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RESEARCH ARTICLE

A Treatment Evaluation of Successive and Simultaneous Visual Stimulus Presentation During Tact Training with Children with Autism

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Abstract
The purpose of this study was to assess whether variations in visual stimulus presentation during tact training would affect efficacy, efficiency, and the emergence of listener responses. Participants included two preschool-aged children diagnosed with autism. We implemented two teaching conditions using an adapted alternating treatment design with intrasubject replications. During successive tact training, the experimenter presented one picture per trial. During simultaneous training, the experimenter pointed to the target picture in a stimulus array. For one participant, both procedures were similarly effective and efficient. For another participant, successive tact training generated fewer errors and better efficiency results. Moreover, both formats resulted in accurate listener responding. Our results suggest that both procedures are effective, and that the simultaneous format may be a viable alternative for teaching tacts.

Keywords Autism · Listener · Stimulus Control · Tact · Verbal Behavior

The tact is a type of verbal behavior whose response form (i.e., what is said, written, signed, and so on) is under the control of a nonverbal stimulus, such as an object, event, or a stimulus property, which can be in any modality (Skinner, 1957). When learning tacts, reinforcement is usually generalized, such as social praise and attention from the verbal community, as this is necessary for behavior to come under discriminative rather than motivational control. Tacts seem to be an essential component of many social interactions (Bak et al., 2021; Marchese et al., 2012). For

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example, when a child says, "There's a kitty," a parent may jointly attend to the cat, smile at the child, and say, "You're right." Once established, tacts are reinforced by "the action which the listener takes with respect to that verbal response" (Skinner, 1957, p. 151).

Developmentally, tacts seem to depend on the acquisition of both listener and echoic behaviors (Greer & Keohane, 2006; Horne & Lowe, 1996). As children develop (typically at 18 to 30 months), stimulus classes come to occasion both speaker and listener responding after only one of those relations has been directly trained (Greer & Longano, 2010; Horne & Lowe, 1996; Miguel et al., 2008). For example, if children are taught to select a book when their mother asks, "Get your book," they may also respond as speakers in the presence of that same object by saying, "Book." This interdependence seems to allow children to learn tacts simply by hearing parents talk about objects or stimulus properties (Horne & Lowe, 1996; Miguel, 2016).

Given the developmental importance of tacts, they are often included in programs aimed at teaching vocal verbal behavior to children with autism spectrum disorder (ASD; e.g., Dixon, 2014; Lovaas, 2003; Sundberg & Partington, 1998). Current tact training recommendations emphasize the use of differential reinforcement of independent versus prompted responses, and generalization strategies such as teaching in the natural environment and pairing social and nonsocial reinforcers (Bak et al., 2021; LeBlanc et al., 2006). Moreover, clinicians must consider the learner's previous experience with specific conditions, as their reinforcement history may affect the efficiency of a given training protocol (Coon & Miguel, 2012; Roncati et al., 2019). Other procedural parameters to consider include the number of targets in a set (Kodak et al., 2020; Vladescu et al., 2020), the inclusion of observing responses (Devine & Petursdottir, 2022), task sequencing presentation (Cuvo et al., 1980, Grow & LeBlanc, 2013; Wunderlich et al., 2014), and different visual stimulus presentation formats (Cuvo et al., 1980). However, there is limited information on how to present visual stimuli.

During vocal tact training, visual stimuli (e.g., pictures or objects) are usually presented in a successive format, during which only a single visual stimulus is shown in each trial (e.g., Delfs et al., 2014, Frampton et al., 2017, Kelley et al., 2007). In a successive tact training trial, a child may respond (correctly or incorrectly) or not respond at all in the presence of the stimulus (Kimble, 1961). This training format does not require scanning an array. As such, any errors on this task would be errors to the target stimulus only, like nonresponses or incorrect tacts (e.g., saying "cat" in the presence of a picture of a dog; Terrace, 1963). Another possible variation is the simultaneous format, in which multiple visual stimuli are shown in each trial (e.g., Cuvo et al., 1980; Lowe et al., 2002; Miguel et al., 2008). Within these trials, the target stimulus is determined by the experimenter (usually by pointing to it), so both the target (i.e., the picture the experimenter points to) and nontarget stimuli (i.e., other pictures in the array) are presented at the same time (Butter & Snyder, 1982; McIlvane, 2013; Pierce & Cheney, 2008). In this format, the participant learns to vocally respond to the target and not to the non-target (Cuvo et al., 1980; Terrace, 1963). This requires some form of scanning behavior, as participants must attend to the target stimulus within an array. Additionally, this format physically resembles a listener trial in which an auditory stimulus is presented (i.e., the name of one stimulus) with an array of pictures or objects. Theoretically, teaching participants to tact using a simultaneous format may generate more robust emergent listener responding, as the two tasks would resemble each other (Capaldi, 1966).

In the only study assessing visual stimulus presentation during tact training, Cuvo et al. (1980) compared successive, simultaneous, and a combined method using a between-groups design. They conducted three experiments with college students, typically developing children, and children with developmental disabilities, in which they taught participants to vocally respond to pictures of three nonarbitrary stimulus classes (i.e., names of coins). For the successive condition, they presented one picture at a time with serial target presentation sequencing. In the simultaneous condition, they presented trials with an array of five stimuli, all of which were targeted concurrently (Cuvo et al., 1980). In the combined training, the experimenter introduced targets successively first. Once participants made six correct responses, tacts for those targets were trained in the simultaneous method (in an array of 3–5 stimuli). The dependent variables were participants' tact accuracy on posttests and training efficiency as measured by trials to criterion. Consistent across groups, the successive method led to the fastest acquisition of tacts as measured by trials to criterion, though participants who received simultaneous or combined training responded with higher accuracy on posttests (Cuvo et al., 1980).

The results obtained by Cuvo et al. (1980) must be interpreted with caution. First, the training conditions varied both visual stimulus formats and task sequencing presentation methods, so the specific effects of visual stimulus format on skill acquisition remain unclear. Next, unequal exposure to reinforcement throughout training trials may have affected posttest accuracy (Cuvo et al., 1980). Further, their tact training procedures did not conform to current standards for teaching children with disabilities, which include fading prompts and delivering differential reinforcement for independent responses (Bak et al., 2021; Green, 2001; Karsten & Carr, 2009). Notably, the researchers did not test for the emergence of listener behavior following tact training, which seems clinically relevant given that children with disabilities may benefit from learning to respond as both speakers and listeners to the same stimuli (e.g., Miguel, 2016; Contreras et al., 2020). Therefore, an important consideration would be identifying tact training methods which are more likely to generate listener responding for specific individuals.

Thus, the purpose of the current study was to assess the effectiveness of successive and simultaneous visual stimulus presentations during tact training. We equated reinforcement exposure across methods by yoking the training blocks of the mastered set to equitable reinforcement exposure opportunities across formats prior to maintenance posttests. We also incorporated current practices for teaching children with ASD (Bak et al., 2021), such as a progressive prompt delay and differential reinforcement for correct versus prompted responses. More specifically, the current study evaluated the efficacy, efficiency, and generalizability of tact training across the two visual stimuli presentation formats, the efficacy of each training method, and the emergence of listener behavior across presentation methods.

Method

Participants and Setting

Participants were two children with ASD, Gio (6 years old) and Martin (5 years old). They were receiving behavior analytic services for approximately 9 and 10–12 hours per week, respectively. For inclusion in the study, participants needed to score at 30+ months age equivalent on the Peabody Picture Vocabulary Test (PPVT; Williams, 2007) and Expressive Vocabulary Test (EVT; Dunn & Dunn, 2007). Participants also needed to score at or above Level 1 (0–18 months) on the Tact Milestone in the Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP) and Level 2 (18–24 months) on the Echoic Milestone (Sundberg, 2014).

Gio scored at Level 3 on the Tact and Echoic Milestones, and Martin scored at Level 2 on Tact and Echoic Milestones. At the time of the study, Gio's ABA sessions included two lessons in which visual stimuli were presented successively (one tact training lesson and one imitation lesson) and one lesson in which visual stimuli were presented simultaneously (one tact training lesson set in the natural environment). Martin was being exposed to two lessons in which visual stimuli were presented successively (two tact training lessons with pictures) and three lessons in which visual stimuli were presented simultaneously (two listener responding lessons and one motor imitation lesson with an array of objects).

Sessions were scheduled so that there were no more than three days in between them. When lapses in training occurred for longer than the prescribed schedule (4 lapses for Gio and 3 lapses for Martin), participants were provided with a refresher training, during which additional training trials were presented until correct independent responding reached levels equal to or greater than the previous training trial. For Gio, sessions were conducted three times per week, for 30 minutes and took place in a clinic setting. With Martin, sessions were conducted three to five days per week, for 35–50 minutes in the home.

Materials and Target Selection

For data collection, we used paper, a pencil, and a laptop camera to videotape all sessions. Picture stimuli were colored, laminated, and consisted of plants and animals (9 x 9 cm; see Table 1) of which the experimental name was unknown to the participant, with the experimenter typically choosing the scientific name as the assigned tact for the study. We selected stimulus sets to be taught individually, as each stimulus was eligible for inclusion if the participant could echo its name within two attempts. When identifying stimuli sets, we accounted for the number of syllables in each condition, overlapping sounds, novelty, and visual properties to equate them (see Cariveau et al., 2021). This controls for four of five relevant criteria for logistical analysis, excluding the number of syllables in individual targets. If participants tacted any of the stimuli in a set during pretests, then that set was replaced

Table 1 Picture stimuli

Gio			
Cashew Oyster Tacca			
Jaca Gooty Wombat			
Anna's Coati Taya			
Fiddle Aster Marmot			
Martin			
Jaca Mantis Wombat			
Fiddle Aster Ibex			
Snub Canna Gooty			
Jade Motmot Oyster			

Stimuli with uncommon names. All names are two syllables and do not start with the same phonemes within a set. Sets were individualized based on participants' echoic responding entirely. We attached pictures with Velcro to either white or colored foam boards, measuring 45 cm wide x 30 cm long during testing and training, respectively.

In preliminary assessments, we presented six pages of colored (blue, yellow, red, green, purple, and orange) construction paper (22 cm x 28 cm). Also, we presented eight items that the caregiver had indicated may have been preferred for each participant (see Pre-Experimental Procedures below). The experimenter provided access to high-preferred items when participants completed their token boards (e.g., laminated paper with icons velcroed on; 10 cm x 12 cm). Participants were already using those token boards with a pre-established exchange schedule (Gio earned 9 tokens and Martin earned 5 tokens) prior to the onset of the experiment.

Response Measurement

We collected data on dependent variables which measured efficacy, efficiency, generalization, and transfer/emergence. Training efficacy was measured as tact posttest accuracy during tact probes and the number of errors in each condition. Throughout training and testing, the experimenter scored each tact response as prompted (i.e., correct vocalizations within 6 s following the prompt), correct (i.e., independent vocalizations of experimenter-defined names within 6 s), or incorrect (no response within 6 s or irrelevant vocalizations). The experimenter scored emergent listener responses as correct (i.e., the participant selects the target picture when given its dictated name) or incorrect (i.e., the participant does not select the target picture). We calculated the number of errors by adding the total number of errors per condition.

Training efficiency was measured by the number of training trials to criterion and the total training time (Schnell et al., 2018). Trials to criterion were calculated by adding the number of trials necessary until the participants independently vocalized the correct names of the pictures in the set. Mastery criterion was set at a minimum of 89% correct independent tact responses across two blocks (with no repeated errors on a single stimulus) in which token reinforcement was delivered on FR1 and FR3 schedules, and above 89% on a tact probe block. The schedule was thinned to prepare participants for the following tact probe. Total training time was measured as the training duration to reach mastery criterion for a stimulus set. The experimenter started the timer once they prompted an orienting response (e.g., saying the child's name and/or asking if the child was ready) and stopped the timer once the last token for the condition was delivered. Emergence of listener responding was measured as the percentage of correct selection responses in listener posttests.

To measure generalization to the untrained visual stimulus presentation format, we presented a tact probe in the untrained format and collected data on the percentage of correct independent tact responses.

Interobserver Agreement

A second observer collected interobserver agreement data (IOA) on participants' responding from live or prerecorded sessions. Interobserver agreement was collected for 33% of all blocks across all conditions for each participant. We calculated trial-by-trial IOA by dividing the total number of trials in agreement by the total number of trials. For listener and tact training trials, agreement was defined as both observers scoring the response as correct or as incorrect at the same prompt level (e.g., prompted or independent). Disagreements were defined as trials in which observers scored differently, with respect to accuracy or prompt level. We calculated interobserver agreement (IOA) by dividing the number of agreements by the sum of agreements and disagreements multiplied by 100%. Interobserver agreement for Gio was 99% (range 89–100%), and 98% (range 89–100%) for Martin during both comparisons.

Procedural Fidelity

We collected data on procedural fidelity across 33% of blocks on a trial-by-trial basis. A trial was defined as correctly implemented when the stimulus array was presented as prescribed by the data sheet with the relevant instruction, prompts, and the appropriate consequence. If any of these components were implemented incorrectly, the whole trial was scored as incorrect. We calculated fidelity by dividing the number of correct trials by the total number of trials and multiplying by 100. Mean procedural fidelity for Gio was 97%, (range 89–100%) and 98% (range 78–100%) for Martin.

Experimental Design

An adapted alternating treatments design (Sindelar et al., 1985; Kodak & Halbur, 2021) with an intrasubject replication was embedded within a nonconcurrent multiple-baseline design across participants (Watson & Workman, 1981). Each comparison consisted of tact and listener pretests, alternated tact training blocks for two sets of stimuli (i.e., Set 1 was associated with the successive condition and Set 2 was associated with the simultaneous condition), tact and listener posttests, and tact and listener maintenance (Cariveau et al., 2021). The first participant completed the baseline probes once and the second participant completed the baseline probes twice. We did not continue initial tact probes until responding reached stability to minimize participants' prolonged exposure to the pictures and their names which could create a testing threat to internal validity (Kazdin, 2010; Terrace, 1963).

Pretest probe presentation order was determined randomly for each participant, within the constraint that tact probes must have preceded listener probes. The presentation of tact training conditions was counterbalanced within participants and across participants (White et al., 2004). Both tact training conditions were associated with a color which varied across participants to control for individual histories of reinforcement with colors. Probes were later presented following training (posttests) to assess if responding would persist in the absence of reinforcement. On posttests, we probed the set in the trained tact format (e.g., successive), in a listener probe, and in a tact probe which utilized the untrained visual stimulus presentation format (e.g., simultaneous). All probes were repeated in the maintenance phase.

Procedure

Preliminary Assessments

Initially, we administered a modified Reinforcer Assessment for Individuals with Severe Disabilities questionnaire (RAISD) to the participants' parents to identify preferred items (Fisher et al., 1996). During the first session, we conducted a Multiple Stimulus Without Replacement preference assessment (MSWO) to determine the participants' preferences for leisure items (DeLeon & Iwata, 1996). The MSWO included arrays of eight toys for Martin and Gio. At the beginning of each session and after each reinforcer interval, the experimenter provided participants with a choice between three of their highest-preferred items (Carr et al., 2000; Egel, 1981) as identified by the MSWO (DeLeon & Iwata, 1996). The experimenter conducted a color preference assessment, as detailed in Heal and Hanley (2007), to control for participants' preferences in the selection of colors which served as condition-correlated stimuli. From the assessment, the experimenter calculated selection percentages and preference rankings (Fisher et al., 1992). The experimenter selected two colors with similar preference rankings to randomly assign to each of the training conditions, in this individualized manner for the participants.

To assess for language skills, the experimenter conducted a simultaneous discrimination pointing assessment to ensure that participants could follow a point to a stimulus in a simultaneous tact probe. This was one nine-trial block in which the experimenter pointed to a stimulus on the foam board in an array of three previously mastered targets while simultaneously saying, "What is it?". If the participant tacted correctly, token reinforcement was delivered on an FR1 schedule. The criterion to master this assessment was 89% correct across one block. The experimenter administered the *Peabody Picture Vocabulary Test - 4th Edition* (PPVT-4), which assesses the participants' responding on tasks in which they select the relevant stimulus from an array when given its name (listener responding, Dunn & Dunn, 2007). The experimenter also administered the *Expressive Vocabulary Test – 2nd Edition* which measured the participants' vocal tact responding when presented with a picture stimulus (speaker responding, Williams, 2007). Both assessments were administered according to the test protocols and scored according to the guidelines.

Experimental Procedures

Each participant completed two experimental comparisons for a within-subject replication. We conducted listener and tact probes during pretests, posttests, and maintenance. During tact training, blocks of each condition were alternated via a randomization phone application with no more than two consecutive blocks of the same condition, until performance criterion was met for one of the sets. After participants reached mastery criterion on one set, the experimenter conducted a listener probe on that set. Training on the set in acquisition and yoked blocks of the mastered stimulus set continued until mastery criterion was met for the set on acquisition, or until the number of training trials reached twice the number of trials needed for the mastered set. When this occurred, the experimenter used the presentation method that was learned in fewer trials to criterion to teach the unmastered set to eliminate the possibility that failure was due to the characteristics of the stimuli. Between all tact training and tact probe blocks of dissimilar visual formats (e.g., a successive training block then a simultaneous training block), the experimenter gave participants a 3–4-min parallel-play break (Cengher et al., 2014). Maintenance probes were conducted two weeks after each comparison was completed. The participants were not exposed to the training stimuli during the 2-week period following each comparison.

Tact Probes

Successive Tact Probes Successive tact probes were administered as pretests, posttests, and maintenance. The experimenter presented a foam board and initiated the testing trial when participants looked directly at the foam board for 1–2 seconds. If participants did not independently look at the board, the experimenter pointed to it, and said, "Look here." Once the orienting response was made, the experimenter flipped the board to show one picture, pointed to the picture, and asked, "What is it?" The positions of the pictures were counterbalanced so that each one was targeted three times per block, no target stimulus was presented in two consecutive trials, and the target picture appeared in each location an equal number of times (Da Hora et al., 2019). The experimenter varied the instructions so that three instructions ("What is it?", "What's this called?", and "What's that one?") were presented at least once within a block (Stokes and Baer, 1977). The experimenter provided neutral social feedback for responding (e.g., "Okay," "Alright," "Thanks"). If no response occurred within 6 s of the vocal instruction, the experimenter said, "Okay" and then presented the next trial.

After every third trial, the experimenter presented a tact trial with a familiar stimulus. Correct tact responses to familiar stimuli resulted in praise and a token associated with access to high-preferred items. The purpose of interspersing familiar tact targets was to maintain responding during the probe condition (Grow & LeBlanc, 2013). To meet mastery criterion during training, participants needed to score a minimum of 89% on a tact probe. If participants scored less than 89% without prompts, we resumed training at the 4-s prompt delay.

Simultaneous Tact Probes Simultaneous tact probes were administered as pretests, posttests, and maintenance blocks. This condition was like the successive probe condition with two exceptions. First, the experimenter presented a foam board with *three* pictures following an observing response of the participant. The experimenter pointed to one of those pictures in the same manner as the simultaneous discrimination pointing assessment, and asked, "What is it?" Second, the experimenter presented interspersed familiar tact trials in the simultaneous format (e.g., three stimulus array).

Listener Probes

Listener probes were administered as pretests, posttests, and maintenance blocks. Across all phases, listener probes were conducted after the tact probes in the trained format. Following an orienting response, the experimenter initiated the trial by reversing the white foam board, presenting an array of three pictures, and asking, "Touch [name of stimulus]." The experimenter presented slightly different instructions within each nine-trial block (e.g., "*Touch* flower", "Flower", "*Where is* flower?") as described above. If participants did not touch one of the stimuli, the experimenter repeated its name once. Consequences for responding on all trials and the frequency of familiar tact interspersal were identical to those during tact probes. However, during listener probes, the experimenter presented mastered *listener* targets for the familiar listener trials. Picture presentation was counterbalanced as described above.

Tact Training

Tact training blocks were presented after the pretests were completed. The experimenter conducted tact training using two variations of visual stimulus presentation for each participant across different sets of stimuli (see Table 1). The experimenter conducted training in nine-trial blocks, in which three pictures were targeted three times per block.

Successive Tact Training The experimenter provided vocal instructions and presented stimuli as in successive tact probes. A progressive prompt delay (i.e., 0 s, 2 s, 4 s, and 6s) was used, in which the experimenter modeled the response after a specified interval with no response (Touchette & Howard, 1984). The experimenter increased the prompt delay after two consecutive blocks of 8/9 correct responses, with no more than one incorrect response per stimulus. The prompt delay was decreased to the previous level when participants made three consecutive errors within a block. If at any point during training, participants responded independently at 8/9, then the next block was conducted at the 6-s delay. If participants scored less than 8/9 correct during the reinforcement fading sequence (one FR1 block, one FR3 block, one Tact probe), training resumed at the 4-s prompt delay, with continuous reinforcement.

The experimenter provided a token and praise for prompted responses, until the participants correctly and independently tacted a specific picture independently three times (Karsten & Carr, 2009; Vladescu & Kodak, 2010). Thereafter, the experimenter provided differential reinforcement for tact responses for that picture. The experimenter delivered praise only for prompted correct responses but provided praise and conditioned reinforcement at twice the magnitude (e.g., two tokens instead of one) for independent correct responses (Boudreau et al., 2015). If the participants did not respond correctly, the experimenter re-presented the trial, immediately provided the echoic prompt, and gave neutral praise statements ("That's right") to error-corrected responses.

Simultaneous Tact Training This condition was similar to successive tact training, with two exceptions. The foam board was a different color, and the experimenter presented tact trials with an array of three pictures and pointed to the relevant picture.

Results

Figure 1 depicts the percentage of correct independent tact and listener responses in nine-trial blocks across participants. The top panel shows the percentage of correct responses for Gio, and the bottom panel depicts the same data for Martin. Each participant completed two comparisons.

Efficacy of the tact training formats was measured via tact probes and error data. Following training in the first comparison, Gio scored accurately across both successive and simultaneous tact probes (see Table 2). During the tact probes of the second comparison, Gio scored accurately in both conditions. Across maintenance phases for both comparisons, Gio scored lower in the successive tact probe relative to the simultaneous tact probe (see Table 2. In the first comparison, Gio made more errors in the successive condition and fewer errors in the simultaneous condition. In the second comparison, Gio made nearly equal errors across both formats (see Table 2).

During the first comparison, Gio reached mastery criterion with the set taught with the simultaneous presentation in fewer trials than the set taught with the

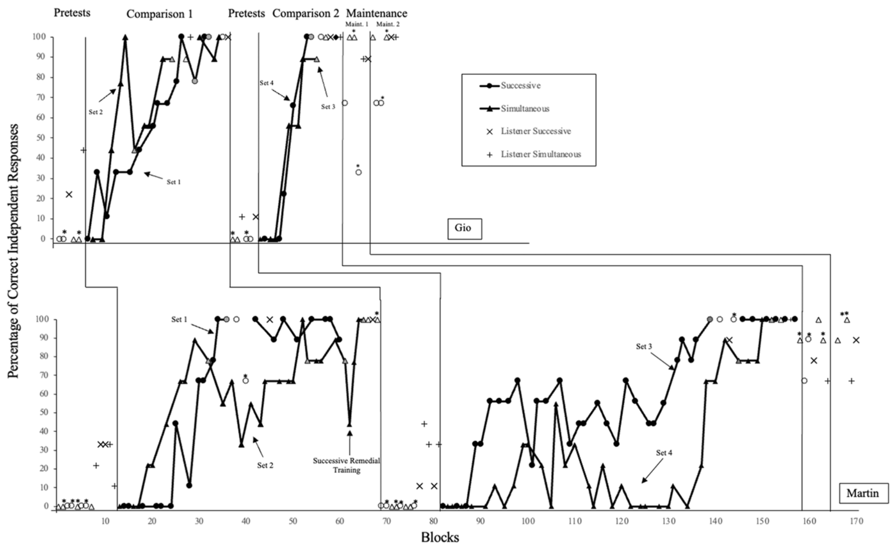

Fig. 1 Tact training and emergent listener responding. The multiple baseline design across participants shows the acquisition and maintenance of tact responding across both training variations, across four sets of stimuli per participant. Probe trials are denoted by open symbols. Gray symbols show tact training blocks with FR3 reinforcement. Asterisks indicate the set was probed in the alternate format. In the Maintenance section, Maintenance 1 shows data from the first comparison sets and Maintenance 2 shows data from the second comparison sets

Table 2 Training efficacy measures

Measure	Number of errors in training		Tact accuracy on posttests and maintenance	
	Successive	Simultaneous	Successive	Simultaneous
Gio				
Comparison 1	15	11	89% Posttest	89% Posttest
			67% Maintenance	100% Maintenance
Comparison 2	7	8	100% Posttest	100% Posttest
			67% Maintenance	100% Maintenance
Martin				
Comparison 1	15	35*	100% Posttest	Remedial (100%)
			67% Maintenance	Remedial (100%)
Comparison 2	53	53	100% Posttest	100% Posttest
			78% Maintenance	89% Maintenance

The number of errors in Martin's comparison 1 in the simultaneous condition were constrained because he met criteria for remedial training. The accurate tact responding on posttests may reflect the stringent mastery criteria (i.e., participants need to score at 89% or higher)

successive presentation (see Table 3). However, these results differed in the second comparison, in which Gio mastered the successive condition one block before the simultaneous condition. In the first comparison, Gio mastered the simultaneous condition in less relative training time (5-min difference), while in the second comparison he mastered the successive condition in less relative training time (15-min difference; see Table 3).

During listener posttests and listener maintenance probes across comparisons, Gio scored somewhat accurately in the listener probes for both formats (see Table 4). Across maintenance phases for both comparisons, Gio scored lower in the successive tact generalization probes (tested in the simultaneous format), relative to his scores in the simultaneous tact generalization probe (tested in the successive format; see Table 4).

First, for Martin, it should be acknowledged that he did not master the set assigned to the simultaneous condition in the first comparison. This was because

Table 3 Efficiency measures

Measure	Trials to criterion		Total training time	
	Successive	Simultaneous	Successive	Simultaneous
Gio				
Comparison 1	135	99	52:19	47:18
Comparison 2	63	72	20:05	34:59
Martin				
Comparison 1	117	234*	48:48	1:29:00
Comparison 2	270	333	2:02:00	2:33:21

The trials to criterion and total training time in Martin's first comparison were constrained by the remedial training criteria

Table 4 Generalization measures

Measure	Listener		Speaker to untrained format	
	Successive	Simultaneous	Successive	Simultaneous
Gio				
Comparison 1				
Posttest	100%	100%	N/A	N/A
Maintenance	89%	89%	33%	100%
Comparison 2				
Posttest	100%	100%	N/A	N/A
Maintenance	100%	100%	67%	100%
Martin				
Comparison 1				
Posttest	100%	Remedial (100%)	67%	Remedial (100%)
Maintenance	78%	Remedial (67%)	89%	Remedial (89%)
Comparison 2				
Posttest	89%	100%	89%	100%
Maintenance	89%	67%	100%	100%

For Martin, tact blocks were probed in the untrained format during maintenance only. For Gio, tact blocks in the untrained format were probed following training (posttests) and in maintenance. The column "speaker to untrained format" reflects the responding in the opposite format

his responding met the criterion for remedial training (training trials reached twice the number required for the mastered set), so Set 2 was ultimately trained with the successive format (see Fig. 1). That unique exposure may have affected the results of the first comparison, and therefore that comparison data should be interpreted with caution. In both comparisons, Martin mastered the set associated with the successive condition in fewer trials relative to the simultaneous condition (see Fig. 3). Similarly, the successive format required less training duration relative to the simultaneous format across comparisons (see Table 3).

During all tact posttests, Martin scored accurately across sets trained in both conditions (i.e., including following remedial training; see Fig. 1 and Table 2). Later, during tact maintenance probes across comparisons, Martin scored lower in the successive probes relative to his scores in the sets which were associated with the simultaneous method (see Table 2). Data were collected on errors to attempt to assess the aversiveness of the training procedures (see Table 2). During tact acquisition in the first comparison, Martin made fewer errors during successive tact training relative to errors during simultaneous tact training (prior to remedial training; see Table 2).

Martin scored accurately in the listener probes in the first comparison, for both sets (see Table 4). During the second comparison posttests, Martin scored somewhat accurately across listener probes for sets trained in both formats (e.g., one or zero errors; see Table 4). During maintenance for the first comparison, Martin scored less accurately in the listener probes for the set that was trained successively relative to the set that was trained in both formats (remedial). During the maintenance phase of the second comparison, Martin scored higher in the listener probe for the set that was trained successively compared to the set that was trained simultaneously. With regard to generalized tact responding, Martin scored 67% in the tact generalization probe for the successive set during the first comparison. Then, Martin scored relatively accurately in tact generalization probes for both the successive set and the simultaneous set during the second comparison posttests. Across both maintenance phases, Martin scored 89–100% across all tact generalization probes for the successive and simultaneous probes (see Table 4).

Gio responded accurately during tact posttests following both training formats (89% on both formats in first comparison and 100% on both formats during the second comparison; see Table 2), and Martin scored 100% throughout all tact posttests. This would suggest that both formats produced generally accurate responding during posttests across participants (i.e., one or zero errors). During maintenance, Gio made more correct tact responses on sets taught simultaneously (100%) compared to sets taught successively (67%), across comparisons (see Table 2). Martin also made more correct responses in simultaneous tact probes (range 89–100%) compared to successive tact probes (67–89%) in both comparisons. Across participants, the simultaneous training condition led to relatively more correct responses in tact maintenance. During listener probes, both participants responded accurately across all four sets and relatively accurately in maintenance across comparisons (see Table 4). In the maintenance phase for the second comparison, Martin scored higher in the listener probe for the successive set relative to the probe for the simultaneous set (see Table 4).

There were also some intersubject differences in responding. For Gio, the presentation method associated with fewer trials to criterion and shorter training time varied across comparisons, and yet for Martin the successive method consistently required fewer learning trials and shorter training duration across comparisons (see Table 3). Moreover, Martin scored higher in listener maintenance probes with the set taught in the successive presentation, whereas Gio scored relatively accurately (89%-100%) following training with both presentation methods (Table 4).

Discussion

This study consisted of a treatment evaluation of simultaneous and successive visual stimulus presentation during tact training for two participants diagnosed with autism. Our results show that the simultaneous format may be a viable alternative to the commonly used successive format, especially if learners demonstrate advanced scanning skills (i.e., as measured by the VB-MAPP Barriers Assessment).

The efficiency and efficacy of each procedure varied across participants. For Gio, both conditions appeared to be effective. However, for this participant, the simultaneous method produced better retention of tact relations in maintenance across both comparisons. Since the simultaneous method provided participants with more exposure to the target stimuli (e.g., three times more presentations), it is possible that Gio may have had more opportunities to covertly tact the S− stimuli when presented in the array (Miguel, 2018). For example, the participant could vocally tact the picture that the experimenter pointed to (the S+) when asked, and then they could have also attended to and tacted the remaining pictures in the array. These opportunities may have facilitated tact acquisition for Gio, who was observed to overtly tact the S+ and the S− stimuli during some of the simultaneous presentation trials.

For Martin, it was apparent that the successive condition was more efficient, as he mastered the targets taught in the successive format in fewer trials to criterion and less training time, across both comparisons (see Table 3). It was possible that for this learner, attending to multiple pictures may have been more difficult (less discriminable) than to a single picture. This pattern aligns with previous research (Cuvo et al., 1980) on relative tact training efficiency between visual stimulus presentation formats (see Table 3). Theoretically, this could be a function of the greater number of opportunities for errors during simultaneous training (i.e., both S− and S+ errors; Zentall & Clement, 2001). For example, if the experimenter points to one picture in the array (S+) but the learner attends to a different picture in the array (S−) and tacts the irrelevant picture, this would be considered an error. Errors have been correlated with increased training trials to criterion, and these two variables are likely functionally related (Green, 2001).

The successive and simultaneous tact training conditions produced the emergence of listener responding across and within participants (see Table 4). This finding aligns with previous research which states that training speaker responses often produces the emergence of listener responses (Bao et al., 2017; Contreras et al., 2020; Delfs et al., 2014; Frampton et al., 2017; Lowe et al., 2002; Miguel et al., 2008, Petursdottir & Carr, 2011). In the context of this study, the learner with advanced scanning and attending skills (Gio), accurate listener responding was observed during posttests and maintenance across both comparisons. For the participant who needed more support with attending and scanning (Martin), both methods generated a high percentage of correct listener responding on posttests, but in maintenance, Martin scored higher in listener on the sets taught successively (see Table 4).

For Martin, the discrepancies in listener maintenance responding in the second comparison can be interpreted in the context of his learning history within the study. Martin cumulatively made more independent speaker responses in the successive set (186) relative to simultaneous set (105) in the second comparison. With the successive set, Martin progressed quicker to higher latencies of the prompt delay and tacted additional successive trials as prescribed by the yoking procedure (see Fig. 1). This overtraining (successive in this case) could have contributed to the superior level of listener responding associated with the successive condition in maintenance (e.g., overlearning, Mazur, 2013 p. 8; Dougherty & Johnston, 1996).

Data on the number of errors during training may be useful in identifying which format is preferred by the learner, as error correction may contain aversive properties (Cariveau et al., 2019; Iwata, 1987; Worsdell et al., 2005). For Gio, the condition with the least number of errors varied across comparisons. For Martin, the successive condition in the first comparison was associated with fewer errors (see Table 2). In Martin's second comparison, both conditions produced an equal number of errors. Anecdotally, Martin often engaged in some collateral responses such as hitting his hands down on the table which suggests that making errors or contacting error correction may have been aversive. Future research could experimentally investigate learners' preference for visual stimulus presentation (e.g., Hanley, 2010), as well as measure the incidence of problem behavior.

Both participants made more correct responses on generalization tact probes on sets trained simultaneously (generalized to the successive format), relative to the number of correct responses on sets trained successively in maintenance and posttests (see Table 4). This could indicate that simultaneous training produces relatively more accurate tacts on generalization probes in the untrained format, as compared to successive training. This pattern of responding could have appeared because simultaneous training involves a more complex stimulus format, in which the learner must orient to the specific picture that the teacher points to in an array. Therefore, if the participant mastered the tact relations in that context, they may have the learning history needed to respond to the comparably simple format (i.e., successive). Whereas the successive training method requires only an orienting response in a field of one, in which the learner could respond correctly without attending to the teachers point to the sole picture. This method may have left participants with relatively inadequate training for the successive sets presented in the simultaneous tact generalization probes, in which attending to the teacher's point would be crucial for correct tacts (MacDonald & Langer, 2017).

Throughout this study, we identified some behavioral indicators of readiness for the simultaneous method. Gio, the learner whose results were similarly effective across both training methods, had experience with tact training in a simultaneous array, spontaneously tacted multiple stimuli in the array in pre-assessments, had strong attending skills (e.g., minimal prompting required), strong scanning skills (VB-MAPP; Sundberg, 2014) scored at Level 3 or above on the VB-MAPP Echoic and Tact Milestones, and did not exhibit problem behavior that interfered with acquisition. Martin, the learner who benefitted more from the successive method was not observed to spontaneously tact multiple stimuli in an array, frequently required prompts to attend to visual stimuli, needed support with scanning behavior, did not have experience with tact training in a simultaneous format, scored at Level 2 on the VB-MAPP Echoic and Tact Milestones, and engaged in some instances of problem behavior.

It is unclear which of these specific variables may contribute to the relative training efficiency or efficacy of a given method, but these are the repertoires that we hypothesize are relevant. Thus, clinicians must consider the verbal repertoire of individual learners when programming for tact training. To assess for this, they may conduct assessments (e.g., VB-MAPP) to analyze the domains and barriers hypothesized to be relevant (Sundberg, 2014). Further, clinicians may reference learners' previous or recent goals to determine if they have been exposed to simultaneous tact training, and if so, consider the acquisition rates with those tasks. Lastly, clinicians could directly observe the learner's responding on tact probe trials with familiar stimuli in a simultaneous array. If the child tacts multiple stimuli in the array (spontaneously or following a point to a stimulus), that responding may indicate that the child could benefit from simultaneous tact training. Conversely, if the learner requires multiple prompts to attend to the array or multiple prompts to tact the same picture, that may suggest that the successive method could be more appropriate.

In summary, we found that both procedures were comparably effective and efficient for Gio, the participant with a more advanced verbal repertoire. Notably, for Gio only, the simultaneous method was more efficient and equally efficacious in the first comparison. Meanwhile, for Martin, the learner who needed more support with attending and scanning, the simultaneous method was less efficient or even inadequate training relative to the successive format (e.g., Set 2; see Fig. 1 and Tables 2 and 3).

It appears that the clinical guidelines for teaching simple discriminations may apply to visual stimulus presentation methods during tact training. Namely, the learner should begin with the simple format (successive) before training with the complex (simultaneous) format (MacDonald & Langer, 2017). In terms of complexity, the successive format requires that participants attend to one stimulus at a time, while the simultaneous format requires that participants follow a point and respond under control of one stimulus and not the others present in the array. It seems that the simultaneous arrangement would better prepare participants to respond in their natural environment, where multiple stimuli may be present at a time (Bak et al., 2021). The simultaneous format may be used by clinicians while reading books to their clients (Lorah & Parnell, 2017; Novak & Peláez, 2004), or talking about objects that the child may be interested in or looking at (LeBlanc et al. 2006). Prior to teaching tacts, clinicians should identify what prerequisite skills are required for the learner to be successful in terms of relative training efficacy, efficiency, and generalization with each type of stimulus presentations. Clinicians can also attempt to conduct treatment evaluations such as the one proposed in the current study, albeit in a more abbreviated fashion (Kodak & Halbur, 2021).

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Data Availability The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Consent to Participate The procedures were approved by California State University's Human Participants Institutional Review Board. Written informed consent was obtained from participants' parents, as well as assent from participants.

References

Bak, M. S., Dueñas, A. D., Avendaño, S. M., Graham, A. C., & Stanley, T. (2021). Tact instruction for children with autism spectrum disorder: A review. *Autism & Developmental Language Impairments, 6*(1), 1–22. https://doi.org/10.1177/2396941521999010

Bao, S., Sweatt, K. T., Lechago, S. A., & Antal, S. (2017). The effects of receptive and expressive instructional sequences on varied conditional discriminations. *Journal of Applied Behavior Analysis, 50*(4), 775–788. https://doi.org/10.1002/jaba.404

Boudreau, B. A., Vladescu, J. C., Kodak, T. M., Argott, P. J., & Kisamore, A. N. (2015). A comparison of differential reinforcement procedures with children with autism. *Journal of Applied Behavior Analysis, 48*, 918–923. https://doi.org/10.1002/jaba.232

Butter, E. J., & Snyder, F. R. (1982). Effect of order of presentation on simultaneous and sequential matching familiar figures tests. *Perceptual and Motor Skills, 55*, 1259–1262.

Cariveau, T., Batchelder, S., Ball, S., & La Cruz Montilla, A. (2021). Review of methods to equate target sets in the adapted alternating treatments design. *Behavior Modification, 45*(5), 695–714. https://doi.org/10.1177/0145445520903049

Cariveau, T., La Cruz Montilla, A., Gonzalez, E., & Ball, S. (2019). A review of error correction procedures during instruction for children with developmental disabilities. *Journal of Applied Behavior Analysis, 52*, 574–579. https://doi.org/10.1002/jaba.524

Carr, J. E., Nicolson, A. C., & Higbee, T. S. (2000). Evaluation of a brief multiple-stimulus preference assessment in a naturalistic context. *Journal of Applied Behavior Analysis, 33*(3), 353–357. https://doi.org/10.1901/jaba.2000.33-353

Capaldi, E. (1966). Partial reinforcement: A hypothesis of sequential effects. *Psychological Review, 73*(5), 459–477.

Cengher, M., Jones, E. A., & Fienup, D. M. (2014). The effects of presession attention on tacting. *Journal of Applied Behavior Analysis, 47*(1), 176–80. https://doi.org/10.1002/jaba.8

Contreras, B. P., Cooper, A. J., & Kahng, S. (2020). Recent research on the relative efficiency of speaker and listener instruction for children with autism spectrum disorder. *Journal of Applied Behavior Analysis, 33*(3), 353–357. https://doi.org/10.1002/jaba.543

Coon, J. T., & Miguel, C. F. (2012). The role of increased exposure to transfer-of-stimulus-control procedures on the acquisition of intraverbal behavior. *Journal of Applied Behavior Analysis, 45*(4), 657–666. https://doi.org/10.1901/jaba.2012.45-657

Cuvo, A. J., Klevans, L., Borakove, S., Borakove, L. S., Landuyt, J. V., & Lutzker, J. R. (1980). A comparison of three strategies for teaching object names. *Journal of Applied Behavior Analysis, 13*(2), 249–257. https://doi.org/10.1901/jaba.1980.13-249

Da Hora, C. L., Debert, P., LaFrance, D. L., & Miguel, C. F. (2019). Inadvertent establishment of location control in matching-to-sample tasks in individuals with autism. *Brazilian Journal of Behavior Analysis, 14*, 15–23.

DeLeon, I. G., & Iwata, B. A. (1996). Evaluation of a multiple-stimulus presentation format for assessing reinforcer preferences. *Journal of Applied Behavior Analysis, 29*(4), 519–533. https://doi.org/10.1901/jaba.1996.29-519

Delfs, C. H., Conine, D. E., Frampton, S. E., Shillingsburg, M. A., & Robinson, H. C. (2014). Evaluation of the efficiency of listener and tact instruction for children with autism. *Journal of Applied Behavior Analysis, 47*, 793–809. https://doi.org/10.1002/jaba.166

Devine, B., & Petursdottir, A. I. (2022). Exploring effects of differential observing responses on vocal tact acquisition. *Behavioral Interventions, 37*(1), 29–42. https://doi.org/10.1002/bin.1782

Dougherty, K. M., & Johnston, J. M. (1996). Overlearning, fluency, and automaticity. *The Behavior Analyst, 19*(2), 289–292. https://doi.org/10.1007/BF03393171

Dixon, M. R. (2014). *The PEAK relational training system: Direct training module*. Shawnee Scientific Press.

Dunn, L. M., & Dunn, D. M. (2007). Peabody picture vocabulary test--fourth edition (PPVT-4) [Database record]. *APA PsycTests*. https://doi.org/10.1037/t15144-000

Egel, A. L. (1981). Reinforcer variation: Implications for motivating developmentally disabled children. *Journal of Applied Behavior Analysis, 14*(3), 345–350. https://doi.org/10.1901/jaba.1981.14-345

Fisher, W. W., Piazza, C. C., Bowman, L. G., Hagopian, L. P., Owens, J. C., & Slevin, I. (1992). A comparison of two approaches for identifying reinforcers for persons with severe and profound disabilities. *Journal of Applied Behavior Analysis, 25*(2), 491–498. https://doi.org/10.1901/jaba.1992.25-491

Fisher, W. W., Piazza, C. C., Bowman, L. G., & Amari, A. (1996). Integrating caregiver report with a systematic choice assessment. *American Journal on Mental Retardation, 101*, 15–25.

Frampton, S. E., Robinson, H. C., Conine, D. E., & Delfs, C. H. (2017). An abbreviated evaluation of the efficiency of listener and tact instruction for children with autism. *Behavior Analysis in Practice, 10*(2), 131–144. https://doi.org/10.1007/s40617-017-0175-y

Green, G. (2001). Behavior analytic instruction for learners with autism: Advances in stimulus control technology. *Focus Autism Developmental Disabilities., 16*(2), 72–85. https://doi.org/10.1177/108835760101600203

Greer, R. D., & Keohane, D. D. (2006). The evolution of verbal behavior in children. *The Journal of Speech and Language Pathology-Applied Behavior Analysis, 1*(2), 111–140. https://doi.org/10.1037/h0100194

Greer, R. D., & Longano, J. (2010). A rose by naming: How we may learn how to do it. *The Analysis of Verbal Behavior, 26*(1), 73–106. https://doi.org/10.1007/BF03393085

Grow, L., & LeBlanc, L. (2013). Teaching receptive language skills. *Behavior Analysis in Practice, 6*, 56–75. https://doi.org/10.1007/BF03391791

Hanley, G. P. (2010). Toward effective and preferred programming: A case for the objective measurement of social validity with recipients of behavior-change programs. *Behavior Analysis in Practice, 3*(1), 13–21. https://doi.org/10.1007/BF03391754

Heal, N. A., & Hanley, G. P. (2007). Evaluating preschool children's preferences for motivational systems during instruction. *Journal of Applied Behavior Analysis, 40*, 249–261.

Horne, P. J., & Lowe, C. F. (1996). On the origins of naming and other symbolic behavior. *Journal of the Experimental Analysis of Behavior., 65*(1), 185–241. https://doi.org/10.1901/jeab.1996.65-185

Iwata, B. A. (1987). Negative reinforcement in applied behavior analysis: An emerging technology. *Journal of Applied Behavior Analysis, 20*(4), 361–378. https://doi.org/10.1901/jaba.1987.20-361

Karsten, A. M., & Carr, J. E. (2009). The effects of differential reinforcement of unprompted responding on the skill acquisition of children with autism. *Journal of Applied Behavior Analysis, 42*(2), 327–334. https://doi.org/10.1901/jaba.2009.42-327

Kazdin, A. E. (2010). *Single-Case Research Design: Methods for Clinical and Applied Settings* (2nd ed.). Oxford University Press.

Kelley, M., Shillingsburg, M. A., Castro, M., Addison, L., & LaRue, R. (2007). Further evaluation of emerging speech in children with developmental disabilities: Training verbal behavior. *Journal of Applied Behavior Analysis., 40*, 431–445. https://doi.org/10.1901/jaba.2007.40-431

Kimble, G. A. (1961). *Hilgard and marquis Conditioning and learning*. Appleton-Century-Crofts.

Kodak, T., & Halbur, M. (2021). A tutorial for the design and use of assessment-based instruction in practice. *Behavior analysis in practice, 14*(1), 166–180. https://doi.org/10.1007/s40617-020-00497-w

Kodak, T., Halbur, M., Bergmann, S., Costello, D. R., Benitez, B., Olsen, M., Gorgan, E., & Cliett, T. (2020). A comparison of stimulus set size on tact training for children with autism spectrum disorder. *Journal of applied behavior analysis, 53*(1), 265–283. https://doi.org/10.1002/jaba.553

LeBlanc, L. A., Esch, J., Sidener, T. M., & Firth, A. M. (2006). Behavioral language interventions for children with autism: Comparing applied verbal behavior and naturalistic teaching approaches. *The Analysis of Verbal Behavior, 22*(1), 49–60. https://doi.org/10.1007/BF03393026

Lorah, E. R., & Parnell, A. (2017). Acquisition of tacting using a speech-generating device in group learning environments for preschoolers with autism. *Journal of Developmental and Physical Disabilities, 29*(4), 597–609. https://doi.org/10.1007/s10882-017-9543-3

Lowe, C., Horne, P., Harris, F., & Randle, V. (2002). Naming and categorization in young children: Vocal tact training. *Journal of the Experimental Analysis of Behavior, 78*(3), 527–549. https://doi.org/10.1901/jeab.2002.78-527

Lovaas, O. I. (2003). *Teaching individuals with developmental delays: Basic intervention techniques*. Pro-Ed.

MacDonald, R., & Langer, S. (2017). *Teaching Essential Discrimination Skills to Children with Autism: A Practical Guide for Parents and Educators*. Woodbine House.

Mazur, J. (2013). *Learning and behavior* (7th ed.). Prentice Hall.

Marchese, N. V., Carr, J. E., LeBlanc, L. A., Rosati, T. C., & Conroy, S. A. (2012). The effects of the question "What is this?" on tact-training outcomes of children with autism. *Journal of Applied Behavior Analysis, 45*(3), 539–547. https://doi.org/10.1901/jaba.2012.45-539

McIlvane, W. J. (2013). Simple and complex discrimination learning. In G. J. Madder (Ed.), *Handbook of behavior analysis* (2nd ed.). American Psychological Association.

Miguel, C. F. (2016). Common and intraverbal bidirectional naming. *The Analysis of Verbal Behavior, 32*(2), 125–138. https://doi.org/10.1007/s40616-016-0066-2

Miguel, C. F. (2018). Problem-solving, bidirectional naming, and the development of verbal repertoires. *Behavior Analysis: Research and Practice, 18*(4), 340–353. https://doi.org/10.1037/bar0000110

Miguel, C. F., Petursdottir, A. I., Carr, J. E., & Michael, J. (2008). The role of naming in stimulus categorization by preschool children. *Journal of the Experimental Analysis of Behavior, 89*(3), 383–405. https://doi.org/10.1901/jeab.2008-89-383'

Novak, Gary, & Peláez, Martha B. (2004). *Child and Adolescent Development: A Behavioral Systems Approach*. Sage Publications.

Petursdottir, A. I., & Carr, J. E. (2011). A review of recommendations for sequencing receptive and expressive language. *Journal of Applied Behavior Analysis., 44*(4), 859–876. https://doi.org/10.1901/jaba.2011.44-859

Pierce, W. D., & Cheney, C. D. (2008). *Behavior analysis and learning* (4th ed.). Taylor & Francis Group LLC.

Roncati, A. L., Souza, A. C., & Miguel, C. F. (2019). Exposure to a specific prompt topography predicts its effectiveness when teaching intraverbal behavior to children with autism. *Journal of Applied Behavior Analysis, 52*(3), 739–745.
Schnell, L., K., Vladescu, J. C., Kodak, T., & Nottingham, C. L. (2018). Comparing procedures on the acquisition and generalization of tacts for children with autism spectrum disorder. *Journal of Applied Behavior Analysis, 51*, 769–783. https://doi.org/10.1007/s11002-023-09668-510.1002/jaba.480
Skinner, B. F. (1957). *Verbal behavior*. Appleton-Century-Crofts.
Sindelar, P. T., Rosenberg, M. S., & Wilson, R. J. (1985). An adapted alternating treatments design for instructional research. *Education and Treatment of Children, 8*(1), 67–76.
Stokes, T. F., & Baer, D. M. (1977). An implicit technology of generalization. *Journal of Applied Behavior Analysis, 10*(2), 349–367. https://doi.org/10.1901/jaba.1977.10-349
Sundberg, M. L. (2014). *The verbal behavior milestones assessment and placement program: The VB-MAPP* (2nd ed.). AVB Press.
Sundberg, M. L., & Partington, J. W. (1998). *Teaching language to children with autism or other developmental disabilities*. AVB Press.
Terrace, H. S. (1963). Discrimination learning with and without "errors" *Journal of the Experimental Analysis of Behavior, 6*(1), 1–27. https://doi.org/10.1901/jeab.1963.6-1
Touchette, P. E., & Howard, J. S. (1984). Errorless learning: Reinforcement contingencies and stimulus control transfer in delayed prompting. *Journal of Applied Behavior Analysis, 17*(2), 175–188. https://doi.org/10.1901/jaba.1984.17-175
Vladescu, J. C., Gureghian, D., Goodwyn, L., & Campanaro, A. M. (2020). Comparing skill acquisition under different stimulus set sizes with adolescents with autism spectrum disorder: A replication. *Behavior Analysis in Practice, 14*(1), 193–197. https://doi.org/10.1007/s40617-020-00506-y
Vladescu, J. C., & Kodak, T. (2010). A review of recent studies on differential reinforcement during skill acquisition in early intervention. *Journal of Applied Behavior Analysis, 43*(2), 351–355. https://doi.org/10.1901/jaba.2010.43-351
Watson, P. J., & Workman, E. A. (1981). The non-concurrent multiple baseline across-individuals design: An extension of the traditional multiple baseline design. *Journal of Behavior Therapy and Experimental Psychiatry, 12*(3), 257–259. https://doi.org/10.1016/0005-7916(81)90055-0
White, K. G., Parkinson, A. E., Brown, G. S., & Wixted, J. T. (2004). Local proactive interference in delayed matching to sample: The role of reinforcement. *Journal of Experimental Psychology: Animal Behavior Processes, 30*(2), 83–95. https://doi.org/10.1037/0097-7403.30.2.83
Williams, K. T. (2007). Expressive vocabulary test, second edition (EVT-2) [Database record]. *APA PsycTests*. https://doi.org/10.1037/t15094-000
Worsdell, A. S., Iwata, B. A., Dozier, C. L., Johnson, A. D., Neidert, P. L., & Thomason, J. L. (2005). Analysis of response repetition as an error-correction strategy during sight-word reading. *Journal of Applied Behavior Analysis, 38*(4), 511–527. https://doi.org/10.1901/jaba.2005.115-04
Wunderlich, K. L., Vollmer, T. R., Donaldson, J. M., & Phillips, C. L. (2014). Effects of serial and concurrent training on acquisition and generalization. *Journal of Applied Behavior Analysis, 47*(4), 723–737. https://doi.org/10.1002/jaba.154
Zentall, T. R., & Clement, T. S. (2001). Simultaneous discrimination learning: Stimulus interactions. *Animal Learning & Behavior, 29*(4), 311–325. https://doi.org/10.3758/BF03192898

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