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A Case Application of Equivalence-Based Instruction to Teach Idiomatic Expressions to a Child with Neurofibromatosis Type-1

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Abstract: Previous research indicates equivalence-based instructioncan be applied to teach a variety of educational and language skills to children. The current project examined the application of equivalence-based instruction to teach three sets of idiomatic expressions of emotion to a five-year-old male with neurofibromatosis type 1. Relations between the emotion, a standard idiomatic expression, and a color-based idiomatic expression were taught directly using a standard discrete trial training procedure. Post-tests indicated that the child reliably acquired symmetrical relations between the name of the emotion and standard and color-basedidioms they corresponded to.Transitiverelationsemerged between standard idiomatic expressionsand color based idiomatic expressions to a lesser extent. The new idiomatic expressions also emerged in relation to a novel picture based on a preexisting relationship between stimuli without additional training. These results were replicated across three sets of stimuli.Limitations and future directions for research are discussed.

Keywords:stimulus equivalence, idiomatic expressions, language training, neurofibromatosis type 1

Introduction

Stimulus equivalence is a behavioral phenomenon when certain relations between stimuli emerge without direct training after training on only some relations between stimuli (Mullen, Dixon, Belisle, & Stanley, 2017).Equivalence-based instruction (EBI) refers to the application ofthis technology to teach skills of academic and practical relevance (Brodsky & Fienup, 2018). For example, a student may be taught to select a picture of a ball when given the spoken word "ball" (A to B relation between stimuli). Next, they would be taught to match the picture of ball to the printed word "ball" (B to C relationship between stimuli). After these initial relations are taught and if equivalence emerges, the student would be able to show the emergence of several untrained relations between these stimuli. Examples of emergence relations would include being able to label the picture of the ball (B to A relationship), match the printed word ball to the picture of the ball (C to B relationship), select the printed word "ball" from a field when given the spoken word "ball" (A to C relationship) and lastly read the printed word "ball" (C to A relationship) after training. The reliable emergence of these relations can save instructors time and improve the efficiency of student learning. EBI has been used to teach a variety of academic skills in areas such as mathematics (Hammond, Hirt, & Hall, 2012), music (Hill, Griffith, & Miguel, 2019), geography (Carp, & Petursdottir, 2015), and language (Zaring-Hinkle, Carp, & Lepper, 2016).

Three types of relations between stimuli emerge after EBI: symmetry, transitivity, and equivalence relations. *Symmetry* refers to bi-directional relationships between two stimuli that emerge after training only in one direction (Dixon, Belisle, Stanley, Daar, & Williams, 2016). Using the example above, if a student was taught make an auditory discrimination to select the printed word "ball"when given the spoken word "ball" (A-B relation), a symmetrical relation would emerge when the student was able to themselves vocally label the printed word "ball" (B-A relation). Similarly, after the student is taught to match the printed word "ball" to a picture of a ball (B-C relation) symmetry would be evidenced by the student being able to match the picture of the ball to the printed word (C-B relation). A *transitive* relation between stimuli occurs when the student derives an additional relation between stimuli A and C based on their common training with stimulus B (Amd, de Almeida, de Rose, Silveira, & Pompermaier, 2017). In the example above, transitive relations would occur when the student can select the picture of a ball given the spoken word "ball" (A-C relation) and vocally label the picture of a ball themselves (C-A relation). When all of these relations emerge, the stimuli are said to function interchangeably with one another in an *equivalence class*.

Specific examples of language skills taught with EBI include teaching labeling to children learning a second language (Rosales, Rehfeldt, & Huffman, 2012), antonyms (Pérez- González, García- Asenjo, Williams, & Carnerero, 2007), question answering (Shillingsburg & Frampton, 2019), and spelling (Tanji &

Noro, 2017). One area that has not received much attention is the use of EBI to teach idiomatic expressions. Idioms are phrases that mean something different than what their individual words indicate when taken literally(Bortfeld, 2003). For example, an individual may state they "are feeling down" or they are "feeling blue" to indicate they feel sad. Idioms are present in many languages and are used fluently by native speakers of that language (Thyab, 2016). Due to their ubiquitous nature in language, instruction in idiomatic expression is considered important to individuals learning English as a second language (Liontas, 2017). In the first attempt to apply EBI to teaching idioms, Eberhardt (2016) used equivalence-based instruction to teach idiomatic expressions to two participants with developmental delays. Participants were taught to respond to questions (i.e., "what's another way to say go to bed?") using an idiomatic expression (i.e., "hit the hay"). Although participants were able to acquire the directly taught relations (A to B and B to C),the participants did not reliably display the emergence derived relations (A to C and C to B) between idiomatic expressions and regular statements.

EBI has been used to teach individuals from numerous populations including children with autism, college students, children with learning deficits, individuals with pathological gambling, and individuals without a clinical diagnosis (Rehfeldt, 2011). One condition that is associated with language deficits that EBI has not been applied with is individuals with neurofibromatosis type-1 (NF-1). NF-1 is one of the most common genetic conditions found in children with an estimated prevalence of 1 in 3500 people. A number of dermatological and neurological issues are common to NF-1 such as brown patches on the skin (café-au-lait spots), tumors, and skeletal abnormalities (Boyd, Korf, & Theos, 2009). NF-1 is also associated with a higher prevalence of other developmental disorders such as autism spectrum disorder, attention-deficit hyperactivity disorder, and behavioral issues (2009). Some of the most common complications of NF-1 are neurocognitive deficits that can include visual-spatial deficits, motor deficits, and verbal and non-verbal language disorders (Williams et al., 2009).

The majority of the research literature on teaching idiomatic expression is focused on teaching those learning English as a second language (e.g., Chen & Wu, 2017; Freyn, & Gross, 2017). Little research is available on the use of instructional procedures to teach idiomatic expression to individuals in their native language who have not yet or are struggling to acquire idiomatic expressions. Therefore, the purpose of the current project was to investigate the use ofa simple EBI procedure to facilitate the emergence of untaught idiomatic expressions to a child with NF-1. Additionally, we examined whether or not idiomatic expressions would emerge after initial training to a pictorial representation of an emotion that was already in the child's repertoire.

Method

Participant, Setting, and Stimuli

The participant in this project was a five-year-old male (Larry) with a diagnosis of NF-1. The current project was completed during the COVID-19 pandemic in an effort by Larry's parents to provide education using evidence-based procedures while school was cancelled. Larry's parents, who were the first and second author, consented to report the results. Assent was also gained from Larry prior to the start of teaching sessions. Larry was provided a diagnosis of NF-1 after café-au-lait spots were noticed at 6 months by his pediatrician and genetic testing later confirmed a mutation on chromosome 17. At the time of the project, Larry was not yet enrolled in kindergarten but attended a pre-kindergarten class at a local school five days a week. Teachers generally reported adequate academic functioning in this setting along with the occasional disciplinary issue (i.e., shoving a peer). Larry had not been referred for neurological or neuropsychological testing at the time of this project. Larry's language had not been formally assessed, but it was noted in informal observations that Larry did not understand some idiomatic expressions that were utilized in day to day conversation.

The setting for the current project was a 15x10' room in Larry's home that contained a table and chairs. Larry commonly used the table to complete homework and other tasks. All sessions were conducted by Larry's parents. Teaching sessions ranged from 5 to 10 minutes and 2 to 4 sessions occurred per day. The teacher sat across from Larry when completing the testing and teaching trials. Three sets of emotions, regular idiomatic expressions, color-based idiomatic expressions, and a picture of an individual expressing that emotion were utilized in the project (see Table 1).

Table 1: Classes of stimuli used in the current project

	A	B	C
Class	*Standard Emotion Label*	*Standard Idiom*	*Color-based Idiom*
1	Sad	Down in the dumps	Feeling blue
2	Happy	On cloud nine	Tickled pink
3	Mad	Bent out of shape	Red in the face

Procedure

Pre-test Probes. Five 12-trial blocks were conducted for a total of 60 pre-test probes. Pre-test probes were conducted in the absence of instruction or reinforcement for responding to questions. Larry was given intermittent praise and reinforcement for attending to the instructor on a VI-2 minuteschedule in this and all conditions below. The instructor sat across from Larry and probed questions using the idiomatic expressions that were used in the project ("What's another way to say you're feeling blue?"). The answersto the questions were those that should emerge after EBI training on some of the statements in the projectas illustrated in Figure 1.

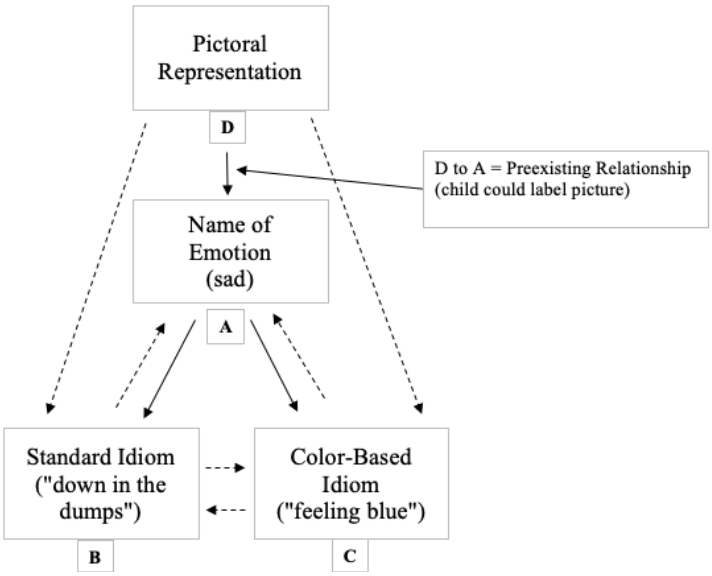

Figure 1: Relations that were taught (solid lines) and relations that emerged (dotted lines) after training in the current project.

Picture Pre-test Probes. In addition to the pre-test probes described above, three pictures that Larry could label correctly with an emotion (i.e., "she feels sad") were identified. The instructor showed the picture to Larry and asked, "how does this person feel?" After this, the instructor asked, "What is another way to say how that person feels?" or "What is a colorful way to say how that person feels?". Picture pre-test probes were conducted four times for each picture in one 12-trial block. Pictures that Larry could label at 80% or above but could not provide an idiomatic expression for (a score of 0%) were included in the project.

EBI Teaching. EBI trials were conducted by the instructor for A to B and B to C relations. After gaining Larry's attention, the instructor asked a question (i.e., "What's another way to say you feel sad?"). Contingent on a correct response ("down in the dumps"), descriptive verbal praise was provided (i.e., "That's correct-down in the dumps is another way to say you feel sad"). Contingent on an incorrect response, the instructor provided a vocal prompt using least to most prompting. In early trials during EBI teaching, the instructor would provide a part of the correct response as a prompt (i.e., "Feeling bl…"). As the project progressed, prompts were faded out to smaller portions of the desired response. A correct response was defined as Larry verbally stating the complete matching response to the question delivered by the instructor. Incorrect responses were defined as any response other than Larry verbally stating the complete matching response to the question including responses that had to be prompted in any manner. Table 2 shows example questions utilized during the EBI and posttest probes.

Table 2. Example of questions used to teach and probe relations in the current project.

Relation	Example Training Question
A to B	What's another way to say someone is sad?
A to C	What's a colorful way to say someone is sad?
Mix	Mix of both above
Relation	**Example Pre/Post-test Question**
B to A	If someone says they are down in the dumps, how do they feel?
C to A	If someone says they are blue, how do they feel?
B to C	What's a colorful way to say someone is down in the dumps?
C to B	What is another way to say someone is blue?

D to B	What's another way to say how he (in the picture) feels?
D to C	What's a colorful way to say how he (in the picture) feels?

One session consisting of a 15-trial block was completed at a time for A to B relations. After three consecutive trial blocks in which Larry scored 80% or higher on all A to B relations, training was initiated on A to C relations. After mastery was achieved on A to C training, both A-B and A-C training trials were interspersed in 12 trial-blocks until Larry reached at least 75% accuracy across each relation for 3 consecutive trial blocks. Following mastery on mixed trial blocks, post-test probes and picture post-test probes were conducted.

Post-test. Post-test probes were conducted after training on all relations was complete and were conducted in the same manner as the pre-test probes. No reinforcement was provided for responses in the post-test probes.

Picture Post-test Probes. After EBI instruction and post-test probes were complete, post-test probes with the pictures were conducted. Picture post-test probes were conducted in the same manner as the picture pre-test probes that were described above. Figure 2 presents a visual outline of the procedure of training, teaching, and probing for emergent relations in the current project.

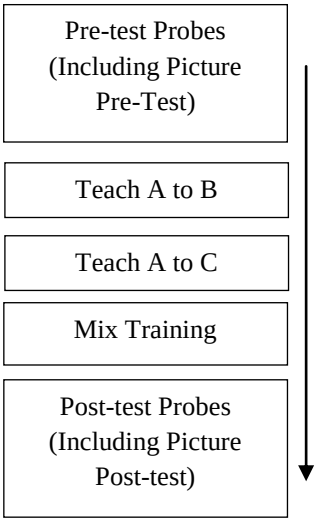

Figure 2*:* Order of pre-test probes, training sessions, and post-test probes in the current project

Interobserver Agreement. Interobserver agreement (IOA) was taken by one of the two authors not completing the training or probing trials on 21% of probing and EBI training sessions. The second observer was seated out of sight away from Larry and the instructor. IOA was calculated using the total count method in which the smaller number of observed correct responses was divided by the larger number of correct observed responses. IOA for all sessions was 100%.

Results

Results for pretest and posttests for all stimulus classes are presented in Figures 3-6. For the stimulus set for the emotion "sad," correct responses ranged from 0% to 20% (*M*=5%) onpre-test probes between emotions and idiomatic expressions. For the stimulus set for the emotion "happy," correct responses ranged from 0% to 20% (*M*=10%) on pre-test probes between emotions and idiomatic expressions. For the stimulus set for the emotion "mad," correct responses ranged from 0% to 60% (*M*=15%) on pre-test probes between emotions and idiomatic expressions.Picture pre-test probes were 0% for both of the probed idiomatic expressions.

Correct responses on post-test probes for the stimulus set of "sad" ranged from 20% to 100% (*M*=65%) for all emergent relations between idiomatic expressions and names of emotions. Correct responses on post-test probes for the stimulus set of "happy" ranged from 40% to 100% (*M*=70%) for all emergent relations between idioms and emotions. Lastly, correct responses on post-test probes for the stimulus set of "mad" ranged from 40% to 100% (*M*=75%). Scores on picture post-tests between the color-based idioms and the picture ranged from 75% to 100% (*M*=92%). Scores on picture post-tests between the regular idioms and the picture ranged from 25% to 50% (*M*=33%).

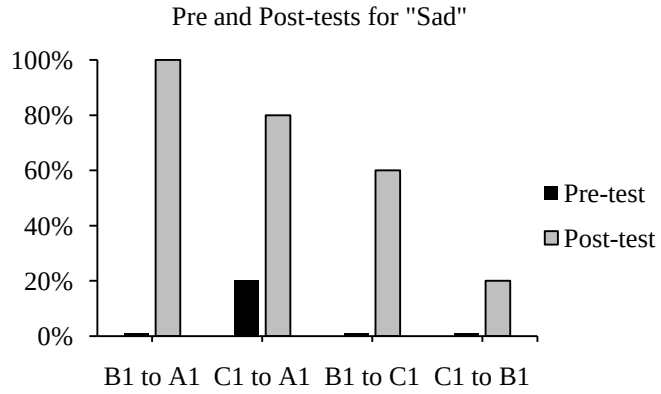

Figure 3: Pre and post-test scores for emergent relations for the stimulus class "sad."

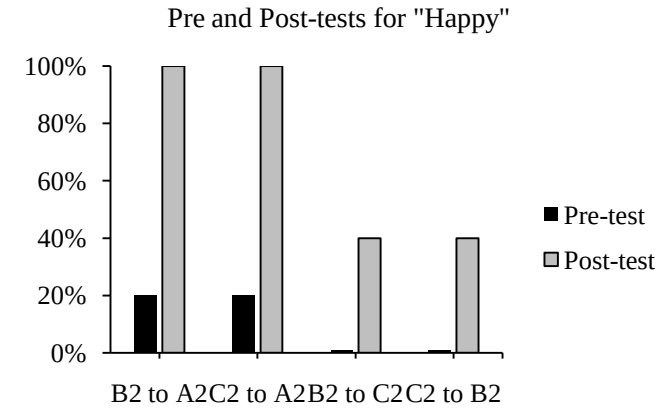

Figure 4: Pre and post-test scores for emergent relations for the stimulus class "happy."

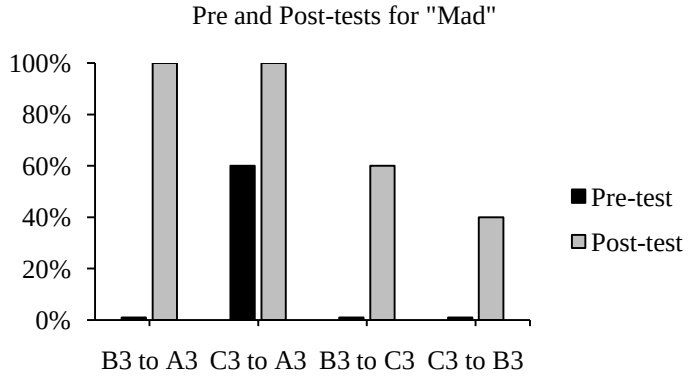

Figure 5*:* Pre and post-test scores for emergent relations for the stimulus class "mad."

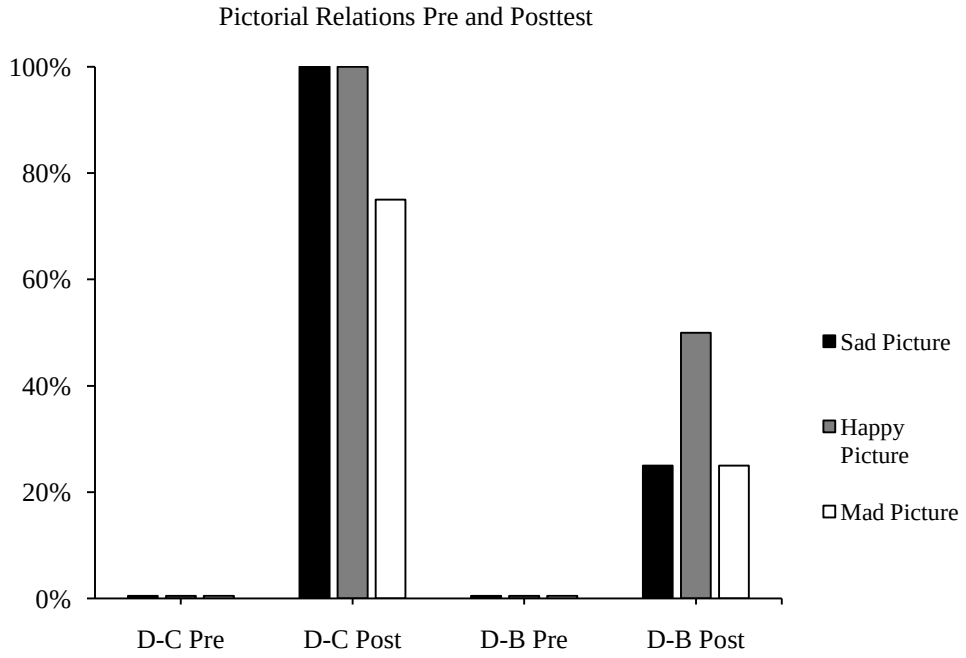

Figure 6*:* Pre and post-test scores for emergent relations between idioms and pictorial example of emotion

Discussion

Results of this project indicate that EBI was effective for facilitating the emergence of symmetrical relations between idiomatic expressions of emotions and labels for those emotions for all three sets of stimuli. EBI was less effective for facilitating the emergence of transitive and equivalence relations between the novel idiomatic expressions after training, but all showed improvement over pre-test scores. Results also indicated that the EBI procedure was effective in facilitating the emergence of relations between color-based idiomatic expressions and a picture that Larry could previously label without additional training and,to a lesser extent, standard idiomatic expressions and the picture.

These results are somewhat similar to those described by Eberhardt (2016) in that some, but not all relations emerged between idiomatic statements and regular statements taught with EBI. In the current project, remedial training was not necessary to facilitate the emergence of untaught relations to some degree for all classes of stimuli. In general, symmetrical relations between idiomatic expressions and labels of emotions emerged to a much higher degree than transitive or equivalence relations between the two types of idiomatic expressions. On picture post-test probes, color-based idioms emerged to a much higher degree than standard idioms. One reason for the difference in emergent relations between idiomatic expressions could have been the similarity in the questions that the instructor provided to Larry (i.e., "what's another way you could say __?" versus "what's a colorful way to say __?"). Future research should change the questions in such a way that they are more easily discriminated between by learners involved in EBI instruction.

Conclusions

The current project expands the literature on EBI by demonstrating its efficacy in teaching relations between idiomatic expressions and other stimuli without the need for remedial training. To our knowledge, it is also the first in which EBI has been applied with a child with NF-1, a common genetic disorder associated with neurocognitive deficits and language impairments. Although the present project is limited to one participant, the results are promising in that a brief teaching procedure facilitated the emergence of relations between idiomatic expressions and labels of emotions without explicit training. Further, some of these idiomatic expressions were able to be applied to a novel picture in a manner the participant was not able to do prior to EBI instruction. The information in the current project describes the application of EBI by a child's parents to teach skills during the COVID-19 pandemic. Futureformal research should continue to examine the conditions necessaryand extent to which EBI facilitates the emergence of relations between stimuli outside of those taught during EBI based on pre-existing relations between stimuli. This information can further improve the efficacy in which EBI procedures can help teach skills to learners and consequently save valuable instructional time.

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