

Toward a Behavioral Analysis of Joint Attention

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Joint attention (JA) initiation is defined in cognitive-developmental psychology as a child's actions that verify or produce simultaneous attending by that child and an adult to some object or event in the environment so that both may experience the object or event together. This paper presents a contingency analysis of gaze shift in JA initiation. The analysis describes reinforcer-establishing and evocative effects of antecedent objects or events, discriminative and conditioned reinforcing functions of stimuli generated by adult behavior, and socially mediated reinforcers that may maintain JA behavior. A functional analysis of JA may describe multiple operant classes. The paper concludes with a discussion of JA deficits in children with autism spectrum disorders and suggestions for research and treatment.

Key words: joint attention, social reinforcer, development, autism

A 3-year-old girl and her family are visiting friends. As the adults sit in the living room and chat, the child plays alone with a puzzle on the floor. Suddenly, a kitten runs into the room. The child's face lights up with surprise and pleasure at the sight of it. Her very next action is not to engage the kitten in play, however, but rather to look up to her mother's face while pointing to the cat: Does Mommy also see it?

Joint attention (JA) has been defined in the literature of cognitive-developmental psychology as "the capacity of the young child to use gestures and eye contact to coordinate attention with an-

other person in order to share the experience of an interesting object or event" (Mundy, Sigman, & Kasari, 1994, p. 389) and "the ability to coordinate attention between interactive social partners with respect to objects or events, or to share an awareness of the objects or events" (Dawson et al., 2002, p. 346; see also Mundy, Sigman, Ungerer, & Sherman, 1986). Although the genesis and elaboration of JA have been of longstanding interest in the fields of cognitive and social development (e.g., Scaife & Bruner, 1975), the topic has been emphasized recently because of a relation between JA deficits and autism (e.g., Carpenter, Pennington, & Rogers, 2002).

Nonverbal JA behavior begins to be emitted by typically developing children between the ages of 9 and 12 months (Bakeman & Adamson, 1984). The earliest developing topographies are gaze shifts between an object or event in the environment and a familiar person. As development progresses, gaze shifts are combined with gestures toward the object or event, and the child eventually emits various combi-

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nations of gaze shift, verbalizations, eye contact, pointing, reaching, or showing an object to a person (Seibert, Hogan, & Mundy, 1984; Tomasello, 1995).

JA presents an opportunity for behavior analysis to address a topic of interest in cognitive-developmental psychology, perhaps to mutual benefit. JA initiation is an inviting topic for behavior analysis in part because the broadly accepted definition within developmental psychology incorporates an unacknowledged Skinnerian-like functional distinction, although it is not described as such. From the cognitive-developmental perspective, an important defining characteristic of JA is that the child's actions are directed toward the result of "sharing the experience" or "sharing an awareness" of an object or event. In contrast, the very same behavior (gaze shift, gesture, vocalization, etc.) would not qualify as JA if it were directed toward the result of obtaining the object. Although developmental psychologists may describe this distinction in terms of the child's "intent," and the consequence of "sharing" may not be objectively defined, the functional emphasis seems clear. From the behavior-analytic perspective, the cognitive-developmental definition of JA initiation might be interpreted as a mand for the adult's behavior of attending to an object (or an observing response that verifies such attending), as distinguished from a mand for the object itself.

The term *joint attention*, taken from the developmental psychology literature, may be potentially misleading for a behavior-analytic audience. *Joint* has been used in behavior analysis to refer to rapid cyclical responding to multiple stimuli (*joint control*; Lowenkron, 1998). In extended JA episodes, there may be a cyclical aspect to the behavior if a child exhibits repeated gaze shifts between an object and an adult. The similarity in terms is coincidental, however, and the present analysis does not propose a relation between JA and joint control as described by Lowen-

kron. The cognitive construct of *attention* is not useful in a behavioral analysis, and the term's implicit reification of attending behavior may be distracting. Nevertheless, *joint attention* is almost universally used and accepted in developmental psychology, and the developmental description is the jumping-off point for the present analysis. We hope that context will make it clear to the reader when JA refers to a topic area in the developmental literature, a construct that is used in cognitive theories, or an objectively defined operant class.

A Behavioral Analysis of JA

This section will advance a behavioral interpretive analysis of JA. In behavioral interpretation, "principles derived from research conducted under the favorable conditions of the laboratory are used to give a plausible account of facts which are not at the moment under experimental control" (Skinner, 1969, p. 100). Interpretation is distinct from experimental analysis.

Interpretation begins with principles derived from experimental analysis and, then, explores the implications of those principles for the understanding of complex behavioral phenomena. As with other historical sciences, if the processes described by these principles are sufficient to produce the observed complex behavior (i.e., the occurrence of the behavior is consistent with the principles) then the behavior is said to be understood (interpreted) in terms of the principles. (Donahoe & Palmer, 1989, p. 401)

The sections on autism that follow this one will include some suggestions for direct experimental analyses that might provide additional corroborating evidence.

Scope of analysis. The present analysis will focus on JA initiation by the child, as in the kitten example above, and the behavior of gaze shift will be emphasized because it is the earliest developing and most frequently displayed response topography. The goal of the analysis is to provide a plausible account of a child's behavior when he or she, as in the example, looks to the

parent at the onset of an interesting event.

The JA research literature also describes JA responding, in which the adult initiates the interaction; for example, the adult points out an object and the child responds by looking at it (Delgado et al., 2002; Whalen & Schreibman, 2003). JA responding is considered below, but it is not part of the contingency analysis of JA initiation because it seems to be functionally distinct, with consequences related to compliance with the adult's mand for attending behavior (i.e., the child is following directions).

Antecedent events. The analysis will characterize the onset of the interesting event (e.g., the kitten's entrance), in an environmental context that includes the presence of a familiar adult, as a *motivating operation* (MO). Laraway, Snyckerski, Michael, and Poling (2003) defined an MO as an environmental event with value-altering and behavior-altering effects. The value-altering effect is seen as a momentary alteration in the effectiveness of another class of events as consequences. Behavior becomes more likely if the MO establishes the effectiveness of a reinforcer or abolishes the effectiveness of a punisher, or becomes less likely if the MO abolishes the effectiveness of a reinforcer or establishes the effectiveness of a punisher. The behavior-altering effect of the MO is seen as an evocative or abative change in the frequency of behavior relevant to those events as consequences, and this may depend on the presence of contextually appropriate discriminative stimuli. Michael (1982, 1993) differentiated the behavioral effects of discriminative and motivational stimulus functions, with the effect of the former due to correlation with an increased probability of reinforcement for a behavior, and the effect of the latter due to changes in the reinforcing capacity of other stimuli.

In JA initiation, the interesting object or event momentarily establishes the reinforcing capacity of a class of stimuli, here termed *adult-attending*

stimuli, as conditioned reinforcers. Adult-attending stimuli are primarily visual indicators that the adult is aware of the interesting event, for example, the adult's eyes are open and oriented toward it. Adult-attending stimuli indicate that the adult is attending to the event and not necessarily to the child. Adult-attending stimuli become effective as conditioned reinforcers after a learning history in which (a) they have been reliable predictors that the adult will react to the interesting event and (b) the adult's reaction has been related to increased reinforcement. Thus, in the present analysis, the JA initiation behavior of gaze shifting is an observing response exhibited because of a history of producing adult-attending stimuli as immediate consequences. Adult-attending stimuli function as links in a behavioral chain: as conditioned reinforcers for gaze shifting and as discriminative stimuli indicating an increased probability of other reinforcers related to the adult's behavior with respect to the child and the interesting object or event; these contingencies are diagrammed in the lower portion of Figure 1. If the gaze shift reveals that the adult is not attending to the object or event, then additional JA initiation responses (verbalizations, gestures) with a history of producing adult-attending stimuli may follow.

Analysis of the interesting event as an MO is required because the child does not continually observe adult-attending stimuli whenever the adult is present. In the absence of the interesting event, adults still generate adult-attending stimuli related to various features of the environment with great frequency (adults are usually looking at something), but these adult-attending stimuli do not function as conditioned reinforcers (adults are often looking at things unrelated to the probability of reinforcement for the child's behavior). The value-altering effect of the interesting event is the increase in reinforcing effectiveness of adult-attending stimuli; the evocative effect is the increase in frequency of gaze shifts that

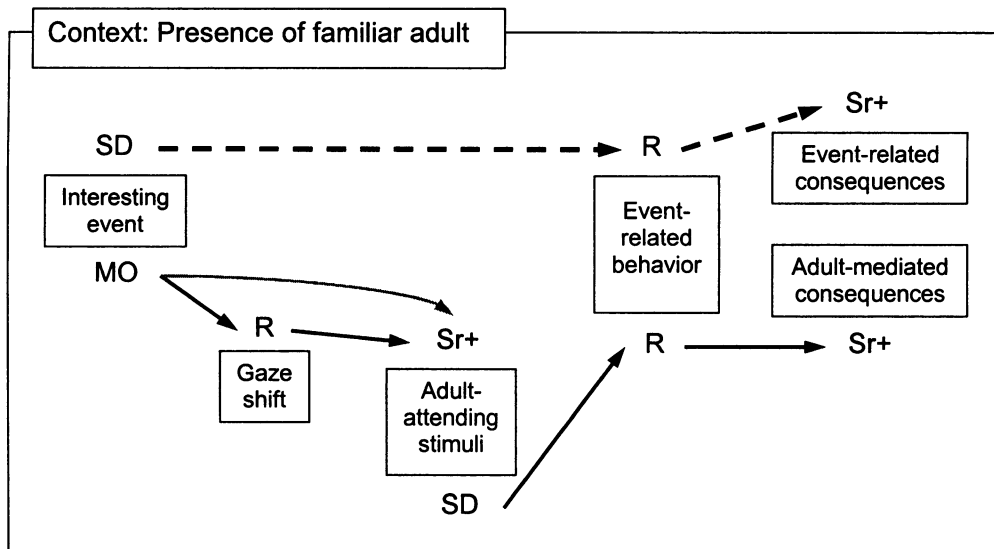


Figure 1. Contingency diagram. Large box indicates a context that includes a familiar adult. Smaller boxes show stimuli and responses. Abbreviations for contingency terms appear above or below boxes: SD = discriminative stimulus; R = response; Sr+ = conditioned reinforcer; MO = motivating operation. Dashed arrows show a three-term contingency that is independent of adult-mediated consequences. Solid arrows show contingencies that may support joint attention initiation. The curved gray arrow from MO to Sr+ represents the reinforcer-establishing effect of the interesting event; the arrow from MO to R represents the evocative effect of the interesting event.

may produce adult-attending stimuli as consequences.

Consequences. At the onset of the interesting event, the child may emit event-related behavior because of a relevant history of event-related consequences (e.g., play with the kitten), as illustrated by the dashed arrows in the top portion of Figure 1. The child may emit event-related behavior only and thus engage in solitary play. Another option is available: The child may emit both event-related behavior and JA initiation because of a reinforcement history that includes both event-related consequences and adult-mediated consequences, the latter shown by the solid arrows in Figure 1. Adult-mediated consequences may include adult-attending stimuli (e.g., the mother continues to look at the kitten) and subsequent event-related stimuli (e.g., the mother joins in play with the kitten). In this case, the contingencies shown by the dashed and solid arrows in Figure 1 occur concurrently. JA initiation implies that the adult-mediated conse-

quences have positive value for the child. A functional analysis may identify several broad classes of consequences and thus the possibility of several operant classes of JA initiation.

The first and probably by far most common is supplemental reinforcement from adult participation. Here, the overall reinforcing value of the consequences produced by activity related to the interesting event is increased by adult-generated generalized social reinforcers such as smiling, signs of approval, affectionate gestures and verbalizations, and so forth. As a result of past experience, the child prefers to play with a toy, look at a picture book, and so forth, when the adult participates in the activity. Supplemental reinforcement seems to be related to the great majority of JA initiation episodes as they are described in cognitive-developmental psychology.

A second possible class of consequences is related to supplemental responses. In this case, the child's experience has been that he or she can com-

plete all of the response requirements related to the reinforcement contingencies of the interesting event more effectively if the adult helps at certain points, and that reinforcement is maximized if the child does not need to stop and overtly seek help each time it is needed. The adult-attending stimuli indicate an adult that is standing by ready to offer assistance as needed. For example, a child cutting out paper dolls may need help only for small details.

A third possible class of reinforcers that may maintain JA initiation is negative reinforcement, the termination of a mildly aversive situation. Startling or unfamiliar objects or events may cause mild conditioned or unconditioned feelings of anxiety or uncertainty (severe feelings of fear seem likely to set the occasion for imperative behavior that would not be classified as JA initiation). If the child's past experience has been that the adult's behavior in such situations is a reliable guide to the level of threat, then one consequence of the gaze shift may be adult-attending stimuli indicating that nothing is amiss. If so, one possible function of the behavior would be the reduction or termination of aversive stimulation (cf. Skinner's 1957 discussion of generalized reinforcement by escape from mild threats, pp. 54–55). This operant class seems closely related to the developmental concept of *social referencing*, in which the child observes the emotional expressions of others to appraise events and guide action. This relation is suggested in part by research demonstrating that maternal expressions can acquire discriminative functions in an operant conditioning paradigm in 9- to 12-month-old infants (Gewirtz & Peláez-Nogueras, 1992).

Summary of behavioral analysis. In the proposed analysis, the onset of an interesting event in a context that includes a familiar adult momentarily increases the reinforcing capacity of adult-attending stimuli. Gaze shift and other JA initiation responses increase in probability because of a history of producing adult-attending stimuli as

consequences. Adult-attending stimuli also function as discriminative stimuli for adult-mediated reinforcement contingencies. A functional analysis of the gaze shift in JA initiation may describe multiple operant classes.

As noted above, the scope of this interpretive analysis is restricted to the child's behavior, which is also the focus of JA descriptions in developmental psychology. The response terms in Figure 1 are the child's behavior, and several of the stimulus terms are the adult's behavior. A complete behavioral account of an entire episode would include a complementary contingency analysis in which the response terms are the adult's behavior and several of the stimulus terms are the child's. Novak and Peláez (2004) provide useful models, based on behavior analysis and dynamical systems principles, for analyses of social reciprocal interactions.

JA Deficits in Autism

Prior research has documented deficits in JA in children with autism (e.g., Carpenter et al., 2002; Mundy et al., 1994; reviewed in Jones & Carr, 2004). These children may fail to orient to speech sounds or social stimuli (Dawson, Meltzoff, Osterling, Rinaldi, & Brown, 1998), and fail to look where others point (Leekam, Hunnisett, & Moore, 1998). Related problems in autism have been reported in declarative pointing and showing (Baron-Cohen, 1989) and referential looking (Charman et al., 1997). For example, Charman et al. found that all children with autism looked at a mechanical toy when it was activated but did not exhibit gaze switches between the toy and an adult who was present. This deficit is characterized as JA related because it is specific to the coordination of adult-child mutual attending to the toy. If the toy is moved out of reach, the child with autism may be as likely as any child to gaze shift and point to elicit aid in obtaining the toy (Mundy et al., 1994).

Significance of JA deficits in autism. JA delays are among the measures used for early diagnosis of autism, for example in the ADOS-G Module 1 (Lord, Rutter, DiLavore, & Risi, 1999; reviewed in Rogers, 2001). For this reason, the remediation of JA deficits in children with autism has been advanced as a helpful criterion for evaluating progress in early intervention programs (Mundy & Crowson, 1997). Deficits in JA have also been associated with differences in subsequent language development (Mundy, Sigman, & Kasari, 1990). The frequency of adult-object gaze switching at age 20 months has been positively related to language gains and decreased social-communication deficits at 42 months in children with autism spectrum disorder (Charman, 2003). One possibility is that the rapid vocabulary expansion of typical preschool development depends in part on the child's ability to determine, via observation of adult-attending stimuli, which object in the immediate environment is related to the adult's speech (Baron-Cohen, Baldwin, & Crowson, 1997; Golinkoff, Hirsh-Pasek, Bailey, & Wenger, 1992; Markman, 1989; Wilkinson, Dube, & McIlvane, 1996). JA deficits are also relevant to some attempts to understand autism from different theoretical perspectives (Jones & Carr, 2004). Examples include Mundy and Neal's (2001) social orienting theory and Bijou and Ghezzi's (1999) behavior interference theory.

Implications for Research and Treatment

Although JA initiation has been identified as an important target for early intervention in children with autism (Mundy et al., 1994), relatively few studies have documented effective interventions for ameliorating JA deficits in young children (e.g., Kasari, Freeman, & Paparella, 2001; Whalen & Schreibman, 2003). This section will outline a few opportunities for research

and intervention that arise from the contingency analysis presented above.

Discrimination of adult-attending stimuli. The interpretive analysis proposes an important role for adult-attending stimuli produced as immediate consequences for JA initiation responses. This raises the possibility that JA initiation deficits could be related to failure of adult-attending stimuli to exert stimulus control. If so, a necessary link in the hypothesized chain of events would be missing. Discrimination of adult-attending stimuli requires the detection of gaze direction in others. The capacity for such behavior seems to be well represented in the typical behavioral repertoires of primate species (Tomasello, Call, & Hare, 1998). Carpenter et al. (2002), however, reported a significant deficit in gaze following in 3- and 4-year-old children with autism, compared to children with other developmental delays. Accurate discrimination of gaze direction and target requires stimulus control by both the adult's eyes and the relevant object in the environment. Deficiencies in this behavior may be one example of the overselective observing and attending (as evidenced by atypically restricted stimulus control) often noted in children with autism and other developmental disabilities (Lovaas, Koegel, & Schreibman, 1979; Schreibman, 1997). One question for continued research is whether experimental analyses of behavioral prerequisites for JA initiation would confirm discriminative and conditioned reinforcing functions of adult-attending stimuli.

Evidence consistent with this possibility comes from Whalen and Schreibman's (2003) report of a training procedure that was highly effective for teaching gaze following in 5 4-year-old children with autism. Training was integrated into ongoing classroom activities, included naturalistic response-reinforcer relations (reinforcers were often toys used as training objects), and interspersed new instruction with practice on previously mastered behavior. The procedure itself is a good example

of instruction based on careful analysis of prerequisite skills. Participants progressed through six instructional steps in which the child (a) engaged with a training object after contact cues (e.g., placing the child's hand on the object), (b) engaged after distal pointing and auditory cues, (c) engaged after distal pointing cues alone, (d) made eye contact with the experimenter when given an auditory cue, (e) chose between the current training object and a different one after eye contact plus a point cue, and finally (f) chose after eye contact plus a gaze cue. Four of the 5 children who completed this training program went on to successfully complete training in JA initiation. The sole failure indicates that gaze following may not be sufficient for JA initiation. This finding is consistent with the present analysis; the child must also value the adult-mediated consequences for which adult-attending stimuli may become discriminative.

Effectiveness of adult-mediated consequences: Assessment. In the present analysis, adult-attending stimuli acquire conditioned reinforcing function because they are discriminative for increased probability of adult-mediated consequences related to the interesting event. This in turn requires that interaction with an adult has some positive value for the child. One question relevant to JA deficits in autism concerns the effectiveness of adult-mediated consequences as reinforcers. Because impairments in social skills and the ability to relate to others are among the defining characteristics of autism, one might predict social interaction with an adult to have limited effectiveness as a reinforcer for at least some children with autism.

We recently began to develop a concurrent choice procedure, based on Harding et al. (1999), to evaluate preference for adult interaction in play in preschool children. A small room equipped for videotaping was divided in half by tape on the floor. Test materials included two similar sets of toys and two adults who were familiar to

the children but not involved in daily teaching, and who sat on the floor next to the toys. Assessment sessions consisted of two 1-min exposure components followed by one 4-min concurrent choice component. At the beginning of each component, a third adult escorted the child to the dividing line at one end of the test room and then left the room; this adult also entered the room at the end of each component to remove the child.

Figure 2 illustrates the procedure with frames taken from session videotapes. In the first component (Figure 2A), only Adult 1 and one set of toys were present, and the adult maintained nondemanding play interactions with the child or initiated interaction if 5 s elapsed without one. In the second component (Figure 2B), only Adult 2 and the other set of toys were present, and the adult read a book and did not look at or otherwise respond to the child. In the third component, both adults and both sets of toys were present. Adult 2 again read a book at all times, as she had during the previous exposure component. When the child was on Adult 1's side of the line (Figure 2C), Adult 1 also behaved as she had before, with nondemanding play interactions. If the child crossed from Adult 1's side to Adult 2's (Figure 2D), Adult 1 stopped all interaction and looked down at the floor, until such time (if any) that the child crossed back.

The videotapes were scored for proportion of time spent on Adult 1's side of the testing room during the concurrent choice component. For 2 typically developing 4-year-olds, this was 100% and 96.9%; for 2 6-year-olds with autism, it was 78.2% and 22.1%. These pilot data illustrate the feasibility of directly assessing the value of adult interactions for young children. They also suggest that such tests may be sensitive to differences between typically developing children and children with autism. With further development to add preliminary preference assessments for adults and toys, stability cri-

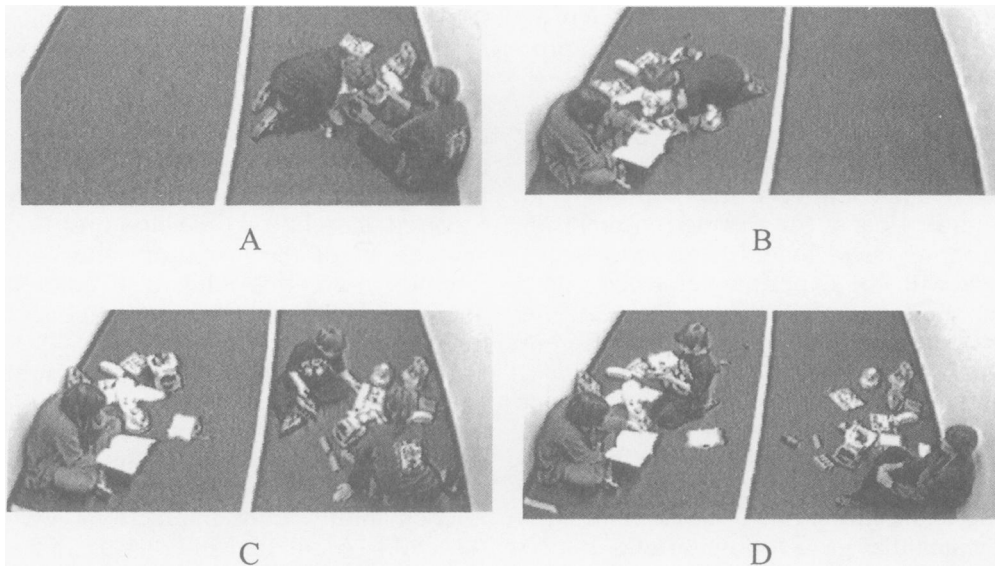


Figure 2. Procedure to assess value of adult interactions. A: Adult 1 plays with the child. B: Adult 2 ignores the child. C and D: Both adults are concurrently available. See text for details.

teria, and so forth, procedures like this one may be a useful component of an experimental analysis of JA initiation. In addition, a functional analysis of the value of adult-mediated consequences in situations that evoke JA initiation in typically developing children may be a useful preliminary step in the design of individualized treatment for JA deficits in autism.

Effectiveness of adult-mediated consequences: Intervention. If (a) supplemental reinforcement by adult-mediated social consequences underlies the discriminative function of adult-attending stimuli and (b) adult-attending stimuli are the conditioned reinforcers that maintain gaze shifts in JA initiation, then JA initiation deficits could be predicted in children who do not value adult-mediated social consequences. As noted above, this may describe at least some children with autism. What could be done to remedy this situation?

One possibility is suggested by the characteristics of effective intervention programs for children with autism. Although scientific analyses have yet to determine all of the “active ingredients” of effective programs (Kasari, 2002), the level of treatment intensity

seems to be one of the important components (e.g., Green, 1996; Lovaas, 1987; McEachlin, Smith, & Lovaas, 1993). Individual intensive instruction, in which the teacher frequently presents reinforcers, provides many opportunities for adult interaction to acquire conditioned reinforcing properties.

In cases in which JA initiation deficits persist despite frequent adult-presented reinforcers, overselective observing and attending may once again be relevant (Lovaas et al., 1979). If a child were to observe and attend only to unconditioned reinforcers (foods, etc.) and previously conditioned inanimate reinforcers (toys, etc.) and fail to observe and attend to the accompanying social stimuli, then the necessary conditions for the acquisition of conditioned social reinforcers would not exist (Lovaas et al., 1966).

One type of intervention that has been effective in reducing stimulus overselectivity is a *differential observing response* (Dube & McIlvane, 1999; Gutowski & Stromer, 2003; Koegel & Schreibman, 1977; Schreibman, 1997). Differential observing response procedures (a) impose contingencies that

control observing behavior and (b) require overt responses that verify discrimination of all relevant stimuli. A differential observing response designed to enhance acquisition of conditioned social reinforcers could, for example, require the child who receives a reinforcer to make successive eye contact with the teacher and the reinforcer and make some overt acknowledgment response that demonstrates discrimination of the specific teacher.

Summary of intervention and research questions. The behavioral interpretive analysis outlined above suggests several possibilities for research and intervention. With reference to the contingency diagram in Figure 1, JA initiation deficits may result from one or more failures of (a) adult-attending stimuli to function as discriminative stimuli, (b) adult-attending stimuli to function as conditioned reinforcers, or (c) adult-mediated interactions to function as conditioned reinforcers. All of these possibilities seem testable, and remedial interventions seem to be feasible.

Concluding Comments

The present paper takes a modest step toward a behavioral analysis of JA. Continued progress resulting in a more complete and well-developed account may offer an opportunity to increase the common ground shared by behavior analysis and cognitive-developmental psychology. One might expect most nonbehavioral developmental researchers and clinicians to be familiar with the functional-analytic behavioral approach as it has been widely and successfully applied to the reduction of problem behavior (e.g., Horner, Carr, Strain, Todd, & Reed, 2002). The behavior analyst and the cognitive-developmental psychologist seem likely to agree that, for example, a tantrum to generate attention is a different class of behavior than a tantrum to escape from demands.

Assuming the best examples are fa-

miliar ones, a functional analysis of JA could serve as an effective illustration of behavior analysis applied to the development of adaptive behavior. The behavior analyst and the cognitive-developmental psychologist seem likely to agree that a child's gaze shifting between a toy and an adult in order to "share the experience" is a different class of behavior from gaze shifting in order to gain access to the toy (or to some other tangible reinforcer in a teacher-imposed contingency). Further, both might also agree that interventions targeting JA initiation deficits in autism should not merely attempt to teach rote chains of behaviors that are topographically similar to the behaviors measured on JA initiation assessments. Rather, such interventions should target the development of discriminative and reinforcing functions of specific classes of stimuli identified by the analysis. An understanding of the functional-analytic approach could mitigate any perception that behavior analysis produces only mechanistic imitations of meaningful behavior. A behavioral analysis of JA may serve as a point of contact between the two disciplines and as an example of the benefits of functional organizing principles for analysis and intervention.

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