Mother and Caregiver Sensitivity Over Time: Predicting Language and Academic Outcomes With Variable- and Person-Centered Approaches

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Sensitive and responsive caregiving is associated with better cognitive and language outcomes. Using the longitudinal data set from the National Institute for Child Health and Human Development (NICHD) Study of Early Child Care and Youth Development, this study asks how changes in the sensitivity of both mothers and caregivers from 6 months to 6 years relates to language and academic outcomes at the start of formal schooling. Three questions are posed: (1) How variable is the quality of caregiving that children experience from mothers and child care providers during early childhood? (2) Do children benefit from both sensitive parents *and* sensitive caregivers? (3) Are changes in sensitivity over time related to cognitive and language outcomes at the end of preschool and the beginning of formal education? Person-centered and variable-centered analyses revealed that children experience changing patterns of sensitivity across time, that children benefit from sensitive interactions with all adults, and that changes in the sensitivity children experience across time are associated with both language and cognitive outcomes.

Stimulating and responsive caregiving environments promote social and cognitive development (Shonkoff & Philips, 2000). A substantial body of research attests to this claim (see Bornstein & Tamis-LeMonda, 1989, and Tamis-LeMonda & Bornstein, 2002, for reviews). Adults who take turns in interactions with young children, share periods of joint focus, and express positive affect provide infants and toddlers with a secure base for exploring their world

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and with the scaffolding needed to facilitate language and cognitive growth (Bradley et al., 1989; Bronfenbrenner & Morris, 1998; Clarke-Stewart, 1973; Howes, 2000; Katz, 2000; Tomasello & Farrar, 1986). For example, evidence strongly suggests that a greater amount and a larger diversity of verbal stimulation foster earlier and richer language outcomes in terms of both vocabulary and grammar (Beebe, Jaffe, & Lachman, 1992; Hart & Risley, 1995, 1999; Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991; Snow, 1986; Tamis-LeMonda, Bornstein, & Baumwell, 2001; see Hoff, in progress, for a review).

There is little debate that sensitive and stimulating caregiving plays an important role in promoting cognitive and language development. Most research, however, treats stimulation and responsiveness as a static variable and asks how characteristics of the mother-child or caregiver-child interaction at one point in time or averaged over time affects either concurrent or later child behavior. Little is known about how individual variation in parental or caregiver sensitivity over time affects child outcomes or even whether parental and caregiver sensitivity is constant over time (but see Bornstein & Tamis-LeMonda, 1989; Landry, Smith, Swank, Assel, & Vellet, 2001; Landry, Smith, Swank, & Miller-Loncar, 2000; Tamis-LeMonda & Bornstein, 2002). This study uses the longitudinal data set from the NICHD Study of Early Child Care and Youth Development to examine this issue. It investigates (1) the degree to which children from 6 to 54 months receive consistent or inconsistent patterns of stimulation and responsiveness from parents and changing child care providers, and (2) the extent to which patterns of change in the responsiveness children receive over time predicts their development at the start of formal schooling. Two statistical procedures not widely used in the cognitive literature are used to address these questions.

Sensitive and stimulating parenting. Stimulating and responsive parenting in early childhood is one of the strongest predictors of children's later language, cognitive, and social skills (Bronfenbrenner & Morris, 1998; Sameroff & Seifer, 1983). Distal measures show that homes rich in age-appropriate toys, reading materials, and conversation provide opportunities for learning that consistently predict higher reading and math scores during elementary and middle school (Bradley & Corwyn, 2002; Bradley et al., 1989; Bradley, Corwyn, Burchinal, Pipes McAdoo, & Garcia Coll, 2001; Senechal & LeFevre, 2002; Whitehurst, Arnold, Epstein, & Angell, 1994; among many others), reading competency in second grade (Scarborough, Dobrich, & Hager, 1991), and even 11th-grade reading comprehension (Cunningham & Stanovich, 1997; Cunningham, Stanovich, & West, 1994). Children's language skills are even more strongly related to proximal measures of quality in parent-child interaction, such as sensitivity cooperation, acceptance, and responsiveness (Landry et al., 2001; Tamis-LeMonda & Bornstein, 2002; Wakschlag & Hans, 1999). Parental warmth demonstrated as open dis-

plays of affection, physical or verbal reinforcement, and sensitivity to children's requests and feelings are also significantly associated with academic achievement and cognitive growth (Bornstein & Tamis-LeMonda, 1989; Burchinal, Campbell, Bryant, Wasik, & Ramey, 1997; Howes, Phillips, & Whitebook, 1992; Landry et al., 2001; Morrison & Cooney, 2002). The affective quality of mother-child interactions in early childhood is further related to early cognitive competencies, such as mental ability scores at age 4, school readiness skills at age 5 and 6, IQ scores at age 6, and vocabulary and mathematics performance at age 12 (Estrada, Arsenio, Hess, & Holloway, 1987). Responsiveness of parents in terms of diversity of language also relates to later proficiency (Weizman & Snow, 2001).

Sensitivity and stimulation in child care. Although the role of sensitive input has been more extensively explored in the parenting literature, responsive and stimulating behavior by caregivers also relates independently to child outcomes. At the distal level, all large, multi-site, observational studies of children's cognitive and language development (Howes et al., 1992; Love et al., 2003; NICHD Early Child Care Research Network [ECCRN], 2000, 2002; Peisner-Feinberg & Burchinal, 1997; Zill, 1999) and most smaller studies (Burchinal, Roberts, Nabors, & Bryant, 1996; Burchinal et al., 2000; Dunn, 1993; Kontos, 1991; McCartney, 1984; Schliecker, White, & Jacobs, 1991) find a direct relationship between the amount of sensitivity in the environment and cognitive and language outcomes. This link between child care *quality* and child outcomes has been observed in child care homes and relative care as well as in center care (Clarke-Stewart, Vandell, Burchinal, O'Brien, & McCartney, 2002; Kontos, Howes, Shinn, & Galinsky, 1997; NICHD ECCRN, 2000, 2002).

In language development, several studies looked more proximally at the caregiver's interaction with the target child. Children whose caregivers were more responsive and stimulating showed higher language scores and larger gains over time (Burchinal et al., 2000). Studies also find direct relationships among responsiveness, stimulation, and language outcomes (McCartney, 1984; NICHD ECCRN, 2000).

The research relating parental and child care interaction with child outcomes has provided powerful information on environmental predictors of cognitive and language success. Yet, research exploring this question generally relies upon group data in which the predictors of stimulation and responsiveness are measured at only one point in time (Hart & Risley, 1995; Hoff & Naigles, 2002; Huttenlocher et al., 1991; Newport, Gleitman, & Gleitman, 1977), are averaged over time (see NICHD ECCRN, 2000, and Tamis-LeMonda & Bornstein 2002, for a review of their work), or are treated as a time-varying covariate (Burchinal et al., 1997; NICHD ECCRN, 2004). Although these studies are informative, they generally

mask individual and group variation that might accrue across time. These investigations do not allow us to ask whether children are receiving constant amounts of sensitivity over time from the parents and caregivers or whether changes in stimulation and sensitivity that they receive over time have any notable effects on child outcomes. That is, they do not treat the sensitivity and stimulation that children receive as a dynamic variable.

Limited evidence suggests that changes in parental sensitivity over time relate to changes in child outcomes (see Bornstein & Tamis-LeMonda, 1989; Landry et al., 2000, 2001; NICHD ECCRN & Duncan, 2003; Tamis-LeMonda & Bornstein, 2002). Landry et al. (2001), for example, found that children who had highly sensitive parents in the first 3 years of life followed by lower sensitivity did not perform as well as children who had consistently high sensitivity across early childhood. Bornstein and Tamis-LeMonda (1989) also looked at patterns of sensitivity and stimulation over time. A longitudinal study of 40 mother-child dyads when the children were between 9 months and 19 months of age revealed that prompt, contingent, and appropriate responses to children's behaviors had dramatic effects on children's later language and cognitive growth. In both the Landry et al. (2001) and the Bornstein and Tamis-LeMonda (1989) studies, more sensitive parents were more stimulating. Operational definitions of sensitivity often embed qualities of stimulation.

The current study expands upon these longitudinal investigations in three ways. First, studies of patterns of change in responsiveness over time and its relationship to cognitive and language outcomes focus almost exclusively on sensitivity/stimulation as it is experienced in the parent-child interaction. With a large proportion of children in alternative care, it is important to ask how sensitivity that emerges in *both* parent and caregiver settings relates (independently and jointly) to child outcomes. Second, available longitudinal studies look at development only until 4 years of age. This study pushes the developmental envelope by asking how patterns of change in sensitivity and responsiveness from mothers and caregivers across time affects cognitive and language outcomes at the end of preschool and after the transition to school in first grade. Finally, this study introduces two relatively new analytic techniques to address questions about relations between sensitivity and responsiveness and child outcome. The variable-centered approach estimates changes in sensitivity and responsiveness in terms of individual growth curves and uses individual differences in growth curve parameters as predictors of child outcomes. In contrast, the person-centered approach identifies types of patterns in the change in sensitivity/stimulation over time, using types as predictors that might differentially relate to outcomes.

Methods

Participants

The NICHD Study of Early Child Care and Youth Development offers a unique opportunity to address these issues with a large geographically, ethnically, and economically diverse population. Children born in hospitals at 10 geographic sites in the United States were followed from birth to first grade. Families were recruited shortly after the child's birth in 1991. For a full description of the sample recruitment and distribution see NICHD ECCRN (2004). A total of 1,097 of the 1,364 original participants continued in the study through 54 months and form the sample for the current study. Mothers of the children in this sample had an average of 14.2 years of education ($SD = 2.51$); 18% were single; and average family income was about four times the poverty threshold ($M = 3.7$, $SD = 2.74$). About three-fourths of the children were European American, non-Hispanic. Importantly, although the analysis sample is not nationally normed, it reflects a diverse range of family backgrounds present in the United States.

Procedure

Infants and their mothers were seen in the lab or in their homes repeatedly from the time the child was 1 month of age until the child was in first grade. Mothers also responded to questions in a telephone interview that was given every 3 months up until age 36 months and approximately every 4 months thereafter. Data for this study were collected using multiple methods: standardized observations of the child or the mother and child, telephone interviews for the mother, and lab-based standardized tests for child outcome measures. Below we outline the measures that were used to provide demographic data, the predictor variable of sensitivity from both mothers and caregivers, and child outcome variables in language, attention, and academic achievement at 54 months of age and in first grade. These outcome measures were collected at the end of preschool (54 months) and in the spring of their first grade.

Measures

Predictor Variables

Demographic measures. During home interviews at 1 month, mothers reported their education (in years) and the study children's sex and ethnicity (non-Hispanic African American, non-Hispanic European American,

Hispanic, or other). The presence of a husband or partner in the home was reported in telephone interviews spaced every 3 to 4 months. Partner status was the proportion of 3- to 4-month intervals during which the mother reported the presence of a husband or partner in the home. Mothers reported family income at 15, 24, 36, and 54 months. Income-to-needs ratios were calculated from U.S. Census Bureau tables as the ratio of family income to the appropriate poverty threshold for each household size and number of children less than 18 years of age. For example, an income of $15,455 in 1995 for a family of four would have an income/needs ratio of 1. Income-to-needs ratio, maternal level of education, child ethnicity, child gender, and the site of data collection were used as control variables in all analyses.

Sensitivity. This measure was an amalgamation of both sensitivity and stimulation as experienced by the child and served as the main predictor variable. It was tabulated from two sources: sensitivity/stimulation in interactions between the child and his or her mother and between the child and his or her child care provider. Importantly, the sensitivity experienced by the child over time from parent and caregiver was the predictor variable, rather than the person delivering sensitive or insensitive care. This becomes critically important in the later analyses because the person delivering sensitive or stimulating care over time for parents will involve a stable person, while the person delivering the sensitive or stimulating care in the child care setting will largely vary over time.

Maternal sensitivity. Qualities of maternal sensitivity and stimulation were rated from a videotaped, semi-structured mother-child dyadic play procedure that occurred in the home when children were 6 and 15 months of age, in the lab when they were 24, 36, and 54 months of age, and in first grade (NICHD ECCRN, 1999). All tapes were coded at a central location by coders who were unacquainted with the family or child care history. The play procedure was designed to elicit interactions that occur between mother and child in the context of the home environment. Maternal stimulation of cognitive development was also evaluated as a part of this interaction using ratings for the number and quality of activities presumed to enhance perceptual, cognitive, linguistic, and physical development.

At 6, 15, and 24 months, composite maternal sensitivity scores were created as the mean of four 4-point ratings: maternal stimulation, maternal sensitivity to child non-distress, intrusiveness (reverse scored), and positive regard. At 36 and 54 months and first grade, the sensitivity composite was computed as the mean of four 7-point ratings (prorated back to a 4-point scale by multiplying by 4/7). The ratings included those of maternal stimulation, supportive presence, hostility (reverse scored), and respect for autonomy. They also included a rating for maternal stimulation that was scored as the number and quality of activities presumed

to enhance perceptual, cognitive, linguistic, and physical development. Scores were equally weighted and then averaged across the assessment periods to create a single rating of sensitivity delivered by the mother. Cronbach's α's for the sensitivity composites were .75, .70, .78, .82, and .85 at 6, 15, 24, 36 and 54 months, respectively. Intra-class correlations were used to calculate inter-coder reliability on the composite scores. Coefficients averaged across pairs of raters were .87, .83, .85, .84, and .88 at 6, 15, 24, 36, and 54 months, respectively. Cross-time correlations ranged from .30 to .52 ($p < .0001$). Low overall scores indicate that mothers were less involved or provided stimulation that was very poorly matched to the child's developmental level or interest. High scores indicate that mothers were sensitive to children's interest and provided age-appropriate cognitive stimulation.

Child care provider sensitivity. At 6, 15, 24, and 36, and 54 months, the child's care environment was assessed using the Observational Record of the Caregiving Environment (ORCE). Observational assessments of caregiver-child interaction were obtained in the primary non-maternal care arrangements of children who were in 10 or more hours of non-maternal care per week at each age. Observations of caregivers and children occurred during two 44-minute cycles of observation conducted on two separate days. The qualitative measures used in this analysis were collected at three equidistant points within the time-sampling periods as well as during 10 minutes at the conclusion of the three cycles. They included assessments for caregiver stimulation of cognitive development, caregiver sensitivity, caregiver detachment, and whether the caregiver established a positive emotional climate in the care environment. Each was rated on a 7-point scale. Inter-rater reliabilities ranged from .76 to .94. Observers across all sites were certified before beginning data collection and were tested for observer drift every 3 to 4 months.

In first grade, the sensitivity and stimulation were assessed through the Classroom Observation System (COS). Observers made time-sampled records of context and of children's behavior for a total of 60 minutes (first grade) spread across the morning, and observers made qualitative or global ratings of classroom contexts and children's behavior on a scale of 1 to 7 before and after the time-sampling sessions (NICHD ECCRN, 2002, 2005b). On the basis of factor analyses and theoretical coherence, two aggregate measures of classroom context were created: instructional support for student learning (stimulation) and emotional support (sensitivity). These composite global measures of first-grade stimulation and sensitivity were averaged together to serve as a concurrent control variable in analyses that examine how predictor variables of experienced sensitivity and stimulation from 6 to 54 months relate to first-grade outcomes.

Hours in non-maternal care. As an additional control variable, we added the average number of hours that the target child spent in non-maternal care at each age from 6 months to 54 months. Average hours in non-maternal care is related to maternal and caregiver sensitivity (NICHD ECCRN, 1999). Hours in care is a maternal report variable based on how many hours the child spent weekly in regular non-maternal care since the time of the last telephone interview. These data were collected every 3 months up to 36 months and approximately every 4 months from 36 to 54 months of age.

Child Outcomes at 54 Months and in First Grade

Child outcomes were selected that measured language prior to entry to school and measured academic achievement and attention at the end of first grade.

Language competence was assessed at 54 months using the Preschool Language Scale (PLS-3; Zimmerman, Steiner, & Pond, 1979). It measures a range of language behaviors, including vocabulary, morphology, syntax, and integrative thinking, which are grouped into two subscales: auditory comprehension and expressive language (Cronbach α's = .89 and .92, respectively, in the current study). These scales were highly correlated (r = .70, $p < .001$ in our sample). The test is standardized to have a mean of 100 and a standard deviation of 15. In our sample, scores ranged from 50 to 133 (M = 99.39, SD = 18.43). The PLS-3 correctly identified 4-year-olds with language disorders 80% of the time, and it was correlated with other language measures (r = .66–.82, see Zimmerman et al., 1979).

Pre-academic skills in first grade were measured with two subtests of the Woodcock Johnson Achievement and Cognitive Batteries (Woodcock & Johnson, 1990). The Letter-Word Identification Test measures skills at identifying letters and words. The Applied Problems Test measures skill in analyzing and solving practical problems in mathematics. Each standard score has a mean of 100 and standard deviation of 15 within the norming population. Within our sample, both scales were reliable based on internal consistency ($\alpha > .90$). Because the scales were highly correlated (r = .57), a summary academic skills score was computed as the mean of the two scale scores.

At first grade, attention was also measured. The Continuous Performance Task (CPT; Rosvold, Mirsky, Sarason, Bransome, & Beck, 1956) was administered to measure errors of omission as a measure of sustained attention. The child was asked to press the button "as fast as you can" each time a target stimulus (a chair) appeared on a monitor screen. A total of 220 stimuli were presented in 22 blocks. Errors of omission occurred when children failed to press the button in response to the appearance of the target

stimulus. A log transformation was applied because of the marked skew in the data obtained.

Data Analysis

Growth curve analyses were conducted (1) to describe patterns of change over time in the sensitivity and stimulation children experienced from their mothers and from their various child care providers, and (2) to determine the extent to which these patterns from one or both sources predicted language and academic outcomes at entry to school. It is important to note that the predictor in these analyses is *not* the person delivering the sensitive and stimulating care, but rather the *care as experienced by the child.* In home assessments, the person (here the mother) and the measure of experienced care are one and the same. In the child care environment, however, the critical variable is experienced care, not the provider who delivers that care. Thus, experienced care over time is the predictor for all of the analyses to be reported. There is a precedent in the literature for examining growth curve analyses and individual variation using predictors of this type (NICHD ECCRN, 2002). It is also interesting to note that given the way we are using the models in this analyses, we are not looking at "growth" over time but rather at *change* over time. We pursued these questions using both variable-centered and person-centered growth curve methods.

The most commonly used variable-centered approach, the hierarchical linear model (HLM), describes intra-individual developmental patterns (here, in care experienced by different children) and identifies inter-individual predictors of developmental patterns (Laird & Ware, 1982; Raudenbush & Bryk, 2002; Singer & Willett, 2003). This approach estimates an individual growth curve for each individual from his or her repeated assessments of experienced care in the home or care environment. For each individual in these analyses, experienced care is defined through an intercept estimated to describe the level of the outcome at a particular age and through a slope estimated to describe the rate of change over time. These individual developmental indices become predictors of interest and can be related to outcomes of interest.[1]

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1. The model for linear change with one grouping variable is as follows:

$Y_{ijk} = (\beta_{0k} + \pi_{0ik}) + (\beta_{1k} + \pi_{1ik})\,\mathrm{Age}_{ijk} + e_{ijk}$

for $i=1,\ldots,n$ individuals,

$j=1,\ldots,p$ occasions,

$k=1,\ldots,r$ groups;

with 2 fixed-effect variables: *Group* and *Age*

and 4 random variables: Y, e, π_{0ik} π_{1ik} ;

The HLM simultaneously estimates the individual and group curves. The individual growth curves are estimated using empirical Bayesian or maximum likelihood methods using both the individual's and the entire sample's data. Group growth curve parameters are estimated as the weighted mean of the corresponding individual curve parameters from the individuals in that group. The weights smooth the individual growth curves toward the group growth curve if they appear too deviant, with error assumed to be the reason that individual curves deviate from the group curve. This smoothing of individual curves and weighting of group curve parameters has been referred to as borrowing strength, and it can greatly increase the precision of parameter estimates and the power to identify predictors of developmental patterns (Raudenbush & Bryk, 2002; Singer & Willett, 2003).

Prototypic growth curve methods are referred to as person-centered analyses of longitudinal data (Bergman, 2001). They are based on the assumption that the population sampled comprises a small number of qualitatively different latent growth curves (Burchinal & Appelbaum, 1991). It is assumed that the latent growth curves differ markedly from each other and that these latent curves account for the individual differences observed in patterns of change over time in an outcome of interest. Currently, trajectory analysis as developed by Nagin and Tremblay (1999) is the most popular method of person-centered growth curve analysis. These trajectory analyses assume the presence of distinct groups of children in terms of the growth trajectories on the sensitivity of care they experienced either at home or in child care. A polynomial model is used to describe the sensitivity and stimulation that children experienced between 6 and 54 months of age so that different trajectory groups be identified that can show different patterns of change ranging from no change through the patterns specified by the highest-order polynomial model specified (i.e., if a linear model is specified, the identified latent profiles can include either positive linear change or negative linear change). The method allows for missing observations and for censored measurement distributions that result in clustering at the scale's minimum or maximum.[2]

This method requires the analyst to specify the number of groups present in the population. However, Nagin and Tremblay (1999) have developed a method to guide the user in selecting the optimal number of groups.

2. Parameter estimates are examined for each group using the following polynomial model:
$y_{it}^{*} = \beta_{0j} + \beta_{1j}Age_{it} + \beta_{2j}Age^{2}it + \varepsilon$
where y_{it}^{*j} = outcome for person i at time t given membership in group j
$\beta_{0j}, \beta_{1j}, \beta_{2j}$ = coefficients describing the growth trajectory for group j

Models are fit in succession, increasing the number of groups by one each time. The change in the Bayesian Information Criterion (BIC) is examined after each model is fit. The model with the largest BIC is accepted as containing the correct number of groups contained in the sample. Individuals are then classified into groups based on the similarity between their growth curve and group prototypic growth curves. After the group trajectories are estimated, the probability of belonging to each group is calculated and the individual is consequently assigned to the group for which it has the highest probability of membership. Once group membership has been assigned, multinomial regression can be performed to investigate the relationship between covariates and the group growth trajectories.

Results

Two sets of analyses were conducted. First, we estimated variable-centered and person-centered growth curves to describe the sensitivity of care experienced by children in interactions with their mothers and child care providers from infancy through 54 months. Second, children's outcomes were predicted from these growth curve indices in multivariate analyses of covariance to determine the extent to which different caregiving experiences over time predicted cognitive and academic skills at first grade. In the models examining outcomes, concurrent quality of parenting and teaching was controlled by including assessments of experienced sensitivity/stimulation at home and at school as covariates.

Growth Curve Analyses

Table 1 describes repeated assessments of stimulation and sensitivity experienced by children in interactions with mothers and caregivers, along with the family demographic characteristics and the first-grade cognitive and academic outcomes.

Sensitivity of care provided by mothers. The HLM (variable-centered) analysis of experienced sensitivity and stimulation delivered by mothers estimated individual linear growth curves and group quadratic curves to describe patterns of change in maternal sensitivity and stimulation in interactions with the target child from 6 months of age through 54 months (see Table 1 for descriptive statistics). Group quadratic slope parameters were used in both the HLM and trajectory analyses. In the HLM, however, only the intercept and linear slopes were estimated for each child. These individual intercepts and slopes were used as subsequent predictors of outcomes. The findings revealed that children experienced significant individual dif-

Table 1. Sample Description

	Child's age	*N*	Percent	Mean	*SD*	Range
Demographic Characteristics						
Maternal education	1m	1,363		14.23	2.51	7–21
Gender: Male	1m	597	51%			
Female	1m	564	49%			
Ethnicity: African-American	1m	173	13%			
Hispanic/Latino	1m	83	6%			
Other	1m	66	5%			
White/nonHispanic	1m	1,042	76%			
Family income/needs ratio	6m–Gr 1	1,096		3.67	2.74	.15–24.5
Two-parent household	6m–Gr 1	1,097		.87	.34	0–1
M. depressive symptoms	6m–Gr 1	1,097		9.23	6.42	0–37
Hour/week child care	1–54m	1,097		30.1	14.6	0–74
Maternal Sensitivity	6m	1,073		2.92	.50	1–4
	15m	1,079		3.03	.49	1.25–4
	24m	1,054		3.03	.57	1–4
	36m	1,058		3.10	.55	.71–4
	54m	1,035		3.05	.55	.71–4
	Grade 1	1,004		2.99	.58	1–4
Caregiver-Teacher Sensitivity	6m	509		2.99	.58	1.2–4
	15m	574		2.94	.57	1.25–4
	24m	598		2.81	.55	1.07–4
	36m	648		2.80	.47	1.46–3.89
	54m	848		2.98	.56	1.13–4
	Grade 1	962		3.03	.63	.76–4
Child Outcomes						
PLS Auditory comprehension	54m	1,063		98.36	19.92	50–139
PLS Expressive language	54m	1,055		100.6	19.95	50–128
WJ-R Applied problems	Grade 1	1,023		110.8	17.1	46–163
WJ-R Letter-word	Grade 1	1,025		112.0	15.8	51–154
WJ-R Academic	Grade 1	1,025		111.4	14.60	69–152
CPT — Omissions	Grade 1	996		2.36	3.93	0–35.6
CPT — log Omissions	Grade 1	996		.83	.80	0–3.6

ferences in both their intercepts of sensitivity (χ^2 (n = 1,302, df = 1) = 384.2, $p < .001$) and in their slopes over time (χ^2 (n = 1,302, df = 1) = 8.35, $p < .01$). Intercepts and slopes significantly correlated ($r = .31$, $p < .001$). The intercept was estimated at the average age of 3 years to enhance the interpretation and power of the main effects (i.e., we had greatest power to test main effects at the mean age of data collection), and the mean estimated intercept was B = 3.04. The random-effects variance was $\sigma^2 = .1303$. The slope described linear change over time, with an average rate of change of B = .034 per year and a random-effect variance of $\sigma^2 = .0026$. In addition, a nonlinear rate of change was detected (B = -.016, SE = .003). Individual differences in quadratic slopes were not significant, so the quadratic slope was dropped from the individual growth curve model and was retained only in the group growth curve. The HLM analysis indicated that, on average, children experience moderately sensitive and stimulating interactions with their mothers during the infant and preschool years. Mothers become slightly more sensitive over time, with slight dip in sensitivity at 15 to 24 months (the "terrible twos").

The trajectory (person-centered) analysis of maternal sensitivity estimated prototypic growth curves and classified the sensitivity and stimulation delivered by each mother into trajectory groups based on the extent to which her growth curve resembled each prototypic group curve. A quadratic growth curve model was specified, and solutions for three, four, and five prototypic groups were estimated. The four-group solution was selected as showing the most parsimonious fit to the data based on the BIC (-4248). Each of these latent profile groups was labeled based on initial sensitivity and patterns of change over time. The estimated four prototypic growth curves are shown in Figure 1 and described in Table 2. The trajectory groups differed in terms of both level and patterns of change over time. One large group emerged (labeled "moderate/increasing"), which included children whose mothers' initial sensitivity was moderately high and who became increasingly sensitive over time. The next-largest trajectory group (labeled "high/stable") included children whose mothers were consistently rated as showing high levels of sensitivity over time. The third-largest group consisted of children (labeled "moderate/stable") whose mothers were moderately sensitive consistently over time. The final, very small group involved children's experience by mothers who showed moderately low levels of sensitivity with babies at 6 months that decreased over time (labeled "low/decreasing"). In summary, the trajectory analysis identified four groups that differed largely in terms of mean level of sensitivity/stimulation experienced by the child.

Sensitivity of care by child care providers. This HLM analysis estimated individual linear growth curves and group quadratic curves to describe pat-

Table 2. Experienced Maternal Sensitivity: Trajectory Groups and Family Characteristics

			Low/decreasing (n = 23)	Moderate/stable (n = 202)	Moderate/increasing (n = 516)	High/stable (n = 356)
Maternal sensitivity						
	6m	M	2.07	2.50	2.87	3.42
		(sd)	(.50)	(.50)	(.41)	(.33)
	15m	M	2.18	2.53	3.00	3.38
		(sd)	(.56)	(.44)	(.37)	(.34)
	24m	M	1.83	2.44	3.01	3.46
		(sd)	(.45)	(.48)	(.41)	(.37)
	36m	M	1.47	2.51	3.12	3.51
		(sd)	(.45)	(.42)	(.37)	(.31)
	54m	M	1.50	2.45	3.08	3.43
		(sd)	(.47)	(.46)	(.37)	(.30)
	Grade 1	M	1.90	2.45	2.99	3.33
		(sd)	(.50)	(.58)	(.47)	(.39)
Caregiver-teacher sensitivity						
	6m	M	2.51	2.95	2.96	3.05
		(sd)	(.66)	(.57)	(.57)	(.57)
	15m	M	2.46	2.83	2.88	3.08
		(sd)	(.70)	(.54)	(.59)	(.51)
	24m	M	2.29	2.56	2.81	2.92
		(sd)	(.68)	(.56)	(.50)	(.57)
	36m	M	2.33	2.60	2.79	2.94
		(sd)	(.51)	(.49)	(.43)	(.45)
	54m	M	2.95	2.84	2.99	3.05
		(sd)	(.48)	(.64)	(.57)	(.50)
	Grade 1	M	2.97	2.82	3.02	3.17
		(sd)	(.65)	(.66)	(.63)	(.58)

Mean hours/wk child care						
	1–54m	M	32.3	32.4	30.9	27.5
		(sd)	(9.9)	(14.5)	(14.6)	(14.7)
Maternal education						
	1m	M	11.5	12.6	14.3	15.7
		(sd)	(1.8)	(2.1)	(2.1)	(2.3)
Gender: male						
	1m	Prop.	61%	52%	52%	47%
Mean income/needs ratio						
	6m–G1	M	1.08	1.98	3.48	5.06
		(sd)	(.53)	(1.39)	(2.34)	(3.17)
Prop.two-parent household						
	6m–G1	M.	48	.70	.89	.96
		(sd)	(.51)	(.46)	(.31)	(.20)
Mean maternal depression						
	6m–G1	M	16.33	13.2	8.8	7.1
		(sd)	(9.0)	(7.0)	(5.8)	(5.4)

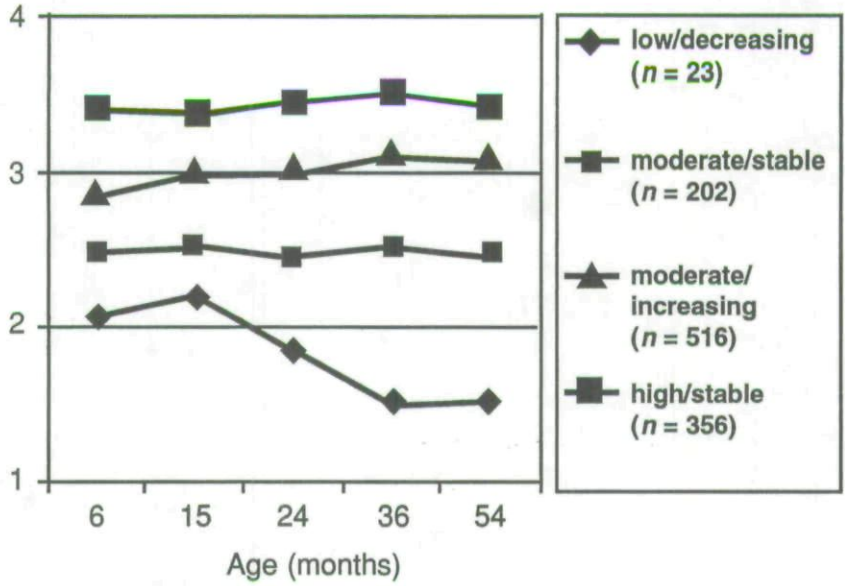

Figure 1. Child-experienced maternal sensitivity: Trajectory groups.

terns of change in sensitivity/stimulation experienced by children in interactions with the target caregivers from 6 to 54 months of age (see Table 1 for descriptive statistics). The HLM (variable-centered) analysis of caregiver sensitivity estimated individual linear growth curves and group quadratic curves to describe patterns of change in caregiver sensitivity in interactions with the target child from 6 months of age through first grade. They revealed that the child-experienced sensitivity showed significant individual differences in both intercept and overall level (χ^2 (n = 1,161, df = 1) = 127.0, p < .001) and in the slope or pattern of change over time (χ^2 (n = 1161, df = 1) = 40.6, p < .001). Intercepts and slopes were significantly correlated (r = -.46). The intercept was estimated at the average age of 3 years, and the mean estimated intercept was B = 2.83 and random-effects variance was σ^2 = .0795. The slope described linear change in the experienced sensitivity/stimulation over time, with a average rate of change of B = .46 per year and a random-effect variance of σ^2 = .0149. In addition, a nonlinear rate of change was detected (B = .044, SE = .005), but individual differences in quadratic slopes were not significant and the quadratic slope was dropped from the individual growth curve model. In summary, the HLM analysis indicated that children received moderately sensitive care from child care providers, but children

experienced more sensitive care from child care providers when they were 6- and 15-month-olds than when they were 24- and 36-month-olds. For the sample as a whole, children experienced higher sensitivity at 54 months than at 36 months, and individual differences in these improvements were not detected in the quadratic slope in individual growth curves.

The trajectory analysis of child care sensitivity estimated prototypic growth curves and classified each child into a trajectory group based on the extent to which his or her growth resembled each prototypic group curve. A quadratic growth curve model was specified, and solutions for three, four, five, and six prototypic groups were estimated. The four-group solution was selected as showing the most parsimonious fit to the data based on the BIC. The estimated four prototypic growth curves are shown in Figure 2 and described in Table 3. Again, the resulting latent profile groups were labeled based on both the initial sensitivity and patterns of change over time. The trajectory groups differ in terms of both level and patterns of change over time. One large group emerged (labeled "moderate/variable") in which caregiver sensitivity was moderately high initially and varied somewhat over time. The next-largest trajectory group (labeled "moderate/stable") included children who experienced moderately high levels of

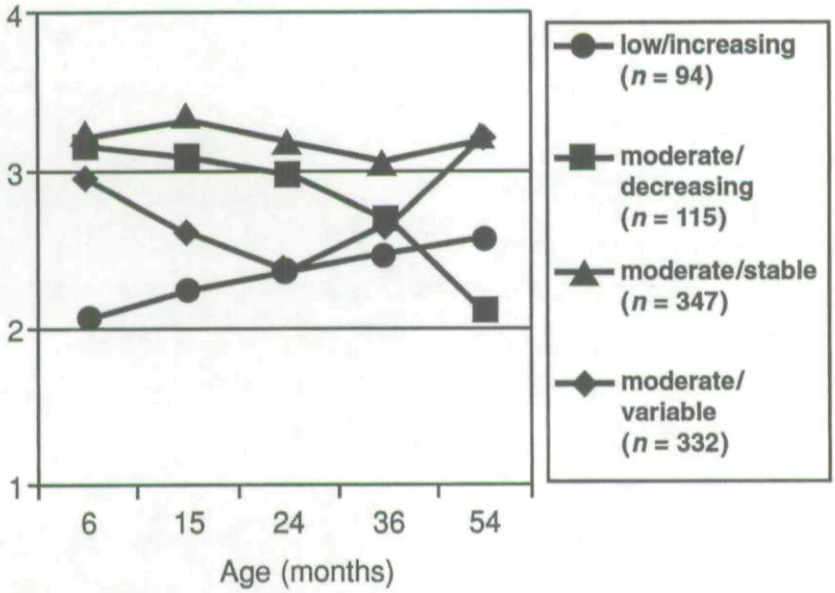

Figure 2. Child-experienced care provider sensitivity: Trajectory groups.

Table 3. Experienced Caregiver Sensitivity: Trajectory Groups and Family Characteristics

			Little or no care (n = 309)	Low/ increasing (n = 94)	Moderate/ decreasing (n = 115)	Moderate/ stable (n = 347)	Moderate/ variable (n = 232)
Caregiver-teacher sensitivity							
	6m	M	[a]	2.07	3.18	3.22	2.95
		(sd)		(.39)	(.39)	(.44)	(.45)
	15m	M	[a]	2.25	3.09	3.34	2.61
		(sd)		(.41)	(.33)	(.44)	(.49)
	24m	M	[a]	2.36	2.99	3.19	2.36
		(sd)		(.48)	(.40)	(.35)	(.41)
	36m	M	[a]	2.48	2.71	3.06	2.62
		(sd)		(.46)	(.46)	(.37)	(.41)
	54m	M	3.2 (.5	2.56	2.11	3.20	3.21
		(sd)	n=149)	(.48)	(.30)	(.38)	(.36)
	Grade 1	M	3.08	3.07	2.94	3.09	2.91
		(sd)	(.64)	(.63)	(.65)	(.61)	(.62)
Maternal sensitivity							
	6m	M	2.94	2.83	2.91	3.06	2.95
		(sd)	(.56)	(.54)	(.53)	(.51)	(.54)
	15m	M	2.95	2.93	2.99	3.12	3.04
		(sd)	(.52)	(.52)	(.49)	(.42)	(.52)
	24m	M	2.92	2.91	2.96	3.18	3.01
		(sd)	(.57)	(.61)	(.60)	(.50)	(.58)
	36m	M	3.00	2.98	3.04	3.26	3.09
		(sd)	(.62)	(.55)	(.50)	(.47)	(.52)

54m	M	2.94	2.95	3.05	3.17	3.04
	(sd)	(.59)	(.60)	(.50)	(.48)	(.54)
Grade 1	M	2.93	2.89	2.89	3.11	2.99
	(sd)	(.60)	(.59)	(.61)	(.49)	(.61)
Average hours/week of child care	M	17.8	41.0	37.5	32.3	35.1
	(sd)	(13.2)	(9.8)	(11.0)	(12.7)	(11.3)
Maternal education	M	13.9	13.8	14.2	15.1	14.3
	(sd)	(2.5)	(2.3)	(2.5)	(2.5)	(2.2)
Gender: male prop						
Family income/needs ratio 6m–G1	M	2.93	3.18	3.56	4.58	3.52
	(sd)	(2.24)	(2.49)	(2.63)	(3.14)	(2.48)
Two-parent household 6m–G1	M	.85	.82	.81	.92	.87
	(sd)	(.36)	(.39)	(.40)	(.27)	(.34)
Maternal depression 6m–G1	M	9.8	9.9	8.5	8.6	8.6
	(sd)	(9.15)	(8.34)	(8.22)	(8.16)	(7.69)

[a] $n < 20$

sensitivity over time. The third-largest group (labeled "moderate/decreasing") consisted of children who experienced moderate levels of sensitivity during infancy but lower levels of sensitivity during preschool years. The next group (labeled "low/increasing") included fewer children, but they experienced rather insensitive care from caregivers during infancy and more sensitive care during the preschool years. Children who were not observed in child care at least twice were lumped into a final group labeled "little or no care."

Correlations Among Predictors, Covariates, and Outcomes

Table 4 shows the correlations between the selected covariates and the individual growth curve parameters from the longitudinal measures of child-experienced sensitivity/stimulation from both mothers and caregivers. Mothers who were sensitive on average tended to show gains over time in sensitivity and stimulation. Caregiver sensitivity and stimulation toward children increased over time. However, the correlations between maternal and caregiver growth curve parameters were only modest at best. Children from more advantaged families tended to have mothers and caregivers who were more sensitive at any given time and overall. Finally, child outcomes tended to be correlated. The two PLS-3 language scores were highly correlated (r = .70) and tended to be correlated with both first-grade academic achievement (r = .56 to .58) and CPT omissions (r = -.22 to -.24). First-grade academic achievement and attention were more modestly correlated (r = -.25).

Caregiving Sensitivity Growth Curves and Child Outcomes

The next set of analyses asked whether first-grade outcomes differed among children who experienced different patterns of sensitivity in the care provided by either the mother or the child caregivers from infancy to school age. One set of analyses asked whether child outcomes differed as a function of the estimated intercepts and slopes from the HLM analyses of child-experienced sensitivity/stimulation care from mothers and caregivers. The other set asked whether the children in the four sensitivity trajectory groups derived from maternal interactions and the children in the four sensitivity trajectory groups derived from caregiver interactions showed different first-grade child outcomes. Interactions between maternal and caregiving sensitivity growth curve parameters were tested in preliminary analyses in the first set of analyses and between groups that experienced different patterns of maternal and caregiver sensitivity over time in the second set of

analyses. Covariates included gender, average hours of child care per week from 6 to 54 months, and demographic characteristics (maternal education, mean income-to-needs from 6 months to first grade, and proportion of time there were two parents in the household from 6 months to first grade). These demographic and child care covariates were included because they were moderately to highly correlated with the sensitivity growth curve parameters from both mothers and caregivers (see Table 4). In addition, the sensitivity ratings of the mother and teacher when the child was in first grade were included to adjust for the quality of concurrent parenting and teaching, respectively.

Variable-centered growth curve predictors. Descriptive statistics showing correlations between individual growth curve indices generated from maternal and caregiver sensitivity and family characteristics are shown in Table 4. The correlations between first-grade outcomes and the two HLM indices of the patterns over time in the quality of maternal care that children experienced between 6 and 54 months are in the first two columns of Table 5. Correlations between child outcomes and the two HLM indices of patterns of the quality of care experienced in care child

Table 4. Correlations Between HLM Indices of Experienced Sensitivity and Family Characteristics

	Maternal Sensitivity		Caregiver Sensitivity	
	Intercept *r*	Slope *r*	Intercept *r*	Slope *r*
Maternal sensitivity				
Intercept	.67***	.25***	–.07*	
Slope	.14***	.00		
Caregiver sensitivity				
Intercept	.14***		–.52***	
Slope	.00			
Maternal education	.52***	.32***	.23***	–.06*
Family income	.43***	.27***	.24***	–.07*
Prop. partner in household	.33***	.23***	.16***	–.02
Maternal depression	–.37***	–.26***	–.10**	.01
Gender (male =1)	–.07*	–.01	–.05	.03
Average hours/week of child care	–.13***	–.07*	–.20***	.01

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 5. First-Grade Outcomes and Experienced Mother Sensitivity: Individual Growth Curves and Trajectory Groups

	HLM Individual Growth Curves		Trajectory Prototypic Growth Curves			
	Parenting intercept (n = 1063) *r*	Parenting slope (n = 1063) *r*	Low/ declining (n = 23) M (sd)	Moderate/ stable (n = 202) M (sd)	Moderate/ increasing (n = 516) M (sd)	High/ stable (n = 356) M (sd)
54m						
PLS auditory comprehension	.54***	.41***	69.30 (9.09)	83.13 (16.62)	98.34 (18.32)	108.8 (16.80)
PLS expressive language	.49***	.38***	69.43 (9.50)	85.34 (19.79)	100.2 (18.54)	110.3 (15.45)
Grade 1						
WJ-R academic skills	.40***	.33*** (9.53)	91.56 (13.65)	101.7 (13.92)	112.4 (12.88)	116.3
CPT — log omissions	–.23***	–.21***	1.33 (1.30)	1.10 (.90)	.85 (.77)	.65 (.71)

Note: * $p < .05$; ** $p < .01$; $p < .001$

between 6 and 54 months are shown in the first two columns of Table 6. First-grade outcomes were correlated with both the intercept and slope of the maternal sensitivity growth curves and with the intercept of the caregiver sensitivity growth curves.

Table 7 lists the results from the regression analyses. These analyses included gender, child's ethnicity, maternal education, income-to-needs ratio, household composition, and average hours of child care per week as covariates. In addition, a dummy variable was created that indicated there was insufficient information about child care provider sensitivity to estimate the caregiver sensitivity growth curve. Children without child care were included in these analyses using an econometric approach for imputing missing values (Allison, 1990). We included a dummy variable that had a value of one when a child was missing child care data and a value of zero when a child had child care data. The inclusion of this dummy variable and the assignment of mean scores to children with missing values for caregiver sensitivity allowed us to include them in the analysis in a manner that did not influence the estimation of parameters to describe the association between outcomes and caregiving sensitivity (see Allison, 1990, and NICHD & Duncan, 2003, for full details). The interactions between maternal and caregiver growth curve parameters were dropped from the analyses when preliminary analyses suggested that those interactions were not necessary and when patterns of interactions for individual outcomes were neither consistent across correlated outcomes nor consistent with developmental theory (e.g., compensatory effects for high-quality child care for children experiencing lower or decreasing level of maternal sensitivity). Finally, first-grade quality was also dropped from preliminary analyses because it did not change observed associations and was missing for over 100 children.

The analysis focused on whether the sensitivity/stimulation intercept and slope from the mother and the sensitivity intercept and slope from the caregivers predicted first-grade outcomes. Separate block tests were conducted to test whether either the maternal or teacher sensitivity growth curve parameters added significantly to the analysis of the child outcomes (i.e., these are statistically equivalent to tests to add blocks of variables in hierarchical regression analyses). Children scored higher on language and academic tests when they experienced more sensitive caregiving from their mothers and caregivers on average over time (see Table 7). In addition, children scored higher on language, academic, and attention outcomes when mothers became increasingly more responsive and stimulating from 6 and 54 months. Similarly, children's expressive language and academic achievement were higher when caregivers became more responsive and

Table 6. First-Grade Outcomes and Experienced Caregiver Sensitivity: Individual Growth Curves and Trajectory Groups

	HLM Individual Growth Curves		Trajectory Prototypic Growth Curves			
	CG sensitivity Intercept (n = 1,020) r	CG sensitivity Slope (n = 1,020) r	Low/ increasing (n = 94) M (sd)	Moderate/ decreasing (n = 115) M (sd)	Moderate/ stable (n = 347) M (sd)	Moderate/ varying (n = 232) M (sd)
54m						
PLS auditory comprehension	.24***	–.04	92.8	98.0	103.9	97.5
			(18.1)	(18.6)	(19.0)	(19.5)
PLS expressive language	.23***	–.06	94.9	98.7	105.4	100.7
			(20.4)	(19.0)	(18.4)	(19.2)
Grade 1						
WJ-R academic skills	.18***	–.01	107.4	110.3	114.6	111.3
			(15.8)	(13.9)	(14.6)	(14.0)
CPT — log omissions	–.12***	.00	.98	.92	.70	.83
			(.81)	(.86)	(.73)	(.77)

* $p < .05$; ** $p < .01$; $p < .001$

stimulating over time. Using Cohen's (1988) guidelines, effect sizes were computed based on regression coefficients and are regarded as large if the effect sizes are greater than .4, moderate if between .2 and .4, and modest if less than .2. The effect sizes were computed to represent the anticipated change in the outcome expressed in standard deviation units associated with a 1 *SD* change in the experienced sensitivity intercept (*SD* = .31) and slope (*SD* = .27) from mothers and the experienced sensitivity intercept (*SD* = .19) and slope (*SD* = .07) from the caregiver. The effect sizes for maternal sensitivity intercepts were moderate (*d* = .27–.28) for language and modest

Table 7. Regressions: Experienced Sensitivity From Mothers and Caregivers: Growth Curve Parameters as Predictors of Language, Academic Skills, and Attention

		PLS Auditory comprehension	PLS Expressive language	WJ Academic achievement	CPT Attention (omission)
Maternal sensitivity/ stimulation–growth curve parameters	$F(2,^a)$	43.3***	46.3***	24.56***	7.56***
Intercept		.23***	.24***	.13**	–.04
Slope–linear age		.08*	.10**	.13***	–.11**
Caregiver sensitivity/ stimulation–growth curve parameters	$F(2,^a)$	3.20*	3.65*	3.75*	1.74
Intercept		.08*	.08*	.09**	–.07
Slope–linear age		.03	.07*	.07*	–.05
Covariates					
Maternal education		.16***	.16***	.17***	–.11**
Income/needs		.12***	.08*	.06	–.00
Partner in household		–.07**	–.04	–.02	–.04
Ethnicity	$F(3,^a)$	9.04***	5.51**	6.06***	1.13
Gender		.13***	.10***	–.01	–.04
Hours/week care		–.01	.01	.06*	–.04
No child care		–.04	–.03	–.01	.01
Model R^2	.36***	.31***	.23***	.09***	

Note: [a] degrees of freedom for error are 1053 for PLS, 1023 for WJ, and 994 for CPT variables

* p < .05; ** p < .01; p < .001

for academic outcomes ($d = .14$), whereas effect sizes for maternal sensitivity slope and caregiver intercept and slope were modest ($.08 \leq d \leq .15$).

Person-centered growth curve predictors. Descriptive statistics involving sensitivity trajectory groups from mothers and caregivers along with family or child care characteristics are shown in Tables 2 and 3, respectively. Those involving first-grade outcomes are shown in the final four columns of Tables 5 and 6, respectively.

The next set of analyses asked whether child outcome differed depending on the type of change in mother and caregiver sensitivity that the children experienced. Results from ANCOVAs are shown in Table 8. The same demographic covariates were included. Analysis models, however, *excluded* interactions between maternal and caregiver groups and first-grade maternal and teacher sensitivity after demonstrating similar findings with and without these terms.

A similar pattern of results obtained as were reported in the HLM analyses, although fewer associations were statistically significant. The ANCOVAs indicated that language and academic achievement outcomes differed across the four sensitivity groups derived from maternal interaction but not among the caregiver sensitivity groups. A linear pattern of differences emerged when the four maternal groups were compared. Effect sizes were computed as the difference between the adjusted group means divided by the estimated standard deviation under the analysis model, the root-mean-squared error. Using Cohen's (1988) recommendations regarding effect sizes for comparing means, differences of .7 or larger were regarded as large, .4–.7 as moderate, and less than .4 as modest. Moderate to large effect sizes emerged when the children whose mothers showed low and declining sensitivity were compared with the children whose mothers showed moderate and increasing sensitivity ($d = .52$, auditory comprehension; $d = .68$, expressive language; $d = .48$ academic achievement) or with children whose mothers showed moderately stable caregiving over time ($d = 1.04$, auditory comprehension; $d = 1.34$, expressive language; $d = 1.00$, academic achievement) and with children whose mothers who showed consistently high levels of sensitivity ($d = 1.38$, auditory comprehension; $d = 1.54$, expressive language; $d = 1.09$, academic achievement). Effects sizes were large, albeit not as large, when children whose mothers showed moderate but increasing sensitivity were compared with children whose mothers showed moderate and stable sensitivity ($d = .52$, auditory comprehension; $d = .66$, expressive language; $d = .52$, academic achievement) and with mothers who showed consistently high levels of sensitivity ($d = .86$, auditory comprehension; $d = .86$, expressive language; $d = .61$, academic achievement). Finally, smaller but significant differences were

Table 8. Analysis of Covariance: Experienced Sensitivity from Mothers and Caregivers: Trajectory Groups as Predictors of Language, Academic Skills, and Attention

		PLS Auditory comprehension	PLS Expressive language	WJ Academic achievement	CPT Attention (omission)
Maternal sensitivity/ stimulation[2]	F(3,[1])	24.7***	28.2***	14.2***	1.56
Low/decrease	Adj M	77.8[a]	77.1[a]	97.8[a]	
Moderate/stable	Adj M	86.1[b]	88.5[b]	104.9[b]	
Moderate/ increasing	Adj M	94.5[c]	99.5[c]	110.8[c]	
High/stable	Adj M	100.0[d]	102.9[d]	112.0[c]	
Caregiver sensitivity/ stimulation[2]	*F(4,[1])*	1.56	1.07	1.02	0.80
Covariates					
Maternal education	*B*	1.41***	1.49***	1.10***	–.04
	(se)	(.25)	(.26)	(.21)	(.01)**
Income/needs	*B*	.92***	.69**	.39*	–.00
	(se)	(.23)	(.24)	(.19)	(.01)
Partner in household	*B*	–3.63*	–1.62	–.34	–.12
	(se)	(1.69)	(1.76)	(1.40)	(.08)
Ethnicity	*F(3,[1])*	14.78***	5.44***	7.43***	2.52
Gender	*B*	5.33***	4.17***	–.21	–.06
	(se)	(.99)	(1.04)	(.81)	(.05)
Hours/week care	*B*	–.05	–.01	.07	.00
	(se)	(.04)	(.04)	(.04)	(.00)
Model R^2		.36***	.31***	.22***	.08***

Note: [1] degrees of freedom for error are 1053 for PLS, 1023 for WJ, and 994 for CPT variables

[2] adjusted means are listed when trajectory group differences were significant. Superscripts show results of pairwise comparisons. Adjusted means with different superscripts are significantly different from each other.

* $p < .05$; ** $p < .01$; $p < .00$

observed when children whose mothers showed moderate and stable sensitivity were compared with mothers who had consistently high levels of sensitivity ($d = .34$, auditory comprehension; $d = .20$, expressive language; $d = .09$, academic achievement). Follow-up analyses indicated that similar results obtained even if first-grade assessments of sensitivity and stimulation from mothers and caregivers were included as a covariate.

Discussion

The present findings suggest three conclusions: (1) child-experienced sensitivity and stimulation from both mothers and caregivers affects child outcomes; (2) change in these aspects of children's experience through preschool is itself a predictor of child outcomes such as language, academic achievement, and attention; and (3) variable-centered and person-centered analyses offer two substantively different ways to examine the relationship of children's contexts for learning and child outcomes over time.

The Case for Looking at Both Maternal and Caregiver Sensitivity

The Committee on Family and Work Policies (2003) reported that in 1999, 9.8 million children under the age of 5 years were in some form of non-maternal care for 40 or more hours per week. Thus, as Bronfenbrenner (1979) forcefully argues, if we are to understand how the environments that children live in affect their social and cognitive outcomes, we must look beyond single predictors like maternal *or* caregiver sensitivity to include the confluence of influences that might affect the child over time. Previous longitudinal studies (Burchinal et al., 2000; NICHD ECCRN, 2002) found that sensitive and responsive caregiving from both home *and* child care relates to language and cognitive outcomes as children enter formal schooling. The results further suggest that while the sensitivity and stimulation experienced from mothers and caregivers are modestly related, it is not the case that sensitive parents choose *only* sensitive caregivers for their children. Child-experienced sensitivity and responsiveness from mothers and caregivers make independent contributions to later child outcomes. Consistent with other literature, more sensitive and stimulating environments at home (Landry et al., 2001; Tamis-LeMonda & Bornstein, 2002) and in child care (Burchinal et al., 1997, 2000; NICHD ECCRN, 2000, 2002; Peisner-Feinberg & Burchinal, 1997) are strongly related to better outcomes for children.

Inspection of the relationships between demographic variables and child outcomes shows the expected patterns. Parents with higher income-

to-needs ratios and better education, as well as families with two-parent households, have children with better language and academic skills. Yet, in our models, these demographic characteristics do not, in and of themselves, account for the findings. Even with these demographic variables held constant, changes in sensitive and responsive parenting and caregiving over time predict language and academic growth. These findings are consistent with others in the literature suggesting a tight relationship between sensitivity or contingent responsiveness to children and cognitive outcomes. They also extend the literature by demonstrating that overall level *and* patterns of change in sensitivity in both contexts during early childhood predict children's later outcomes (Landry et al., 2001).

Perhaps the most interesting finding from this study concerns the relation of child outcomes to changes over time in the experienced caregiving from mothers or caregivers. The HLM analyses indicate that language and academic skills are enhanced when mothers or caregivers become more responsive over time, regardless of initial level of responsiveness. Indeed, children's attention was related to change over time in maternal sensitivity, not to overall level of sensitivity. Thus, the current practice of using measures of maternal or caregiver sensitivity from a single time point ignores a potentially important aspect of the child's experiences at home or in child care.

Although this study breaks new ground in examining the way in which children experience both parent and caregiver sensitivity over time, it also has limitations. The first is that it is impossible from these data to examine the separable impact of *stability* of care and *quality* of care in the alternative care environment. The analyses using children in interaction with their mothers hold stability constant, thus permitting a pure examination of the ways in which fluctuations in sensitive and stimulating caregiving over time relate to changes in child outcomes. In contrast, changes in sensitivity and stimulation from caregivers over time could result from differences in the caregivers themselves or from differences in the kind of interactions that these caregivers have with children, because the study did not reliably track who the caregivers were at each age. Perhaps this is not a serious limitation, however, because the evidence presented in this study still suggests that child-experienced sensitivity and stimulation over time (be it through a person or context) relates to child outcomes.

The second limitation is that we cannot separately analyze the constructs of sensitivity and stimulation, for our operational definition of sensitivity embeds stimulation within it. This is not uncommon in the literature, for more sensitive parents are also more stimulating especially as children age (Tamis-LeMonda & Bornstein, 2002). We fail to ask not only about different contributions of experienced sensitivity and stimulation but also

about whether different kinds of stimulation (e.g., through play or language per se) selectively bolstered language and academic development.

Experienced Sensitivity/Stimulation and Child Outcomes

Prior longitudinal studies examined the relationship between sensitivity and stimulation and child outcome during infancy and the preschool years, but not beyond. Here we offer a glimpse of how the dynamic nature of sensitivity and stimulation in early childhood relates to language and academic achievement during the transition to school and into first grade. We chose four child outcomes that are central to school success at 54 months: language, literacy, mathematical competencies, and attention. There is abundant literature suggesting that each of these skills is important to later academic achievement, relating language at entry to school with reading (Scarborough, 2001) and math (Cocking & Chipman, 1988; Cocking & Mestre, 1988). Further, early reading and mathematical competencies are associated with later reading and math scores (Shonkoff & Phillips, 2000; Storch & Whitehurst, 2002). Theoretically, sustained attention is also central for effective learning in school (Bowman, Donovan, & Burns, 2001; NICHD ECCRN, 2005a).

Not only are these skills pivotal for learning and school readiness, but research demonstrates that each of these outcomes is malleable and responsive to environmental variation (e.g., in language, see Hart & Risley, 1995; in literacy, see Senechal & Lefevre, 2002; in mathematical competencies, see Ginsburg, 1989; and in attention, see NICHD ECCRN, 2002). By using outcomes that are both critical to early school success and responsive to sensitive and responsive contexts, we were able to ask how dynamic changes in the sensitivity of caregiver and parent relate to these outcomes.

Our results suggest that parent sensitivity is important for school success. In the HLM analysis, child-experienced sensitivity from mothers across time related to all four of the outcome variables for their children. This relationship was revealed not only in the relation of school success to the intercept or average scores of children across time, but also in its relation to the slope or changing nature of sensitivity as the child grew older. Further, and importantly, in the person-centered analyses, consistently high sensitivity across time conferred a significant advantage for children even beyond that which was offered by moderate and increasing stimulation.

With caregivers, a similar though not as strong pattern emerged. Caregiver sensitivity was related to three of the four child outcomes, with attention being the only one that bore no relationship to caregiver behavior. In this analysis, the intercepts modestly predicted language and academic outcomes.

However, in the person-centered analyses, no differences were detected in child outcomes across the four patterns of caregiver sensitivity. The caregiver profiles were also less disparate than the parent profiles for sensitivity (e.g., moderate stable sensitivity vs. moderate varying sensitivity), leaving less room for change in predictors to be reflected in later outcomes. Taken together, these results affirm the relationship between the level and change in responsive and sensitive environments and child outcomes.

Variable-Centered and Person-Centered Approaches

The conclusions presented above regarding prediction of outcomes from change and level of sensitivity are especially robust because trajectories of the child-experienced sensitivity from both mother and caregiver were characterized using both a variable-centered and a person-centered approach. The variable-centered approach assumed that there were substantial individual differences in level and rate of change but that these differences were quantitative rather than qualitative. The person-centered approach assumed that there were substantial differences in the overall shape of the trajectories but that differences among individuals showing the same trajectory pattern were minimal. With these data, the HLM approach provided more information regarding patterns of change in child-experienced sensitivity from mothers, because differences among the trajectory groups did not appear in the person-centered analyses. In contrast, the latent trajectory analysis of the degree to which children experienced changes in sensitive and responsive care in child care did reveal trajectories with different patterns of caregiver sensitivity over time. Thus, it is possible that the more informative summary of the child's experiences would be the person-oriented approach if we had detected interesting differences in child outcomes associated with these trajectory groups. Overall, the variable-centered approach appeared to provide more reliable, and perhaps valid, descriptions of patterns of change in caregiving sensitivity for mothers and caregivers, because the data matched the model assumptions of the variable-centered approach more closely than the person-centered approach.

Whereas the variable-centered approach provided better prediction in these analyses, conceptually, the person-centered approach would provide better indices of patterns of change under certain circumstances. The latter approach assumes that there are qualitatively different latent profiles and that within each profile group all individuals show very similar patterns of change over time. Therefore, the person-centered approach would likely have provided better prediction of child outcomes if we had identified groups in which either maternal or caregiver sensitivity showed markedly

different patterns of increases or decreases over time. Given the lack of change between groups in the person-oriented approaches, it is little wonder that the trajectories they generated did not uniquely predict outcomes (Nagin & Tremblay, 1999).

Conclusion

Results from the current study, then, demonstrate three main points. First, it is critical to examine childhood experiences that result from both parents and caregivers. Second, it is critical to examine the dynamic nature of these experiences over time. Finally, newer analytic approaches are now available to enable researchers to investigate how the changing contexts that constitute children's early environments jointly and independently contribute to later social and cognitive behaviors. Although these analyses are not typically used in the study of early cognitive development, they allow us to apply a different lens on the development of language and cognition as it unfolds through time.

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