Antecedents of Exploratory Competence at One Year

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The start of the 2nd year is a period of transition and substantial variability among toddlers in play and attention abilities. This longitudinal study examined the antecedents of variation among 13-month-old toddlers in these exploratory competencies in the infants' own information-processing abilities at 5 months (indexed by visual fixation in the laboratory), the infants' vocal and exploratory activities at 5 months (measured during naturalistic observation in the home), mothers' stimulation of infants at 5 months, and mothers' IQ. Infant visual fixation and maternal IQ predicted toddler symbolic play; furthermore, infant visual fixation, infant activity, and maternal IQ predicted toddler attention span. In contrast, mothers' early stimulation did not predict play or attention in toddlers. Structural equation modeling was used to assess prediction of the three significant antecedents (infant visual fixation, infant activity, and maternal IQ) to toddlers' exploratory competence, a latent variable representing the shared variance between play and attention. Together, the three predictors accounted for 50% of the variance in toddler exploratory competence. These data broaden the scope of infant and mother prediction beyond toddler verbal-representational abilities to encompass domains of toddler exploration.

At the start of the 2nd year, play and attention go through marked transitions as children become increasingly capable of representing experiences of self and others in symbolic play (Fein, 1981; McCall, 1979; O'Connell & Bretherton, 1984; Piaget, 1962) and of regulating and sustaining attention (Bakeman & Adamson, 1984; Harding & Golinkoff, 1979; Kopp, 1987; Krakow, Kopp, & Vaughn, 1981; Ruff & Lawson, 1990; Tamis-LeMonda & Bornstein, 1990). Children vary considerably in their play and attention competencies at this

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In prior research, we isolated a factor in 13-month-olds’ play and attention called exploratory competence, a latent construct consisting of the unique variance shared by children’s play and attention (Tamis-LeMonda & Bornstein, 1990). In this follow-up study, we explored antecedents of toddlers’ exploratory competence. Specifically, we examined the contributions of infant information processing and home activity earlier in infancy, and maternal stimulation and IQ to these toddler competencies. Do these factors (alone or together) predict toddlers’ play sophistication, attention span, and exploratory competence? We assessed infant visual fixation because laboratory measures of infant attention have been shown to be valid predictors of childhood verbal ability and performance on standardized intelligence tests (see Bornstein & Sigman, 1986, for review). We also studied infants’ home activities based on findings that infant visual and tactual exploration and positive vocalization predict later verbal and intellectual performance (e.g., Bornstein, 1985; Cameron, Livson, & Bayley, 1967; DiLalla et al., 1990; Olson, Bayles, & Bates, 1986; Roc, McIver, & Roc, 1983). For mothers, we assessed encouragement of infant attention towards aspects of the environment; maternal didactics have been shown to possess substantive predictive validity for concurrent and future cognitive and social achievements of children (see Belsky et al., 1980; Olson, Bates, & Bayles, 1984). Finally, we collected data on mothers’ IQ because parental intelligence is associated with cognitive skills in infancy and early childhood; moreover, these associations maintain even after controlling for parental stimulation and other aspects of the home environment (DeFries, Plomin, Vandenberg, & Kuse, 1981; Hardy-Brown & Plomin, 1985; Longstreth et al., 1981; Plomin, 1987; Thompson, 1990; Thompson & Plomin, 1988).

To date, studies that have assessed relations between infant visual fixation, infant activity, maternal stimulation, and/or maternal IQ and childhood outcome have typically focused on children’s verbal aptitudes or standardized IQ performance rather than their exploratory competencies. Moreover, the majority of studies typically assess the predictive validity of single measures in infant or in mother to child functioning rather than considering factors in both partners as contributors to later competencies. This study takes a first step toward investigating multiple antecedents of toddlers’ exploratory skills.
**METHOD**

**Sample**

Thirty-nine mothers and infants (19 males, 20 females), recruited from private pediatric and obstetric groups in New York City, participated in this longitudinal study. All infants were term at birth ($M$ weight = 3.35 kg, $SD$ = 0.51; $M$ length = 50.8 cm, $SD$ = 2.93) and healthy throughout the course of the study. Infants came from middle socioeconomic (SES) status households ($M$ = 60, $SD$ = 4.96, on the Hollingshead Four Factor Index [Department of Sociology, Yale University, New Haven, CT]; Gottfried, 1985).

Dyads were seen twice at 5 months of age ($M$ = 161 days, $SD$ = 9.72, at the time of the laboratory assessment; $M$ = 162 days, $SD$ = 8.90, at the time of the home observation); half of the sample was first seen in the laboratory and half, first visited at home. Dyads were visited again at home at 13 months ($M$ = 401 days, $SD$ = 4.36). At the time of the 5-month observation, mothers completed a brief questionnaire that supplied demographic data and information about their infants’ health status from birth, their educational histories, and so forth. Administration of the Wechsler Adult Intelligence Scale–Revised (WAIS–R; Wechsler, 1981) was completed on a third separate home visit.

Ten additional subjects who had been seen at 5 months were excluded from the final sample: 3 infants did not habituate; 1 was an extreme on both univariate and bivariate plots involving visual fixation (Tukey, 1977); and 6 moved out of state before completion of the study.

**5-Month Laboratory Observation**

*Setting.* To obtain data on visual fixation, the infant was placed in a standard infant seat approximately 60 cm from a matte white stimulus screen measuring approximately $45 \times 90$ cm. A dim signal lamp, 7 mm in diameter, was centrally embedded in the panel 3.5 cm above the infant's eye level. The rest of the infant area was enclosed by white curtaining. A projector (located in an adjacent control room) cast images of stimulus slides onto the screen through a window located behind the infant. The infant’s upper torso and the projector light were televised with a camera whose lens was located in a 1.3-cm hole in the stimulus panel at the infant’s eye level. The video signal was displayed on two monitors, one for experimenters and one for mothers; this signal was also video recorded for subsequent scoring and analysis.

*Procedures.* Sessions began when the infant was in an alert state. Before each stimulus presentation, the infant’s attention was drawn to the center of the stimulus panel by the signal lamp. Once the infant was oriented, a 10-s pretest stimulus (a three-ring bull’s-eye) was projected. Next, an affectively
neutral female face (Bornstein & Benasich, 1986) was presented using an infant-control habituation paradigm. Immediately following habituation, infants were tested over four 10-s trials in which the familiar stimulus and a novel stimulus (a red and black 4.5-cycle/degree square-wave grating) were each presented twice, sequentially, and in a randomized counterbalanced order. Following the test phase, infants saw a 10-s posttest with the same stimulus used in the pretest.

On-line judgments of infant looking were made by an experimenter who observed the infant on one monitor and initiated and terminated stimulus presentation. A second experimenter judged infant looking on-line independently, preserving these judgments by pressing buttons on a remote unit that fed directly into the timer and memory of the microprocessor. The infant began to accumulate looking time when judged to look at the stimulus for a minimum of .30 s. To terminate a trial, the infant had to look away from the stimulus for 1.5 s. A single “look” with these parameters defined a trial. The mean duration of the infant’s first two looks constituted a baseline, and stimulus presentations continued until the infant reached a habituation criterion of two consecutive looks each less than 50% of that baseline.

Scoring. The duration of the infant’s peak look (in seconds) during the habituation session served as the principal measure of visual fixation; peak look is reliable and stable, and covaries with measures of habituation, such as decrement and slope (Colombo, Mitchell, O’Brien, & Horowitz, 1987). Duration measures such as peak look, are also consistently valid predictors of later intellectual functioning (e.g., Bornstein, 1989; Sigman, Cohen, Beckwith, & Parmelee, 1986; Slater, Cooper, Rose, & Perry, 1985; Tamis-LeMonda & Bornstein, 1989). Scoring reliability for fixation data was established with a second independent coder; Pearson reliabilities (r) on looking times for nearly half the sample averaged .95.

5-Month Home Observation
Home visits allowed mothers and infants to be observed in surroundings familiar to them. Visits were scheduled during times when infants were rested and alert. Mothers were asked to follow their usual routine and to disregard the observer’s presence insofar as possible. The observation period lasted a minimum of 55 min; the first 10 min constituted a warm-up and were not used in data analysis. The succeeding 45 min of observation were scored on-line using 60-s intervals in which 30 s of observation were followed by 30 s of recording.

Infant Activity. At the initiation of each 30-s observation interval the observer noted the infant’s state (adapted from Brazelton, 1973). Infants were judged to be in states of quiet or active alert in 94% of intervals across the visits. During coding intervals, observers noted whether or not the infant
engaged in each of four target activities: vocalizing nondistress, looking at mother, looking at an object, or touching an object. One comprehensive index of infant activity was derived by tallying the number of intervals in which infants exhibited one or more of these four activities. Coding reliability was established with a second coder, who independently coded approximately 15% of the visits. Kappa agreement for infant state based on matched coding intervals averaged .75; kappa agreement for infant activity averaged .64.

**Mother Object Stimulation.** During coding intervals, observers recorded whether mothers encouraged infant attention towards an aspect of the environment. Mothers could do this by demonstrating how something worked, pointing, naming an object, describing the unique qualities of an object, or positioning the infant with the explicit purpose of facilitating the infant’s visual and/or tactual exploration of an object. A comprehensive index of maternal stimulation was obtained by tallying the number of intervals in which mothers encouraged infants’ attention. This measure has been shown to be a reliable and valid predictor of infant and toddler abilities across samples and cultures (e.g., Bornstein, Azuma, Tamis-LeMonda, & Ogino, 1990; Bornstein, Miyake, & Tamis-LeMonda, 1985–1986; Bornstein, Toda, Azuma, Tamis-LeMonda, & Ogino, 1990; Sigman et al., 1986; Vibbert & Bornstein, 1989). Kappa agreement for maternal stimulation, calculated on 15% of the sample, across matched intervals, averaged .62.

**13-Month Home Observation**

Data on toddler play competence and attention and on mother play stimulation at 13 months were collected during a home visit at a time when the mother felt her toddler would be alert and rested. The home visit consisted of a videotaped session of toddler and mother engaging in 15 min of free play. Mothers were told that the experimenter was interested in general aspects of children’s development and that she was to remain with her toddler, behave in her usual manner, and disregard the experimenter’s presence. A set of toys (doll, blanket, teapot with cover, two teacups, two saucers, two spoons, a toy telephone, toy vehicle, two small picture books, foam rubber ball, and a set of nesting barrels) was placed on the floor in front of toddler and mother. All videotaped sessions had time simultaneously recorded to the nearest 0.1 s for subsequent scorings.

Children’s play competence and attention and mothers’ play stimulation were coded from the videotaped play session. Play, attention, and maternal stimulation were each coded by a different person, so that coders were blind to the nature of the other data sets.

**Toddler Play Competence.** During 60 consecutive 15-s intervals, the coder noted which of four levels of symbolic play the child achieved (Belsky &
Most, 1981; Fein, 1981; Fein & Apfel, 1979; McCune-Nicolich, 1981). Briefly, the four levels were defined as (1) self-directed pretense (e.g., drinking from a teacup), (2) other-directed pretense (e.g., putting doll to sleep), (3) sequential pretense (e.g., stirring in cup and drinking), and (4) substitution pretense (e.g., pretending block is a spoon). On the basis of children's performance, one comprehensive measure of toddler's total symbolic play was calculated by summing the frequencies obtained for each of the four levels of play. Intercoder reliabilities for toddler play were obtained by having independent coders score toddler play on 20% of the sample; kappa agreement for the four levels of play averaged .82.

**Toddler Attention Span.** Each child's visual orienting during the play session was divided into attention episodes. An attention episode was defined as visual orientation to a target play object or related set of objects (e.g., doll and blanket) lasting a minimum of 2 s. The episode terminated when the infant turned away from the target for more than 2 s. The onset and offset of each episode was rounded to the nearest second based on the prerecorded time signal appearing on the videotapes. For each child, the mean length of the two longest episodes of uninterrupted attention was calculated. This index of attention was selected because it is conceptually analogous to the infant measure of peak look during habituation and has been found to be a valid and reliable index of attention during the 2nd year (Power et al., 1985; Tamis-LeMonda & Bornstein, 1990). Interobserver reliabilities for attention span were obtained by having three independent coders score the attention of 20% of the toddlers; Pearson reliabilities calculated for time data averaged .87.

**Mother Play Stimulation.** Mothers' play stimulation was coded during the same 15-s contiguous time blocks as children's play. During each interval, the experimenter noted whether mother actively attempted to engage her toddler in play, for example, by demonstrating a play action or by soliciting play from her toddler. We focused on mothers' play stimulation because this measure demonstrates substantial variability, is reliable, possesses validity for children's play during the 2nd year in diverse populations, and is a stable dimension of parenting across the 2nd year (Tamis-LeMonda & Bornstein, 1989, 1990, 1991, 1993; Tamis-LeMonda, Bornstein, Cyphers, Toda, & Ogino, 1992). One composite measure of maternal play stimulation was generated by tallying the number of coding intervals in which mothers exhibited stimulation. Interobserver reliabilities for maternal stimulation were obtained by having three independent observers code 23% of the sample; kappa agreement for maternal play stimulation averaged .86.

**Maternal IQ**
Mothers' IQ scores were assessed during a third home visit. Two experimenters attended the visit: One administered four subscales of the WAIS–R
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(Wechsler, 1981) to mothers, while the second occupied the child in a room separate from the testing setting. Two subscales were administered from the verbal portion (Information and Vocabulary) and two from the performance portion (Picture Completion and Block Design). These subscales were chosen because they demonstrate the strongest associations to total verbal score, total performance score, and full scale IQ in the representative population ($r = .77-.90$). Testing time averaged 45 min.

Six of the 39 mothers were not administered the WAIS-R: 1 mother refused; 2 were familiar with the test; and 3 could not be visited a third time. To maintain the integrity of the longitudinal design, we included these subjects in analyses by assigning them the mean WAIS-R score for the group (see Cohen & Cohen, 1983). Two precautions were taken with respect to this decision. First, we compared these subjects to the remaining 33 on all the variables measured; they did not differ statistically in any way. Second, we conducted all analyses with the 33 subjects first and compared results with the complete sample; results were essentially identical.

RESULTS

Descriptive statistics and concurrent correlations for the 5- and 13-month variables are reported first. We next assess prediction from infants’ visual fixation and activity to toddlers’ 13-month play, attention, and exploratory competence (a latent variable formed from the variance shared by toddler play and attention), and from mothers’ stimulation and IQ to these same outcome measures. Finally, we report the unique contributions of the identified mother and toddler predictors to the three toddler measures (i.e., over and above the other predictors) as well as their joint predictive validity for toddler outcome.

Descriptive Statistics and Concurrent Correlations

5 Months. Table 1 presents descriptive statistics and intercorrelations for infant peak look, infant home activity, and maternal object stimulation at 5 months. Infant visual fixation and home activity were independent. Maternal object stimulation related to infant activity, but not to infant visual fixation.

During the habituation session, as a whole, infants habituated. They attended equally on the pretest ($M = 6.3$ s, $SD = 2.46$) and posttest trials ($M = 5.8$ s, $SD = 2.49$), $t(38) = 0.79$, n.s.; their novelty preference was significantly greater than chance ($M = 55\%$, $SD = 9.30$), $t(38) = 3.28$, $p < .001$; and finally, they looked more at the novel stimulus during the test phase relative to the last two habituation trials ($M = 60\%$, $SD = 13.59$), $t(38) = 4.59$, $p < .001$. These findings eliminate fatigue and other causes as interpretations of habituation.
TABLE 1
Descriptive Statistics and Concurrent Correlations Among 5-Month Measures

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
<th>Range</th>
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<th>2</th>
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<tr>
<td>Infant peak look</td>
<td>23.5</td>
<td>16.1</td>
<td>4.5-68.4</td>
<td>-.16</td>
<td>-.06</td>
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<tr>
<td>Infant home activity</td>
<td>35.3</td>
<td>6.9</td>
<td>15.0-45.0</td>
<td>---</td>
<td>.43*</td>
<td></td>
</tr>
<tr>
<td>Maternal object stimulation</td>
<td>12.4</td>
<td>7.9</td>
<td>2.0-32.0</td>
<td>---</td>
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<td></td>
</tr>
</tbody>
</table>

*p < .01.

13 Months. Table 2 shows descriptive statistics and intercorrelations for toddler symbolic play, attention span, and mothers' play stimulation at 13 months. Toddlers' play related to their attention. Maternal play stimulation related to toddler play, but not to toddler attention.

Maternal IQ. As a group, mothers in the sample demonstrated above average performance on both verbal and performance subscales of the WAIS-R. Their overall verbal IQ was 125, and their overall performance IQ was 110; full scale IQ was 121 on average. Their scores were normally distributed. As expected, the two verbal scores were related, \( r = .66, p < .001 \), and the two performance scores were related, \( r = .46, p < .01 \). Performance on the verbal scale was related to that on the performance scale, \( r = .40, p < .05 \). Mothers' IQ was related to their stimulation of children at both ages, \( r_s = .44 \) and \( .43, p < .05 \), but not to infant fixation or infant activity in the home.

Predictive Models From 5 Months to 13 Months

The next sets of analyses examined the contributions of infant (i.e., visual fixation and activity) and mother (i.e., early stimulation and IQ) to the three outcomes in toddlers: play, attention, and exploratory competence. In all of these analyses, we covaried mothers' concurrent stimulation from toddler criterion measures because data on toddlers were collected in the home in the context of interaction with mothers.

Structural equation modeling was used in analyses that examined the antecedents of toddlers' exploratory competence. This statistical technique

TABLE 2
Descriptive Statistics and Concurrent Correlations Among 13-Month Measures

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
<th>Range</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toddler symbolic play</td>
<td>5.7</td>
<td>5.3</td>
<td>0.0-19.0</td>
<td>---</td>
<td>.38*</td>
<td>.30*</td>
</tr>
<tr>
<td>Toddler attention span</td>
<td>90.7</td>
<td>41.8</td>
<td>25.0-205.0</td>
<td>---</td>
<td>.10</td>
<td></td>
</tr>
<tr>
<td>Maternal play stimulation</td>
<td>36.7</td>
<td>13.0</td>
<td>8.0-68.0</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
</tbody>
</table>

*p < .05.
was chosen because it generates solutions for models in which a hypothetical construct is assumed to be "latent" to observed measures and is best represented by a factor score made up of multiple indicators (Biddle & Marlin, 1987). Latent variables are presumed to be more reliable and free of error than the indicator variables from which they are formed (Martin, 1987). Because of the relatively small sample size, several precautions were taken when using structural equation modeling. First, the models tested included only one dependent latent factor (comprised of two indicators) and two to three predictors, thus minimizing the number of estimated parameters. Second, model testing was confirmatory rather than exploratory. That is, our approach was a priori because we have shown that independent measures of mother and infant are valid predictors of diverse cognitive competencies in several samples in different cultures (e.g., Bornstein & Tamis-LeMonda, 1989, 1990, Tamis-LeMonda & Bornstein, 1989). Finally, in discussing these data, we remain descriptive, focusing on effect magnitudes, rather than taking an inferential approach, because the generalizability of findings from small samples is limited and goodness-of-fit estimates may be inflated (Geweke & Singleton, 1980; Tanaka, 1987; Tanaka, Panter, Winborn, & Huba, 1990).

**Infant Contributions to 13-Month Play, Attention, and Exploratory Competence.** At the zero-order level, infant visual fixation related inversely to toddler play and attention, but only the correlation for attention achieved significance, \( r = -0.20 \) and \(-0.29, p < .05\). Infant home activity did not relate to toddler play or attention, \( r = 0.06 \) and \(0.18\).

We next explored the contributions of visual fixation and home activity to the latent factor of toddler exploratory competence. In this model, we residu-alized the two infant predictors by mothers' early stimulation and IQ prior to entering them in the model so that unique infant contributions to toddler exploration might be tested. Both infant visual fixation and activity predicted toddlers' exploratory competence in the expected directions, \( r = -0.46 \) and \(0.40\), \( ps < .01\), respectively. The goodness-of-fit indices were adequate, \( \chi^2(1) = 1.33, p = .25\) (Bentler-Bonnet GFI = .91).

**Maternal Contributions to 13-Month Play, Attention, and Exploratory Competence.** This set of analyses explored predictive associations between mothers' stimulation and IQ and toddlers' play, attention, and exploratory competence. Mothers' stimulation did not relate to toddler play or attention, \( r = -.02 \) and \(-.06, \), respectively. Mothers' IQ was related positively to toddler play and attention, but only the relation to attention achieved significance, \( r = .26 \) and \(0.41, p < .01\), respectively. Structural equation modeling tested the contributions of the two mother variables to the latent variable of exploratory competence. We partialed 5-month infant activity from maternal
stimulation prior to entering maternal stimulation in the equation because 5-month stimulation was examined in an interactive setting with infants and covaried with infant activity. This permitted assessment of mothers' unique early contribution to toddlers' exploration above infants' interactive contribution. Results indicated that maternal IQ, but not stimulation, predicted variance in toddler exploratory competence, \( r_s = .34, p < .05 \), and \( -.17 \), respectively. Model fit indices were good, \( \chi^2(1) = .03, p = .87 \) (Bentler-Bonnet GFI = .99).

**Unique and Joint Contributions of Infant and Mother to Toddler 13-Month Exploratory Competence.** The final analyses tested the unique contributions of the three significant predictors (i.e., infant visual fixation, infant home activity, and mother IQ) to toddler play, attention, and exploratory competence. Because mothers' early stimulation did not predict any of the toddler outcome measures, we eliminated mother stimulation as predictor in these analyses. Before doing so, however, we examined interactions between mothers' early stimulation and the other three predictors (i.e., infant visual fixation, infant home activity, and maternal IQ) to play and attention separately. None was significant. As noted before, however, maternal stimulation did relate to two of the infant predictors, infant activity and maternal IQ; to determine the unique contributions of each, therefore, we covaried mothers' stimulation from these predictors in subsequent analyses.

Table 3 presents unique (i.e., partial) predictive correlations between each of the three antecedents and toddler play and attention performance, that is, the prediction of each infant or mother predictor over and above contributions of the other two predictors. As indicated, shorter peak looks were associated with more symbolic play and longer attention episodes, although only the correlation for symbolic play reached conventional significance.

<table>
<thead>
<tr>
<th>TABLE 3</th>
<th>Predictive Partial Correlations From 5-Month Infant Activity and Visual Fixation and Maternal IQ to Toddler Play and Attentiona</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Months</td>
<td></td>
</tr>
<tr>
<td>Infant peak look</td>
<td>- .32*</td>
</tr>
<tr>
<td>Infant home activityb</td>
<td>0.09</td>
</tr>
<tr>
<td>Maternal IQc</td>
<td>.25*</td>
</tr>
</tbody>
</table>

* *p < .10. **p < .05. ***p < .01.  
*aPredictive correlations over and above the other two antecedents.  
bResidualized by 13-month maternal play stimulation.  
cResidualized by 5-month maternal object stimulation.
Infant home activity predicted toddler attention, but not play. Maternal IQ was related positively to toddler play and attention, but only the prediction to attention achieved a conventional level of significance. Interactions among the three predictors did not explain further variance in toddler outcome measures above these main effects.

Finally, Figure 1 presents the results for the structural equation model testing the unique contributions of the three antecedents to the latent factor of exploratory competence. Represented in this model are the partial correlations for each of the three predictors to exploratory competence, that is, their unique relations to the latent variable over and above the other two contributors. As indicated, each of the antecedents explains unique variance in toddler exploratory competence (partial rs = .45–.63, ps < .01); together, they accounted for 50% of the variance in toddler outcome. As indicated, both the chi-square and Bentler-Bonnet fit indices for the model were good.

**DISCUSSION**

This study examined the predictive validity of infant visual fixation and home activity at 5 months, and maternal stimulation and IQ separately and together for toddler symbolic play, attention, and exploratory competence at 13 months. Infant visual fixation, infant activity, and maternal IQ differentially...
predicted unique variance in toddlers' play, attention, and exploratory competencies.

The data demonstrate relations between peak look and toddler play, attention, and exploratory competence. Prior research in our laboratory had identified similar patterns of prediction from visual fixation to toddler representational competence (Bornstein, 1985, 1989; Tamis-LeMonda & Bornstein, 1989), a factor formed from language comprehension and symbolic play, yet unrelated to toddler exploratory competence (Tamis-LeMonda & Bornstein, 1990). Taken together, these studies indicate that visual fixation in infancy predicts diverse and independent outcomes in the child; this suggests that visual fixation might be partitioned into different component processes (see also Bornstein & Sigman, 1986; Colombo & Mitchell, 1988; Lecuyer, 1987a, 1987b, 1988; Sigman, 1988).

Researchers have conceptualized visual fixation data as reflecting multiple constructs such as representation, motivation, arousal, temperament, and state, among others (Bornstein & Sigman, 1986; Colombo & Mitchell, 1988; Lecuyer, 1987a, 1987b, 1988; Rose, 1992; Sigman, 1988). One central process thought to explain individual variation in visual fixation is the infant's ability to coordinate and focus attention. It has been suggested that the infant who is better able to regulate attention so as to monitor effectively incoming environmental information might be the infant who habituates quickly and/or demonstrates shorter looking time during visual fixations (Sigman, 1988). Similarly, Lecuyer (1987a, 1987b, 1988) has speculated that fast habituators might have greater control over processing, shorter periods of blank staring, and greater attention than slow habituators. As suggested by Ruff and Saltarelli (1993) and by Tamis-LeMonda and Bornstein (1993), attention during visual fixation paradigms differs functionally from attention during exploration with objects, thus, the nature of diverse contexts and measures needs to be considered when interpreting patterns of looking in infants. Shorter visual fixation in laboratory procedures might index more efficient or faster processing in young infants; in contrast, in situations that permit older infants to explore actively (as during free play), sustained interest, particularly when coupled with more sophisticated play activity, appears to index greater competence. Our data empirically support these theoretical speculations by demonstrating an inverse relation between visual fixation in infancy and exploratory competence in toddlerhood.

This study also indicates that 5-month-old infants who exhibit more positive activity in the home, as measured by exploratory acts and nondistress vocalizing, sustain attention for longer periods and display more competent exploration at 13 months. Other studies assessing ongoing infant activity have likewise demonstrated prediction from infant vocalizing and/or environmental attention to verbal performance and IQ in early childhood (e.g., Bornstein, 1985; Bornstein et al., 1985–1986; Cameron et al., 1967; Roe et al.,
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1983). These data support a model of infant-to-childhood stability and, at the same time, broaden the scope of infant prediction to encompass domains of competence other than those subserved by verbal–representational abilities (see also Heinicke, Diskin, Ramsey-Klee, & Oates, 1986).

Finally, associations obtained here between maternal IQ and toddler attention and exploratory competence provide tentative evidence that variation among children in certain aspects of exploration might partly reflect a genetic basis (Bornstein & Tamis-LeMonda, 1990; Heinicke et al., 1986; Parrinello & Ruff, 1988; Porges, 1983). Significantly, maternal WAIS–R predicted toddler outcome after covarying mothers' early and later stimulation. This suggests that the mechanism of prediction from maternal IQ to toddler outcome is direct rather than being mediated or explained by its association with maternal stimulation (DeFries et al., 1981; Hardy-Brown & Plomin, 1985; Plomin, 1987; Thompson & Plomin, 1988).

In contrast to these significant predictors, maternal stimulation did not predict any of the toddler outcome measures. Other studies show that early maternal stimulation can predict toddler competencies. The lack of prediction from mothers' stimulation to toddler outcomes might be specific to the child measures we examined. It may be, for example, that mothers' stimulation better predicts aspects of language growth or representational competencies during the toddler period (e.g., Furrow, Nelson, & Benedict, 1979; Nelson, 1973; Newport, Gleitman, & Gleitman, 1977; Olson et al., 1986; Tamis-LeMonda & Bornstein, 1989, 1990) than it does exploratory competencies. Here, we assessed toddlers' ability to sustain attention; as suggested by Parrinello and Ruff (1988), unless infant attention is actually interrupted, the end of the episode, and thus duration of attention, is under infant control. It may also be that other aspects of maternal interaction are better predictors of toddlers' exploratory competencies than those assessed here.

These infant–toddler and mother–toddler correlations point to underlying cognitive-attentional processes in infants that are stable into the 2nd year as well as in part determined by maternal IQ. Nonetheless, it would be misleading simply to attribute stability and prediction to genetic or otherwise endogenous processes. By 5 months, infants have had a potentially telling, albeit short, history of interactions that might already explain variation in those aspects of visual fixation and activity that we have assessed (Bornstein, 1985; Bornstein & Tamis-LeMonda, 1990). We are presently examining the early antecedents of 5-month infant functioning.

REFERENCES


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