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The Development of Responses to People and a Toy in Infants with Down Syndrome

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The behavior of eight infants with Down syndrome was observed biweekly from 8 to 24 weeks and monthly up to 48 weeks. At each visit the infants were presented with their mother, a female stranger, and a rattle puppet that were alternately active and passive. Each condition lasted 60 s. The results showed that by 4 months of age the infants began to differentiate, in the proportion of time they looked, smiled, and vocalized, between people and the toy. They did not discriminate, however, between mother and female stranger and between the active and passive adults until the second half of the first year. In particular, whereas normal infants usually show distress toward passive or "still-face" adults, the infants in this study continued to vocalize, at times even with smiling faces. The implications of these atypical aspects of the social development of infants with Down syndrome for their subsequent nonverbal communicative development are discussed.

Down syndrome social perception communication
adult–infant interaction object–infant interaction

Distinguishing between people and objects would seem an important prerequisite for the development of communication (Gelman & Spelke, 1981). Nonhandicapped infants begin to make this discrimination in the second month of life (Brazelton, Koslowski, & Main, 1974; Klein & Jennings, 1979; Legerstee, 1986;

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Legerstee, Corter, & Kienapple, in press; Legerstee, Pomerleau, Malcuit, & Feider, 1987; Trevarthen, 1977). When facing their communicative mother or female stranger, infants have been found to smile, vocalize, and alternate their gazes. However, when presented with a familiar object that moves and sounds contingently upon their eye contact, these infants engage in intense arm activity while staring at the object continuously (Legerstee et al., in press; Legerstee et al., 1987). This contrast suggests that 2-month-old infants begin to differentiate in their responses between people and objects when variables such as contingency and familiarity are being manipulated.

At this age, nonhandicapped infants also expect people to react when in a communicative setting. This evidence comes from studies in which infants have been presented with the impassive face of an adult (Bloom, 1977; Legerstee et al., in press; Legerstee et al., 1987; Tronick, Als, & Adamson, 1979). Confronted with unresponsive adults, the infants begin to cry and turn their heads. Systematic comparisons with a familiar static object does not evoke comparable responses. Rather, the infants' behavior remains similar to that when facing the contingently responding object (Legerstee et al., in press; Legerstee et al., 1987). It has been suggested that the infants' distress may reflect their expectation that when in a communicative setting, people should engage in reciprocal acts of communication with them (Gelman & Spelke, 1981; Tronick et al., 1979).

It is not clear when infants with Down syndrome begin to differentiate the various attributes that distinguish people from objects. Impaired and delayed communicative development appears to be associated with the syndrome (Landry & Chapieski, 1989; Mundy, Sigman, Kasari, & Yirmiya, 1988). In particular, infants with Down syndrome seem to have difficulty producing nonverbal requests for objects. This deficit appears to be specific to Down syndrome children because it is not found in mental-age-matched high-risk groups (Landry & Chapieski, 1989; Mundy et al., 1988).

Communicating with people about objects demands attention to social and nonsocial aspects of the environment. Although the integration of attention to people and objects does not become consolidated in normal infants until the second year of life (Bakeman & Adamson, 1984), the process appears to commence around 6 months of age when normal infants can be seen to begin to alternate their attention between people and things (Legerstee et al., 1987). It has been suggested that the emergence of the ability to shift attention depends on skills acquired during earlier face-to-face interactions and object explorations (Adamson & Bakeman, 1982). If the development of joint attention depends on abilities nurtured during earlier developmental phases, then the problem in shifting attention may originate in these earlier interactions.

Researchers examining early social development of Down syndrome infants report that their responses to people are often delayed and different from that of nonhandicapped infants (Berger & Cunningham, 1981, 1983, 1986; Gunn, Berry, & Andrews, 1982; Jones, 1980). For instance, Berger and Cunningham

(1981) showed that the developmental pattern of attention in Down syndrome infants over the first 6 months does not follow a similar course as that of nonhandicapped infants. Down syndrome infants were later than normal infants in the onset of eye contact with their mothers and in the establishment of a peak or high levels of this behavior. Once established, however, eye contact was maintained much longer than in the normal infants. Gunn et al. (1982), studying 6- to 9-month-old Down syndrome infants, further observed that by 9 months they had not yet begun to look away from their mothers to inspect some aspect of their surroundings. Instead, the attention remained interpersonal rather than becoming referential (e.g., glancing back and forth from person to object). In addition, the vocal output of the Down syndrome infants appear significantly lower during the first 3 months than that of normal infants. When the Down syndrome infants began to vocalize, however, it was often out of phase, resulting in vocal clashes with their mothers (Berger & Cunningham, 1983). Studies on affective responses further highlight the specific difference in the responses of Down syndrome infants to people. It appears that the onset of smiling is significantly delayed in infants with Down syndrome, occurs less frequently, and is of shorter duration than that of nonhandicapped infants (Berger & Cunningham, 1986). In addition, their affective responses seem to have a "dampened" quality (Cicchetti & Sroufe, 1978; Serafica & Cicchetti, 1976), which may inadvertently affect mother–infant interactions (Emde, Katz, & Thorpe, 1978).

Together, these studies document the atypical aspects of the responses to people in infants with Down syndrome, but they do not provide information on the developing discrimination of people and objects. Clarification of this issue is important because of the hypothesized links between early independent social and object attention and a later shifting of attention between the two classes. The purpose of the present research is to study this discrimination empirically by examining at what age the infants' behavior would become specific and appropriate to people and a toy. To rule out that differential responsiveness could be due to a difference in activity level evoked by the stimuli rather than to the social–nonsocial distinction, we presented the infants alternately with their naturally interacting mother and a puppet that responded contingently to the infants' gazes. Making the nonsocial stimulus move contingently is a necessary control because adults communicating with infants naturally respond in a contingent fashion to the eye contact of their infants (Legerstee, 1983; Legerstee, Kienapple, & Walsh, 1989; Papousek & Papousek, 1984; Watson, 1972). To further rule out that differential responsiveness to the mother as compared to the toy could be interpreted as being attributable to familarity of the social stimulus (Jackson, Campos, & Fischer, 1978), we introduced a female stranger to our experiment. Because normal infants change their communicative behavior when facing an unresponsive person (Bloom, 1977; Legerstee et al., 1987; Tronick et al., 1979), the infants were also filmed when the social and nonsocial stimuli remained immobile.

METHOD

Subjects

Eight infants with Down syndrome (4 girls and 4 boys) participated in the study. They were all term infants and healthy (no heart or obvious neurological and sensory defects). All infants were diagnosed by chromosome count to be Trisomy 21, were first- or second-born, had normal deliveries, and came from middle-class families. Mothers averaged 32 years of age (range = 27–37). All infants were between 56 to 66 days old at the beginning of the study ($M = 62$ days). Their mental development was assessed twice during the study with the Bayley Scales of Infant Development (1969). At the beginning of the study, the infants' mean mental developmental index (MDI) was less than 2 months, and at age 6 months, their mean MDI was 4.9.

The eight mothers were recruited through two health centers in two major cities where they were enrolled in infant stimulation programs. They were seen biweekly until 24 weeks of age and monthly until 48 weeks of age (both chronological ages). The mothers were told that the study of a 10-month duration dealt with the reactions of their infants when presented with objects, strangers, and themselves and that their transportation would be reimbursed.

Procedure

The interactions were videotaped in an assessment room, furnished with an infant bed, table, couch, and chairs. Infants were filmed when content and healthy. In order to reduce distraction, cameras and furniture were placed out of the visual field of the infant. Infants were seated in a specially constructed infant seat tilted upward at a 45° angle. This seat supported the head and the trunk while permitting free movements of arms and legs.

Two cameras and a split screen generator recorded the infants' and adults' behaviors simultaneously on videotape. The cameras were positioned 1.8 m away from the participants. At each visit, the infants were presented with six experimental conditions: (1) active mother, (2) passive mother, (3) active stranger, (4) passive stranger, (5) active object, and (6) passive object. In the *social* condition, the mother or the stranger sat in front of the infants at a 20- to 30-cm distance. Different female strangers were presented at each visit. In the *active* condition, the adults were asked "to speak with the babies as they normally do." In the *passive* condition, they were asked not to talk but to maintain a friendly face. In the *nonsocial* condition, a graspable plush toy rattle was held in front of the infant at a 20- to 30-cm distance by the experimenter. Different plush toys of the same size were used at each visit. In the *active* condition, the experimenter, hidden behind a screen, shook the rattle each time the infant looked at it; in the *passive* condition, the rattle was kept immobile. Each of the six conditions lasted 60 s and were presented in random order to control for sequence. Due to fatigue or crying, not all sessions were completed for some infants. The amount of missed stimulus presentations was less than 10%.

Dependent Variables

Seven infant behaviors were coded from the videotapes for each of the six conditions: Gazes, smiles, positive, negative and neutral vocalizations, and forward arm extensions for the right and left arms.

Gazes were defined as eyes aligned with the stimulus face. Because it is difficult to determine from video records where infants are looking, a naive observer was placed behind the stimulus. She illuminated a small light, visible on camera, each time the infant looked at the stimulus face. A recording of gaze direction was thus present on the screen. *Smiles* were scored when the infants turned up the corners of their mouths (mouth may be open or closed). *Positive vocalizations* were scored when infants vocalized with a happy face (eyebrows and lips turned up). *Negative vocalizations* were scored when infants vocalized with unhappy faces (frowning, lowering of the corners of the mouth), and *neutral vocalizations* were scored when infants' faces showed no expression (equal tendency to progress in a negative or positive direction). *Forward arm extensions* were scored when the infants directed the arms toward the stimulus. The arm movements were being scored for the right and left arms. Arm movements not falling in this category were labeled "other" but were not incorporated in the data analysis.

Scoring

The videotapes were scored in real time from a TV monitor with a 14-inch 35.56 cm screen. One side of the screen was covered so that only the responses of the infants were visible. All behaviors (except vocalizations) were scored without sound. To ensure that the observer had correctly indicated the infants' gazes during filming, two coders viewed the videotapes to ascertain that when the light indicated a visual fixation, their heads were aligned with the stimulus face. On only three occasions was there a discrepancy. These conditions were scored for gazes after 100% agreement was reached about the direction of gaze of the infants. The coders used event recorders to code the infants' behaviors. This information was then fed into a computer for statistical analyses. Interobserver reliabilities using the scoring method were calculated for 10% of the experimental sessions (two sessions per infant). Pearson correlation coefficients of .80 or above were found for all behaviors.

RESULTS

In order to account for slight variations in the mothers' entrance and exit times, the total durations of each response were transformed in proportional durations (total duration of a response/total duration of the session). In order to assess when young infants with Down syndrome begin to differentiate between mother, female stranger, and toy, the dependent variables were submitted to a multivariate analysis of variance (MANOVA) repeated-measures, within-

subject design, with Age (15) × Stimuli (3: mother, stranger, object) × Activity Level (2: active and passive) as independent variables. Tukey's HSD ($\alpha = .05$) was used to compare the group means for each of the independent variables.

Gazes

Main effects of Age, $F(14,98) = 3.56$, $p < .0001$, and Activity Level, $F(1,7) = 5.59$, $p < .05$, indicated that these variables had an influence on the looking behavior of the infants (see Figure 1). A significant Age × Stimuli interaction, $F(28,196) = 1.73$, $p < .017$, and subsequent post-hoc analyses further revealed that at 12 weeks and at 14 weeks, the infants produced more gazes to the puppet than to the mother and stranger. This trend remained throughout development (except for 16, 30, 44, and 48 weeks, when little difference was noted in gazing toward mother, puppet, and stranger) without reaching further significance levels. An Age × Stimuli × Activity Level interaction, $F(28,196) = 1.88$, $p < .007$, and subsequent post-hoc analyses indicated that at 22, 24, 32, 44, and 48 weeks, the infants looked significantly less at passive than at active people.

Smiles

Main effects of Stimuli, $F(2,14) = 5.97$, $p < .013$, and of Activity Levels, $F(1,7) = 12.44$, $p < .01$, showed that these variables influenced the smiles of the infants (see Figure 2). A significant Age × Stimuli × Activity Level interaction, $F(28, 196) = 2.94$, $p < .001$, and subsequent post-hoc analyses showed that the infants smiled significantly more at active people than at passive people or the puppet at 18, 22, and 48 weeks, but that they smiled significantly more at their active mother at 32 weeks.

Arm Extensions

Overall main effects of Age (right arm, $F(14,98) = 6.72$, $p < .0001$; left arm, $F(14,98) = 3.93$, $p < .0001$) and Stimuli (right arm, $F(2,14) = 19.54$, $p < .0001$; left arm, $F(2,14) = 15.30$, $p < .0001$) indicated that these variables had a significant influence on the forward arm extensions of the infants (see Figure 3). A significant Age × Stimuli interaction for both arms (righ arm, $F(28,196) = 11.53$, $p < .0001$; left arm, $F(28,196) = 6.69$, $p < .0001$) revealed that at 22 weeks the infants began to produce significantly more forward arm extensions to the puppet than to the people. This trend remained significant throughout development. Because of the similarities noted in the development of forward arm extensions for both arms, Figure 3 shows the combined means for the right and left arm responses.

Vocalizations

Positive Vocalizations. Main effects of Age, $F(14,98) = 4.09$, $p < .0001$, and of Stimuli, $F(2,14) = 9.81$, $p < .002$, revealed that these variables had an effect

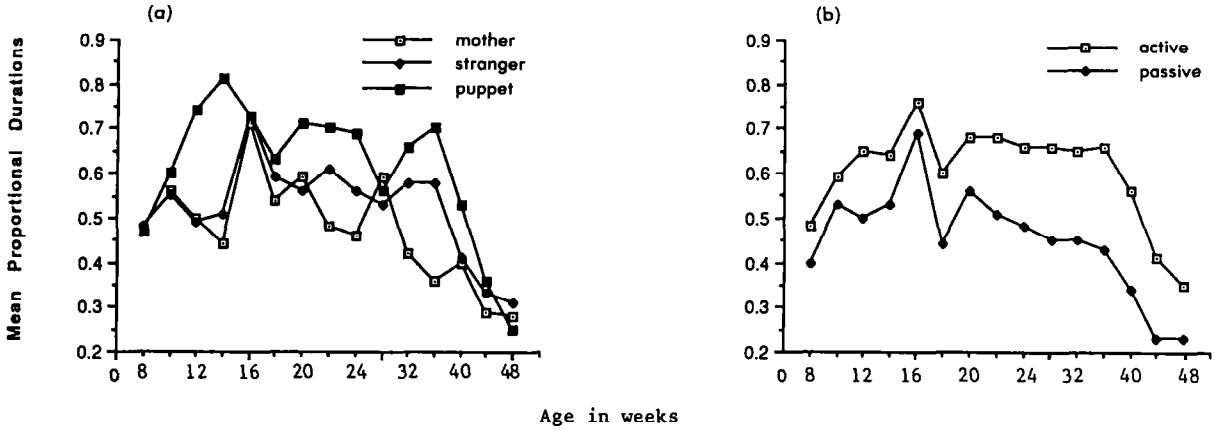

Figure 1. Gazes toward the puppet, mother, and stranger (a) and toward active and passive stimuli (b).

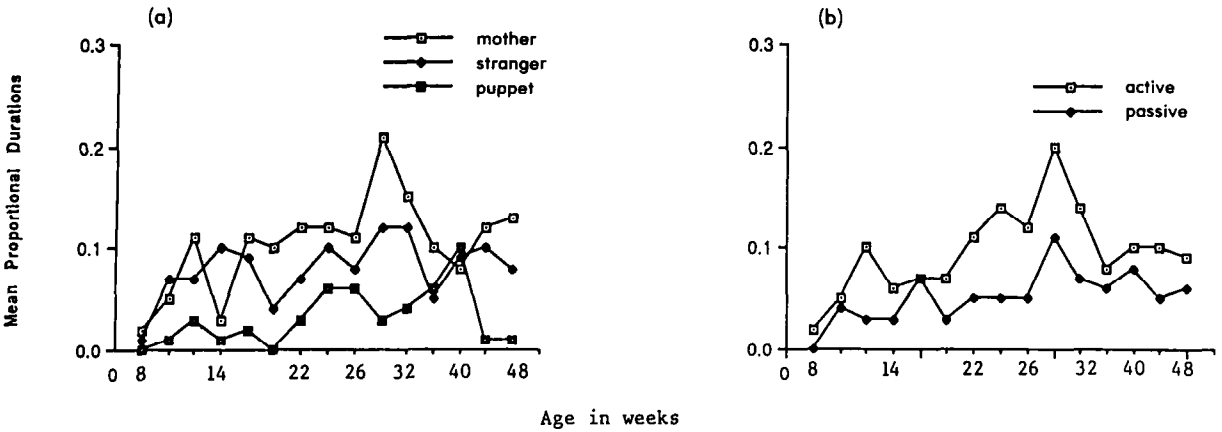

Figure 2. Smiles toward the puppet, mother, and stranger (a) and toward active and passive stimuli (b).

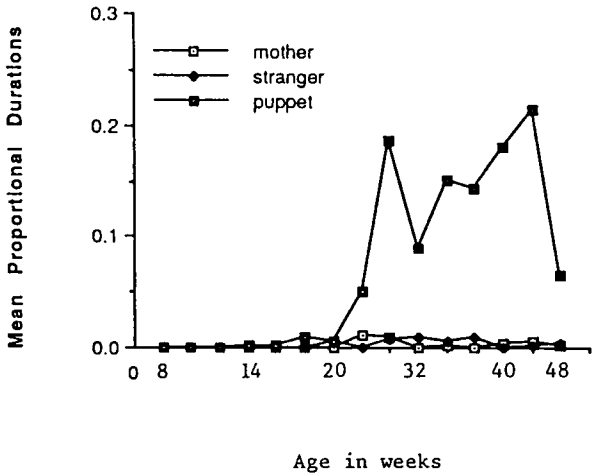

Figure 3. Arm extensions toward the puppet, mother, and stranger.

on the positive vocalizations of the infants. A significant Age × Stimuli interaction, $F(28,196) = 1.76$, $p < .015$, and subsequent post-hoc analyses indicated that at 16 weeks the infants produced significantly more positive vocalizations to people than to the object. An Age × Activity Level interaction, $F(28,196) = 2.89$, $p < .001$, and subsequent post-hoc analyses further revealed that at 20 weeks the infants vocalized more to passive than to active stimuli. An Age × Stimuli × Activity Level interaction, $F(28,196) = 3.05$, $p < .0001$, further revealed that at 28 weeks the infants produced significantly more of these vocalizations to the passive stranger than to all other stimuli. The means of the positive vocalizations are presented in Table 1.

Neutral Vocalizatons. Overall main effects for Age, $F(14,98) = 3.10$, $p < .001$, and Stimuli, $F(2,14) = 5.54$, $p < .017$, indicated that these variables had a significant effect on the development of neutral vocalizations. An Age × Stimuli interaction, $F(28,196) = 3.19$, $p < .0001$, and subsequent post-hoc analyses further indicated that these vocalizations were produced significantly more to people than to the puppet at 18 weeks of age. An Age × Stimuli × Activity Level interaction, $F(28,196) = 1.57$, $p < .041$, and subsequent post-hoc analyses indicated that at 20 and at 36 weeks these vocalizations were emitted primarily when the adults were passive. In fact, as the means in Table 2 indicate, these vocalizations were produced more to the passive mother during 13 out of the 15 age periods studied, and more to the passive stranger during 11 out of 15 ages, albeit not significantly so.

Negative Vocalizations. A significant Age × Activity Level interaction, $F(28, 196) = 1.99$, $p < .026$, and subsequent post-hoc comparisons indicated that these vocalizations were produced primarily to passive stimuli at 20 weeks of age.

TABLE 1
Mean Proportional Durations of Positive Vocalizations to Active (A) and Passive (P) Mother, Stranger, and Puppet at 15 Age Levels

Age	Mother		Stranger		Puppet	
(Weeks)	A	P	A	P	A	P
8	.000	.000	.000	.000	.000	.000
10	.000	.000	.006	.000	.000	.000
12	.019	.017	.005	.014	.000	.000
14	.080	.031	.013	.009	.037	.000
16	.102	.058	.018	.052	.007	.031
18	.049	.079	.000	.000	.000	.000
20	.085	.134	.014	.039	.000	.037
22	.013	.043	.017	.044	.018	.037
24	.071	.014	.057	.016	.004	.027
28	.141	.050	.085	.023	.010	.031
32	.078	.057	.011	.064	.013	.036
36	.022	.013	.000	.007	.015	.020
40	.058	.035	.108	.050	.029	.025
44	.062	.000	.014	.111	.000	.000
48	.020	.043	.003	.130	.000	.008

TABLE 2
Mean Proportional Durations of Neutral Vocalizations to Active (A) and Passive (P) Mother, Stranger, and Puppet at 15 Age Levels

Age	Mother		Stranger		Puppet	
(Weeks)	A	P	A	P	A	P
8	.044	.024	.015	.009	.010	.005
10	.005	.038	.001	.018	.006	.011
12	.021	.029	.051	.030	.002	.042
14	.066	.109	.077	.073	.018	.031
16	.018	.061	.014	.049	.000	.023
18	.072	.132	.020	.122	.003	.036
20	.012	.040	.019	.062	.011	.024
22	.042	.095	.011	.032	.000	.021
24	.045	.027	.018	.088	.000	.028
28	.016	.057	.003	.052	.002	.025
32	.002	.027	.006	.060	.003	.021
36	.021	.100	.019	.023	.005	.041
40	.000	.123	.028	.042	.013	.028
44	.000	.015	.000	.013	.019	.021
48	.010	.030	.008	.003	.000	.046

DISCUSSION

Our results showed that by 4 months, infants with Down syndrome began to differentiate many of their responses between people and objects. They gazed longer at the puppet but smiled and produced more neutral and positive vocali-

zations to the mother and female stranger. The onset of this differential responsiveness in the Down syndrome infants occurred 2 months later than that reported in normal infants (Legerstee et al., 1987) and corresponded to the delay noted on their mental age equivalent of the Bayley (1969). Berger and Cunningham (1981, 1983, 1986) observed similar delays in the onset of gazes, smiles, and vocalizations toward people in the Down's population. By 22 weeks, the infants reached significantly more to the puppet than to people. The fact that this differential responsiveness appeared somewhat later seemed more related to their motor development than to their developing ability to begin to discriminate between social and nonsocial stimuli. A similar developmental trend has been shown in nonhandicapped infants (Legerstee et al., 1987).

This differential responding to people and the toy could not have been due to a greater familiarity of the mother. The infants responded differentially toward the stranger and puppet and toward mother and puppet from 4 months of age on, with more social responses (vocalizations, smiles, etc.) toward the women. Actually, the Down syndrome infants did not discriminate in their responses between the mother and the stranger until the second part of the first year. Research on the behaviors of normal infants in similar situations revealed a consistent awareness of strangers by the fourth month of life (Legerstee et al., 1987; Klein & Jennings, 1979) and a wariness (increase in negative vocalizations and a decrease in gazes) toward the end of the first year (Legerstee et al., 1987). This shift from awareness to wariness of strangers in the normal population did not exhibit itself in the behaviors of the Down syndrome infants during this period of study.

Interestingly, whereas 2-month-old normal infants seemed to show distress when faced with unresponsive adults (Bloom, 1977; Legerstee et al., in press; Legerstee et al., 1987; Tronick et al., 1979), the Down syndrome infants continued to vocalize with neutral facial expressions. Although they decreased their smiles at 4 months, they did not turn away their gazes from the noncommunicative adults until 6 months of age. Gunn, Berry, and Andrews (1979) also found that when at that age infants with Down syndrome were exposed alternately to contingent and noncontingent vocalizations provided by their mothers, they decreased their gazes toward the mother who communicated randomy, indicating that any conversations they had been having had ended. Thus, whereas the Down syndrome infants seemed sensitive to the changing situation from 4 months of age on, they did not seem to notice the incongruence of the situation until approximately 6 months of age.

Our research further provides information about the evolution of the responses to the social and nonsocial stimuli. After the onset of differential responsiveness to people and objects at 2 months in nondelayed infants (Legerstee et al., 1987), subsequent development is marked by a peak in social responsiveness between 2 and 4 months (Bruner, 1975; Legerstee et al., 1987; Pierault-Le Bonniec, 1983; Trevarthen & Hubley, 1978). Thereafter, when the normal

infants become capable of grasping objects, they show a decrease in their display of affectivity and attention to adults. This change has been attributed to the infants' developing motor and cognitive skills, permitting more effective interactions and explorations with an expanding environment (Bakeman & Adamson, 1984). By 6 months, however, the nonhandicapped infants again increase responding to the social stimuli (in particular the mother) with gazes, vocalizations, and smiles, although maintaining attentiveness to the nonsocial stimuli (gazes, neutral vocalizations, and arm extensions; Legerstee et al., 1987). If objects are now introduced in the interaction, the infants' earlier dyadic interactions gradually become triadic "as object-focused attention becomes embedded in social contexts" (Bakeman & Adamson, 1984, p. 1278).

The peak in development of the social responses in Down syndrome infants occurred around 32 weeks and the peak in reaching, at 40 weeks. Thereafter, however, infants with Down syndrome decreased their vocalizations and gazes to the adults and their overall responsiveness (reaching, gazing, and smiling) to the puppet. Other studies investigating the responses of Down syndrome infants in independent play (Landry & Chapieski, 1989) and in interactions with people (Cichetti & Sroufe, 1976) have reported low levels of attention to the two classes during the beginning of the second year of life. In the Landry and Chapieski (1989) study, mothers could enhance object exploration in their Down syndrome infants to a level comparable to that of preterm infants if they used specific verbal and nonverbal techniques that did not require the infants to shift their attention. Although that study did not show that these specific techniques led to joint attention skills, visual co-orientation (where mothers follow infant attention) has been found to be a precursor to joint attention (shifting attention to notice where mother is looking) in nonhandicapped infants (Bakeman & Adamson, 1984).

In summary, whereas young infants with Down syndrome began to differentiate in their responses between people and toys during the first half of the year, they did not distinguish as clearly and as consistently between the mother and female stranger and active and passive adults. These subtle distinctions seemed to demand greater cognitive sophistication of the infants and were consequently responded to during the second half-year of life. The decrease in interest noted toward the end of the first year to both people and objects seemed to indicate that Down syndrome infants were not yet developing the attentional capabilities that would allow them to eventually shift attention back and forth between person and object if presented together in one context.

In addition to the delays in the development of person–object discriminations, there appear to be differences in the quality of responsiveness as well. Whereas normal infants readily seemed to indicate their displeasure to the noncommunicative adults (Legerstee et al., 1987; Tronick et al., 1979), the Down syndrome infants continued to vocalize, at times even with happy facial expressions. This atypical behavior of the Down syndrome infants in this study and others (Berger & Cunningham, 1983; Jones, 1980; Mundy et al., 1988)

may lead to a difficulty in interpreting the behavior of the Down syndrome infant. Mundy, Seibert, and Hogan (1985) have proposed a model in which they suggest that the cognitive limitations of the developmentally delayed infants are the basis of the shortcomings in their nonverbal communicative skills, because their cognitive handicap gives rise to deficient environmental interactions. Thus, parents failing to comprehend the expressive behaviors of their infants may react in such a way as to reduce the opportunities for the infants to experience contingent responsiveness (Mundy et al., 1988). Contingent caretaker's responsiveness in early infancy may be one of the means to establish a turn-taking, dialogue-like type of communication, in the course of which infant and mother can develop mutual understandings (Newson, 1979). The absence of it may mean a delay in the establishment of a reciprocal-affective phase in face-to-face interactions and in the subsequent emergence of a more mature form of communication, one in which things external to the interaction are shared.

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