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Comparing In-View Rotation to Out-of-View Rotation when Teaching Receptive Labels for Children Diagnosed with Autism Spectrum Disorder

Caitlin Garvey
cgarveyautpar@aol.com

Comparing in-View Rotation to Out-of-View Rotation when Teaching Receptive Labels for Children Diagnosed with Autism Spectrum Disorder

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Caitlin C. Garvey

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Kimberly Schulze, Chairperson
Odessa Luna
Michele Traub
Benjamin Witts

Abstract

Research shows that individuals with autism spectrum disorder (ASD) can make significant gains with the use of early intensive behavioral intervention (EIBI). Discrete trial teaching (DTT) is one of the most widely used procedures to teach a variety of skills to individuals with ASD. Specific teaching practices within DTT vary and many recommendations exist for practitioners to ensure these gains reflect genuine skill development and are not the result of faulty stimulus control. The field of applied behavior analysis (ABA) relies on empirical evidence and practices have evolved with growing research. However, some recommendations regarding DTT have not been empirically tested for effectiveness or efficiency. This study used an adaptive alternating treatment design to evaluate the effects and efficacy of counterbalancing stimuli in-view of the learner and out-of-view of the learner when teaching receptive labels for three children diagnosed with ASD. The results indicated that both methods were effective though there were differences in efficiency.

Keywords: autism spectrum disorders, discrete trial teaching, counterbalancing, receptive labels

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Chapter 1: Introduction and Review of Literature

Discrete trial teaching (DTT) has been widely used to teach individuals diagnosed with autism spectrum disorder (ASD) and is considered one of the most effective instructional methods for children with ASD (Smith, 2001). DTT is a concentrated teaching method that involves multiple trials that break down a skill into smaller parts, teaching one sub-skill at a time until mastery, to teach a new set of more complex skills (Green, 2001; Leaf & McEachin, 1999). It requires an active response from the learner and presents many opportunities to demonstrate a target skill. DTT has the following components: an instruction or cue (discriminative stimulus), a prompt (though this may not occur in every trial), a learner response, and feedback or consequence (Green, 2001; Leaf & McEachin, 1999). As is consistent with the hallmarks of applied behavior analysis (ABA), DTT has been empirically evaluated and repeatedly proven to be an effective instructional method (Lovaas, 1987; Smith, 2001. Differences in the clinical application of DTT has led to continuing research of teaching methods that are not only effective, but efficient as well.

All ABA professionals strive to teach effectively by establishing stimulus control and discrimination skills. Guided by clinical practice and academic research, behavior analytic curricula for instructing learners with ASD includes techniques for teaching how to discriminate among various types of stimuli. Discrimination learning is an essential process for acquiring complex behaviors and are required for success in areas such as communication, cognition, academic, social, and self-help skills (Green, 2001; Lovaas, 2003). Discriminations can be simple or conditional. Simple discriminations involve a three-element contingency: the antecedent stimulus (S), the response (R) and the consequence (C) and are established by reinforcing certain responses in the presence of certain antecedents, and not in the presence of other antecedents. For example, in the presence of the spoken instruction “Clap your hands” (S1), the response of clapping hands is reinforced, and the response of stomping feet (S2) is not. In the presence of the instruction “stomp your feet” (S2), stomping (R2) is reinforced and clapping hands (R1) is not. Conditional discriminations, in contrast, are established by reinforcing responses to certain antecedent stimuli only if they are accompanied by additional stimuli (Green, 2001). Conditional discriminations involve a four-part contingency-conditional stimuli, antecedent stimuli, responses, and consequences. Curricular examples of this relevant to learners with ASD are object-picture correspondence, picture-based communication, conditional identity matching and receptive vocabulary. An example of conditional discrimination in receptive labeling is an individual receiving reinforcement for touching a spoon (S1) in response to the verbal instruction “Find spoon” (S3). The response of touching a plate (S2) is not reinforced. However, in response to the instruction “Find plate” (S4), touching plate (S2) is reinforced while touching spoon (S1) is not (Green, 2001).

When specific responses reliably occur under specific antecedent stimulus conditions and not under other conditions, stimulus control has been established (Green, 2001). However, many individuals with ASD can become quite adept at responding correctly without listening to an instruction or using the discrimination (Green, 2001; Grow & LeBlanc, 2013; Leaf & McEachin, 1999; Lovaas, 2009; Smith, 2001). ABA practitioners attempt to eradicate this undesired or faulty stimulus control. Experts and curriculum authors describe common pitfalls, instructor errors, and superstitious response patterns that can result in faulty stimulus control. Instructors may inadvertently prompt a correct response by looking at the target stimulus when issuing an instruction or providing facial cues (nod when a student reaches toward the correct response or frown when a student reaches for the incorrect response) (Lovaas, 2009). Errors in arranging materials can result in a side-bias (such as the learner simply choosing the stimulus on the left) or a student responding with the first or last item the instructor touched (Green, 2001).

A pioneer of applying ABA to individuals with ASD, Lovaas (2013) recommended teaching receptive language as a simple discrimination first in his seminal work The ME Book. He argues in a later work, “there is no reason to expect that a student with developmental delays can differentiate between instructions without being taught to do so” (Lovaas, 2003, p. 112) and recommends introducing each target stimuli in isolation until mastery to strengthen the relationship between an SD and a response. He acknowledges that, initially, the student learns to respond based on the response that was most recently reinforced and that this does not create true stimulus control. He describes simple discrimination training, mass trials, as well as the use of differential reinforcement as teaching tools. Once these relationships are strong enough, he argues, the instructor can introduce distractor stimuli, gradually intermix instructions, and eventually implement random rotation of trial order. Lovaas emphasizes the importance of random rotation of trial order to ensure the correct discrimination has been learned. He also recommends removing and replacing stimuli between trials to ensure discrete presentation and facilitate attention to stimuli. He advises changing the location of the target stimulus on the table and random rotation of target stimuli. In experimental research, the location of stimuli was found to be a controlling variable in conditional discrimination tasks (Sidman, 1992; Sidman et al., 1982) and random rotation of the location of stimuli as well as the random rotation of the target was first discussed.

In 2001, Green published an often-cited commentary on advances in stimulus control technology in match-to-sample (MTS) tasks, a set of procedures to teach conditional discriminations. She described how to avoid the development of faulty stimulus control and to decrease potential learner errors. Green argued that teaching simple discriminations can result in unwanted stimulus control since the student simply has to touch the only stimulus available to access reinforcement. She argued it may also inadvertently teach inattention since the learner does not need to attend to the sample stimuli at all and predisposes learners to respond with the response that was most recently reinforced (Green, 2001). Another recommendation is to ensure that a target stimulus is never placed in the same position across two consecutive trials and that the placement of target and non-target stimuli are balanced across trials. Green provided an example of stimulus placement and trial order that fulfills these parameters and warns that deviations can lead to faulty stimulus control. Additional recommendations include requiring an observing response, using simple instructions, and errorless teaching methods rather than trial and error. The combination of clinical experience and research led to new recommendations for DTT practitioners to ensure learners were genuinely learning discriminations and not responding under faulty stimulus control.

A 2009, study by Gutierrez et al. compared the rate of learning receptive discriminations using two procedures. The first procedure taught receptive discrimination by introducing novel stimuli in isolation (i.e., no distractors present) and then gradually progressing to a conditional discrimination (i.e., with distractor stimuli). The second procedure involved teaching receptive discriminations exclusively as conditional discriminations. Gutierrez et al. (2009) found that the simple/conditional procedure lengthened the number of trials to mastery compared to the conditional only procedure but attributed this to the incorporation of an additional training procedure rather than slowed acquisition. Targets that were mastered from each intervention (simple/conditional and conditional only) were further compared with a conditional discrimination phase. In this phase, the two targets that had been taught to mastery in each initial procedure were paired for additional discrimination training (with each serving as a distractor for the other). Their results were mixed. They found when the initial teaching procedure did not include a simple discrimination phase, more teaching sessions were needed to reach mastery for some individuals and some training sets. At one-month maintenance probes, all participants maintained the conditional receptive discrimination regardless of the initial teaching procedure (with the exception of one set for one participant). Gutierrez et al. demonstrated that two methods of teaching receptive language that seemingly conflicted did not yield clinically significant differences in rate of learning. By constantly testing clinical recommendations, the field of ABA is able to practice the most efficient and effective practices.

In 2013, Grow and LeBlanc published a commentary on ‘best practice’ guidelines for DTT practitioners. They reiterated Green’s view that clinicians counterbalance the trial order and placement of stimuli. They also advocated that a barrier or screen be placed in front of the learner to block their view of stimuli being rearranged, a recommendation originally described by Green (2001). The rationale provided is that instructors may unintentionally set down the correct stimulus first or last regardless of the position in the array (Grow & LeBlanc, 2013), leading to faulty stimulus control.

As the field of ABA grows, there are differing recommendations in areas of DTT, reinforcement, and data collection. Many empirically-based, commonly-used practices (continuous data collection, paired preference assessments, strict prompting hierarchies) have been shown to be unnecessary, ineffective, and/or inefficient (Leaf et al., 2015; Soluaga et al., 2008; Taubman et al., 2013) Other guidelines that are considered "best practice" and are commonly implemented have yet to be empirically tested. This paper will focus on the recommendation that changing the placement of stimuli should be done out of view of the learner, by placing a screen in front of stimuli or arranging them on a mat next to the instructor in the intertrial interval (Green, 2001). For a guideline to truly be a 'best practice' recommendation, its effect and efficiency should be empirically demonstrated. This study compared the effects of counterbalancing stimuli in-view and out-of-view of the learner.

Chapter 2: Methods

Participants

This study included three participants independently diagnosed with ASD between the ages of 3- and 4-years-old. A battery of assessments, including cognitive assessments, language assessments, and adaptive behavior assessments were administered to each participant. Participants currently received behavioral intervention that included programming for teaching receptive labels and all had a previous history with discrete trial teaching. None of the participants had a history with the counterbalancing approach (in-view or out-of-view) prior to the study.

Oscar, a 3-year, 11-month-old male, had been receiving an average of 28 hours per week of behavioral intervention for 28 months prior to the start of the study. Oscar received an Adaptive Behavior Composite Score of 83 on the Vineland Adaptive Behavior Scores, 3rd Edition (VABS-III) (Sparrow et al., 2016), a 116-standard score on the Expressive One Word Picture Vocabulary Test, 4th Edition (EOWPVT-4, Martin & Brownell, 2011), a 108-standard score on the Peabody Picture Vocabulary Test, 4th Edition (Dunn & Dunn, 2007) and had an IQ of 113. Oscar could receptively label over 1000 words, exhibited spontaneous language, and engaged in limited interfering behavior (pouting).

Fred, a 4-year, 6-month-old male, had been receiving an average of 28 hours a week of behavioral intervention for 32 months prior to the study. Fred received an Adaptive Behavior Composite score of 70 on the VABS-III, a 110 standard score on the EOWPVT-4, a 101 standard score on the PPVT-4, and had an IQ of 108. He could receptively label over 1000 words, exhibited spontaneous language, and engaged in aberrant behavior such as pouting and nonresponsiveness that could interfere with learning tasks.

Ernest, a 4-year, 2-month-old male, had been receiving an average of 24 hours per week of behavioral intervention for 21 months prior to the study. Ernest received an Adaptive Behavior Composite score of 84 on the VABS-III, a 121 standard score on the EOWPVT-4, a 104 standard score on the PPVT-4 and had an IQ of 112. He could receptively label over 1000 words, exhibited spontaneous language, and demonstrated limited interfering behavior (e.g., attempted to alter demands placed by instructor).

The same clinician provided intervention across all participants, sets, and conditions. She had nine years of experience providing behavioral intervention for individuals diagnosed with ASD. She had no prior training or history with the counterbalancing protocol and had never taught receptive labels using this protocol prior to the study.

Setting

Sessions took place at a private clinic that provides behavior analytic intervention. Research sessions were conducted once a day for two to five days per week and lasted approximately 15 minutes in duration. The room had a table, two chairs, and other relevant teaching materials.

Materials and Targets

Materials used during the study included picture cards, data sheets, a barrier, a token board, and a treasure box. The instructor used a separate data sheet for each condition with written instructions for how to implement the prompting procedure and a scoring key. Two versions of trial order and stimulus rotation were used to limit the learner from identifying a pattern in responding. The specific version used was randomly rotated by flipping a coin prior to each session. See Appendix A for an example of the data collection sheet(s). The barrier used was a cardboard 12- x 15-inch poster board. The token board used during intervention was a laminated board with a total of 36 tokens, broken up into three parts separated by color (i.e., green, brown, and blue). The colored sections indicated the level of reinforcement that was available to the participant, described in more detail below. The treasure box contained various toys ranging from $0.25-$5.00 that the participant could earn and take home following intervention if they reached a certain number of tokens. Picture cards were printed and laminated on 4 x 6-inch paper. There were up to three sets of picture cards per participant, one for each condition, with each set consisting of three different unknown picture cards. There was a total of 12 targets for Oscar and 18 targets for Fred and Ernest. Skill targets were general knowledge labels considered appropriate for the participant as determined by the researcher and clinical supervisor and consisted of cartoon characters and sports team logos.

Dependent Measure

Skill Acquisition

The primary dependent measure was the acquisition of each target skill taught in each teaching condition. Skill acquisition was determined through daily probe trials which is more thoroughly described below. Percentage correct was calculated by dividing the total number of trials in which the participant responded correctly, by the total number of trials, then multiplying by 100. Mastery criterion was reached when the student responded with 100% accuracy across three consecutive daily probes.

Efficiency Data

The secondary dependent measure was the efficiency of each teaching condition. The number of teaching sessions per set required to reach mastery was calculated to assess the efficiency of each procedure.

Daily Probes

Daily probes occurred during baseline, intervention, and maintenance. Daily probe sessions consisted of six total trials—two for each target. Each set was probed separately; therefore, targets in the in-view condition were probed together, while the targets in the out-of-view condition were probed together. The presentation of target stimuli was based on recommendations of Green (2001) and Grow and LeBlanc (2013), such that the array was counterbalanced across trials so that the target stimulus was present in each location; alternating among the left, middle, and right positions an equal number of times. In addition, each stimulus was targeted an equal number of times (i.e., twice). The order of targets within the probe trials was also pre-determined.

During daily probes, no priming, prompting, corrective feedback, or planned reinforcement occurred for participant responding. The researcher presented the 3stimulus array in a horizontal line in front of the participant. The researcher then delivered an instruction to select the target stimulus (e.g., “Find bubbles”). The participant was given approximately 5 s to respond. The researcher responded with neutral feedback (e.g., “Thank you”) regardless of participant responding. During daily probes, the interventionist did deliver praise and corrective feedback for learning how to learn behaviors (e.g., sitting appropriately, refraining from self-stimulatory behavior, scanning the array).

Baseline

Baseline consisted of one daily probe. The order of condition presentation was randomly determined by an automated randomizer (www.random.org).

Intervention

A most-to-least prompting procedure was implemented during both conditions (i.e., in-view, out-of-view). The prompting hierarchy used was a full physical prompt, gestural prompt, and no prompt. Each target stimulus was on its own prompting hierarchy and could move up and down the hierarchy regardless of participant responding on the other targets. Therefore, each target stimulus could be on a different level within the prompting hierarchy. Criteria to move to a less intrusive prompt was two consecutive correct responses on the current prompt level. Criteria to move to a more assistive prompt was one incorrect response. For a sample data sheet, see Appendix A.

A token economy was used during intervention sessions. A token was delivered for the first correct response provided within the prompting hierarchy. For example, if “apple” moved from full physical prompt to gestural prompt, the student would receive a token. If the “apple” moved from gestural prompt to full physical prompt, the student would not receive a token for correct responding, only social praise. Once a target had moved into the “no prompt”, tokens were only delivered for independent correct responses. The token board was visually broken into three sections (i.e., green, brown, and blue) with 36 tokens total. Each section represented a different level of reinforcement at the completion of the teaching session. Earning 0-6 tokens (green section) resulted in no visit to the treasure chest and the student returned to his therapy session as usual. Earning 7-28 tokens (brown) resulted in a minute to play with items in the treasure chest, but participants could not take anything home. Earning 29-36 tokens (blue) resulted in access to the treasure chest and the student could pick one item to take home. Tokens were delivered by the instructor starting from the bottom section (green) until it filled up, then moved on to the middle section (brown) until it was filled, then finally the top section (blue).

In-View Condition

Stimuli were presented in an array of three in which the location of the target stimulus was counterbalanced and predetermined. The responses were recorded as either correct, incorrect, or no response. The researcher delivered an instruction to select the target stimulus for the first trial (e.g., "Find apple"). If the participant responded correctly, the researcher delivered verbal praise (e.g., "Great, that's it!"), provided the appropriate level of reinforcement (described above), rearranged the stimuli in-view of the learner, and started the next trial. If the participant responded incorrectly or did not respond, the researcher provided corrective feedback (e.g., "No, that wasn't it"), rearranged the stimuli in-view of the learner, and then started the next trial. In each set, each stimulus was targeted six times for a total of 18 trials per session.

Out-of-View Condition

Procedures were identical to the in-view condition with one exception. Prior to the instructor rearranging target stimuli in the intertrial interval, a barrier was placed between the learner and the materials so that the movement of stimuli occurred out-of-view of the learner. After rearranging the stimuli, the instructor then removed the barrier prior to delivering the instruction (e.g., "Find bubbles"). The same data sheet used in the in-view condition was used (see Appendix A).

Maintenance

Three maintenance sessions were conducted in the same manner as probe trials and occurred at one week following mastery of the stimuli assigned to one of the conditions.

Design

An adapted alternating treatment design was used to measure the effects of the two conditions (i.e., in-view rotation, out-of-view rotation). Participants' responses during baseline, teaching procedure, and maintenance sessions were measured until mastery criteria was met (i.e., 100% correct responses on daily probes for three consecutive sessions). If a participant reached mastery criterion in one of the conditions but had not reached mastery criterion on the other condition; the participant had 10 sessions to reach mastery criterion.

Interobserver Agreement and Treatment Integrity Measure

Interobserver agreement was scored by a secondary observer via video-taped sessions. Interobserver agreement was calculated by dividing the number of agreements by the total number of agreements plus disagreements and multiplying it by 100 to get a percentage. Interobserver agreement was taken in 37.39% of probe sessions (ranging across participants from 22.85 to 48.00), 39.58% of in-view sessions (range 20.00 to 50.00), 37.70% of out-of-view sessions, and 31.25% of maintenance sessions (range 27.77 to 33.33). IOA for daily probe sessions was 100%, for teaching trials during the in-view condition was 100%, teaching trials during the out-of-view condition was 100% and for maintenance probes was 100%.

Treatment integrity was measured by a second independent observer to assess proper implementation of baseline, intervention, and maintenance conditions. For example, for the baseline condition, the researcher's performance was scored as correct if he or she: (a) placed the comparison array in the correct locations according to the data sheet, (b) provided the correct instruction, (c) provided approximately 5 s for the participant to respond, and (d) provided neutral feedback despite the participant's response. Treatment integrity was calculated by dividing the number of correct responses by the total number or correct and incorrect responses and multiplying it by a 100 for the percentage. Treatment integrity was taken in 25.20% of probe sessions (range across participants 24.00 to 28.94), and 27.08% of maintenance sessions (range 22.22 to 41.66). Treatment fidelity for all probe sessions was 99.69% across participants. Treatment fidelity was taken during 29.16% of in-view teaching sessions (range 26.1 to 42.85) and was calculated to be 100.00% across participants. Treatment fidelity was taken in 26.22% of out-of-view teaching sessions (range 23.07 to 36.84) and was calculated to be 99.65% across participants. Examples of treatment integrity data sheets is found Appendix B (daily probes), Appendix C (in-view condition) and Appendix D (out-of-view condition).

Chapter 3: Results

Oscar

Figure 1 (see Appendix E) displays the results of probes across two sets of stimuli and two conditions (i.e., in-view, out-of-view). In Set 1, Oscar reached mastery criterion after three sessions for the stimuli assigned to the in-view condition and reached the mastery criterion after seven sessions for the stimuli assigned to the out-of-view condition. For Set 2, Oscar reached the mastery criterion for the stimuli assigned to the in-view condition after 11 sessions and reached the mastery criterion for the stimuli assigned to the out-of-view condition after 12 sessions. Since Oscar reached the mastery criterion first for the stimuli assigned to the in-view condition for both Set 1 and Set 2, a third set was not run. Table 1 (see Appendix E) provides a detailed summary of sessions to mastery for each set and condition. During maintenance sessions across sets, Oscar responded correctly in 100.00% and 97.16 % of trials in the in-view and out-of-view conditions, respectively.

Fred

Figure 2 (see Appendix E) displays the results of probes for Fred across three sets and two conditions. In Set 1, Fred reached mastery criteria for the stimuli assigned to the in-view condition after ten sessions and for the stimuli assigned to the out-of-view condition after twelve sessions. In Set 2, he reached mastery criteria for the stimuli assigned to the in-view condition after five sessions and for the stimuli assigned to the out of view condition after five sessions. In Set 3, he reached mastery criteria for the stimuli assigned to the in-view condition after three sessions and reached mastery criteria for the stimuli assigned to the out-of-view condition after nine sessions. During the assessment of maintenance, Fred responded correctly on 90.73 % of trials for the in-view condition and 96.29% of trials for the out-of-view condition across the three sets.

Ernest

Figure 3 (see Appendix E) shows the results of probes for Ernest across three sets of stimuli for both intervention conditions. In Set 1, Ernest reached mastery criteria for the stimuli assigned to the in-view condition after four sessions and for the stimuli assigned to the out-of-view condition after five sessions. In Set 2, Ernest reached mastery criteria for the stimuli assigned to the in-view condition after three sessions and for the stimuli assigned to the out-of-view condition after three sessions. In Set 3, Ernest reached mastery criteria for the stimuli assigned to the in-view condition after eight sessions and for the stimuli assigned to the out-of-view condition after six sessions. During maintenance sessions, across the three sets, Ernest responded correctly in 98.14% of probe trials and 100.00% of probe trials in the in-view and out-of-view conditions, respectively.

Chapter 4: Discussion

The purpose of this study was to evaluate the effectiveness and efficiency of rotating stimuli in-view and out-of-view of the learner in a receptive labeling task. Dependent measures of skill acquisition and efficiency were used to compare the two methods. All participants reached mastery criteria for all sets across conditions. For two participants (Oscar, Fred), the in-view condition was more efficient, requiring fewer teaching sessions than the out-of-view condition. For one participant (Ernest), results were idiosyncratic. For Set 1, the in-view condition was more efficient, for Set 2, the efficiency was the same, and for Set 3, the out-of-view condition was more efficient. However, there was variability within and between participants in terms of the level of efficiency of each condition. For Oscar, in Set 2, there was only one additional teaching session needed to reach mastery of the out-of-view condition, whereas in Set 1, over twice as many teaching sessions were needed to reach mastery. For Fred, the level of efficiency was also inconsistent across sets. Set 1 required only two additional out-of-view teaching sessions to reach mastery but Set 3 required three times as many out-of-view sessions. There was less variability in the level of efficiency across conditions for Ernest, with mastery reached within one to two additional teaching sessions across conditions. In terms of maintenance, there was little difference across conditions for Oscar and Ernest. For Fred, maintenance was slightly higher for the out-of-view condition than the in-view, but both conditions had maintenance levels above 90%. Taken together, the results across participants showed that rotating stimuli in-view of the learner resulted in more efficient acquisition of targets and similar levels of maintenance. Though not empirically measured, an increase in the duration of the intertrial interval during the out-of-view condition may have given participants more opportunity to engage in off-task behaviors. Anecdotally, each participant commented on the use of the board, at times attempted to touch it, and could become provocative about trying to see the movement of materials behind it. These additional distractions may have affected their acquisition of the targets.

Counterbalancing stimuli has been recommended to limit faulty stimulus control in teaching conditional discriminations, and the recommendation to rotate stimuli out-of-view of the learner was argued to be an additional safeguard (Green, 2001; Grow & LeBlanc 2013). The results of this study provided no evidence that rotating stimuli in-view of the learner leads to faulty stimulus control; all targets were mastered and maintained. However, results did show that rotating stimuli out-of-view of the learner may have increased the number of teaching sessions to reach mastery, in some instances considerably.

The findings of this study expand the literature on best practices in discrete trial teaching. This is the first study to directly compare effects of rotating stimuli in-view to out-of-view within a DTT approach to learners diagnosed with ASD. Rotating stimuli out-of-view of the learner was not shown to have an effect on mastery of learning targets and was shown to be less efficient, which may impact the decision of clinicians considering implementing out-of-view rotation as part of DTT protocol. Additionally, ABA has been criticized by some as being overly sterile and artificial. In addition to efficiency concerns, the additional implementation of a physical barrier may affect the treatment acceptability levels of parents and other professionals (teachers, speech pathologists, paraprofessionals). Anecdotally, the use of the barrier did create an additional burden on the technician in addition to data collection, reinforcement delivery and rearranging of stimuli. The rearranging of stimuli while holding the barrier in place and attending to the child was logistically challenging.

One of the rationales given to support rotating stimuli out-of-view of the learner is that the learner may pick up on inadvertent cues given by the interventionist. He or she may inadvertently touch the target item in a pattern that is identifiable to the learner (touching the target item last, for example). A training approach that teaches the interventionist to be mindful of inadvertent cues and avoid any kind of discernable pattern may be a better solution than using a barrier. Training interventionists to be more skilled at identifying learner patterns leading to faulty stimulus control as well as identifying their own behaviors that may contribute to faulty stimulus control may preclude the adherence to strict protocols that have been widely applied.

Limitations

This study has several limitations. First, all participants had a history of at least 21 months of intervention utilizing DTT. It is unknown if the results would be different using individuals who had less of a history with DTT. Second, all participants scored high on standardized assessments, had acquired many receptive discriminations, and had low levels of interfering behavior. It is unknown if the results would be different with participants who had scored lower on standardized assessments, acquired fewer receptive discriminations, or had higher rates of interfering behavior. A third limitation is that maintenance was only collected at one week. There may have been more variability between conditions had maintenance been collected at one month. Additionally, generalization across variations of the stimuli, settings, and therapists was not assessed. Finally, it is possible that sets of stimuli were not equivalent. It is possible that certain sets were more difficult than others and happened to be assigned to the out-of-view condition. However, the specific sets that required more trials to acquisition seem to be unique to individual participants. There were three specific sets that were taught to more than one participant, and results did not show that a specific set consistently required more teaching sessions across participants than others.

Future Research

In addition to these limitations, there are several areas of future research to evaluate. Future researchers may look to apply this research to other learning tasks where materials are rotated (matching). Future researchers may also look to evaluate these procedures with a wider range of individuals diagnosed with ASD of different demographics characteristics. Lastly, in this study, both trial order and the placement of each stimulus was counterbalanced. Comparing the effects of rotating stimuli out-of-view and in-view of the learner when trial order is not counterbalanced may be an area of future research.

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Appendices

Appendix A

Example of Data Collection Sheets—Both Conditions

(Both conditions) Example of data collection sheets which illustrates how to properly counterbalance three visual comparison stimuli in an array and the rotation of the discriminative stimulus. The sample was presented according to each trial. The target stimulus for each trial is bolded. The prompt level required to gain the correct response was circled. The probe trials were located on the first page of the data sheet (e.g., front of the page) The teaching trials were located on the second page (e.g., back of the page).

Prompt Score

FP= Full Physical

G= Gestural Prompt

NP= No Prompt

Response Scoring Key:

+ = correct

- = Incorrect

NR= No Response

VERSION 1	Trial	Left	Center	Right	Response
Probe	1	Apple	**Bubbles**	Lion	+ - NR
	2	**Lion**	Apple	Bubbles	+ - NR
	3	Bubbles	Lion	**Apple**	+ - NR
	4	Apple	Bubbles	**Lion**	+ - NR
	5	Lion	**Apple**	bubbles	+ - NR
	6	**Bubbles**	Lion	apple	+ - NR

Intervention (both conditions)	Trial	Left	Center	Right	Prompt Required			Response		
	1	Apple	**Bubbles**	Lion	FP	G	NP	+	-	NR
	2	**Lion**	Apple	Bubbles	FP	G	NP	+	-	NR
	3	Bubbles	Lion	**Apple**	FP	G	NP	+	-	NR
	4	Apple	Bubbles	**Lion**	FP	G	NP	+	-	NR
	5	Lion	**Apple**	Bubbles	FP	G	NP	+	-	NR
	6	**Bubbles**	Lion	Apple	FP	G	NP	+	-	NR
	7	Apple	Bubbles	**Lion**	FP	G	NP	+	-	NR
	8	Lion	**Apple**	Bubbles	FP	G	NP	+	-	NR
	9	**Bubbles**	Lion	Apple	FP	G	NP	+	-	NR
	10	Apple	**Bubbles**	Lion	FP	G	NP	+	-	NR
	11	**Lion**	Apple	Bubbles	FP	G	NP	+	-	NR
	12	Bubbles	Lion	**Apple**	FP	G	NP	+	-	NR
	13	Apple	Bubbles	**Lion**	FP	G	NP	+	-	NR
	14	Lion	**Apple**	Bubbles	FP	G	NP	+	-	NR
	15	**Bubbles**	Lion	Apple	FP	G	NP	+	-	NR
	16	Apple	Bubbles	**Lion**	FP	G	NP	+	-	NR
	17	Lion	**Apple**	Bubbles	FP	G	NP	+	-	NR
	18	**Bubbles**	Lion	Apple	FP	G	NP	+	-	NR

VERSION 2	Trial	Left	Center	Right	Response		
Probe	1	Bubbles	Lion	**Apple**	+	-	NR
	2	**Lion**	Apple	Bubbles	+	-	NR
	3	Apple	**Bubbles**	Lion	+	-	NR
	4	Bubbles	**Lion**	Apple	+	-	NR
	5	Lion	Apple	**Bubbles**	+	-	NR
	6	**Apple**	Bubbles	Lion	+	-	NR

Intervention (both conditions)	**Trial**	**Left**	**Center**	**Right**	**Prompt Required**			**Response**		
	1	**Apple**	Lion	Bubbles	FP	G	NP	+	-	NR
	2	Lion	**Bubbles**	Apple	FP	G	NP	+	-	NR
	3	Bubbles	Apple	**Lion**	FP	G	NP	+	-	NR
	4	Apple	Lion	**Bubbles**	FP	G	NP	+	-	NR
	5	**Lion**	Bubbles	Apple	FP	G	NP	+	-	NR
	6	Bubbles	**Apple**	Lion	FP	G	NP	+	-	NR
	7	Apple	**Lion**	Bubbles	FP	G	NP	+	-	NR
	8	Lion	Bubbles	**Apple**	FP	G	NP	+	-	NR
	9	**Bubbles**	Apple	Lion	FP	G	NP	+	-	NR
	10	**Apple**	Lion	Bubbles	FP	G	NP	+	-	NR
	11	Lion	**Bubbles**	Apple	FP	G	NP	+	-	NR
	12	Bubbles	Apple	**Lion**	FP	G	NP	+	-	NR
	13	Apple	Lion	**Bubbles**	FP	G	NP	+	-	NR
	14	**Lion**	Bubbles	Apple	FP	G	NP	+	-	NR
	15	Bubbles	**Apple**	Lion	FP	G	NP	+	-	NR
	16	Apple	**Lion**	Bubbles	FP	G	NP	+	-	NR
	17	Lion	Bubbles	**Apple**	FP	G	NP	+	-	NR
	18	**Bubbles**	Apple	Lion	FP	G	NP	+	-	NR

Appendix B

Treatment Fidelity Data Sheet for the Daily Probes

Scoring Key

+ = Correct

- = Incorrect

Trial	Places the comparison array in the correct position as indicated	Delivers the correct instruction	Provides approximately 5 seconds for the participant to respond	Provides neutral feedback
1				
2				
3				
4				
5				
6				
Total correct				
Percentage				

Appendix C

Treatment Fidelity Data Sheet for the In-View Condition

Trial	Places the comparison array in the correct position as indicated	Delivers the correct instruction	Delivers the appropriate prompt	Provides approximately 5 seconds for the participant to respond	Provides appropriate feedback	Delivers the appropriate reinforcement
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
Total correct						
Percentage						

Appendix D

Treatment Fidelity Data Sheet for the Out-of-View Condition

Trial	Place barrier in front of learner	Place the comparison array in the correct position	Remove barrier	Deliver the correct instruction	Delivers appropriate prompt	Provide approx. 5 secs for the participant to respond	Provide appropriate feedback	Provides appropriate reinforcement
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
Total correct								
Percentage								

Appendix E
Figures and Tables

Figure 1

Oscar's probe results across baseline, intervention, and maintenance for the in-view and out-of-view conditions across two sets

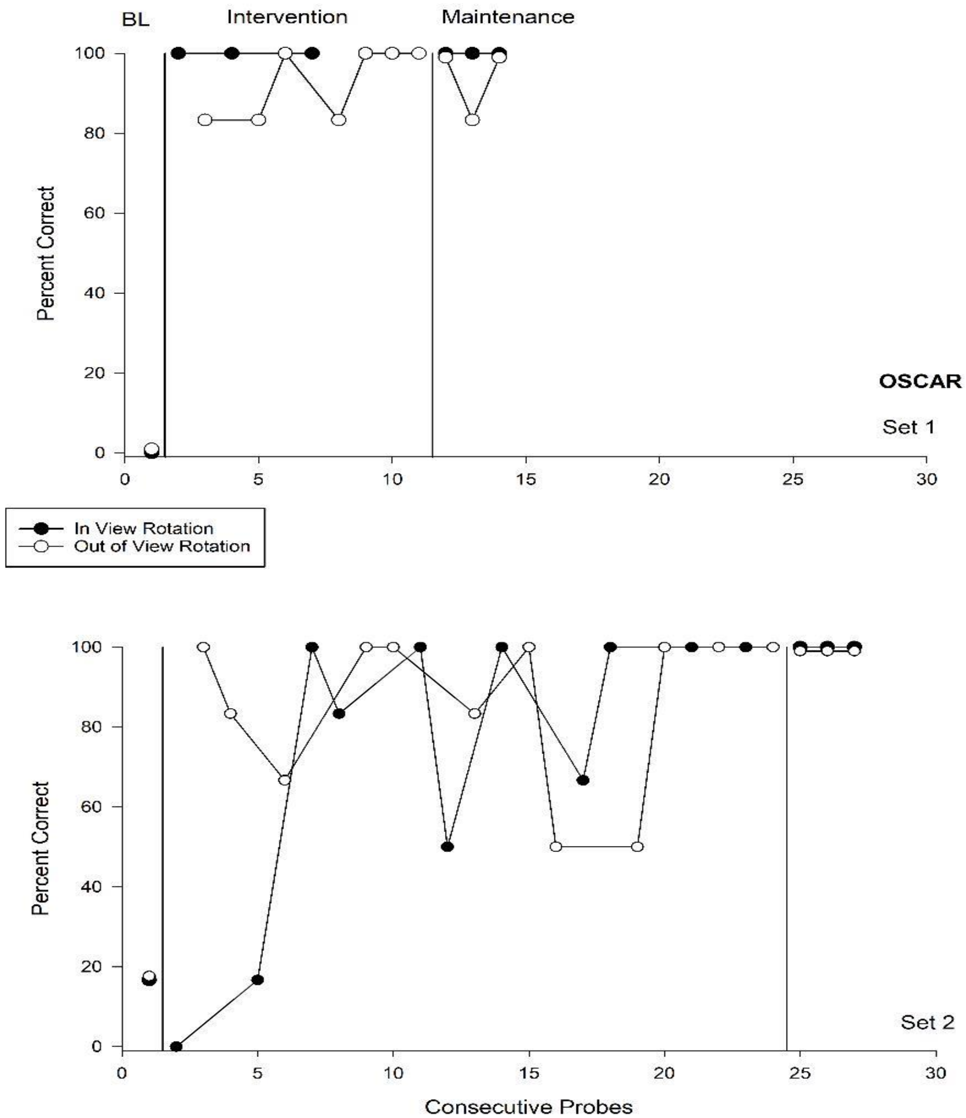

Figure 2

Fred's probe results across baseline, intervention, and maintenance for the in-view and out-of-view conditions across three sets

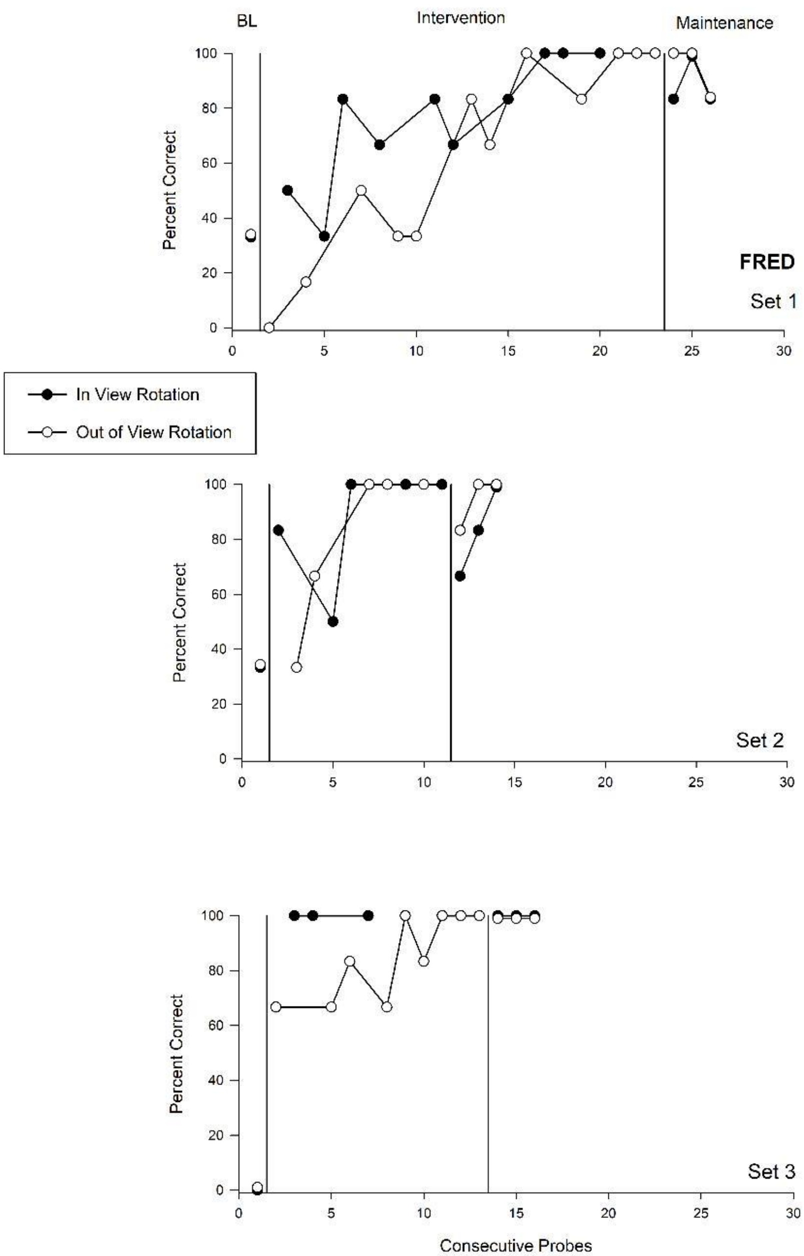

Figure 3

Ernest's probe results across baseline, intervention, and maintenance for the in-view and out-of-view conditions across three sets

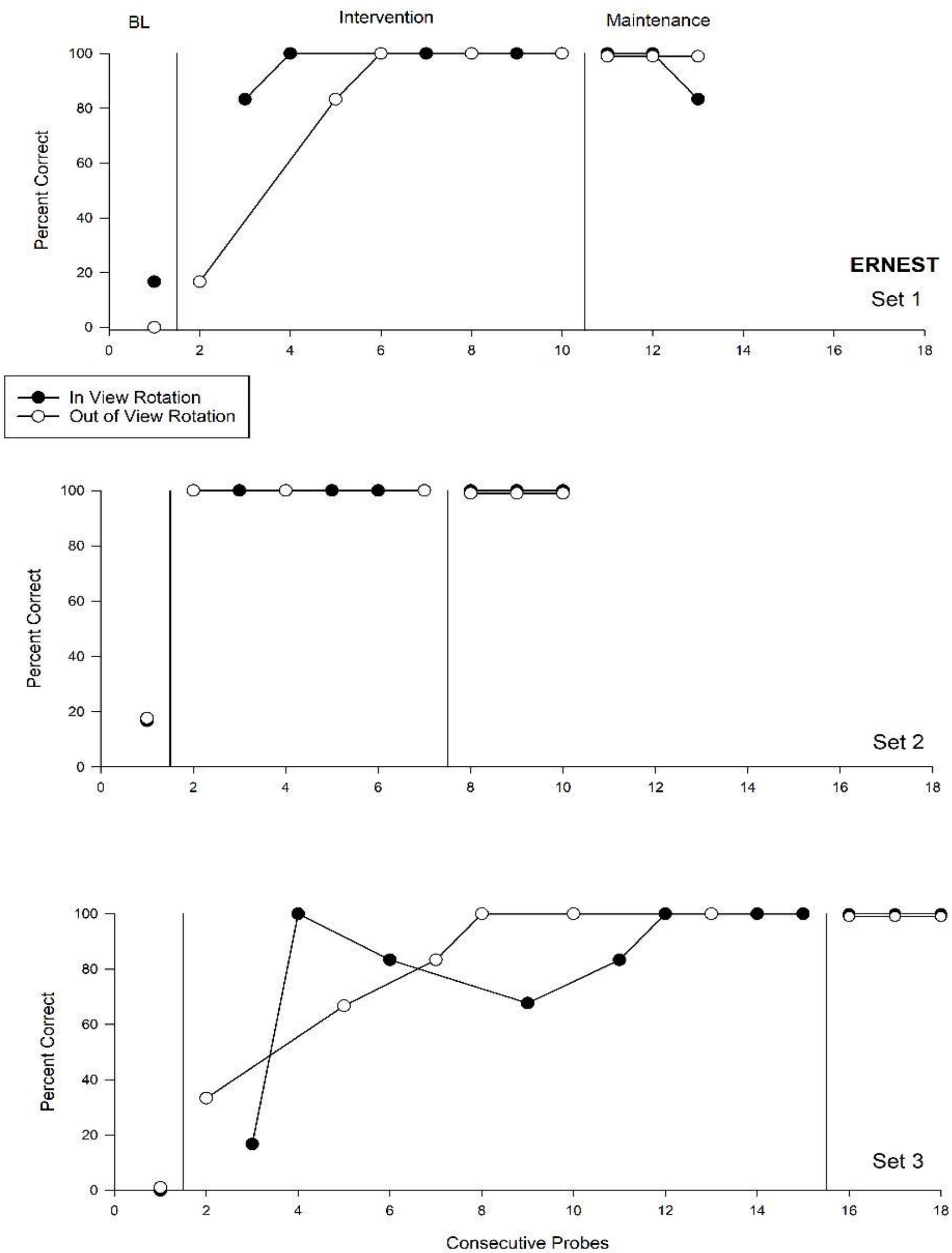

Table 1

Number of Sessions to Mastery for Each Participant Across Sets and Conditions

Participant	Set	In View	Out of View
Oscar	1	3	7
	2	11	12
Fred	1	10	12
	2	5	5
	3	3	9
Ernest	1	4	5
	2	3	3
	3	8	6

Table 2

Teaching Targets by Participant, Set, and Condition

Participant	Set	In View	Out of View
Oscar	1	Baloo Gus Jumba	Frollo Quasimoto Kronk
	2	Clippers Sonics Trailblazers	Nuggets Thunder Wizards
Fred	1	Kaa Pongo Hades	Quasimoto Frollo Kronk
	2	Figaro Pegasus Cleo	Hugo Gepetto Klopin
	3	Clippers Sonics Trailblazers	Mr. Smee Pascal Kuzco
Ernest	1	Kaa Pongo Hades	Astros Diamondbacks Tigers
	2	Expos Mariners Rockies	Gambit Magneto Cyclops
	3	Mimic Vulcan Changeling	Gladiator Bishop Quiksilver