Habituation and Maternal Encouragement of Attention in Infancy as Predictors of Toddler Language, Play, and Representational Competence

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TAMIS-LEMONDA, CATHERINE S., and BORNSTEIN, MARC H. Habituation and Maternal Encouragement of Attention in Infancy as Predictors of Toddler Language, Play, and Representational Competence. CHILD DEVELOPMENT, 1989, 60, 738-751. In a longitudinal study, infants' habituation and mothers' encouragement of attention were assessed at 5 months, and toddlers' language comprehension, language production, and pretense play and mothers' encouragement of attention were assessed at 13 months. Structural equation modeling was used to examine the unique contributions of infant habituation and maternal stimulation to toddlers' cognitive abilities. Habituation predicted language comprehension, pretense play, and a latent variable of language and play after the influences of both 5- and 13-month maternal encouragement of attention were partialled. Likewise, early maternal encouragement of attention explained unique variance in toddlers' language comprehension and the language-and-play latent variable after infant habituation was controlled. These findings indicate that links between early habituation and later cognitive development are direct and not solely mediated by maternal stimulation, and that maternal stimulation of young infants influences the development of children's representational competence over and above infants' own information-processing abilities.

In recent years, a number of studies have demonstrated moderate longitudinal associations between measures of infant attention and measures of childhood intellectual development. For example, habituation in the first 6 months of life has been reported to explain up to 59% of the variance in indices of Childhood intelligence between 2 and 8 years (see Bornstein & Sigman, 1986, for a review).

This predictive validity has implicitly been attributed to stability in the child, where stability is defined as consistency in the rank order of children's performance over time. It may be that individual differences in both habituation and mental test performance represent shared variation in some underlying mental process, and that associations between earlier and later measures reflect the stability of children's stature in that process. Alternatively, however, cognitive stability in the child could be mediated by maternal activity. For example, maternal stimulation is associated at 2 and at 5 months with infants' visual and tactual exploration (Bornstein & Tamis-LeMonda, 1988), and maternal stimulation in the first year predicts 1-year play competence (Belsky, Goode, & Most, 1980), 1-year vocabulary size (Bornstein, 1985; Ruddy & Bornstein, 1982), 1-year habituation efficiency (Riksen-Walraven, 1978), 1½-year cognitive competence (Clarke-Stewart, 1973), 2-year cognitive/language competence (Olson, Bates, & Bayles, 1984), 3-year language performance (Bee et al., 1982), 4-year intelligence test performance (Bornstein, 1985), and
 Taken together, research on habituation and on maternal stimulation underscores the necessity of assessing both factors in order to estimate the unique and joint contributions of infant and mother to childhood cognition. To date, studies in these two areas have been pursued relatively independently of one another, as investigators commonly focus on the predictive validity of infant habituation or maternal stimulation for childhood cognition. An exception is a study conducted by Ruddy and Bornstein (1982) which showed that habituation and maternal encouragement of attention measured in the same sample at 4 months uniquely account, respectively, for 28% and 31% of the variance in 12-month productive vocabulary. The present longitudinal study advances this line of predictive research in order that the independent and joint contributions of infant and mother to a broader range of children's cognitive abilities may be examined. Specifically, we assessed the predictive validity of infant habituation and maternal encouragement of attention at 5 months and maternal encouragement of attention at 13 months for children's language comprehension and production, pretense play, and underlying representational competence at 13 months. We conducted our analyses using structural equation modeling so that we could assess the contributions of infant stability as well as early and late maternal stimulation to toddler performance while forming error-free latent variables from measures thought to represent underlying cognitive components such as representational competence.

We chose to study infants at 5 months because past research has found that measures of infant habituation at this age are reliable over short- and long-term periods (e.g., Bornstein & Benasich, 1986; Bornstein, Pêcheux, & Lécuyer, 1988; Colombo, Mitchell, O'Brien, & Horowitz, 1987), and that they are valid predictors of children's mental functioning (see Bornstein & Sigman, 1986). We selected 13 months as a criterion age period because of the important cognitive-developmental transitions that occur at this time. The emergence of naming and pretense play at the start of the second year is thought to reflect the growth of underlying cognitive capacities such as the ability to make use of symbolic representation (e.g., Bates, Bretherton, Shore, & McNew, 1983; Bretherton & Bates, 1984; McCall, 1979). Consequently, the start of the second year is a time of great change and variation in abilities to comprehend and to produce language and to represent actions symbolically in play (Bates, Bretherton, & Snyder, 1988; Belsky et al., 1980; Vibbert & Bornstein, 1988). Studies that demonstrate associations between rates of development in language and play lend empirical support to the notion that these two representational systems may be subserved by the same underlying mental ability to abstract from the immediate context (Bates et al., 1983; Bretherton & Bates, 1984; McCune, 1985; Ungerer & Sigman, 1984; Vibbert & Bornstein, 1988).

Our study had three main goals. First, we determined whether infant habituation at 5 months would predict emerging language, play, and representational competence at 13 months, and if so whether infant habituation would predict these abilities independent of maternal encouragement of attention at 5 and at 13 months. Second, we examined the predictive validity of maternal encouragement of attention at 5 months for toddlers' 13-month language, play, and representational competence independent of infant ability. Finally, by obtaining data on habituation and maternal stimulation, we assessed the combined contributions of these two sets of variables in infancy for toddler cognitive competence.

**Method**

**Sample**

Thirty-seven mothers and infants (19 males and 18 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 = 3.39 kg; $M$ length = 51.3 cm), healthy throughout the course of the study, and free of any known neurological or visual abnormalities. All infants came from middle- to upper-socioeconomic-status households ($M$ = 59.8 on the Hollingshead Four Factor Index, 1975, Gottfried, 1985).

Dyads were first seen in the home and laboratory when babies were 5 months of age, $M$ = 161 days at the time of the laboratory assessment and $M$ = 163 days at the time of the home observation. They were seen again at home at 13 months, $M$ = 402 days. All visits were scheduled during times when the infants were in states of quiet or active alert (Brazelton, 1973). At the time of the 5-month observation, mothers completed a brief questionnaire that supplied demographic data and information about the infants' health status from birth, etc. Because these variables were unrelated to any of the 5- or 13-month mater-
Five-Month Laboratory Observation

Habituation was measured in the laboratory using stimuli and procedures developed by Bornstein and Benasich (1986).

Stimuli.—Habituation stimuli consisted of two lifelike color slides of female faces wearing affectively neutral expressions. Approximately half the infants saw one face and half the second. Pretests established that the two stimuli were equivalently discriminable and equally attractive to infants. After habituation, infants were tested with a red-and-black 4.5-cycle/degree square-wave grating which served as a novel test stimulus. A three-ring red bull’s-eye was used as the pretest and posttest stimulus.

Experimental arrangements.—During habituation, the infant was placed in a standard infant seat approximately 60 cm from a matte-white stimulus screen measuring approximately 45 × 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 mother; this signal was also recorded on videocassettes for subsequent scoring and analysis with the assistance of a microprocessor. The infant’s face filled approximately 60% of the 20.5-cm monitor screens.

Procedures.—Habituation sessions began when the infant was in an alert and sated state. Infant involvement during habituation was coded independently by two experimenters each using the same 5-point scale (5 = involved and interested and 1 = crying, does not complete session). Infants averaged a rating of 4.6 across the session.

All infants experienced the following sequence in habituation: Before each stimulus presentation the infant’s attention was drawn to the center of the stimulus panel by the signal lamp; once the baby was oriented, a stimulus was projected. Infants first saw a 10-sec pretest. Next, the habituation stimulus was presented using an infant-control habituation paradigm. Immediately following habituation, infants were tested with four 10-sec trials in which the habituation stimulus and the novel stimulus were each presented twice, sequentially, and in a randomized counterbalanced order. Following the test phase, infants saw a 10-sec posttest with the same stimulus used in the pretest.

Scoring.—Measures of baseline, slope of decline, and decrement of habituation were obtained, and a latent variable was formed from these three measures. This latent variable served as the primary habituation index used in a series of structural equation models; prior research has demonstrated the short-term reliability of this index (Bornstein & Benasich, 1986). Scoring reliability was established with a second independent coder; r’s on looking times for 15 infants averaged .95.

Five-Month Home Observation

Home visits allowed mothers and infants to be observed in surroundings familiar to them. Mothers were asked to adhere to 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 divided into 60-sec time-sampling intervals (Seitz, 1988): 30 sec of observation followed by a 30-sec period during which the observer recorded the occurrence or nonoccurrence of selected mother and infant activities. Beeps that demarcated each 30-sec period were transmitted to the observer through an earplug attached to an automatic timer.

At the initiation of each 30-sec 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 an average of 94% of the timesampling intervals across the visits. Encouragement of attention was coded whenever a mother actively attempted to direct her infant’s attention physically or verbally toward herself or toward an aspect of the immediate 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 or the mother herself. Interactive behaviors that were not explicit attempts at focusing the infant’s attention (e.g., simply talking to infant, smiling at infant, looking at infant, responding to infant vocalizations) were not credited. This distinction between encouragement of infant attention and other forms of maternal activity is central since a mother could consistently interact with her infant without ever encouraging.

Coding reliability was established with a second independent coder; agreement for matched time-sampling intervals for six visits averaged 93%, with base rates of maternal encouragement ranging from 2% to 42%. (Percent agreement was chosen as a reliability index because of the positively skewed distribution of encouragement base rates; Shrout & Fleiss, 1979.)

**Thirteen-Month Home Observation**

During a 2 1/2-hour home visit, the experimenter interviewed the mother about her child’s receptive and productive vocabulary and videotaped 15 min of infant-mother free play.

**Child language.**—Mothers were questioned about their children’s receptive and productive vocabularies using the Bates et al. language interview (1988). Earlier studies have shown this interview to yield reliable data on language and to possess concurrent and predictive validity for language performance beyond 13 months (Bates et al., 1988; Bretherton & Bates, 1984). During the language interview, the experimenter read specific lexical items taken from general verbal categories (e.g., food) and asked the mother whether her child understood and/or produced each item. If a mother reported that her child understood and/or produced a given word or phrase, the experimenter probed to determine more about receptive or productive mastery of the item and the child’s “context-restricted” versus “context-flexible” mastery of the item. In order for a child to be credited with comprehension, his or her response had to be appropriate to the target word or phrase (e.g., stopping an action if mother said “no”). To be credited with production, the child had to show consistent and appropriate use of a sound that closely approached the adult version of the target word. If mastery of an item was indicated, the experimenter questioned the mother to determine if comprehension or production was restricted or flexible, that is, whether any specific gestural, vocal, temporal, or spatial cues were necessary for the child to display competence with the item.

Interview data were scored according to procedures outlined by Bates and colleagues (1988). Each of the child’s words was categorized as a common noun (excluding pronouns), specific noun (names), or non-noun (including pronouns and action words and phrases); and each word or phrase was classified as flexible or restricted. We considered the child’s ability to abstract from the immediate context, that is, to use flexible speech, as a more appropriate and advanced index of representational ability (Bates et al., 1988; Snyder, Bates, & Bretherton, 1981). The following measures were used in data analysis: (1) the numbers of flexible common nouns comprehended and produced, (2) the numbers of flexible non-nouns comprehended and produced, and (3) percentages of flexible comprehension and production, calculated by dividing the numbers of flexible words comprehended or produced by the total numbers of words comprehended or produced.

Coding reliability for language data was assessed by having two coders independently score the audio recordings and transcripts of six maternal interviews; agreement for total comprehension and total production averaged 92% and 97%, respectively; agreement for the flexible-restricted language distinction averaged 90% for comprehension and 92% for production.

**Child play and maternal encouragement of attention.**—Each mother-infant dyad was videotaped for 15 min during a free-play session. The mother was asked to behave in her usual manner and disregard the experimenters’ presence as much as possible; no further instructions were given. A set of 11 toys (doll, blanket, teapot with cover, two teacups, two saucers, two spoons, a toy telephone, toy train, two small picture books, foam rubber ball, and a set of nesting barrels) was placed on the floor in front of toddler and mother. These toys afforded the child the opportunity
to exhibit various levels of play—from simple manipulation to more sophisticated pretense.

Two data sets were coded from the videotaped play sequence: child play competence and maternal encouragement of attention. Play and maternal encouragement were each coded by separate individuals who had never seen the children before; therefore, all 13-month coders were blind to measures obtained during the 5-month assessments and to the results of the other 13-month data sets.

Child play was evaluated according to a modified version of a 13-point play scale developed by Belsky et al. (1980). A 15-sec continuous time-sampling procedure was employed in which the experimenter coded occurrence of the following play actions: (1) mouthing, (2) simple manipulation, (3) functional activity, (4) juxtaposition, (5) functional relational activity, (6) approximate pretense, (7) self-directed pretense, (8) other-directed pretense, (9) pretense involving object substitution, (10) sequential pretense in which two or more similar pretense actions are exhibited, (11) sequential pretense in which two or more different pretense actions occur, (12) sequencing of two or more similar pretense acts with an object substitution, and (13) sequencing of two or more different pretense acts with an object substitution. During a 15-sec time frame, a given play level was scored only once regardless of the number of times it occurred.

On the basis of children's play performance, we calculated one comprehensive variable, percent pretense play, by dividing the number of the child's pretense actions (scores of 7 or greater) by the total number of the child's play actions. We chose to focus on pretense play for two reasons. First, pretense requires children to draw on preexisting knowledge about the world rather than relying on the concrete properties of materials. As an example, the functional act of turning a telephone dial depends on properties of the telephone (e.g., the dial itself), whereas pretending to talk on a telephone requires children to abstract beyond the immediate situation to prior experiences with telephones. This ability to represent experience in pretense play has been hypothesized to reflect underlying cognitive abilities such as symbolic representation (e.g., McCune, 1985). Second, we distinguished between concrete and pretense actions because we consider pretense to be conceptually similar to flexible (context-free) language, which also requires the use of mental representation (see also Ungerer & Sigman, 1984).

Coding reliability was established by two independent coders; agreement across the 13 levels of play for matched time-sampling intervals for eight infants averaged 97%. Because children's play levels were assessed from free-play sessions in which mothers were present, we removed maternal influence from child play performance prior to all analyses by partialing 13-month maternal encouragement of attention.

Maternal encouragement of attention was also assessed from the videotaped play session. A 15-sec continuous time-sampling procedure was employed in which the experimenter recorded whenever a mother actively attempted to direct her toddler's attention physically or verbally toward an aspect of the immediate environment. Mothers could do this, for example, by demonstrating how something worked, pointing, naming an object, or describing the unique qualities of an object. Encouragement was scored once in a given interval, regardless of the number of times it occurred. As in the 5-month procedure, maternal behaviors that were not explicit attempts at directing children's attention were not credited. One composite measure of maternal stimulation was generated by tallying the number of coding intervals in which maternal didactics occurred.

Coding reliability was established by independent observers. Agreement for matched time-sampling intervals for eight mothers averaged 94%, with base rates of encouragement ranging from 55% to 92%.

Results
The results of this study are organized in three parts. First, descriptive statistics and concurrent correlations for the 5-month and the 13-month variables are reported. Next, 5–13-month predictive zero-order relations are discussed. Last, a series of structural equation models that test hypothesized longitudinal associations is described. Prior to any of these analyses, we examined univariate box plots and bivariate scatterplots to detect the presence of outliers (Tukey, 1977); data from two dyads were selectively excluded because they were bivariate outliers on the lagged maternal encouragement to toddler criterion measures. Additionally, all proportion measures were arc sin transformed.

Descriptive Statistics and Concurrent Correlations
Five months.—Table 1 presents descriptive statistics and intercorrelations for infant and mother variables at 5 months. In general,
shorter baselines, shallower slopes, and less decrement covaried. Maternal encouragement of attention at 5 months was associated with response decrement.

All infants habituated; four sets of analyses eliminated fatigue and other factors as interpretations of habituation. First, infants attended equally on the pretest \((M = 6.2\text{ sec})\) and posttest trials \((M = 6.4\text{ sec})\), \(t(36) = 0.35\). Second, infants' novelty preference was significantly greater than chance, \(M = 56\%\), \(t(36) = 2.91, p < .001\). Third, a measure of infants' looking at the novel stimulus during the test phase relative to the last two habituation trials also exceeded chance, \(M = 60\%\), \(t(36) = 4.52, p < .001\). Finally, infants' attention to the familiar stimulus in the test phase was equivalent to their attention on the last two habituation trials, \(M = 54\%\), \(t(36) = 1.49\).

Thirteen months.—Table 2 shows descriptive statistics and intercorrelations for toddler and mother variables at 13 months. Language-comprehension measures all related to one another. In addition, the number of flexible common nouns comprehended related to the number of flexible non-nouns produced, but neither related to percent flexible production. Examination of comprehension-production cross-correlations showed that the number of flexible nouns comprehended related to the number of flexible nouns produced, and that all three comprehension measures were associated with percent flexible production. Pretense play was associated with comprehension but not with production. Finally, maternal encouragement of attention related to toddlers' common nouns comprehended and to pretense play.

Predictive Relations between 5 Months and 13 Months

Table 3 presents lagged associations between infant habituation and maternal stimulation at 5 months and 13-month toddler language and play and maternal stimulation. In general, shorter baselines, shallower slopes, and lower decrement scores—more mature habituation (Bornstein et al., 1988)—predicted greater comprehension and a higher percentage of pretense play. All three measures of habituation related to 13-month maternal encouragement in the expected directions, although only the relation between slope and later maternal encouragement was significant. Maternal encouragement of attention predicted toddlers' language comprehension but did not predict toddler language production or play. Finally, maternal encouragement of infant attention was positively correlated but not stable over the 7-month period.

Structural Equation Modeling

In order to examine the independent and joint contributions of infant and mother at 5 months to infant language and play at 13 months, a series of theoretical models was generated and tested using structural equation modeling. Although our sample size was small, and therefore places limitations on the generalizability of findings (see Tanaka, 1987), the application of structural equation modeling was chosen because LISREL makes it possible to generate solutions for models in which one or more of the hypothetical constructs is assumed to be "latent" and is best represented by a factor score made up of multiple indicators (Biddle & Marlin, 1987). Since our study focused on variables

As predicted, both habituation and maternal encouragement related to flexible measures of language comprehension but did not relate to restricted language measures. Similarly, pretense play related to flexible language measures but not to restricted measures. These findings support the a priori notion that flexible language is tapping representational ability.
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<th></th>
<th>Mean</th>
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<td>.74**</td>
<td>.79**</td>
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<td>.63**</td>
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<td>.15</td>
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<td>.66**</td>
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<td>...</td>
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<td>...</td>
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* p < .05.
** p < .01.
TABLE 3
PREDICTIVE ZERO-ORDER RELATIONS BETWEEN 5-MONTH INFANT HABITUATION AND MATERNAL ENCOURAGEMENT OF ATTENTION AND 13-MONTH TODDLER LANGUAGE AND PLAY AND MATERNAL ENCOURAGEMENT OF ATTENTION

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<th>Maternal Encouragement of Attention</th>
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<td>.31*</td>
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<td>Non-nouns flexible</td>
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<tr>
<td>Percent flexible</td>
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<td>.31*</td>
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<td>.10</td>
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<tr>
<td>Non-nouns flexible</td>
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<tr>
<td>Percent flexible</td>
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<td>-.06</td>
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<tr>
<td>Toddler pretense play</td>
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<td>.41**</td>
</tr>
<tr>
<td>Maternal encouragement of attention</td>
<td>-.23</td>
<td>.34*</td>
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</table>

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

thought to represent underlying cognitive components, the use of latent variables as representative of measured variables was deemed appropriate. Moreover, structural modeling is preferable to other factor analytic techniques because it separates variance that is unrelated to the factor score from explained variance, thereby allowing for clearer interpretations (Martin, 1987).

In each of the models tested, a latent variable of habituation was formed from the measured variables baseline, slope, and decrement. The latent variable of habituation served as a more comprehensive estimate of habituation since together these indicators represent the start level of habituation, the course of the infant’s decline in attention, and the asymptote of habituation, respectively. Moreover, each of the indicators contributes only moderately overlapping information about habituation to the construct, 30% of shared variance on average. Finally, because the latent variable of habituation represents core variance shared by baseline, slope, and decrement, and eliminates error variance associated with these same measures, it may represent a purer estimate of the underlying construct than do single indices. Statistically, the formation of this latent variable is justified since the measures used are not direct linear combinations of one another; this means that their construction into a latent variable does not violate any arithmetic assumptions associated with LISREL (Tanaka, personal communication). In addition, a latent variable was formed from the measured variables flexible nouns and flexible non-nouns in comprehension. In the zero-order analyses, neither habituation nor maternal encouragement of attention predicted language production, and so models associated with production are omitted. The single play variable, percent pretense play, also served as a dependent index; this variable represented children’s residual play variance after the influence of 13-month encouraging attention was removed. Finally, a latent variable termed “representational competence” was formed from the observed variables percent pretense play and percent flexible comprehension.

Three pairs of models are presented, one for each of the three 13-month criterion measures, comprehension, play, and representational competence. Models 1 and 2 test the hypothesis that infant habituation and maternal encouragement of attention at 5 months each predicts unique variance in 13-month language comprehension. Models 3 and 4 test the unique contributions of infant and mother at 5 months to 13-month residual play. Finally, Models 5 and 6 test the hypothesis that habituation and maternal encouragement of attention at 5 months each relates to 13-month representational competence.

The results of the six tested models are presented in Table 4. The following data are presented for each model: (1) predictor, (2) criterion, (3) goodness-of-fit, adjusted goodness-of-fit, and chi-square fit indices, and (4) individual correlations for each of the infant and mother associations and (where appropri-
<table>
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<th>Predictor</th>
<th>Criterion</th>
<th>GFI</th>
<th>Adjusted GFI</th>
<th>$\chi^2$</th>
<th>df</th>
<th>$p$</th>
<th>$r$</th>
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<td>.97</td>
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<td>.73</td>
<td>-.30*</td>
<td>-.31*</td>
</tr>
<tr>
<td>3</td>
<td>b) Mother</td>
<td>Residual play</td>
<td>.99</td>
<td>.99</td>
<td>.04</td>
<td>2</td>
<td>.98</td>
<td>-.36*</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>b) Mother</td>
<td>Residual play</td>
<td>.96</td>
<td>.84</td>
<td>4.08</td>
<td>4</td>
<td>.40</td>
<td>-.33*</td>
<td>-.33*</td>
</tr>
<tr>
<td>5</td>
<td>a) Habituation</td>
<td>Representational competence</td>
<td>.94</td>
<td>.82</td>
<td>6.62</td>
<td>7</td>
<td>.47</td>
<td>-.60**</td>
<td>-.55**</td>
</tr>
<tr>
<td>6</td>
<td>b) Mother</td>
<td>a) Representational competence</td>
<td>.90</td>
<td>.72</td>
<td>13.33</td>
<td>10</td>
<td>.21</td>
<td>-.59**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b) Encouragement of attention</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.30*</td>
<td>.32*</td>
</tr>
</tbody>
</table>

* $p < .05$.
** $p < .01$. 
Habituation and encouragement of attention to language comprehension.—Model 1 tests the association between the latent variable of habituation at 5 months and language comprehension at 13 months. Table 4 shows that habituation is significantly associated with language comprehension; babies who habituate in a more mature fashion at 5 months comprehend more language at 13 months. Model 2 tests, first, whether maternal 5-month encouragement of attention significantly adds to the amount of criterion variance in language comprehension explained by habituation and, second, whether habituation continues to predict comprehension after maternal encouragement is partialled. As Model 2 shows, the partial correlation between 5-month maternal stimulation and 13-month language comprehension remains significant after the influence of 5-month habituation is removed, as does the partial correlation between 5-month habituation and 13-month language comprehension after removing the influence of 5-month maternal encouragement of attention. Regression analysis shows that, together, infant habituation and maternal encouragement of attention at 5-months explain 20% of the variance in toddlers' 13-month language comprehension. The interaction of habituation and 5-month stimulation was not significant.

Habituation and encouragement of attention to play.—We next asked whether habituation would predict residual play variance, that is, play after the influence of 13-month encouragement of attention was considered. Model 3 shows that habituation significantly predicts residual play; however, as Model 4 shows, 5-month maternal encouragement of attention does not relate to toddler play competence.

Habituation and encouragement of attention to representational competence.—Finally, we questioned whether habituation and maternal encouragement of attention would each predict a latent variable of representational competence constructed of language and play. Model 5 shows that habituation predicts representational competence, even when the influence of 13-month maternal input is removed. Model 5 also shows that habituation predicts maternal stimulation, but not when the child's later representational competence is partialled. Not shown is the fact that 13-month maternal stimulation is concurrently associated with toddlers' representational competence, \( r = .38, p < .05 \).

Model 6 tests the contribution of 5-month maternal stimulation above that of infant habituation and tests the association between habituation and representational competence after partialing 5-month and 13-month maternal stimulation. Figure 1 presents the results from four separate stages of analysis. First, a model including the latent variable of habituation, the latent variable of representational competence, and 5- and 13-month maternal stimulation was tested. Significant associations between habituation and representational competence, habituation and 13-month maternal stimulation, 5-month maternal stimulation and 13-month representational competence, and 13-month maternal stimulation and toddler representational competence were obtained. The goodness-of-fit index for the model was moderate. Second, the relation between habituation and representational
comprehension was examined after the influences of both 5- and 13-month maternal encouragement of attention were removed. (Partial correlations are shown in Figure 1 in italics in parentheses.) Habituation significantly predicted representational competence, independent of early and later maternal encouragement of attention. Third, the influence of early maternal stimulation on later representational competence was tested with the influences of both 13-month maternal stimulation and 5-month habituation partialed. This association continued to be significant, demonstrating that early encouragement of attention has a pure effect on 13-month representational capacity in children. Finally, the lagged association between infant habituation and 13-month maternal stimulation was examined after partialing the infant’s later representational ability. Under these circumstances, habituation failed to predict 13-month maternal encouragement of attention.

In order to examine the combined contributions of infant habituation and maternal encouragement of attention at 5 months to toddlers’ representational competence at 13 months, a hierarchical multiple regression analysis was run in which maternal encouragement of attention at 13 months was entered first, followed by habituation and maternal stimulation at 5 months. Maternal stimulation at 13 months explained a significant 12% of the variance in toddlers’ representational competence. Moreover, the change in $R^2$, after 13-month encouragement of attention was considered, showed that habituation and maternal encouragement of attention at 5 months explained an additional significant 36% of the remaining variance in toddlers’ symbolic representational ability at 13 months. Together, habituation and encouragement of attention at 5 months and 13-month encouragement of attention explained 45% of the total variance in toddlers’ representational competence at 13 months. The addition of the interaction between habituation and encouragement of attention at 5 months did not lead to a significant increment of $R^2$.

Discussion

This study examined cognitive stability from infancy into toddlerhood, as well as the predictive role of early maternal stimulation for toddlers’ cognitive growth. Our results showed that infants who habituated in a more mature fashion, as indexed by a latent variable comprised of habituation baseline, slope, and decrement, had more flexible language comprehension, displayed more pretense play, and exhibited more advanced representational ability as toddlers. In addition, maternal encouragement of infant attention at 5 months predicted a significant proportion of variance in toddler language comprehension and representational competence at 13 months. Importantly, habituation at 5 months explained up to 32% of the variance in these 13-month cognitive measures after the effects of both 5- and 13-month maternal encouragement of attention were partialed, and early maternal stimulation uniquely explained 9% of the variance in language comprehension and representational ability after habituation was partialed. Together, infant habituation and early maternal stimulation explained 20% of the variance in toddler language comprehension and 36% of the variance in the latent variable of pretense play and language comprehension.

Before discussing these findings, it is important to note that the sample size and relative homogeneity of the population we studied may limit the generalizability of the present results. In addition, it may be that the infant and mother interrelations we obtained are specific to the measures we chose to examine (e.g., pretense play, flexible language), to the specific ages during which we assessed infant and mother, and to the particular procedures we chose to study these aspects of behavior (e.g., naturalistic observation). Finally, although our findings indicate that habituation and maternal encouragement each explains moderate and nonoverlapping variance in toddler cognition, it may be that other infant and/or maternal variables would predict better, or that other criterion measures would better capture cognitive competence in toddlers.

The fact that habituation predicted 13-month language comprehension and play after maternal encouragement of attention was controlled suggests that cognitive stability from infancy to toddlerhood is at least partly independent of maternal stimulation after middle infancy. A number of researchers have documented significant associations between infant habituation and childhood intelligence, but few have assessed whether and how much variance in children’s performance is uniquely explained by habituation independent of maternal stimulation. It appears that these predictive habituation-to-toddler relations, to some degree at least, reflect stability in the underlying mental representational abilities of children themselves.

These results extend earlier work in which habituation at 4 months was found to
predict 12-month language over and above 4-month maternal encouragement of attention (Ruddy & Bornstein, 1982). First, we found that habituation and maternal stimulation during infancy explained unique residual variance in toddler ability, that is, toddler performance after the concurrent influence of later maternal encouragement of attention was also removed, and, second, we demonstrated links between early habituation and maternal encouragement and toddlers' play and representational competence, a new index of mental abilities that combines language and play.

Importantly, this study is the first to identify associations between habituation and play development. Past investigators of habituation have either solely used verbal indices as criterion measures or, in cases where additional criterion data were obtained, failed to find associations between habituation and nonverbal outcome measures (Bornstein, 1985; Slater, Cooper, Rose, & Perry, 1985). The fact that infant habituation predicts toddler play competence as well as language suggests that processes underlying habituation are not specific to those required by language but may rather reflect a more general cognitive ability such as children's use of mental representation.

This point is further elaborated by the strong association between habituation and the latent variable of play and language. Indeed, habituation exhibited a stronger association to the 13-month latent variable of representational competence (explaining 32% of the variance) than to either language or play (explaining 12 and 13% of the variance, respectively), suggesting that this symbolic factors score might be a better reflection of the kind of cognitive ability tapped by habituation than might language or play alone. Theoretically, variance associated with the original measures of language comprehension and pretense play can be partitioned into three areas: (1) variance associated with general underlying cognitive abilities, such as mental representation, (2) variance specific to the domain studied, that is language or play, and (3) error variance. When forming the latent variable of symbolic representation, both error variance and variance specific to language alone and to play alone are not included. Instead, the obtained construct represents covariance thought to be associated with some shared underlying cognitive capacity. If habituation does reflect early representational abilities, we would expect it to predict symbolic representation better than single measures of language or play.

Habituation also influenced mothers' activity over time. However, when infants' 13-month representational competence was controlled the correlation between habituation and later maternal stimulation was attenuated to nonsignificance. This finding indicates that the obtained longitudinal infant-to-mother association is probably supported by consistency in infant cognitive status, rather than being uniquely influenced by early infant attention.

Like others, we found that the magnitude of associations between habituation and 13-month toddler abilities was generally moderate, with habituation uniquely explaining between 10 and 32% of the variance in criterion measures. Although this leaves a large proportion of criterion variance unaccounted for, it improves considerably upon the predictive correlations obtained by traditional infant assessment scales, such as the Bayley Scales (Bayley, 1949). Contrary to the results of past investigators, we found that early maternal stimulation, as we measured it, predicted toddler language but not play. It may be that maternal encouragement of attention begins to influence child pretense play only after 5 months (e.g., Belsky et al., 1980), or that other types of maternal behavior, such as responsiveness, might predict better (Bornstein & Tamis-LeMonda, in press). Moreover, we found no association between habituation or maternal behavior at 5 months and 13-month-olds' language production, nor between language production and play. This lack of predictability may be ascribable to the low levels of production and its similarly low variance; 85% of the children in the present sample had less than seven words in their flexible productive vocabularies.

Our findings ought not to be interpreted within a simple "nature-nurture" framework. Measures of habituation are not pure estimates of infant cognitive ability, and maternal stimulation is not a purely exogenous factor. We assessed habituation when infants were already 5 months old; by this age, mothers and infants have shared a considerable history of dyadic exchange. We believe that prior interactions must have influenced both habituation and maternal didactic style as examined in the present study, and we are currently investigating the origins of both in the newborn period.

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