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Boundary Conditions of Observational Learning in Children with Autism Spectrum Disorders

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by

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Whether a child with autism spectrum disorder will exhibit observational learning may depend on their attention to a part of the observed contingency and the stimulus modalities of the observed contingency. The absence of observational learning due to one or more of these variables would constitute a boundary condition. We held attention constant and used a multiple probe design combined with a repeated acquisition design to tested observational learning across a diverse set of contingencies, which composed of a hidden-edible, hidden-toy, hidden-video, tact, receptive-identification , and intraverbal contingencies. During preteaching, two children with autism spectrum disorder showed observational learning with two and four of the six contingencies. During teaching, children learned to engage in differential observing responses for the behavior and consequences performed by the model with the hidden-video contingency. During postteaching, one child showed generalization of observational learning on the receptive-identification and intraverbal contingencies, both children showed observational learning with the hidden-video contingency, and no generalization on the tact contingency. Thus, teaching was initiated with the tact contingency, which led to consistent increases in observational learning with targets unassociated with teaching. Results extend previous research demonstrating the utility of teaching differential observing responses on observational learning in children with autism spectrum disorder. Moreover, inconsistent observational learning across contingencies in pre and postteaching suggests that a comprehensive approach composed of testing across a variety of contingencies is necessary.

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ASD	autism spectrum disorders
DOR	differential observing
OL	observational learning

Boundary Conditions of Observational Learning in Children with Autism Spectrum Disorder

Observational learning (OL) is "learning based on observing the responding of another organism and/or its consequences" (Catania, 1998). Neurotypical children readily learn through observation (Hoyson, Jamieson, & Strain, 1984). By contrast, children with a developmental disability such as autism spectrum disorder (ASD) are less likely to learn through observation without specialized instruction (Hoyson et al., 1984; Taylor & DeQuinzio, 2012; Varni, Lovaas, Koegel, & Everett, 1979). This is a concern because an OL repertoire permits acquiring new skills without direct instruction and children experience many indirect learning opportunities daily. For these reasons, demonstrating the efficacy of instructional strategies that increase OL in children with ASD is crucial.

Researchers have discussed and experimentally demonstrated the influence of several component skills on OL with individuals with ASD. The component skills included attending, generalized imitation, delayed imitation, and consequence discrimination (Delgado & Greer, 2009; DeQuinzio & Taylor, 2015; DeQuinzio, Taylor, & Tomasi, 2018; MacDonald & Ahearn, 2015; Palmer, 2012; Masia & Chase, 1997; Taylor, DeQuinzio, & Stine, 2012). Studying the effects of the component skills on OL entails modeling contingencies for an observer (hereafter called an observation opportunity) and testing what was learned from the observation (hereafter called a response opportunity). An observation opportunity is composed of trials in which another person (hereafter called a model) experiences a contingency, and a response opportunity is composed of trials in which the observer's responses are tested in the contingency they observed. OL has occurred if the observer engages in the modeled response that produced reinforcement rather than the response that did not.

Researchers have tested the effects of teaching the component skills on OL with different types of contingencies and different approaches in programming observation and response opportunities. For example, MacDonald and Ahearn (2015) targeted two types of contingencies.

The first involved learning to select one of several concealments used to hide a preferred item among two or three concealment locations (hereafter called hidden-item contingency). The second involved learning to select one of several images based on the spoken nonsense word (referred to as the academic task and hereafter called the receptive-identification contingency; cf. MacDonald & Ahearn, 2015). For the hidden-item contingencies, antecedents included different sets of materials to conceal the preferred item and the materials were presented in a horizontal array (e.g., three cups equally spaced apart). The behavior performed by the model was selecting one of the concealments (e.g., cup on the right). The consequence was direct reinforcement (Thompson & Iwata, 2000 described reinforcement delivery that was not socially mediated as a direct contingency) for selecting the correct cup (e.g., picking up the cup on the right revealed a preferred edible) or no reinforcement for selecting the incorrect cup (e.g., picking up the cup on the left revealed a neutral item or nothing). Said technically, the stimulus modalities of the hidden-item contingency included a visual antecedent, a visual behavior, and visual-direct reinforcement.

With the receptive-identification contingency, two adults were present, one to act as the model and one to act as the teacher. Antecedents included three images depicting unknown symbols corresponding to spoken nonsense words, presented equally spaced apart in a horizontal array, and the spoken instruction to select one of the images (e.g., “Pick zing”). The behavior performed by the model was selecting one of the images (e.g., the image on the right). The consequence was indirect reinforcement for selecting the correct image (i.e., delivery of preferred edible socially mediated by the teacher delivered a preferred edible) or no reinforcement and verbal feedback for selecting the incorrect image (i.e., the teacher said, “No, that is wrong”). Said technically, the stimulus modalities of the receptive-identification contingency included a visual-auditory antecedent, a visual behavior, and a visual- or auditory-indirect consequence mediated by the teacher. After learning the component skills, five of six children diagnosed with a

developmental disability-learned to select the concealment with a preferred item rather than the concealment with a neutral or no item through observation with untaught contingencies. In addition, teaching procedures led to generalization of OL on the untaught receptive-identification contingency for one child and with untaught images for three children.

DeQuinzio and Taylor (2015) found that teaching children to discriminate between modeled correct and incorrect responses (i.e., consequence discrimination) in observation opportunities facilitated OL of tacts in children with ASD. Two adults were present in observation opportunities, one to act as the model and one to act as the teacher. Antecedents included various images of unknown items, presented individually across trials, and the question "What is it?" asked by the teacher. The behaviors performed by the model were correct and incorrect tacts. The consequence was indirect reinforcement for emitting the correct tact (i.e., the teacher delivered brief praise and a preferred item) or no reinforcement and verbal feedback for emitting the incorrect tact (i.e., the teacher said "I'm sorry, that is wrong"). Said technically, the stimulus modalities of the tact contingency for the observer included a visual-auditory antecedent, an auditory behavior, and visual-auditory indirect reinforcement. After learning consequence discrimination, four children demonstrated OL between correct and incorrect tacts. In addition, one child demonstrated OL with the generalization set unassociated with teaching.

Taken together, the differences between the stimulus modalities of the hidden-item, receptive-identification, and tact contingencies approximate different ends of a continuum of complexity that could be used to test OL. Because there are different stimulus modalities across the contingencies that can be learned through observation, there are likely differences in the difficulties of learning one contingency over another. Green (2001) suggests that before children with ASD should be expected to learn conditional discriminations, they must first be capable of acquiring simple discriminations. Applying this logic to OL, children with ASD should first be able to demonstrate OL with a simple contingency such as the hidden-item before demonstrating

OL with more complex contingencies such as the receptive-identification or tact.

It remains unknown if OL is functionally independent because a limitation of previous research is the lack of testing across a host of contingencies with different stimulus modalities. Results from MacDonald and Ahearn (2015) suggest that OL may be functionally independent for some children and with some contingencies. For example, in preteaching four children demonstrated differential OL on some of the hidden-item contingencies and one child demonstrated OL on the receptive-identification contingency. After teaching, most children demonstrated OL on at least one untaught hidden-item contingency and only one child demonstrated OL on the untaught receptive-identification contingency.

The presence of OL on some contingencies but not others suggests that OL is not an all or nothing phenomenon and a more comprehensive approach to studying OL treatments is necessary. Thus, a next step for research entails testing OL across a host of contingencies differing in the complexity of stimulus modalities, teaching an OL repertoire with a simple contingency like the hidden-item, and testing the generality of the teaching procedures on more complex contingencies like the receptive-identification or tact. The efficiency of OL interventions would be notably enhanced if teaching with a simple contingency facilitated generality of OL on more complex contingencies. At the same time, the absence of OL across one or more contingencies would constitute a boundary condition of the effects produced by the teaching procedures and the component skills would need to be taught with those contingencies.

The hidden-item contingency may be relatively easy to learn because the reinforcer is continuously concealed in the same location across the trials in an observation opportunity. For example, if the model picks up the cup on the right that conceals the reinforcer on the first trial, the observer can continue to look at that cup for the remaining trials until their opportunity to respond. In contrast, the receptive-identification and tact contingencies may be more difficult to learn through observation because the antecedents and behaviors are briefly presented and

alternate across trials. For example, the antecedent for the receptive-identification contingency includes various images that change locations in the array and the instruction varies across trials (e.g., teacher says “Pick cup” on one trial and “Pick dog” on the next trial). With the behavior, the model selects different images across trials. With the antecedent for the tact contingency, various images are presented individually and the question (e.g., “What is it?”) remains the same across trials. With the behavior, the model emits correct and incorrect tacts across trials. Thus, for OL to occur with the receptive-identification and tact contingencies, the observer must be capable of discriminating between the various antecedents, behaviors, and consequences the model experiences at the time of observation. Said differently, the difference in complexities of stimulus modalities between observed contingencies may influence whether an observer demonstrates OL.

Researchers have varied in their approach to teaching OL component skills. For example, MacDonald and Ahearn (2015) taught children to leverage OL with the hidden-item or receptive-identification contingencies through a treatment package that taught attention, imitation, delayed imitation, and consequence discrimination. First, children were taught to engage in attention (i.e., eye contact with the model) after the model instructed the child to “Watch me”. Second, children were taught to imitate the model’s selection response at the time of observation. Third, children were taught delayed imitation in the same manner as imitation with the addition of a 5-s delay between the response performed by the model and the child’s opportunity to imitate. Fourth, children were taught consequence discrimination in observation opportunities and consequence discrimination was considered present if the child selected the container concealing the preferred item rather than the containers concealing nothing. DeQuinzio and Taylor (2015) and DeQuinzio et al. (2018) took a different approach to teaching consequence discrimination by providing children with a response opportunity after each trial of an observation opportunity. In observation opportunities, the model performed correct tacts to one set of images and incorrect tacts to a second set of images. In teaching, children were given their response opportunity after each trial

of an observation opportunity. On trials where the model performed a correct tact, children were taught to imitate the tact when presented with the same antecedent stimulus. On trials where the model performed an incorrect tact, children were taught to say "I don't know" when presented with the same antecedent stimulus. Delgado and Greer (2009) taught children with ASD to engage in a differential observing response (DOR) to the consequences performed by the model in observation opportunities. The DOR taught to children entailed pointing to a green block immediately after observing the model perform a correct response and access a reinforcer and a red block immediately after observing the model perform an incorrect response and access no reinforcer.

Collectively, teaching children to engage in DORs to the consequence may facilitate the stimulus control necessary for OL occur. However, teaching children with ASD to engage in DORs to the behavior and consequence at the time of observation may enhance the efficacy of OL treatments. This hypothesis is supported by results from MacDonald and Ahearn (2015) and conceptual interpretations suggesting that an observer must attend to and behave in a manner analogous to the model for OL to occur (Palmer, 2012). To date, no study has evaluated the effects of teaching DORs to the behavior and consequence performed by the model at the time of observation on OL in children with ASD. Thus, the purpose of the current investigation was to test OL across a host of contingencies with children with ASD, teach children to leverage OL by engaging in DORs for the behavior and consequence performed by the model at the time of observation, and test the generality of the teaching procedures on untaught contingencies.

CHAPTER 1: METHOD

Participants, Setting, Materials, and Inclusion Criteria

Two children with ASD referred to our clinic for early intervention services were recruited. We reviewed the children's mastered skills from the Assessment of Basic Language

and Learning Skills-Revised (ABLLS-R; Partington, 2008) to determine whether they exhibited pre-requisite skills for the observational-learning contingencies (hereafter described as observed contingencies) and teaching procedures used in this evaluation. First, children selected pictures of common items when hearing their name (ABLLS-R, Skill C14d). Second, children imitated motor movements with objects (ABLLS-R, Skill D1). Third, children echoed spoken words (ABLLS-R, Skill E12). Fourth, children were not able to acquire novel tacts (ABLLS-R, G10) and receptive-identification skills (ABLLS-R, C18) with minimal teaching.

All sessions took place in classrooms with two or more child-sized chairs and one child-sized table. Session blocks comprised up to five sessions, were conducted up to two times per day, and up to five days per week. Rick was a 5 year old boy diagnosed with ASD and spoke in two to three word sentences to communicate. Bran was a 7 year-old boy diagnosed with ASD and spoke in one to two words to communicate.

Six observed contingencies were used to test OL. The hidden-edible contingency included three 16 oz Solo red plastic cups and preferred edibles. The hidden-toy contingency included three black opaque storage bins (46.05 cm by 31.11 cm) with attachable lids and preferred tangibles. A plywood sheet (60.96 cm by 83.83 cm) was used to block the child from seeing the location of the hidden items between trials. The hidden-video contingency included an electronic tablet device (19.55 cm by 25.14 cm) depicting three play buttons evenly spaced apart horizontally in rows of three on the screen of a PowerPoint slide, a preferred 30-s video clip, and laminated images of the video clips depicted on paper (7.62 cm by 12.7 cm). The tact contingency included sets of two images displayed on printer paper (21.59 cm by 27.94 cm) and laminated. The receptive-identification contingency included sets of three images displayed on printer paper (21.59 cm by 27.94 cm) and laminated.

Response Measurement, Interobserver Agreement, and Treatment Integrity

Table 2 provides the operational definitions for all dependent measures. OL was the primary measure, scored as an occurrence or nonoccurrence on a trial-by-trial basis, and converted into a percentage. OL was considered present if the child scored 83% correct or better in a response opportunity, which comprised two to six trials (procedures described in detail below) depending on the contingency. In teaching, children were taught to engage in differential observing responses (DOR) to the behaviors and consequences the model performed in observation opportunities to promote acquisition of OL. Table 2 shows the operational definitions for correct and prompted DORs for the behavior and consequences (hidden-video and tact contingencies) used while teaching on a trial-by-trial basis.

Table 3 provides the operational definitions for procedural terminology. One or two adults were present for every session, with one to act as the model and one to act as the teacher. Contingencies were modeled for the child in observation opportunities and comprised six to 18 observation trials (procedures described in detail below). OL was subsequently tested in response opportunities and comprised two to six response trials. The model prompted eye contact in all observation opportunities and eye contact occurred if the child had his or her face and both eyes directed at the antecedent materials, the behavior the model emitted, and the consequence. Eye contact with the entire contingency was prompted to ensure that the absence of OL was not due to observing part of the contingency.

Sessions were scored live or from video recordings. Interobserver agreement was scored by a second independent observer for 30% of sessions for each child. An agreement was defined as obtaining the same score for a given trial. Responses were mutually exclusive and only one response could be scored per trial. To calculate interobserver agreement, the number of trials with agreements were divided by the sum of trials with agreements and disagreements and converted to a percentage. Interobserver agreement for the preference and target identification assessments

was 100% and 96%, respectively. Interobserver agreement across the different conditions of the study for Rick and Bran was 99%.

Treatment integrity was scored for 40% of sessions via videos, and data were collected on accurate implementation of the procedures for eye contact, correction procedures, and consequence delivery. Treatment integrity of the procedures for eye contact, correction procedures, and consequence delivery was 100%, 100%, and 99%, respectively.

Observation and Response Opportunities

One adult acted as the model for observation and response opportunities with Observed Contingencies 1 through 3 in Table 1. A second adult acted as the teacher for observation and response opportunities with Observed Contingencies 4 through 6 but not for Observed Contingencies 1 through 3 because the participation of the teacher was not necessary to deliver programmed antecedents and consequences to the model. A limitation of prior research was that the model performed only correct or incorrect responses to the same stimulus (DeQuinzio & Taylor, 2015; DeQuinzio et al., 2018). To address this, we increased the number of incorrect responses the model performed such that most of the responses performed by the model were incorrect, thus increasing the believability that the child's correct responses in response opportunities were due to OL. In addition, performing more behaviors per antecedent in observation opportunities mitigated chance responding as an alternative explanation for increases in observational learning.

For Observed Contingencies 1 through 3 seen in Table 1, observation opportunities comprised 24 trials divided into bins of three observation trials each followed by one response trial (i.e., 18 observation trials and six response trials). Across the three observation trials of each bin, the model emitted three selection responses, one that contacted reinforcement and two that contacted no reinforcement. Reinforcement and no reinforcement trials were ordered such that no

reinforcement always occurred on the third trial in a bin to decrease the likelihood that children's correct responses were due to imitation. For example, if the model performed a reinforcement trial on the last observation trial of a bin and the child subsequently selected the correct concealment on their response opportunity trial, it would be impossible to know if that correct response was due to OL or imitation. At the start of a bin, the model hid two preferred edibles or items with the concealment in one of the three locations using the plywood sheet to block the child's view (excluding the hidden-video contingency because the preferred video clip was triggered by selecting a button displayed on a PowerPoint slide). At the start of each observation trial, the model instructed the child to "Watch." After securing the child's eye contact, the model performed a selection response and experienced the programmed consequence. The child's response trial was initiated immediately after the model performed the last observation trial in a bin. At the start of the response trial, the model secured the child's eye contact and said, "You try." The child was allowed to emit one selection and contact the corresponding consequence per response trial. OL was considered present if the child scored 83% or higher across the six response trials of the response opportunity.

For Observed Contingencies 4 through 6 seen in Table 1, observation opportunities comprised six observation trials. Tables 4 through 6 provide examples of the structure of observation opportunities for the tact, receptive-identification, and intraverbal contingencies, respectively. Across the six trials, the teacher delivered two antecedents three times a piece to the model. The model performed three responses two times a piece to each antecedent for a total of six responses. Of the six responses, two were correct and four were incorrect. For example, incorrect responses with the tact contingency comprised the two correct responses emitted by the model as incorrect to the opposite antecedent (e.g., saying "Tambor" when presented with the image of a stamp and saying "Sello" when presented with the image of a drum) and two were the third unrelated incorrect responses (e.g., saying "Cuerno" when presented with the image of a

stamp or drum). In this way, a correct response for the child had to be conditional on discriminating the antecedent, behavior, and consequence at the time of observation, described technically as a conditional discrimination. In addition, performing more incorrect responses in observation opportunities increased believability that children's correct responses were due to OL.

Antecedents were presented in randomized sets of two. The order of reinforcement and no reinforcement trials were randomized so a reinforcement trial never occurred on the last trial of an observation opportunity to rule out the possibility that correct responses in response opportunities were due to imitation. At the start of each observation trial, the model secured the child's eye contact and the teacher presented the programmed antecedent. Next, the model engaged in the programmed correct or incorrect response and the teacher delivered the corresponding consequence (i.e., reinforcement or no reinforcement). Reinforcement included general praise (i.e., "Correct") and access to a preferred stimulus (i.e., token [Bran only] or edible), and no reinforcement included general feedback (i.e., saying, "Wrong") and no preferred stimulus. The teacher never delivered prompts for the correct modeled behavior during observation or response opportunities.

The child's response opportunity was initiated immediately after each observation opportunity. Response opportunities comprised two-to-six trials. Across those trials, the teacher presented the two antecedents up to three times a piece to the child in randomized sets of two and the child was given up to 5 s to respond. Contingent on a correct response, the teacher delivered general praise (i.e., saying "Correct") and a reinforcer. Contingent on an incorrect or no response, the teacher delivered general feedback (i.e., saying "Wrong") and moved to the next trial. The teacher terminated a response opportunity early if the child emitted two incorrect responses to minimize the effects of differential reinforcement during response opportunities. OL was considered present if the child scored 83% correct or higher in a response opportunity.

Attending Procedures

The model promoted the child's eye contact to the antecedents, behaviors, and consequences demonstrated in all observation opportunities to ensure that the absence of OL was not due to observing a part of the contingency. In observation opportunities, the model used a least-to-most prompt procedure (i.e., point, visual blinder, and light chin touch) to secure the child's eye contact before demonstrating each part of the observed contingency. For example, if the child was not engaging in eye contact with the antecedent (e.g., stimuli on the table [hidden-edible] or the teacher [tact]) within 5 s of the model instructing the child to "Watch," the model used a point prompt to facilitate eye contact with the antecedent. If the point prompt did not facilitate eye contact, the model used a visual blinder prompt (i.e., using one's hand to minimize the child's visual field of anything but the antecedent). If the visual blinder did not facilitate eye contact, the model used a light chin touch. Finally, the model used a variable-ratio schedule of reinforcement to deliver a preferred edible or token (Bran only, rationale provided below) for attending during observation opportunities.

Description of Observed Contingencies

Rather than using the term *task* as in MacDonald and Ahearn (2015), we used *observed contingency* to emphasize that OL requires discrimination of the antecedent, behavior, and consequence. Observed Contingencies 1 through 3 seen in Table 1 included visual-visual discriminations with direct reinforcement and aligned with the simple hidden-item contingencies used by MacDonald and Ahearn (2015). Observed Contingencies 4 through 6 seen in Table 1 included changes to the modality of the antecedent, behavior, consequence, and complexity of antecedent-behavior discriminations, which may enhance the difficulty of OL relative to the visual-visual hidden-item contingencies. OL was tested across contingencies with visual-auditory-auditory (tact), visual-auditory-visual (receptive-identification), and auditory-auditory (intraverbal) antecedent-behavior discriminations. These contingencies were used for three

reasons. First, they are commonly used in clinical programming for children with ASD. Second, the generality of the effects produced by acquiring an OL repertoire would be notably enhanced if the child engaged in OL with observed contingencies that included a diverse set of relatively more complex discriminations. At the same time, the absence of OL across one or more contingencies would constitute a boundary condition of the effects produced by the teaching procedures and the component skills would need to be taught with those contingencies. Third, OL has not been tested in children with ASD across these types of contingencies in the same study.

Hidden-edible. The antecedent included three opaque cups, equally spaced apart in a row. The behavior comprised a selection of one of the three opaque cups, which were equally spaced apart in a row. One cup concealed the edible and two cups concealed nothing. The consequence included direct access to an edible preferred by the child or no edible. This contingency was used because it aligned our procedures with MacDonald and Ahearn (2015) and permitted efficient tests of OL. That is, this contingency mitigates testing threats to internal validity because the location of the cup hiding the edible changes after the child's response trial.

Hidden-toy. The antecedent included three opaque bins with lids equally spaced apart in a row. The behavior comprised a selection of one of the bins. The consequence included direct access to a toy preferred by the child or no toy. This contingency was used to test whether simply changing the type of concealment (i.e., bins rather than cups) used and the preferred item (i.e., toy rather than edible) would impose variability on OL as modeled by MacDonald and Ahearn (2015). In addition, this contingency mitigates testing threats to internal validity.

Hidden-video. The antecedent included three play buttons equally spaced apart and presented on a PowerPoint slide depicted on an electronic tablet screen. The behavior comprised a selection of one of the buttons. The consequence included direct access to a 30-s video clip preferred by the child, no video clip, or no video clip and a red "X" (altered PPTX condition only). This contingency was used to test whether simply changing the type of concealment (i.e.,

play buttons rather than cups or bins) used and the preferred item (i.e., video rather than edible or toy) would impose variability on OL as modeled by MacDonald and Ahearn (2015). In addition, this contingency mitigates testing threats to internal validity.

Tact contingency. The antecedent included an image and the question from the teacher "What is it?" The behavior comprised a Spanish tact. The consequence included the statement "Correct" and indirect (i.e., socially mediated) access to an edible preferred on by the child on correct trials or the statement "Wrong" and no edible on incorrect trials. Up to seven sets of two unknown images (14 images) and seven sets of three unknown Spanish words (21 words) as tacts were identified in preassessments. A set comprised two unknown images and three unknown Spanish tacts. For each set, two of the Spanish tacts were correct, one for each image, and the third Spanish tact was always incorrect. Table 4 provides an example of an observation opportunity for the tact contingency.

Receptive-identification contingency. The antecedent included three images presented equally spaced apart in an array and the teacher's instruction to touch one of the images. The behavior comprised a selection of one of the images. The consequence included the statement "Correct" and indirect access to an edible preferred by the child on correct trials or the statement "Wrong" and no edible on incorrect trials. Up to seven sets of three unknown images (21 total images) and seven sets of two unknown Spanish words (14 total words) to use as antecedent instructions were identified in preassessments. Sets comprised three unknown images and two unknown Spanish words. For each set, two of the images were correct, one for each of the Spanish words, and the third image was always incorrect. Table 5 provides an example of an observation opportunity for the receptive-identification contingency.

Intraverbal contingency. The antecedent included a question from the teacher. The behavior comprised a one-word English intraverbal response. The consequence included the statement "Correct" and indirect access to an edible preferred by the child or the statement

"Wrong" and no edible. Up to seven sets of two unknown questions (14 total questions) and seven sets of three unknown English words (21 total words) to use as intraverbal responses were identified in preassessment. A set comprised two unknown questions and three unknown English intraverbals. For each set, two of the English intraverbals were correct, one for each question, and the third English intraverbal was always incorrect. Table 6 provides an example of an observation opportunity for the intraverbal contingency.

General Procedures

The schematic seen in Figure 1 shows the general outline of the study. First, preassessment procedures were initiated to identify highly preferred edibles, toys, and video clips via the preference assessment. Next, unknown sets of targets were identified for the tact, receptive-identification, and intraverbal contingencies via the set identification assessment. Next, preteaching procedures were initiated with the tact, receptive-identification, and intraverbal contingencies with Sets 1 and 2 (with the exception of Set 3 for Bran with the receptive-identification contingency) in a staggered manner. Repeated measures were not obtained and subsequent sets were not tested if OL was observed with Sets 1 and 2 of a given contingency in preteaching.

The number of observation opportunities for Set 1 was twice as large as the number of observation opportunities for Set 2 and the number of observation opportunities provided for Set 1 was cutoff number for OL in postteaching. That is, believability that OL occurred is increased if high levels of correct responses occurred after a smaller number of observation opportunities in postteaching relative to the cutoff number of observation opportunities provided for Set 1 in preteaching. If OL was observed with Set 1 or 2 but not the other, repeated measures were obtained with the set where OL was observed and preteaching was initiated with Set 3. For example, in preteaching Bran demonstrated OL with Set 1 of the receptive-identification contingency in the fifth response opportunity. However, he did not demonstrate OL with Set 2.

Thus, we tested OL with Set 3 and obtained repeated measures with Set 1. This was done to ensure that high levels of correct responding in response opportunities was due to OL and not chance responding. That is, believability that correct responding was due to OL is increased with each replication of OL across additional sets for a given contingency. Next, preteaching procedures were initiated with the hidden-edible, hidden-toy, hidden-video, and hidden-edible 2-min contingencies.

Teaching was then initiated with the hidden-video contingency. After the child achieved mastery with the teaching procedures, postteaching was initiated with the hidden-video contingency. If the child demonstrated OL with the hidden-video contingency, preteaching procedures were initiated with the remaining contingencies where OL was not observed to collect generalization data. Next, the teaching procedures were introduced with the tact contingency using sets of stimuli unassociated with pre and postteaching. After the child achieved mastery with the teaching procedures, postteaching was initiated with Sets 1 through 4 of the tact contingency. In postteaching, OL was tested across Sets 3 and 4 to further increase believability in the effects of the teaching procedures over OL. It is important to note that preteaching procedures were not implemented with Sets 3 and 4 to avoid potential testing threats to internal validity because each observation of the same contingency increases the likelihood of OL.

Preassessment

Paired-stimulus preference assessment. A limitation of prior research was that consequences performed by the model in observation opportunities were not empirically identified (Delgado & Greer, 2009; DeQuinzio & Taylor, 2015; MacDonald & Ahearn, 2015). To address this concern, procedures based on Fisher et al. (1992) were used to identify highly preferred edibles, toys, and 30-s video clips, which were informed by nominations from the child's teacher or caregivers via the Reinforcer Assessment for Individuals with Severe Disabilities (Fisher, Piazza, Bowman, & Amari, 1996). Items identified as highly preferred were

used as reinforcers in observation opportunities and in teaching. To identify preferred video clips, a scene from each clip was printed on a 7.62 cm by 12.7 cm card for the child to select when presented in an array. Before each observation opportunity and teaching session, the three top-ranked items were presented in a row equally spaced apart, from which the child was asked to make a selection (Luczynski & Hanley, 2010); the item selected was used as the reinforcer in the subsequent research block.

Set identification. The purpose of this assessment was to identify unknown targets for the tact, receptive-identification, and intraverbal contingencies. Procedures informed by DeQuinzio and Taylor (2015) were used to identify sets of unknown images, Spanish words (tact and receptive-identification contingencies), and English questions (intraverbal contingency). In these assessments, the child was presented with an antecedent and given up to 5 s to respond. Differential reinforcement was delivered contingent on correct responses. Images were considered unknown if the child emitted incorrect or no responses across two opportunities. In addition, the researcher ensured that the child could echo the Spanish names of each image and English intraverbals to ensure that the absence of OL was not due to the child's inability to imitate the behavior they saw contact reinforcement in observation opportunities. Unknown Spanish words and English intraverbals were included as sets if the child could echo them across three opportunities. Sets were then scored by two-to-five graduate level students and faculty for the complexity of discriminations between images and words using a seven-point Likert scale. Images and words were replaced if one or more individuals scored the complexity as a six or higher. For example, the Spanish words "Cerno" (hog) and "Cuerno" (antler) were words consistently scored as a 6 or 7 when paired in the same set.

Preteaching and Postteaching

First, OL was tested using a one-to-one ratio of observation-to-response opportunities (i.e., each observation opportunity was followed by the child's response opportunity) with Sets 1

through 2 of the tact, receptive-identification, and intraverbal contingencies. Next, OL was tested across the hidden-edible, hidden-toy, hidden-video, and hidden-edible 2-min delay contingencies.

Teaching Video Contingency

Teaching DOR. The purpose of these procedures was to evaluate the effects of engaging in DORs for the model's behaviors and consequences during an observation opportunities on acquisition of OL. In observation opportunities, children were first taught to engage in DORs to the model's behavior with no consequences modeled in an observation opportunity. Next, DORs to the consequence were taught with two consequences modeled in observation opportunities. That is, bins comprised two observation trials rather than the three observation trials performed in pre and postteaching. The teaching procedures were implemented with three consequences if the child did not demonstrate OL in postteaching (Rick) after achieving mastery with the teaching procedures with two consequences. The treatment procedures were first initiated with two consequences because that was the minimum number of consequences required for the model to demonstrate a correct and incorrect response. In addition, if sufficient at increasing OL, teaching with two consequences would be more efficient than teaching with three consequences. Differential reinforcement was delivered in the form of an edible item for independent correct responses. Differential reinforcement was initially delivered for prompted correct responses but systematically removed based on visual inspection. Finally, children were taught to select the correct button corresponding to the DOR of the model's behavior in their response opportunity.

No consequences modeled. First, children were taught to tact the button location that the model selected (i.e., saying "One," "Two," or "Three" after the model selected the button in the left, middle, or right location, respectively) when presented with the three buttons on the PowerPoint slide within 5 s. This skill was taught using a progressive prompt procedure beginning with a 0-s prompt delay (PD) and progressing to a 5-s PD. A trial began with the model pointing to one of the buttons and asking "What number" and ended after the child engaged in a

prompted or independent correct response. Mastery criteria to progress to the next phase was at least two sessions at 80% prompted correct (0-s PD sessions) or independent correct (5-s PD sessions) or better, and sessions comprised 12 trials.

Two consequences modeled. Sessions comprised six bins of two observation trials where the model performed a correct selection response and contacted reinforcement (first consequence) on the first trial and an incorrect selection response and contacted no reinforcement (second consequence) on the second trial. The child's response trial was programmed immediately after the last observation trial in a bin. At the start of an observation trial, the model initiated the PowerPoint on the electronic tablet screen to depict the three play buttons, instructed the child to "Watch," subsequently selected one of the three button locations, and contacted the corresponding consequence. The DOR to the behavior was defined as tacting the button location (i.e., saying "One," "Two," or "Three" for the button on the left, middle, or right, respectively) that the model selected within 5 s of the model pressing the button. The model used a 5-s PD to an echoic prompt to teach the child to engage in the DOR to the modeled behavior.

The model used a progressive-prompt procedure to teach the DOR to the consequence and started with a 0-s PD to an echoic prompt and progressed to a 5-s PD after two sessions with 80% prompted correct responses or better. In the response opportunity, to teach the child to correctly select the button location that corresponded to the button location demonstrated as correct, the model began with a 0-s PD to a point prompt and progressed to a 2-s PD after two sessions with 80% prompted correct responses or better. Prompt delays for selections were removed from the response opportunity if the child was not acquiring correct selections within a reasonable number of sessions which was determined via visual inspection. Postteaching was initiated after DORs for the behaviors, DORs for the consequences, and correct selections were observed at 80% independent correct or better for three consecutive sessions. The teaching video

intervention with three consequences modeled was initiated if the child did not demonstrate OL in postteaching.

Three consequences modeled. Procedures were identical to the teaching procedures with two consequences modeled except for session structure. Sessions comprised six bins of three observation trials (identical to pre and postteaching sessions). On one observation trial in a bin, the model performed a correct selection response and contacted reinforcement (first or second observation trial). On two observation trials in a bin, the model performed an incorrect selection response and contacted no reinforcement (second or third consequence). The last observation trial in a bin was never modeled as correct. The child was given their response trial immediately after the third observation trial in a bin. Postteaching was initiated after DORs for the behaviors, DORs for the consequences, and correct selections were observed at 80% independent correct or better for three consecutive sessions.

Teaching Tact Contingency

Children were taught to engage in DORs for the model's behavior and the consequences observed in a sequential manner using sets not associated with pre or postteaching. A progressive-prompt procedure was used to teach the DORs starting with a 0-s PD and progressing to a 5-s PD. Children were first taught to emit the DOR for the model's behavior without observing any consequences. After achieving mastery, children were taught to emit the DORs for the consequences while observing programmed consequences. Differential reinforcement in the form of a preferred edible (Rick) or a token (Bran) was delivered contingent on the DORs.

Teaching DOR for the behavior. Sessions comprised six observation trials during which the model engaged in three responses twice to two target images in a randomized manner without performing consequences. A trial began with the model instructing the child to "watch" and ended after the child engaged in a prompted or independent correct DOR for the model's

behavior (i.e., echoing the tact modeled). Children were taught to echo the behavior performed by the model regardless of whether it was correct or incorrect because an observer must behave in a manner analogous to the model at the time of observation for OL to occur (Palmer, 2012). After the child performed at mastery (i.e., 80% or better of trials with independent DORs for the model's behavior across three consecutive sessions), teaching the DOR for the consequence procedures were initiated.

Teaching DOR for the consequence. Sessions were identical to teaching the DOR to the model's behavior except that the model performed consequences in observation opportunities. Thus, observation opportunities were identical to pre and postteaching except for the inclusion of prompts. The same progressive-prompt procedure was used to teach the child the DOR to the consequence. The child's response opportunity was initiated immediately after each observation opportunity without the delivery of prompts for correct responses. For replication purposes, a second teaching set was used if the child demonstrated mastery in a response opportunity with the first set during a response opportunity. Postteaching was initiated immediately after the child achieved mastery with two teaching sets (Rick) or four teaching sets (Bran). The increased mastery criteria was used for Bran because of the additional teaching modifications (detailed below).

Bran required additional teaching modifications for the DORs to establish the intended stimulus control. Tokens were used in place of edible reinforcers because Bran began to inconsistently consume the edible reinforcer, started to request access to an electronic tablet during teaching sessions, and intermittently engaged in disruptive behavior (i.e., throwing edible reinforcers or other nearby materials) when access to the tablet was denied. In response, a reinforcer assessment of tokens was conducted and tokens were subsequently used in place of edibles. Rather than use the electronic table, tokens were used to maintain short and equivalent durations between observation and response opportunities across children. In the reinforcer

assessment, Bran was taught to place a block in one of two bins presented equally spaced apart in an array of two on a table. Sessions comprised 12 trials. At the start of a session, the model described the contingency (i.e., “If you place a block in this bin, you get a token. If you place a block in this bin, you get nothing.” while simultaneously pointing to the bin on the right or the bin on the left) and prompted him to place one block in each bin to expose his behavior to the contingencies for that session. Sessions ended after Bran placed the remaining blocks in either of the bins and the bin that produced access to tokens was randomized across sessions.

Next, the topography of the DOR for the consequence was changed to a thumbs up for a consequence with reinforcement delivered and a thumbs down for consequence with no reinforcer. This change was made for two reasons. First, OL with teaching Set 1 remained low despite Bran demonstrating mastery with the DORs for the behavior and consequence in observation opportunities when the topography of the DOR for the consequence was a vocal response. Second, a proportion of Bran’s errors in response opportunities were formally similar to the DOR for the consequence (e.g., Bran sometimes said “Token” or “No token” in response opportunities when presented with the antecedent). The next modification comprised removing reinforcement for DORs during observation opportunities (i.e., No Sr+ for DOR phase of Figure 7 second panel). In this phase, tokens were only delivered for attending (observation opportunities) and emitting correct responses in response opportunities. The next modification made comprised delivering reinforcement for emitting the DOR for the consequence during observation opportunities only on programmed reinforcement trials (i.e., Sr+ DOR of CR phase of Figure 7 second panel). This was done to promote the intended stimulus control exerted by discriminating the consequence as reinforcement or no reinforcement. Once Bran achieved mastery in this phase, the researchers reversed to the previous phase (i.e., No Sr+ for DOR phase of Figure 7 second panel) to provide Bran with experience practicing the component skills and acquiring the teaching set targets using procedures that closely aligned with how he would

experience postteaching with the tact contingency. Postteaching procedures were initiated immediately after Bran demonstrated the DORs at the mastery level and acquired the tacts for the fourth teaching set.

Experimental Design

A concurrent multiple-probe design across children was used to demonstrate functional control of the teaching procedures on OL through staggered introduction of the teaching procedures across children. For example, teaching procedures with the hidden-video contingency were initiated with Bran only after Rick demonstrated OL in postteaching. Next, teaching procedures for the tact contingency were initiated with Rick and postteaching was initiated once he achieved mastery with the teaching procedures. Three types of hidden-item contingencies (i.e., hidden-edible, hidden-toy, and hidden-video) were used because they provided an assessment of restricted stimulus control in that the only difference between the variations was the type of concealment (i.e., cups, bins, or buttons) hiding the item and the preferred item (i.e., edible, toy, or video); MacDonald and Ahearn (2015) observed restricted stimulus control to one of the stimulus variations with two of six children.

A repeated-acquisition design (Kennedy, 2005) across similarly difficult sets of stimuli was used to strengthen believability in the effects of the teaching procedures on OL through intrasubject replication. Because each observation of the same contingency increases the probability that learning will occur, believability in the effects of the teaching procedures are increased if the child demonstrates OL after a smaller number of observation opportunities in postteaching relative to the number in preteaching. Although repeated acquisition designs have primarily been used in basic research (Kennedy, 2005), use of this design may be advantageous in studying OL because it permits evaluating the effects of different conditions on learning. For example, Colozzi, Ward, and Crotty (2008) used a multiple probe design combined with a repeated acquisition design across experimental conditions to evaluate the effects of a

simultaneous prompt procedure delivered in a 1:1 setting versus a group setting in children with developmental disabilities.

CHAPTER 2: RESULTS

Figures 2 depicts the results where functional control of the teaching procedures over OL was demonstrated with Rick and Bran on the hidden-video and tact contingencies. Percentage of trials with correct selections during response opportunities for the hidden-video contingency (first and third panels) are denoted by closed diamonds. Percentage of trials with correct tacts during response opportunities for the tact contingency (second and fourth panels) with Sets 1, 2, 3, and 4 are denoted by closed circles, open circles, closed squares, and open squares respectively. Gray bars denote the number of trials in a response opportunity (second and fourth panels). The descriptor altered PPTX and an arrow is used to indicate when the addition of the red "X" on the PPTX slide following an incorrect selection in observation and response opportunities change was initiated. The solid line across panels represents the teaching procedures used for the hidden-video contingency (data depicted in Figures 4 and 5 for Rick and Bran, respectively) and the tact contingency (data depicted in Figures 6 and 7 for Rick and Bran, respectively).

In preteaching, both children demonstrated deficient OL across the hidden-video and tact contingencies. In postteaching, Rick demonstrated OL with the hidden-video contingency after achieving mastery with the teaching video three consequences modeled procedures (first panel fourth phase) and continued to demonstrated deficient OL with the tact contingency (second panel second phase). In postteaching, Bran demonstrated OL with the hidden-video contingency after achieving mastery with the teaching video two consequences procedures (third panel third phase) and continued to demonstrated deficient OL with the tact contingency (fourth panel first phase). In postteaching for the tact contingency, OL was observed after two to six observation opportunities across Sets 1 through 4 with Rick (second panel third phase) and two to five observation opportunities across Sets 1 through 4 with Bran (fourth panel second phase).

Figure 3 is the summary graph depicting Rick (first row) and Bran's (second row) results across all contingencies and sets. The function of this graph is to characterize these children's OL repertoire at different points in the study. Results for preteaching, postteaching with the video contingency, and postteaching with the tact contingency are depicted in the first, second, and third columns, respectively. Open squares indicate that OL was not observed in that response opportunity. Closed squares indicate that OL was observed in that response opportunity. In preteaching (first row first column), Rick demonstrated OL on the hidden-edible, hidden-toy, receptive-identification (Sets 1 and 2), and intraverbal (Sets 1 and 2) contingencies and deficient OL on the hidden-edible (2-min delay), hidden-video, and tact (Sets 1 and 2) contingencies. In postteaching with the video contingency (first row second column), Rick demonstrated OL with the video (three-button) contingency and deficient OL with the tact (Set 1) contingency. In postteaching with the tact contingency (first row third column), Rick demonstrated OL with Sets 1 through 4 of the tact contingency within one to six observation opportunities. In preteaching (second row first column), Bran demonstrated OL on the hidden-edible, hidden-edible (2-min delay), and hidden-toy contingencies and deficient OL with the hidden-video, tact (Sets 1 and 2), receptive-identification (Sets 1, 2, and 3 excluding Set 1 response opportunity 5), and intraverbal (Sets 1 and 2) contingencies. In postteaching with the video contingency (second row second column), Bran demonstrated OL with the hidden-video, receptive-identification (Sets 1 through 4), and intraverbal (Sets 1 through 4) contingencies and deficient OL with the tact (Sets 1 and 2) contingency. In postteaching with the tact contingency (second row third column), Bran demonstrated OL with Sets 1 through 4 within two to five observation opportunities.

Figures 4 and 5 depict the results for the teaching video contingency intervention for Rick and Bran, respectively. The first panel depicts percentage of trials with correct DORs for the model's behavior (observation opportunities), the second panel depicts percentage of trials with correct DORs for the consequences (observation opportunities), and the third panel depicts

percentage of trials with correct selections (response opportunities). Percentage of trials with prompted and independent correct responses are depicted by open and closed circles, respectively.

As shown in Figure 4, Rick achieved mastery with the teaching video with two consequences modeled procedures within 12 sessions. Postteaching was then initiated and Rick performed below mastery with the video (three-button) contingency (first panel third phase of Figure 3). Next, the teaching video with three consequences modeled procedures were initiated 4and Rick achieved mastery within three sessions (Figure 7). Postteaching was then initiated a second time and Rick demonstrated OL at the mastery level (first panel fourth phase of Figure 2). As shown in Figure 7, Bran achieved mastery with the teaching video with two consequences modeled within 18 session. Postteaching was then initiated and Bran demonstrated OL at the mastery level (third panel third phase of Figure 2). Thus, Bran did not require the teaching video intervention with three consequences modeled to demonstrate OL at the mastery level in postteaching.

Figures 6 and 7 depict the results for the teaching tact contingency intervention for Rick and Bran, respectively. The first panel depicts percentage of trials with correct DORs for the model's behavior (observation opportunities), the second panel depicts percentage of trials with correct DORs for the consequences (observation opportunities), and the third panel depicts percentage of trials with correct tacts (response opportunities). Percentage of trials with prompted and independent correct responses are depicted by open and closed circles, respectively. Gray bars in the third panel depict the number of trials in a response opportunity.

As seen in Figure 6, Rick demonstrated high stable levels in correct DORs for the model's behavior (first panel second and third phase) and low to moderate variability of independent correct DORs for the consequence (second panel second and third phases). Within-session analysis showed that Rick consistently emitted the DOR to the consequence on trials

where the model received a reinforcer and inconsistently on trials where the model received no reinforcer. However, high stable levels of independent correct DORs for the model's behavior and low to moderate levels of independent correct DORs for the consequence was sufficient for Rick to acquire the tacts for teaching Sets 1 and 2 (third panel first and second phases). Next, postteaching procedures were initiated and Rick demonstrated OL with Sets 1 through 4 from the tact contingency (second panel third phase of Figure 2).

As seen in Figure 7, Bran acquired the tacts for teaching Set 1 (third panel fifth phase) after achieving mastery with token reinforcement, a motor DOR, and reinforcement for the DOR of the consequence on programmed reinforcement trials (Sr+ DOR of CR [second panel eighth phase]). The effects of this intervention were replicated with teaching Set 2 which Bran acquired within two observation opportunities (third panel sixth phase). Next, reinforcement was removed for engaging in the DOR (No Sr+ DOR) during observation opportunities with teaching Sets 3 and 4 (second panel tenth and eleventh phases) to provide Bran with a history of using the DORs in observation opportunities that more closely approximated what he would experience in postteaching. Bran acquired the tacts for teaching Sets 3 and 4 after observing four and two observation opportunities, respectively (third panel seventh and eighth phases). Next, postteaching procedures were initiated and Bran demonstrated OL with Sets 1 through 4 from the tact contingency (fourth panel second phase of Figure 2).

CHAPTER 3: DISCUSSION

We taught two children with ASD to leverage OL by engaging in DORs for the behavior and consequence performed by the model in observation opportunities. In preteaching, Rick and Bran demonstrated differential OL with some contingencies. Learning to engage in DORs for the behavior and consequence performed by the model with the hidden-video contingency led to increases in OL with that contingency in postteaching and increases in OL with the receptive-identification and intraverbal contingency for Bran. However, increases in OL with the tact

contingency were not observed. Thus, teaching was introduced with sets of stimuli unassociated with pre and postteaching which led to robust OL in postteaching with the tact contingency.

Testing OL across a host of contingencies varying in the complexity of stimulus modalities is the largest contribution to the OL literature from the current investigation. The presence of OL on some contingencies in pre and postteaching suggests that OL is not an all or nothing phenomenon and a more comprehensive approach composed of testing OL across a variety of contingencies is necessary for studying OL treatments in children with ASD. Future research should replicate the procedures from the current investigation to permit stronger conclusions about the extent to which children with ASD exhibit differential deficits in OL.

Being able to learn through observation with one type of contingency does not mean that an observer is capable of learning through observation with other types of contingencies. This conclusion is supported by Rick and Bran's preteaching results and the continued deficient OL they demonstrated with the tact contingency after acquiring the DORs taught with the hidden-video contingency; moreover, continued deficient OL with the tact contingency constituted a boundary condition of the teaching video contingency procedures. One plausible reason for the absence of generality on the tact contingency was that the topography of the DOR for the behavior was overly specific to the hidden-video contingency. Remember, children were taught to say "One." "Two," or "Three" as DORs for the behaviors in the video contingency. If an observer must attend to and behave in an analogous manner as the model for OL to occur (Palmer, 2012), it makes sense that generality was not observed because saying "One," "Two," or "Three" is topographically different from every tact the model performed in observation opportunities. Thus, the topographical difference between the DOR for the behavior taught with the hidden-video contingency and the tacts performed by the model with the tact contingency may have prevented rather than promoted generality. This interpretation is supported by Rick and Bran's postteaching tact contingency results because they demonstrated robust OL across Sets 1 through 4 after

acquiring the DORs for the behaviors and consequences. Future researchers should further investigate how the topography of DORs taught with one contingency influence generality of the teaching procedures on untaught contingencies.

Our teaching procedures extend previous research (Delgado & Greer, 2009; DeQuinzio & Taylor, 2015; DeQuinzio et al., 2018; MacDonald & Ahearn, 2015; Taylor et al., 2012) because teaching children to engage in DORs for the behaviors at the time of observation is a novel treatment component. In addition, teaching children to engage in DORs for the behavior and consequence led to robust OL on sets unassociated with the teaching procedures. Teaching children to engage in DORs to the consequence may have functional similarities to the peer-monitoring intervention from Delgado and Greer (2009), which entailed teaching children to point to a green block after observing the model perform a correct response and access a reinforcer and a red block after observing the model perform an incorrect response and access no reinforcer. The inherent portability of the DORs taught in the current study makes them advantageous for teaching OL in clinical settings because additional stimuli (i.e., red and green blocks) are not necessary.

Use of the repeated acquisition design, delivering differential reinforcement in response opportunities, and terminating response opportunities early based on incorrect responses may serve as a model for future research for numerous reasons. First, each observation of the same contingency increases the probability that OL will occur. With the repeated acquisition design, intrasubject replication of the effects produced by the teaching procedures is obtained and threats to internal validity are mitigated if OL in postteaching is replicated across multiple sets after a relatively smaller number of observation opportunities compared to the number in preteaching. For example, in postteaching Rick and Bran demonstrated OL with Sets 1 through 4 of the tact contingency within two to six observation opportunities compared to the 10 to 20 observation opportunities modeled with Set 1 in preteaching. To the best of our knowledge, this is the first

study demonstrating the utility of the repeated acquisition design in evaluating OL in children with ASD. Second, we included differential reinforcement in response opportunities to avoid potential motivational issues as modeled by MacDonald and Ahearn (2015). Previous research has avoided delivering differential consequences in response opportunities (Delgado & Greer, 2009; DeQuinzio & Taylor, 2015; DeQuinzio et al., 2018) to rule out differential reinforcement as a threat to internal validity. However, lack of differential reinforcement in response opportunities may hinder OL and likely differs from what children experience in the natural environment. For example, Delgado and Greer (2009) found that unconsequating children's responses in response opportunities caused motivational issues for one of two children. To address these concerns, we included differential reinforcement in response opportunities as modeled by MacDonald and Ahearn (2015) and both children demonstrated robust OL after achieving mastery with the teaching procedures. Third, we terminated response opportunities early to further mitigate differential reinforcement as a threat to internal validity. Future research should consider including differential reinforcement in response opportunities and terminating sessions once a predetermined criteria is met.

Testing OL after every observation opportunity may serve as a standard approach for future OL research and a good starting point for clinical practice for numerous reasons. There is no consensus among researchers about the number of observation opportunities to perform before testing. For example, in observation opportunities from MacDonald and Ahearn (2015) the model performed three correct and three incorrect responses per target before testing OL with the receptive-identification contingency. In observation opportunities from DeQuinzio et al. (2018), the model performed one response per target before testing OL. In the current study, three responses were modeled per target, one correct and two incorrect prior to each response opportunity. This approach is helpful because it permits more accurate analysis of the number of observations a child requires before OL will occur. In contrast, performing more correct

responses per target before testing OL limits conclusions about how many observations were necessary. Finally, it may be more efficient for clinical practice to start by testing OL after every observation opportunity because children may be able to indicate rather quickly that they can learn through observation.

Bran's receptive-identification and intraverbal results show a possible fleeting effect of the teaching video contingency procedures over OL. After acquiring the DORs with the hidden-video contingency, Bran acquired Sets 1 through 5 of the receptive-identification contingency within one to six observation opportunities and Sets 1 through 4 of the intraverbal contingency within four to 40 observation opportunities. However, interpretations about the extent to which these results are due to the teaching video contingency procedures warrant caution because intersubject replication was not obtained. Similarities between the stimulus modalities of the hidden-video and receptive-identification contingencies may be part of the reason for the observed increases in OL with the receptive-identification contingency. For example, the antecedent for both contingencies included visual stimuli presented in a horizontal array. Although the locations of the images in the array changed across observation trials, the images were present on each trial. This contrasts with the tact contingency because only one of the two target images was present on each observation trial and the intraverbal contingency because only one of the two spoken intraverbals was presented on each observation trial. Although Bran required a progressively larger number of observation opportunities across Sets 1 through 4 of the intraverbal contingency, increases were likely due to OL. These results tentatively suggested that Bran required a larger number of observation opportunities with the intraverbal contingency for OL to occur. Future research should investigate whether the teaching tact intervention leads to generality on the intraverbal contingency.

It is important to note that Bran engaged in OL at the mastery level in the fifth response opportunity for Set 1 from the receptive-identification contingency in preteaching (first column

second panel of Figure 3), however he demonstrated low levels of OL with Set 1 in subsequent response opportunities. High levels in the fifth response opportunity may be due to chance responding rather than OL because Bran did not demonstrate OL with Sets 2 through 3 in preteaching. For example, it is possible that Bran selected the correct images on the first through fifth trials by chance. These result may support arguments to include repeated measures for the same set after OL is observed in postteaching. However, use of the repeated acquisition design and testing across multiple sets render such arguments moot because replication is achieved by repeatedly demonstrating OL, across multiple sets, and within a smaller number of observation opportunities compared to the number modeled in preteaching. Nevertheless, future research should obtain repeated measures after detecting OL to increase believability that high levels of responding are due to OL and not chance responding.

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Table 1

Contingency Name, Antecedent, Behavior, and Consequence Stimulus Modalities of the Observed Contingencies

Contingency Name	Observed Contingency					
	Antecedent		Behavior		Consequence	
	Stimulus	Modality	Stimulus	Modality	Stimulus	Modality
1. Hidden-edible (cups)	Three cups	Visual	Selection	Visual	Edible	Visual-direct
2. Hidden-toy (bins)	Three bins	Visual	Selection	Visual	Toy	Visual-direct
3. Hidden-video (buttons)	Three play buttons	Visual	Selection	Visual	Video	Visual-direct
4. Tact	Image and "What is it"	Visual-auditory	Label	Auditory	Edible	Visual-auditory-indirect
5. Receptive-identification	Three images and "Touch image"	Visual-auditory	Selection	Visual	Edible	Visual-auditory-indirect
6. Intraverbal	Question	Auditory	Answer	Auditory	Edible	Visual-auditory-indirect

Table 2

Operational Definitions for Dependent Measures

Dependent Measure	Operational Definition
Observational learning	An emitted response that matched the topography of the response observed that produced reinforcement rather than the responses that contacted no reinforcement on the first opportunity (i.e., the absence of a history of differential reinforcement; MacDonald & Ahearn, 2015).
Differential observing response for the behavior (hidden-video contingency)	Tacting the location of the play button the model touched (i.e., saying "One" for the left-button press, "Two" for the middle-button press, and "Three" for the right-button press) within 5 s.
Differential observing response for the consequence (hidden-video contingency)	Tacting the presence or absence (i.e., saying "Video" or "No video") of reinforcement within 5 s.
Differential observing response for the behavior (tact contingency)	Echoing the tact the model emitted within 5 s.
Differential observing response for the consequence (tact contingency)	Tacting the presence or absence (i.e., saying "Gummy" or "No gummy") of reinforcement within 5 s. For Bran, the definition was modified to emitting a thumbs up for the presence or thumbs down for the absence of reinforcement within 5 s.

Table 3

Operational Definitions for Procedural Terminology

Procedural Term	Operational Definition
Eye contact	Child having his or her face and both eyes directed at the antecedent materials, behavior the model emitted, and the consequence the model experienced in observation opportunities.
Model	The adult that engaged in modeled responses, prompted the child to engage in eye contact (observation trials), arranging materials between trials, delivering preferred items contingent on eye contact, and data collection (observation and response opportunities).
Teacher	The adult that delivered all antecedents and consequences to the model (observation opportunities) and child (response opportunities).
Observation trial	Programming the antecedent, a response by the adult model, and the consequence for a given contingency in front of the child.
Observation opportunity	Six observation trials the model performed for the child.
Response trial	The child's opportunity to engage in a response under the antecedent conditions from the preceding observation opportunities.
Response opportunity	Two-to-six response trials where the child was given the opportunity to engage in a response under the antecedent conditions from the preceding observation opportunities.

Table 4

Example of an Observation Opportunity for the Tact Contingency

Trial	Antecedent (Teacher)	Behavior (Model)	Consequence (Teacher)
1	“What is it?” and image of stamp	“Tambor”	“Wrong” and no reinforcer
2	“What is it?” and image of drum	“Tambor”	“Correct” and reinforcer
3	“What is it?” and image of drum	“Cuerno”	“Wrong” and no reinforcer
4	“What is it?” and image of stamp	“Sello”	“Correct” and reinforcer
5	“What is it?” and image of drum	“Sello”	“Wrong” and no reinforcer
6	“What is it?” and image of stamp	“Cuerno”	“Wrong” and no reinforcer

Table 5

Example of an Observation Opportunity for the Receptive-Identification Contingency

Trial	Antecedent (Teacher)	Behavior (Model)	Consequence (Teacher)
1	Three image array and “Touch avispa”	Selects wasp	“Correct” and reinforcer
2	Three image array and “Touch trompeta”	Selects purse	“Wrong” and no reinforcer
3	Three image array and “Touch avispa”	Selects purse	“Wrong” and no reinforcer
4	Three image array and “Touch trompeta”	Selects trumpet	“Correct” and reinforcer
5	Three image array and “Touch trompeta”	Selects wasp	“Wrong” and no reinforcer
6	Three image array and “Touch avispa”	Selects trumpet	“Wrong” and no reinforcer

Table 6

Example of an Observation Opportunity for the Intraverbal Contingency

Trial	Antecedent (Teacher)	Behavior (Model)	Consequence (Teacher)
1	“Who does research?”	“Cleaver”	“Wrong” and no reinforcer
2	“What pulverizes meat?”	“Wings”	“Wrong” and no reinforcer
3	“What pulverizes meat?”	“Researcher”	“Wrong” and no reinforcer
4	“Who does research?”	“Researcher”	“Correct” and reinforcer
5	“What pulverizes meat?”	“Cleaver”	“Correct” and reinforcer
6	“Who does research?”	“Wings”	“Wrong” and no reinforcer

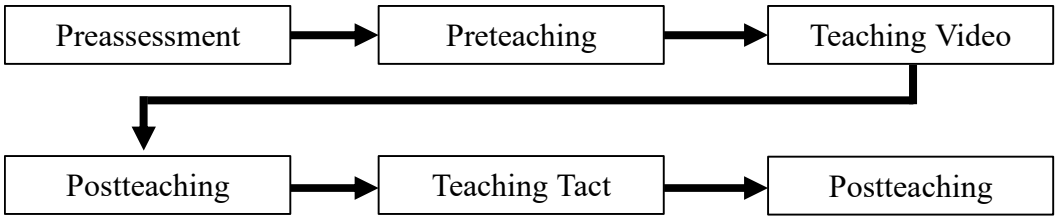

Figure 1. Schematic of general procedures depicts children's progression through the different assessments and conditions of the study. In preassessment, highly preferred items were identified and unknown targets were identified for the tact, receptive-identification, and intraverbal contingencies. In preteaching, OL was tested across all contingencies. Next, teaching procedures were introduced with the hidden-video contingency. Postteaching was initiated on contingencies where OL was not observed immediately after the child achieved mastery with the teaching video procedures. Next, the teaching procedures were introduced with the tact contingency. Postteaching was initiated on with Sets 1 through 4 of the tact contingency immediately after the child immediately after the child achieved mastery with the teaching tact procedures

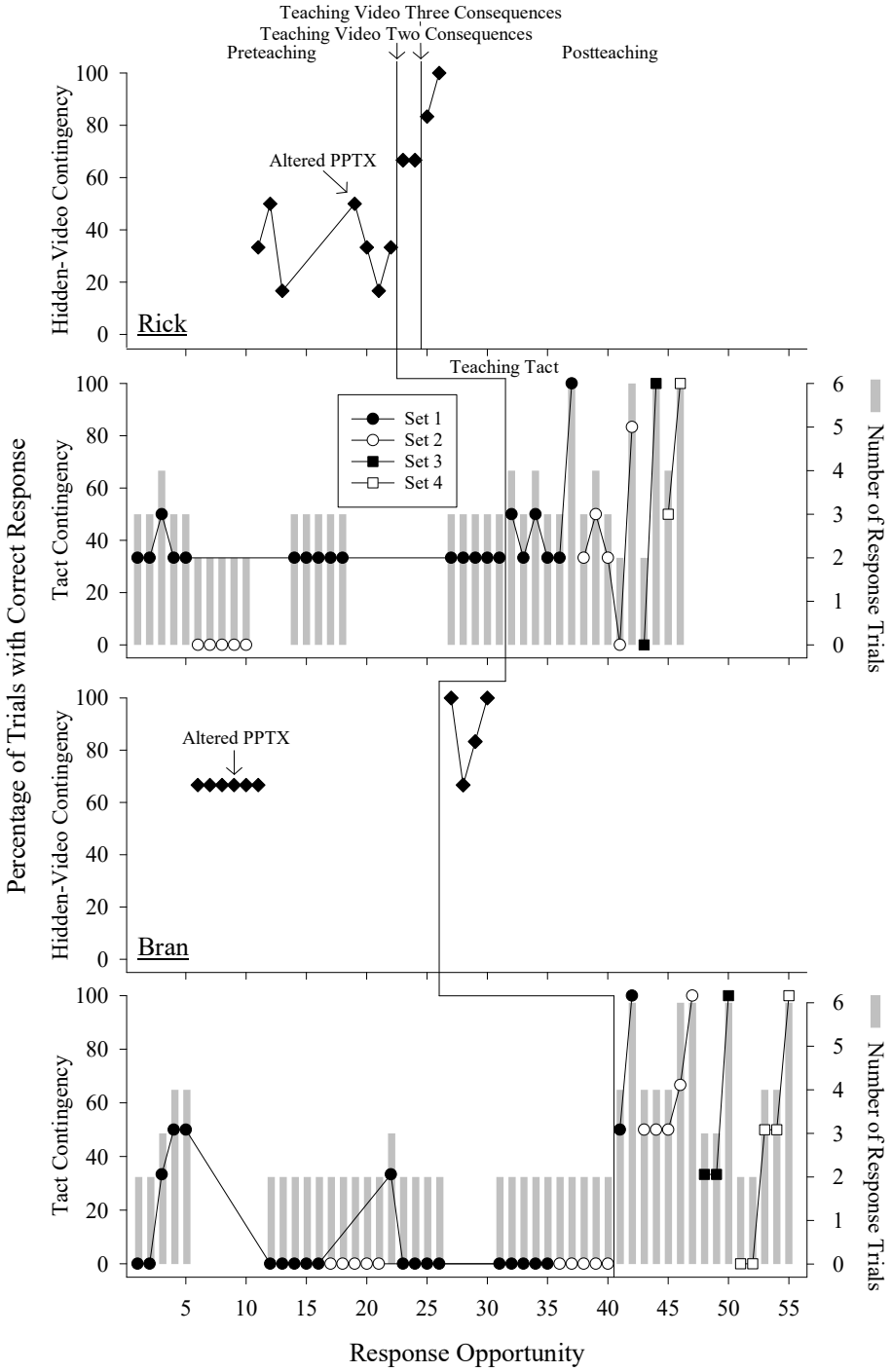

Figure 2. Results for Rick (Panels 1 and 2) and Bran (Panels 3 and 4) on the hidden-video (Panels 1 and 3) and tact (Panels 2 and 4) contingencies using a one-to-one ratio of observation to response opportunities. Response opportunities comprised six (hidden-video) or two-to six (tact) trials. Closed diamonds depict percentage of trials with correct selections on the hidden-video contingency. Percentage of trials with correct tacts for Sets 1, 2, 3, and 4 are depicted by closed circles, open circles, closed squares, and open squares, respectively. Gray bars depict number of trials in a response opportunity.

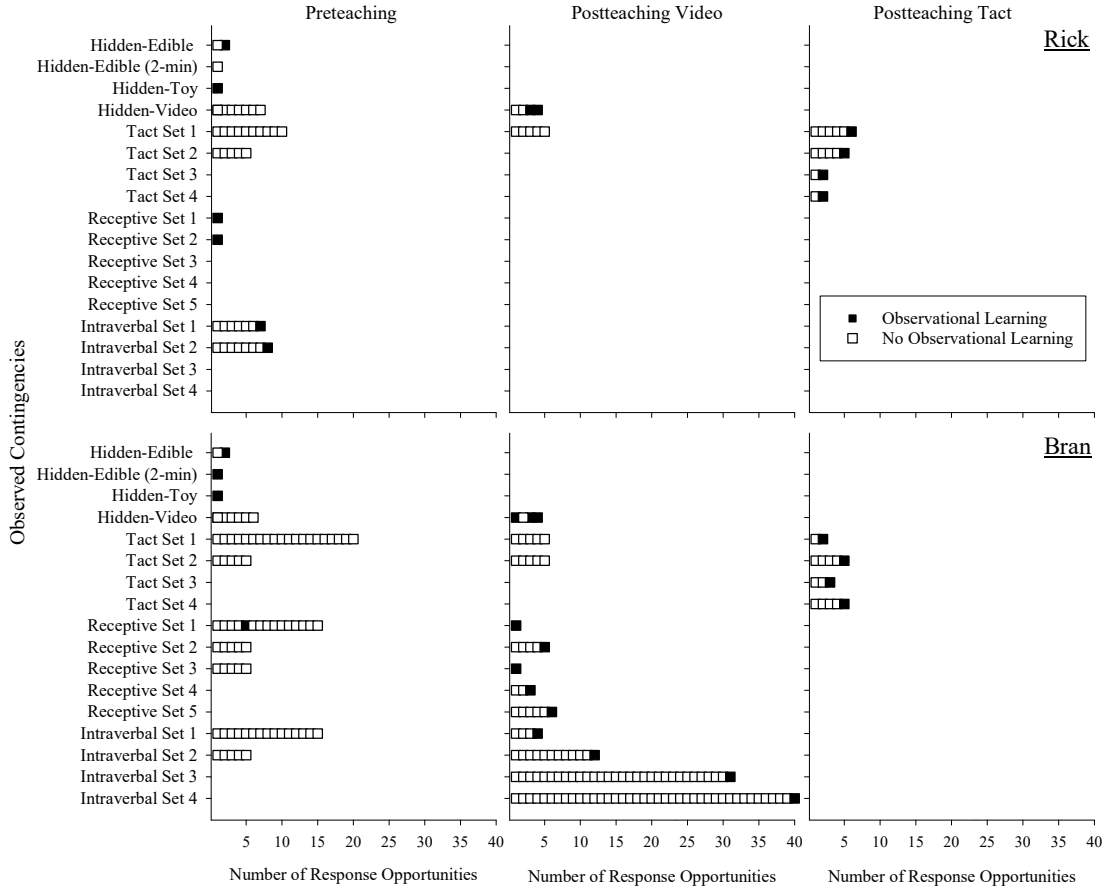

Figure 3. Summary of Rick (first row) and Bran's (second row) OL repertoires across all contingencies. Results for preteaching, postteaching with the video contingency, and postteaching with the tact contingency are depicted in the first, second, and third columns, respectively. Closed squares indicate that OL occurred and open squares indicate that OL did not occur in that response opportunity.

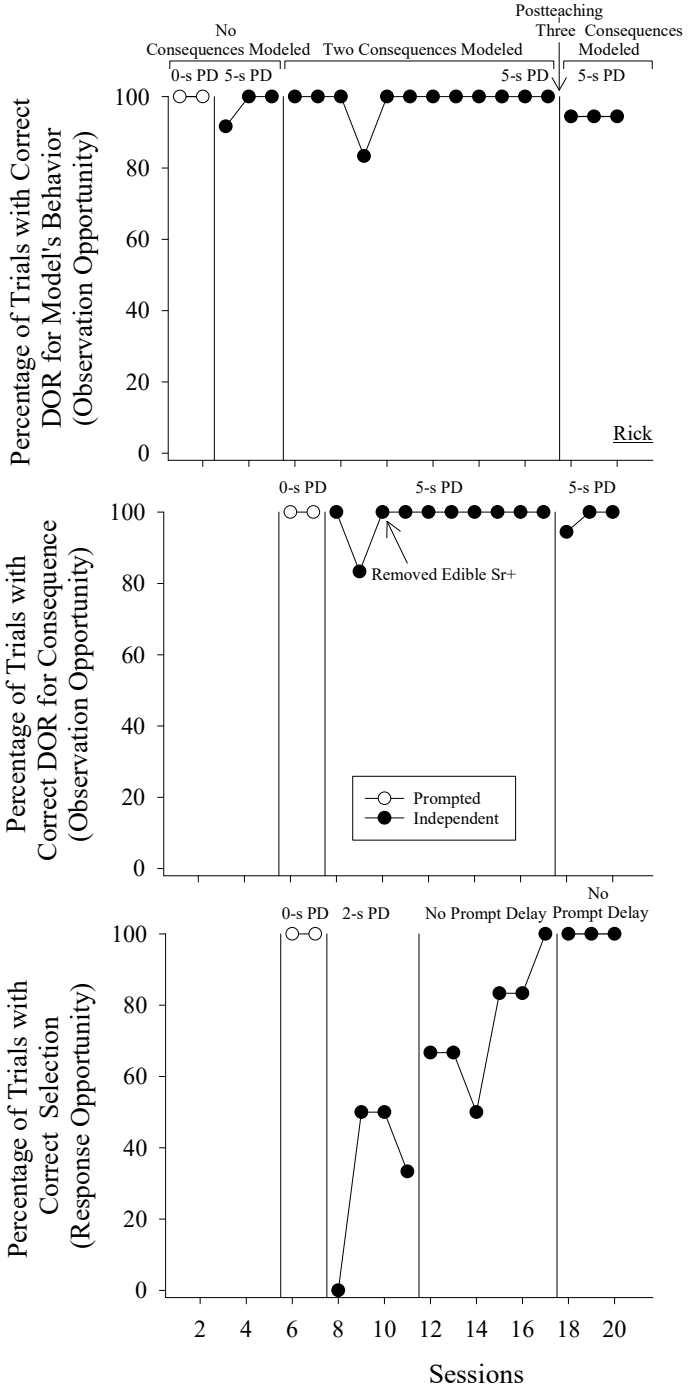

Figure 4. Rick's results with the teaching video contingency procedures. Percentage of trials with correct DOR for model's behavior and consequence are depicted in the first and second panel, respectively. Percentage of trials with correct selections in response opportunities are depicted in the third panel. The postteaching phase label represents initiation of postteaching procedures.

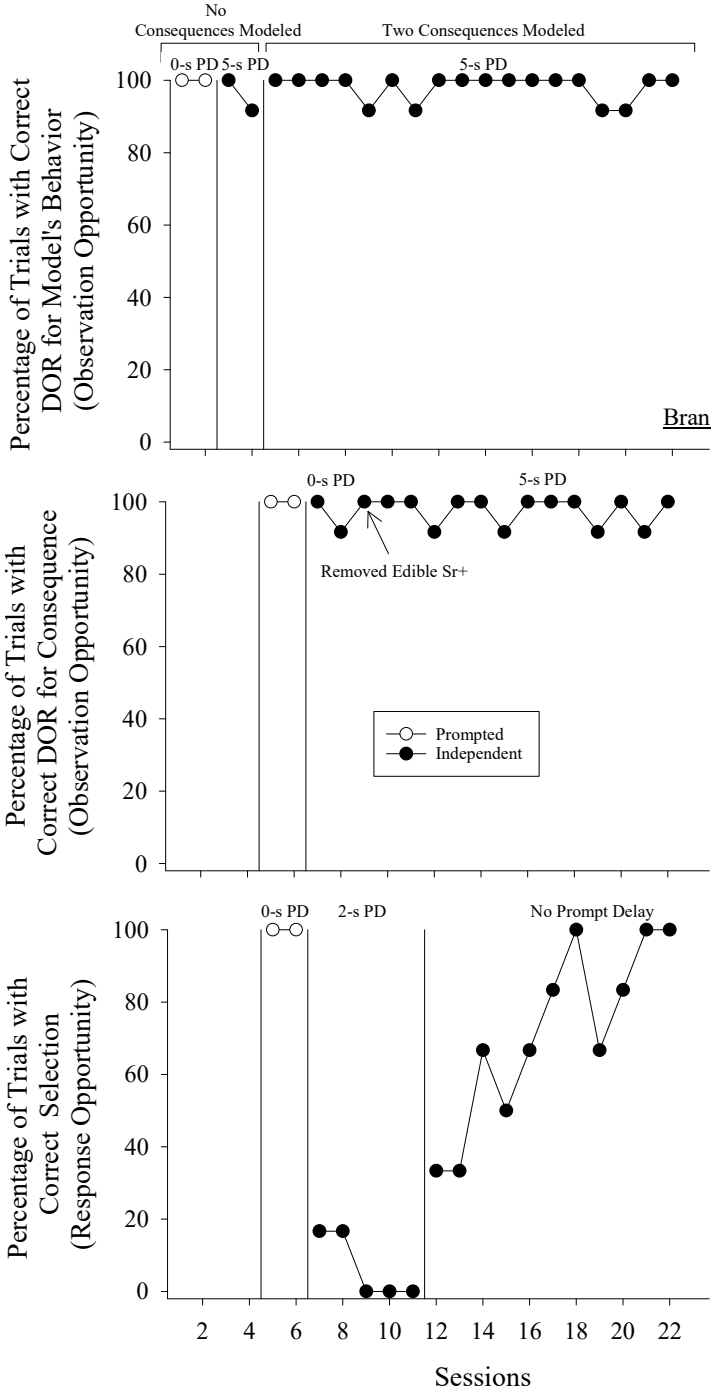

Figure 5. Bran's results with the teaching video contingency procedures. Percentage of trials with correct DOR for model's behavior and consequence are depicted in the first and second panel, respectively. Percentage of trials with correct selections in response opportunities are depicted in the third panel.

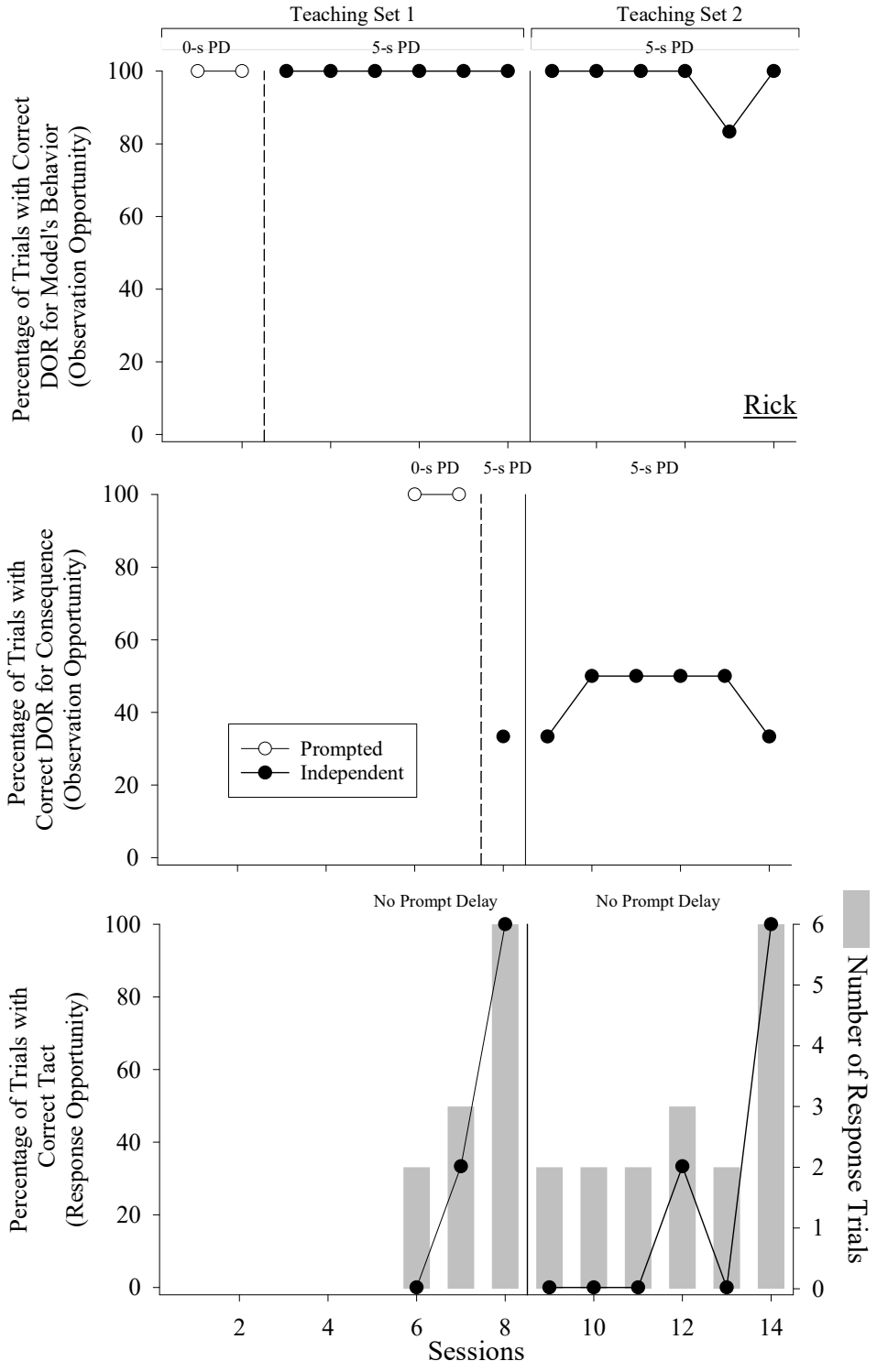

Figure 6. Rick's results with the teaching tact contingency procedures. Percentage of trials with correct DOR for model's behavior and consequence are depicted in the first and second panel, respectively. Percentage of trials with correct tacts in response opportunities are depicted in the third panel. Gray bars denote number of trials in a response opportunity.

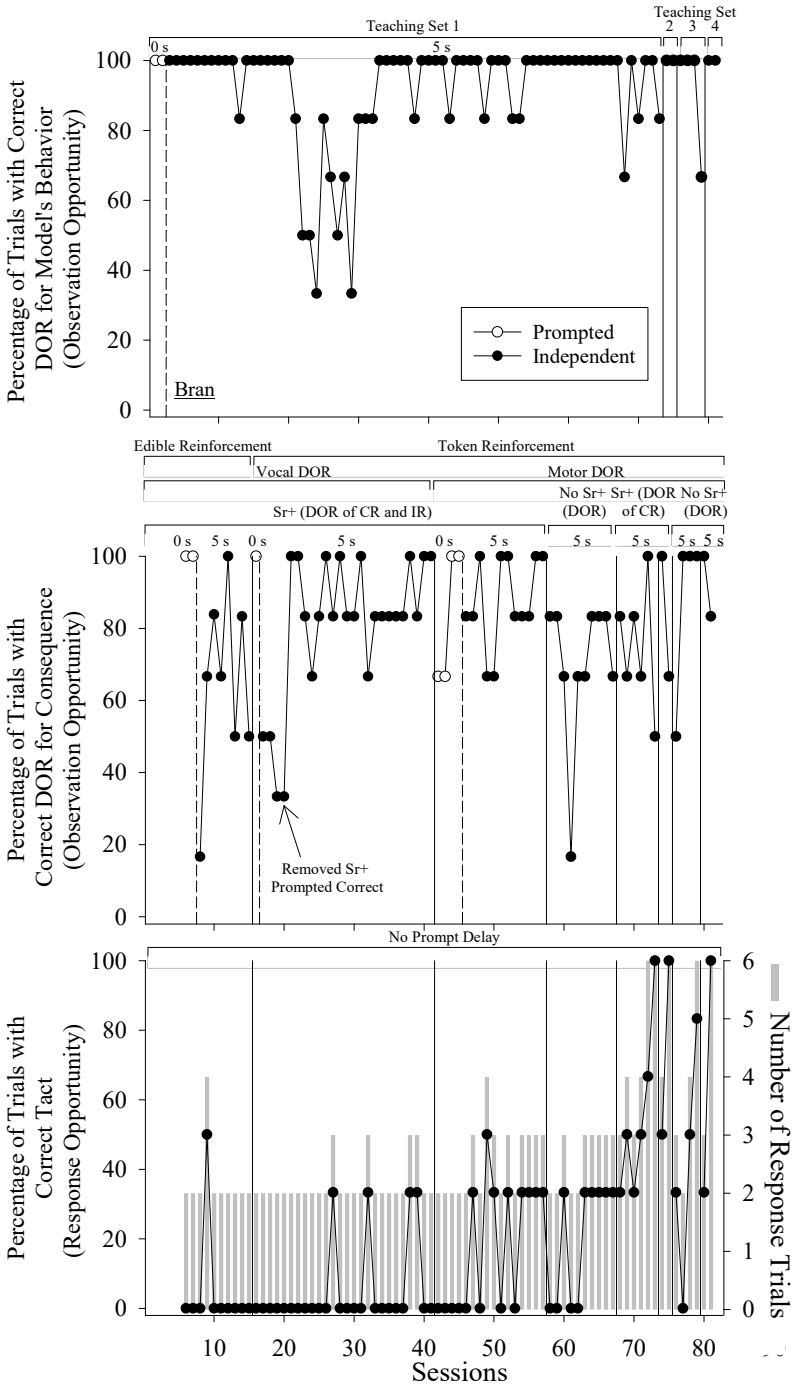

Figure 7. Bran's results with the teaching tact contingency procedures. Data for reinforcement delivered for DORs for the consequence on programmed correct and incorrect trials (Sr+ DOR of CR and IR) are shown in the second panel first through sixth phases. Data for no reinforcement delivered for DORs for the consequence (No Sr+ DOR) are shown in the second panel seventh, tenth, and eleventh phases. Data for reinforcement delivered for DORs for the consequences on programmed correct trials only (Sr+ DOR of CR) are shown in the second panel eighth and ninth phases.