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The Integration of Person and Object Attention in Infants With and Without Down Syndrome

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The ability to share attention with people over objects was examined in two groups of infants, one with and the other without Down syndrome. Each group was composed of two cohorts, one with a mean mental age of 8.6 months, and the other, of 16.5 months. Their attentional pattern was coded using six attention states following the work by Bakeman and Adamson (1984). To examine the influence of social partners on this ability, they were observed playing with their mother, a peer, and the peer's mother in a longitudinal study for four visits, once every 2 months. Infants in both groups displayed an increasing tendency to coordinate their attention, whereas simple onlooking, passively sharing objects, and person play decreased. Overall, infants produced more coordinated attention when with adults than with a peer. These findings support those of Bakeman and Adamson. In this study, however, infants with Down syndrome displayed less object play than infants without Down syndrome, and also less coordinated attention. It is argued that the development of coordinated attention depends on the integration of person and object domains, and that impairment in either one of the domains produces problems during the interaction phase. Discussion centers on infant constraints and environmental factors that influence the development of coordinated attention in infants.

coordinated attention Down syndrome preverbal communication

By the time infants begin to produce their first word, they have already engaged with their caretakers in social routines during which they communicate nonverbally about things in the environment. One of the mechanisms that allows for sharing of meaning is coordinated attention. Coordinated attention is the ability to alternate gazes back and forth between a person and an object during social interaction. Infants use their gazes to signal to social partners their interest in a particular object. The emergence of this skill represents a critical social-cognitive advance for the developing infant (Werner & Kaplan, 1963). It reflects an awareness that meanings can be exchanged between people, and it suggests an understanding that social partners can serve an instrumental function. As such, coordinated attention is considered an intention to communicate, and to play a central role in the infants' communicative and subsequent linguistic development (Schaffer, 1977; Tomasello, & Farrar, 1986).

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It has been suggested (Legerstee, 1997; Sugarman-Bell, 1978; Vygotsky, 1978) that the ability to coordinate attention develops through a process of specification and subsequent integration of person and object domains. For instance, during the first 6 months of life, when presented with their mother and toys, infants will focus either exclusively on the person or the object. Thereafter, these two forms of interactivity progressively become coordinated with each other. The development of coordinated attention is an example of this integration. It is evident in the furtive glances the infant now directs at the mother's face and the toy in which the infant is interested (Bakeman & Adamson, 1984; Legerstee, Pomerleau, Malcuit, & Feider, 1987). Mothers usually seize this opportunity and begin to name the object the infant is gazing at. It has been proposed that "the epistemic triangle (which comprises the active subject, the object of knowledge, and a cosubject) is constructed from such a coordination of subject–object and intersubjective forms of interaction, and that representational thought is the result" (Chapman, 1992, p. 50). This argument appears to be supported by the finding that, by approximately 12 months of age, when infants are ready to coordinate their attention between people and objects for sustained periods of time, they also begin to use symbolically mediated behaviors; they request help from people in obtaining objects, or direct people's attention to an interesting object with nonverbal gestures (Mundy, Kasari, & Sigman, 1992).

Bakeman and Adamson (1984) observed the development of coordinated attention to people and objects in two groups of infants aged 6–12 and 12–18 months, respectively. The infants were seen in their homes in interaction with their mother and a same-aged peer. They found that early attentional patterns developed gradually during the 1st and 2nd years of life. Infants progressed from an exclusive focus on either a person or an object, to an intermediate state ("passive joint") where mother and child shared a toy, but the infant showed little awareness of the mother, to a more interactive state where infants coordinate their attention to both the person and an object with which the person is involved. In addition, infants produced more coordinated attention when interacting with their mother than with the peer although toward the end of the study "even quite unskilled peers became appropriate partners for the exercise of these capacities" (Bakeman & Adamson, 1984, p. 1278).

If the development of coordinated attention depends on the interaction of person and object domains, then impairment in either one of the domains would result in problems during the interaction phase. Infants with Down syndrome show significant and measurable delays on specific nonsocial measures in the early months of life. They take longer to habituate and have poorer visual recognition memory than infants without Down syndrome (Fantz, Fagan, & Miranda, 1975), and some are unable to learn a contingency in a nonsocial context (Ohr & Fagen, 1994). They show less active involvement with toys than normal infants (Krakow & Kopp, 1983; MacTurk, Vietze, McCarthy, McQuiston, & Yarrow, 1985), and compared to infants without Down syndrome, they appear to have delays in expressive language skills and in preverbal communicative behaviors (Mundy et al., 1992). In contrast, infants with Down syndrome do not show significantly different scores from infants without Down syndrome when tested on social interaction tasks during the 1st year of life (Legerstee & Bowman, 1989). It is possible that the infant's atypical functioning in the nonsocial domain produces problems in the subsequent interaction phase, which may lead to deficits in higher order structures that enable language. In order to test this hypothesis, this research will replicate and extend Bakeman and Adamson's (1984) prior work by studying the developmental course of attention during the 1st and 2nd years of life in infants with and without Down syndrome.

In addition, in order to determine the role of social partners in the development of attention, infants will be observed with mature partners who are familiar with the infant (their mother), with women who are less familiar with the infant's level of functioning (female acquaintance), and with less competent communicators (a same-aged peer). Unlike Bakeman and Adamson (1984), we added a nonfamiliar adult in order to assess whether the social partner's familiarity with the infant is important for the development of coordinated attention because familiarity affords opportunity for the dyad to establish routinized activities (Bruner, 1973).

We hypothesized that the development of attention for both groups would be similar in that infants will progress from a phase of person or object attention to one where the two interact. However, we expected that infants would produce different amounts of coordinated attention when interacting with different social partners. Finally, because infants with Down syndrome have been hypothesized to lack in object involvement, we expect them to exhibit significant delays in their ability to coordinate the social and nonsocial domains. Consequently, infants with and without Down syndrome, matched for mental age, were videotaped during their 1st and 2nd years of life, once every 2 months over an 8-month period while they played with their mother, a peer, and the peer's mother. Their attentional behavior was segmented into sequences of mutually exclusive and exhaustive attentional states that sees the infants progress from just onlooking to states that are either person or object oriented, to the passive sharing of an object, to the final state where infants enter into nonverbal referential communication with a person about an object the two share.

METHODS

Participants

Twenty-two infants with Down syndrome (17 boys and 5 girls) participated in this study. All infants were diagnosed to have trisomy 21. Infants were recruited through infant stimulation centers and through regional Down syndrome parent associations. Caretakers were informed that infants should meet the following criteria to be eligible:

1. The infant has Down syndrome but does not exhibit severe sensory motor handicaps.
2. The infant is between 12 and 26 months of age at the time of recruitment.
3. The infant's developmental age is between 6 and 20 months.
4. The mother speaks English and agrees to participate.

Because the research was a replication of the Bakeman and Adamson (1984) study, only 12 infants without Down syndrome (6 boys and 6 girls) were recruited. They were 6 to 20 months at the time of recruitment, and were matched at the first visit with infants with Down syndrome on mental age and demographic characteristics (see Table 1).

Taken together, there were a total of 136 subject visits (34 infants, 4 visits each), and a total of 544 observational conditions (four 5-min observational conditions per infant).

Within each group, infants were divided into two cohorts, one with high and one with low mental age. The mental ages were assesed with the Bayley (1969) scales of infant development. Because coordinated attention becomes consolidated for normal infants between 12 to 14 months of age (Bakeman & Adamson, 1984), infants with a mental age below 12 months were included in the lower mental age group (n = 11, range = 6.0–11.0 months for infants with Down syndrome and n = 6, range 6.5–11.0 months for infants without Down syndrome), whereas those infants with an equivalent greater than or equal to 12 months were included in the higher mental age group (n = 11, range 12–20.5 months for infants with Down syndrome and n = 6, range 13–21.5 for infants without Down syndrome). Table 2 presents the mean mental and chronological ages for both cohorts within each group at the first and last visits.

Procedure

Comparable to the Bakeman and Adamson (1984) study, all infants were seen once every 2 months at home for a total of four visits. For each observation session, mothers were asked to invite one same-aged peer without Down syndrome and the peer's mother to play. In order to control for potential stranger or novelty effects, all peers and the peers' mothers must have had prior contact with the infants during the

TABLE 1
Demographic Information on Target Infants' and Peers' Families

	Infants with Down Syndrome		Infants without Down Syndrome	
	Low MA	**High MA**	**Low MA**	**High MA**
Target Infants				
Age range of Mothers[a])	26–37	28–47	28–37	27–36
Mean age of Mothers[a]	32.0	34.0	32.5	31.7
Mean Schooling for Mothers[a]	17.9	16.0	15.7	16.2
Age range of Fathers[a]	28–45	28–47	29–40	30–50
Mean age of Fathers[a]	34.5	34.2	34.3	38.3
Mean Schooling for Fathers[a]	16.0	16.5	15.8	17.0
SES range[b]	Lower Middle–Upper Middle	Lower Middle–Upper Middle	Lower–Upper Middle	Lower Middle–Upper Middle
Modal SES[b]	Middle	Middle	Middle	Middle
Peers				
Age range of Mothers[a]	27–43	25–38	26–36	29–38
Mean age of Mothers[a]	33.7	32.0	30.3	33.2
Mean Schooling for Mothers[a]	15.2	15.5	14.2	15.7
Age range of Fathers[a]	27–46	23–45	29–40	25–44
Mean age of Fathers[a]	35.5	32.5	32.3	35.2
Mean Schooling for Fathers[a]	15.2	15.8	14.8	16.7
SES range[b]	Lower Middle–Upper Middle	Lower Middle–Upper Middle	Lower–Upper Middle	Lower Middle–Upper Middle
Modal SES[b]	Middle	Middle	Middle	Middle

Note. MA = mental age; [a]In years; [b]In classes.

TABLE 2
Mean Development Age (in Months) for Infants With (DS) and Without (ND) Down Syndrome of Low and High MA Levels at the First and Final Visits

	Low MA Level		High MA Level	
	DS (*n* = 11) *M*(*SD*)	DS (*n* = 6) *M*(*SD*)	DS (*n* = 11) *M*(*SD*)	DS (*n* = 6) *M*(*SD*)
Visit 1				
Bayley MA	8.6 (1.7)	8.5 (1.8)	16.5 (2.9)	18.4 (3.9)
CA	17.3 (2.1)	8.1 (3.1)	22.6 (4.9)	17.6 (3.8)
Visit 4				
Bayley MA	13.2 (3.0)	15.6 (1.7)	19.2 (3.6)	23.5 (5.7)
CA	24.2 (2.9)	18.3 (2.6)	32.5 (3.8)	23.7 (6.1)

Note. MA = mental age; CA = chronolgical age.

month of testing. In all cases but one (in each group), the same peer and peer's mother attended every session.

Videotaping sessions took place in the home of the target child. The mothers of infants were told that we were interested in observing the ways that children with and without Down syndrome typically interact with people and objects. Filming was stopped when the infant became upset or tired, and resumed when the infant was in a pleasant state again.

Each session consisted of four conditions. Order of presentation of conditions was randomized within and between sessions to control for order effects. The fourth condition, in which infants played alone with toys, was not analyzed for the present purpose. Each condition lasted 5-min and was followed by a 3-min break between sessions. Breaks were included to prevent carry-over effects, and to allow time to change partners and to return all toys within the child's reach. In the mother condition, the target infants and their mothers were observed while playing on the floor with a set of toys provided by the experimenter. In the peer condition, the target infants and the peers were seated near the array of toys. In the female stranger condition, the peer's mother and the target infant played with the toys. Both mothers were asked to play with the children using the toys as they normally would when at home during free time.

Apparatus

Three sets of toys were used. Each set contained a toy telephone, a book, colored nesting cups, a doll, an animal on wheels, musical instruments, a jack-in-the-box, a rattle, a set of keys, and a puzzle. Sets varied only in the color of objects, the kind of animal, and the book included. Order of set presentation was randomized over sessions.

Filming was done with a portable Camcorder and took place in the room in which the infant commonly played. Infants were filmed so that both participants and focal objects were in full view, with the focus on the infant's face in order to show where the infant was looking.

Behavioral Categories

Coding of attentional behaviors followed a scheme developed by Bakeman and Adamson (1984). This scheme segregates infant attention into six distinct, mutually exclusive and exhaustive states that are defined by how the infant is involved with persons and/or objects. The attention states are ordered to reflect the theoretical progression from person or object attention, to the more mature attentional state where the two interact. As attention states are construed as periods of some duration only, attention that was maintained for 3 s or longer was coded. The states are as follows:

1. *Unengaged.* The infant is not involved with a person or object, but is awake and may be scanning the environment.
2. *Onlooking.* The infant is observing the actions of a person without participating.
3. *Person.* The infant interacts with a person, but objects are not involved in their activity (e.g., laughing, tickling, crying, reaching toward each other).
4. *Object.* The infant interacts with objects only; no attention is paid to people.
5. *Passive Joint.* The infant and a person are involved with the same object, but the infant does not acknowledge the presence of the other person.
6. *Coordinated.* Infants interact with objects and a person, and acknowledge the other person's presence by coordinating their attention between the two.

Coding Procedures

After each visit the master tapes were randomly transposed onto unlabeled copies using a VCR with an internal time generator. In this way, a clock was imposed directly onto the image to aid in determining length of sessions and behaviors. Attentional states were coded by hand on a second-by-second basis.

Interrater Reliability

To obtain reliability, four coders naive to the experimental hypotheses coded a random selection of 20% of the data. The experimenter coded the same data. Cohen's kappa coefficient was computed for each condition separately. Agreement was assessed on a second-by-second basis for all behaviors. This allowed for discrepancies in coding of both frequency and duration to be taken into account in one score. Kappa scores were used because they correct for chance. Training continued until kappa scores averaged at least .80 with each partner. For videotapes of infants with and without Down syndrome, kappa coefficients for all behaviors ranged from .80–.95 with the peer, .80–.93 with the mother, and .80–.84 with the peer's mother. This procedure was repeated after 50% of the data had been coded by the four coders. Again, agreement was high, kappas ranged from .80–.89 for all behaviors in all conditions.

Data Reduction

The frequencies and durations of each of the dependent variables (unengaged, onlooking, person, object, passive joint, and coordinated attention) were coded for each condition and visit. In order to account for slight variations in the length of the sessions due to the infant being distressed or occasionally being out of focus, the frequencies and durations were transformed into the proportion of time infants spent in each behavior (total duration of a state/total duration

TABLE 3
Mean Proportion of Time and Standard Deviation of Engagement States of Infants With (DS) and Without (ND) Syndrome as a Function of Mental Age, Visit, and Condition

	Low Mental Age Group				High Mental Age Group			
	Visit				Visit			
Condition	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Unengaged								
Peer DS								
M	13.8	17.7	22.3	19.9	10.2	4.6	20.9	19.1
SD	10.3	17.0	15.6	13.9	8.9	5.1	20.5	18.4
Peer ND								
M	28.7	24.2	13.1	7.3	13.6	9.0	6.2	5.8
SD	20.8	17.3	8.1	9.2	11.5	5.5	4.0	6.6
Mother DS								
M	6.8	3.4	5.3	10.9	3.2	2.7	4.6	3.9
SD	2.1	4.2	4.2	9.9	4.1	3.4	3.6	4.9
Mother ND								
M	19.1	1.9	6.6	2.6	5.4	9.1	1.3	2.8
SD	7.0	3.5	7.3	2.8	8.3	7.1	1.6	2.9
Peer Mother DS								
M	6.8	3.0	13.7	7.8	3.7	2.1	3.0	6.0
SD	7.4	3.1	11.6	7.3	5.0	3.0	4.0	5.7
Peer Mother ND								
M	9.9	2.8	6.6	3.7	4.1	8.9	2.9	3.2
SD	7.2	1.8	9.4	5.6	4.2	12.6	2.2	5.9
Onlooking								
Peer DS								
M	49.1	43.5	34.5	33.7	27.8	19.6	32.5	28.0
SD	27.6	26.8	20.2	21.6	22.7	9.7	25.7	19.7
Peer ND								
M	18.2	11.8	20.5	29.3	18.2	14.9	6.5	20.5
SD	22.4	8.9	15.2	17.6	22.4	7.3	4.0	10.9
Mother DS								
M	20.0	21.3	10.3	7.2	8.6	5.2	5.7	6.0
SD	21.2	18.2	10.1	6.5	8.0	4.3	5.0	4.6
Mother ND								
M	20.8	13.5	11.3	13.0	8.9	6.4	5.7	4.8
SD	13.7	13.7	7.6	8.5	8.4	2.2	5.8	4.4
Peer Mother DS								
M	32.7	33.7	23.7	10.3	8.1	7.6	9.2	7.9
SD	22.5	25.1	10.7	12.8	3.2	4.4	7.3	3.6
Peer Mother ND								
M	24.7	25.2	12.9	11.7	13.5	9.7	5.9	16.8
SD	13.8	15.0	4.7	9.3	8.2	7.9	5.0	19.6
Person								
Peer DS								
M	4.9	2.8	2.3	2.3	0.6	4.5	5.3	0.6
SD	2.1	2.5	2.2	3.7	1.4	2.9	2.7	2.0
Peer ND								
M	21.0	5.4	6.6	12.8	2.2	7.0	5.4	2.1
SD	31.3	4.5	3.6	14.5	3.1	8.2	4.2	2.6
Mother DS								
M	2.7	3.3	1.0	1.9	0.9	2.7	0.1	0.8
SD	2.1	3.6	1.5	1.1	1.9	2.7	.4	1.0
Mother ND								
M	3.5	1.2	1.0	3.8	0.0	1.3	2.3	1.2
SD	5.4	1.9	1.5	7.4	0	1.5	4.1	1.4
Peer Mother DS								
M	10.4	9.4	5.5	5.3	2.0	1.9	0.9	2.3
SD	8.2	9.3	4.7	2.3	2.3	1.1	1.3	2.5
Peer Mother ND								
M	6.8	4.1	3.8	2.8	4.3	2.4	3.2	1.8
SD	8.5	2.1	2.1	2.0	6.9	3.2	4.0	2.8
Object								
Peer DS								
M	28.0	32.6	37.1	32.4	47.2	56.8	30.4	42.4
SD	30.1	29.1	21.6	23.7	26.1	20.7	21.9	25.0
Peer ND								
M	29.7	50.2	53.8	49.7	50.7	54.6	66.8	56.3
SD	34.6	20.4	22.4	30.9	17.6	15.5	14.1	13.5
Mother DS								
M	26.7	15.9	18.2	18.7	10.8	12.3	14.3	16.5
SD	21.8	7.6	9.8	11.5	8.9	11.1	11.6	12.5
Mother ND								
M	38.5	37.5	33.6	43.1	42.3	16.1	27.7	23.6
SD	16.6	26.5	13.0	26.4	14.7	10.5	16.0	20.6
Peer Mother DS								
M	15.9	17.4	11.2	16.7	16.2	19.0	19.8	13.5
SD	13.1	10.5	12.7	13.8	13.1	15.3	16.8	13.9
Peer Mother ND								
M	31.3	34.8	25.4	31.6	32.6	15.7	40.6	38.0
SD	15.4	25.3	20.6	17.1	22.7	17.2	20.9	21.4
Passive Joint								
Peer DS								
M	3.7	3.4	2.2	11.4	8.0	9.5	4.7	8.2
SD	2.4	3.9	3.6	10.0	6.9	8.8	6.5	8.1
Peer ND								
M	2.6	0.4	1.7	3.7	11.0	11.4	11.8	8.3
SD	2.9	0.9	2.4	4.9	23.2	8.7	8.8	6.9
Mother DS								
M	40.0	49.0	57.3	54.1	62.0	61.0	58.0	48.2
SD	25.9	24.8	11.3	19.0	25.7	13.7	25.7	22.3
Mother ND								
M	14.4	42.3	34.5	33.9	36.4	62.3	22.1	15.5
SD	10.5	26.4	27.8	21.9	25.6	11.6	15.9	9.7
Peer Mother DS								
M	28.2	29.7	38.2	49.2	52.4	50.6	48.4	41.3
SD	19.1	20.0	21.0	24.5	32.2	30.4	21.7	22.7
Peer Mother ND								
M	20.2	30.3	37.4	45.7	39.3	52.1	18.2	8.0
SD	10.2	16.8	17.6	24.3	20.2	23.8	8.1	8.9
Coordinated								
Peer DS								
M	0.5	0.0	0.0	0.2	4.5	3.5	6.1	1.7
SD	1.7	0.0	0.0	0.8	3.5	4.0	3.4	3.2
Peer ND								
M	0.0	1.2	4.1	5.0	9.9	2.7	3.0	5.5
SD	0	3.1	4.8	4.0	18.0	5.5	7.3	9.1
Mother DS								
M	3.8	7.1	7.3	7.2	14.6	16.1	17.3	24.7
SD	3.4	4.5	9.7	7.3	15.4	13.5	17.5	18.3
Mother ND								
M	1.8	6.5	12.4	3.1	6.9	4.2	40.7	52.9
SD	4.6	10.6	17.4	4.8	10.9	5.2	20.8	30.3
Peer Mother DS								
M	5.8	6.4	7.5	10.6	17.7	18.6	18.1	28.9
SD	2.3	9.9	7.0	12.4	11.6	9.1	18.3	26.9
Peer Mother ND								
M	6.8	2.5	11.7	4.2	4.2	11.0	28.7	32.2
SD	8.1	6.3	10.1	5.1	3.8	12.9	26.6	28.5

of a session). Preliminary analyses showed that these categories occurred too infrequently to affect the derived proportions. Proportional percent of time was used in order to compare these results with those of Bakeman and Adamson (1984).

RESULTS

The average proportion of time spent in each behavioral state and the standard deviations for each group are presented in Table 3. To determine whether infants with and without Down syndrome would display reliably different responses to each partner with development, each proportion of an infant's behavior was submitted to repeated measures, multivariate analyses of variance (MANOVAs) with group (with, and without Down syndrome) and cohort (lower, higher mental age) as the between-subjects factors, and visits (1st, 2nd, 3rd, 4th) and condition (peer, mother, peer's mother) as the within-subjects factor. Because of the linear dependency among dependent measures in this mutually exclusive and exhaustive coding scheme, MANOVAs were conducted in two sets, one with onlooking, person, and object attention as dependent measures, and the other with passive joint and coordinated attention as dependent measures. The remaining dependent measure, unengaged, was submitted to a univariate repeated measures analysis of variance (ANOVAs). Interactions were analyzed by planned orthogonal contrasts. Post hoc simple effects analyses were conducted when necessary.

Prior to analyses, data distributions were examined for normality and homogeneity of variance. The assumptions were upheld.

Coordinated Attention

Mental age x group x visit x condition interaction, $F(6, 180) = 2.23, p < .038$ and planned comparison revealed that lower and higher mental age infants with Down syndrome displayed less coordinated attention than lower and higher mental age infants without Down syndrome, $F(1, 30) = 12.31, p < .001$. However, when playing with an adult, higher mental age infants from both groups displayed more coordinated attention than lower mental age infants without Down syndrome. In contrast, no developmental trend for either group was observed when they played with their peers. The infants without Down syndrome displayed more coordinated attention when they played with their mother than with the peer's mother, except at Visits 1 and 4 for the lower mental age group, when there was no difference, and at Visit 2 for the higher mental age group, when they displayed more coordinated attention with the peer's mother (see Figure 1).

Passive Joint

A group x condition interaction, $F(4, 27) = 5.54, p < .002$, revealed that infants with Down syndrome produced significantly more passive joint than those without Down syndrome when playing with the adults. However, there were no differences between the groups when the infants played with a peer, $F(1, 30) = 12.11, p < .002$.

There was also a significant mental age x visit x condition interaction, $F(12, 19) = 3.70, p < .005$. Differences occurred in the amount of passive joint that the two cohorts displayed across visits when playing with adults rather than peers, $F(1, 30) = 28.74, p <.001$. Simple effects showed that, whereas passive joint increased across visits for both groups of lower mental age infants when playing with their mothers; linear trend, $F(1, 32) = 6.06, p < .019$ and with the peer's mother, linear trend, $F(1, 32) = 11.86, p < .002$, it decreased in the higher mental age infants when playing with their mothers; linear trend $F(1, 32) = 10.02, p < .003$, and with the peer's mother; linear trend, $F(1, 32) = 9.51, p < .004$. These effects were not noted toward the peer (see Figure 2).

Object Attention

A significant main effect for condition, $F(6, 25) = 33.69, p < .000$, and orthogonal comparisons

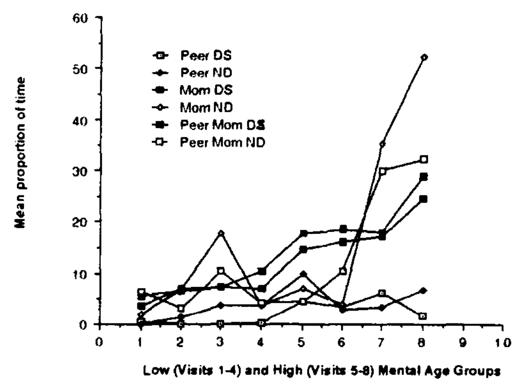

Figure 1. Mean proportion of time of coordinated attention as a function of mental age, group, visit, and condition.

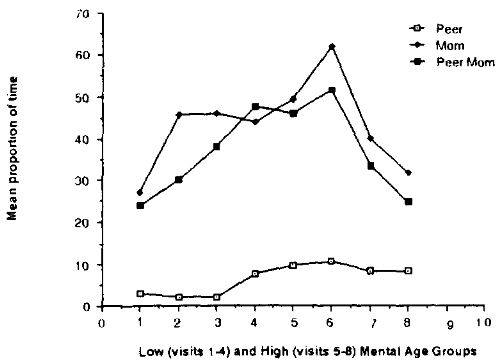

Figure 2. Mean proportion of time of passive joint attention as a function of mental age, visit, and condition.

revealed that significantly more object attention occurred when infants played with peers than with adults, $F(1, 30) = 46.54, p < .001$. A significant group x visit interaction, $F(9, 22) = 3.50, p < .008$, showed that infants with Down syndrome engaged in significantly less object attention than did infants without Down syndrome across all visits, except at the last visit, when both infants with and without Down syndrome produced the same amount of object attention (see Figure 3).

Person Attention

A mental age x visit x condition interaction, $F(18, 13) = 3.39, p < .015$, and planned comparison indicated that person attention declined over visits for the lower mental age infants when playing with the peer mother only; linear trend $F(1, 32) = 9.67, p < .004$. Lower mental age infants produced significantly more person engagement when playing with the peer's mother than when playing with their own mother, $F(1, 32) = 22.86, p < .001$.

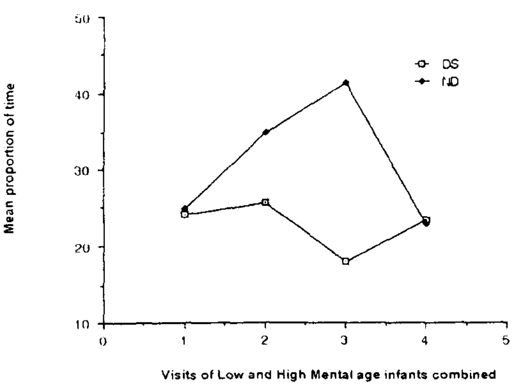

Figure 3. Mean proportion of time of object engagement as a function of group and visit.

Onlooking

A group x condition interaction, $F(6, 25) = 4.17, p < .005$, and planned contrasts revealed that infants with Down syndrome engaged significantly more in onlooking than infants without Down syndrome when they played with the peer than with the adults, $F(1, 30) = 10.53, p < .003$.

A significant mental age x visit interaction, $F(9, 22) = 3.05, p < .016$, indicated that infants in the lower mental age group decreased the amount of onlooking over visits, linear trend, $F(1, 30) = 10.53, p < .003$, whereas infants in the higher mental age group maintained a flat profile of onlooking over visits. In addition, infants in the higher mental age group maintained consistently lower levels of onlooking across visits than infants in the lower mental age group.

Unengaged

A main effect for mental age, $F(1, 30) = 6.05, p < .020$, indicated that lower mental age infants spent more time unengaged than higher mental age infants. A group x visit x condition interaction, $F(6,25) = 2.93, p < .026$, and planned comparison showed that both groups of infants spent significantly more time unengaged with the peer than with the adults, $F(1, 30) = 8.36, p < .007$. In addition, whereas infants without Down syndrome decreased their unengaged state with all partners, infants with Down syndrome showed a significant increase; linear trend, $F(1, 30) = 28.92, p < .00$ in unengaged states over visits, in particular, when playing with the peer.

Sequential Analyses

ANOVAs provide information about the amount of time infants spend in the various engagement states, whereas sequential analyses describe whether the engagement states are sequenced in any systematic way within each condition (e.g., Bakeman & Adamson, 1984; Legerstee, Corter, & Kienapple, 1990). Consequently, in order to find out whether the patterns of attention, in particular of passive and coordinated joint attention, were sequenced in any particular way with the person and object engagement states, episodes of passive and coordinated joint attention were submitted to sequential analyses following Bakeman and Adamson's design. To find out whether these sequences occur at a higher rate than would be expected by chance, z scores were calculated (Allison & Likert, 1982).

For the sequential analyses, the infants' attention states were pooled within each visit and condition. Because of insufficient data, the z scores of Visits 1 and 2, and of Visits 3 and 4 were pooled for each group, and each mental age level and their mean z scores were recorded under Visits 1 and 2 and Visits 3 and 4, respectively (see Tables 4 and 5). Sequences that did not produce enough z scores, such as those involving person, and passive joint coordinated, are not given in the tables.

The results confirmed the findings of Bakeman and Adamson (1984) that passive joint engagement was likely to be preceded or followed by object play. In this study, these sequences occurred in both groups of infants and throughout development when they played with the adults, but not when they were with the peers. Coordinated attention was also preceded by object play in both groups of infants (albeit less frequently than the passive/object transitions), and only when infants played with their mothers. However, in contrast to the results of Bakeman and Adamson, coordinated attention was followed only by object play during the final visit in infants without Down syndrome when they played with the adults. This transition did not occur in infants with Down syndrome.

TABLE 4
Transitions to Passive and Coordinated Joint Engagement

Antecedent–Consequent State	Infants with Down Syndrome				Infants without Down Syndrome			
	Low Mental Age Visit		High Mental Age Visit		Low Mental Age Visit		High Mental Age Visit	
	1 & 2	3 & 4	1 & 2	3 & 4	1 & 2	3 & 4	1 & 2	3 & 4
Unengaged–passive joint								
Mother	—	—	—	—	—	-2.88**	-1.3	-1.5
Peer	—	—	—	-1.1	—	—	-1.2	—
Peer Mother	-1.5	-1.6	—	—	—	—	—	—
Onlooking–passive joint								
Mother	2.8**	3.0***	—	2.8**	1.6	—	—	—
Peer	—	—	—	—	1.2	1.4	2.3**	2.8**
Peer Mother	2.1*	—	3.0***	—	—	—	—	—
Object–passive joint								
Mother	—	2.5*	2.5*	2.2*	3.4***	3.5***	2.0*	2.7**
Peer	—	—	—	—	—	—	1.4	—
Peer Mother	3.2**	1.3	—	2.7**	3.4***	2.1*	4.2***	3.3***
Unengaged–coordinated								
Mother	—	-1.1	—	-1.6	-2.0*	—	-1.4	—
Peer	—	—	—	-2.0*	—	—	—	—
Peer Mother	—	-1.0	—	—	—	—	2.0*	—
Onlooking–coordinated								
Mother	-1.1	-1.4	—	-1.1	—	—	—	—
Peer	—	—	—	—	—	—	—	—
Peer Mother	—	-1.2	—	—	—	—	—	-1.8
Object–coordinated								
Mother	—	2.2*	—	2.0*	—	2.1*	—	—
Peer	1.3	—	—	—	—	—	—	1.4
Peer Mother	—	—	—	1.1	—	—		

Note. Scores are z scores based on episodes pooled across subjects, within each visit and condition. Because of insufficient data, the z scores of Visits 1 and 2 and also of Visits 3 and 4 were pooled for each Group and each Mental Age level.
*$p<.05$; **$p<.01$; ***$p<.001$.

TABLE 5
Transitions from Passive and Coordinated Joint Engagement in Infants

Antecedent–Consequent State	Infants with Down Syndrome				Infants without Down Syndrome			
	Low Mental Age Visit		High Mental Age Visit		Low Mental Age Visit		High Mental Age Visit	
	1 & 2	3 & 4	1 & 2	3 & 4	1 & 2	3 & 4	1 & 2	3 & 4
Passive joint unengaged								
Mother	-1.3	—	—	—	—	-2.0*	—	-2.3*
Peer	—	—	-1.2	-1.1	—	-1.8	-1.2	-2.0*
Peer Mother	-1.1	-2.2*	—	-1.4	—	—	—	—
Passive joint onlooking								
Mother	-1.8	-2.5**	—	-1.7	—	-1.2	-1.2	—
Peer	—	—	—	—	-1.5	—	-1.6	3.2**
Peer Mother	—	—	—	—	—	—	—	—
Passive joint–object								
Mother	3.2**	4.3***	2.8**	3.4***	3.2**	2.6**	3.0**	3.0**
Peer	—	1.2	—	2.1*	—	2.0*	—	—
Peer Mother	5.5***	—	1.8	2.6**	2.1*	2.5	3.6***	3.0**
Coordinated–unengaged								
Mother	—	—		-1.1	-2.6*	1.0	—	—
Peer	1.2	—	2.5*	—	—	—	—	—
Peer Mother	—	—	—	—	—	—	-2.0*	—
Coordinated–onlooking								
Mother	—	-2.0*	—	—	—	—	—	—
Peer	—	—	—	1.1	—	—	—	—
Peer Mother	—	—	—	—	—	—	—	—
Coordinated–object								
Mother	—	—	—	—	1.7	—	—	2.8**
Peer	—	—	—	—				
Peer Mother	—	—	—	—	—	—	—	2.00*

Note. Scores are z scores based on episodes pooled across subjects, within each visit and condition. Because of insufficient data, the z scores of Visits 1 and 2 and also of Visits 3 and 4 were pooled for each Group and each Mental Age level.
*$p<.05$; **$p<.01$; ***$p<.001$.

The engagement state, onlooking, occurred before a period of passive joint engagement significantly more than was likely to occur by chance, but only when infants with Down syndrome played with the adults and when the infants without Down syndrome played with a peer. Like Bakeman and Adamson, we found that the person state did not systematically precede either passive or coordinated joint engagement, and that, at times, the sequence unengaged to and from passive was significantly less likely to occur than would be expected by chance.

In order to determine whether the significant sequences identified here changed as a function of mental age, group, visit, or condition, repeated measures ANOVAs were performed on the individual z scores. To save space, only the significant p values will be reported. The results showed a significant interaction for mental age x group x visit x condition ($p < .01$) for the transition from object to passive joint. This interaction revealed that this transition occurred more in infants without than with Down syndrome. When they occurred in infants with Down syndrome, it was primarily in the higher mental age group during the final visits. Overall, these transitions occurred more when both groups of infants played with the adults than with the peer. The transitions from passive joint to object attention showed a significant effect of condition ($p < .01$), indicating that the transition from passive joint to object occurred significantly more when infants played with adults than with the peer. The transitions from object play to coordinated attention showed a significant visit by condition interaction ($p < .05$). Overall, the infants produced these transitions more when they played with the mother than with the other partners at Visits 3 and 4 only. No significant effects were found for the transition from coordinated to object engagement state. The transition, onlooking to passive, showed a significant group x condition interaction ($p < .029$), revealing that this transition occurred more frequently when infants with Down syndrome played with adults, and when infants without Down syndrome played with peers.

DISCUSSION

This study examined the hypothesis that the ability to coordinate attention emerges from the interconnectivity of social and nonsocial domains under the guidance of competent communicators. Consequently, the development of attention was examined in infants when interacting with objects and social partners that were hypothesized to differ on communicative competence and familiarity.

The results showed that the ability to coordinate attention increased with development, whereas simple onlooking, passively sharing objects, and person play decreased in both groups of infants. Thus, infants developed from a phase where they were primarily person or object oriented to one where attention to people and objects interact in a nonverbal communicative exchange. For example, infants without Down syndrome increased time spent in coordinated attention from 3% to 30%, but they decreased the amount of time spent observing people from 10% to 1% and observing their activities (onlooking) from 21% to 14%. Other studies report that infants without Down syndrome begin to coordinate attention by the end of the 1st year of life (Sugarman-Bell, 1978) and to do so routinely by the middle of the 2nd year (Bakeman & Adamson, 1984). Similar patterns were found for infants with Down syndrome. They increased coordinated attention from 3% to 18%, but decreased attention to people from 6% to 1% and observed their activities (onlooking) from 33% to 14% over the duration of the study.

In addition to similarities, the display of attentional behaviors of the two groups of infants showed differences as well. Infants with Down syndrome produced less coordinated attention and progressed more slowly compared to infants without Down syndrome. They increased their ability to coordinate attention with their mother from 15% to 25% over 8 months, compared to 5% to 50% for infants without Down syndrome, with most of the increase occurring over the final two visits. Thus, for the infants with Down syndrome, the overall production of coordinated attention appeared less affected by the adult partner, which indicates infant-based constraints on the development of coordinated attention. These constraints appear related to impairment in the object domain. As predicted, infants with Down syndrome spent less time in object play (23.5% at the beginning and 24% at the end of the study) than infants without Down syndrome (33% vs 39%, respectively), and they spent less time coordinating their attention between people and objects (3.4% at the beginning of the study and 18.4% at the end) than infants without Down syndrome (2.8% vs 30.5%, respectively). Instead, infants with Down syndrome spent more time passively sharing attention to objects with adults (24% and 33%, respectively) than infants without Down syndrome (12% vs 10%, respectively). Not only did infants with Down syndrome function more as passive participants than infants without Down syndrome, but the transition that led both groups of infants into, and out of, passive play showed that these passive states are qualitatively different for the two groups. Overall, the transitions from object play to passive joint occurred less frequently in infants with Down syndrome than in infants without Down syndrome. Instead, onlooking often led to passive joint in infants with Down syndrome, but only when they played with their mother. It would seem that infants with Down syndrome became involved in objects because adults actively integrated objects into their play. When onlooking led to passive joint in infants without Down syndrome, it was in the peer condition only. This suggests, that infants without Down syndrome were more able to engage in unguided object play with others, and consequently, in activities that offer opportunities for referential communication. Landry and Chapieski (1989) also described infants with Down syndrome as relatively passive participants during play. In that study, the infants *observed* their mothers' attention-directing actions instead of *interacting* with her, and explored toys less often than the preterm infants.

Familiarity of the adult partner influenced the type of play the infants engaged in. When interacting with their mother, infants with Down syndrome shared in the interactions with the object (passive joint), but when interacting with the peer's mother, onlooking and person attention occurred more often. The sequential analyses concerning the transition from passive joint object play indicated that *after* passive joint, infants would engage in solitary object play at a rate higher than would be expected by chance. Thus, by introducing objects in play, mothers of infants with Down syndrome were motivating their infants to continue to perform an activity that they did not readily engage in when alone or when with a female acquaintance. Other studies have also pointed out that mothers of infants with Down syndrome offer more assistance and are more actively involved in play than mothers of infants without Down syndrome (Beeghly, Perry, & Cicchetti, 1989). However, even in such supportive environments, infants with Down syndrome still appeared to engage in less structured turn-taking, as is evident in our study by the low amount of coordinated attention infants with Down syndrome produced when with their mother compared to the infants without Down syndrome.

The adult partner's influence is most evident when examining the adult–peer differences. When both groups of infants played with peers, they displayed significantly less mature interaction states than when interacting with the adults. For example, they spent more time in unengaged, onlooking, person, or object states, and less time in a shared context, such as passive and coordinated attention. Bakeman and Adamson (1984) found similar behavioral differences between the adult–peer conditions in their infants. They suggested that adults are better able to support passive joint attention states, partly because adults appear more able and willing to structure the interaction: "they may provide predictably repeating patterns of actions as they interact with infants patterns that may have developmental roots in the person-focused games of earliest infancy" (p. 1287). Sequential analyses of the infant's pattern of attentional behavior also revealed that the interactions adults provide infants with are qualitatively different than those of the peer in both groups of infants, because more play episodes involving objects evolved into passive joint and coordinated attention when both groups of infants played with adults than with a peer.

In summary, this study replicates and extends the research by Bakeman and Adamson (1984). It showed that, with development, infants with and without Down syndrome displayed an increasing tendency to participate in coordinated attention; this serves to underscore the generality of Bakeman and Adamson's previous findings. In addition, our results indicated that children with Down syndrome displayed an attenuated tendency to engage in object play and also in coordinated attention relative to children without Down syndrome. The findings regarding object play and passive joint attention replicate previous findings by Landry and Chapieski (1989) and Krakow and Kopp (1983). This study provides new data concerning the *process* of coordinated attention in both typical and atypical populations. It appears that the development of the ability to coordinate attention relies on an integration of person and object domains and environmental factors. In particular, coordinated attention appears a product of a triadic structure. This socially constructed state, which has emerged from the interconnectivity of subsystems under the guidance of social partners, is now free to interconnect with other systems (e.g., linguistic) to form more complex structures that allow for the expression of more advanced behaviors, such as language. The infant's lack of attention to the nonsocial domain makes it more difficult for parents to encourage the exercise of coordinating attention in their infants. As a result, caretakers may not persuade the infant to pay attention to their *own* attentional focus and "thus the intended referent of their language" (Tomasello & Farrar, 1986). Therefore, the predictable referential context that makes both partners' gestures immediately meaningful fails to be established readily for the infant with Down syndrome. The low occurrence of such interactive episodes must make it more difficult for the infant with Down syndrome to establish the joint attention for communication and hence, interfere with the child's earliest language development.

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