RESEARCH ARTICLE

Utilizing PEAK Relational Training System to Teach Visual, Gustatory, and Auditory Relations to Adults with Developmental Disabilities

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Abstract Two multiple baseline designs were conducted across participants to determine if the promoting the emergence of advanced knowledge (PEAK) equivalence module was an effective tool in teaching adults with autism relationships between stimuli. More specifically, a transitivity program utilizing the gustatory sensory modality was implemented. Stimuli were selected and probed initially preceding the training. First, gustatory stimuli to a visual picture were trained. Then, a visual picture to a spoken word was trained. Finally, once mastery criterion was reached, each participant's responding was tested to determine whether there were derived relations following training. Results showed that all three participants reached mastery criterion in training sessions and were able to derive new relations without direct training.

Keywords Developmental disabilities · Group home · PEAK-E · Verbal behavior

1. This study shows that adults in group home settings can learn complex skills related to verbal behavior via evidence-based teaching strategies.
2. Due to the short implementation time, this study gives implications for adults to utilize evidence-based curriculum on a wide scale to teach communication skills.
3. This study gives implications to the tool that was used, PEAK-E, including that it is practical to use in an applied setting.
4. This study gives implications to current practitioners to seek evidence-based assessments and curriculum when designing verbal behavior-based programs.

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The lifetime cost for caring for someone with autism spectrum disorder (ASD) and an intellectual disability can reach upward of \$2.44 million dollars (Buescher, Cidav, Knapp, & Mandell, 2014). On average, in the USA, 1,609,091 adults over the age of 18 who have been diagnosed with autism also have an intellectual disability. There is a crucial need for a better understanding of the effectiveness and cost-effectiveness of interventions as well as the support arrangements that address the needs of individuals with ASD and their families. Interventions that are based on scientific principles of applied behavior analysis (ABA) are recognized as effective treatments for children with autism (National Autism Center, 2015). Thirty years of research has demonstrated the efficacy of applied behavioral methods in reducing inappropriate behavior and in increasing communication, learning, and appropriate social behavior (Office of the Surgeon General, 2000). More specifically, much of the research has focused on people with disabilities and autism. Within the field of applied behavior analysis, a method of teaching is often utilized called discrete trial training. Discrete trial training (DTT) is a method of teaching in simplified and structured steps. DTT teaches each step of a skill one at a time instead of the entire skill all at once. This has shown to be a successful method of teaching for people with autism and disabilities (Smith, 2001).

While it is common to teach concepts that require direct teaching via DTT, more complex theories can be taught in this manner. Stimulus equivalence (Sidman, 1971) is often taught to people with autism using DTT. For children with autism, this can be especially useful for teaching new forms of behavior and new discriminations. Stimulus equivalence itself refers to the emergence of untaught stimulus relations following a history of reinforcement for relating the stimuli in finite ways. Stimulus equivalence can accelerate learning gains by arranging certain training trials such that they produce the emergence

of new novel responses and relationships between stimuli (Sidman, 1971, 1994). Equivalence relations, defined by the properties of reflexivity, symmetry, and transitivity, provide behavioral criteria for the definition and assessment of meaning and comprehension. Reflexivity refers to the matching of a sample to itself, sometimes called identity matching. Symmetry refers to the reversibility of a relation. Finally, transitivity refers to the transfer of the relation to new combinations through shared membership (Cooper, Heron, & Heward, 1987; Sidman, 1971, 1994). The stimulus equivalence paradigm of reflexivity, symmetry, and transitivity provide economical and effective methods to teach complex repertoires. Although stimulus equivalence research has been shown effective, the use of stimulus equivalence in applied settings with people with autism and other disabilities has been very limited (Rose, Souza, & Hanna, 1996). Research has been especially limited in demonstrating its utility in adults with disabilities.

Since 2011, 27 applied studies on stimulus equivalence have been published in the *Journal of Applied Behavior Analysis* (JABA); of those 27 studies, only 12% were conducted with adults. The stimuli utilized in the 27 studies included pictures, text, letters, numbers, and arbitrary symbols, as well as monetary stimuli (Rehfeldt, 2011). Along with using primarily adolescent participants, all of the previously mentioned studies have exclusively used visual and/or auditory stimuli. Although similar research designs and methods have been utilized, the research capitalizing on stimulus equivalence with adults with autism across sensory modalities is limited.

Some studies have utilized stimulus equivalence procedures to teach equivalence across sensory modalities with typically developing adults. Fienup and Dixon (2006) taught and tested for maintenance of visual-olfactory and visual-visual stimuli relations following equivalence training in college students. Results demonstrated a small advantage to the visual-olfactory training stimulus sets. In an additional study, Hayes, Tilley, and Hayes (1988) examined if stimulus equivalence classes can be formed involving gustatory stimuli, as compared with visual stimuli in typically developing adults. Results showed that equivalence classes eventually formed for all subjects. Results even showed that gustatory-visual conditional discriminations required fewer training trials and equivalence classes based on these discriminations emerged in testing with fewer errors than was the case with visual stimuli.

In an applied example of the use of equivalence training, Toussaint and Tiger (2010) demonstrated something different utilizing stimulus equivalence across sensory modalities to children with degenerative visual impairments. This is one of the few studies that demonstrated stimulus equivalence utilizing something other than visual or auditory stimuli. Following a series of pretests, braille instruction involved providing a sample braille letter and teaching the selection of the

corresponding printed letter from a comparison array. Toussaint and Tiger (2010) then assessed and captured the formation of equivalence classes through tests of symmetry and transitivity among printed letters, the corresponding braille letters, and their spoken names.

In addition to the need for more research using complex learning theories to acquire quicker learning, it has been recognized that individuals with autism and disabilities display sensory-perceptual abnormalities, meaning their senses may be hypersensitive compared to typically developing individuals (O'Neill & Jones, 1997). This gives reason to further study interventions that address sensory modalities other than visual-visual and verbal-visual. To address the limitations that clinicians face, such as lack of a formal training system to teach stimulus equivalence across sensory modalities and tools to utilize with children and adults, the promoting the emergence of advanced knowledge (PEAK) relational training system was developed. It was developed with the intention to create new tools that are logical, empirically validated, and easy to use with people with autism and other intellectual disabilities. There is currently not a standardized protocol available that teaches stimulus equivalence in an applied setting. This training system teaches skills across sensory modalities and is applicable across age groups. The PEAK relational training system is an evaluation and curriculum guide for teaching basic and advanced language skills from a contemporary behavior analytic approach. This evaluation and curriculum guide does not have an age limit nor does it cater to a specific population (Dixon, 2015).

The equivalence module of PEAK (PEAK-E) is part of this training package which is part 3 of 4 total modules. PEAK-E, developed from past literature on stimulus equivalence, gives the experimenter or practitioner an assessment to test for the learner's concepts of equivalence. Following the assessment, this tool gives the practitioner (or researcher in this case) a program guide to choose specific programs to teach the learner, and in an order that is developmentally appropriate. This package is drastically different than any other program guide used in the applied setting (Dixon, 2015).

Much research has been conducted using the direct training module, but research utilizing the equivalence module is still lacking. Dixon, Whiting, Rowsey, and Belisle (2014) showed the relationship between IQ scores and PEAK assessment scores within the direct training module. Results showed that the higher the PEAK assessment score, the higher the IQ of individuals with intellectual disabilities. Research and data has also suggested that PEAK may be especially useful as an assessment and curriculum guide for individuals with autism (Dixon, Belisle, Whiting, & Rowsey, 2014; McKeel, Dixon, Daar, Rowsey, & Szekely, 2015; Rowsey, Belisle, & Dixon, 2015). Current studies are beginning to address the validity of PEAK-E. In one such study, authors taught and tested for acquisition of anatomical equivalent body parts while rule

following. Following the training, three male students with disabilities demonstrated derived rule following (Dixon, Speelman, Rowsey, & Belisle, 2016). An additional study evaluated the use of PEAK-E to teach and test complex mathematical skills in two males with autism. Results showed an emergence of derived relations (Dixon, Belisle, Stanley, Daar, & Williams, 2016). All of the studies listed have included participants ages 5–21. More research on the equivalence module of PEAK is necessary in order to show its success as a tool to teach stimulus equivalence.

The purpose of the current study was to determine if the equivalence module of the PEAK relational training system had utility in teaching relationships between stimuli to adults with developmental disabilities and autism. More specifically, programs from the equivalence module were utilized to teach equivalence using the gustatory sensory modality. Participants were taught to match a sample taste to a picture, then taught to match a spoken word to the same sample picture, and finally examined whether derived relations emerged without direct training of the spoken word to the sample taste. Much research has been conducted with children utilizing these types of programs but extended research is necessary with adults with autism.

Method

Participants and Experimenters

The following participants were selected for this study based on their diagnosis and their minimal problem behaviors. All participants attended a vocational day program throughout the week. Participant 1, George, was a 69-year-old male with a diagnosis of moderate intellectual disability, ASD, and bipolar disorder, along with unspecified anxiety disorder. George was currently living independently in an intermittent community-integrated living arrangement where he received minimal supports. George's most recent IQ score was 67. Participant 2, Adam, was a 23-year-old male with a primary diagnosis of ASD along with a moderate intellectual disability. Adam lived at home with his family and had an IQ score of 55. Adam also participated in an autism-based classroom while attending the vocational day program. Participant 3, Jackson, was a 24-year-old male with a diagnosis of ASD, a moderate intellectual disability, unspecified depressive disorder, and attention deficit hyperactivity disorder (ADHD). Jackson was living in a community integrated living arrangement with four other male clients where staff were available 24 h a day. Jackson's current IQ score was 49. Jackson also had a one on one support staff person due to previous problem behaviors and his high level of activity.

One experimenter conducted all sessions. The experimenter was a graduate student completing her master's degree in

applied behavior analysis. The experimenter had previous experience running discrete trial training sessions, understood the concepts of stimulus equivalence, and utilizing the direct training module of PEAK. A human subjects committee approved the research at the agency and at the university institution.

Setting and Materials

All sessions took place at the day program where the clients attended. Session location varied based on the availability of a quiet area with minimal distractions. A majority of the sessions were implemented within the "autism classroom," in the craft room, or in the resource room so minimal noise and other clients or staff were not present. The PEAK relational training system equivalence module was utilized for all sessions. All data collection sheets, pre-assessments, instructions, and programs for running the sessions were located inside of the PEAK-E module book. Stimuli utilized for teaching gustatory programs were placed into uniform white cups with a small label that was only visible to the experimenter.

Stimuli for the sessions included a variety of edible items, and pictures related to the edible items. Equivalent pictures to edible stimuli were topographically different and included some but not all of the "typical stimuli" listed in the PEAK program 10K. Stimuli with two listed and divided by a backslash indicate that one or the other was used if the participant was too familiar with one of the stimuli in that class. The edibles that were utilized included cheerios, goldfish, M&M's, skittles, raisins, string cheese, sweet tarts, and peanuts. Pictures were 4 × 6 and included wheat/heart, ocean/boat, a chocolate lab, a rainbow/fruit, vineyard/drums, the Eiffel Tower, Wrigley Field, and a martini. Audible stimuli included "health, fish, chocolate, sweet, grape, plane, yummy, ball game."

Measurement, Design, and Interobserver Agreement

Two (a three tier and a two tier) multiple probe designs across participants were conducted. The same procedures were presented in each design, but different stimuli were presented. Interobserver data were collected for at least 30% of the trials by a case manager who had previous experience working with the PEAK programming and the scoring data collection system. Interobserver agreement was 100% for all sessions. All sessions were scored utilizing the data collection sheet that was provided in the PEAK equivalence module manual. Scores were added together and divided by 100 to determine the final percentage. Mastery criteria for each trial block were set at 90%. When the client completed three trial blocks consecutively with 90% mastery criteria or higher, the skill was considered mastered. All responses were scored on a scale of 0, 2, 4, 8, and 10 based on the level of prompting required to

elicit a correct response, by quantity of prompts. A 0 was scored when no response was given after multiple attempts at prompts. A 2 was scored when multiple prompts or reduced stimulus array eventually produced a response. A 4 was scored when two prompts, at most, produced the response with a full stimulus array. An 8 was scored when one single prompt of either verbal or visual nature was given to the participant. A 10 was scored when independent accurate response occurred with no prompt given (Dixon, 2015).

Procedure

The PEAK-E module contains a pre-assessment in the manual. This assessment guides the experimenter through an assessment which uses arbitrary stimuli to test whether the participants have the ability to engage in derived relational responding. Once it was determined that participants did not have those skills, skills were chosen from the manual. A baseline phase was implemented, followed by a symmetry training phase, a transitivity test phase, a symmetry training phase, and ended with a final transitivity test phase. Since the first multiple probe design was missing transitivity probes throughout the phases, a second multiple probe design across two tiers was implemented that included probes. A preference assessment was not required as the participants responded well to praise and the experimenter's verbal correction.

Pre-assessment Short Form

The PEAK equivalence pre-assessment is a brief evaluation that uses arbitrary stimuli to help guide the experimenter in determining the learner's preexisting ability to demonstrate reflexivity, symmetry, transitivity, and equivalence. The pre-assessment was conducted with each client to determine which skills to directly target. The pre-assessment was comprised of two test programs for each relation type and was broken down into categories of basic, intermediate, and advanced. Basic pre-assessment programs utilized visual to visual arbitrary stimuli. Intermediate programs utilized auditory stimuli and the sensory modality of touch. Advanced programs utilized olfactory and gustatory stimuli. Instructions were followed on the assessment programs provided in the module along with utilizing the stimuli provided in the back of the book.

For the basic reflexivity program (assessment), the participant was provided with an arbitrary drawing at the top of the table with two other arbitrary drawings beneath it. The experimenter then asked "Find the same"; the correct response was scored as pointing to the drawing that matched the stimulus placed at the top of the table. For the basic symmetry program (assessment), a yellow marker was presented at the top of the table with two arbitrary drawings beneath it. The experimenter pointed to the yellow marker followed by one of the arbitrary

drawings and stated "This is the same as this." The experimenter then placed the arbitrary drawing at the top of the table with a coin and yellow marker below it and stated "Find the same." A response was scored correct if the participant selected the yellow marker. For the basic transitivity program (assessment), three spoons were placed at the top of the table with the words "yud," "kej," and "fra" beneath them. The experimenter pointed to the spoons, then to yud and stated "This is the same as this." Yud was then presented at the top of the table with kej, "eed," and fra beneath it. The experimenter pointed to yud, then to kej and stated "This is the same as this." The experimenter then presented the three spoons at the top of the table with fra, eed, and kej beneath them and was asked to "find the same." A correct response was scored as yes if the participant answered kej.

Pre-assessment Gustatory

The pre-assessment programs that utilized gustatory stimuli were tested due to the fact that this was the skill being targeted. The pre-assessment was scored with the assessment form provided and scored ranging from 0 to 2. A 0 was scored if the learner responded incorrectly to two questions, one for one correct, and two for both correct. The scores from the pre-assessment were then utilized as a benchmark for where to begin training. The authors chose to complete the short-form pre-assessment rather than both short-form and full assessment as the purpose of the current study was to probe the level of each relation the participant could engage in rather than receive a complete score on their ability to perform each of the 184 skills in the manual.

Baseline Test

One program was selected based on the assessment results, 10K transitivity: gustatory, visual, and auditory. A test trial was conducted with each client prior to training to determine if the skills being taught were previously in the participant's repertoire. The test trials consisted of 10 trials where each participant earned no reinforcement or consequences during testing and a score of either 0 or 10 per trial, 0 was recorded if incorrect responses and 10 was recorded for correct responses. Reflexivity testing for stimuli was not formally trained due to mastery of the skill during pre-assessment sessions. When testing symmetry relation A-B (gustatory to picture), an edible stimulus was presented along with three comparison pictures placed on the table in front of them; the statement "Find the same" was delivered. The participant was required to point to the picture that matched the edible stimulus provided. When testing for symmetry relation B-C (picture to auditory), a picture was presented on the table in front of them followed by the statement, "What is this?" The participant was required to vocalize the correct response. Correct and incorrect responses

were noted on the program sheet for the experimenter. Following test trials, training began.

Correct and Incorrect Responses

When training began, the same procedures were utilized from baseline test trials. During training, prompts and reinforcement were provided to each participant. For each session, verbal praise of “great job,” “Yes!” or “Good” were paired with high fives, handshakes, and/or fist bumps for independent correct responses (10 scored). If an incorrect response was given, the experimenter would state “Try again” and represent the question and stimuli utilizing least to most prompting to evoke a correct response.

Symmetry Train

Training began with teaching the selection of an edible stimulus in the presence of an “equivalent” picture on a 4×6 card (A-B). An edible stimulus was presented along with three comparison pictures placed on the table in front of them; the statement “Find the same” was given. The participant was required to point to the picture that matched the edible stimulus provided. Prompting and reinforcement was provided contingent upon varying responses. After mastery criterion was achieved, a picture on a 4×6 card was then trained to an auditory word (B-C). A picture was presented on the table in front of the participant followed by the statement, “What is this?” The participant was required to vocalize the correct response. Again, reinforcement and/or least to most prompting was utilized contingent upon the participant’s response as stated above in the train section, until mastery. Mastery was met when the participant responded with at least 90% accuracy for three consecutive trial blocks.

Transitivity Test

Upon reaching mastery criterion of A-B relations and B-C relations, each participant was then administered a final trial. In the final test trial, participants were expected to demonstrate derived relations with the absence of previous training A-C. The participant was presented with one of the edible stimuli and then asked “what did you taste?” The participant was expected to vocalize the correct response listed on the program form. Three sessions were conducted across participants when testing A-C, the same mastery criterion of 90% or higher was applied before termination.

Post-test

After training was conducted and each participant reached mastery criterion, the gustatory programs of the pre-assessment were

readministered. The programs were readministered in the same manner as the initial pre-assessment.

Results

Results in Fig. 1 showed that all three participants demonstrated equivalence following reflexivity and symmetry training. All participants responded at 0–40% accuracy during baseline while meeting mastery criterion relatively quickly during symmetry training. Jackson and George needed a maximum of three sessions to acquire symmetry in each relation while Adam took more sessions to meet criterion for B-C training. Although some differences in level or stability were seen across subjects, the general pattern of responding was consistent. A-B and B-C probes were taken throughout the study to show that the results occurred only when the training occurred, but then maintained following the training. As A-C probes were missing prior to A-C testing in Fig. 1, a second multiple probe design was implemented to show control over the responding.

Figure 2 shows a multiple probe design across two participants. Baseline levels in both tiers were between 0 and 10% accuracy in responding. Mastery criterion of 90% accuracy across three consecutive sessions was met quickly in each symmetry relation training phase. A-C transitivity testing showed at least three consecutive sessions of mastery criterion met following training. Symmetry and transitivity probes throughout the design showed that the participants did not display equivalence until after the symmetry training. In Figs. 1 and 2, all participants showed stability during baseline and that they did not previously have the skills being taught within their repertoires. All participants also demonstrated the ability to maintain the skill previously taught when moving on to another training phase.

Figure 3 shows a bar graph of pre-assessment short-form scores before and after the study. The short-form version of the pre-assessment was administered to Jackson, Adam, and George and determined that all participants would begin with the transitivity program due to their prior learning history and ability to complete the symmetry and reflexivity programs. Pre-assessment scores of the gustatory programs prior to and after training are displayed in Fig. 3. There were only three gustatory programs that were administered with a maximum possible score of 6. All participants showed an increase in score after training on the program that was conducted.

Table 1 displays the amount of trials it took to reach mastery criterion for each participant. Jackson was able to

Fig. 1 A multiple probe design was conducted across participants

demonstrate mastery criterion in six trial blocks when trained on relation A-B with an average score of 95% accuracy. Jackson then reached mastery criterion in five trials when trained on relation B-C with an average score of 96% accuracy. George was able to demonstrate mastery criterion when trained on relation A-B in seven trial blocks with an average of 96% accuracy. He then reached mastery criterion in four trial blocks for relation B-C with an average of 97% accuracy. Finally, Adam was able to demonstrate mastery criterion in eight trial blocks with an average score of 93% accuracy. He then demonstrated mastery criterion in 11 trial blocks with an average score of 94% accuracy. All participants were able to demonstrate mastery criterion when tested on the A-C relation for three consecutive trial blocks.

Discussion

The results demonstrate that PEAK equivalence module has support that it was a useful tool in teaching equivalence to adults with developmental disabilities. The use of the gustatory sensory modality also supported that stimulus equivalence could be trained outside of just verbal to visual stimuli or visual to visual stimuli, which is typically conducted (Rehfeldt, 2011) to train language skills. Though studies have evaluated other sensory modalities by training and testing for successful equivalence (Fienup & Dixon, 2006; Hayes et al., 1988), the current study showed application using an assessment and curriculum guide in the applied setting.

Fig. 2 A second multiple probe design was conducted across two participants

These experiments demonstrated that this tool was effective in teaching that some foods can be equivalent to other stimuli including words and pictures. Following teaching simple stimuli that are deemed equivalent such as those in this study, teaching other gustatory stimuli may have more meaning. Practitioners and researchers may teach these individuals that particular foods or stimuli are dangerous or unsafe when initially they may lack the judgment typically necessary to make these choices. This is especially important for individuals in this population who are under supervision but potentially have opportunity to live on their own. Generalization and responding to novel stimuli during this skill must be trained and tested to make for a natural and practical application.

Fig. 3 Pre-assessment scores of the gustatory programs prior to and after training are displayed above

A main limitation of the current study was that transitivity probes were not present in the first three tier multiple probe designs; however, a second multiple probe design was conducted to include these probes. When this occurred, probes remained at 0% accuracy prior to completion of symmetry training which implied that the results were due to the training itself. Figure 1 shows symmetry probes and baseline level probes were evident prior to the training and remained high (above mastery of 90% correct) following that particular training, which implied that the results were due to the training.

Another limitation of the study was that George had a history of reinforcement with some stimuli. His prior learning history had shaped his ability to develop certain relations and this was displayed when the initial A-B training began. This was evident because with the initial stimuli used, George responded with accurate words when seeing the pictures. Therefore, alternative stimuli were identified for him (noted in materials section). Mid-training, Adam stated that he did not like the gustatory stimuli that were being provided. These stimuli were then removed and replaced with more preferred items to maintain compliance. When using gustatory stimuli, some participants may not prefer the taste of particular items,

Table 1 Trial blocks to criterion

Participants	A-B	B-C
Jackson	6	5
George	7	4
Adam	8	11

which may result in extraneous variables influencing the data. It is recommended that the experimenter gather data on whether any of the gustatory stimuli are particularly non-preferred to the participant prior to training. A final limitation of the study was that Jackson often engaged in non-compliance. Jackson refused programming and often asked the instructor if they were done. Although this did not reflect in his scores or ability to reach mastery criterion, non-compliance and impulse behaviors often affect this population.

Although some limitations were identified in the current study, the analysis of this data leads to important future implications and practice in this area. First, training- and testing-derived relations across sensory modalities are an important process to understand. It is imperative that researchers continue this research and practice. This is especially true for individuals with developmental disabilities who hold deficits in their vocal ability to respond. Limiting teaching stimuli to vocal and visual senses may limit the extent of teaching that can be done. Second, utilizing evidence-based assessments and treatment curricula is important to base behavioral interventions from. With continued research in the area of PEAK-E, as well as the other modules, researchers will be able to identify limitations and the validity of this as a tool in research and practice. This study showcases the utility of utilizing this tool in the applied setting. Third, utilizing equivalence training procedures to teach adults with language disabilities to respond functionally is important. Though much research focuses on children with autism, adults who reside in group home settings will benefit from communication training and equivalence-based procedures that will result in quick acquisition. Finally, as this is the first study to publish findings from the pre-assessment included in the PEAK-E, researchers should evaluate the validity of the short-form assessment as an assessment tool.

Utilizing PEAK relational training system as a tool to assess and teach verbal language skills to adults with autism and developmental disabilities can be useful in that it is very practical to use and data suggest quick acquisition of functional communication skills. It is the responsibility of practitioners and researchers to discover the most efficient and evidence-based interventions to improve functional verbal skills of these individuals. Continuous use and research of this tool should avail.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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Ethical Approval All applicable international, national, and/or institutional guidelines for the care and use of animals were followed. All procedures performed in studies involving human participants were in

accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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