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Maternal Responsiveness and Children's Achievement of Language Milestones

Catherine S. Tamis-LeMonda, Marc H. Bornstein, and Lisa Baumwell

This prospective longitudinal study examined the contribution of dimensions of maternal responsiveness (descriptions, play, imitations) to the timing of five milestones in children's ($N = 40$) early expressive language: first imitations, first words, 50 words in expressive language, combinatorial speech, and the use of language to talk about the past. Events-History Analysis, a statistical technique that estimates the extent to which predictors influence the timing of events, was used. At 9 and 13 months, maternal responsiveness and children's activities (e.g., vocalizations, play) were coded from videotaped interactions of mother–child free play; information about children's language acquisition was obtained through biweekly interviews with mothers from 9 through 21 months. Maternal responsiveness at both ages predicted the timing of children's achieving language milestones over and above children's observed behaviors. Responsiveness at 13 months was a stronger predictor of the timing of language milestones than was responsiveness at 9 months, and certain dimensions of responsiveness were more predictive than others. The multidimensional nature of maternal responsiveness and specificity in mother–child language relations are discussed.

INTRODUCTION

The supporting role of maternal responsiveness for children's advances in cognition broadly, and in language specifically, is well documented (e.g., Bloom, 1993; Bornstein, 1989; Bornstein, Tamis-LeMonda, & Haynes, 1999; Landry, Smith, Miller-Loncar, & Swank, 1997). This prospective longitudinal study examined relations between dimensions of mothers' responsiveness and the achievement (i.e., age of onset) of language milestones in children's first and second years of life. Specifically, this study investigated whether mothers who are more responsive to the vocal and exploratory behaviors of their children have children who imitate words, spontaneously express their first words, achieve 50 words/phrases in their expressive vocabulary, engage in combinatorial speech, and use language to talk about the past, sooner in development. The study questioned whether maternal responsiveness uniquely predicts children's achieving any or all of these basic language milestones over and above the contributions of children's own vocalizations and activities, and it examined which forms of responsiveness at which ages predicted which language milestones.

This study emphasized the social-interactive bases of early language acquisition, a position that is rooted in the writings of Vygotsky (1962) and Bruner (1983). Although children's earliest achievements in language are influenced by developments in perception, cognition, and phonology, they are virtually always embedded in a social context: Language enables children to share intents, thoughts, and desires with others and, hence, constitutes one of the most relevant vehicles for sustained intersubjectivity (Bloom, 1993, 1998; Trevarthen, 1993). The view espoused in this study is that within the normative range of language acquisition, variation among children is largely explained by differences in the verbal information and meanings afforded to children by their social communicative partners. Optimum occasions for language learning occur when adult speech is focused on and relevant to children's attention (Bloom, 1993, 1998). This position is supported by research indicating that children best acquire new pieces of linguistic information when engaged in joint attention with a mature language user (Moore & Dunham, 1995).

Child activities and maternal responsiveness. In the first year, children's exploration of objects, play, vocalizations, and actual bids to mother constitute prominent indicators of affect, attention, communication, and cognitive functioning. The extent to which children engage in these activities varies substantially, as do the responses of mothers to these different modes of childhood expression (Baumwell, Tamis-LeMonda, & Bornstein, 1997; Bornstein et al., 1992; Rogoff, Mistry, Radziszewska, & Germond, 1992; Tamis-LeMonda, Bornstein, Baumwell, & Damast, 1996). Mothers who respond promptly, contingently, and appropriately to their children's activities are thought to inculcate a sense of self-efficacy, motivation, and security of attachment in them (Ainsworth, 1973; Bornstein et al., 1992; Matas, Ahrend, & Sroufe, 1978; Skinner, 1986; Watson, 1985). In addition, mothers who are verbally

responsive to the foci of their children's attention may specifically support advances in children's language by providing labels for objects and events under joint attention, thereby easing the challenge of children's matching linguistic symbols to their referents and reinforcing the social-communicative functions of language (e.g., Baldwin & Markman, 1989; Bloom, 1993; Bloom, Margulis, Tinker, & Fujita, 1996; Carpenter, Nagell, & Tomasello, 1998; McCune, 1995; Tomasello & Farrar, 1986). Indeed, mothers have been shown to be especially sensitive to their children's interests and abilities, for example, by fine-tuning the semantic and syntactic content of their utterances to match their children's level of understanding (e.g., Clarke-Stewart, VanderStoep, & Killian, 1979; Cross, 1978). Maternal speech that semantically matches children's speech, as one form of responsiveness, strongly predicts children's linguistic abilities (Barnes, Gutfreund, Satterly, & Wells, 1983; Cross, 1978). In essence, maternal responsiveness ensures that mother and child "share a way of looking at the world" (Snow, 1986), a foundation that enables children to interpret and make sense of adult utterances during parent–child conversation.

The study of maternal responsiveness directly bears on the role of joint attention in early language acquisition, because mothers who respond to their children's communications and exploratory bouts are, by definition, keying into the same topic of interest as their children. By engaging in responsive modes of interaction, adults provide children with clearer pragmatic cues to word learning, thereby enabling children to more easily negotiate ongoing activities with adults (Akhtar, Carpenter, & Tomasello, 1996; Bloom, 1998; Snow, 1989; Zukow, 1991). Thus, responsive exchanges between mothers and their children are rooted in the contributions of both, in that children in essence "signal" their choices of communication, and mothers react to those signals in a sensitive manner.

The efficacy of parental responsiveness may not be global, however. When maternal responsiveness is decomposed into different dimensions (e.g., responding to play versus responding to language), its relation to children's abilities is specific (Keller, Lohaus, Voelker, Cappenberg, & Chasiotis, 1999; Tamis-LeMonda et al., 1996). This suggests that maternal responsiveness may be more profitably studied as a multidimensional construct, with certain outcomes in children being affected by specific types of responsiveness at specific periods in development (e.g., Bornstein, 1989; Bornstein & Tamis-LeMonda, 1997; Tamis-LeMonda, 1996; Wachs, 1992). As an example, it is possible for two mothers to be similar in their overall responsiveness (i.e., how often they respond to changes in their children's behaviors) and yet differ in the *target* activities to which they respond: One mother may respond to her child's verbal overtures and another to her child's exploratory initiatives. In addition, the *type* of responses mothers exhibit vary in their content: One mother may respond by affirming her child's activities ("Good job!"), and another by describing her child's actions ("You put the circle in the shape sorter.").

Research by Bornstein and colleagues (1992) exemplifies this multidimensional approach to maternal response targets and response types—they distinguished maternal responses to infants' nondistress vocalizations from responses to infants' exploration (looking at objects or at mother) and identified telling differences among French, Japanese, and American cultures. Moreover, they found that responsiveness to different target activities in infants related in specific ways to infants' activities across these cultures: Infants whose mothers responded more to their object attention were found to explore their environments more, whereas infants whose mothers responded to their dyadic overtures were found to display an increased amount of looks and bids toward their mothers. The present study also examined specific dimensions of maternal responsiveness (i.e., to specific infant targets and using specific forms) in relation to the timing of children's achieving specific language milestones in their first and second years.

Language milestones in children. The expressive language achievements that were assessed were first imitations, first spontaneous words, achievement of 50 words, combinatorial speech, and the use of language to talk about the past. Each of these five milestones is thought to index an important achievement in children's communicative and cognitive abilities (see Bloom, 1993; Fenson et al., 1994; Lifter & Bloom, 1989; Roberts, 1999; Tamis-LeMonda, Bornstein, Kahana-Kalman, Baumwell, & Cyphers, 1998), and they typically emerge in relative succession in normally developing children. Specifically, infants' vocal imitations provide parents with the opportunity to reinforce the meaningfulness of particular phonetic forms to their children (McCune, 1992), and children who more often imitate words outside of their verbal repertoires early in language acquisition demonstrate larger lexicons at 17 and 21 months of age (Masur, 1995). First spontaneous words in expressive language signal the start of word learning in the second year, an overt indication that children are beginning to associate words with environmental referents (Bates, Bretherton, & Snyder 1988; McCall, Eichorn, & Hogarty, 1977). The accumulation of 50 words in expressive language coincides with a sudden acceleration in the production of lexical items (Nelson, 1973) thought to signify

developments in categorization (Gopnik & Meltzoff, 1987), object permanence (Bloom, 1973; Lifter & Bloom, 1989), phonetic capabilities (Roberts, 1999), and the use of language to refer to different components or attributes of objects and events (Bloom, 1973; McCune, 1995). The onset of combinatorial speech is thought to signify a child's ability to represent and encode relations between independent entities (McCall et al., 1977), thereby setting the stage for advances in semantic and grammatical abilities (Fenson et al., 1994). Finally, the use of language to talk about the past is thought to evidence the child's ability to linguistically symbolize a past experience that is independent of immediate perceptual and motor experiences (Tamis-LeMonda et al., 1998).

An Events-History approach. The aim of this study was to examine the predictive validity of dimensions of maternal responsiveness for the timing of children's achieving different language milestones, rather than how much children express at a fixed period in development. To do so, Events-History Analysis (also referred to as Survival Analysis) was used. This statistical technique provides conceptually and empirically useful metrics regarding the predictors of "event onsets" and estimates as to how much an event is displaced in time (i.e., occurs sooner or later) in the presence of significant predictors (see Willett & Singer, 1991, 1993, for reviews).

For example, by using this approach it is possible to ask "What is the probability that children will speak their first words at 9 months, 9½ months, 10 months, 10½ months, through the end of the study, if they have not already done so?" The set of conditional probabilities of the target event occurring across the specified ages is termed the *baseline hazard function.* If the event is equally likely to occur at any given age, the hazard function will be flat, because the probability for achieving the event does not depend on age. If the baseline hazard function peaks at a specific age, it suggests that children are more likely to achieve the event at that age than at others.

From baseline hazard probabilities, the *baseline survivor function* can be calculated. The survivor function represents the cumulative probability of an event occurring in a group of children at successive ages. As a hypothetical example, the cumulative probability of a group of children achieving first words in expressive language would most likely be 0 at 9 months (because no children have yet achieved the milestone at this time); at 11 months, the cumulative probability might be .15; by 13 months, the cumulative probability might be .60; and so forth, until all children in the sample have expressed their first words, at which point the baseline survivor function reaches 1.00.

A third Events-History metric, *median lifetime*, provides information as to when a sample achieves a given milestone on average. The median lifetime is signified when the cumulative probability of an event occurring reaches .50 in the survivor function.

Importantly, baseline hazard and survivor functions can be compared with *fitted hazard and survivor functions* that provide estimates about the displacement of an event (i.e., its movement forward or backward in time) in the presence of predictors. If a variable is found to be a significant predictor of the timing of milestones, it is possible to contrast estimates of median lifetimes for subgroups of children. As an example, Events-History Analysis makes it possible to estimate by how many weeks or months children with less versus more responsive mothers will differ in achieving first words in expressive language, and what specific forms of maternal responsiveness are most predictive of children's achieving first words.

Investigations of socialization factors in children's language have typically examined prediction to children's language at a specific criterion age (e.g., Bates et al., 1988; Tamis-LeMonda & Bornstein, 1994). One exception is research by Huttenlocher and colleagues (Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991; Huttenlocher, Levine, & Vevea, 1998) in which children's language growth was assessed over time in relation to different forms of environmental input. In one study (Huttenlocher et al., 1991), children's expressive language during interaction with their mothers was assessed every 2 to 4 months between the ages of 14 and 26 months of age. The investigators noted that children showed an upward curvature in growth trajectories over time, and that this acceleration in vocabulary growth was accounted for by overall parental speech to children. These authors, however, focused on sheer amounts of adult speech, rather than responsive speech, and did not consider the contributions of the child in predicting language growth.

More recently, by using Events-History Analysis, it has been shown that mothers' overall responsiveness at 13 months predicted the timing of several second-year language milestones (Tamis-LeMonda et al., 1998). Specifically, children with more responsive mothers were found to achieve the vocabulary spurt and combinatorial speech, and use language to talk about the past sooner in development than were children with less responsive mothers. In the present research this line of research was extended in four main ways. First, a multidimensional approach to maternal responsiveness was taken by noting, for every instance of maternal responsiveness, what mothers responded to as well as how they responded. This more differentiated approach to parenting built on earlier research

in which maternal responsiveness was treated as a global attribute. As such, the question was whether sheer maternal responsiveness was what mattered for children's language development, or whether the specific nature of mothers' responses was important. Second, related to the task of coding the content of mothers' responses, observational measures of children's attention, play, vocalizations, and bids were included as potential predictors of later language. Third, in the assessment of both mother and child, the study asked whether maternal responsiveness continued to predict language development above children's own activities, a question not previously addressed. Finally, prediction to two new language milestones in children—first imitations and first words—was examined. In prior research, the timing of children's first words predicted children's subsequent language; thus, this milestone in particular was considered to be worthy of further examination.

To summarize, the questions asked were which forms of maternal responsiveness predict the timing of several child language milestones, whether maternal responsiveness at 9 or at 13 months is more predictive, and whether responsiveness continues to predict the timing of children's language achievements over and above children's own contributions. A transactional perspective on early development suggests that both mother and child influence one another both within and across time (Sameroff, 1983); hence, a fuller picture of environmental specificity and mother–child mutuality in language growth is advanced when dimensions of maternal responsiveness and domains of child activity are considered jointly.

METHOD

Participants. Forty mother–child dyads (17 mothers and sons and 23 mothers and daughters) participated in the study. Participants were recruited from private obstetric and pediatric groups in a large metropolitan area. Only firstborn, term infants who were free of any known neurological and sensory abnormalities participated. All participants came from relatively homogeneous, European American, middle- to upper-middle-class intact households ($M = 58.7$, $SD = 6.3$, on the Four Factor Index of Social Status; Hollingshead, 1975) in which both mother and father were native English speakers. Mothers ($M = 33.2$ years of age, $SD = 3.4$) and fathers ($M = 35.7$ years of age, $SD = 4.8$) had completed an average of 5.6 ($SD = 2.1$) and 5.3 ($SD = 1.7$) years of schooling past high school, respectively. Dyads were visited in their homes when children were between the ages of 9 and 10 months of age ($M = 9.5$, $SD = .2$), and then again when the children were between the ages of 13 and 14 months ($M = 13.7$, $SD = .4$). Because demographic variables were unrelated to any 9- and 13-month child and mother measures in this sample, they were not considered in analyses.

In general, child gender was not associated with maternal responsiveness nor with children's observed activities at 9 and 13 months. Girls, however, achieved some milestones sooner than boys, 17.2 versus 18.7 months for 50 words in expressive language, 17.7 versus 19.5 months for combinatorial speech, 17.4 versus 19.4 months for first talking about the past, ts(39) = 2.13 to 3.08, ps $< .05$. Gender was therefore examined in interaction with each of the predictors in relation to the timing of each of the criterion measures. No interactions were observed. Whether main effects were maintained over and above the contribution of gender was also assessed. Because gender did not play a role in any of these analyses, data for all 40 participants were combined in the analyses. Gender differences were noted, however, for children at the extremes of language; these differences are discussed further in the results.

Children's activities and maternal responsiveness at 9 and 13 months. At both ages, mother and child were asked to play on the floor with a standard set of toys for 10 min. The dyad had the opportunity to play with any or all of the toys provided by the experimenter, and mothers were asked to use only the experimenter's toys during the play session.

Event-based coding of all child activities and all maternal responses was conducted on videotapes of mother–child play. The coding of child activities and maternal responsiveness was based on the approach of Bornstein and Tamis-LeMonda (1989) and Bornstein et al. (1992), which is elaborated in Baumwell et al. (1997). Experimenters began coding when children exhibited a change in their ongoing behavior that fell into one of four categories: (1) bidding to or looking at mother, (2) exploring an object/toy (i.e., looking at or manipulating the object), (3) vocalizing, or (4) playing with a toy or object (i.e., engaging in nonsymbolic or symbolic levels of play with the object). Children's exploring of objects was distinguished from their playing with objects on the basis of documentation in the literature that younger children (e.g., 9-month-olds) primarily explore objects (i.e., through mouthing and manipulation) but that by 13 months, children increasingly engage in combinatorial and symbolic play with objects (see Belsky, Goode, & Most, 1980). The categories of child behaviors, as well as maternal responses to these individual behaviors, were all mutually exclusive. If children displayed overlapping categories of behaviors (e.g.,

looking and vocalizing), the vocalization was coded. The forced-choice approach was deemed necessary for analytic purposes.

After noting the child's activity, the coder recorded whether or not the mother responded within a 5-s window. A maternal response was defined as a positive and meaningful change in the mother's behavior that was contiguous and contingent on the child's act. As an example, if the child looked at a cup (target act = exploring) and the mother said "cup," the mother was credited with responsiveness; similarly, if the child said "cup" (target act = vocalizing) and the mother responded "That's a cup," she would also be credited with responding. For each maternal response that was noted, coders also recorded what mothers did when they responded (referred to as a maternal response type). Types of responsiveness were coded into one of six categories: (1) affirmations of a child's actions (e.g., "Yes," "That's right," "Good job"); (2) imitations of a child's vocalization (e.g., "ball" after child said "ba"); (3) descriptions of an object, event, or activity (e.g., "That's the spoon you're holding"); (4) questions about an object, event, or activity (e.g., "What is that?"); (5) play prompts or demonstrations (e.g., "Why don't you feed the doll?"); and (6) exploratory prompts (e.g., "Look here," "What else can we do?"). These categories of response types were mutually exclusive. Over 90% of maternal responses could be classified into one of these six categories. The frequency of each of the four child activities, the frequency with which mothers responded to each of these target child activities, and the frequency of the six subtypes of maternal responsiveness at both 9 and 13 months were then calculated.

Four random reliability checks at each age for each coder (n = 24) were conducted to ensure reliability; Cohen's (1960) κ averaged .77 for child target acts and .73 for maternal response types.

Language measures. At the conclusion of the 9-month home visit, experimenters provided mothers with a packet of language inventories and arranged a convenient weekly schedule to discuss children's language over the telephone following guidelines reviewed in the materials. Packets included versions of the Early Language Inventory (ELI; Bates et al., 1988) and MacArthur Communicative Development Inventories (MCDI; Fenson et al., 1994) as well as checklists exemplifying various semantic and syntactic uses of words and phrases (Tamis-LeMonda & Bornstein, 1994). At earlier interview ages (e.g., 9 to 12 months), a subset of the MCDI was used (specifically, the ELI upon which the MCDI was based) because children at these ages expressed few words and their receptive language was still limited. Early interviews were conducted relatively quickly (15 to 20 min), whereas later interviews, which used the full MCDI, took up to 2 hr.

Maternal report was selected as an appropriate method for obtaining data on children's language because it is cost and time efficient and valid (Bornstein & Haynes, 1998), thereby providing a methodologically feasible approach to obtaining detailed and accurate data on a relatively large cohort of children at repeated intervals. The predictive validity of maternal report for children's language is especially strong when assessment is limited to current and emergent behaviors and when a recognition format is used, thereby placing fewer demands on the respondent's memory (see Fenson et al., 1994). During each telephone interview, the interviewer read to the mother a list of lexical items taken from a broad range of verbal categories (e.g., food, commands, toys, activities) and asked about her child's expression of each item and about related items that did not appear on the inventory. Mothers were instructed to have the lists (which they had received in their language packets) available during these telephone interviews so that they could read along with the interviewer, thereby enhancing the accuracy of responses. Detailed notes on mothers' responses to all probing were made. During interviews, the interviewer asked the mother, in order, whether her child imitated or expressed each word and phrase on the list. In the case of spontaneous expression, the interviewer further probed as to whether the child's expression was context "flexible" or context "restricted" (e.g., saying "ball" to all balls, even to those not present, as opposed to saying "ball" only to a specific ball). To receive credit for expressing a "word," children had to (1) approximate the phonetic form of the word (e.g., "ehh" for bottle was not credited, whereas "bot" for bottle was), (2) use the phonetic form in a consistent way with a recognizable meaning, (3) express the word spontaneously, and (4) use the word across multiple contexts. Thus, words used in restricted contexts were noted but were not counted in analyses (see Bates et al., 1988; Goodwyn & Acredolo, 1993; Tamis-LeMonda & Bornstein, 1994; Tamis-LeMonda et al., 1998; Vihman & McCune, 1994). Thus, relatively conservative criteria were adopted for crediting different language achievements.

After probing about specific words and phrases, the interviewer next asked the mother whether her child was "putting two or more words together." If a mother reported that her child was combining words, the experimenter probed for specific examples of the child's constructions and asked the mother to provide contextual information about the child's word combinations. The achievement of combinatorial speech was indicated when (1) the child was reported to link

two or more words in a single phrase, (2) the mother was able to provide the context for her child's use of the phrase, (3) each of the words in the phrase could be classified as independent words in the child's vocabulary, and (4) each of the words in the phrase could be classified into distinct semantic categories (e.g., actor, action, object of action, patient, possession, and so forth; see Tamis-LeMonda & Bornstein, 1994; Tamis-LeMonda et al., 1998). Thus, unanalyzed phrases such as "whassat?" "nomore," and the like did not qualify as combinatorial speech.

Finally, the interviewer asked the mother to describe any instances during the prior 2-week period in which her child used language to talk about the past. Examples of such utterances were read to mothers to clarify what was meant by talking about the past (e.g., "grandma choo-choo" to indicate that grandma had visited by train the prior week). Again, phrases only qualified as memories if mothers could (1) state the phrase the child used, (2) state when the child used the phrase, and (3) provide supportive information about the event that served as the referent to the verbal memory. Children's expressions that seemed arbitrary or that were expressed in confusion, and phrases used as parts of a verbal game or routine, did not qualify as memories. Examples of creditable memories expressed by children in the study included the following: One mother reported that her child pointed to a spot on the table and said "mommy coffee" to indicate that her mother had spilled coffee there earlier; another child pointed to the stove saying "baby touch" to indicate that she had touched the hot stove the previous day.

From interviews, the child's age in days was calculated for the following measures in expressive language: (1) *first imitation*, when the child first repeated the phonetic approximation of a target adult word; (2) *first words*, when the child acquired minimally one new flexible word during two consecutive interviews; (3) *50 words*, when the child accumulated a total of 50 flexible words in the expressive vocabulary; (4) *combinatorial speech*, when the child first combined two or more words; and (5) *language used to talk about the past*, when the child first used a word or phrase to refer to a past experience. The calculation of a child's age of achievement for each milestone was computed from the exact age of the child (in days) at the time of the telephone call during which the language milestone was reported to occur. Because interviews were spaced by only 1 to 2 weeks, error around these age estimates was limited and constant across children.

RESULTS

Results are organized as follows. First, descriptive data are presented on the four target child activities, mothers' responses to each of the four target activities, the frequencies of different types of maternal responses, and the timing of criteria language milestones. Second, the results of the Events-History Analyses, which were performed to test the contributions of child activities and maternal responsiveness at each age to the achievement of each of the five criteria language milestones separately, are presented. These analyses are presented in three waves. The combined and unique contributions of the four target child activities (Table 1, C1 through C4) and maternal responses to those target activities (Table 1, MR1 through MR4) to the timing of each language milestone (Table 1, LM1 through LM5) are presented separately. These analyses were conducted for 9-month predictors followed

Table 1 Predictors and Dependent Measures

Predictors			
Target Child Activities at 9 and 13 Months	Maternal Responses to Child Activities at 9 and 13 Months	Maternal Response Types at 9 and 13 Months	Dependent Measures: Milestones in Children's Expressive Language
(C1) Bids/looks toward mother	(MR1) Responding to bids/looks toward mother	(MRT1) Affirmations	(LM1) First imitations
(C2) Exploration of/looking at objects and toys	(MR2) Responding to exploration/looking at objects and toys	(MRT2) Imitations	(LM2) First words
(C3) Vocalizations	(MR3) Responding to vocalizations	(MRT3) Descriptions	(LM3) 50 words
(C4) Play	(MR4) Responding to play	(MRT4) Questions	(LM4) First combinatorial speech
		(MRT5) Play prompts	(LM5) First use of language to talk about the past
		(MRT6) Exploratory prompts	

by analyses based on the same predictors at 13 months. To do this, nested hierarchical χ^2 analyses were used. In these analyses, the baseline hazard functions for each of the language milestones (i.e., for the group in the absence of any predictors) were compared to fitted hazard functions in which the combined effect of two predictors (one child and one mother) were included. A significant reduction in the χ^2 goodness-of-fit statistic indicated that child and mother measures together improved model fit when added to the baseline model. To examine the unique influences of mother and child over and above the other, the fitted models that included the two predictors (child and mother) were compared with models that included single predictors (mother only or child only). As an example, one analysis asked whether maternal responsiveness to child vocalizations at 9 months (Table 1, MR3) uniquely predicted the timing of children's first words (Table 1, LM2) over and above children's vocalizations at 9 months (Table 1, C3) and vice versa. A χ^2 value for the model including the two predictors of child vocalizations and maternal responsiveness that was significantly lower than the χ^2 value for the model including the single predictor of child vocalizations would indicate that the addition of maternal responsiveness to the model improved its fit.

Third, the predictiveness of specific "types" of responsiveness (Table 1, MRT1 through MRT6) was examined for the timing of each child language milestone, again comparing the contributions of maternal responsiveness over and above child activities at each age separately by using nested χ^2 models. Thus, for example, fitted models that included the variable maternal imitations (Table 1, MRT2) and child vocalizations (Table 1, C3) for children's language milestones (Table 1, LM1 to LM5) were compared with fitted models including child vocalizations only. Differences in the χ^2 values for the two sets of fitted models (those that included mother and child variables versus those that included child variables only) indicated which forms of maternal responsiveness were predictive above child contributions. These analyses were again conducted separately at each of the two ages for each of the five criteria language milestones.

Finally, in instances in which significant child or mother predictors of language milestones were identified, summary statistics for two extreme subgroups of children were modeled and contrasted: children representing the lowest 10th percentile of the predictor variable (e.g., children with low responsive mothers on a particular dimension) and children representing the highest 10th percentile on the predictor variable (children with highly responsive mothers on a particular dimension). These analyses illustrate the utility of Events-History Analysis in estimating the displacement of an event in time as a function of different levels of significant predictors.

Descriptive statistics. Descriptive statistics for the

Table 2 Descriptive Statistics on Child and Mother Measures

Variable	*M*	*SD*	*Range*
Child activities			
Frequencies at 9 months			
Bids/looks toward mom	11.7	6.9	2–27
Exploration	24.6	6.9	8–46
Vocalization	19.3	11.8	2–51
Play	11.4	7.4	0–31
Frequencies at 13 months			
Bids/looks toward mom	15.2	8.9	2–36
Exploration	18.5	6.8	9–36
Vocalization	27.3	17.5	1–91
Play	30.2	11.9	4–51
Maternal responsiveness			
Frequencies at 9 months			
Responses			
Responses to bids/looks toward mom	9.5	5.8	2–23
Responses to exploration	16.3	6.5	3–32
Responses to vocalization	9.7	6.4	1–28
Responses to play	6.6	5.4	0–22
Types			
Responses with affirmations	8.7	6.1	0–24
Responses with imitations/expansions	2.1	2.6	0–11
Responses with descriptions	14.5	6.2	4–27
Responses with questions	1.7	1.6	0–5
Responses with play prompts	12.1	6.7	3–30
Responses with exploratory prompts	1.3	1.9	0–9
Frequencies at 13 months			
Responses			
Responses to bids/looks toward mom	12.3	7.7	1–32
Responses to exploration	12.8	6.0	2–25
Responses to vocalization	15.9	10.6	0–44
Responses to play	19.5	8.6	4–40
Types			
Responses with affirmations	14.0	6.4	2–28
Responses with imitations/expansions	4.2	4.6	0–21
Responses with descriptions	18.0	6.9	8–33
Responses with questions	2.3	2.3	0–8
Responses with play prompts	21.7	9.5	7–43
Responses with exploratory prompts	.7	1.3	0–6
Expressive language milestones			
Age of achievement (months)			
First imitation	11.1	1.7	9.0–15.0
First words	12.8	2.8	10.0–21.0
50 words	17.9	2.3	13.4–21.4
First combinatorial speech	18.7	2.3	14.0–22.0
First use of language to talk about the past	18.4	2.6	13.9–22.0

frequencies of the four target child activities at the two ages, dimensions of maternal responsiveness at the two ages, and the timing of the five criteria language milestones are presented in Table 2. As expected, most measures were marked by substantial variability. (This article focuses on children's achievement of milestones; therefore, relations among and between child and mother predictors at each age and the cross-age stabilities of child and mother measures are not reported.) For most child activities, mothers responded to about 60% of actions (one exception being bids, which were responded to more frequently), a finding that accords with descriptive data provided in other studies of maternal responsiveness (e.g., Bloom et al., 1996).

Achievement of the five criteria language milestones was used to determine which variables might be considered predictors for which criteria at each of the two ages. On the basis of the fact that all language milestones were achieved after the initial 9-month home visit, 9-month maternal responsiveness and 9-month child activities were considered potential predictors of all five milestones. In contrast, maternal responsiveness and child activities at 13 months were only considered potential predictors of the timing of 50 words in expressive language, combinatorial speech, and use of language to talk about the past because these milestones reliably occurred only after the 13-month visit. That is, observed measures of child and mother at 13 months were not tested as predictors of first imitations or first words because both of these language milestones were achieved earlier than 13 months on average.

The unique contributions of child and mother to children's achieving language milestones. The contributions of specific child activities and maternal responsiveness to those activities to model fit were examined separately for each of the criteria language measures. Table 3

Table 3 Chi-square Goodness-of-Fit Indices Testing the Contributions of Child and Mother at 9 Months to Children's Expressive Language Milestones

Criterion/Predictor	Baseline Hazard	Fitted χ^2 (2 IVs)[a]	Child over Mother[b]	Mother over Child[b]
First imitation	94.8			
Responses to bids/child bids		.9	.7	.9
Responses to exploration/child exploration		10.8**	.9	6.4*
Responses to vocalization/child vocalization		4.2	1.2	3.6
Responses to play/child play		2.3	.0	.9
First words	166.2			
Responses to bids/child bids		6.4*	.3	2.0
Responses to exploration/child exploration		3.3	2.0	3.2
Responses to vocalization/child vocalization		10.7**	.6	6.4*
Responses to play/child play		6.3*	.4	1.6
50 words	198.6			
Responses to bids/child bids		1.7	.0	.3
Responses to exploration/child exploration		3.0	3.0	2.4
Responses to vocalization/child vocalization		6.3*	1.9	5.2*
Responses to play/child play		6.5*	.2	4.8*
Combinatorial speech	166.5			
Responses to bids/child bids		7.0*	.0	1.2
Responses to exploration/child exploration		.9	.9	.8
Responses to vocalization/child vocalization		7.4*	.1	3.1
Responses to play/child play		7.8*	.6	6.4*
First use of language to talk about the past	196.6			
Responses to bids/child bids		4.1	1.2	2.8
Responses to exploration/child exploration		.6	.5	.3
Responses to vocalization/child vocalization		4.0	3.2	4.0*
Responses to play/child play		7.9*	.5	6.3*

[a] Change in χ^2 when comparing fitted functions for two independent variables (2 IVs; i.e., mother and child) with baseline hazard functions.
[b] Change in χ^2 when comparing fitted models including mother and child to those with mother only or with child only.
* $p < .05$; ** $p < .01$.

provides the χ^2 model-fit indices for pairs of mother and child measures at 9 months, and Table 4 provides χ^2 values for mother and child measures at 13 months. The first column of data provides the χ^2 values for the baseline hazard functions (no predictors); the second column provides the change to this χ^2 value for fitted models including both mother and child predictors; the third column provides the change in χ^2 values for models testing the contribution of child over maternal responses; and the last column provides changes to χ^2 values for models testing the contribution of mother over child.

As shown in Table 3, although particular pairings of mother and child variables together improved model fit for all criteria language measures, none of the observed child activities at 9 months predicted the timing of language outcomes over and above the contribution of maternal responsiveness, χ^2 change values for 2 $df \leq$ 3.2. In contrast, mothers' responses to children's exploration uniquely predicted the timing of children's first imitation (i.e., over and above children's exploration at 9 months); mothers' responses to children's vocalizations uniquely predicted the timing of children's first words in expressive language (over and above children's vocalizations); mothers' responses to children's vocalizations and play uniquely predicted the timing of children's achieving 50 words in expressive language (over and above children's play acts and vocalizations); mothers' responses to children's play uniquely predicted the timing of combinatorial speech (over and above children's play); and mothers' responses to children's vocalizations and play uniquely predicted children's first use of language to talk about the past (over and above children's play and vocalizations).

As shown in Table 4, specific pairs of mother and child measures at 13 months predicted the timing of 50 words in expressive language, combinatorial speech, and use of language to talk about the past. Only one of the child measures at 13 months, however, continued to predict the timing of language milestones after maternal responsiveness to those acts was considered: Children's exploration predicted 50 words in expressive language apart from their mothers' responsiveness to children's exploration. In contrast, mothers' responsiveness to children's vocalizations and play consistently predicted the three criteria, even after children's vocalizations and play were considered.

Contributions of types of maternal responses to children's achieving language milestones. In the third set of analyses, the predictive validity of the six types of maternal responses at 9 and at 13 months (i.e., affirmations, imitations, descriptions, questions, play prompts, and exploratory prompts) was examined for the five language milestones over and above children's own activities. Because the different types of responses were not linked to specific target acts in children, chil-

Table 4 Chi-square Goodness-of-Fit Indices: Testing the Contributions of Child Activities and Mother Responsiveness at 13 Months to Children's Expressive Language Milestones

Criterion/Predictor	Baseline Hazard	Fitted χ^2 (2 IVs)[a]	Child over Mother[b]	Mother over Child[b]
50 words	198.6			
Responses to bids/child bids		.3	.3	.3
Responses to exploration/child exploration		4.5	4.4*	2.7
Responses to vocalization/child vocalization		25.0***	.3	12.2***
Responses to play/child play		8.5*	1.0	6.1*
Combinatorial speech	166.5			
Responses to bids/child bids		2.1	.3	1.1
Responses to exploration/child exploration		1.9	.9	1.6
Responses to vocalization/child vocalization		9.2*	.1	3.9*
Responses to play/child play		12.5**	2.8	10.3***
First use of language to talk about the past	196.6			
Responses to bids/child bids		2.1	1.2	.3
Responses to exploration/child exploration		2.6	1.7	.5
Responses to vocalization/child vocalization		14.3***	.0	5.0*
Responses to play/child play		6.1*	1.8	5.6*

[a] Change in χ^2 when comparing fitted functions for two independent variables (2 IVs; i.e., mother and child) with baseline hazard functions.
[b] Change in χ^2 when comparing fitted models including mother and child to those with mother only or with child only.
* $p < .05$; ** $p < .01$; *** $p < .001$.

dren's total activities (i.e., the sum of the frequencies for the four child acts, Table 1 C1 through C4) were considered in these analyses. One exception was the response type "imitate/expand," which could only be expressed in response to a child's vocalization; this form of responsiveness was examined relative to children's vocalizations. The aim of these analyses was to explore which forms of maternal responsiveness were uniquely predictive of children's language.

Table 5 presents the χ^2 values for these analyses at 9 months; and Table 6, for analyses at 13 months. As shown, pairings of types of maternal responsiveness and child acts at 9 months predicted four of the five language milestones. When types of maternal responses were considered above children's activities, maternal descriptions at 9 months predicted the timing of first imitations; maternal affirmations, descriptions, and play prompts predicted the timing of children's first words in expressive language; and maternal play prompts predicted the timing of children's achieving

Table 5 Chi-square Goodness-of-Fit Indices for Types of Maternal Responses at 9 Months

Criterion/Predictor	Baseline Hazard	Fitted χ^2 (2 IVs)[a]	Mother over Child[b]
First imitation	94.8		
Response with affirmations/child acts		5.5	2.4
Responses with imitations[c]/child vocalization		1.4	.8
Responses with descriptions/child acts		12.7**	9.6**
Responses with questions/child acts		3.5	.4
Responses with play prompts/child acts		2.5	1.1
Responses with exploratory prompts/child acts		4.6	.2
First words	166.2		
Responses with affirmations/child acts		12.4**	4.0*
Responses with imitations/child vocalization		4.4	.2
Responses with descriptions/child acts		12.5**	4.0*
Responses with questions/child acts		10.0**	1.5
Responses with play prompts/child acts		8.9*	4.2*
Responses with exploratory prompts/child acts		1.9	1.8
50 words	198.6		
Responses with affirmations/child acts		2.6	.5
Responses with imitations/child vocalization		1.4	.2
Responses with descriptions/child acts		2.8	.6
Responses with questions/child acts		2.4	.2
Responses with play prompts/child acts		5.8*	4.2*
Responses with exploratory prompts/child acts		1.2	.6
Combinatorial speech	166.5		
Responses with affirmations/child acts		10.8**	.9
Responses with imitations/child vocalization		4.4	.1
Responses with descriptions/child acts		10.2**	.3
Responses with questions/child acts		10.0**	.1
Responses with play prompts/child acts		8.0	6.5**
Responses with exploratory prompts/child acts		.2	.1
First use of language to talk about the past	196.6		
Responses with affirmations/child acts		4.2	2.4
Responses with imitations/child vocalization		.2	.1
Responses with descriptions/child acts		1.9	.1
Responses with questions/child acts		1.8	.0
Responses with play prompts/child acts		5.4	3.8+
Responses with exploratory prompts/child acts		.9	.6

[a] Change in χ^2 when comparing fitted functions for two independent variables (2 IVs; i.e., mother and child) with baseline hazard functions.

[b] Because child variables did not continue to predict language milestones over and above mother, analyses on maternal response types focused on mother-over-child analyses only.

[c] Because mothers could respond only by imitating when their children vocalized, vocalizations, rather than total child acts, were considered in these nested χ^2 models.

*$p < .05$; **$p < .01$; +$p < .10$.

Table 6 Chi-square Goodness-of-Fit Indices for Types of Maternal Responses at 13 Months to the Timing of Children's Expressive Language Milestones

Criterion/Predictor	Baseline Hazard	Fitted χ^2 (2 IVs)[a]	Mother over Child[b]
50 words	198.6		
Responses with affirmations/child acts		14.6***	2.3
Responses with imitations/child vocalization		26.0***	13.3***
Responses with descriptions/child acts		14.2***	1.8
Responses with questions/child acts		13.2**	.8
Responses with play prompts/child acts		3.6	1.2
Responses with exploratory prompts/child acts		2.0	.1
Combinatorial speech	166.5		
Responses with affirmations/child acts		12.4**	.3
Responses with imitations/child vocalization		13.7**	8.4**
Responses with descriptions/child acts		12.2**	.1
Responses with questions/child acts		12.2**	.2
Responses with play prompts/child acts		6.8*	4.7*
Responses with exploratory prompts/child acts		.7	.4
First use of language to talk about the past	196.6		
Responses with affirmations/child acts		4.4*	.8
Responses with imitations/child vocalization		14.5***	5.3*
Responses with descriptions/child acts		3.6	.0
Responses with questions/child acts		8.4*	4.8*
Responses with play prompts/child acts		1.0	.4
Responses with exploratory prompts/child acts		2.2	.1

[a] Change in χ^2 when comparing fitted functions for two independent variables (2 IVs; i.e., mother and child) with baseline hazard functions.
[b] Because child variables did not continue to predict language milestones over and above mother, analyses on maternal response types focused on mother-over-child analyses only.
* $p < .05$; ** $p < .01$; *** $p < .001$.

50 words in expressive language and the timing of combinatorial speech, and marginally predicted the timing of first using language to talk about the past. As shown in Table 6, mother and child measures at 13 months predicted the timing of the three milestones. When specific maternal responses were assessed, maternal imitations and expansions of children's vocalizations at 13 months predicted the timing of 50 words in expressive language; maternal imitations, or expansions, and play prompts predicted the timing of combinatorial speech; and maternal imitations, or expansions, and questions predicted the timing of children's first talking about the past.

A related set of analyses (not presented in tables), investigated whether types of maternal responses at 9 months predicted children's language milestones over and above the same types of maternal responses at 13 months; and whether types of maternal responses at 13 months continued to predict children's language milestones over and above the same types of maternal responses at 9 months. These analyses were conducted by comparing the nested fitted models; that is, χ^2 fit indices for models including 9- and 13-month responses together were compared with those including 9-month responses only or 13-month responses only. The results indicated that all forms of maternal responsiveness continued to predict later language milestones in children (i.e., the timing of 50 words in expressive language and the timing of combinatorial speech) after considering the same types of responses at 9 months. Responsiveness at 9 months, however, no longer predicted later language milestones after considering maternal responsiveness at 13 months.

To review, when considering the contributions of maternal responsiveness and child observed activity together, observed child measures did not generally improve model fit over and above matching forms of maternal responsiveness. In contrast, maternal responsiveness at both ages consistently predicted children's language milestones after the matched target child activity at the same ages was considered. Children's exploratory and communicative overtures most strongly predicted later language when considered in a dyadic and responsive context—when children acted, and mothers responded accordingly, the further development of children's language was supported. In addition, predictive relations between maternal responsiveness and child language were

Table 7 Dimensions of Maternal Responsiveness That Predict Child Language Milestones

Criterion Language Measure	9 Months: Response to Child Target	9 Months: Type of Response	13 Months: Response to Child Target	13 Months: Type of Response
First imitations	Exploration	Descriptions		
First words	Vocalizations	Affirmations Descriptions Play prompts		
50 words in production	Play Vocalizations	Play prompts	Play	Imitate/expand
First combinatorial speech	Play	Play prompts	Play Vocalizations	Imitate/expand Play prompts
First use of language to talk about the past	Play Vocalizations	No specific sig.	Play Vocalizations	Imitate/expand Questions

highly specific, and relations between 13-month maternal responsiveness and later child language were generally more robust than were relations between 9-month maternal responsiveness and later child language. Table 7 summarizes the dimensions of maternal responsiveness that uniquely contributed to the timing of each child language milestone on the basis of the Events-History Analyses. Specific aspects of maternal responsiveness to specific child activities at specific ages related to the timing of specific language milestones.

Statistical Modeling of Survivor Functions: High versus Low Groups

In Events-History Analysis, statistical models of hazard and survivor functions for subgroups of children can be obtained by using the parameter estimates of significant predictors. The purpose of such analyses is to illustrate the utility of Events-History Analysis in demonstrating the displaced timing of an event under different levels of significant predictors. Because predictors better explain the timing of developmental milestones, the median lifetimes (i.e., the average age of event occurrence) of the subgroups will diverge in the presence of those predictors (Willett & Singer, 1991, 1993).

In the last set of analyses, the effects of maternal responsiveness on children's language acquisition were modeled for extreme values of significant predictors. Values at the lowest and highest 10th percentiles were identified for those measures of maternal responsiveness that were found to uniquely predict the timing of children's language milestones. (These are accepted standards for this statistical technique; see Willett & Singer, 1993.) Using these values and the parameter estimates for the significant predictors, two fitted survivor functions were modeled for each of the child language milestones—one for low levels of maternal responsiveness (i.e., the value at the 10th percentile of the relevant predictors) and one for high levels of maternal responsiveness (i.e., the value at the 90th percentile of the predictors). This was done by substituting the extreme values and parameter estimates into modeled hazard equations. The only dimensions of responsiveness included in these analyses were those found to improve model fit over and above matched child activities, as indicated in Table 7.

More specifically, for each criterion measure, fitted survivor functions were first plotted for the children of mothers who were low versus high on responding to specific target acts (i.e., those found to be unique predictors over and above child contributions) and for the specific types of responsiveness. For the two early occurring language milestones (the timing of first imitations and of first words), estimated survivor functions were based on maternal responsiveness at 9 months. For the three later occurring language milestones (50 words in expressive language, combinatorial speech, and language used to talk about the past), estimated survivor functions were based on maternal responsiveness at 13 months. The decision to divide the data in this way was based on the finding that 13-month responsiveness continued to predict later language milestones over and above 9-month responsiveness, but 9-month responsiveness did not predict later language milestones over and above 13-month responsiveness.

Specifically, then, for the language milestone first imitations, fitted survivor functions for high versus low responsiveness to exploration at 9 months were contrasted, and then functions for high versus low levels of responding with descriptions were contrasted. For timing of first words, fitted survivor functions for high versus low responsiveness to child

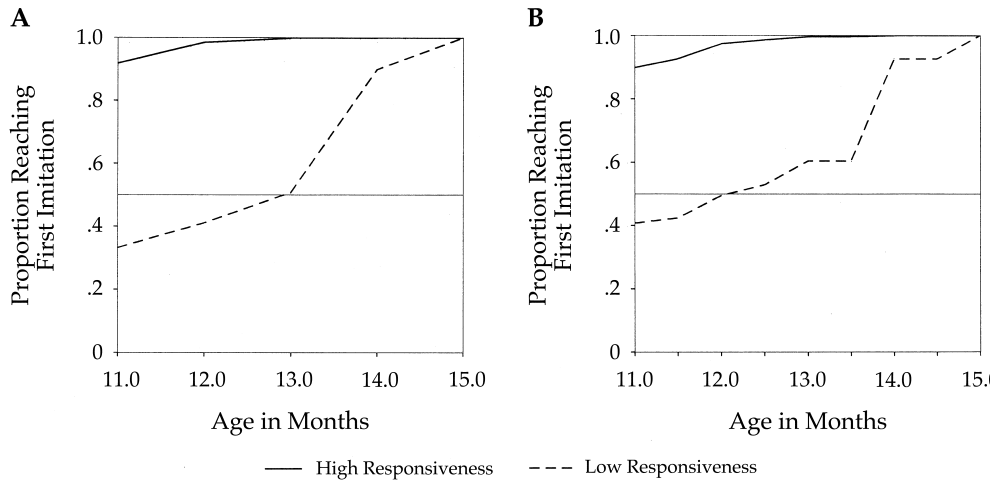

Figure 1 (A) Modeling fitted survivor functions for the timing of first imitations: Estimated function for high levels of maternal responsiveness to exploration at 9 months (upper 10th percentile) and estimated function for low levels of responsiveness to exploration at 9 months (lowest 10th percentile). (B) Modeling fitted survivor functions for the timing of first imitations: Estimated function for high levels of maternal responding with descriptions at 9 months (upper 10th percentile) and estimated function for low levels of maternal responding with descriptions at 9 months (lowest 10th percentile).

vocalizations at 9 months were contrasted; and then fitted survivor functions for high versus low levels of responding with affirmations, descriptions, and play were contrasted. For 50 words in expressive language, fitted survivor functions for high versus low responsiveness to vocalizations and play at 13 months were contrasted; and then fitted survivor functions for high versus low levels of responding with imitations were contrasted. For combinatorial speech, fitted survivor functions for high versus low responsiveness to vocalizations and play were contrasted; and then fitted survivor functions for high versus low levels of responding with imitations and play were contrasted. Finally, for the timing of first use of language to talk about the past, fitted survivor functions for high versus low responsiveness to vocalizations and play

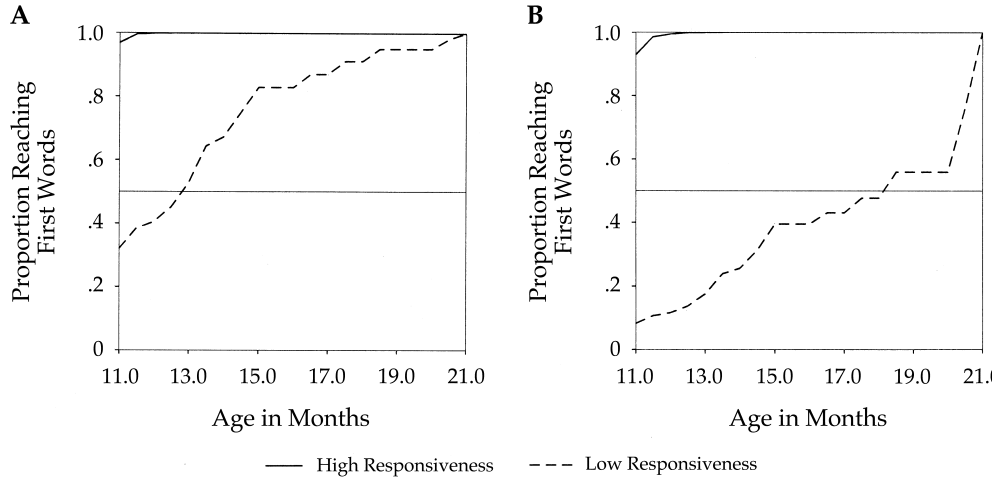

Figure 2 (A) Modeling fitted survivor functions for the timing of first words: Estimated function for high levels of maternal responsiveness to vocalizations at 9 months (upper 10th percentile) and estimated function for low levels of maternal responsiveness to vocalizations at 9 months (lowest 10th percentile). (B) Modeling fitted survivor functions for the timing of first words: Estimated function for high levels of maternal responding with affirmations, descriptions, and play prompts at 9 months (upper 10th percentile) and estimated function for low levels of responding with affirmations, descriptions, and play prompts at 9 months (lowest 10th percentile).

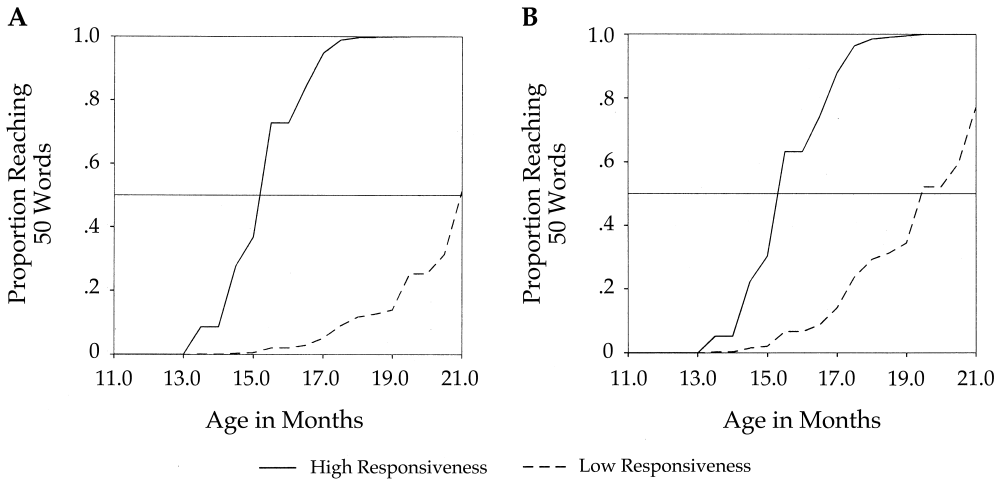

Figure 3 (A) Modeling fitted survivor functions for the timing of 50 words in expressive language: Estimated function for high levels of maternal responsiveness to play and vocalizations at 13 months (upper 10th percentile) and estimated function for low levels of maternal responsiveness to play and vocalizations at 13 months (lowest 10th percentile). (B) Modeling fitted survivor functions for the timing of 50 words in expressive language: Estimated function for high levels of maternal responding with imitations and expansions at 13 months (upper 10th percentile) and estimated function for low levels of maternal responding with imitations and expansions at 13 months (lowest 10th percentile).

were contrasted; and then fitted survivor functions for high versus low levels of responding with imitations, or expansions, and questions were contrasted.

The estimates obtained from the fitted survivor functions for these subgroups for each of the five language milestones are presented in Figures 1 through 5. In these figures, divergences in median lifetimes (i.e., the point at which half the subgroup was estimated to attain the milestone) as well as in the percentages of children who were estimated to attain each milestone by study end are evident. As an example, Figure 1A shows that nearly all the children with mothers who demonstrated high responsiveness to their exploration at 9 months were estimated to imi-

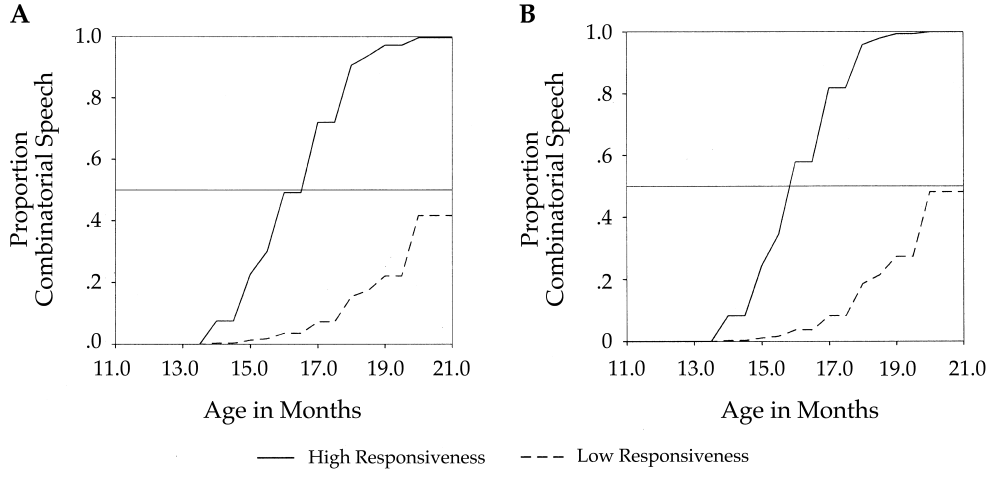

Figure 4 (A) Modeling fitted survivor functions for the timing of combinatorial speech: Estimated function for high levels of maternal responsiveness to play and vocalizations at 13 months (upper 10th percentile) and estimated function for low levels of maternal responsiveness to play and vocalizations at 13 months (lowest 10th percentile). (B) Modeling fitted survivor functions for the timing of combinatorial speech: Estimated function for high levels of maternal responding with imitations, expansions, and play prompts at 13 months (upper 10th percentile) and estimated function for low levels of maternal responding with imitations, expansions, and play prompts at 13 months (lowest 10th percentile).

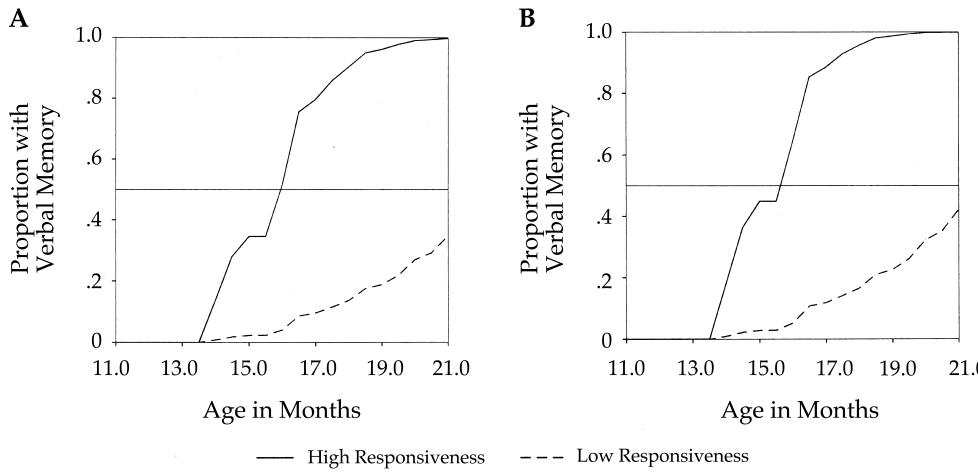

Figure 5 (A) Modeling fitted survivor functions for the timing of use of language to talk about the past: Estimated function for high levels of maternal responsiveness to play and vocalizations at 13 months (upper 10th percentile) and estimated function for low levels of maternal responsiveness to play and vocalizations at 13 months (lowest 10th percentile). (B) Modeling fitted survivor functions for the timing of use of language to talk about the past: Estimated function for high levels of maternal responding with imitations, expansions, and questions at 13 months (upper 10th percentile) and estimated function for low levels of maternal responding with imitations, expansions, and questions at 13 months (lowest 10th percentile).

tate words as early as 11 months. In contrast, only half of the children with low responsive mothers were estimated to imitate words at 13 months. Figure 2A shows that close to 100% of the children whose mothers demonstrated high responsiveness to their vocalizations at 9 months were estimated to produce their first words by 11 months. In contrast, only half of the children with low responsive mothers were estimated to produce their first words by 13 months. Figure 3A indicates that half of the children whose mothers demonstrated high responsiveness to play and to vocalizations at 13 months were estimated to achieve 50 words in expressive language on average by 15.2 months, but that half of the children whose mothers demonstrated low responsiveness to play and to vocalizations were estimated to have a median lifetime for the same milestone at 21 months, or nearly 6 months later. In extreme cases, estimates for subgroups in the average onset of language milestones (i.e., median lifetimes) differed by 6 months, and percentages of children estimated to achieve the milestones by study end with high versus low responsive mothers differed by as much as 60%.

Of interest was whether children at the extremes in language and maternal responsiveness differed by gender. The high and low groups of children, as modeled in Events-History Analysis (using the 10th and 90th percentiles on responsiveness), each included between 3 and 4 children for each milestone. Although these extreme groups were small, there was a consistent tendency for low groups to be represented by boys and for high groups to be represented by girls. Specifically, for the timing of 50 words in expressive language, 2 males and 1 female were in the low group and 4 females were in the high group. For the timing of combinatorial speech, 2 males and 1 female were in the low group, and 3 females were in the high group. For the timing of first use of language to talk about the past, 3 males were in the low group and 3 females were in the high group. Although these groups sometimes overlapped, they also included different children. A total of 12 children were represented at extreme ends on maternal responsiveness and the timing of language milestones.

DISCUSSION

This prospective longitudinal investigation examined prediction from child activity and maternal responsiveness to children's achieving five significant developmental milestones in expressive language: first imitations, first words, 50 words in expressive language, first combinatorial speech, and first use of language to talk about the past. A substantial body of research has documented relations between maternal responsiveness and children's early language achievements. The goal in this study was to evaluate the predictive validity of different dimensions of maternal responsiveness at 9 and at 13 months to the timing of these

different critical child language abilities. To do so, Events-History Analysis was used to assess when different linguistic competencies emerged in children, and which factors best explained the differential timing of their emergence.

Maternal responsiveness at both 9 and 13 months predicted all five child language milestones over and above children's own activities. This is not to say that children's own behavior is unimportant. Indeed, maternal responses occur in the context of children's participation in exploratory and communicative activities. By definition, maternal responsiveness reflects the temporal sequence of child-act and mother-respond, which clearly depends on the outward expression of initiation and intent on the part of the child. This dependency is also reflected in the nature of mother–child relations that were identified. Mothers certainly cannot imitate vocalizations that do not occur. Therefore, the finding that imitations become especially relevant at 13 months directly addresses children's changing competencies and intents. Additionally, the changing nature of the predictive validity of responsiveness from 9 to 13 months, as well as differences in the predictive validity of different forms of responsiveness, itself suggests that children play an active role in determining what is meaningful and relevant to them as their needs change and as they develop more enhanced competencies. As Snow (1986, p. 86) noted:

> Mothers are able to provide children with semantically relevant and interpretable speech because they follow up on topics introduced by the child. It seems clear that some mothers will be better at doing this than others, but also that some children will be better at eliciting semantically relevant and interpretable speech than others.

The finding, however, that children's vocalizations alone are not predictive of other milestones suggests that the child's intention must be embedded in a responsive and supportive social environment. The finding that children are differentially keying into different forms of maternal responses at the two ages points to the active role of children in determining what environmental information is most relevant to their own developmental needs. These findings, therefore, highlight the importance of considering language growth in the context of responsive social exchanges between caregivers and children. Relations between mothers' responsiveness at 9 months and the timing of the language milestones of 50 words in expressive language, combinatorial speech, and first use of language to talk about the past attenuated to nonsignificance, however, when the influence of 13-month maternal responsiveness was considered. It appears that although dimensions of 9-month maternal responsiveness predicted early achievements in language (imitations and first words), their relations to milestones occurring in the latter half of the second year may be explained by stability in maternal responsiveness or child language over time (Bornstein et al., 1999). In contrast, maternal responsiveness at 13 months uniquely predicted the timing of children's 50 words in expressive language, combinatorial speech, and first use of language to talk about the past.

With respect to the predictive validity of different dimensions of maternal responsiveness, both general and specific patterns emerged. Some forms of maternal responsiveness consistently predicted criterion measures of child language. Notably, mothers' responses to children's vocalizations and play predicted the developmental timing of four out of five language milestones: Children whose mothers responded contingently to their child's vocalizations and play activities spontaneously expressed first words, achieved 50 words in expressive language, engaged in combinatorial speech, and used language to first talk about the past earlier than children with less responsive mothers.

A second pattern of results was more specific in nature—that is, certain responses at certain developmental periods predicted certain language milestones, but not others. For example, mothers' affirmations and descriptions at 9 months, but not 13 months, predicted early language milestones in children; and, in contrast, mothers' responding with vocal imitations and expansions at 13 months, but not at 9 months, predicted the timing of children's achieving language milestones. Finally, at 13 months, maternal questions predicted the timing of children's first use of language to talk about the past but did not predict the timing of 50 words in expressive language or combinatorial speech.

How can these specific findings be interpreted? It is probable that certain forms of responsiveness are more or less appropriate or effective vis-à-vis children's abilities and the cognitive challenges children face at different developmental stages. By 9 months of age, children's rapidly advancing cognitive and motor abilities make them more competent at exploring their environments as they begin to learn about the functions of objects. Mothers' attunement to children's exploratory initiatives—by responding to children's exploratory engagements, affirming children's actions, and providing labels for objects and events that are the foci of children's attention—might be especially relevant at this time. Descriptions, in particular, provide verbal information to children that is semantically relevant to their attention focus.

By 13 months of age, children are becoming increasingly more sophisticated communicative partners, and feedback on and elaboration of their own language initiatives may be especially meaningful. That is, as children's own utterances begin to approximate adult phonetic forms, imitating and expanding on those vocalizations may directly shape children's vocalizations, foster their feelings of efficacy, reinforce their initiatives at communicating, and provide meaning to their utterances. It is not surprising that responses to children's own vocalizations and play robustly predicted children's language. By responding to children's attempts to communicate through language and play at 13 months, adults are both reinforcing children's intentionality and ensuring that the conversation will remain semantically related to, and within conceptual reach of, the children's interests. All or some of these possibilities might explain the increasing predictive power of mothers' imitations by 13 months. Moreover, by 13 months of age, children are beginning to engage in more advanced forms of play, moving beyond exploring objects in concrete ways to juxtaposing toys appropriately (e.g., placing lids on teapots, blocks in shape sorters) and engaging in fleeting episodes of symbolic play (e.g., pretending to drink from a toy cup). With respect to symbolic play in particular, at 13 months of age, children begin to enter the realm of "pretending," particularly in situations in which there is the support of a more knowledgeable social partner who demonstrates and encourages pretense in the child (Tamis-LeMonda & Bornstein, 1990, 1991). At this time, responses to children's play initiatives may become especially relevant and serve to support advancement in this emerging realm of representation. It is at this time of enhanced play competence that mothers' responses to basic exploration (i.e., children just looking or touching objects) lose predictive validity, whereas their responses to children's play activities gain predictive validity.

Another finding was that mothers' responding to their children's activities by asking questions related specifically to the timing of children's use of language to talk about the past. Asking a child questions may specifically require the child to reconstruct events and access information that is stored in long-term memory—cognitive demands that may specifically facilitate children's spontaneous efforts at retrieving and verbalizing their past experiences, that is, the expression of memories (Sigel, Stinson, & Flaugher, 1991). Indeed, researchers have noted the important role of adults in children's early remembering (Fivush, 1997), particularly with respect to asking questions about things that happened in the past (Hudson, 1990). As an example, Ratner (1984) observed that 2- and 3-year-old children whose mothers frequently asked questions showed better memory abilities both concurrently and up to a year later. The present findings extend this observation downward by identifying associations between responsive questioning and children's talk about the past in the second year of life. These mother–child exchanges could reflect the earliest manifestations of autobiographical memory in children.

It is important to reflect on some limitations of this investigation. The participants came from homogeneous, intact, middle-class families. Thus, the ages at which the various milestones were achieved, as well as the factors found to predict those achievements, might not readily generalize to other populations. Second, these findings must be considered in light of various aspects of the methodology and the child and mother predictors and criterion measures selected for investigation. For example, although responsiveness at 9 months did not predict certain milestones in expressive language, other research in the authors' laboratory has shown that related responsiveness in infancy predicts children's receptive language and representational competence broadly, thereby reinforcing the notion of specificity in mother–child relations (Baumwell et al., 1997; Bornstein & Tamis-LeMonda, 1989). A third limitation concerns the relatively narrow developmental window of the present investigation—9 to 21 months. Whether specific forms of maternal responsiveness at these specific ages continue to exert a telling influence on children's later developments is unknown, although others have noted substantively long-term effects of responsiveness on children's cognitive development more broadly (e.g., Beckwith & Cohen, 1989; Bloom, 1993; Bloom et al., 1996). Additionally, it is not known whether variation in children's early language competencies, as demonstrated in this study's sample, has long-term implications for children's language development.

These data illustrate the usefulness of Events-History Analysis in developmental research. Although several researchers have highlighted the critical role of maternal responsiveness in children's cognitive and linguistic developments (e.g., Bornstein & Tamis-LeMonda, 1989; Olson, Bayles, & Bates, 1986), few investigators have previously examined prediction to the timing of children's developmental achievements. Aside from the research program of Bloom and colleagues, in which prediction from children's emotions, intentions, and play (for example) were examined in relation to the timing of various language milestones (Bloom & Beckwith, 1989; Bloom & Capatides, 1987; Lifter & Bloom, 1989), most researchers have emphasized children's language gains at specific criterion

ages. A focus on development along a continuum, rather than at a fixed point in time, is aptly addressed by the statistical approach of Events-History Analysis. The analyses undertaken in this investigation indicate meaningful shifts in children's achieving language milestones as a function of different forms of maternal responsiveness experienced at particular ages. These data contribute to accurately modeling the influence of socialization factors on children's early language acquisition, the specific nature of those factors, and how they help explain variation in children's achieving important developmental events.

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ADDRESSES AND AFFILIATIONS

Corresponding author: Catherine S. Tamis-LeMonda, Department of Applied Psychology, New York University, 239 Greene Street, 5th floor, New York, NY 10003; e-mail: ct1@is8.nyu.edu. Marc H. Bornstein is at the National Institute of Child Health and Human Development, Bethesda, MD; and Lisa Baumwell is also at New York University.

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