

Social Referencing and Children with Autism

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Abstract During social referencing, infants as young as 6 months of age look to others when confronted with unfamiliar or unexpected events in the environment and then respond to these events based on affective cues of the parent or caregiver (e.g., smiling and frowning). Social referencing is important for early communication and language development. Unfortunately, social referencing repertoires are limited or completely lacking in children with autism. Despite these documented social deficits, little research has focused on ameliorating social referencing deficits. The purpose of this paper is to present a behavior-analytic conceptualization of social referencing and the implications for ameliorating social referencing deficits of children with autism.

Keywords Social referencing · Autism · Operant analysis

A 12-month-old is sitting in the seat of a shopping cart as her mother pushes her through the grocery store. An unfamiliar adult approaches and says, “You are so cute! Are you being mommy’s helper?” The child immediately looks at her mother. Recognizing the person as her coworker, the mother smiles and nods her head. The child looks at the unfamiliar adult, smiles, and says, “Yah- yah!” According to Campos and Sternberg (1981), young children can, in these interactions, learn about environmental events and to regulate their own behavior by observing the emotional or affective responses of others. Social referencing, which has been observed in infants as young as 6 months of age, is an example of such an interaction in which children appear to observe the emotional reactions of others as a means of determining how to respond in ambiguous or novel situations (Mireault et al. 2014). A social referencing interaction is

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a sequence of events that begins when a child encounters an uncertain or novel object or situation in the environment (e.g., a stranger) and looks to the parent or caregiver for information (e.g., smile and head nod) about how to respond (Walden 1991). Typically, the adult provides information to the child in the form of facial expressions, gestures, and or vocal responses (Kim et al. 2010). In turn, the child responds by either approaching the object or situation or avoiding the object or situation.

Social referencing in typically developing infants has been studied by cognitive-developmental psychologists. Typically, infants are exposed to novel or ambiguous situations, such as a “visual cliff” (i.e., infants are placed on a Plexiglas surface that provides invisible support over an apparent drop), animated toys, or strangers (Sorce et al. 1985). Studies generally contrast the effects of “positive emotional messages” and “negative emotional messages” provided by the mother on the behavior of the infant. When provided with positive emotional messages (e.g., joy), infants are more likely to cross the visual cliff, reach for toys, and approach strangers. When provided with negative emotional messages (e.g., fear), these same responses are less likely.

Although an operant analysis of social referencing was first presented by Gewirtz and Peláez-Nogueras (1992) and more recently by Peláez et al. (2012), very little research has used this analysis to help alleviate social referencing deficits of children with autism. Both analyses focused mainly on social referencing in typically developing infants. Specifically, Peláez et al. (2012) presented the case for conceptualizing social referencing as an operant class that is established through stimulus discrimination and reinforcement. The authors suggested that an operant analysis of social referencing could assist in the development of social referencing interventions in populations where social referencing is deficient. Thus, the primary purpose of this paper is to expand the behavior-analytic conceptualization of social referencing. Moreover, we describe the social referencing deficits of children with autism and review the limited research conducted on addressing these deficits. We conclude with implications and directions for future research.

Behavior Analysis of Social Referencing

A Behavior Chain

Traditional explanations of social referencing have utilized a socio-cognitive conceptualization, describing it as “a process in which one person utilizes another person’s interpretation of the situation to formulate his or her own interpretation of it” (Feinman 1992, p. 4). An alternative and perhaps more parsimonious interpretation of social referencing is one that conceptualizes social referencing as a behavior chain (Gewirtz and Peláez-Nogueras 1992; Schlinger 1995). Each component response in a behavior chain produces stimulus conditions that function as both a conditioned reinforcer for the previous response and as a discriminative stimulus for the following response.

The social referencing behavior chain is a two-link chain in which there are two primary responses of the child; responding in the first link is the observing response and responding in the second link is either an approach or avoidance response. Figure 1 displays a diagram of a social referencing episode in which the observing response produces affective stimuli that evoke an approach response. A social referencing

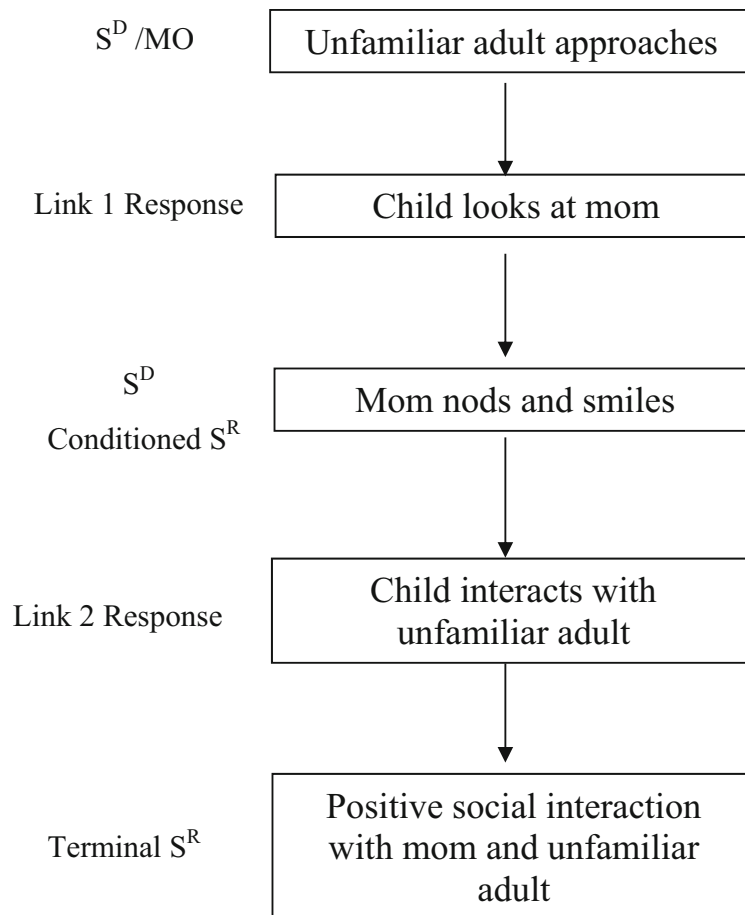


Fig. 1 Diagram of the social referencing behavior chain in which the observing response produces affective stimuli that evoke an approach response with social interaction as the terminal reinforcer

episode begins when a child is exposed to an ambiguous or a novel stimulus (e.g., an unfamiliar adult). This stimulus evokes an observing response by the child (e.g., the child looks at the mother). The stimuli (e.g., an unfamiliar adult) that evoke the observing response in the first link could acquire two possible discriminative functions depending on the availability of reinforcement for responding when these stimuli are present. That is, if reinforcement is available for observing responses (i.e., mom interacts with the child by displaying verbal and or non-verbal responses) in the presence of these stimuli, they serve an S+ function. Alternatively, if reinforcement is not available for observing responses (i.e., mom does not interact with the child) in the presence of these stimuli, they serve an S- function.

The child looking at the mother is an observing response by definition because it produces a discriminative stimulus (Catania 2013). In this case, the discriminative stimulus is the affective display presented by the mother (i.e., a response, such as smiling, frowning, head nodding, head shaking). This begins the second link of the chain. The affective stimulus (e.g., smile and head nod) serves two functions in the behavioral chain of events. It serves as the conditioned reinforcer that maintains the observing response as well as the discriminative stimulus that evokes the subsequent response of either approach or avoidance by the child (e.g., interact with the stranger or do not interact with the stranger). The affective stimuli become discriminative for approach or avoidance responding because they are correlated with reinforcement (e.g., social interaction with mother and adult, access to some novel event, stranger

or aversive event avoided), extinction (e.g., no social interaction with mother, no access to novel event), or even punishment (e.g., exposure to stranger, aversive event, scolding from mother).

Discriminated Responding

Responding within the social referencing chain can be characterized as discriminated responding. Discriminated responding is a product of discrimination training. Generally speaking, during discrimination training, responding in the presence of S+ stimuli is reinforced while responding in the presence of S- stimuli is extinguished. This procedure produces more frequent responding in the presence of S+ stimuli and less frequent responding in presence of S- stimuli.

The observing response is a discriminated response in social referencing. In the presence of ambiguous stimuli, observing is reinforced by the production of an affective discriminative stimulus. Hence, ambiguous stimuli serve S+ functions because they are correlated with reinforcement contingencies for observing. In the presence of unambiguous or standard stimuli, observing is not reinforced by the production of affective discriminative stimuli. For this reason, non-ambiguous stimuli serve S- functions because they are correlated with extinction or non-reinforcement for engaging in an observing response. Once observing occurs more frequently in the presence of ambiguous (S+) stimuli and less frequently in the presence of non-ambiguous (S-) stimuli, discriminated observing is demonstrated.

Another discrimination learned during social referencing occurs with affective stimuli. As mentioned previously, observing produces affective discriminative stimuli for subsequent discriminated responding in the form of approach or avoidance. Therefore, certain classes of affective stimuli, such as smiling, head nodding, and pointing, serve S+ functions for approach responding if such responding produces reinforcement. These same stimuli simultaneously function as S- stimuli for avoidance responding if extinction conditions are produced for such responding. Using similar logic, classes of affective stimuli, such as frowning, a fearful expression, or head shaking, serve S+ functions for avoidance responding and S- functions for approach responding. Differentiated approach and avoidance responding is demonstrated when both of the following conditions occur: (a) the frequency of approach responding is higher in the presence of approach-affective stimuli (S+) and less frequent in the presence of avoidance-affective stimuli (S-) and (b) the frequency of avoidance responding is higher in the presence of avoidance-affective stimuli (S+) and less frequent in the presence of approach-affective stimuli (S-).

Stimulus Classes

The formation of stimulus classes is another outcome of discrimination training procedures (Fields and Reeve 2000). A stimulus class is defined by a set of stimuli that come to evoke a common response class (Haring et al. 1989) and share a functional similarity in that they are correlated with reinforcement for these responses. There are a number of stimulus classes that can be formed within the social referencing paradigm. The first is the class of ambiguous stimuli that evoke an observing response. These stimuli share some common physical features or might be physically dissimilar. For example, the presence of a stranger, a loud noise, or the presence of a novel toy might

all be members of the class of stimuli that evoke an observing response. Regardless of physical similarities and differences, these stimuli are classes by definition because of their functional similarity. That is, reinforcement is likely when responding occurs in their presence. A second class of stimuli is the affective stimuli that evoke approach responding. Members of this stimulus class might include smiling, head nodding, and pointing, for example. Although these stimuli are physically dissimilar, if they share the same function in social referencing, they are part of the same stimulus class. A third class of stimuli is the affective stimuli that evoke avoidance responses. Members of this class might include frowning, gasping, or head shaking, for example, and would also share the same function to be part of the same stimulus class.

Motivating Operations

Above, we described the discriminative functions that ambiguous stimuli might acquire when they are correlated with reinforcement for observing responses. In addition to these discriminative functions, it is also possible that the presence or absence of ambiguous stimuli functions as motivating operations. Consider again the example in Fig. 1. The unfamiliar adult who approaches the infant and parent at the grocery store momentarily alters the reinforcing value of the mother's affective behavior as a conditioned reinforcer for infant observing. When the ambiguous stimulus is present, in this case the stranger, the infant has to seek "information" in the form of discriminative stimuli that "tells" the infant what to do (i.e., evokes either approach or avoidance of the ambiguous stimulus). Therefore, the presence of the ambiguous stimulus increases the reinforcing value of the adult affective response as a conditioned reinforcer and is an establishing operation for infant observing. When the ambiguous stimulus is absent (i.e., there is no stranger or a familiar person is present), the value of the adult affective response as a conditioned reinforcer is weakened because that "information" is not needed; hence, the absence of the ambiguous stimulus is an abolishing operation for infant observing.

Conceptualizing the ambiguous event as an establishing operation makes sense in cases where the adult produces similar affective responses (e.g., smiling or frowning) in the presence and absence of the ambiguous stimulus; however, as we just discussed, these stimuli might not function as reinforcers for observing in the absence of an ambiguous stimulus. Alternatively, it might be the case that the affective responses produced by the adult are specific to the ambiguous stimulus and include combinations of responses such as smiling and hand gestures, which are not likely to occur at other times. In these cases, it is perhaps more likely that the ambiguous stimulus functions as a discriminative stimulus for the observing response because it is correlated with particular consequences in the form of adult-produced affective stimuli.

Similarities and Differences with Joint Attention

Behavior analysts might be familiar with the term social referencing because it often appears in the literature along with the term joint attention, with the terms sometimes used interchangeably. Some researchers have even described joint attention as a fundamental skill underlying social referencing or as a prerequisite to the development

of social referencing (Vaillant-Molina and Bahrick 2012; Warreyn et al. 2005). However, it is not clear that they refer to the same phenomenon.

There are some structural similarities between social referencing and joint attention. Similar to social referencing, joint attention is observed between the ages of 9 and 18 months and is a social interaction that can involve the infant orienting toward another person in response to an event in the environment (Slaughter and McConnell 2003). Specifically, joint attention has been defined as the coordinating of attention between an object or event in the environment and another person as a means of “sharing the experience” of an object or event (Mundy et al. 1994). As infants approach 12 months of age, looking behavior becomes coordinated between people and objects (Striano and Rochat 2000). Social referencing and joint attention both involve this type of “referential looking.” Furthermore, both joint attention and social referencing require that social stimuli, such as facial expressions, gestures, and adult attending stimuli, function as reinforcers for referential looking.

It has been argued that referential looking in joint attention and social referencing share a negative reinforcement function (Dube, et al. 2004). During joint attention, when gaze shift is preceded by a stimulus that has caused an unconditioned response such as startle, adult attention to the environmental stimuli or directly to the child could possibly alleviate fear by terminating the aversive event or by alleviating aversive stimulation (i.e., fear) within the child. Similarly, during social referencing, adult affective stimuli act as discriminative stimuli for avoidance responses in the presence of aversive stimuli. However, there is a difference with respect to the conditions under which looking occurs in joint attention and social referencing. In joint attention, observing occurs in the presence of both non-ambiguous and standard stimuli because of a history of reinforcement for gaze shifting under both conditions, whereas in social referencing, observing occurs in the presence of ambiguous stimuli only.

An additional difference between the two phenomena is with respect to the overall function of joint attention and social referencing. Peláez (2009) argued that social referencing and joint attention responses are different with respect to function. Whereas the main function of joint attention initiations is said to be access to social positive reinforcement (e.g., adult interacts with child; Dube et al. 2004), the said function of social referencing is to gain information about how to respond in uncertain or ambiguous contexts (Peláez 2009).

Traditionally, joint attention was defined by cognitive-developmental psychologists and mainly addressed in that literature. In 2004, Dube, MacDonald, Mansfield, Holcomb, and Ahearn outlined a contingency analysis of joint attention and highlighted related intervention and research implications for children with autism based on this analysis. This publication served as the impetus for behavior analysts working with children with autism to design and evaluate interventions for ameliorating the joint attention deficits of children with autism (see Meindl and Cannella-Malone 2011 and White et al. 2011 for comprehensive reviews).

Behaviorally Based Research on Social Referencing

Gewirtz and Peláez-Nogueras (1992) were the first researchers to explain social referencing as a learned process and provide evidence that social referencing responses

in typically developing infants can come under the control of operant contingencies. They argued that maternal facial displays can reliably predict or serve as discriminative stimuli for contingencies of approach or avoidance responses within ambiguous contexts. In their study, 20 pairs of mothers and infants, ages 9–12 months, participated. Infants sat in booster chairs facing a puppet theatre and their mothers stood next to them. Experimenters presented infants with toys covered by white cloths to serve as ambiguous stimuli. Mothers presented initially neutral maternal facial displays, such as palms to cheeks and fist to nose, when infants engaged in orienting responses following the presentation of the covered toys. For ten of the participant pairs, a fist-to-nose facial display signaled that reaching for a hidden toy would be followed by reinforcement (i.e., music was played). Reaching for the toy in the presence of a palms-to-cheeks facial display resulted in punishment (i.e., loud, harsh sound). For the other half of the participant pairs, the function of the facial displays was reversed so that the fist-to-nose display signaled punishment and the palms-to-cheeks display signaled reinforcement. Infants were more likely to reach for the covered toy in the presence of the maternal facial display that signaled reinforcement for this response and less likely to reach for the covered toy in the presence of the maternal facial display that signaled punishment for this response. The authors argued that an innate ability to interpret maternal emotions was unnecessary in explaining social referencing because, in this case, arbitrary facial displays came to control approach or avoidance responses of infants when these stimuli were differentially associated with consequences for infant behavior.

Peláez et al. (2012) conducted a systematic replication of this study with younger infants (ages 3–5 months). In this study, typical emotional displays were used in which joyful expressions signaled reinforcement for infant reaching and fearful expressions signaled punishment for infant reaching. Infants learned to respond differentially to the facial expressions by reaching more often for the toy in the presence of joyful maternal facial expressions and reaching less often for toys in the presence of fearful maternal facial expressions.

In a more recent replication, Peláez et al. (2013) used the same discrimination training and reinforcement procedure to teach infants of depressed mothers to engage in social referencing responses. Prior to the intervention, these infants engaged in fewer looking, reaching, and avoidance responses compared with controls (i.e., infants of non-depressed mothers). After the intervention, the infants of depressed mothers engaged in more social referencing responses than they did prior to the intervention and either equal to or more than that of the control group. Collectively, these studies by Peláez and colleagues support the notion that social referencing responses can be established in populations where social referencing has not yet emerged or is deficient by arranging discriminative stimuli and contingencies.

Social Referencing Deficits of Children with Autism

Some children with autism lack social referencing responses altogether or show deficits in producing social referencing responses (Sigman et al. 1992; Warreyn et al. 2005). For example, children with autism have difficulty responding to the non-verbal affective behavior of others such as facial expressions (Weeks and Hobson 1987) and bodily gestures (Ham et al. 2011), orienting toward facial expressions during social

interactions (Magrelli et al. 2013), and imitating facial expressions (Markodimitraki et al. 2013). One contributing factor for these deficits might be the failure of children with autism to orient toward or to observe social stimuli (Dawson et al. 1998). Affective stimuli, such as facial expression and bodily gestures, are socially mediated stimuli important for social referencing. The failure to orient toward affective stimuli could pose problems for learning social responses. In the absence of an orienting response, the child has missed an opportunity to observe the affective stimuli of others. Children with autism who do not observe affective discriminative stimuli in turn do not experience the reinforcement or extinction contingencies for discriminating affective stimuli. Consequently, responding to affective stimuli does not come under discriminative control.

Stimulus overselectivity, sometimes referred to as restrictive stimulus control (Dube and McIlvane 1999), might also contribute to the failure of children with autism to respond to social-affective stimuli. Lovaas et al. (1979) argued that children with autism demonstrate stimulus overselectivity when they respond to only one component of a complex stimulus. A social interaction is a complex event that includes many stimuli such as consequences mediated by other people and the verbal and non-verbal behavior of other people. Additionally, there are many physical dimensions of others (e.g., hair color, height, color of clothing) and the environment (e.g., ambient lights, sounds) to which the child might respond. If children with autism orient toward affective stimuli, but then respond to a stimulus in the environment or one produced by the other person that is socially irrelevant (e.g., the hum of an air conditioner or the color of the person's eyes), then they will not contact reinforcement contingencies that promote orienting toward or observing social-affective responses in the future.

Moreover, it also is possible that the terminal consequence in the social referencing behavior chain, the social interaction with a parent, might not function as a reinforcer for a child with autism given his or her social deficits. If this is the case, the observing response that initiates the behavioral chain will not be strengthened and there will be no opportunity for link 2 responding.

Research Evaluating Social Referencing Interventions

Delays in social information-seeking or a lack of social information-seeking in infants has been associated with a diagnosis of autism in early childhood (Cornew et al. 2012). Additionally, early deficits in social referencing are associated with poorer verbal and social skills later in childhood (Stone and Yoder 2001). Thus, interventions that address these deficits could prove beneficial for long-term social and verbal gains, particularly for children who might show deficits in these areas. Several studies have demonstrated success in teaching social skills related to social referencing or responses that might be considered components of social referencing. For instance, some behavior analysts have taught children with autism to respond to the affective behavior of others (Argott et al. 2008; Axe and Evans 2012; Daou et al. 2014; Gena et al. 1996; Schrandt et al. 2009) and others have taught children with autism to look at an adult to initiate joint attention or to respond to joint attention initiated by others (see Meindl and Cannella-Malone 2011 and White et al. 2011 for reviews). Despite the social referencing deficits of children with autism, there has been little research focusing specifically on the

amelioration of social referencing deficits. The operant learning analysis presented above provides a platform for behavior analysts to design and experimentally evaluate treatment protocols that teach social referencing. A limited amount of evidence already exists that supports this notion. However, only one published study to date has evaluated operant learning procedures for directly targeting the entire social referencing behavior chain.

Brim et al. (2009) demonstrated that children with autism could learn both the first-link observing response and the second-link discrimination of affect. Social referencing training (verbal prompts, manual guidance, and reinforcement) was used to teach social referencing responses across handwriting, verbal imitation, and gross motor imitation tasks. Participants were first taught to engage in an observing response (i.e., to orient toward and to look at the face of the experimenter) in the presence of ambiguous stimuli only. Ambiguous stimuli were variants of standard task materials and included items such as a piece of chalk as a writing utensil and a paper bag as a writing surface presented for the handwriting task, two-syllable words presented on auditory recordings with strange noises in the background (e.g., the word “orange” played with a cough in the background) as the verbal imitation task, and gross motor video models presented with the model wearing animal masks or filmed upside down as the motor imitation task. Following observing in the presence of the ambiguous stimuli, the experimenter presented one of two affective discriminative stimuli: a smile and head nod or a frown and head shake. In the presence of the smile and head nod (S1), task completion was reinforced. In the presence of the frown and head shake (S2), task termination (e.g., putting away the handwriting materials) was reinforced. All four participants learned to engage in the observing response in the presence of the ambiguous stimuli, and the S1 and S2 affective displays came to exert discriminative control over task completion and termination.

The experimenters then assessed the extent to which the participants exhibited discriminated observing in the presence of standard task materials by conducting a test in which presentations of standard task materials and ambiguous task materials were interspersed. Only one of the participants demonstrated discriminated observing under these conditions. The other three participants were subsequently taught to discriminate the ambiguous and standard task materials using a training procedure in which observing was reinforced only in the presence of the ambiguous task materials and not in the presence of the standard task materials.

Directions for Research

The results of Brim et al. (2009) suggest that children with autism can be taught social referencing using behavior-analytic teaching procedures. This study demonstrated that both first-link and second-link social referencing responses can be brought under the control of relevant stimuli within the social referencing behavior chain. That is, ambiguous objects can acquire discriminative control over observing responses, and adult affective displays can acquire discriminative control over approach and avoidance responses, by carefully arranging contingencies for both. Despite the success of the Brim et al. study, it has not yet been replicated. A replication might include the use of more affective stimuli and an evaluation of responding to these stimuli as classes that

evoke approach or avoidance responses. Additionally, various types of ambiguous and non-ambiguous stimuli can be evaluated as stimulus classes as well to determine if they indeed evoke observing responses.

Unlike the paucity of social referencing studies with children with autism, there are numerous experimental and descriptive studies examining social referencing with children of typical development. The results of those studies also could inform social referencing research with children with autism. For instance, Kim and Kwak (2011) found that typically developing infants engaged in observing responses more often when they encountered ambiguous stimuli than when they encountered unambiguous stimuli and, subsequently, more frequently responded to the facial expression of the adult when ambiguous stimuli set the occasion for observing. In this case, it is possible that the ambiguous stimulus created an establishing operation for the facial expression of the adult to function as a reinforcer for observing. The presence of the ambiguous stimulus momentarily altered the value of the adult facial expression as a reinforcer. Future research might test this phenomenon with children with autism. Specifically, researchers might determine the effects of the presence of the ambiguous stimulus (i.e., establishing operation) and the absence of the ambiguous stimulus (i.e., abolishing operation) on the observing response (Howlett et al. (2011). Consider this example. In one condition, experimenters create an establishing operation by presenting items hidden under cloths as ambiguous stimuli. When observing occurs, experimenters produce affective responses that evoke either approach or avoidance of the hidden item. In another condition, experimenters create an abolishing operation by presenting familiar items in view of the participants. If observing occurs in this condition, affective responses are not presented. If observing responses occur more frequently in the establishing operation condition and less frequently in the abolishing operation condition, it would support the idea that motivating operations can influence responding of children with autism during social referencing. In sum, research is needed evaluating the evocative and abative effects of ambiguous stimuli and standard stimuli respectively.

As described previously, stimulus overselectivity could account for the failure of children with autism to respond to the affect of others. Thus, a direction for future research could be to evaluate procedures for reducing restricted stimulus control with respect to complex social stimuli by incorporating differential observing responses (Dube and McIlvane 1999) when training affect discrimination. For example, researchers might evaluate how affect discrimination improves by first requiring children with autism to vocally tact the facial expression as an observing response when it is produced. Researchers might also consider evaluating the use of verbal instructions (Dube et al. 2010) when training affect discrimination. For instance, the experimenter might pair a verbal instruction with the facial expression (e.g., say, “move back” while frowning and shaking head). Studies with infants of typical development have found that they responded more frequently to both positive and negative messages when those messages were delivered vocally (Kim et al. 2010; Vaish and Striano 2004) than when they were delivered via gesture or facial expression alone. In the case of children with autism who fail to respond to the facial expressions of others, vocal instructions could be paired with the facial expressions and then systematically faded. In another study with typically developing infants, Peláez et al. (2012) provided a methodologically sound demonstration of the effects of discrimination training on acquisition of social

referencing responses. Recall that Peláez et al. (2012) used reinforcement and punishment to teach discriminated reaching. A similar set of procedures could be evaluated with children with autism.

Finally, at the beginning of this paper, we described some similarities and differences between social referencing and joint attention. The growing research on improving joint attention in children with autism could be helpful in guiding research on social referencing. Both joint attention and social referencing require that social stimuli function as reinforcers; however, because of the core social deficits of autism (American Psychiatric Association 2013) and because some children with autism do not orient toward social stimuli (Dawson, et al. 1998), social interactions are perhaps less likely to function as reinforcers. Research on establishing such stimuli as reinforcers would prove valuable for teaching social referencing. Holth et al. (2009) described an operant discrimination protocol for establishing conditioned social reinforcers to be used when training joint attention responses in children with autism. First social stimuli, a smile and head nod, were established as a discriminative stimulus for grabbing edible reinforcers from a table. Following this, the smile and head nod were provided contingently as reinforcers for other response sequences such as stacking blocks. In another condition, response sequences were reinforced with social stimuli established as reinforcers through a standard pairing procedure. Response rates were higher when the conditioned reinforcer established via the operant discrimination training was used as opposed to when the conditioned reinforcer established through pairing was used. Future research might replicate these findings and apply them to social referencing.

In summary, interventions that address social referencing deficits could prove beneficial for long-term social and language gains for children with autism. It is our hope that this behavior analysis of social referencing will serve as an impetus for research evaluating procedures for teaching social referencing as well as the long-term impact of these skills. We believe that interpreting social referencing as a behavioral chain of discriminated responses that are controlled by classes of stimuli and consequences is a necessary step toward the development of such interventions and analyses.

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References

- American Psychiatric Association (2013). *Diagnostic and statistical manual of mental disorders*: (5th ed.). Washington DC: Author. doi:10.1176/appi.books.9780890425596.893619.
- Argott, P., Townsend, D., Sturme, P., & Poulson, C. L. (2008). Increasing the use of empathic statements in the presence of a non-verbal affective stimulus in adolescents with autism. *Research in Autism Spectrum Disorders*, 2, 341–352. doi:10.1016/j.rasd.2007.08.004.
- Axe, J. B., & Evans, C. J. (2012). Using video modeling to teach children with PDD-NOS to respond to facial expressions. *Research in Autism Spectrum Disorders*, 6, 1176–1185. doi:10.1016/j.rasd.2012.03.007.

- Brim, D., Townsend, D. B., DeQuinzio, J. A., & Poulson, C. L. (2009). Analysis of social referencing skills in children with autism. *Research in Autism Spectrum Disorders*, 3, 942–958. doi:10.1016/j.rasd.2009.04.004.
- Campos, J. J., & Sternberg, C. (1981). Perception, appraisal, and emotion: the onset of social referencing. In M. E. Lang & L. R. Sherrod (Eds.), *Infant social cognition: empirical and theoretical considerations* (pp. 273–314). Hillsdale: Erlbaum. doi:10.1007/s10803-012-1518-8.
- Catania, C. A. (2013). *Learning* (5th ed.). Cornwall-on-Hudson: Sloan Publishing.
- Cornew, L., Dobkins, K. R., Akshoomoff, N., McCleery, J. P., & Carver, L. J. (2012). Atypical social referencing in infant siblings of children with autism spectrum disorders. *Journal of Autism and Childhood Schizophrenia*, 42, 2611–2621. doi:10.1007/s10803-012-1518-8.
- Daou, N., Vener, S. M., & Poulson, C. L. (2014). Analysis of three components of affective behavior in children with autism. *Research in Autism Spectrum Disorders*, 8, 480–501. doi:10.1016/j.rasd.2014.01.005.
- Dawson, G., Meltzoff, A. N., Osterling, J., Rinaldi, J., & Brown, E. (1998). Children with autism fail to orient to naturally occurring stimuli. *Journal of Autism and Developmental Disorders*, 28, 479–485. doi:10.1023/A:1026043926488.
- Dube, W. V., & McIlvane, W. J. (1999). Reduction of stimulus overselectivity with nonverbal differential observing responses. *Journal of Applied Behavior Analysis*, 32, 25–33. doi:10.1901/jaba.1999.32-25.
- Dube, W. V., MacDonald, R. P. F., Mansfield, R. C., Holcomb, W. L., & Ahearn, W. H. (2004). Toward a behavioral analysis of joint attention. *The Behavior Analyst*, 27, 197–207. doi:10.1901/jaba.1999.32-25.
- Dube, W. V., Dickson, C. A., Balsamo, L. M., O'Donnell, K. L., Tomanari, G. Y., Farren, K. M., Wheeler, E. E., & McIlvane, W. J. (2010). Observing behavior and atypically restricted stimulus control. *Journal of the Experimental Analysis of Behavior*, 94, 297–313. doi:10.1901/jeab.2010.94-297.
- Feinman, S. (1992). In the broad valley: an integrative look at social referencing. In S. Feinman (Ed.), *Social referencing and the social construction of reality in infancy* (pp. 3–13). New York: Plenum.
- Fields, L., & Reeve, K. F. (2000). Synthesizing equivalence classes and natural categories from perceptual and relational classes. In J. C. Leslie & D. Blackman (Eds.), *Experimental and applied analysis of human behavior* (pp. 59–83). Reno: Context Press.
- Gena, A., Krantz, P. J., McClannahan, L. E., & Poulson, C. L. (1996). Training and generalization of affective behavior displayed by youth with autism. *Journal of Applied Behavior Analysis*, 29, 291–304. doi:10.1901/jaba.1996.29-291.
- Gewirtz, J. L., & Peláez-Nogueras, M. (1992). Social referencing as a learned process. In S. Feinman (Ed.), *Social referencing and the social construction of reality* (pp. 151–173). New York: Plenum Press. doi:10.1007/978-1-4899-2462-9_7.
- Ham, H. S., Bartolo, A., Corley, M., Rajendran, G., Szabo, A., & Swanson, S. (2011). Exploring the relationship between gestural recognition and imitation: evidence of dyspraxia in autism spectrum disorders. *Journal of Autism and Development Disorders*, 41, 1–12. doi:10.1007/s10803-010-1011-1.
- Haring, T. G., Breen, C. G., & Laitinen, R. E. (1989). Stimulus class formation and concept learning: establishment of within- and between-set generalization and transitive relationships via conditional discrimination procedures. *Journal of the Experimental Analysis of Behavior*, 52, 13–25. doi:10.1901/jeab.1989.52-13.
- Holth, P., Vandbakk, M., Finstand, J., Gronnerud, E. M., & Sorensen, J. M. (2009). An operant analysis of joint attention and the establishment of conditioned social reinforcers. *European Journal of Behavior Analysis*, 10, 143–158. doi:10.1037/h0100311.
- Howlett, M. A., Sidener, T. M., Progar, P. R., & Sidener, D. W. (2011). Manipulation of motivating operations and use of a script-fading procedure to teach mands for location with language delays. *Journal of Applied Behavior Analysis*, 44, 943–947. doi:10.1901/jaba.2011.44-943.
- Kim, G., & Kwak, K. (2011). Uncertainty matters: impact of stimulus ambiguity on infant social referencing. *Infant and Child Development*, 20, 449–463. doi:10.1002/icd.708.
- Kim, G., Walden, T. A., & Knieps, L. J. (2010). Impact and characteristics of positive and fearful emotional messages during infant social referencing. *Infant Behavior & Development*, 33, 189–195. doi:10.1016/j.infbeh.2009.12.009.
- Lovaas, O. I., Koegel, R. L., & Schreibman, L. (1979). Stimulus overselectivity in autism: a review of research. *Psychological Bulletin*, 86, 1236–1254. doi:10.1037//0033-2909.86.61236.
- Magrelli, S., Jermann, P., Noris, B., Ansermet, F., Hentsch, F., Nadel, J., & Billard, A. (2013). Social orienting of children with autism to facial expressions and speech: a study with a wearable eye-tracker in naturalistic settings. *Frontiers in Psychology*, 4, 1–15. doi:10.3389/fpsyg.2013.00840.

- Markodimitraki, M., Kypriotaki, M., Ampartzaki, M., & Manolitsis, G. (2013). Effects of context and facial expression on imitation tasks in preschool children with autism. *Early Child Development and Care, 183*, 1276–1292. doi:10.1080/03004430.2012.721357.
- Meindl, J. N., & Cannella-Malone, H. I. (2011). Initiating and responding to joint attention bids in children with autism: a review of the literature. *Research in Developmental Disabilities, 32*, 1441–1454. doi:10.1016/j.ridd.2011.02.013.
- Mireault, G., Crockenberg, S., Sparrow, J. E., Pettinato, C. A., Woodward, K. C., & Malzac, K. (2014). Social looking, social referencing and humor perception in 6-and- 12-month-old infants. *Infant Behavior & Development, 37*, 536–545. doi:10.1016/j.infbeh.2014.06.004.
- Mundy, P., Sigman, S., & Kasari, C. (1994). Joint attention, developmental level, and symptom presentation in autism. *Development and Psychopathology, 6*, 389–401. doi:10.1017/s0954579400006003.
- Peláez, M. (2009). Joint attention and social referencing in infancy as precursors of derived relational responding. In R. A. Rehfeldt & Y. Barnes-Holmes (Eds.), *Derived relational responding: applications for learners with autism and other developmental disabilities* (pp. 63–78). Oakland: New Harbinger.
- Peláez, M., Virues-Ortega, J., & Gewirtz, J. L. (2012). Acquisition of social referencing via discrimination training in infants. *Journal of Applied Behavior Analysis, 45*, 23–36. doi:10.1901/jaba.2012.45-23.
- Peláez, M., Virues-Ortega, J., Field, T. M., Amir-Kiaei, Y., & Schnerch, G. (2013). Social referencing in infants of mothers with symptoms of depression. *Infant Behavior & Development, 36*, 548–556. doi:10.1016/j.infbeh.2013.05.003.
- Schlinger, H. D. (1995). *A behavior analytic view of child development*. New York: Plenum Press. doi:10.1007/978-1-4757-8976-8.
- Schrandt, J. A., Townsend, D., & Poulson, C. L. (2009). Teaching empathy skills to children with autism. *Journal of Applied Behavior Analysis, 42*, 17–32. doi:10.1901/jaba.2009.42-17.
- Sigman, M. D., Kasari, C., Kwon, J., & Yirmiya. (1992). Responses to the negative emotions of others by autistic, mentally retarded, and normal children. *Child Development, 63*, 796–807. doi:10.1111/j.1467-8624.1992.tb01662.x.
- Slaughter, V., & McConnell, D. (2003). Emergence of joint attention: relationships between gaze following, social referencing, imitation, and naming in infancy. *The Journal of Genetic Psychology: Research and Theory on Human Development, 164*, 54–71. doi:10.1080/00221320309597503.
- Sorce, J. F., Emde, R. N., Campos, J. J., & Klinnert, M. D. (1985). Maternal emotional signaling: its effect on the visual cliff behavior of 1-year-olds. *Developmental Psychology, 21*, 195–200. doi:10.1037//0012-1649.21.1.195.
- Stone, W. L., & Yoder, P. J. (2001). Predicting spoken language in children with autism spectrum disorders. *Autism, 5*, 341–361. doi:10.1177/1362361301005004002.
- Striano, T., & Rochat, P. (2000). Emergence of selective social referencing in infancy. *Infancy, 1*, 253–264. doi:10.1207/S15327078IN0102_7.
- Vaillant-Molina, M., & Bahrick, L. E. (2012). The role of intersensory redundancy in the emergence of social referencing in 5½-month-old infants. *Developmental Psychology, 48*, 1–9. doi:10.1037/a0025263.
- Vaish, A., & Striano, T. (2004). Is visual reference necessary? Contributions of facial versus vocal cues in 12-month-olds' social referencing behavior. *Developmental Science, 7*, 261–269. doi:10.1111/j.1467-7687.2004.00344.x.
- Walden, T. A. (1991). Infant social referencing. In J. Garber & K. A. Dodge (Eds.), *The development of emotion regulation and dysregulation* (pp. 69–88). New York: Cambridge University Press. doi:10.1017/cbo9780511663963.005.
- Warreyn, P., Roeyers, H., & De Groote, I. (2005). Early social communicative behaviors of preschoolers with autism spectrum disorder during interaction with their mothers. *Autism, 9*, 342–361. doi:10.1177/1362361305056076.
- Weeks, S. J., & Hobson, R. P. (1987). The salience of facial expression for autistic children. *Journal of Child Psychology and Psychiatry, 28*, 137–152. doi:10.1111/j.1469-7610.1987.tb00658.x.
- White, P. J., O'Reilly, M., Streusand, W., Levine, A., Sigafos, J., Lancioni, G., & Aguilar, J. (2011). Best practices for teaching joint attention: a systematic review of the intervention literature. *Research in Autism Spectrum Disorders, 5*, 1283–1295. doi:10.1016/j.rasd.2011.02.003.