Behavioral Development

Teaching Children With Autism to Respond to Joyful and Fearful Expressions Within Social Referencing

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We used a multiple baseline design across 4 participants to determine the effects of discrimination training, verbal instructions, and manual guidance on the differential responding of children with autism to fearful and joyful expressions within social referencing. All 4 participants learned to discriminate the expressions presented within the context of social referencing, but generalization to other people, stimuli, and settings was limited. A discussion of social referencing and future directions for research are discussed.

Keywords: autism, social referencing, emotions, facial expressions

Behavioral markers of autism can appear in the first year of life and as young as 6 months of age (Chawarska, Macari, & Shic, 2013). Neimy, Pelaez, Carrow, Monlux, and Tarbox (2017) summarized these early markers as the absence of facial recognition, pointing, reaching, eye contact, gaze shifting, joint attention, and social referencing. These deficits are characterized as a lack of social information-seeking, are associated with poorer verbal and social skills later in childhood (Stone & Yoder, 2001), and have been identified as early indicators of autism (Cornew, Dobkins, Akshoomoff, McCleery, & Carver, 2012; Thorup, Nyström, Gredebäck, Bölte, & Falck-Ytter, 2018). Of these early behavioral markers, joint attention and gaze shift have received much attention for remediation in the behavior-analytic literature. On the contrary, social referencing has received very little focus, despite the fact that is has been argued to be important to the development of language and social skills and has been identified as a

deficit of children with autism (Sigman, Kasari, Kwon, & Yirmiya, 1992). This may be attributed to a confusion about the similarities and differences between joint attention and social referencing (see DeQuinzio, Poulson, Townsend, & Taylor, 2016, for a relevant discussion) and a traditional interpretation of social referencing as a developmental and social–cognitive process (Feinman, 1992). Only one study to date has evaluated procedures for teaching social referencing to children with autism (Brim, Townsend, DeQuinzio, & Poulson, 2009).

To understand the social-referencing deficits of children with autism, it is useful to first understand social referencing in typically developing children. Social referencing appears between 9 and 12 months of age and occurs when an infant observes the reactions of others to determine how to respond to novel or ambiguous environmental events (Gewirtz & Peláez-Nogueras, 1992). Research has included arrangements in which the infant is exposed to ambiguous situations, such as a visual cliff, strangers, or animated toys. Infants demonstrating social referencing look to caregivers when confronted with these stimuli and, in turn, caregivers display either positive emotional responses (e.g., joy) or negative emotional responses (e.g., fear). Typically developing infants are more likely to cross the visual cliff, reach for toys, and approach strangers when

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mothers display positive facial expressions than when facial expressions are negative (Sorce, Emde, Campos, & Klinnert, 1985).

Hence, social referencing relies on a child's response to the affective stimuli displayed by social partners. Children with autism have difficulty recognizing the emotions of others, and there is a deficit in responding to and discriminating affective stimuli, such as facial expressions (Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001; Weeks & Hobson, 1987). Perhaps this is the case because children with autism do not often orient toward the faces of others during social interactions (Constantino et al., 2017; Magrelli et al., 2013), they show challenges imitating facial expressions (DeQuinzio, Townsend, Sturmey, & Poulson, 2007; Markodimitraki, Kypriotaki, Ampartzaki, & Manolitsis, 2013), and display difficulty noticing and identifying facial expressions (Sato et al., 2017).

The conceptualization of social referencing as operant behavior (Peláez, 2009; Peláez, Virues-Ortega, Field, Amir-Kiaei, & Schnerch, 2013; Peláez, Virues-Ortega, & Gewirtz, 2012) provides a basis for training social referencing in children with autism. Social referencing can be explained as a two-link chain of stimulus–response interactions in which each component response in the chain produces stimulus conditions that function as both a conditioned reinforcer for the previous response and as a discriminative stimulus for the following response (DeQuinzio et al., 2016). An illustrative example can be found in a study by Gewirtz and Peláez-Nogueras (1992), who were the first to describe social referencing as operant behavior. In this study, 9- to 12-month-old infants and their mothers were seated next to each other. Toys covered by cloths were presented to infants as ambiguous stimuli. After infants engaged in an orienting response, mothers presented arbitrary cues. A "fist-to-nose expression" signaled reinforcement for reaching for the toy. A "palms-to-cheeks expression" signaled punishment for infant reaching. Infants learned to respond differentially to these cues, reaching for toys in the presence of the maternal cue that signaled reinforcement and not reaching for toys in the presence of the maternal cue that signaled punishment. In a replication conducted by Peláez et al. (2012), 4- to 5-month-old infants and their mothers

were studied under a similar paradigm. This time, however, facial expressions were displayed by mothers as opposed to presenting arbitrary cues. Joyful expressions, such as smiling, signaled reinforcement for infant reaching, and fearful expressions, such as fear, signaled punishment for infant reaching. Infants learned to respond differentially to the facial expressions, again supporting the notion that social referencing is operant. These two studies provide evidence that social referencing can be acquired by typically developing infants through operant learning procedures. Furthermore, and most relevant to behavior analysts working in autism treatment environments, these results provide a framework for remediating these deficits in children with autism.

As reviewed in DeQuinzio et al. (2016), there is only one published study to date that demonstrated children with autism could learn the discriminations required for social referencing. Brim et al. (2009) demonstrated that children with autism between the ages of 5 and 8 years old could be taught to engage in the components of the social-referencing response chain. A multiple-baseline-across-responses design was used to evaluate social-referencing training (i.e., verbal prompts, manual guidance, and reinforcement) on the occurrence of social-referencing responses (i.e., discriminated observing and the conditional discrimination of affect) across handwriting, verbal imitation, and gross-motor imitation tasks. They first taught independent observing in the presence of ambiguous stimuli (i.e., atypical task-related materials, such as aluminum foil in a piece of paper). Once independent observing occurred within each trial, instructors presented affective discriminative stimuli consisting of a smile and head nod or a frown and head shake that signaled reinforcement for task completion and task termination, respectively. All participants learned the observing response and the conditional discrimination in the presence of the two affective displays, demonstrating that children with autism could learn social-referencing responses.

Although the results of Brim et al. (2009) were promising in terms of addressing the social-referencing deficits of children with autism, only one additional study to date has been published since, leaving an important area of behavioral intervention relatively untapped. Weis-

berg and Jones (2019) taught gaze-shift responses within the context of joint attention, requesting, and social referencing to children with autism. In terms of social referencing, the authors focused on Link 1 responding (i.e., the observing response in the form of gaze shift to an adult) and demonstrated that prompting and reinforcement were effective for some participants, whereas others required individual modifications.

Additional research is needed to better understand factors related to teaching social referencing to children with autism, and in particular, to focus on Link 2 responding, which requires the discrimination of affect, a notable deficit in individuals with autism. Brim et al. (2009) used two affective stimuli (i.e., smile and frown) to signal discriminative responding in the form of task completion and task termination. It is unknown if children with autism could learn to discriminate other facial expressions (i.e., joy and fear) within social-referencing tasks that signal approach and avoidance responses, similar to those taught to typically developing infants in Peláez et al. (2012). Given the scarcity of research in this area, the goals of this study were to (a) partially replicate Peláez et al. with children with autism; (b) determine the effects of differential reinforcement, manual prompts, and simultaneous verbal instructions on the discrimination of affect during Link 2 of the social-referencing response chain; and (c) measure generalization of affect discrimination to other adults and environments not associated with treatment. We focused on Link 2 of the behavioral chain because discrimination of facial expressions is a long-documented deficit of children with autism, and such a focus closely replicates the procedures of Peláez et al., who prompted Link 1 responding in typically developing infants if it did not occur as means to present Link 2 affective stimuli.

Method

Participants

Children who attended a behaviorally based school, where the primary teaching was based on applied behavior analysis, were invited to participate. We recruited students who were between the ages of 4 and 8 years old and who had experience using token economies, a history of

learning simple discriminations, match-to-sample conditional discriminations, and who demonstrated generalized imitative repertoires. Additionally, we required that participants did not currently respond to facial expressions or demonstrated inappropriate behavior in response to facial expressions, had no prior training with social referencing or joint attention, and scored within Levels 1 and 2 of the Verbal Behavior Milestones Assessment and Placement Program in the social, imitation, and Visual Perceptual Skills and Matching-to-Sample domains. The exception to this was Kasey, who scored in Level 3 on the Visual Perceptual Skills and Matching-to-Sample domain (see details below). Parents were informed that participation was voluntary and that their decision to provide consent for their child to participate would not impact their child's services. Once written consent was provided, the preassessments were conducted. All sessions were conducted by teachers familiar with the participants and trained by the first author in the study procedures.

Nora was 7 years 3 months old at the time of the study. Many of her instructional programs were focused on improving verbal behavior and targeted skills such as matching words to pictures, stating phrases appropriate to the context, labeling verbs, asking questions, introducing herself, answering general knowledge questions, following instructions with a delay, reciprocating comments about objects, labeling objects to function, requesting items from a peer, labeling pictures, and placing items or oneself according to stated prepositions. Kasey was 6 years 6 months old at the time of the study. His instructional programs targeted verbal and social skills such as asking questions within a conversation, maintaining eye contact while speaking, answering questions, following multistep instructions, describing pictures and objects using multiple attributes, describing similarities and differences, and introducing oneself. Andy was 5 years 2 months old at the time of the study. His instructional programs focused on improving social and verbal repertoires such as eye contact, matching words to pictures, labeling nouns and verbs, articulating, answering general knowledge questions, stating contextual verbal phrases, and following directions. Oscar was 4 years 3 months old at the time of the study. His instructional programs focused on a

variety of social and verbal repertoires such as sustaining eye contact, reciprocating verbal comments about objects, describing pictures using full sentences, stating contextual phrases, labeling possession using pronouns, labeling items according to attribute, engaging in a verbal response to name, taking turns, and following directions. Additional participant characteristics can be found in Table 1.

Experimental Design

We used a nonconcurrent multiple baseline design across participants. We evaluated the effects of differential reinforcement, manual guidance, and verbal instructions on the discrimination of facial expressions during social referencing.

Dependent Measures, Response Definitions, and Data Collection

Correct responding on a joyful trial was defined as reaching for the container within 3 s of the joyful facial expression. Correct responding on fearful trials was defined as moving away from the container by taking at least one step back within 3 s of the fearful facial expression. Data were summarized as the percentage of two-trial blocks with a correct response (a correct response on both a joyful and fearful trial had to occur to score the trial block as correct). There were three trial blocks per session for a total of six trials (three joyful and three fearful) per session.

Interobserver Agreement and Treatment Integrity

Interobserver agreement (IOA) was calculated for responses observed during baseline, discrimination training, and generalization sessions. Interobserver agreement was calculated on a trial-by-trial basis by dividing the number of agreements by the number of agreements plus disagreements and converting the result to a percentage. An agreement was counted if both the instructor and a second observer independently scored a response as correct or incorrect in the same trial. For Nora, IOA was collected for 34% of all sessions with a mean IOA coefficient of 91%. For Kasey, IOA was collected for 25% of all sessions with a mean IOA coefficient of 100%. For Andy, IOA was collected for 23% of all sessions with a mean IOA coefficient of 91%. For Oscar, IOA was collected for 44% of all sessions with a mean IOA coefficient of 100%.

Treatment-integrity (TI) data were collected on the accurate implementation of the independent variable during all conditions. An independent observer used a checklist containing all of the procedures (e.g., environmental arrangement, accurate production of facial expression for trial type listed on the data sheet, use of prompts, use of verbal instruction, delivery of reinforcement, and use of error correction) and scored a plus (+) for each step completed correctly and a minus (−) for each step completed incorrectly. The percentage of total steps completed correctly was calculated by dividing the

Table 1
Participant Characteristics

| Participant | CA | PPVT-IV | EVT-II | VBMAPP domain | | |
				Social	Imitation	VPMTS
Nora	7–3	2–4	3	5/15	9.5/10	13/15
Oscar	4–3	3–3	3–5	4.5/15	7.5/10	12/15
Andy	5–2	2–4	2–2	1.5/15	5.5/10	6.5/15
Kasey	6–6	5–11	6–6	10/15	6.5/10	15/15

Note. CA = chronological ages; PPVT-IV = Picture Peabody Vocabulary Test (Dunn & Dunn, 2007); EVT-II = Expressive Vocabulary Test (Williams, 2007); VBMAPP = Verbal Behavior Milestones Assessment and Placement Program; VPMTS = Visual Perceptual Skills and Matching-to-Sample. CA and age equivalents on the PPVT and EVT are reported in years and months. VBMAPP scores are reported as a fraction of the total score for each domain.

number of correct steps by the total number of steps and multiplying by 100. Treatment-integrity data were collected during 20%, 14%, 25%, and 29% of sessions for Nora, Kasey, Andy and Oscar, respectively, and the mean TI was 96%, 100%, 99%, and 100%, respectively.

Setting and Materials

To promote generalization using multiple exemplar training, we used a variety of settings, instructors, and stimuli during training sessions. Training sessions took place in various rooms in the school, including classrooms, offices, meeting rooms, and the kitchen. All rooms contained tables and chairs. For each participant, we randomly assigned three rooms for training sessions and three rooms for generalization sessions. For all participants, two instructors conducted training sessions and one instructor not associated with training conducted the generalization sessions. Instructors were assigned according to availability.

Various opaque containers (e.g., canvas bins, tote bags, reusable shopping bags) were used to initiate social-referencing trials. Six different bags were used during training sessions, and four bags were reserved for generalization sessions. All of the containers were solid colored tote bags, reusable shopping bags, or canvas containers. None of the containers were transparent (i.e., participants were unable to see through them), and all of the containers were structured so that their shape could not be distorted by the small items inside. Additionally, the toys placed inside the containers were small, hand-held-sized items, such as various types of toy vehicles, water wands, small figurines, small stuffed toys, and small balls. Toys were placed in the containers for joyful trials, but containers were empty on fearful trials. A blanket was used to cover the table and conceal the containers stored underneath between trials.

Participants' individualized token systems were used to reinforce hands down and quiet behavior during intertrial intervals, and backup rewards (chosen by the participant from individualized choice boards) were provided after the session. For each participant, token boards consisted of 10 small laminated stickers adhered to a small binder.

Pictures of various facial expressions were used for the receptive-identification task.

Three-by five-inch index cards were created using images of facial expressions found by searching the Internet using the search terms "joyful expression," "fearful expression," "sad expression," and so forth. We chose pictures of three different people with varying skin, hair, and eye color for to use as sample stimuli for both the joyful and fearful expressions, totaling six unique cards. The comparison stimuli depicted people different than those used in the sample pictures displaying joyful, fearful, angry, sad, and surprised facial expressions.

Instructors presented joyful and fearful expressions during the imitation assessment and in baseline, training, generalization, and maintenance. Joyful expressions were presented as an open smile with teeth showing and mouth slightly open. Fearful expressions were presented as furrowed eyebrows, mouth turned downward and slightly open with head and or upper body making a slight movement backward. An open mouth was used for each expression so that instructors could simultaneously emit verbal instructions during training.

Preassessments

Eye contact. Because we planned to present the facial expressions for a duration of 5 s during social-referencing training, we wanted to ensure that participants could sustain eye contact for that duration prior to baseline. During this assessment, the instructor presented five trials during which she called the participant's name and said "Look." The participant had 3 s to respond to the instruction. The instructor started the timer when the participant looked at the participant and stopped the timer when the participant looked away. If the participant looked at the instructor for at least 5 s, a plus was scored on the data sheet. If the participant did not look for a duration of 5 s, a minus was scored on the data sheet. No prompts or reinforcement were provided during this assessment. Criterion for moving on to baseline was correct responding on four out of the five trials. If participants did not respond correctly on four out of the five trials, we implemented three training sessions during which we used a finger swipe (i.e., extending the index finger and moving it from the participant's visual field to the space in front of the instructor's eyes) to teach participants to respond to the instruction,

"Look." We provided praise (e.g., "Good looking at me!") and a token for correct responses. Oscar was the only participant who did not meet criterion during this initial assessment and required training.

Follows one-step instructions. Because we planned to use verbal instructions during discrimination training, we wanted to ensure that participants could respond to the target one-step instructions (i.e., "Get it" and "Move back") prior to inclusion in the study. During this assessment, the instructor presented five trials for each instruction. To assess responding to "Get it," the instructor placed a small item on the table just out of reach of the participant. Correct responding on "Get it" trials consisted of reaching toward the item with an extended arm. An incorrect response consisted of not reaching for the item. A correct response on the "Move back" trials consisted of taking one step away from the instructor. An incorrect response consisted of not taking one step away from the instructor. If the participant followed the instruction without prompts within 3 s of the instruction, a plus was scored on the data sheet. If the participant did not follow the instruction within 3 s of the instruction, a minus was scored on the data sheet. No prompts or reinforcement were provided during this assessment. Criterion for moving on to baseline was correct responding on 90% of the trials. If participants did not meet this criterion, we implemented three training sessions during which we used manual guidance and a progressive prompt delay (i.e., 0 s, 3 s) to teach responding to these instructions. Nora, Oscar, and Andy required this training, but Kasey did not.

Matching nonidentical facial expressions and imitation. We wanted to ensure that prior to participation in the study, participants could discriminate among facial stimuli. We used two assessments to test for this discrimination. Participants were required to score at 80% or above on either (but not both) of these assessments to proceed with baseline because criterion scores on either were an indication of the discrimination, and we did not want to exclude participants who could not produce the facial expressions themselves if they could discriminate among the facial stimuli.

The first receptive task was conducted using a matching-to-sample format. The sample pictures depicted faces with either joyful or fearful expressions from three different people. The comparison stimuli consisted of joyful, fearful, angry, sad, and surprised facial expressions of people who were not the same person depicted in the sample stimulus. The correct comparison stimulus matched the facial expression of the sample but was a different person. The incorrect comparison stimuli did not match the facial expression of the sample and also were different people. We conducted five joyful trials and five fearful trials in random order. The instructor placed the comparison stimuli on the table in front of the participant in a messy array. The instructor required the participant to observe the sample stimulus for each trial by holding up the picture and saying, "Touch the face." After the participant touched the sample stimulus, the instructor said, "Match the face." If the participant matched the facial expression of the sample picture to the corresponding facial expression in the comparison picture within 3 s, the instructor scored a plus on the data sheet, else the instructor scored a minus on the data sheet. No prompts or reinforcement were provided during this assessment. All four participants met criterion during this assessment and did not require training.

During the imitation assessment, the instructor said, "Do this" and modeled a joyful or fearful expression for 5 s. If the participant imitated the facial expression within 3 s, the instructor scored a plus on the data sheet. Responses were considered correct if some part of the facial display was imitated (e.g., if the participant turned down the corners of the mouth but did not also present the furrowed brow, we scored it as a correct response). If the participant did not imitate the facial expression, the instructor scored a minus on the data sheet. Five joyful trials and five fearful trials were presented in random order. All four participants met criterion during this assessment and did not require training. All preassessment data are available from Jaime A. DeQuinzio.

Procedure

Baseline. We conducted baseline to establish the current level of responding to joyful and fearful expressions presented within the context of social referencing. The instructor sat at a table, and the participant stood next to the table

perpendicular to the instructor. A trial started when the instructor placed either container on the table according to a trial type predetermined and listed on the data sheet. If the participant did not look at the instructor within 2 s of the container being placed on the table, the instructor prompted it by swiping her finger from the participant's eyes toward her own eyes. Once eye contact occurred, the instructor presented the facial expression indicated on the data sheet (i.e., either joyful or fearful) for 5 s. After presenting the facial expression, the instructor waited 3 s for the participant to respond. After 3 s, the container was removed, and the instructor waited 3 s before presenting the next trial. No programmed reinforcement was provided if the participant responded correctly on either trial type.

To ensure on-task behavior between trials, instructors provided one token plus praise during each intertrial interval to reinforce hands downs and remaining quiet. Once 10 tokens were earned, participants were provided access to preferred items, which typically occurred at the end of each session. This token system remained in place across training, generalization, and maintenance.

Training.   Training sessions were set up the same as those described in baseline except that differential reinforcement, manual guidance, and verbal instructions were used. Verbal instructions (i.e., "Get it" on joyful trials and "Move back" on fearful trials) were first presented simultaneously with the facial expressions (i.e., the instructor presented the facial expression for 5 s and at the same time stated the verbal instruction). Following this, verbal instructions were then presented with a 3-s delay (i.e., the instructor presented the facial expression for 5 s and added the verbal instruction at the 3-s mark). Finally, verbal instructions were removed (i.e., the facial expression alone was presented for 5 s with no verbal instruction). The criterion to advance to the subsequent condition was correct responding on 100% of the two-trial blocks for two sessions.

If the participant responded correctly on joyful trials by reaching for the container within 3 s of the presentation of the facial expression, the instructor provided behavior-specific praise, instructive feedback (e.g., "Good reaching! It's okay to touch it!"), and provided access to what was inside the container for 3 s. If the partici-

pant responded incorrectly on joyful trials, the instructor used manual guidance (i.e., placed her hand on the participant's hand and guided him or her to extend their arm and reach toward the container) to assist in the performance of the response and provided instructive feedback (i.e., "This is reaching when I make a happy face"). An error correction trial followed in which the instructor represented the same trial. If the participant responded correctly, the instructor provided praise but did not provide access to the item inside the container. If the participant did not respond correctly, the instructor waited 3 s, and moved on to the next trial.

If the participant responded correctly on fearful trials by moving back within 3 s of the termination of the compound discriminative stimulus (facial expression and verbal instruction), the instructor provided behavior-specific praise and instructive feedback (e.g., "Good moving back! That is right, it's scary. You don't touch it."). If the participant responded incorrectly on fearful trials, the instructor used manual guidance (i.e., placed her hand on the participant's shoulder and guided him or her to step back) to assist in the performance of the response and provided instructive feedback (i.e., "This is moving back when I make a scared face"). An error-correction trial followed in which the instructor represented the same trial. If the participant responded correctly, the instructor provided general praise (e.g., "Good"). If the participant did not respond correctly, the instructor waited 3 s, and then moved on to the next trial.

Manual guidance and time delay for Nora. We initially attempted to use only manual guidance and a time-delay procedure for Nora because we had planned to introduce the components of the treatment (i.e., verbal instructions) sequentially. We started with a 0-s delay and then moved to a 3-s delay. Because she did not demonstrate skill acquisition with this procedure, we added verbal instructions (described earlier) and decided not to replicate the time-delay procedure across the remaining participants.

Modifications for Oscar.   For Oscar, when we removed the verbal instructions, he continued to respond correctly on joyful trials, but he failed to respond correctly on fearful trials. Therefore, we returned to the previous fading

step for fearful trials, delaying the verbal instruction. Instead of removing the verbal instruction completely, we decided to use a more systematic stimulus-fading procedure. We presented the full verbal instruction ("Move back") for Session 63. We then faded the instruction by removing the last two letters ("Move ba") for Session 64. We then removed the last three letters for Session 65 ("Move b"), the final word for Session 66 ("Move"), all but the first two letters for Session 67 ("Mo"), and all but the first letter ("M") for Session 68. For Sessions 69 and 70, the instructor presented closed lips and then no prompts, respectively. In Sessions 71 and 72, all prompts were removed for fearful trials.

Generalization. Generalization sessions were conducted approximately every three training sessions. Generalization sessions were the same as baseline: however, the instructor, containers, and setting were novel.

Three of the four participants required generalization training because they did not demonstrate criterion responding during generalization sessions. Generalization training consisted of the same training procedures described earlier.

Maintenance. Maintenance sessions were conducted the same as baseline. For Nora and Andy, maintenance was conducted 1 week and 1 month after the final training session. For Oscar and Kasey, maintenance was conducted 1 week, 2 weeks, and 1 month after the final training session.

Results

Figure 1 shows the percentage of two trial blocks, for both training (closed circles) and generalization (open squares) sessions, with correct discrimination across conditions. For all four participants, responding during training sessions in baseline was stable at zero levels with the exception of the final baseline session for Andy. With the introduction of manual guidance using a 0-s time delay and a 3-s time delay, responding for Nora did not increase above baseline levels. Therefore, we implemented verbal instructions simultaneous with the facial expression and used manual guidance with a 3-s time delay following the facial expression. These procedures were replicated across the other participants.

During this first condition with the verbal instructions provided simultaneously with the facial expression, correct responding for Nora increased to 100% mastery for two consecutive sessions after four training sessions. During the first session when the verbal instruction was delayed, correct responding for Nora decreased to zero but then increased to 100% mastery for two consecutive sessions after 11 training sessions. When the verbal instructions were removed, Nora initially responded at 100% for the first two sessions of this condition, but her data decreased and became variable before finally reaching mastery again after seven training sessions. Maintenance data were low at 1-week and 1-month follow up, with correct responding at 67% and 33%, respectively.

Kasey demonstrated rapid acquisition of the discrimination, reaching 100% mastery for two consecutive sessions after three training sessions when the verbal instruction was implemented simultaneously with the facial expressions. Correct responding remained at 100% for the remaining conditions and throughout maintenance.

For Andy, responding in baseline was low and stable until the last session when it increased to 33%. When we implemented simultaneous verbal instructions, correct responding remained at 33% for three sessions but increased to 100% mastery for two consecutive sessions after six training sessions. Correct responding was highly variable when the verbal instruction was delayed but reached mastery after seven training sessions in this condition. When the verbal instruction was removed, Andy's correct responding decreased to 67% and then increased to 100% after two training sessions and remained there during maintenance.

For Oscar, correct responding increased to 100% mastery for two consecutive sessions after seven training sessions when the verbal instruction was presented simultaneously with the facial expression. When the verbal instruction was delayed, correct responding for Oscar decreased initially to zero but increased to 100% mastery after six training sessions. When the verbal instruction was removed, responding dropped to baseline levels. Because we noticed that Oscar responded correctly on the joyful trials in each block when the verbal instruction was removed, but not the fearful trials, we implemented stimulus fading of the verbal instruc-
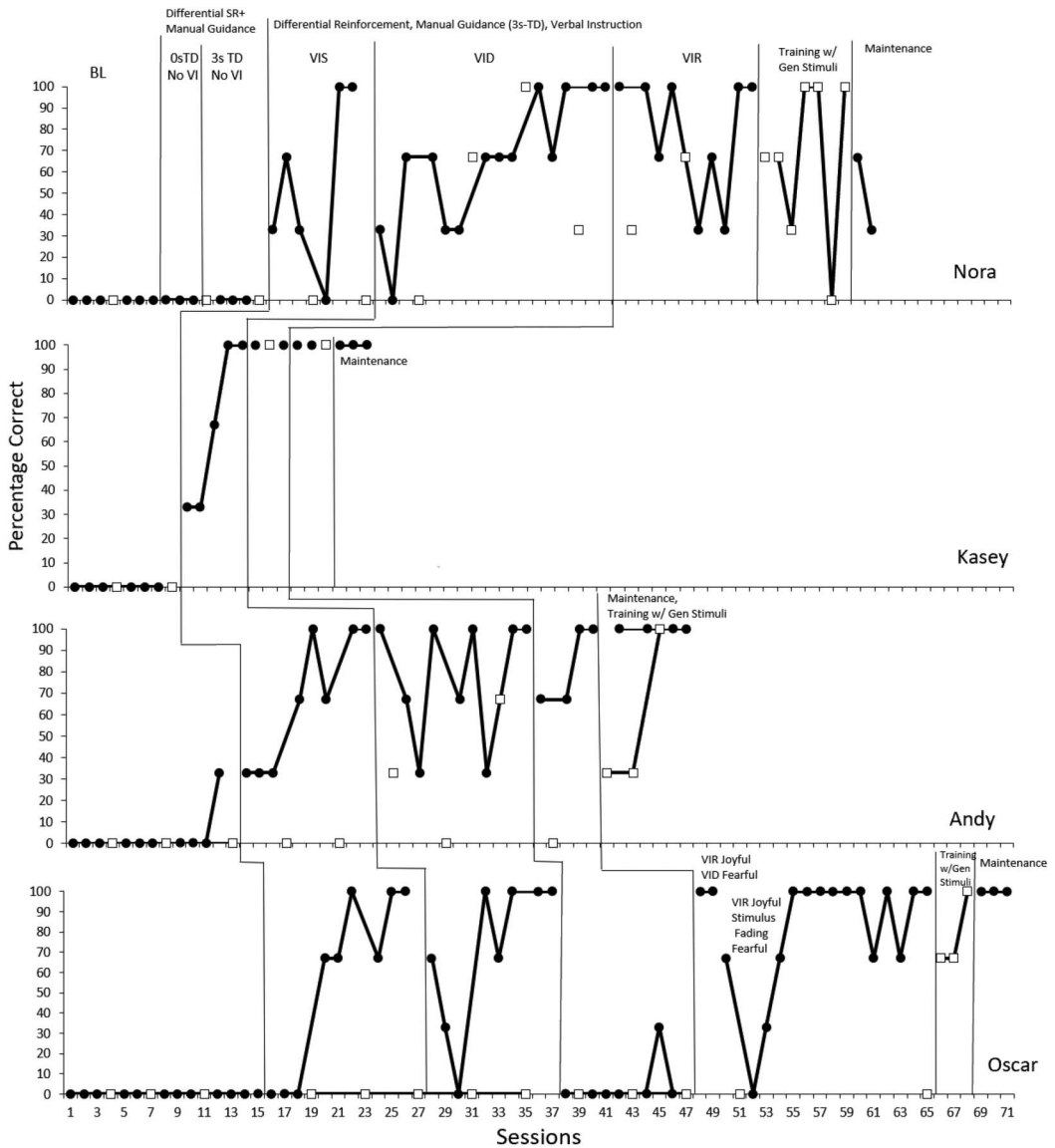
Figure 1. The percentage of two-trial blocks, during both training (closed circles) and generalization (open squares) sessions, with a correct discrimination during baseline; differential reinforcement; manual guidance with no verbal instruction and differential reinforcement; manual guidance (3-s time delay) with verbal instruction simultaneous (VIS), verbal instruction delayed (VID), and verbal instruction removed (VIR); training with generalization stimuli; and maintenance for Nora, Kasey, Andy, and Oscar.

tion for fearful trials only. During this condition, responding on the fearful trials was initially variable but increased to 100% after four training sessions with the verbal instruction finally removed for the last two sessions of this condition. Correct responding during mainte-

nance for Oscar was 100% at 1 week, 2 weeks, and 1 month following the completion of training.

Responding during generalization sessions was zero throughout baseline for all participants. For Nora, correct responding during gen-

eralization sessions was variable throughout all phases of the study. Correct responding was zero with simultaneous verbal instructions and at the start of delayed verbal instructions. Correct responding increased to 100% during Session 35 in this condition and decreased to 33% at the end of this condition. Correct responding did not increase above 67% in the final training condition. When we implemented generalization training, correct responding increased to 100%, although responding remained variable. For Kasey, correct responding was 100% for each generalization session that was conducted. For Andy, correct responding during generalization sessions was zero with simultaneous verbal instructions. Correct responding increased to 67% with delayed verbal instructions but dropped to zero when verbal instructions were removed. When we implemented generalization training, correct responding increased to 100%. For Oscar, correct responding on generalization sessions remained at zero across all conditions. When we implemented generalization training, correct responding increased to 100%.

Discussion

The results of this study demonstrate that children with autism can learn to respond to affective stimuli within a social-referencing framework, replicating the results of Brim et al. (2009) and extending the results of Peláez et al. (2012) to children with autism. All four participants learned to respond to joyful and fearful expressions using manual guidance and differential reinforcement, and by pairing facial expressions with verbal instructions and by subsequently fading the verbal instructions. These results are consistent with studies with infants of typical development that have found more responding to the vocal reactions of caregivers (Kim, Walden, & Knieps, 2010; Vaish & Striano, 2004) than to gestures or facial expressions alone.

Restrictive stimulus control (Dube & McIlvane, 1999), also termed *stimulus overselectivity*, might contribute to the failure of children with autism to respond to the affect of others, as children might respond to only one component of a complex stimulus. This study perhaps addressed this issue by first training affect discrimination prior to social-referencing training

and by pairing verbal instructions with the facial expressions. Future researchers might also consider evaluating how affect discrimination improves by first requiring a differential observing response (e.g., vocally tact the facial expression) when the adult produces the affective stimulus (DeQuinzio et al., 2016; Dube & McIlvane, 1999) within the framework of social referencing.

Generalization to untrained environments, stimuli, and people was mixed, despite training across varied instructors, stimuli, and environments. Kasey demonstrated generalization. Nora and Andy demonstrated some generalization, but we had to implement training to increase responding to generalization stimuli. Oscar failed to generalize, and we had to implement training for the generalization stimuli. Maintenance data demonstrated that all participants maintained the discrimination during follow-up probes with the exception of Nora. At first look, it is unclear why generalization was limited, as we trained across three environments using two to three instructors, and a variety of containers, doing our best to incorporate multiple exemplar training. Some children with autism might require many more exemplars for generalization to occur.

After further analysis, we might suspect that control was restricted to the facial expressions of the instructors (and reinforcement they provided) in training. It is plausible that training facial expressions as stimuli that are predictive of reinforcement would also establish the facial expressions as conditioned reinforcers (Holth, Vandbakk, Finstad, Grønnerud, & Sørensen, 2009). Expanding the functionality of the stimuli could potentially improve responding to those stimuli by children with autism.

An additional concern with limited generalization is whether the repertoire had been established at all if it was not demonstrated under conditions that varied from those of training. First, it is noteworthy that although generalization to nontraining conditions did not occur reliably for all participants, we did observe maintenance of responding when treatment components were removed. This is promising and certainly a step in the right direction. However, demonstration of "first trial performance" under nontraining contexts would imply that a generalized repertoire of social referencing was, in fact, established. Given the very limited re-

search in this area, we believe that these results are informative in developing effective, individualized protocols to teach children with autism to discriminate nonvocal social cues within the context of social referencing. Future research can expand on these results by evaluating procedures for producing generalized social referencing.

We were successful in partially replicating the results of Peláez et al. (2012), but there are important differences to highlight. In Pelaez et al., reach responses were brought under the control of two facial expressions using punishment and reinforcement. It is not surprising that this protocol was successful for neurotypical babies who reliably attend to and reach for items as they are presented and encountered. Children with autism might not attend as reliably to the presence of stimuli, as the participants in the current study did not reach in baseline when the container was placed on the table. To fully replicate the procedures of Peláez, we would have had to first teach the participants to engage in a reach response, and subsequently teach the discrimination, punishing the reach response that was just established. We did not see value in this approach. Furthermore, we were concerned with attempting to measure and teach a nonresponse (i.e., no reach), as baseline responding indicated that participants already did not reach. In this case, it would be hard to determine if participants learned the discrimination or were simply not responding. Therefore, we taught two distinct responses and used naturally occurring contingencies similar to Brim et al. (2009). Praise was delivered along with the item in the container for reaching on joyful trials (i.e., reinforcement). If reaching occurred on fearful trials, praise and the item were not provided (i.e., extinction). Praise alone was delivered for moving back on fearful trials, and there was no item provided so that the consequences would more closely simulate natural contingencies during social referencing (i.e., avoidance of the stimulus).

Although well intentioned, these differential contingencies could have produced challenges for Oscar, who failed to respond correctly on fearful trials when the verbal instructions were removed. We had to implement a more systematic fading of the verbal instruction on fearful trials for Oscar. Perhaps his failure to respond correctly on fearful trials was a learned discrim-

ination of the different reinforcement contingencies in place for joyful (toy and praise) and fearful (no toy and praise) trials. In neurotypical children, avoidance of the ambiguous stimulus and parent attention and praise function as reinforcers for avoidance responses. This might not be the case for children with autism. We also did not assess whether praise and attention functioned as reinforcers prior to the study. This is something to be addressed in future research. Furthermore, it is not surprising that one of the four participants required modifications to the procedure, given the complexity of social referencing and the social-learning challenges inherent autism, as other studies have also had to individualize procedures Weisberg and Jones (2019).

We did not teach differential observing responses (Link 1), as done by Brim et al. (2009). Future research should concentrate on fully replicating this study using varying ambiguous and nonambiguous stimuli. Additionally, other antecedent conditions may be manipulated, including motivating operations (e.g., satiation and deprivation of social interactions; Holth et al., 2009), presence and absence of ambiguous stimuli (DeQuinzio et al., 2016), and an attentive and inattentive adult (Stenberg, 2003).

The context within which we studied social referencing was restricted to a specific derived ambiguous situation (i.e., items in concealed bags) and two facial expressions (i.e., joyful and fearful). It is unknown if these procedures would be successful at teaching social referencing in other contexts such as with strangers and familiar people, safe and unsafe scenarios, fearful and nonfearful situations, and thus leaves many avenues for future research. Additionally, Barrera and Maurer (1981) noted that 5- to 7-month-olds can discriminate basic emotions such as happy, sad, fear, anger, disgust, and surprise. Future research should evaluate the use of these basic facial expressions that could evoke approach or avoidance responses during Link 2 of social referencing.

A noteworthy extension of our study was the assessment of the discriminations of facial expressions prior to the study. Specifically, we assessed whether participants could discriminate between the two facial expressions used in the study outside the context of social referencing within imitation and match-to-sample tasks. Although we did this to ensure that a failure to

respond during the training was not due to the inability to discriminate, it did not ensure that such established prerequisites are required for social referencing. This would be another interesting avenue for future research.

Social referencing in children with autism is an understudied area of research in behavior analysis. As DeQuinzio et al. (2016) argued, social referencing has not received the same focus that joint attention has in the behavior-analytic research, despite its importance to the development of social behavior. We demonstrated that verbal instructions added to a package of manual guidance and differential reinforcement can be useful to facilitate social referencing when paired with facial expressions. Additionally, this study highlighted some challenges with teaching this complex repertoire that are important considerations for future research and practice.

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