figures.