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Dyadic Interaction Profiles in Infancy and Preschool Intelligence

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The present study reports the results of a 2-year longitudinal study of a sample of 23 mother–infant dyads observed during a free-play interaction session when infants were 6 and 8 months of age and then assessed for language and intellectual outcomes during the second and third years of life. Analyses of interaction variables during infancy showed developmental trends across these ages in which bouts of joint attention increased but the maternal role in the initiation and maintenance of such bouts decreased. A cluster analysis of the developmental patterns of the dyads' interaction variables divided the sample into two subgroups. One of the subgroups ($n = 17$) was characterized by the normative developmental trend described above and by high levels of joint attention at both ages. In a smaller second subgroup ($n = 6$), dyads were generally unsuccessful at attaining joint attention despite relatively high and consistent maternal initiation and attentional switching at both ages. Dyads in the first cluster showed significantly higher scores on the MacArthur Language Inventory at 24 months and on the Vineland Adaptive Behavior Scales and Weschler Primary Preschool Scale of Intelligence at 40 months. Differences between the clusters appeared to diverge more strongly at assessments administered later ages. © 2000 Society for the Study of School Psychology. Published by Elsevier Science Ltd

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It has become widely recognized over the last decade that the interactions infants have with their caregivers provide them with a rich source of opportunities for learning and general stimulation (e.g., Hart & Risley, 1992,

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1995). Although initial forays into the area of infant–caregiver interactions were motivated by hypotheses concerning socioemotional development, more recent work has focused on examining the influences of the interactive context on language and cognitive development.

Indeed, the literature on early interaction has successfully identified many important variables relevant to development in these domains. For example, Hart and Risley (1995) carefully documented the environment in which children acquire language, and showed that the amount of language stimulation is critical to the child's early lexical expansion. The evidence suggests that high levels of interaction and stimulation are correlated with early vocabulary growth. This early vocabulary in turn shows continuity with preschool intelligence and contributes significant variance to achievement in spoken language, reading, and spelling as late as the third grade (Walker, Greenwood, Hart, & Carta, 1994).

In addition to research showing the general stimulative effects of early interaction, various literatures on specific patterns of engagement within adult–infant interaction have burgeoned over the last two decades. Perhaps the best known of these involves the phenomenon of "joint attention" (e.g., Baldwin, 1995; Bakeman & Adamson, 1984; Saxon, 1997; Tomasello, 1992, 1995; Tomasello & Farrar, 1986; Tomasello & Todd, 1983). Here, investigators have consistently observed that the amount of coordinated attention in free play shown by infants and caregivers with regard to objects and events is strongly predictive of language development. For example, Tomasello and Todd and Tomasello and Farrar found positive correlations between joint attention and vocabulary acquisition. In a series of controlled studies, Dunham and colleagues corroborated these findings (e.g., Dunham & Dunham, 1992; Dunham, Dunham & Curwin, 1993; Dunham, Dunham, Tran, & Akhtar, 1991).

Logically speaking, dyadic joint attention can be attained in several ways. The caregiver may follow the infant's attentional cues and join with the infant's current focus on an object or event in an attempt to seize an opportunity for interaction or verbal stimulation; this strategy has been termed "attention following." On the other hand, the caregiver may attempt to influence the interaction more directly by attempting to elicit the infant's attention away from one object or event to another; this has been called "attention switching." Tomasello (1992) has posed the "attentional mapping hypothesis" to synthesize the various mechanisms underlying joint attention, maternal interaction styles, and language. This hypothesis maintains that attention switching requires the infant to shift attention to an intended object so that joint attention with the caregiver can occur. Such switching might place more of an attentional burden on the infant, and requires greater effort on the infant's part to engage in joint attention. Attention following, on the other hand, does not require a shift in the infant's attention because the infant is already attending to the object and thus, the likelihood of learning the object's label or some descriptive word is enhanced. Indeed, in support of this hypothesis, it has been noted recently that the maintenance of high levels of caregiver directives, initiation, and activity during interaction may not always be beneficial to the infant (Tomasello, 1992; Tomasello & Todd, 1983). This point has also been made within the context of the development and implementation of early interventions (Hoge & Parette, 1995; McCathren, Yoder, & Warren, 1995; Murray & Hornbaker, 1997).

Although this literature is empirically and theoretically consistent, it does present a thesis that somewhat contradicts the widely accepted notion that high levels of parental stimulation are beneficial to the development of infants and young children (e.g., Hart & Risley, 1995). This apparent paradox has been addressed in a recent series of publications on the topic of attention following and attention switching (Dunham & Dunham, 1992; Dunham et al., 1991, 1993; Pecheaux, Findji, & Ruel, 1992; Saxon, Frick, & Colombo, 1997). Essentially, this literature suggests that young infants (i.e., 6 months and younger) are generally more passive and less likely to initiate or lead interactions with their caregivers. As a result, they are more dependent on, and may benefit more from, caregivers who actively seek to switch the infant's attentional focus during interaction (Dunham & Dunham, 1995; Pecheaux et al., 1992). On the other hand, older infants (i.e., later in the first year and beyond) are generally less passive and are better able to "take the lead" during such interaction. As a result, older infants may benefit more from styles in which the caregiver follows the lead of the infant's attentional focus (Dunham & Dunham, 1992; Tomasello & Farrar, 1986). This scenario has received further recent support from research by Carpenter, Nagell, and Tomasello (1998), who have documented a clear developmental pattern in which infants move from sharing to following to directing others' attention and behavior in social (i.e., interactive) contexts.

If this scenario is accurate, then the manner in which parent–child interaction *changes* with the child's propensity for intiating social activity may be a more important indicant of language and intellectual outcome than parental interactional style at any one point or time. To our knowledge, this prediction has not been tested empirically. The current report documents a longitudinal follow-up of a sample of infants who were seen at 6 and 8 months of age with their mothers in a brief free-play interaction session. The subsample is part of a larger sample that participated in a short-term longitudinal study of the development and continuity of interactional styles and attention (Saxon et al., 1997). In that study, changes in maternal interactive styles observed across those ages corresponded well to the proposed scenario of directing (i.e., switching) to taking direction (i.e., following);

Table 1
Demographic Characteristics

	Longitudinal Sample (n = 23)		Not Participating in Follow-up (n = 42)	
Variable	Mean	*SD*	Mean	*SD*
Gestational age (weeks)	39.3	1.2	39.6	1.4
Birthweight (grams)	3429	387.8	3421	630.1
Maternal age (years)	32.7	3.9	31.9	4.0
Maternal education (years)	15.3	1.9	15.5	1.7
Number of siblings	1.0	0.9	1.0	1.2

mothers engaged in significantly less attentional switching with their infants at 8 months than at 6 months of age. Thus, given this normative developmental profile, we hypothesized that the cognitive and language outcome of infants might be optimal in dyads where such a profile was evident, but perhaps less optimal when it was not evident. Therefore, we reassessed this group on their language development at the mid- and end-points of the second year, and then performed a full assessment of intelligence and adaptive skills midway through the third year.

METHOD

Participants

The 23 mother–infant dyads participating in this study were part of a larger short-term longitudinal study on the relationship of early attention and interaction at 6 and 8 months of age. An original self-selected sample of 65 dyads were recruited by telephone and mail using county birth records from the greater Kansas City area (Saxon et al., 1997). Following that study, these 65 dyads were contacted again by mail and phone, and 23 infants (16 male, 7 female) and their mothers agreed to meet with us and provide long-term follow-up measures. These measures included data on the child's language development at 17 and 24 months of age (respective *SD*s for age at these assessments = 0.52 and 0.42 months), and returning for a full cognitive assessment at 40 months of age (SD = 0.72 months). Demographic characteristics for those dyads participating in the longitudinal sample are shown in Table 1, along with the same variables for those who chose not to return for the follow-up. There were no significant differences between the dyads who chose to return and those who chose not to return on any of the demographic variables measured (multivariate $F(5, 56) = 0.95$, *ns*).

Mother–Infant Interaction Sessions

The procedure for measuring mother–infant interaction (see Saxon et al., 1997) was modeled after Rocissano and Yatchmink (1983, 1984) and Tomasello and Todd (1983). The mother and infant were led to a quiet room containing a toddler's chair surrounded by a tray, a chair for the mother, and five toys.[1] A video camera was positioned on a tripod 2 m away from the seated dyad to afford a record of the direction of infants' visual attention toward mother and toys, as well as vocalizations between mother and infant. When mother and infant were seated, toys were placed randomly on the tray, and the mother was instructed to play and interact with her infant as she ordinarily would. The play session was videotaped for ten minutes.

Measures. The coding of behavior from the sessions is described in Saxon et al. (1997). Briefly, videotapes were analyzed using a microcomputer-driven VCR and software (VCRLink®) that allowed for frame-by-frame analyses and coding of interaction behaviors. Of the 10-minute sessions, one minute was allowed to elapse on the videotape before coding began. Behavior was coded on the next 7 minutes of interaction. During those 7 minutes, a number of different variables were coded that reflected the focus of interaction between mothers and infants, and the activity (or lack of same) in which mothers engaged to attempt to elicit or maintain joint attention with their child. The eight variables analyzed for the current study are delineated and described in Table 2. Interrater reliability was calculated on 15% of the total sessions from the original study, with Pearson product-moment reliabilities ranging from + .72 (for Maternal Attention Following) to + .95 (for Total Interactive Turns).

Longitudinal Follow-Up Measures

Language assessments (17 and 24 months). The MacArthur Communicative Development Inventory (MCDI; see Fenson et al., 1993, 1994) was administered at 17 and 24 months of age (respective *SD*s for age at these assessments equal .52 and .42 months) to measure the language competence of children. The MCDI is a parent-report measure that has been shown to yield highly reliable and valid scores of language competence for children ranging in age from 8 to 30 months. Internal consistency coefficients are well above .90 (for a thorough exposition of the psychometric properties of the MCDI, see Fenson et al., 1994).

Infant and toddler forms of the MCDI have been developed, and both have various subscales. The infant form (8 to 17 months) consists of two subscales: Verbal Comprehension and Verbal Production. The former is a checklist of words the parent believes the child understands, whereas the latter is a checklist of words the parent has heard the child say. A composite score is derived by summing these two subscales. The toddler form (18 to 30 months) also consists of several subscales, of which the primary subscale

[1]The following five toys were available during free play: Shelcore Clutch Ball (red), Playskool Baby-Ernie's Rubber Duckie (yellow), Mattel-Disney "Activities To Go–Kiddie Camera," Mattel-Disney "Bambi Rattle Ring," and Mattel-Disney "Baby Mickey All-Stars Sports Rattle" (orange).

Table 2
Definition of Variables From the Interaction Session

Variable	Definition
Total interactive turns	Total number of sequential opportunities for a shifting of the focus for interaction. Turns are defined by the occurrence of a pause of at least 1 s in which either of the partners may initiate or respond to a prior social cue. Social cues include vocal/nonvocal communicative gestures (words, pointing, nodding, or head shaking), other nonverbal vocalizations (whining, laughing), or gaze toward partner.
Mother-led joint attention	The frequency of joint-attention episodes (see Tomasello & Todd, 1983) that are initiated and maintained by the mother's active manipulation of the child's attention or behavior using social cues (see "turns" above).
Maternal attention switching	The arithmetic sum of the two following variables: *Maternal redirections:* The frequency of initial attempts by the mother to shift the infant's focus of attention. *Maternal sustained redirections:* The frequency of persistent maternal redirections (i.e., subsequent redirections that follow an initial unsuccessful attempt to shift the infant's focus of attention).
Maternal attention following	The frequency of occurrences of responses or bids by the mother to the focus of the child's attention. The mother's response is spontaneous and not solicited by any behavior of the child.
Maternal observing	Total amount of time within the session that the mother watches her infant play but makes no attempts to interact.
Joint-attention episodes	The frequency of episodes in which the mother and child are engaged in interaction with the same object, and where the infant attention shifts attention back and forth from mother to object.

is Verbal Production (i.e., a checklist of words the child can produce). The toddler form also provides a rudimentary measure of the longest sentences uttered by the child; the parent is asked to list the three longest sentences they have heard the child say. A mean sentence length is then calculated by averaging the number of words in the sentences. Therefore, in the present study, the 17-month measure included Verbal Comprehension, Verbal Production, and a composite score. At 24 months, the language measure included Verbal Production and mean sentence length.

Intelligence testing (40 months). The Weschler Preschool and Primary Scale of Intelligence–Revised (WPPSI-R; Weschler, 1989) was used to assess cognitive ability. The WPPSI-R assesses the general intelligence of children 36 months to 75 months of age. The WPPSI-R contains 12 subtests, 6 in the Performance Scale (often referred to as the "nonverbal" scale), and 6 in the Verbal Scale. Five of the six subtests in each scale are designated as the standard subtests (Sattler, 1992). Each toddler was administered the five standard subtests in each of the two scales. The subtests that comprise the standard Verbal Scale are Information, Comprehension, Arithmetic, Vocabulary, and Similarities, whereas the standard subtests on the Performance Scale include Object Assembly, Geometric Design, Block Design, and Picture Completion.

Two of the 23 subjects (both female) did not complete the entire WPPSI-R because of noncompliance or refusals during testing. Partial results on the WPPSI-R were not included in this study, and so results shown below involving the WPPSI-R reflect the data of only 21 participants. The WPPSI-R was administered at 40 months of age (SD = .72 months).

Adaptive behavior (40 months). At the same age that the WPPSI-R was administered, Vineland Adaptive Behavior Scales (VABS, Sparrow, Balla, & Cichetti, 1984) was used to assess the social competence of children. The VABS emphasizes measurement of adaptive behavior, which has been defined as "the ability to perform daily activities required for personal and social sufficiency" (Sattler, 1992, p. 384). The adaptive behavior scale consists of four domains (Communication, Daily Living Skills, Socialization, and Motor Skills). These measure skills ranging from self-care, to knowledge of phone number and street address, to the ability to make friends. The survey form (used by an interviewer with a respondent familiar with the behavior of the individual in question) contains 297 items and produces five standard scores (mean = 100, SD = 15): the four domain scores and the adaptive behavior score (which is an average of the four domain scores). In each case, the mother was interviewed.

Follow-up protocol. Participants were contacted by phone and mail and surveyed as to their interest in continued participation. Once so recruited, the MCDI was mailed to participants prior to infants' 17- and 24-month birthdays. Mothers completed the MCDI and returned it by mail. When children reached their 40-month birthdays, mothers agreed on a mutually convenient time during a 5-day span to schedule their child's visit to the laboratory where the child was assessed on the WPPSI-R and VABS. A psychologist trained on the WPPSI-R and VABS administered and scored the tests. Each protocol was checked for errors and reviewed by a second research associate blind to the purpose of the study. Parents were sent results in letter format with opportunities for discussion offered.

Table 3
Means (and Standard Deviations) for Interactional Variables at 6 and 8 Months of Age

Variable	6 months	8 months	$t(21)$	Test-retest r
Total interactive turns	58.0 (16.6)	56.0 (10.5)	0.58	0.35
Mother-led joint attention	5.0 (4.2)	2.9 (3.7)	2.11**	0.31
Maternal attention switching	19.6 (10.5)	14.7 (10.3)	2.22**	0.50**
Maternal redirections	15.7 (6.6)	12.7 (8.2)	1.79*	0.44**
Maternal sustained redirections	3.9 (4.8)	2.0 (2.9)	2.22**	0.53**
Maternal attention following	37.3 (12.7)	40.1 (9.8)	0.94	0.25
Maternal observing	53.4 (58.9)	56.4 (48.0)	0.23	0.32
Joint-attention episodes	12.4 (8.1)	16.2 (8.0)	1.93*	0.30

* $p < .10$.
** $p < .05$.

RESULTS

Interaction Variables at 6 and 8 Months of Age

Table 3 shows the means and standard deviations for interaction variables collected at 6 and 8 months of age and analyzed for this study. As is evident from Table 3, paired *t* tests across the ages indicated that significant or near-significant changes occurred for five different variables. The frequency of mother-led joint attention episodes significantly decreased, even though the total frequency of episodes of joint attention increased marginally ($t(21) = 1.93$, $p = .07$). In addition, the number of maternal redirections showed a decreasing trend ($t(21) = 1.79$, $p = .09$), and sustained maternal redirections decreased significantly. As might be expected, the frequency of maternal switching (the arithmetic sum of the two redirection variables) also decreased significantly. These results are consistent with patterns observed from the full sample as reported by Saxon et al. (1997). Saxon et al. showed a significant decrease in maternal switching, and an increasing trend for the frequency of joint attention was also evident.[2]

The general pattern shown in Table 3 is in agreement with results on the developmental pattern of mother–child interaction reported elsewhere. Essentially, several studies suggest that the young infant is a more passive participant in dyadic interaction and that, at earlier ages, the mother takes a more active role in initiating interchanges and presenting materials (Bakeman & Adamson, 1984; Pecheaux et al., 1992). Older infants, however, are

[2] It is worth noting that the pattern of change seen in this follow-up sample was also seen in the larger sample from which they were drawn. We entered the eight interaction variables listed in Table 3 in a mixed-design MANOVA that included factors of Age (2: 6 and 8 months) and Follow-Up Status (2: Participated vs. Did Not Participate in Follow-up). Neither the main effect for Follow-Up Status, $F(8, 54) = 0.846$, *ns*, nor the Age X Follow-Up Status, $F(8, 54) = 1.897$, *ns*, attained significance. Thus, this analysis suggests that (a) those dyads who participated in the follow-up were not significantly different from those who did not participate in the follow-up, and (b) both those who participated in the follow-up and those who did not had the same pattern of age-related change.

generally viewed as more active and initiating partners in such interaction and, as a result, such infants generally "drive" the interaction at these later ages. The data here fully conform with that pattern: Mothers were more active (higher maternal-led joint attention, higher levels of maternal redirection and persistent redirections) during the interaction session at 6 months of age than at 8 months, but at 8 months the overall frequency of joint attention was increased.

Cluster Analysis of Developmental Patterns of Interaction

As noted above, the results here are in general agreement with previously observed changes in mother–infant interaction during the first year. However, we hypothesized that some dyads within the longitudinal sample might deviate significantly from the "normal" pattern reflected in Table 3. Because of the relatively small size of the current longitudinal sample, sophisticated modeling techniques were not appropriate. However, we believed that a grouping algorithm to identify subgroups within the sample showing different developmental profiles of interaction might be instructive. Thus, those variables showing significant or near-significant changes across the 6- and 8-month interaction sessions were entered into a cluster analysis.

A cluster analysis is a descriptive statistical technique that seeks to determine the presence of subgroups within a sample (Green, 1990). Such subgroups are identified by a set of variables that are considered to be theoretically or empirically relevant to the question at hand. Distances between values on these variables are computed for each case and, through an iterative procedure, different cases within the database are joined in a series of steps until all cases have been grouped. Similarity or dissimilarity coefficients are generated at each step during this procedure, and it is possible to determine from these parameters, which of the steps provides more or less optimal fits or groupings. Because we had observed changes in the frequency of total joint attention, mother-led joint attention, redirections, and sustained redirections from 6 to 8 months of age, we entered these four variables[3] into the analysis to determine if there might be such subgroups within the present sample.

A number of different clustering algorithms are available. Based on the superiority of Ward's method (a minimum variance method; Ward, 1963) in detecting a priori clusters in a comparative analysis of the performance of various clustering logorithms (Milligan & Cooper, 1987; see also Green, 1990), we chose to use it for the present analysis. The similarity among cases was computed using squared Euclidean distances. The analysis

[3] Each of the four variables was measured twice (once at 6 months and once at 8 months). Therefore, the clustering was based on a total of eight variables.

Table 4
Mean Values (and Standard Deviations) of Interaction Variables for the Two Clusters

	Cluster A (n = 17)			Cluster B (n = 6)		
Variable	6 months	8 months	$t(16)$	6 months	8 months	$t(5)$
Mother-led joint attention	6.1 (4.4)	3.3 (4.1)	2.41*	1.8 (1.6)	2.0 (2.1)	0.95
Maternal redirections	15.8 (6.4)	12.1 (8.0)	1.93*	15.3 (8.0)	14.3 (9.3)	0.27
Maternal sustained redirections	3.8 (4.5)	1.5 (1.8)	2.28*	4.0 (6.1)	3.5 (4.6)	0.36
Joint-attention episodes	15.8 (6.5)	19.1 (7.1)	1.26	2.7 (1.2)	8.0 (3.6)	3.06**

* $p < .05$
** $p < .01$.

yielded a two-cluster solution for the sample of 23 infants in the present study.[4] One cluster (Cluster A) contained 17 subjects (74% of the longitudinal sample), and the other cluster (Cluster B) contained 6 subjects (26%).[5]

Once the cases were clustered, we examined the means of the interaction variables on which they were divided. The result of this analysis is presented in Table 4. Essentially, the larger group (Cluster A) shows significant and more robust forms of the developmental trends shown in Table 4. This group showed strong and significant decreases in the frequency of mother-led joint attention, redirection, and sustained redirection from 6 to 8 months of age. Interestingly, the total amount of joint interaction did not vary across these ages, although it is important to note that these dyads were at a relatively high level of joint attention even at 6 months of age.

The interactions of the smaller group (Cluster B) were very interesting as well. There was little or no change in maternal-led joint interaction,

[4]Along with a number of available clustering algorithms, there are a number of different criteria for determining the optimal number of clusters to be derived from an analysis (Milligan & Cooper, 1985, 1987). Two common criteria are the "stepsize" method and the "point-biserial" method (see Green, 1990). Both of these methods suggest that either two or three clusters provide a reasonable solution for the current data set. However, the stepsize method indicated that the two-cluster solution was optimal (respective stepsizes for the two- and three-cluster solution were 1228 and 906), and the point-biserial solution suggested some advantage for the three-cluster solution (the respective point-biserial coefficients were .34 and .55, both ps $< .001$). In the end, we settled on the two-cluster solution for two reasons. First, the three-cluster solution included a very small ($n = 3$) subgroup. Aside from questions about the validity of such a small group (Green, 1990), this group would have made for highly unbalanced sample sizes (14, 3, and 6) in subsequent ANOVAs. Second, we did examine the subsequent analyses with both the two- and three-cluster solutions and the final conclusions proffered remained essentially unchanged, irrespective of the solution employed.

[5]We attempted to validate this clustering outcome with the 42 infants who did not participate in the longitudinal follow-up. We repeated the clustering procedure used here with those dyads, and observed a similar pattern: Dyads with high levels of joint attention at both ages were associated with low levels of redirection and a large drop in sustained redirection from 6 to 8 months.

Table 5
Means and Standard Deviations for Outcome Variables

Outcome Instrument	Subscale	Mean	*SD*
MCDI (17 months)	Verbal comprehension	216.7	82.3
	Verbal production	50.7	43.2
	Composite score	333.2	123.4
MCDI (24 months)	Verbal production	334.8	163.8
	Mean sentence length	3.9	2.2
VABS (40 months)	Communication	101.7	7.6
	Daily living	95.8	15.2
	Socialization	101.4	14.6
	Motor skills	86.3	12.9
	Adaptive behavior	95.0	14.0
WPPSI-R (40 months)	Performance	104.3	15.4
	Verbal	100.4	13.9
	Full	102.6	14.9

Note. MCDI = MacArthur Communicative Development Inventory; VABS = Vineland Adaptive Behavior Scales; WPPSI-R = Weschler Preschool and Primary Scale of Intelligence–Revised.

which was relatively low at 6 months and remained so at 8 months. Similarly, both maternal redirection and sustained redirection remained at elevated levels from 6 to 8 months, relative to Cluster A. The total amount of joint attention did increase significantly for this cluster. However, this increase must be viewed in light of the fact that the frequency of joint attention at 6 months was relatively low; even with a threefold increase at 8 months, the level was still well below the frequency of joint attention observed in Cluster A at 6 months. Thus, this cluster profile indicates a small group of dyads in which mothers continue to be active in trying to initiate interactions at both 6 and 8 months. Although these dyads achieve an increase in joint attention from 6 to 8 months, they are relatively unsuccessful at attaining joint attention at either age.

Relation of Cluster Membership to Outcome Variables

Means and standard deviations for all of the outcome variables are presented in Table 5. The final analysis examined whether cluster membership was associated with performance on the outcome measures of this study. To do this, the two clusters were used as grouping variables to analyze differences in outcome variables (17- and 24-month MCDI variables and 40-month WPPSI-R and VABS scores). Differences between the clusters were examined with independent-sample t tests.

Cluster membership predicted significant differences on several of the outcomes. These are presented in Table 6. Toddlers from Cluster A generally showed higher scores on all measures compared to toddlers from Cluster B. In most cases, the differences between the clusters on the outcome

Table 6
Outcome Means (and Standard Deviations) as a Function of Interaction Cluster Membership

		Cluster		
Outcome Measure	Subscale	A	B	t test
MCDI (17 months)	Verbal comprehension	229.4 (88.9)	181.0 (49.0)	$t(21) = 1.25$
	Verbal production	60.1 (46.5)	23.8 (10.5)	$t(21) = 1.89$
	Composite score	358.1 (130.6)	262.5 (60.2)	$t(21) = 1.70$
MCDI (24 months)	Verbal production	384.6 (168.8)	232.0 (78.9)	$t(21) = 2.11$*
	Mean sentence length	4.5 (2.0)	2.2 (1.7)	$t(21) = 2.55$**
VABS (40 months)	Communication	104.2 (6.3)	94.5 (6.5)	$t(21) = 3.24$**
	Daily living	99.0 (14.4)	86.7 (14.6)	$t(21) = 1.80$
	Socialization	102.8 (16.5)	97.3 (6.1)	$t(21) = 0.79$
	Motor skills	89.8 (12.9)	76.3 (6.5)	$t(21) = 2.43$*
	Adaptive behavior	98.6 (14.3)	84.7 (6.4)	$t(21) = 2.29$*
WPPSI-R (40 months)	Performance	109.3 (12.8)	88.4 (12.2)	$t(19) = 3.20$**
	Verbal	104.6 (12.0)	86.8 (11.5)	$t(19) = 2.93$**
	Full	107.6 (11.9)	86.6 (12.4)	$t(19) = 3.40$**

Note. MCDI = MacArthur Communicative Development Inventory; VABS = Vineland Adaptive Behavior Scales; WPPSI-R = Weschler Preschool and Primary Scale of Intelligence–Revised.
* $p < .05$.
** $p < .01$.

measures were statistically significant. On the WPPSI-R, toddlers in Cluster A scored significantly above average (score of 100) on the Performance and Full scale scores, $t(15) = 2.88$ and 2.54, respectively, both $ps < .05$. Toddlers in Cluster B were not significantly below average on the WPPSI-R scale scores, although tests of the Full scale and each of the subscales against 100 approached significance (Performance, $p = .10$; Verbal, $p = .06$; Full, $p = .07$).

It is noteworthy that the differences between the clusters seem to widen as the children get older. For example, at 17 months, the clusters differ only marginally on one subscale (Production) of the MCDI. However, by 24 months, they diverge significantly on both the Production subscale and mean sentence length. By 40 months, significant differences were seen on Verbal, Performance, and Full scale WPPSI-R scores, and on three of the subscales of the VABS (Communication, Motor skills, and Adaptive Behavior). It is possible that the apparent divergence of the two clusters reflects differences in the properties of the different assessments administered at the various follow-up ages. However, it is also possible that the differences in early interaction represent a cumulative or "sleeper" effect of early interaction over time.[6] Indeed an age-related increase in the effect associated with early interaction variables has been reported previously by Baumwell, Tamis-LeMonda, and Bornstein (1997).

With perhaps the exception of the VABS Motor subscale and the WPPSI-R Performance scale, it appears that the outcome variables that show differences between these two clusters are loaded heavily toward language development. This finding is in keeping with other research showing the importance of early interaction and joint attention for language skills later in life.[7]

DISCUSSION

We can summarize the findings of the present study as follows. First, in the sample of mother–infant dyads followed longitudinally here, we were able

[6] A direct test of the divergence of the two clusters would require a repeated measures ANOVA or MANOVA. Except for one outcome measure, we did not use the same assessment (or same version of the same test) at more than one of the follow-up ages, and so only one such direct test was possible. This was performed on the language production subscales on the MCDI, which were measured at 17 and at 24 months of age. The Age (2: 17/24 months) × Cluster (2) mixed-design ANOVA yielded a significant two-way interaction, $F(1, 21) = 4.232$, $p = .05$. Interpretation of this analysis might be tempered by the fact that *SD*s were very different for both clusters at each of these time points. However, the outcome suggests that the clusters did significantly diverge with age.

[7] Although we did not take extensive data on socioeconomic status, we did assess the level of maternal education, and it did not vary significantly as a function of cluster membership. Furthermore, our findings remain unchanged when maternal education was covaried in the analyses. Thus, although we cannot definitively rule out the influence of more general social factors, the few analyses we ran did not provide evidence in favor of such influence.

to document developmental trends in the nature of interaction across a relatively brief age span at the middle of the first year of life. Even though these changes are observed here with a relatively small sample, the trends fit well with what has been observed in other work (e.g., Carpenter et al., 1998) showing a shift away from maternally-initiated and -led joint attention as infants get older. Second, we found that the sample could be parsed into two subgroups that showed different patterns of change in interaction from 6 to 8 months. One group displayed a pattern of decreased maternal switching and high levels of joint attention across both ages, whereas another group showed generally low levels of joint attention in the context of continuing maternal switching across the two ages. Third, mean cognitive and language outcome was significantly more optimal for dyads in the former cluster than for those in the latter cluster. Finally, in agreement with at least one other previous report on the predictive validity of early interaction (Baumwell et al., 1997) the differences between the clusters appeared to widen with age.

The data here provide further support for several existing tenets in the early interaction literature. First, they collaborate previously reported findings concerning the correlation between high levels of joint attention and positive cognitive, adaptive, and language outcomes. Second, they provide partial validation for a proposed developmental sequence of attentional direction during interaction in infancy, in which caregivers take an active "lead" in interactions with very young infants, but then allow the infant to initiate interactive bouts as the infant becomes increasingly able to do so (Carpenter et al., 1998; Dunham & Dunham, 1995). Third and finally, the findings serve as another reminder to us that what occurs during even the early parts of the first year of life are potentially important as indicators of the intellectual/adaptive development that will be manifest in later childhood.

Beyond these points, the data make some novel contributions in their own right. Most important, they raise the intriguing possibility that the developmental pattern of interaction itself may be an important signal or marker in the prediction of language and cognitive abilities during the preschool period. The data here suggest that infants from dyads who were less successful at attaining joint attention, despite the continuity and persistence of maternal switching, showed less optimal cognitive and language outcomes during the second and third years of life. The current data do not allow us to detemmine whether the difficulty to attain joint attention in some mother–infant dyads was attributable to some attentional or interactional characteristics of one or the other member of the dyad (e.g., whether the infant could not sustain attention or whether the mother was, in some way, too intrusive to recruit the infant's attention) or perhaps to some dynamic interaction between the two members of the dyad. Such a question would necessarily require further research, preferably with a larger sample (see below) and more sophisticated analytic techniques than the current data set would allow.

With the discussion of the findings and their implications aside, there are some important and obvious limitations to the present study that deserve mention. First, these findings are based on a very brief sample (10 minutes, of which 7 minutes were actually coded) of mother–infant free play. Second, because of the small sample size, we think that assumptions about the generality of the findings should be appropriately tempered. Third, despite the obvious strengths of the longitudinal approach and the detail of behavioral assessment involved, the fact remains that this is essentially a correlational study, and we have not measured or controlled for many factors that might qualify these conclusions. The current findings do not definitively demonstrate that such early interaction patterns (or that developmental profiles of such early interaction patterns) *cause* good language/cognitive outcomes; indeed, it remains an open question as to whether the large differences between these clusters on the outcome measures are attributable to differences in early dyadic patterns of interaction alone. It is possible that the correlation we have observed here between early interaction patterns and later outcome is attributable to some third variable, such as genetic influence, or perhaps the parent's concurrent (rather than early) interaction patterns, or perhaps even some general level of maternal sensitivity. However, we would point out that research on early intervention that models exactly this sequence of interactive patterns with infants and toddlers (e.g., Hoge & Parette, 1995; McCathren et al., 1995; Murray & Hornbaker, 1997) has been found to be effective in increasing early language. For that reason, it seems likely that early interactive patterns have an important role in influencing later cognitive, intellectual, and language development and certain adaptive skills. Finally, given the use of cluster analysis with such a small sample, these results must be regarded as an initial exploratory foray, rather than a definitive statement about the importance of analyzing developmental patterns of interaction.

In any case, however, the findings do suggest that educators interested in early experience or measurement may well find many indicants (or possibly determinants) of school-age cognitive, intellectual, and language function in infancy and early childhood. The results of the present study suggest that an optimal developmental profile of dyadic interaction as early as 6 to 8 months of age is correlated with positive adaptive, language, and intellectual outcomes in preschool-age children. The transition of control within dyadic interactions from mother (when the infant is young) to the infant (when the infant is older) may provide a richer context for learning words and other important cognitive skills. This type of information may help school professionals design effective strategies for early intervention and infant stimulation programs. Legislation has been developed to provide comprehensive early intervention services for infants and toddlers with disabilities (Education for the Handicapped Act Amendments, 1986). As such, it seems essential to us that the development and implementation of such services should be guided by empirical knowledge about strategies that may be effective and successful in promoting optimal language and cognitive outcomes. We believe that the pursuit of future work that extends this knowledge and evaluates its effectiveness will be advantageous.

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