J. Child Lang. **25** (1998), 675–700. Printed in the United Kingdom
© 1998 Cambridge University Press

Predicting variation in the timing of language milestones in the second year: an events history approach*

CATHERINE S. TAMIS-LEMONDA
New York University

MARC H. BORNSTEIN
National Institute of Child Health and Human Development

RONIT KAHANA-KALMAN
Albert Einstein College of Medicine

LISA BAUMWELL
New York University

LISA CYPHERS
New York University

ABSTRACT

In a longitudinal investigation of 40 child–mother dyads, we examined prediction from three indexes of children's own language: (1) vocal imitations, (2) first spontaneous words in production, and (3) receptive language starting at 0;9, and their mothers' verbal responsiveness at 0;9 and 1;1, to the developmental onset of three significant language milestones of the second year: (1) 50 words in productive language, (2) combinatorial speech, and (3) the use of language to express a memory. In these analyses, we utilized EVENTS HISTORY ANALYSIS, a statistical technique well suited to questions concerning when in development certain events begin and the extent to which predictors influence the timing of those events. The timing of children's first words in production, the timing of their achievement of 50 words in receptive language, and maternal responsiveness at 1;1 each contributed uniquely

[*] C.T.L. was supported by research grants HD20559, HD20807, HD48915, and by two Research Challenge Fund Grants from New York University. M.H.B. was supported by research grants HD20559 and HD20807 and by a Research Career Development Award HD00521 from the National Institute of Child Health and Human Development. We thank J. McClure and A. Melstein-Damast for comments and assistance. Address for correspondence: Catherine S. Tamis-LeMonda, New York University, Department of Applied Psychology, 239 Greene St., 5th floor, New York, New York, 10003, USA. Tel: 212-998-5399. Fax: 212-995-4358. e-mail: CST@xp.psych.NYU.EDU

to variation in the timing of the three language milestones. When child and mother factors were considered together, the onset of the three language milestones differed by as much as 0;5 months for children in the lower and upper 10th percentiles of the predictor variables. The present findings contribute to generating and testing specific models about child and mother factors thought to explain variation in key aspects of children's second-year language development.

INTRODUCTION

During the course of the child's first two years, notable developments occur in lexical, semantic, and grammatical aspects of language. Further, considerable variation has been documented among children in the developmental onset of key language abilities in each of these domains (e.g. Nelson, 1973; Bates, Bretherton & Snyder, 1988; Bornstein & Lamb, 1992; Fenson, Dale, Reznick, Bates, Thal & Pethick, 1994; Tamis-LeMonda & Bornstein, 1994). In this longitudinal investigation, we examined this variation in a new way and evaluated the contributions of selected child and mother predictors to the onset of 50 words in expressive language, use of combinatorial speech, and use of language to express a memory, three language milestones thought to demarcate important transitions in cognitive-representational abilities. We predicted that children who imitate vocalizations, utter first words spontaneously, and understand language sooner, and children who are engaged in verbal interactions with more responsive mothers, achieve milestones of second-year language performance earlier. To test these hypotheses, we obtained measures of children's language accomplishments at bi-monthly intervals from 0;9 to 1;9. These repeated assessments of language were coupled with observational measures of maternal responsiveness at 0;9 and 1;1 in order to analyse children's and mothers' unique contributions to children's emerging language. We also utilized events history analysis (also referred to as SURVIVAL ANALYSIS, a term which derives from its origins in actuarial science), a technique especially useful to identifying WHEN in development children achieve milestones and WHAT FACTORS predict the timing of those achievements.

Criterion measures of linguistic achievement

The first language measure that we examined was the onset of 50 WORDS IN CHILDREN'S PRODUCTIVE LANGUAGE, a criterion that has often been considered a landmark in early vocabulary development (Nelson, 1973). Around the time children accumulate about 50 words in their expressive vocabularies, they also experience a sudden acceleration in producing lexical items (see Bloom, 1973, 1993; Reznick & Goldfield, 1992). For example, Bloom (1993) showed that at the time children evidenced a vocabulary spurt they had an average of 51 different words and that all children in her research reached the 50-word vocabulary mark within 1 month of showing a substantial acceleration in their productive lexicons (Bloom, Margulis, Tinker & Fujita, 1996). Based on these findings, they identified the end of the EARLY WORD LEARNING PERIOD as occurring when children acquire a vocabulary of about 50 words. Relatedly, Schwartz (1988) suggested that children are better able to organize sound systems relative to one another at about the time they exhibit 50 different words in production. The second milestone we documented was the timing of children's first use of COMBINATORIAL SPEECH. The emergence of combinatorial speech is thought to indicate a child's ability to infer and symbolically encode relations between entities (McCall, Eichorn & Hogarty, 1977) and has been thought to set the stage for a number of other important semantic and grammatical advances (Fenson *et al.*, 1994). Third, we examined children's use of language to EXPRESS A MEMORY. Across its early ontogenesis, language progresses toward increased decontextualization in which words that were once context-dependent come to be used in the absence of obvious referents (e.g. Tamis-LeMonda & Bornstein, 1990, 1994). For example, initially the word 'car' might be said to a child's specific red toy car, only later to be generalized to all toy cars, to cars in pictures, and to cars in the street. Still later, a child might say 'car' (in the absence of seeing a car) to communicate about a car drive to the zoo the prior week. This last instance gives evidence that the child is using language to symbolize a past experience that is separate from (and possibly in opposition to) the present perceptual and motor experience. Together, these three indexes constitute key milestones of second-year linguistic achievements.

Predictors of variation in linguistic achievement

What factors might predict variation in children's achievement of these language milestones? We hypothesized that children's earlier achievements in imitating language, first spontaneous words in production, and receptive language status, as well as higher levels of verbal responsiveness in mothers would predict the early onset of these three criterion linguistic milestones. First, we speculated that the early appearance of VOCAL IMITATIONS would explain variation among children in later productive language milestones, as imitation potentially indexes early articulatory control in approximating adult phonetic forms (McCune, 1992) as well as the emergence of more fundamental cognitive attributes (such as means-ends separation; McCall *et al.*, 1977). McCune (1992) suggested that imitations might be central to the social support of language, as children who produce sounds that approximate adult-like speech provide their parents with the opportunity to respond to these sounds in a meaningful way. She observed that the child who says 'ba', following mothers' reference to a bottle, is in a position to produce 'bottle' later if mother in turn treats the child's utterance as the name for the object. Phonetic capability, as potentially indicated by earlier linguistic imitations, has been recognized as an early contributor to language development by Vihman & McCune (1994), among others, who have demonstrated relations between these earlier vocal parameters and later expressive abilities.

The second predictor that we considered was the timing of children's FIRST SPONTANEOUS WORDS IN PRODUCTION. Early first words might, like imitations, index articulatory control as well as underlying maturing cognitive ability. McCall *et al.* (1997) speculated that, at the time children utter their first words a cognitive transition takes place in which associations are formed between two potentially separable entities, enabling objects and labels to exist apart from one another and from the child. They speculated that the ability to cognize the association between an objective word and an object as existing independent from the utterance underlies children's first spontaneous expressions using words; this ability is presumed to set the stage for later vocabulary expansion. It is also possible that children's first understandings (i.e. early receptive language), which are often evident much earlier than the actual expression of first words, might indicate this cognitive underpinning, and first expressive words instead denote children's first motives (and abilities) to communicate these meanings to others. As such, children who express their first words sooner might be those who are more motivated to share mental meanings with others through verbal dialogue, a view that accords with Bloom's (1993) model of intentionality.

However, these productive abilities alone might not suffice for the expression of internalized thoughts at later periods in the language acquisition process. Therefore, we also considered emerging RECEPTIVE ABILITIES to be fundamental to achieving milestones in productive language during the second year of life. This notion is best evidenced in the work of Bates *et al.* (1988) who reported about children with below-average productive abilities but superior receptive language skills early in the second year; these children later demonstrated marked advances in productive abilities at 1;8 months. Others have also documented relations between measures of children's early receptive language and subsequent indices of productive language (e.g. Tamis-LeMonda & Bornstein, 1994).

Finally, to broaden the focus of this study to encompass social influences on toddlers' language (Garton, 1992; van IJzendoorn, Dijkstra & Bus, 1995), we examined the contribution of maternal responsiveness to children's emerging linguistic abilities. Empirically, language has been shown to be influenced by certain maternal interactions both concurrently and predictively from infancy through early childhood, and as a specific dimension of parenting, RESPONSIVENESS, appears central (Bornstein, 1989; Tamis-

LeMonda, 1996). Responsiveness refers to the prompt, contingent, and appropriate responding by adults to children's behaviours (Bornstein & Tamis-LeMonda, 1989). In the domain of early language, mothers who imitate, expand on, and otherwise reinforce their children's attempts at language mastery and who are sensitive to their child's current interests (e.g. by labelling an object that is the focus of the child's attention) might encourage advances in language by both inculcating feelings of efficacy in children and easing the task of symbol-referent matching (Dunham & Dunham, 1992). Empirically, maternal responsiveness relates concurrently to toddler speech and vocabulary progress in the second year (e.g. Olson, Bayles & Bates, 1986), and responsiveness in infancy predicts greater receptive language and representational competencies at 1;1 months (Bornstein & Tamis-LeMonda, 1989; Baumwell, Tamis-LeMonda & Bornstein, 1997), greater language abilities at 1;1 and 1;8 (Tamis-LeMonda, Bornstein, Baumwell & Damast, 1996), three- and four-year Stanford-Binet scores (Bakeman, Adamson, Brown & Eldridge, 1989), and larger receptive vocabularies, more responsiveness to mothers' utterances, and higher scores on the Bayley Scales of Infant Development (MDI) at 24 months, and higher Wechsler Intelligence Scale scores (WISC) at 12 years (Beckwith & Cohen, 1989).

Events history analysis

Traditional developmental studies of language acquisition have focused on predicting achievements at a single criterion age (but see Huttenlocher, Haight, Bryk, Seltzer & Lyons, 1991). The methodological approach and analytic procedures applied in the present study focus on when in development certain language milestones emerge and WHAT PREDICTS the timing of their emergence, rather than on HOW MUCH children know at a fixed time in development and what predicts variability among children at that time. To this end, we used events history analysis (also referred to as 'survival analysis', a term which derives from its origins in actuarial science). This statistical technique uses discrete and/or continuous variables at one point in time to predict the onset of some discrete event at a later point in time, and provides metrics that are conceptually and empirically useful in isolating predictors of those events (see Willett & Singer, 1991, 1993, for review). In addition, events history analysis enables researchers to work with 'censored data', that is to estimate the effect of predictors on the timing of events even when not all milestones have been achieved by all children by the end of data collection. This permits data collection to occur over briefer periods than required by statistical approaches such as regression in which all participants must achieve the milestone before the end of the study.

One metric that is obtained through events history analysis is the BASELINE HAZARD FUNCTION, which represents the conditional probability of an event occurring at discrete ages. For example, using this approach it is possible to ask 'What is the probability that a child will reach the 50 word milestone in production at 1;3, 1;4, 1;5, and so on if he/she has not already done so?'. The shape of such hazard functions depends on the nature of the event in question. If the event is equally likely to occur at any given age, the hazard function will be flat. To the extent that the baseline hazard function shows peaks at discrete ages, it suggests that children are more likely to experience the event at certain ages than they are at others.

From baseline hazard probabilities, a second metric, the BASELINE SURVIVOR FUNCTION, can also be plotted. Again using the example of 50 words in expressive language, the baseline survivor function would represent the cumulative probability of the event occurring in a group of individuals at successive ages. As a hypothetical example, if an investigator assesses a group of children monthly from 1;0 to 2;0, the cumulative probability of those children achieving 50 words in production would most likely be 0 at 1;0 (as no children have yet achieved the milestone); by 1;3, the cumulative probability might be 15; by 1;6 the cumulative probability might be 45, and so forth, until all children achieved the 50-word milestone, at which point the baseline survivor function reaches 100.

A third metric, MEDIAN LIFETIME, provides information as to when individuals achieve a given milestone ON AVERAGE. The median lifetime is defined as the point in the baseline survivor function at which the cumulative probability of the event reaches 50, that is when half of the population achieves the target event.

Importantly, baseline hazard and survivor functions might be contrasted with FITTED HAZARD AND SURVIVOR FUNCTIONS which provide estimates as to how much the timing of an event is displaced (i.e. moved forward or backward in time) given data on relevant predictors. As an example, in the present study, we ask whether children differing in the timing of their first words in production achieve the milestone of 50 words in production at varying times in development. By comparing subgroups of children (e.g. the 10% of children showing the earliest onset of first words in production versus the 10% showing the latest onset of first words in production), it is possible to assess the differences in the average ages at which the two groups achieve the language milestone of 50 words in production.

METHODS

Sample

Participants were 40 first-born (17 boys and 23 girls) and their mothers recruited from private pediatric groups in the New York City vicinity. Inclusionary criteria for the study included being term at birth, a history of no developmental delays, English as an only language in the family and first-born status. Mothers (M age = 33·2 years, $S.D.$ = 3·4) and fathers (M age = 35·7 years, $S.D.$ = 4·8) had completed an average of 5·6 ($S.D.$ = 2·1) and 5·3 ($S.D.$ = 1·7) years of schooling past high school, respectively. Children came from relatively homogeneous, middle- to upper-middle-class intact households (M = 58·7, $S.D.$ = 6·3, on the Hollingshead Four Factor Index of Social Status, 1975) and had all been term at birth. Data collection on children's language began when children were between 0;9 and 0;10 and ended after they turned 1;9. Participants were also visited in their homes between the ages of 0;9 and 0;10 (M = 0;9.15, SD = 0·12) and again between the ages of 1;1 and 1;2 months (M = 1;1.21, SD = 0·18).

We chose to begin the study when children turned 0;9 months as at this time children show increased receptiveness to the communicative intent of others, increased use of gestural and vocal signals (e.g. open and close grasp motion to solicit the adult as an agent of a goal), and intentionality in communications with others (Bates, Benigni, Bretherton, Camaioni & Volterra, 1979). From this period through the end of the second year, children's communicative and representational abilities go through marked transitions manifested in increased abilities to imitate units of language, spontaneously produce a verbal symbol for communication, add new symbols to the language repertoire once the symbolization process is understood, and combine symbols to communicate more complex messages (Goodwyn & Acredolo, 1993).

Procedures

Language. At the end of the 0;9 visit, experimenters provided mothers with a packet of language inventories and arranged a convenient bimonthly schedule to discuss children's language development over the telephone following guidelines reviewed in the materials. Packets included versions of the Bates *et al*. (1988) and MacArthur *Communicative Development Inventories* (CDI; Fenson *et al*., 1994). At earlier interview ages (0;9 to 1;1), a subset of the CDI was used (specifically, the earlier version of the Bates inventory upon which parts of the CDI were based) as children at these ages expressed few words and their receptive language was still limited. Thus, early interviews could be conducted relatively quickly (15 to 20 minutes), whereas later interviews, which utilized full CDI, took up to 2 hours. Both early and later interviews were conducted over the telephone.

Parental report was selected as an appropriate method for obtaining data on children's language for several reasons. First, the use of maternal interviews made it methodologically feasible to obtain data on a relatively large cohort of children at repeated intervals. Parental report is cost and time efficient, a necessary requirement for the valid collection of repeated data for a large number of children. Second, parents have the opportunity to observe their children in a wide range of situations; thus, parental report is likely to reflect what children know at earlier stages of language acquisition, whereas samples of free speech may reflect forms children are likely to use, particularly in the context of the observation (Bates *et al.*, 1988; Nelson, 1973). Third, maternal report provides accurate data with strong psychometric properties and predictive validity (see Fenson *et al.*, 1994, for review). This is particularly true when assessment is limited to current and emergent behaviours and when a recognition format is used (placing fewer demands on the respondent's memory).

In each interview, the experimenter read 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 understanding and production of each item as well as related items that might 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 might read along with the experimenter, thus enhancing the efficiency and validity of calls. To assess child comprehension, the experimenter asked the mother: (1) whether her child understood an item, (2) if so, what the child's typical response to the item was, and (3) whether item comprehension depended on any specific gestural, vocal, or temporal cues. To assess child production, the experimenter asked the mother: (1) whether her child produced each item, (2) whether production was spontaneous or in imitation, and (3) whether production was CONTEXT RESTRICTED or CONTEXT FLEXIBLE (e.g. saying 'ball' to a specific red ball or to balls in general).

In order to obtain data on the timing of predictor and criterion language measures, it was first necessary to determine the qualifications of a word in comprehension as well as in production. Guidelines for such decisions were conservative and based on studies that have established criteria in determining credit for a word (e.g. Vihman & McCune, 1994). So, for example, Goodwyn & Acredolo's (1993) criteria for the qualification of a generalized symbol include spontaneous usage, occurrence in stereotyped form, and use in reference to multiple exemplars of the underlying concept. In the present investigation, for a lexical item to qualify as a word in receptive language the child had to show a consistent response to the word that was appropriate to the word's meaning (e.g. stopping an action if mother said 'no'), and understanding had to be judged as free of contextual support (e.g. the child would stop the action without an accompanying gesture by mother or other cues). For production, an item qualified as a word if it met several criteria. First, the child had to use a sound unit in a consistent form with a consistent and recognizable meaning; second, the phonetic form of the sound unit had to approximate the adult construction (e.g. *ehh* for a bottle was not credited as a word, whereas *ba* for a bottle was); third, the word had to be expressed spontaneously (i.e. except for the predictor of 'imitation', immediate repetitions of adult language did not count); and fourth, the use of the word had to be considered flexible, that is free of contextual cues and used across multiple contexts. Thus, words used as pure performatives (e.g. saying 'bye-bye' only in a waving routine) or in restricted contexts (e.g. saying 'doll' only to the child's Raggedy Ann) were noted but were not counted in the present analyses (see also, Nelson, 1973; Bates *et al.*, 1988; Tamis-LeMonda & Bornstein, 1994; Vihman & McCune, 1994).

After probing about individual lexical entries, the experimenter next asked the mother whether her child was putting two words together. In the event that she answered yes, the experimenter further probed for examples of these combinations and asked the mother to provide details about the situations in which any word combinations were produced. The achievement of COMBINATORIAL SPEECH was conservative and indicated when the child combined two words each of which had previously held the status as a separate lexical entry and could be classified into distinct semantic categories including actor, action, object of action, patient, possession, and so forth (see Tamis-LeMonda & Bornstein, 1994). Terms like *bye-bye*, *allgone*, or *peek-a-boo*, which functioned for the child as a single word, were not counted as combinatorial speech.

Finally, the experimenter asked the mother to report any instances during the prior two-week period in which her child used language to express a memory. Various examples of such utterances were read to mothers in order to clarify the meaning of the child's utterance (e.g. '*grandma choo-choo*' to indicate that grandma had visited by train the prior week). As was the case for all milestones, extensive probing was conducted when mothers mentioned the use of a memory to ensure that the child's mention of unseen referents was not expressed in confusion or used as a linguistic game (other categories in our interview packet existed for both random expressions by children as well as linguistic routines). If a mother stated that her child used languaage to express a memory she was asked to provide detail on the context of the expression as well as background information about the referent of the expression. For example, one mother reported that her child pointed to an empty windowsill the week of the phone interview, with no prompting and no prior discussion of the past event, and said 'flower, boom, yucky!' to refer to a plant that had fallen from the windowsill nearly a month earlier and had covered the carpet with dirt.

Based on these criteria, age in days was calculated for the following language measures: (1) First imitation – this was indicated by the child's first repetition of the phonetic approximation of a target adult word (e.g. 'ba' said in imitation of mother's prior statement 'ball'); (2) First words in production – this was indicated when the child acquired minimally one new flexible word in two consecutive interview periods; (3) 50 words in receptive language –

This was indicated when the child accumulated a total of 50 flexible words in his/her receptive vocabulary; (4) 50 words in productive language – this was indicated when the child accumulated a total of 50 flexible words in his/her productive vocabulary; (5) Combinatorial speech – this was indicated when the child first combined two words into a single utterance, using the criteria reviewed above, and (6) Language used in memory – this was indicated when the child used a word or phrase to refer to a past experience.

After completion of the interview with mother, information about the child's recent language achievements were entered into a computer file on the child. Interviews with mothers and entries into the computer files were conducted by five researchers who were supervised by one constant researcher over the course of the entire study. The constant researcher checked every interview that had been conducted on every child in order to keep decisions constant and to check for reliability. Any changes to information about a child's language development were noted by the constant interviewer prior to making changes on the computer files. Agreement for words and phrases in production and in comprehension was calculated by dividing the number of agreements by the number of agreements plus disagreements. Reliabilities based on percentage agreement were consistently over 90%, with the vast majority of interviews indicating reliabilities between 95% and 100%. As might be expected, there were no disagreements with respect to the existence of a word or phrase in the child's vocabulary; instead, disagreements pertained to whether a word should be classified as restricted or flexible. Still such disagreements were rare, given the standardized methods that were used in ascertaining information about context flexibility (i.e. experimenters probed for necessary cues in word understanding or production using a constant checklist format).

Maternal verbal responsiveness

Maternal responsiveness was assessed from 10-minute videotaped interactions of mother–child free play at the 0;9 and 1;1 home visits. Mother and toddler were asked to play on the floor with a standard set of toys, mothers being directed to disregard the experimenter as much as possible. The dyad had the opportunity to play with any or all of the toys provided by the experimenter, and only the experimenter's toys were used.

The measure of maternal responsiveness was modified from Bornstein, Tamis-LeMonda, Tal, Ludemann, Toda, Rahn, Pecheux, Azuma & Vardi (1992) and detailed in Baumwell *et al.* (1997). Specifically, responsiveness was defined as a positive and meaningful change in mothers' verbal behaviour subsequent to and dependent on a change in a child vocal or exploratory act within a 5-second period following the act. As an example, if the child looked at a bottle and the mother said 'bottle', the mother was credited with responsiveness; similarly, if the child said 'bottle' to a bottle, and mother responded 'that's a bottle', she would also be credited with responding. From these data, a total verbal responsiveness score was obtained by summing the frequency of times a mother verbally responded to her toddler. Three trained coders, unaware of children's language interview data, coded 80 videotapes (40 each at 0;9 and 1;1). Four random reliability checks at each age for each coder were used to ensure reliability (24 reliabilities were computed in all). Cohen's (1960) Kappa averaged 0·75 for maternal verbal responsiveness.

RESULTS AND DISCUSSION

Results are organized around three sets of analyses. First, descriptive data and intercorrelations are presented on children's language milestones and mothers' responsiveness. Second, events history analysis is utilized to test the contributions of each of three potential predictors to the timing of each of the three criterion milestones separately and to test their unique contributions (i.e. over and above one another). Using hierarchical chi-square analyses, BASELINE survivor and hazard functions were compared to FITTED survivors and hazard functions, that is, those models which include predictors. A significant decline in the chi-square goodness-of-fit statistic indicates an improvement in model fit when the relevant predictor is added to the baseline model. So for example, the chi-square value of the FITTED model examining the prediction of timing of first imitation to the timing of combinatorial speech would be subtracted from the chi-square value of the baseline model in which no predictors are considered. A significant reduction to the chi-square value would indicate that the addition of the variable 'timing of first imitation' improves the ability to estimate when a child will engage in combinatorial speech. The analogy of this analysis in the more standard regression approach would be obtaining a significant F value when regressing an independent measure on a dependent variable.

Second, we also used nested chi-square models to test the UNIQUE contributions of a given predictor over and above the contributions of the other predictors. So for example, the chi-square value of the FITTED model examining the prediction of timing of first imitation AND timing of first words to the timing of combinatorial speech would be subtracted from the chi-square value of the fitted model only testing the contribution of the timing of first imitation. A decline in the chi-square value would indicate that the addition of the variable timing of first words in production improves the ability to estimate when a child will engage in combinatorial speech over and above the contribution of first imitation. The analogy of this analysis in a standard regression approach would be to identify a significant F-change value when entering a second predictor in a hierarchical regression equation.

Third, for significant predictors, the language trajectories and summary statistics of two subgroups of children were contrasted and plotted – those representing the lowest 10th percentile of the predictor variable (e.g. children showing the latest appearance of first words in production) and those representing the highest 10th percentile on the predictor variables (e.g. children showing earliest appearance of first words in production). These analyses illustrate the utility of events history analysis to demonstrate the displaced timing of an event under different levels of significant predictors. As 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).

Preliminary to these analyses, demographic data were examined in relation to all independent and dependent measures included in the models. Neither maternal nor paternal age, education, nor SES (in our range) related to any measures. Additionally, child gender was not associated with any of the predictor variables. However, males and females differed in the timing of the onset of 50 words in production, $t\,(39) = 2{\cdot}13$, $p < 0{\cdot}05$; combinatorial speech, $t = 3{\cdot}08$, $p < 0{\cdot}01$; and first expressing a memory, $t\,(39) = 2{\cdot}84$, $p < 0{\cdot}01$, with girls achieving all three milestones earlier than boys. The mean age for achieving 50 words in production was 1;5.6 months for girls and 1;6.21 months for boys; the mean age for combinatorial speech was 1;5.21 months for girls and 1;7.15 months for boys; the mean age for first expressing a memory was 1;5.12 months for girls and 1;7.12 months for boys. In order to ensure that relations between independent and dependent measures were similar for boys and girls, we examined gender in interaction with each of the predictors in relation to the timing of each of the three criterion measures. No interactions were observed. In instances in which events history analysis demonstrated significant predictions, we assessed whether main effects maintained over and above the contribution of gender. Gender did not play a role in any analyses; that is, main effects were not attenuated after considering the role of gender. Thus, we report analyses for all 40 participants together.

Table 1 presents descriptive data and correlations among predictor and criterion measures. The relative mean ages and ordering of emergence of each of the language milestones accords with the work of other investigations on emerging linguistic competencies (see Nelson, 1973; Bates *et al.*, 1988; Goodwyn & Acredolo, 1993; Fenson *et al.*, 1994). The three criterion measures covaried, as expected, but shared only 31% variance on average. Not shown is the fact that the slope of children's vocabulary growth before versus after 50 words in production differed tremendously, as was anticipated. Specifically, children produced an average of 5·9 new words per month before the 50 word mark and produced an average of 39·3 new words per month after the 50 word mark, $t\,(39) = 8{\cdot}83$, $p < 0{\cdot}001$, lending further support to the importance of this milestone in the growth of language.

TABLE 1. *Descriptive data and correlations among measures* ($n = 40$)

	Mean	S.D.	Range	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Predictors										
(1) First imitation	11.1	1.7	9.0–15.0	0.54***	0.26†	−0.47**	−0.32*	0.30†	0.36*	0.14
(2) First words in production	12.8	2.8	10.0–21.0	—	0.43**	−0.52***	−0.44**	0.68***	0.63***	0.44**
(3) 50 words comprehension	13.3	1.7	10.2–18.4		—	−0.44**	−0.42**	0.47**	0.40**	0.48**
(4) Maternal responsiveness at 0;9	50.2	15.7	17–90			—	0.70***	−0.42**	−0.49***	−0.42**
(5) Maternal responsiveness at 1;1	70.2	19.2	27–117				—	−0.52***	−0.57***	−0.31*
Child criteria										
(6) 50 words in production	17.9	2.3	13.4–> 21					—	0.76***	0.69***
(7) First combination	18.7	2.3	14.0–> 21						—	0.58***
(8) First expression of a memory	18.4	2.6	13.9–> 21							—

† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

TABLE 2. *Chi-square goodness-of-fit indices for individual predictors of language milestones* ($N = 40$)

Criterion/predictor	Baseline χ^2	Fitted	Change to χ^2 (1 d.f.)	Unique predictor?
50 words in production	198·6			
(1) First imitation		196·5	2·2	no
(2) First words prod.		173·7	24·9**	yes
(3) 50 words comp.		188·4	10·2***	yes
(4) Resp. at 0;9		193·3	5·3*	no
(5) Resp. at 1;1		186·7	11·9***	yes
First combination	166·5			
(1) First imitation		162·5	4·0*	no
(2) First words prod.		146·1	20·3***	yes
(3) 50 words comp.		158·4	8·1**	no
(4) Resp. at 0;9		155·6	11·0***	no
(5) Resp. at 1;1		152·2	14·3***	yes
First expression of a memory	196·6			
(1) First imitation		196·5	0·1	no
(2) First words prod.		188·2	8·4**	yes
(3) 50 words comp.		186·4	10·1**	yes
(4) Resp. at 0;9		191·0	5·5*	no
(5) Resp. at 1;1		193·1	3·4	no

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Similarly, child language predictors demonstrated substantial variation, covaried moderately, and demonstrated moderate to strong prediction to the criterion language measures.

Table 2 presents the chi-square values for the baseline hazard functions and the chi-square values for fitted models for each of the predictors. The chi-square change column represents the change to model fit as individual predictors are added to the model (i.e. for 1 d.f.). These data, and data on the unique contributions of each of the predictors to outcomes (i.e. nested models), are reviewed separately for each outcome.

Predicting the onset of 50 words in production. As shown in Table 2, first words in production, 50 words in receptive language and maternal responsiveness at 0;9 and at 1;1 were each significant predictors of children's achievement of 50 words in production. Timing of first imitation did not predict this language milestone. Subsequent examination of the unique predictive validity of each of the four measures showed that age of first words in production improved prediction to the timing of 50 words in production over the contribution of the timing of 50 words in receptive language, χ^2 change $= 19.9$, $p < 0.001$, and over the contribution of maternal responsiveness at 0;9 months, χ^2 change $= 19.6$, $p < 0.001$, and responsiveness at 1;1, χ^2 change $= 18.1$, $p < 0.01$. Second, the timing of 50 words in receptive language contributed unique variance to explaining the timing of 50 words in production over and above the contribution of the timing of first words in production, χ^2 change = 5·2, $p < 0·05$, maternal responsiveness at 0;9 months, χ^2 change = 6·6, and responsiveness at 1;1 months, χ^2 change = 3·9, $p < 0·01$ and 0·05, respectively. Third, responsiveness at 0;9 months DID NOT uniquely contribute to the timing of 50 words in production over and above the other predictors. This pattern suggests that the relation between earlier responsiveness and this language milestone is mediated by intervening linguistic competencies as well as mothers' later responsiveness. In support of this conclusion are the findings that 0;9 responsiveness predicted the timing of 50 words in receptive language, the timing of first words in production, and 1;1 responsiveness. In turn, these mediators predicted when children acquired 50 words in their productive lexicons. Finally, responsiveness at 1;1 months contributed unique variance to the timing of 50 words in production over and above the timing of first words in production, χ^2 change = 5·1, $p < 0·01$, the timing of 50 words in receptive language, χ^2 change = 5·5, $p < 0·01$, and responsiveness at 0;9 months, χ^2 change = 6·6, $p < 0·01$.

Predicting the onset of combinatorial speech. All five independent variables predicted combinatorial speech (Table 2). Examination of unique predictions from each of the independent measures showed that, first, the timing of first imitation DID NOT contribute unique variance to the timing of combinatorial speech over and above any of the other predictors. The initial relation between timing of first imitation and timing of combinatorial speech appears to be mediated by the timing of first words in production. That is, early imitation relates to early first words in production which in turn predicts earlier achievement of combinatorial speech. Second, the timing of first words in production improved prediction to the timing of combinatorial speech over the contribution of timing of 50 words in receptive language, χ^2 change = 15·0, $p < 0·001$, maternal responsiveness at 0;9, χ^2 change = 11·3, $p < 0·001$, and maternal responsiveness at 1;1 months, χ^2 change = 11·6, $p < 0·001$.

In contrast, the timing of 50 words in receptive language DID NOT contribute unique variance to the timing of 50 words in production over and above the contribution of the timing of first words in production or maternal responsiveness. It may be that measures of productive rather than receptive language are better predictors of when children will utter their first sentences. Bates *et al*. (1988) found that production measures at early stages of language, rather than comprehension, were stronger predictors of MLU at 1;8 months, and this accords with the finding of Tamis-LeMonda & Bornstein (1994) that productive language at 1;1, but not receptive language, predicted children's MLU scores at 1;9.

Responsiveness at 0;9 contributed unique variance over the contribution of the timing of first imitation, χ^2 change = 7·3, $p < 0·01$, and 50 words in receptive language, χ^2 change = 6·1, $p < 0·01$, but did not contribute unique variance over the timing of first words in production or responsiveness at 1;1 months. Responsiveness at 1;1 months contributed unique variance to the timing of combinatorial speech over and above the timing of first imitation, χ^2 change = 11·6, $p < 0·001$, the timing of first words in production, χ^2 change = 5·4, $p < 0·01$, the timing of 50 words in receptive language, χ^2 change = 8·0, $p < 0·01$, and responsiveness at 0;9 months, χ^2 change = 3·7, $p < 0·05$. Again, earlier responsiveness appeared to improve model fit through its relation with first words in production and later responsiveness, both of which uniquely predicted when children will first combine words.

Predicting the onset of first expressing a memory. Timing of first words in production, 50 words in receptive language, and maternal responsiveness at 0;9 were each significant predictors of the timing of first expression of a memory. Examination of unique prediction to this criterion showed that, first, the timing of first words in production improved prediction to the timing of first expressing a memory over the contribution of first imitation, χ^2 change = 10·5, $p < 0·001$, the timing of 50 words in receptive language, χ^2 change = 5·5, $p < 0·01$, maternal responsiveness at 0;9 months, $\chi^2 = 4·6$, $p < 0·05$, and maternal responsiveness at 1;1 months, $\chi^2 = 6·2$, $p < 0·01$. Second, the timing of 50 words in receptive language contributed unique variance over and above the contribution of the timing of first words in imitation, χ^2 change = 10·1, $p < 0·001$, first words in production, χ^2 change = 7·2, $p < 0·01$, maternal responsiveness at 0;9, χ^2 change = 6·4, $p < 0·01$, and maternal responsiveness at 1;1 months, χ^2 change = 7·0, $p < 0·01$. Importantly, receptive language was an even stronger predictor of the timing of the child's first expressing a memory than first words in production. By definition, expressing something about a past experience calls on representational abilities that are independent of present motor and perceptual experiences. This finding is consistent with suggestions that early measures of receptive language are critical indicators of concurrent and later representational abilities. For example, Tamis-LeMonda & Bornstein (1990, 1994) showed that measures of receptive language at 1;1 relate concurrently to measures of symbolic play and that they predict measures of symbolic play and semantic language toward the end of the second year. Here we add to these findings by demonstrating that the timing of 50 words in receptive language, thought to indicate representational abilities, might be a prerequisite to productive milestones that call upon internal schemata and expression of past events. Neither rote production nor unanalysed repetition of frequently occurring phrases is sufficient for the verbal expression of a memory to occur. Instead, memories might be expected to summon the use of symbols to refer to

TABLE 3. *Median lifetimes and percentage of children achieving language milestones at study end for subgroups of children*

	Low 10th %[a]		Upper 10th %[a]	
Criterion/predictors	Med.[b] age	%[c]	Med. age	%
50 words production				
(1) First words production	1;9	58	1;4.15	100
(2) 50 words comprehension	1;7.15	77	1;5	99
(3) Resp. at 1;1	1;7.15	78	1;5	98
(4) 3 predictors	1;9	58	1;3.15	100
First combination				
(1) First words production	1;8.15	60	1;5	98
(2) Resp. at 1;1	1;8	56	1;4.15	92
(3) 2 predictors	> 1;9	35	1;4.15	100
First expression of a memory				
(1) First words production	> 1;9	34	1;5	89
(2) 50 words comprehension	> 1;9	49	1;5	93
(3) 2 predictors	> 1;9	28	1;4.15	98

[a] Age estimates for children who would be classified in the lowest or highest 10th percentile on each of the variables that demonstrated unique prediction to outcome.
[b] In cases where the majority of children never attained the language milestone in question, the median lifetime is not determined as it occurs later than 1;9, the end of data collection.
[c] Percent of children who had achieved the milestone by 1;9.

internal representations of past events. Finally, maternal responsiveness did not uniquely contribute to the timing of first expressing a memory over and above the other predictors.

Children high versus low on each of the predictor measures. In events history analysis, the effects of the significant predictors on the timing of criterion language milestones can be illustrated by contrasting the timing of critical events (here 50 words in production, combinatorial speech, and language used in memory) for subgroups of children who differ on predictor variables (Willett & Singer, 1993). That is, if a particular measure is found to predict the onset of a target event, as indicated by the nested chi-square models, it is possible to quantify how much (e.g. by how many months) children at different levels of the predictor (e.g. those of high or low responsive mothers) vary in the timing of the target event.

Accordingly, in the final stage of analyses we identified children at the lowest 10th and upper 90th percentiles for each of the unique predictors (the accepted standard suggested for this statistical technique; Willett & Singer, 1993). Specifically, for each of the measures that were found to be unique predictors of language milestones in children, that is, maternal responsiveness at 1;1, first words in production, and 50 words in comprehension, we calculated values for the 10th and 90th percentiles. Events history analysis was

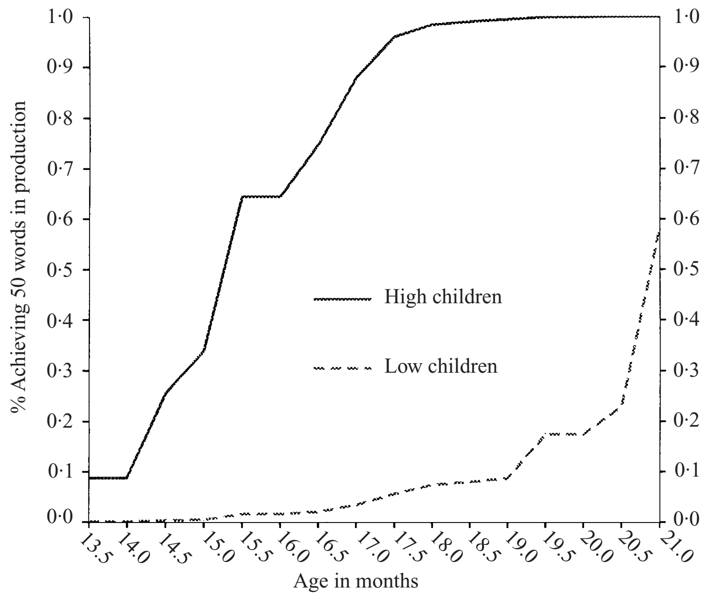

Fig. 1. Predicting timing of 50 words in production. *High children* – Survivor function for children who achieve the milestones first words in production and 50 words in comprehension early in development and have highly responsive mothers at 1;1. *Low children* – Survivor function for children who achieve the milestones first words in production and 50 words in comprehension late in development and who have low responsive mothers at 1;1.

then used, as above, to plot the fitted survivor functions for two subgroups of children, those with high scores on each of the significant predictors (examined separately for each predictor in the first part of analyses) and those with low scores on each of the significant predictors. These plots were obtained by substituting the calculated values in each of the hazard probability equations.

We then examined the JOINT contributions of significant predictors to each of the criterion language milestones for the two subgroups of children. This was done by substituting the low and high values for TWO OR MORE variables that UNIQUELY predicted each of the language outcomes in hazard probability equations. From these solutions, the fitted survivor functions of subgroups of children who were high or low on TWO OR MORE PREDICTORS were plotted. These plots address questions such as: given a child is low on the predictors A AND B (e.g. maternal responsiveness AND the timing of first words in production), when would he/she be expected to exhibit the outcome C (e.g. combinatorial speech)?

Specifically, for the timing of 50 words in productive language, we contrasted fitted survivor functions for children who had late onset of first words in production, late achievement of 50 words in receptive language, AND

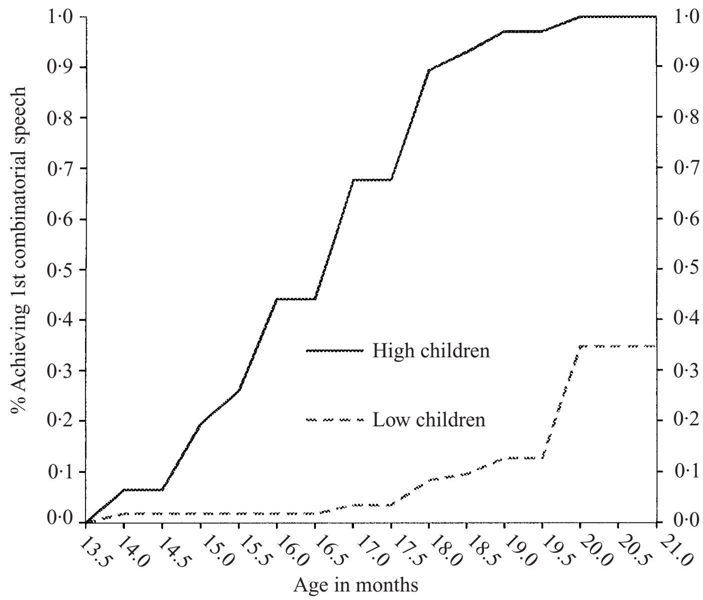

Fig. 2. Predicting timing of combinatorial speech. *High children* – Survivor function for children who achieve the milestones first words in production early in development and have highly responsive mothers at 1;1. *Low children* – Survivor function for children who achieve the milestones first words in production late in development and who have low responsive mothers at 1;1.

low responsive mothers at 1;1 with children who had early onset of first words, early achievement of 50 words in receptive language, and highly responsive mothers at 1;1. These were the measures found to UNIQUELY predict the achievement of 50 words in production (see Table 2). For the criterion measure FIRST COMBINATORIAL SPEECH, we contrasted functions for children who had late versus early onset of first words in production AND who had low versus high verbally responsive mothers at 1;1. Finally, for the criterion measure FIRST EXPRESSION OF A MEMORY, we contrasted children who were late versus early on first words in production and achieving 50 words in receptive language.

The data obtained from all of the fitted survivor functions for the two subgroups of children are presented in Table 3. Two important findings for the two subgroups of children are presented. First, the median lifetimes for each of the outcomes are shown; these represent the median age in months at which the milestone is achieved for children below the 10th and above the 90th percentiles of each of the significant predictors. Second, the percentage of children who had achieved the milestone by the end of the study (1;9) is presented. For example, as indicated in the first line of Table 3, children with late first words in production achieved 50 words in production on average by 1;9 as opposed to 1;4.15 for children with early first words in production. By the end of the study, only 58% of children with late first words in production had achieved 50 words in production, whereas 100% of those children with early first words had achieved this milestone.

In the extreme cases for each criterion milestone, that is when multiple predictors were considered, the two subgroups of children differed in their onset of 50 words in production by $5\frac{1}{2}$ months, the onset of combinatorial speech by $4\frac{1}{2}$ months, and the onset of first expressing a memory by $4\frac{1}{2}$ months. Additionally, percentages of children achieving these three milestones in the two (high vs. low) subgroups differ by as much as 70%.

The fitted survivor functions, on which data in Table 3 are based, are presented in Figures 1 to 3. These figures depict the cumulative probabilities

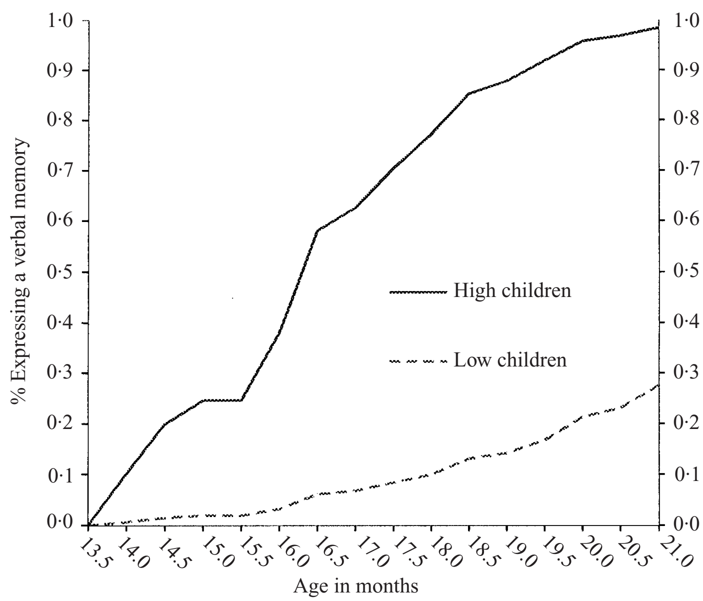

Fig. 3. Predicting timing of verbally expressing a memory. *High children* – Survivor function for children who achieve the milestones first words in production and 50 words in comprehension early in development. *Low children* – Survivor function for children who achieve the milestones first words in production and 50 words in comprehension late in development.

of achieving each of the three criterion milestones for the two subgroups of children – those with high scores on two or more predictors versus those with low scores on two or more predictors. These plots clearly illustrate how children represented at the extremes of predictors diverge in their acquisition of language milestones.

CONCLUSIONS

In this longitudinal investigation, we examined prediction from child and mother measures to the developmental onsets of three key language milestones in toddlers: (1) 50 words in production, (2) combinatorial speech, and (3) language used to express a memory. A substantial body of research has documented the variation among children in these linguistic achievements; our aim was to re-examine this variation and to evaluate predictions to these critical language measures using events history analysis, a statistical technique that permits assessment of WHEN various linguistic competencies emerge in children and WHICH FACTORS best explain the differential timing of those emerging abilities. In general, the timing of children's first words in production, 50 words in receptive language, and maternal responsiveness at 1;1 each UNIQUELY contributed to one or more of these criterion linguistic milestones. In contrast, prediction from children's first imitations and maternal responsiveness at 0;9 appeared to be mediated by their short-term relation to first words in production, receptive language, and later maternal responsiveness. That is, significant predictive relations from the timing of children's first imitations and maternal responsiveness to criterion measures at 0;9 were attenuated after considering the timing of children's own first words in production and mothers' responsiveness at 1;1.

Specifically, early achievement of first words in production predicted an earlier onset of all three linguistic milestones; it may be that early first words index articulatory control, desire to communicate with others, and NOMINAL INSIGHT (i.e. the cognitive realization that things have names), all of which are prerequisite to further gains in language. Relations between children's earlier first words and their later linguistic accomplishments might also be explained by Bloom *et al.*'s (1996) suggestion that children have a COGNITIVE AGENDA to express something on their mind; children exhibiting first words sooner might be demonstrating an early intentionality that paves the way for further linguistic advancement.

In contrast to the robust predictive validity of the timing of first words, receptive language and maternal responsiveness at 1;1 showed more limited patterns of prediction to each of the criterion measures. Receptive language was a stronger predictor of 50 words in production and using language to express a memory, and responsiveness predicted the timing of 50 words in production and combinatorial speech. Early receptive skills might portend the abilities to access an inner mental representation and translate the mental schemata of that event into verbal symbols, whereas sensitivity in maternal interactions might serve to expand children's lexicons, to support movement to multi-word speech, or, alternatively, to indicate to children that perspectives have been shared (Bloom *et al.*, 1996), perhaps supporting children's own intentions to communicate and learn more about the world.

Importantly, each of the linguistic milestones examined here is hypothesized to reflect underlying transitions in toddlers' cognitive-representational abilities, including categorization, analysis of events into component parts, symbolization of relations between independent entities, and insight into the independence of symbols and perceived experiences. For example, investigators have identified 50 words in production as the start of a new period in language growth, and many associated sudden accelerated gains in children's lexicons to the time they achieve this milestone (Bloom, 1973; Nelson, 1973; Bloom, 1993; Bloom *et al.*, 1996). This sudden growth in language, often referred to as a 'vocabulary spurt', has been associated with changes to children's conceptual developments that are relevant to the understanding that objects belong in categories (Gopnik & Meltzoff, 1987). Lifter & Bloom (1989) suggest that the vocabulary spurt might also be linked to the acquisition of object permanence. Others have suggested that such a change is associated with the sophisticated realization that ALL things have names (Baldwin & Markman, 1989), or increased synaptic connectivity (Bates, Thal & Janowsky, 1992). Similarly, the transition to combinatorial speech is thought to index global cognitive achievements that extend beyond the domain of language; this determination is supported by parallel developments in other areas, for example, the shift from single to sequenced acts in symbolic play and the emergence of increased abilities to classify objects (e.g. Shore, O'Connell & Bates, 1984). Finally, the use of language to express a memory appears to reflect the complete independence of symbol from referent, as verbal memories must presumably be generated from mental representations and the translation of those memories to verbal codes, rather than being solely triggered by external perceptual or motor supports. Thus, at a more general level, these findings indicate that early markers of language development in children and sensitivity in parents both contribute to late cognitive-representational developments.

On a cautionary note, it is important to point out some limitations of this investigation. The participants in this study come from homogeneous, intact, middle-class families. Thus, the ages at which the various milestones were achieved, as well as the factors found to predict these achievements, might not generalize to other populations. Second, these findings must be considered in light of our methodological approach and the child and mother predictions and criterion measures that were selected for investigation. For example, child measures of language were all derived from maternal report, even though such a methodology is useful and valid, child measures may have related to one another as well as to maternal responsiveness because of individual differences in the way mothers supply information about children's language. It is possible that mothers who overestimate children's production may likewise overestimate children's comprehension. In addition, although maternal responsiveness at 0;9 did not uniquely predict the particular language milestones we examined, that is not to say that sensitive parenting at 0;9 months is not critical to other advances in language or cognitive development more generally. Indeed, responsiveness in infancy is predictive of children's receptive language and representational abilities at the start of the second year (e.g. Bornstein & Tamis-LeMonda, 1989; Baumwell *et al.*, 1997) and also predicts standardized intelligence performance in subsequent years (e.g. Beckwith & Cohen, 1989; Bakeman *et al.*, 1989). It is also possible that maternal responsiveness predicted children's language in this study because responsive parents are simply more talkative in general. However, investigators who have contrasted maternal responsiveness with other types of maternal verbal interactions have found quite consistently that responsiveness *per se* is an important predictor of children's cognitive-linguistic abilities over and above the amount of verbal input that children receive (e.g. Bornstein & Tamis-LeMonda, 1997; Baumwell *et al.*, 1997). Indeed, evidence exists that maternal interactions that are insensitive to children's own interests, but are instead controlling and intrusive, are associated with lower productive language in children (e.g. Tomasello & Farrar, 1986).

A final comment on the utility of events history analysis in developmental research is warranted. The choice to utilize events history analyses, as opposed to more traditional regression approaches, rests on the investigator's own perspective above the nature and meaning of the event that is being evaluated. Specific to language, if a particular milestone is viewed as an important and qualitatively distinct event in children's development AND if the nature of data collection permits evaluation of children's abilities at a number of discrete periods (e.g. monthly intervals), events history analysis is particularly useful in evaluating factors that might displace the milestone forward or backward in time. If however, the target event is considered an arbitrary point on a continuous process of growth, regression approaches might be more appropriate. In this study, we considered moments such as children's first words, 50 words in production, first combination of words, and first verbal expression of a memory to indicate important and transitional periods in language growth. Nonetheless, others might contend that such moments are not discrete events in the language learning process, but are a part of a continuous process. For example, although discussion of a vocabularly spurt in the second year is ubiquitous in the literature, it has been noted that some children (as many as a third) acquire language at a relatively steady pace or in a series of small bursts (Goldfield & Reznick, 1990). Whether events history analysis provides the same benefits in assessing predictors of language growth in such children remains to be examined.

The present investigation illustrates the use of a relatively new statistical tool to evaluate the contributions of child and mother to the timing of events in early language growth. The metrics provided by this approach, such as the median lifetimes on subgroups of children, are valid and useful. As an example, we found that children who scored low on two to three predictors tended to achieve the milestones of 50 words in production, combinatorial speech, and the verbal expression of a memory four to six months later on average than children who were high on the same predictors; only 28% to 58% of children who were low on predictors achieved the three milestones by 1;9 as compared to 100% of those children who were advanced on child and mother predictors. These data contribute to the burgeoning literature on the dramatic individual differences evidenced in children's early language acquisition and the factors that contribute to those differences. Together, children's initial propensities to speak and mothers' responsiveness at the start of the second year largely influence when and whether children will achieve a number of key language milestones over the course of the next several months.

REFERENCES

Bakeman, R., Adamson, L. B., Brown, J. V. & Eldridge, M. E. (1989). Can early interaction predict? How and how much? In M. H. Bornstein & N. A. Krasnegor (eds), *Stability and continuity in mental development: behavioral and biological perspectives* (235–48). New York: Erlbaum.

Baldwin, D. A. & Markman, E. M. (1989). Establishing word-object relations: a first step. *Child Development* **60**, 381–98.

Bates, E., Benigni, L., Bretherton, I., Camaioni, L. & Volterra, V. (1979). *The emergence of symbols: cognition and communication in infancy*. New York: Academic.

Bates, E., Bretherton, I. & Snyder, L. (1988). *From first words to grammar: individual differences and dissociable mechanisms*. Cambridge: C.U.P.

Bates, E., Thal, D. & Janowsky, J. (1992). Early language development and its neural correlates. In I. Rapin & S. Segalowitz (eds), *Handbook of neuropsychology*, vol. 7. *Child neuropsychology*. Amsterdam: Elsevier.

Baumwell, L., Tamis-LeMonda, C. S. & Bornstein, M. H. (1997). Maternal verbal sensitivity and child language comprehension. *Infant Behavior and Development* **20**, 2, 247–58.

Beckwith, L. & Cohen, S. E. (1989). Maternal responsiveness with preterm infants and later competency. In M. H. Bornstein (ed.), *Maternal responsiveness: characteristics and consequences: new directions for child development* (pp. 75–87). San Francisco: Jossey-Bass.

Bloom, L. (1973). *One word at a time: the use of single-word utterances before syntax*. The Hague: Mouton.

Bloom, L. (1993). *The transition from infancy to language*. USA: Cambridge University Press.

Bloom, L., Margulis, C., Tinker, E. & Fujita, N. (1996). Early conversations and word learning: contributions from child and adult. *Child Development* **67**, 3154–75.

Bornstein, M. H. (1989). *Maternal responsiveness: characteristics and consequences*. San Francisco: Jossey-Bass.

Bornstein, M. H. & Lamb, M. E. (1992). *Development in Infancy*. New Jersey: McGraw-Hill.

Bornstein, M. H. & Tamis-LeMonda, C. S. (1989). Maternal responsiveness and cognitive development in children. In M. H. Bornstein (ed.) *Maternal responsiveness: characteristics and consequences*. *New directions for child development*, no. 43. San Francisco: Jossey-Bass.

Bornstein, M. H. & Tamis-LeMonda, C. S. (1997). Maternal responsiveness and infant mental abilities: specific predictive relations. *Infant Behavior and Development* **20**, 283–96.

Bornstein, M. H., Tamis-LeMonda, C. S., Tal, J., Ludemann, P., Toda, S., Rahn, C. W., Pecheux, M., Azuma, H. & Vardi, D. (1992). Maternal responsiveness to infants in three societies: America, France, and Japan. *Child Development* **63**, 808–21.

Cohen, J. (1960). A coefficient of agreement for nominal scales. *Educational and Psychological Measurement* **20**, 37–47.
Dunham, P. & Dunham, F. (1992). Lexical development during middle infancy: a mutually driven infant-caregiver process. *Developmental Psychology* **28**, 414–20.
Fenson, L., Dale, P. S., Reznick, J. S., Bates, E., Thal, D. & Pethick, S. (1994). Variability in early communicative development. *Monographs of the Society for Research in Child Development* **59** (5, serial no. 242).
Garton, A. F. (1992). *Social interaction of the development of language and cognition*. Hove: Lawrence Erlbaum Associates.
Goldfield, B. & Reznick, J. S. (1990). Early lexical acquisition: rate, content, and the vocabulary spurt. *Journal of Child Language* **17**, 171–83.
Goodwyn, S. W. & Acredolo, L. P. (1993). Symbolic gesture versus word: is there a modality advantage for onset of symbol use? *Child Development* **64**, 688–701.
Gopnik, A. & Meltzoff, A. (1987). The development of categorization in the second year of life and its relation to other cognitive and linguistic developments. *Child Development* **58**, 1523–31.
Hollingshead, A. B. (1975). *The four-factor index of social status*. Unpublished manuscript, Yale University.
Huttenlocher, J., Haight, W., Bryk, A., Seltzer, M. & Lysons, T. (1991). Early vocabulary growth: relation to language input and gender. *Developmental Psychology* **27**, 236–48.
Lifter, K. & Bloom, L. (1989). Object knowledge and the emergence of language. *Infant Behavior and Development* **12**, 395–423.
McCall, R. B., Eichorn, D. H. & Hogarty, P. S. (1977). Transitions in early mental development. *Monographs of the Society for Research in Child Development* **42** (serial no. 171).
McCune-Nicolich, L. (1981). Toward symbolic functioning: structure of early pretend games and potential parallels with language. *Child Development* **52**, 785–97.
McCune, L. (1992). First words: a dynamic systems view. In *Phonological Development: Models, Research, Implications*. Parkton, MD: York Press.
Nelson, K. (1973). Structure and strategy in learning to talk. *Monographs of the Society for Research in Child Development* **38** (1–2, serial no. 149).
Olson, S. L., Bayles, K. & Bates, J. E. (1986). Mother–child interaction and children's speech progress: a longitudinal study of the first two years. *Merrill-Palmer Quarterly* **32**, 1–20.
Reznick, J. S. & Goldfield, B. (1992). Rapid change in lexical development in comprehension and production. *Developmental Psychology* **28** (3), 406–13.
Schwartz, R. (1988). Phonological factors in early lexical acquisition. In M. Smith & J. Locke (eds), *The emergent lexicon: the child's development of a linguistic vocabulary*. San Diego: Academic Press.
Shore, C., O'Connell, B. & Bates, E. (1984). First sentences in language and symbolic play. *Developmental Psychology* **20** (5), 872–80.
Tamis-LeMonda, C. S. (1996). *Parenting sensitivity: individual, contextual and cultural factors in recent conceptualizations*. Thematic issue of *Early Development and Parenting* **5**, no. 4.
Tamis-LeMonda, C. S. & Bornstein, M. H. (1990). Language, play, and attention at one year. *Infant Behavior and Development* **13**, 85–98.
Tamis-LeMonda, C. S. & Bornstein, M. H. (1994). Specificity in mother–toddler language-play relations across the second year. *Developmental Psychology* **30**, 283–92.
Tamis-LeMonda, C. S., Bornstein, M. H., Baumwell, L. & Damast, A. M. (1996). Responsive parenting in the second year: specific influences on children's language and play. In C. S. Tamis-LeMonda (guest editor), *Parenting sensitivity: individual, contextual and cultural factors in recent conceptualizations*, Thematic Issue *of Early Development and Parenting* **5** (4), 167–71.
Tomasello, M. & Farrar, M. J. (1986). Joint attention and early language. *Child Development* **57**, 1454–63.
van IJzendoorn, M. H., Dijkstra, J. & Bus, A. G. (1995). Attachment, intelligence, and language: a meta-analysis. *Social Development* **4**, 115–28.

Vihman, M. M. & McCune, L. (1994). When is a word a word? *Journal of Child Language* **21**, 517–42.
Willett, J. B. & Singer, J. D. (1991). From whether to when: new methods for studying student dropout and teacher attrition. *Review of Educational Research* **61**, 407–50.
Willett, J. B. & Singer, J. D. (1993). Investigating onset, cessation, relapse and recovery: why you should, and how you can, use discrete-time survival analysis to examine event occurrence. *Journal of Consulting and Clinical Psychology* **61**, 952–65.