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BRIEF REPORT

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The Use of Multiple Exemplar Instruction to Induce Emergent Listener Discriminations and Emergent Intraverbal Vocal Responses in Autistic Children

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Abstract

This study tested for the emergence of listener discriminations and intraverbal vocal responses following tact training with four autistic children. All participants were trained to tact the name and the favorite food of two contrived cartoon monsters in the presence of a picture of the monster (e.g., "What is the name of this monster?" – "Max" and "What food does the monster eat?" – "Sweets") to evaluate the effects of emergent listener discriminations and emergent intraverbal vocal responses. Once criterion was met on the tact training, participants were tested for emergent listener discriminations (e.g., "Who eats sweets?" And "Who is Max?") and emergent intraverbal vocal responses (e.g., "What food does Max eat?" – "Sweets" and "Who eats sweets?" – "Max" in the absence of the picture). After training, all four participants engaged in emergent listener responding but only one participant engaged in emergent intraverbal responding. Multiple exemplar instruction (MEI) was used to teach those who could not engage in emergent intraverbal responding, and it was demonstrated to be effective. These findings are educationally significant because efficiency of instruction is important to maximize instructional impact, and to reduce the time and resource-intensive nature of behavior-analytic programming.

Keywords Listener discriminations · Intraverbal · Tact training · Emergent verbal behavior · Multiple exemplar instruction

Promoting emergent behavior is a critical feature of effective behavior-analytic programming (e.g., Greer & Ross, 2008; Rehfeldt & Barnes-Holmes, 2009). Emergent behavior is defined as the acquisition of a new behavior not directly taught or reinforced but is the result of teaching a different behavior (Aguirre et al., 2016).

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In the absence of promoting the relevant verbal behavior skills that produce generative or emergent responding, a consumer must be directly taught all responses which would substantially limit their skill acquisition and result in highly inefficient programming. Therefore, arranging instruction to promote emergent responding is implicated and enjoys a growing body of behavior analytic research (e.g., Hotchkiss & Fienup, 2020; Jennings & Miguel, 2017; May et al., 2012; Rosales et al., 2011).

Emergent behavior can be predicted based on an analysis of stimulus equivalence framework first described by Sidman (1971). The framework, based on reflexivity, symmetry, and transitivity, suggests that if stimulus A is taught to be equivalent to stimulus B, and stimulus A is taught to be equivalent to stimulus C, then what should emerge without direct teaching is that stimulus B is also equivalent to stimulus A and stimulus C is also equivalent to stimulus A (symmetry). Subsequently, stimulus B is also equivalent to stimulus C and vice versa (transitivity). There are numerous forms of emergent behavior children need to become independent learners.

Emergent listener discrimination refers to the emergence of listener behavior following the direct teaching of corresponding speaker behavior (e.g., Fiorile & Greer, 2007; Lowe et al, 2002). Using the stimulus equivalence framework described above, emergent listener discriminations refer to the B-A and C-A symmetrical relations.

Another area of emergent behavior which has been a focus for researchers is emergent intraverbal responding. A number of studies have tested for the emergence of intraverbals following tact training (e.g., Belloso-Diaz & Perez-Gonzalez, 2015; May et al., 2012; Petursdottir & Haflidadottir, 2009). In these experiments, tact training was implemented to produce emergent intraverbal responding. The relations A to B and A to C were directly taught as tacts, and the transitive relation B to C (and C to B) were tested for the emergent intraverbals.

May et al. (2012) taught three autistic adolescents two verbally controlled tacts in the presence of a picture of a monster (A). In this experiment, when children were asked, "What is the name of this monster?" they were taught to respond with "Simon" (B). When they were asked, "What food does this monster eat?" they were taught to respond with "chips" (C). Once responding had met the mastery criteria for these two tact responses, they assessed for the emergence of the two intraverbal responses, "What food does Simon eat?" – "chips" (B-C) and "What monster eats chips?" – "Simon" (C-B). The three adolescents demonstrated the emergence of the intraverbals.

Similarly, Belloso-Diaz and Perez-Gonzalez (2015) taught three typically developing children (aged 5–6 years) two verbally controlled tacts in the presence of a picture (A-B and A-C). Subsequently the participants were tested for the emergence of the two intraverbals (B-C and C-B) in the absence of the picture and reinforcement. The three children demonstrated the emergence of the intraverbals in the absence of pictures.

In some cases, however, researchers have shown that intraverbals did not emerge even when their studies were designed to demonstrate that phenomenon. Petursdottir and Haflidadottir (2009) showed that tact training was not successful in producing emergent intraverbal responding in two, 5-year-old, neurotypical children (though one participant did demonstrate emergent intraverbal responding for the B-C

relation, but not the C-B relation). There is a dearth of research regarding how emergent intraverbal responding can be induced.

Multiple studies have demonstrated that emergent verbal behavior can be induced following the implementation of a multiple exemplar instruction (MEI) procedure (e.g., Fiorile & Greer, 2007; Greer et al., 2005; Olaff et al., 2017). LaFrance and Tarbox (2019) described the MEI procedure as the rapid and random rotation of instruction across different operants over numerous sessions to induce emergent behavior. For example, if emergent listener discrimination is the target following direct tact training, then MEI consists of rotating instruction across listener and speaker behaviors. The behaviors targeted in the MEI procedure should vary according to the targeted behavior that is being induced.

Allan et al. (2015) successfully demonstrated the emergence of reverse intraverbals with autistic children using a procedure similar to MEI. In contrast, Lechago et al. (2015) showed that MEI was not successful in inducing emergent intraverbal responding following listener training. In their experiment, however, participants were taught listener discriminations rather than tacts, their study evaluated categorization, and their MEI procedure did not include tact training though it did include the intraverbal. Because of these inconclusive findings, further investigation is needed to determine what variables influence the effectiveness of MEI.

The purpose of the current study was to extend research conducted by May et al. (2012) and Belloso-Diaz and Perez-Gonzalez (2015) on emergent intraverbal responding, while also testing for emergent listener discriminations, using MEI as the independent variable. Autistic children participated in the current study and were tested for emergent listener intraverbal responding following tact training. If there was no evidence of emergent behavior, then we introduced an MEI procedure which involved alternating instructions across tact, listener, and intraverbal behaviors.

Method

Participants and Setting

Four males with developmental delays and an independent diagnosis of autism participated in the study. Alfie, Bob, and Callum were aged 6, and Doug was aged 5. They were included in the study based on a robust intraverbal responding, specifically answering questions and responding to behavior chains, and rapid acquisition of tacts without requiring prompts. Table 1 displays a summary of the intraverbals mastered by each participant.

The study was conducted in an independent day school for autistic children. Sessions were conducted in the participants' classrooms and sessions were conducted one to two times per day, five to 10 times per week. Other people were present, but the environment was quiet.

Table 1 Summary of the types of intraverbals mastered by each participant

Participant	Answering a question	Social interchanges	Translations	Word associations	Behavior chains
Alex	✓	✓	✓		✓
Bob	✓				✓
Callum	✓				✓
Doug	✓		✓		✓

Materials

Pictures of monsters were used in this study. The use of contrived stimuli ensured that the participants had no experience with the selected stimuli. Pictures were printed on paper measuring 10 cm x 7cm in size and displayed color illustrations of cartoon monsters. The color illustrations are shown in Table 2. There were four sets of stimuli with each set including two monsters.

Dependent Variable

The dependent variable in this study was the number of correct emergent listener discriminations (B-A and C-A) and the number of correct emergent intraverbal vocal responses (B-C and C-B), as shown in Fig. 1 (the dashed lines) and described further in Table 3 (the tested relations).

Procedure

The diagram in Fig. 2 illustrates the experimental procedure along with the set of stimuli corresponding to each stage.

Probe The experimenter asked the participants to answer questions concerning the A-B-C relations for each stimulus shown in Table 3. The probe included all four sets of stimuli described in Table 2. Each relation was tested once for each participant, and the order of the presentation was randomized across participants.

Set 1 Tact Training (A-B and A-C) The tact training sessions consisted of teaching the A-B and A-C relations for each of the two monsters in Set 1. The experimenter presented a picture of the target monster and the vocal antecedent, "What is the name of this monster?" and, "What food does this monster eat?" Correct responses were vocally praised, and incorrect responses were corrected by the experimenter. A correct response was defined as responding within 3 s with a 1-word vocal response to the experimenter's question, e.g., "Max" in response to "What is the name of this monster?" and the experimenter presenting the picture of Max. An incorrect response was defined as any other response other than the target behavior, or no response within 3 s of the presentation of the antecedent. For clarity, an incorrect

Table 2 Sets 1–4 of stimuli used during tests and training sessions

Picture	Name	Food
Set 1		
	Max	Sweets
	Joy	Apples
Set 2		
	Sam	Grapes
	Joe	Biscuits
Set 3		
	Lee	Crisps
	Elle	Banana
Set 4		
	Bob	Pizza
	Cass	Cheese

response also included an approximation of the correct response (e.g., "Mark" instead of "Max") and repeating the question and providing the response (e.g., "What is the name of the monster Joy"). The correction involved repeating the vocal antecedent and modeling the correct response for the participant to imitate. Corrected responses were not reinforced. This continued until the participant's responding met the mastery criterion of 18/20 correct responses over two consecutive sessions or 20/20 for one session. Each training block consisted of 20 trials, comprised
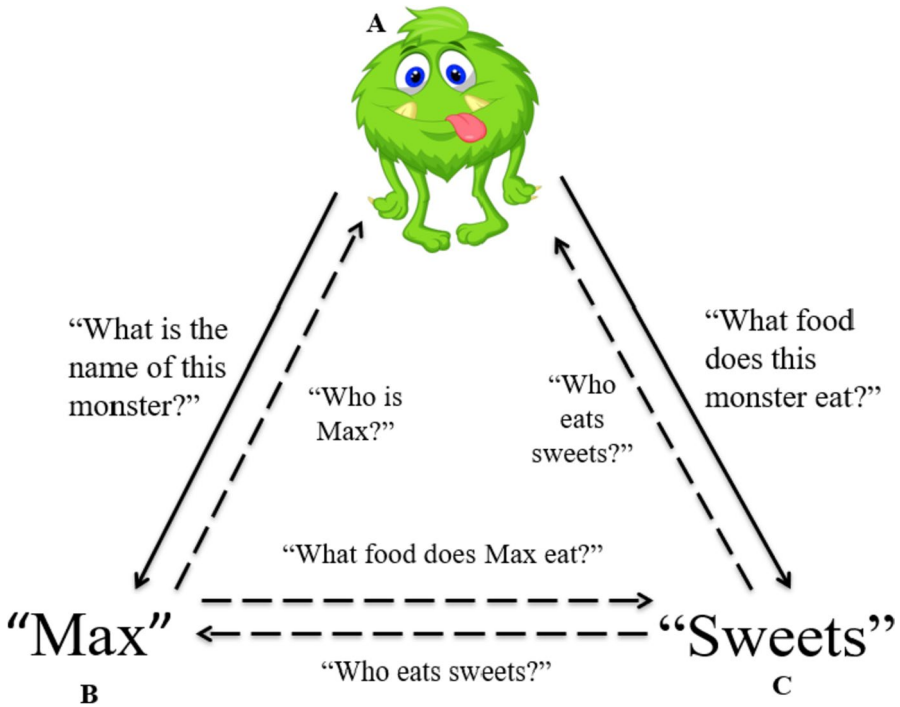
Fig. 1 Diagram to show tact and intraverbal relations taught and tested

of 10 for each monster, split into five questions relating to the A-B relation and five for the A-C relation.

Set 1 Test for Emergent Responding (Pre-Test) Testing for emergent responding involved asking the participants to answer four questions related to emergent responding (listener discriminations (e.g., B-A and C-A) and intraverbal vocal responding (B-C and C-B)) for each stimulus in one set (two monsters). Correct responses were not reinforced, and incorrect responses were not corrected. Participants who did not respond correctly to all four questions in this test for emergent responding continued to the MEI Procedure.

MEI Procedure (Set 2) MEI was conducted with participants if responding did not reach the mastery criterion for the emergence of the listener discriminations or the intraverbal vocal responses. Set 2 stimuli were rotated across tacts, listener discriminations, and intraverbal responding. See Table 4 for an example of a teaching sequence. Data were collected in blocks of 20 presentations, and each block included 3 or 4 questions relating to each of the verbal responses. Correct responses were reinforced, and incorrect responses were corrected by the experimenter by repeating the vocal antecedent and modeling the correct response for the participant to imitate. The mastery criterion was 18/20 correct responses for two consecutive sessions.

Table 3 The trained and tested relations, stimuli and correct responses for Set 1

| Type	Relation	Stimuli		Correct response
		Picture	Vocal question	
Trained	A1-B1 Tact-training		"What is the name of this monster?"	"Max"
Trained	A2-B2 Tact-training		"What is the name of this monster?"	"Joy"
Trained	A1-C1 Tact-training		"What food does this monster eat?"	"Sweets"
Trained	A2-C2 Tact-training		"What food does this monster eat?"	"Apples"
Tested	B1-A1 Listener discrimination	Target picture presented in a field size of four alongside 2 foils (not included in the study) and the second monster included in the current set.	"Who is Max?"	
Tested	B2-A2 Listener discrimination	Target picture presented in a field size of four alongside 2 foils (not included in the study) and the second monster included in the current set.	"Who is Joy?"	
Tested	C1-A1 Listener discrimination	Target picture presented in a field size of four alongside 2 foils (not included in the study) and the second monster included in the current set.	"Who eats sweets?"	
Tested	C2-A2 Listener discrimination	Target picture presented in a field size of four alongside 2 foils (not included in the study) and the second monster included in the current set.	"Who eats apples?"	
Tested	B1-C1 Intraverbal	None	"What food does Max eat?"	"Sweets"
Tested	B2-C2 Intraverbal	None	"What food does Joy eat?"	"Apples"
Tested	C1-B1 Intraverbal	None	"Who eats sweets?"	"Max"
Tested	C2-B2 Intraverbal	None	"Who eats apples?"	"Joy"
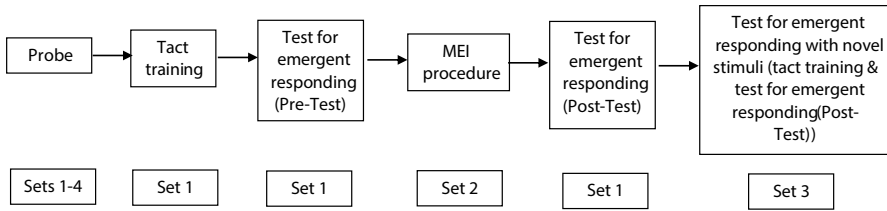
Fig. 2 Diagram to show experimental procedure and stimuli utilised in each phase

Sessions were typically conducted in sets of 20 trials. A break was then provided to the participant. A second set of 20 trials was conducted if the participant remained motivated to respond to the stimuli.

Test for Emergent Responding (Set 1 Stimuli; Post-Test) The test for emergent responding was repeated after responding met the mastery criterion for the MEI procedure, using Set 1 stimuli (different stimuli to those used in the MEI procedure). If the participant did not demonstrate listener or tact responding during the four probes, the MEI produce was re-introduced using Set 4. Following mastery of the MEI procedure with Set 4 stimuli, emergent responding was re-assessed with Set 1.

Test for Emergent Responding with Set 3 Stimuli (Post-Test) An additional test for emergent responding was conducted using Set 3 stimuli. This test consisted of tact training and the test for emergent responding (listener discriminations and intraverbal responses).

Design

A pre-test–post-test design was used. For each participant we conducted pre-MEI probes to assess for emergent responding with Set 1 stimuli. MEI was then conducted with Set 2 stimuli. After responding met the mastery criterion during MEI, we re-assessed emergent responding with Set 1. A final assessment of emergent responding was conducted with Set 3 stimuli.

Interobserver agreement

Interobserver agreement was calculated for 72% of the test sessions, tact training, and MEI sessions across all participants by dividing the number of responses for which the experimenter and a second observer agreed on the outcome (i.e., agreements), by the sum of the agreements and disagreements, multiplied by 100. The tested relations (dependent variables) and trained relations, as described in

Table 4 Example teaching sequence for the MEI procedure

Teaching sequence	1st presentation	2nd presentation	3rd presentation	4th presentation
1	Tact: What is the name of this monster? *With picture* (Sam)	Listener discrimination: Who is Joe?	Intraverbal: Who eats grapes? (Sam)	Intraverbal: What food does Joe eat? (biscuits)
2	Intraverbal: What food does Sam eat? (grapes)	Tact: What food does this monster eat? *With picture* (biscuits)	Listener discrimination: Who eats biscuits? (Joe)	Tact: What is the name of this monster? *With picture* (Joe)
3	Listener discrimination: Who is Sam?	Intraverbal: Who eats biscuits? (Joe)	Tact: What food does this monster eat? *With picture* (grapes)	Listener discrimination: Who eats grapes? (Sam)
4	Intraverbal: Who eats grapes? (Sam)	Tact: What is the name of this monster? *With picture* (Sam)	Intraverbal: What food does Sam eat? (Grapes)	Listener discrimination: Who eats biscuits? (Joe)
5	Tact: What food does this monster eat? *With picture* (biscuits)	Intraverbal: What food does Joe eat? (biscuits)	Tact: What is the name of this monster? *With picture* (Joe)	Listener discrimination: Who is Joe?

Table 3, were included in this calculation. The interobserver agreement was 100% across all sessions.

Results and Discussion

Results for all participants across each test for emergent responding are presented in Fig. 3. None of the participants responded correctly to the initial probe trials. Alfie's responding met criterion in the tact training phase (A-B, A-C) after 3
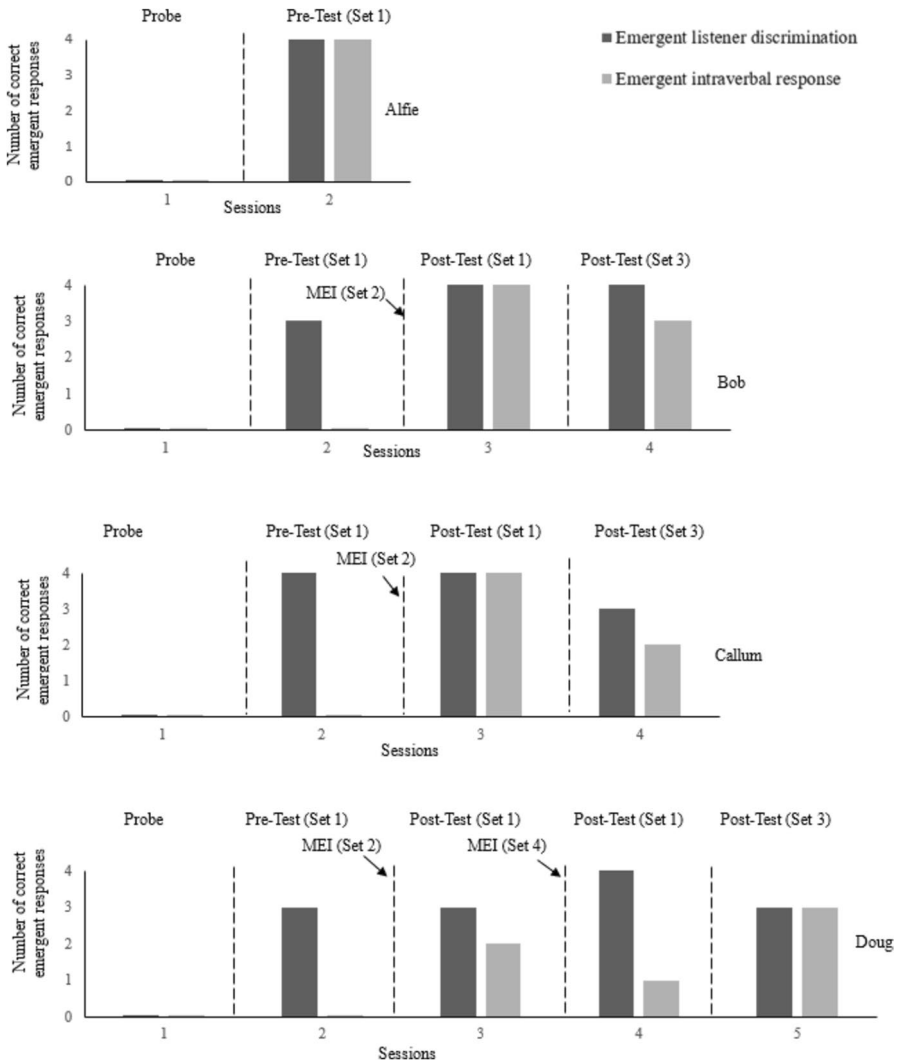

Fig. 3 Correct responses for probes, pre-tests, and post-tests for emergent responding for each participant

blocks of tact training (60 presentations). Following tact training he demonstrated emergent listener and intraverbal responses. Therefore, MEI was not implemented for Alfie as he already demonstrated emergent responding. These findings support the existing literature on emergent responding (Belloso-Diaz & Perez-Gonzalez, 2015; Lowe et al., 2002; May et al. 2012).

During the initial test for emergent responding for Bob, Callum, and Doug, emergent listener discriminations were observed, but not emergent intraverbal responding. The MEI intervention was therefore implemented. During the post-MEI test for emergent responding, Bob and Callum demonstrated emergent listener and intraverbal responding. The assessment for emergent responding using Set 3 stimuli also demonstrated that they engaged in emergent listener and intraverbal responding.

Correct responding in the subsequent post-MEI test for emergent responding for Doug only increased marginally. The MEI procedure was therefore repeated with Set 4 stimuli. Following this second set of MEI, another post-MEI assessment for emergent responding was conducted with Set 1. Doug demonstrated emergent listener discriminations but not emergent intraverbal responding. A test with Set 3 stimuli (tact training and test for emergent responding) was conducted and Doug demonstrated both emergent and intraverbal responding.

Results for Bob, Callum, and Doug showed that teaching tacts resulted in emergent listener discriminations, but not emergent intraverbal vocal responses. However, when these participants were exposed to the MEI procedure, they emitted emergent intraverbal responses.

The study had a few limitations. First, a more robust experimental design needs to be employed to demonstrate a functional relationship between MEI and emergent intraverbal responding. Second, the participants all demonstrated emergent listener discriminations in the initial test for emergent responding, so the MEI procedure may not have required the inclusion of listener discriminations. The MEI procedure could have involved a rotation of tact and intraverbal responses only to reduce unnecessary training time but still induce emergent intraverbal responding.

Future research on MEI and emergent responding could include a comparison group that only receives repeated testing for emergent responding. Correct emergent responding may increase with repeated testing, and this may be more efficient than MEI.

Additionally, the participants' prerequisite skills should be considered. Table 1 shows that Alfie demonstrated a broader range of intraverbal responses compared to Bob, Callum, and Doug at the initial stage of the experiment. This broader range of intraverbals may explain why emergent intraverbal responding was demonstrated for Alfie pre-MEI. The question remains whether the focus should be to improve an individual's intraverbal skills prior to testing for emergent behavior or to implement a procedure, such as MEI, to aim to facilitate it. Finally, follow-up post-tests for emergent responding in a naturalistic setting would be a useful addition to the experimental design. It was suggested by Rosales et al. (2011) to use a more "naturalistic approach" (e.g., naming items in a picture book) to further evaluate the emergence of untaught verbal behavior.

Although our conclusions must be stated with some caution due to the non-experimental design of the current study, these findings lend some support to previous

research and illustrate the potential for language skills to be taught utilizing procedures that focus on emergent responding, therefore reducing the number of teaching trials required for participants to master an objective (May et al., 2012). For participants who did not respond correctly to the emergent relations, MEI was shown to be a potentially useful procedure for facilitating emergent intraverbal vocal responding. Emergent verbal behavior should be viewed as a crucial goal when designing curricular objectives for children with and without disabilities as the generalization of skills and efficiency of instruction is an important consideration for curricular design.

Data availability Data that support the findings are available from the corresponding author upon reasonable request.

Declarations

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

Ethical approval Ethics approval is in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. Consents were obtained from participants' parents prior to the commencement of the study.

Informed consent The study was approved by the School's Ethics Committee and signed consent was obtained from the participants' parents. Participants' assent was also obtained.

References

Aguirre, A. A., Valentino, A. L., & LeBlanc, L. A. (2016). Empirical investigations of the intraverbal: 2005–2015. *The Analysis of Verbal Behavior, 32*, 139–153. https://doi.org/10.1007/s40616-016-0064-4

Allan, A. C., Vladescu, J. C., Kisamore, A. N., Reeve, S. A., & Sidener, T. M. (2015). Evaluating the emergence of reverse intraverbals in children with autism. *The Analysis of Verbal Behavior, 31*, 59–75. https://doi.org/10.1007/s40616-014-0025-8

Belloso-Diaz, C., & Perez-Gonzalez, L. (2015). Effect of learning tacts or tacts and intraverbals on the emergence of intraverbals about verbal categorization. *Psychological Record, 65*, 749–760. https://doi.org/10.1007/s40732-015-0145-0

Fiorile, C. A., & Greer, R. D. (2007). The induction of naming in children with no prior tact responses as a function of multiple exemplar histories of instruction. *The Analysis of Verbal Behavior, 23*, 71–87. https://doi.org/10.1007/BF03393048

Greer, R. D., & Ross, D. E. (2008). *Verbal Behavior Analysis: Inducing and Expanding Complex Communication in Children with Severe Language Delays*. Allyn & Bacon.

Greer, R. D., Stolfi, L., Chavez-Brown, M., & Rivera-Valdes, C. (2005). The emergence of the listener to speaker component of naming in children as a function of multiple exemplar instruction. *The Analysis of Verbal Behavior, 21*(1), 123–134. https://doi.org/10.1007/BF03393014

Hotchkiss, R. M., & Fienup, D. M. (2020). A parametric analysis of a protocol to induce bidirectional naming: Effects of protocol intensity. *The Psychological Record, 70*(3), 481–497. https://doi.org/10.1007/s40732-020-00383-5

Jennings, A. M., & Miguel, C. F. (2017). Training intraverbal bidirectional naming to establish generalized equivalence class performances. *Journal of the Experimental Analysis of Behavior, 108*(2), 269–289. https://doi.org/10.1002/jeab.277

LaFrance, D. L., & Tarbox, J. (2019). The importance of multiple exemplar instruction in the establishment of novel verbal behavior. *Journal of Applied Behavior Analysis, 53*, 10–24. https://doi.org/10.1002/jaba.611

Lechago, S. A., Carr, J. E., Kisamore, A. N., & Grow, L. L. (2015). The effects of multiple exemplar instruction on the relation between listener and intraverbal categorization repertoires. *Analysis of Verbal Behavior, 31*, 76–95. https://doi.org/10.1007/s40616-015-0027-1

Lowe, C. F., Horne, P. J., Harris, F. D., & Randle, V. R. (2002). Naming and categorization in young children: Vocal tact training. *Journal of the Experimental Analysis of Behavior, 78*, 527–549. https://doi.org/10.1901/jeab.2002.78-527

May, R., Hawkins, E., & Dymond, S. (2012). Brief report: Effects of tact training on emergent intraverbal vocal responses in adolescents with autism. *Journal of Autism and Developmental Disorders, 43*, 996–1004. https://doi.org/10.1007/s10803-012-1632-7

Olaff, H. S., Ona, H. N., & Holth, P. (2017). Establishment of naming in children with autism through multiple response-exemplar training. *Behavioral Development Bulletin, 22*, 67–85. https://doi.org/10.1037/bdb0000044

Petursdottir, A. I., & Haflidadottir, R. D. (2009). A comparison of four strategies for teaching a small foreign language vocabulary. *Journal of Applied Behavior Analysis, 42*, 685–690. https://doi.org/10.1901/jaba.2009.42-685

Rehfeldt, R. A., & Barnes-Holmes, Y. (2009). *Derived relational responding: Applications for learners with autism and other developmental disabilities*. New Harbinger Publications.

Rosales, R., Rehfeldt, R. A., & Lovett, S. (2011). Effects of multiple exemplar training on the emergence of derived relations in preschool children learning a second language. *The Analysis of Verbal Behavior, 27*, 61–74. https://doi.org/10.1007/BF03393092

Sidman, M. (1971). Reading and auditory-visual equivalences. *Journal of Speech, Language, and Hearing Research, 14*, 5–13. https://doi.org/10.1044/jshr.1401.05