A Curvilinear Trend in Naming Errors as a Function of Early Vocabulary Growth

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This research examines changes in word retrieval and naming during a developmental period in which there is a substantial increase in productive vocabulary. That increase generally occurs when children have between 50 to 150 words in productive vocabulary. We examined children’s naming errors in two studies for what these errors could tell us about the emerging lexicon. The method we used for eliciting spontaneous naming was picture book reading by the parent. In Experiment 1, 12 children were followed longitudinally at three-week intervals from 15 to 22 months. Parent diaries were used as a measure of vocabulary growth. Experiment 2 used a cross-sectional design to compare the naming errors of 60 children assigned to one of three vocabulary ranges. Measures of vocabulary size were based on the MacArthur Communicative Development Inventory. In both experiments we found a sharp increase in naming errors in the picture book task that was coincident with sudden changes in productive vocabulary. These naming errors were often perseverative in nature and appear to reflect interference in the retrieval process from previously retrieved words. The results suggest that these errors in naming are a consequence of changes in lexical processing that occur with rapid growth of productive vocabulary and concurrent increased rates of speaking.

Between 12 months and 2 years of age, children make a dramatic transition from not talking to talking. This transition has been much studied by developmentalists for the knowledge and comprehension that underlie it and for the changes it brings to social and cognitive behavior. Fewer studies have examined the actual processes involved in producing words in context and how these processes might change as vocabulary rapidly grows (Stemberger, 1989; Wijnen, 1990, 1992). In this paper, we pursue a dynamic, process-oriented approach to the study of language by asking how retrieving a word might

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change as a function of initial vocabulary growth. In doing so, we study the operations of the mental lexicon at the earliest stages of its formation and during a period of rapid change.

The starting point for this study was the close observation of changes in naming that occurred in one child, Sarah, (the daughter of the first author) between 17 and 19 months of age—an age which, for this child, marked a period of accelerated vocabulary growth. Typical of most children beginning to produce words, one of Sarah’s favorite activities consisted of pointing to and naming familiar objects in picture books. (See DeLoache & DeMendoz, 1987; Murphy, 1978; Ninio & Bruner, 1978, for other evidence of these behaviors.) During this initial period of rapid vocabulary growth, however, a temporary disturbance occurred in the correct naming of familiar objects. That is, Sarah sometimes pointed to a pictured object but called it by the wrong name. For example, she might point to a picture of a bear—an object named correctly on other occasions—and label it “duck.” These naming errors did not appear to be overextensions in that they consisted of words that had been used correctly in the past and that could be named correctly upon direct questioning. Moreover, the errors were neither intentional nor playful in appearance but occurred most frequently in naming routines involving several objects in succession. Finally, these naming errors lasted for a period of only a few weeks.

Our working hypothesis is this: As vocabulary “scales up,” as children go from producing no words to many words and from slow to faster rates of talking, there is a temporary increase in naming errors, that is, in retrieving the right word at the right moment. As a first step in documenting the existence of these errors, we concentrate on issues in productive vocabulary growth which we measure directly in the experiments. In the General Discussion, we will raise the complicated question of the relation between receptive and productive vocabulary growth. We outline here three issues pertinent to the experiments that follow:

**Why Retrieval Errors May Change as Vocabulary Grows**

The adult literature provides clues as to why word retrieval may be unstable during the period of early vocabulary growth. First, lexical access is faster and less errorful for adults when the target word is from a sparsely populated rather than densely populated region of the lexicon, that is, when the word has few rather than many similar lexical neighbors (Charles-Luce & Luce, 1990). Initially, children’s lexicons must be sparsely populated throughout, but during the time of early vocabulary growth the lexicon will become increasingly crowded. Thus, retrieval processes may have to “catch up” to the new demands of a more densely populated lexicon.

Second, lexical access in adults is strongly determined by the frequency of the target word in the language (e.g., Forster & Chambers, 1973) and also by its age of acquisition (Walley, 1993). Apparently, word retrieval benefits
from the accrued effects of practice at hearing and speaking words. If this is so, it is reasonable to expect that processes of word retrieval will be particularly vulnerable as children begin to produce many new words most of which are “low frequency” words in the sense of the child’s own experience.

Thus, the adult data suggest why we might find, as we observed in Sarah, a rise and fall in retrieval errors as productive vocabulary grows: (1) more interference among words at the time of retrieval as more words are added to the lexicon and (2) more robust retrieval as individual words become more highly practiced.

Number of Words versus Rate of Vocabulary Growth

Sarah’s naming errors occurred at a time of marked vocabulary growth, a period characterized by both increases in the number of words produced and increases in the rate at which new words are added to productive vocabulary. It is unclear which aspect of growth, number or rate, might be most relevant to emerging processes of word retrieval. These two aspects are highly correlated in development. Many researchers have described an abrupt increase in the rate of new word productions, an increase commonly known as the “naming explosion” or “vocabulary spurt” (Benedict, 1979; Bloom, 1973; Dromi, 1987; Gershkoff-Stowe & Smith, 1991; Goldfield & Reznick, 1990; Nelson, 1973). This shift in the rate of new word productions typically occurs when children are 18 to 20 months of age. However, it is more closely related to the number of words in children’s productive vocabulary than their age, occurring when children have approximately 50 to 100 words (Bates, Bretherton, & Snyder, 1988).

There is considerable debate as to whether or not all children exhibit a rate-shift in new word productions (Goldfield & Reznick, 1990; Mervis & Bertrand, 1995) and whether or not it involves all of productive vocabulary or primarily nouns (Bloom, Tinker, Margulis, 1993; Lieven, Pine, & Barnes, 1992). Nonetheless, there are many reported cases in the literature, enough to suggest that it is a common event. And in some cases, it is truly dramatic. Dromi (1987), for instance, recorded a rise of 44 new words in her daughter’s productive vocabulary in the course of a single week. Clearly, such sudden increases in the number of new word productions could disrupt, at least for a time, the correct retrieval of a known word.

It is also possible, however, that the absolute number of words in the child’s spoken language vocabulary is also associated with how often errors are made. This idea fits with recent evidence from connectionist models of language learning. For example, Plunkett and Marchman (1993) demonstrated a qualitative shift in network performance on a novel verb learning task with quantitative changes in vocabulary size (see also Marchman & Bates, 1994). Their work suggests that similar abrupt changes may result as children reach some critical number of words (e.g., over 50 words).
Amount of Talking

A final possibility is that the transient naming errors observed in Sarah were not related to vocabulary growth per se but to one of the consequences of a larger vocabulary, namely, talking more. As children talk more, they will need to retrieve words closer together in time and thus face the possibility of retrieving words out of order. Relevant to this possibility are findings by Wijnen (1990) suggesting that as children begin to produce multiword combinations there is a brief period of repetition and substitution errors in their productions. A similar phenomenon could characterize children’s one-word stage as they attempt to comment on many objects in close succession.

Rationale for the Experiment

The primary question of this research is whether the phenomenon suggested by Sarah’s naming errors occurs in other children. The secondary questions concern what aspects of early vocabulary growth are related to this transient period of naming errors if they exist. In the present experiment, we used a task based on the context within which Sarah had made her errors, picture book reading. When young children look at pictures they often spontaneously point to and name objects, thus exhibiting two critical components for the study of lexical processes: the point by the child provides information about the stimulus (the object for which a name is sought) and the spoken name is, of course, the dependent measure of interest.

Sarah’s errors specifically suggested they may be retrieval errors because they consisted of misnamings in which both the correct object name and the misapplied word had been used correctly by Sarah in the past. In order to document whether children’s naming errors involve known words, we used a longitudinal design in Experiment 1. Children came into the laboratory every three weeks and participated in the picture book reading task. Over the course of the experiment, we kept track of the number of times that children had correctly named each object in the book. Children were approximately 15 months at the start of the study, just prior to the characteristic period of rapid vocabulary expansion. In order to measure productive vocabulary growth, parents kept a home diary of all new words produced by their children throughout the experiment. In Experiment 2, we replicate the main findings of Experiment 1 using a cross-sectional design.

EXPERIMENT 1

Method

Subjects

Twelve children (6 females, 6 males) from two separate samples participated in the longitudinal study. Both samples came from middle class, Caucasian families in which English was the
TABLE 1
Mean Age (in months) and Cumulative Words Produced at First Laboratory Session

<table>
<thead>
<tr>
<th></th>
<th>Sample 1</th>
<th>Sample 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>(n):</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>(M) age:</td>
<td>16.14</td>
<td>17.41</td>
</tr>
<tr>
<td>Range:</td>
<td>15.67–16.7</td>
<td>15.63–20.2</td>
</tr>
<tr>
<td>Cumulative words at start of study:</td>
<td>28.2</td>
<td>37.6</td>
</tr>
<tr>
<td>Range:</td>
<td>4–84</td>
<td>22–62</td>
</tr>
</tbody>
</table>

only language spoken. Potential subjects were identified from birth announcements in the local newspaper.

Five children comprised the first set of subjects (2 females, 3 males). They ranged in age from 14.9 to 15.9 months \((M = 15.6)\) at the time of initial contact. Parents' reports of the number of words children from this group spoke revealed a mean total productive vocabulary of 14.9 words (range = 1–50) at the start of the study.

A second sample of seven children (4 females, 3 males) was drawn from the same subject pool the following year. Two changes were made in the procedure through which parents were contacted for participation. First, initial contact was made when children were slightly younger \((M = 14.4\) months). The mean total productive vocabulary for this second group was 12.4 words (range = 4–22) at initial contact. A second modification involved calling parents each week about the number of new words their children had acquired. In most cases, laboratory visits began when the child produced approximately 35 different words. The mean number of days between the time parents began keeping a record of their children's lexical development and the first observation session was 22 days for the first sample and 88 days for the second sample.

The original goal was that individual children participate for 8 sessions (6 months). However, three factors contributed to varying number of sessions: (1) Family change (relocation, new baby, new job); (2) rapid vocabulary growth—once children approached 200 words in their productive vocabulary, parents had difficulty maintaining the diary and children took less interest in the picture book task; and (3) slow vocabulary growth—some of these children whose parents agreed participated beyond the 8 sessions. Table 1 shows the mean age and range for children in each group, their total productive vocabularies at the time observations began, and the mean number of sessions and their range for children in each group.

Three additional children began the study but their data are not included. Of these, one child was later independently diagnosed as language delayed. The second child left the study at 23 months with a productive vocabulary of only 20 words. Data from the third child were excluded because she spoke little in the laboratory sessions.

**Stimuli**

The picture books used to elicit naming behavior in the first sample were *Brown Bear, Brown Bear* by Bill Martin (Holt & Co., 1983) and *Corduroy* by Don Freeman (Viking Press, 1968). On each page of *Brown Bear, Brown Bear* children saw one large, colorful picture of an animal. Each picture corresponded to a simple text in which the object was named twice in a rhythmic fashion. The second book had a more complex storyline containing several objects per page. This book did not elicit much naming behavior among the children. Consequently, we replaced it in the second sample with *My Little Golden Word Book* by Joe Kaufman (Western Publishing, 1968). This simple book presented pictures of four common objects and their labels on each page. Thus children in both samples used *Brown Bear, Brown Bear* throughout the study but
differed in the second book they used. A list of the objects that appeared on each page of the three books can be found in Appendix A.

Procedure

Measures of productive vocabulary. We used a traditional diary method to estimate the productive vocabulary of children at each session. Parents were asked to record any new words or phrases their child spontaneously produced each day. This included non-imitative utterances that differed from conventional word use according to adult standards (e.g., ‘‘gak’’ for duck) as well as onomatopoeia suggesting pragmatic or referential meaning for the child (e.g., ‘‘choo-choo’’). In the second sample, we supplemented the diary method with a vocabulary checklist that provided a sample of words in different object classes. The purpose of this addition was to facilitate the record keeping process for parents (Reznick & Goldsmith, 1989).

Picture book reading. Each child and a parent came to the laboratory every 3 weeks. The same parent (11 mothers and 1 father) accompanied the child across sessions. During each laboratory visit parents were instructed to name and point to the objects in each of the two experimental picture books. Although the order of the books varied among children and across sessions to fit individual attentional needs, the same books were used consistently for each child across sessions. This enabled us to monitor children’s knowledge and naming of pictured objects and parents’ behavior. All sessions were videotaped for later coding.

Measures

Child behavior. Children’s responses were coded for the number of times they produced an utterance related to the book as indicated by the direction of the child’s gaze or gestures toward the book. Extraneous, unrelated behaviors occurred infrequently and were not counted. Children’s naming attempts occurred both with and without pointing to the pictured object. Our analyses concentrate on joint pointing and naming because we could be most confident given multiple pictures on a page of the object the child intended to name. An error in naming was counted if the child pointed to one object, for example, the bird, but offered an incorrect name, e.g., ‘‘cup.’’ Thus the error data we report are errors in production.

The reliability of the coding for two independent observers was established for a random selection of three of the twelve children for two sessions each (a total of six, 20-min sessions). The percent agreement was high: 96% for all naming acts and 95% for naming errors.

Parent behavior. To address the possibility that parents were contributing to any changes in naming errors during this period of rapid vocabulary growth, we coded two general categories of parent responses. These included the number of times the parent supplied the name of an object in each session and the questions they directed toward their child. The first set of parent responses included any behavior that marked a referent by naming it. The second category of responses included the number of ‘‘what’’ questions asked by the parent which directly elicited the name of a pictured object (e.g., ‘‘what’s this?’’). Interrater reliability of parent responses for the same randomly selected set of subjects and sessions described above was 96%.

Results

The two questions motivating this study are (1) whether other children show the rise and fall in naming errors that Sarah did and, if they do, (2) what aspects of vocabulary growth and productive naming are related to these transient errors? We address these questions by examining the relationship between individual children’s naming behavior in the laboratory and their productive vocabulary growth as measured by the at-home diaries. We report
the group data on these two measures and then turn to the main analyses and individual performances.

Figure 1 shows the mean frequencies of children’s attempts (both correct and incorrect) to name objects in the picture books. As is apparent in the figure, the children readily attempted to name the pictures—offering on average a minimum of 10 attempts in the first session when they were just introduced to the books and an average of 36 attempts in later sessions. The number of naming attempts across the eight sessions was submitted to a one-way analysis of variance for repeated measures. For the three children who did not participate for all eight sessions, the number of naming attempts at their last session was used to fill the missing cells. (See the profiles of individual children in Fig. 3 below.) This analysis yielded a main effect of Session, $F(7,77) = 6.18$, $p < .001$. Post-hoc analyses (Newman–Keuls, $\alpha = .05$) indicate that children made reliably fewer attempts at session 1 than at session 3. The number of naming attempts from session 3 on does not differ from each other. The critical points revealed by these data that are relevant for subsequent analyses are: (1) even from the first sessions children attempt to name the pictures with some frequency, (2) the frequency of children’s naming attempts stabilizes at a reasonably high level by session 3, and (3) there is considerable individual variability.

Figure 2 shows the mean cumulative vocabulary growth as measured
by the parent diaries. As is apparent, this is a period of considerable and continuous productive vocabulary growth for the children in this experiment, changing from an average of 39 words at the initial session to an average of 158 words at the last session. This group curve, however, is made up of individual patterns of vocabulary growth that vary considerably.

A Transient Period of Naming Errors?

Do children in general show the same transient pattern of naming errors as did Sarah? To address this question, we counted individually, for each child, the number of times in each laboratory picture book session that the child pointed to an object in the picture book (e.g., a bird) and called it by a wrong name (e.g., “cup”). Figure 3 shows the frequency of naming errors as a function of session for each of the 12 children. In addition, parental diary reports of at-home productions is given in parentheses, revealing the wide range of individual variability in vocabulary growth. However, inspection of children’s naming errors in the laboratory suggests that Sarah is not unique in exhibiting an episode of errorful naming; nine of the children exhibited a brief (1 or 2 session), distinct rise in naming errors. Moreover, for some of these children the number of naming errors in the most errorful
session was quite dramatic. We asked whether the distribution of errors varied reliably across sessions for each individual child by calculating individual \( \chi^2 \)s \((df = \text{number of sessions} - 1, \alpha < .05)\). By this measure, errors were distributed unequally across sessions for all but three children: Mallory, Elizabeth, and Susan.

These individual curves suggest a transient period of naming errors for many of the children in this study—children, who like Sarah, are in a period of rapid vocabulary growth. In the next set of analyses, we ask what aspects of vocabulary growth are related to the increase in errors. For these following analyses, we aligned individual children’s data by the session in which they showed the maximum number of errors. This was easily determined for all but two of the children: Mallory, who had two consecutive sessions in which she showed a maximum number of errors and Susan, who had four sessions distributed throughout the study that were maximal. Accordingly, we took Mallory’s first ‘maximum’ as her session of maximum error while omitting Susan’s data. This decision was based on the fact that Mallory’s data provided a coherent estimate of when naming was most errorful whereas Susan’s data did not. Also note that including Mallory and Elizabeth, who did not show a statistically reliable increase in errors, is the conservative approach in that it increases variability in the data set and works against finding a relation between errors and aspects of lexical growth. In sum, with the exclusion of Susan’s data, the number of children included in the analyses below is 11.

**Developmental Correlates**

We examined three aspects of lexical growth that may be associated with changes in the frequency of errors: (1) the number of words and the number of specifically object words in productive vocabulary by parent report, (2) the rate of new word and new object word acquisitions by parent report, and (3) the amount and rate per minute of naming attempts by children in the laboratory. These factors are presented separately in Figs. 4 through 7. In each of the figures, the data are aligned by the session of maximum error. Because some children produced the majority of their errors early in the study and some children produced them later in the study, the total number of children contributing data to each session is shown in parenthesis. We examined number of object words as well as the number of total words in children’s productive vocabulary because of the current controversy about the dominance

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1 We chose to report the data in terms of frequency rather than error rate principally because, for many sessions, the frequency of naming attempts was often too low to establish a reliable measure of error rate. For example, a child who produced a total of 2 utterances, 1 of which was incorrect, would have a 50% error rate; by the same token, a child who produced 100 utterances would need for 50 of those utterances to be incorrect in order to yield a similar rate of error. This discrepancy in the relative size of the data sets across sessions makes an analysis of proportions difficult to interpret.
Fig. 3. Frequency of individual children's naming errors with cumulative number of words in productive vocabulary in parentheses for each session.
NAMING ERRORS

Mallory

Matthew

Susan

Teddy

Thomas

Zoe

Errors

Errors

Errors

Errors

Errors

Errors

Session

Session

Session

Session

Session

Session

(29) (30) (35) (41) (54) (72) (77)

(24) (32) (50) (64) (89) (110)

(28) (39) (56) (88) (109) (124) (150)

(34) (47) (117) (122)

(45) (59) (72) (85) (100) (191) (205)

(43) (47) (63) (67) (93) (112) (127)
of object words in early vocabulary growth and because our laboratory task asks children to retrieve specifically object names. For all post-hoc analyses below, the Newman Keuls method for repeated measures was used (α = .05) and all differences cited as reliable are reliable by this method.

Figure 4, aligned by each child’s session of maximum naming errors in the laboratory, shows the mean cumulative number of object words and all words in the children’s productive vocabulary. The number of words increased steadily over time, $F(6,60) = 31.752, p < .001$, as did the number of object words, $F(6,60) = 21.713, p < .001$. During the session of maximum error, children had a mean of 95 total words (range = 50–155) and 57 object words (range = 27–125). However, the session of maximum error does not appear distinguished in any other way relative to the other sessions by this measure.

We determined rate of vocabulary growth by calculating the number of new words (and new object words) added to productive vocabulary by parent reports during each of the three-week periods. These data are presented in Fig. 5, with session −3 rather than session −4 beginning on the X axis because our measure of interest is rate of new word additions from one session to the next. Again, we see significant changes occurring in the course of the experiment. In particular, we find the greatest magnitude of change taking
place between the session of maximum error and the session just prior to it. During this 3-week interval, children added 16 new object words (range = 4–22); this jump in rate of new object words between adjacent sessions is reliable; $F(5,45) = 3.518, p < .009$. The total number of new words added during this 3-week interval was 23 (range = 10–63); this difference, but no other adjacent contrast, approached significance ($p < .10$). Thus, it appears that a substantial increase in the number of new words (and particularly object words) is temporally associated with the rise in naming errors in the laboratory. Interestingly, the proportional change in productive vocabulary does not seem so substantial; there was a 28% increase in the cumulative productive vocabulary in the 3-week interval ending with the session of maximal error and a 19% increase in the 3-week interval prior to that. Apparently, then, the critical parameter is not percentage growth but the total number of new words.

Finally, Figs. 6 and 7 show the number and rate of naming attempts in the laboratory aligned by the session of maximum naming errors in the laboratory. As can be seen in Fig. 6, this number increased reliably over sessions, $F(6,60) = 12.737, p < .001$. Again, the sharpest and only reliable adjacent jump occurs between the session of maximum error and the one preceding it, with the mean number of utterances per session doubling from 25.7 to 51.5 naming attempts. This pattern of naming attempts rules out one simple explanation of the transient rise in the number of naming errors. It is not the case that the session in which children made many errors was the one session in which
they talked a lot. Rather, the session in which they made many errors is the one in which they began to talk a lot. This suggests that there is a temporary increase in naming errors at just the time when the child’s productive vocabulary is flooded with new items. However, as children continue using these lexical items and to make more naming attempts, the errors do not continue but abruptly decline, as shown in Fig. 3.

Given that children’s number of naming attempts per laboratory session changed over the course of the experiment, it is also likely that the number of naming attempts per unit time also changed. The temporal proximity of retrieval attempts to each other could be an important factor in these errors. Accordingly, we coded the number of naming attempts produced per minute per session for each child. Since this was a laborious procedure, we coded naming attempts for only one of the two books used by children each session (*Brown Bear*, the one experimental book presented to all children in the study). The mean number of words per minute as a function of session (aligned by session of maximum error) is shown in Fig. 7. As is clear, the rate of naming attempts increases dramatically at the session of maximum error, \( F(6, 60) = 5.776, \ p < .001 \). The rise from the just preceding session to the session of maximum error is reliable; the difference between the session of maximum error and the next is not. Thus, errorful naming is temporally located at the developmental point when children first try to make many
naming attempts in the laboratory and thus try to retrieve the names for the pictured objects in closer temporal succession.

In total, the evidence just examined suggests that the transient period of naming errors in the experiment occurs at a time when verbal behavior is beginning to change—when the rate of new object words produced at home first jumps, when children attempt to name the pictured objects more often in the laboratory, and when these naming attempts occur more closely together in time.

To assess the relationships more closely, we determined for each child and each aspect of vocabulary growth and naming behavior, when the maximum between two adjacent sessions had occurred; we defined the session of maximum change as the second of these two adjacent sessions. In the few cases where children exhibited two intervals with equal and maximal change we defined the session of maximum change in terms of the first of these. Our question, then, is whether maximum changes in some aspects of vocabulary growth are more closely related to the session of most errorful naming. Accordingly, we correlated the session of maximum naming errors with the session of maximum change for each of the other measures. These correlations, along with their slopes and intercepts, are presented in Table 2. As shown, the session in which the maximum number of errors occurred was significantly correlated to each measure, \( p < .001 \). All are changing together during this time period; but are the intervals of maximal change in some aspects of vocabulary growth temporally closer to the session of errorful naming than others? The slopes and \( Y \) intercepts of the lines for predicting the session of
maximum error from the sessions of maximum change in the other measures provide information about their temporal proximity; if intervals of maximal change occur at the same time, a slope of 1.00 and a Y intercept of 0 is expected. As is apparent in Table 2, it is the interval of maximum change in rate of vocabulary growth (both object words and total words) that occurs at the same time as the session of most errorful naming. This result supports our idea that adding many new words to a rapidly forming lexicon temporarily disrupts retrieval of stored items in memory. The negative Y intercepts for the other measures of vocabulary growth and talking in the laboratory indicate that intervals of maximum change on these measures tend to precede the session of most errorful naming. However, strong inferences are not warranted because of the small sample size and because many aspects of early vocabulary growth and use clearly move together and are likely to be interdependent. Still, the results point to a shift in rate of vocabulary growth as a likely key factor behind the occurrence of the transient naming errors.

Nature of the Errors

What are the errors like that occur during the brief episode of errorful naming? To answer this question, we examined children’s familiarity with the correct object names, the naming events that just preceded an error, and the phonological and semantic relationship between the misapplied name and the mismarked object. Altogether, this evidence suggests that the errors stem from difficulties in retrieving known words. In the analyses that follow, we concentrate on the errors that occurred during the session of maximum naming errors. Subsequently, we will present evidence on how these errors from this episode of errorful naming differ from the more infrequent errors that occurred in the other sessions.
Word familiarity. Because this is a longitudinal experiment, we have some evidence on the degree to which children knew the appropriate names of the objects in the picture books. At the time of the session of maximum naming errors, the children had typically heard their parents name each object in the book many times (on average, more than 25 times) in previous laboratory sessions. This fact alone suggests that the target word—the object pointed to by the child but incorrectly named—was a word known to the child. To obtain a preliminary measure of individual word familiarity, we asked whether the correct word, that is, the one the child did not supply, had been produced at least once by the child prior to the error. Considering only errors that occurred during the session of maximum error, we found that for 76% of all errors, the child had produced the correct word at least once prior to the error, and usually many more times. This fact is consistent with the idea that these errors may be errors of retrieval—that is, they may reflect failures of accessing the correct word in the mental lexicon rather than failures of knowing the right word.

Interference. Retrieval errors could result from two possible kinds of interference: (1) repetition effects—interference from recently retrieved words and (2) similarity effects—interference from phonologically or semantically similar words. Again, concentrating on just the errors that occurred in the session of maximum naming errors, we looked for repetition effects by examining the time frame that spanned the last three naming attempts by the child just prior to each naming error. For example, if a child pointed to the picture of the dog and said “bird,” we asked whether the child had said “bird” within the timeframe of the child’s last three naming attempts. We arbitrarily chose the last three naming attempts in an effort to use a window narrow enough that it was within the timeframe of known repetition effects in the adult literature but wide enough to capture the possibly slower memory dynamics of young children (Case, Kurland, & Goldberg, 1982).

We found that 61% of all naming errors in the session of maximum error were repetitions of one of the last three object words uttered by the child. Thus the naming errors during the session of maximum errors are, in a sense, perseverative. However, these errors do not appear to result from an immediately repeated motor act. While 61% of the time the misretrieved words had been produced in the last three naming attempts, it was the just previously spoken word in less than 31% of the cases. Moreover, the average time between preceding production of the word (in the last three utterances) and its production as a naming error was 11.25 s and only in 14% of the cases was the prior production within 3 s of its subsequent misapplication. These repetition effects in children’s errors thus appear to occur over relatively long time intervals, and are similar to the temporal properties of repetition effects in adult lexical access and memory (see Forster, 1990).

We classified each error as a potential “semantic/perceptual” error if the two objects were roughly similar in shape (e.g., dog and cat); 52% of the errors met our definition. Thus, children’s misretrievals were often of recently
said object names for things similar in appearance (and frequently, category) to the object being labeled.

Finally, we found little evidence of phonological confusions. We classified each error as potentially based on phonetic similarity if the two words in question shared their initial phoneme (e.g., dog and duck) or if they rhymed (e.g., plane and train). Only 8% of the children’s naming errors met our definition of phonetic similarity. This result is considerably less than the phonologically similar errors reported for adults but is consistent with findings of children’s spontaneous sound errors (Wijnen, 1992; but see also Stemberger, 1989). Thus, although sound similarity effects may be involved in children’s naming errors at this age, the present results do not provide strong evidence for them.

We also examined whether the relatively infrequent errors in the sessions other than the session of maximum error were repetition, “semantic/perceptual,” or phonological errors. Repetition errors characterized 35% of the naming errors in these other sessions, considerably less than the 61% observed in the session of maximum error. “Semantic/perceptual” errors by our definition constituted 20% of the naming errors in these other sessions, again considerably less than the 52% observed in the session of maximum error. Finally, phonological errors (by our definition) were extremely rare in these other sessions, occurring less than 6% of time. In these other sessions children typically made very few naming errors (on average, two per child, per session). Thus the above description of the nature of the errors in these sessions may not be reliable. Still, unlike the errors in the session of most errorful naming, these other errors are not so clearly instances of repetition or semantic confusions.

The findings that the errors in the session of maximum error were repetition and “semantic/perceptual” errors is suggestive about their cause: lingering activation from a previously retrieved word combined with semantic similarity to interfere with the retrieval of the sought word. We will consider this idea and why children at this point in development might be particularly prone to these forms of interference in greater detail in the General Discussion.

Changes in Parents’ Behavior

Parents were an important part of this experiment, naming the pictures in the books and querying their children about the pictures. It is to be expected that these parent behaviors might change as children learn more words and talk more in the experimental sessions. (See Ninio & Bruner, 1978, for pertinent data.) To address this possibility, we coded in detail parents’ behavior during the “reading” of one book each session (Brown Bear).

Figure 8 shows the mean number of times parents supplied the name of a pictured object or asked their children to name the objects themselves, aligned by the session of maximum error. Little change was apparent in the number of times parents named a picture in the book across the experimental sessions, \( F(3,30) = 1.788, p < .169 \); labeling was frequent throughout the study. For
example, during the session of maximum error, parents provided correct picture labels an average of 50 times. Although the range of parent naming was quite large (range = 31–74), individual parents were remarkably consistent from session to session. Figure 8 also shows that questions requiring children to produce the name of an object (e.g., “what’s that?”) more than doubled during the course of the study, $F(6,60) = 3.281, p < .007$. Importantly, however, the frequency of “what is that?” questions during the session of maximum error was not correlated with the number of naming errors that occurred during that session, $r(10) = .28$.

One final piece of evidence suggests that it is not the questions parents ask that create the rise and fall in errors but changes in the children themselves. During the experimental sessions, children’s attempts to name objects in the picture books were sometimes self-generated and sometimes elicited in response to a “what is that?” question by the parent. Figure 9 shows the mean frequency of self-generated and elicited errors aligned by the session of maximum error. Although both kinds of naming errors show a similar curvilinear trend, it is the self-generated errors and not the ones associated with the parents’ behavior that occur most frequently during the experiment. This was confirmed by a two-way analysis of variance revealing a main effect of type (self-generated versus elicited), $F(3,30) = 6.304, p < .03$. These results thus suggest that although parents’ linguistic behavior changes throughout the experiment, it does not appear to be a critical factor in causing the observed episode of errorful naming.
In sum, the main results of Experiment 1 are these: (1) Many children in the early stages of word learning exhibit a transient period of errorful naming, a period in which they name a pictured object by the wrong name. (2) The occurrence of these errors is temporally located at the point of a discontinuous increase in the number of object words being added to productive vocabulary and at a time when children attempt to name more objects, and do so more frequently per unit of time. (3) These errors appear to be retrieval errors, the correct names are often known by the children; the misapplied name is one just recently uttered by the child, and the misapplied name is one that correctly refers to a similar object. Thus, the errors seem to reflect interference from just previously retrieved and semantically similar words.

EXPERIMENT 2

Throughout the course of Experiment 1, children were learning many words at home and learning the names for the pictures in the experimental books. Is a transient period of errorful naming like that observed in Experiment 1 specific to the course of learning the circumscribed set of words in the books themselves or is a transient period of errorful naming a more general phenomenon occurring for all sorts of words at this time? We provide beginning evidence on this question in Experiment 2 by replicating the findings of Experiment 1 in a cross-sectional study. We do this to ensure that children’s repeated visits to the laboratory and repeated exposures to the books did not in some way create the transient episode of naming errors. In this experiment
NAMING ERRORS

children ranging in age from 14 to 24 months, visited the laboratory twice within a one-week period to “read” picture books with their parent. Our question was whether children in the midst of acquiring many new object names would show more errorful naming of the kind observed in Experiment 1 than children who had not reached or who had passed that point in word learning.

There are many problems with attempting a cross-sectional replication and it is important to explicitly recognize these. The most serious problem concerns the determination of just where in the course of early word learning individual children are. In Experiment 1, parents became practiced diary recorders of their children’s utterances. The two visits to the laboratory employed in this cross-sectional design are incompatible with diary records of all produced words. Thus we measured number of words in each child’s productive vocabulary via the MacArthur Communicative Developmental Inventory. This is a checklist of 680 of the most common words in the productive vocabulary of young children and is a highly reliable instrument (Fenson et al., 1994). However, there has been recent controversy that this instrument does not measure exactly what diary data measure and may be biased toward object words (Bloom, Tinker, & Margulis, 1993; Nelson, Hampson, & Kessler Shaw, 1993; Tardiff, 1996). Further, in Experiment 1, we were able to measure both the number of words in children’s productive vocabulary and the rate of new additions. In this cross-sectional study, we will only have a measure of the number of words in each child’s productive vocabulary, not rate of change. Using, then, just the number of words in children’s productive vocabulary, the findings of Experiment 1 suggest the critical developmental time for these episodes of naming errors occurs when children have between 50 to 150 total words. Thus, in Experiment 2, we assigned children to one of three groups according to their productive vocabulary size: under 50 words, 50–150 words, and over 150 words. This division was designed to provide a broad window with which to compare the naming errors in children over the course of early word learning.

A second difficulty is that the episode of errorful naming that we observed occurred within a brief developmental moment, lasting one or two sessions (3 to 6 weeks). Given the brevity of the developmental phenomenon, it will be difficult in a cross-sectional design to capture individual children at just the right moment. Still, if this brief period of errorful naming occurs roughly in the time frame of 50 to 150 words and if we test a sufficient number of children in this range, they should on average show more errorful naming than do children with fewer or more words in their productive vocabulary.

Method

Subjects

Sixty children, 20 in each of the three vocabulary ranges, participated in the experiment. All children came from middle-class, Caucasian, English-speaking families and were recruited from
TABLE 3
Number and Mean Age (in months) and Cumulative Words By Size of Productive Vocabulary

<table>
<thead>
<tr>
<th></th>
<th>Under 50</th>
<th>50–150</th>
<th>Over 150</th>
</tr>
</thead>
<tbody>
<tr>
<td>n:</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>M word:</td>
<td>24</td>
<td>92</td>
<td>274</td>
</tr>
<tr>
<td>Range:</td>
<td>7–49</td>
<td>50–148</td>
<td>155–524</td>
</tr>
<tr>
<td>M age:</td>
<td>16.4</td>
<td>18.5</td>
<td>22.3</td>
</tr>
<tr>
<td>Range:</td>
<td>14.7–20.6</td>
<td>15.2–21.2</td>
<td>18.5–24.8</td>
</tr>
</tbody>
</table>

newspaper announcements of babies born in Bloomington and from personal contacts. Nine additional children were tested but replaced either because they participated little in the experimental sessions, were extremely distracted, because their utterances could not be reliably interpreted as either correct or incorrect, or because the parents did not follow experimenter instructions.

Parent reports of the number of words in their children’s spoken-language vocabulary were based on the Toddler version of the MacArthur Communicative Development Inventory (CDI). Norms for the CDI derive from a sample of 1800 children and feature high validity and reliability (see Fenson et al., 1994).

The number of words in the children’s productive vocabularies ranged broadly across the three groups, from seven to 524 words. The 20 children (12 girls, 8 boys) in the Under 50 word group were a mean age of 16.4 months and had an average vocabulary of 24 words. This compares to a mean age of 18.5 months for the 20 children (10 girls, 10 boys) in the 50–150 word group; their average spoken vocabulary was 92 words. Children in the Over 150 word group (13 girls, 7 boys) were a mean age of 22.3 months and had an average of 274 words. These data are presented in Table 3.

Stimuli
Two picture books were used for eliciting naming behavior. One was *Brown Bear, Brown Bear* by Bill Martin, the same book used in Experiment 1 for all of the children in both sample sets. The second book, *What Does Bunny See?*, was constructed specifically for this study and was similar in design to *Brown Bear*. Each page had a large, appealing picture of an object and a simple text that repeated the name of the object twice. The primary difference between the two books was the taxonomic category from which the objects were selected. In *Brown Bear* all of the objects belonged to the category of animals while the second book contained objects from a variety of semantic categories. A list of the objects in *What Does Bunny See?* can be found in Appendix B.

Procedure
Parents and their children came to the laboratory twice within a period of 1 week. In previous studies we have found that many young children do very little talking in unfamiliar surroundings and often require more than one visit to feel at ease in the laboratory. Consequently, we asked parents to return a few days later (mean = 3.1 days) so that we might obtain a more accurate sampling of their children’s naming behavior.

Parents completed the CDI at the beginning of the first visit. During the picture book reading task the parent and child sat together on a small couch with the Experimenter across a table from them. Parents were instructed to read to their child as they normally did at home and to encourage the child to name and point to the objects in each book. The order of the books was counterbalanced across children and, with few exceptions, between the first and second visit for each child.
NAMING ERRORS

Measures

Child behavior. We analyzed children’s spontaneous, i.e., self-generated, naming of the objects in the two experimental picture books. A self-generated response was any attempt to name a pictured object that occurred on the child’s own, including those that occurred in response to hearing the object labeled by the parent. Names elicited by parents in response to direct questioning (e.g., “What’s that?”) were not included. This decision was based on the finding from Experiment 1 that errorful naming occurred principally in self-generated naming attempts rather than elicited ones. In addition, the parents in this cross-sectional study came for just two visits and were highly variable in the number of “what is that?” questions asked of individual children.

We included as a naming attempt any spontaneous word offered as a name with or without a point to the pictured object as long as the object of regard was clear. We did this (in contrast to Experiment 1 in which we counted words with explicit points only) because many children with vocabularies of over 150 words did not point much and because both books had only one picture on all but one page at the end of the book, thus making the intended object unambiguous.

Interrater reliability between two independent coders for a random sample of 25% of the children for self-generated naming, both correct and incorrect, was 90%.

Parent behavior. As in Experiment 1, two categories of parent behavior were coded while reading the experimental books: the number of times parents provided the label of the objects for the children and the number of questions directed toward the children that required them to name the object (“what is that?”). These behaviors included parents’ attempts to focus their children’s attention to specific details of the picture, for example, the comment, “The baby is wearing a diaper,” or the question, “What color is the frog?” Interrater reliability of parent responses for a random sample of 25% of the subjects was 93%.

Results

Children were assigned to the three groups according to the number of total words in their productive vocabulary as measured by the CDI. The mean number of object names in this count was: 15.1 (Range = 3–30) for children with less than 50 total words, 58 (range = 27–110) for children with 50–150 total words, and 173 (range = 104–285) for children with more than 150 total words. Thus at each vocabulary level, object words constituted a substantial portion of total vocabulary (see, Bates, Marchman, Thal, Fenson, Dale, Reznick, Reilly, & Hartung, 1994).

Naming Errors as a Function of Vocabulary Size

The frequency of naming errors was determined from children’s self-generated naming attempts. Across the three vocabulary ranges, children produced a mean number of 8, 41, and 49 naming attempts per visit, \( F(2,57) = 18.0, p < .001 \). Thus, naming attempts rise dramatically at the time children have more than 50 words. Post-hoc analyses of this and all following differences used the Newman–Keuls procedure for between-subject comparisons. By this measure, the number of naming attempts among the two more advanced groups does not differ.

Figure 10 shows the frequency of naming errors. These also differ across the three vocabulary ranges, \( F(2,57) = 10.28, p < .001 \). Post hoc comparisons show that these errors rise reliably from the first to the second vocabulary group and fall reliably from the second to the third vocabulary group. Thus
despite the fact that naming attempts are frequent for children in both the 50–150 word group and the Over 150 group, naming errors occur more often for the 50–150 word group.

Developmental Correlates

We cannot ask, as in Experiment 1, whether errors in individual children are related to the rate of productive vocabulary growth but we can ask whether the frequency of errors is related to the number of naming attempts and the rate of naming attempts in the laboratory. We already know from Figure 9, that across all levels of vocabulary development, there will not be a strong correlation between naming attempts and naming errors. We know this because while children in the 50–150 group produce many naming attempts and many naming errors, children in the Over 150 group produce just as many naming attempts but few naming errors. Indeed, this prediction was confirmed by a correlational analyses, across all three groups of children, between the number of self-generated naming attempts and the proportion of those naming attempts that were errors, \( r(59) = -.35 \). This result, in conjunction with those of Experiment 1, suggests that although the number of naming attempts might be related to variables correlated with the error, they are not the principal cause. Rather, the more critical variable appears to be the shift from naming few objects to naming many; children who are just beginning to know many words and just beginning to make many naming attempts may be more likely to produce retrieval errors.
We further examined the number of naming attempts per unit of time. The mean rates were .76, 2.27, and 4.93 naming attempts per minute for children in the three vocabulary groups, respectively. Rate of naming attempts in the laboratory increased reliably from one vocabulary group to the next, $F(2,57) = 28.452, p < .001$. Again, this fact tells us that rate of naming attempts by itself does not cause the errors. However, rapid naming attempts, one after another, may be disruptive for children who are just beginning to produce many words. Accordingly, we asked whether the children in the 50–150 word group, who made many naming errors, were also children who made many naming attempts in a unit of time. We obtained a strong correlation between rate of naming attempts and naming errors for this group, $r(59) = .71$, but not for the Under 50 word group, $r(59) = .27$, nor for the Over 150 word group, $r(59) = .25$. Apparently, at the point of the initial acceleration in productive vocabulary growth, children’s word retrievals are easily disrupted when retrievals are close together in time. This result fits with the similar finding in Experiment 1 and with the finding in that experiment that the errors often consist of interference from a previously retrieved word.

**Naming Errors as a Problem of Retrieval**

The majority of naming errors in Experiment 1 during the 50 to 150 word period resulted from the effects of interference from a previously retrieved word. Thus, we asked what percent of the errors produced by children in Experiment 2 were repetitions of a previously spoken word. As in Experiment 1, we measured repetition effects by determining the number of errors that consisted of repeating a word that had been uttered among the child’s last three naming attempts. This analysis revealed that 46% or almost half of the errors were repetitions of a recently uttered word. Again, a previously retrieved word appears a source of interference at this developmental point. Moreover, as in Experiment 1, the percent of naming errors that were repetitions was greatest for the children in the 50 to 150 word group: Repetition errors for the Under 50 word group and the Over 150 word group occurred only 12 and 29% of the time, respectively, $F(2,57) = 9.557, p < .001$. Thus we find again a rise and fall of repetition errors as a function of vocabulary size.

Additionally, we counted the number of semantic/perceptual confusions as in Experiment 1; they were substantial for children at all word levels: 55% for children who have 50 to 150 words and make relatively many naming errors, and 43% for the children in the other two groups. Also, as in Experiment 1, phonological errors were rare, less than 3% for all children.

Thus as in Experiment 1, children with 50 to 150 words in their productive vocabulary appear particularly vulnerable to interference from recently retrieved and also semantically/perceptually similar words when retrieving an object name.
Changes in Parents’ Behavior

Figure 11 shows the mean number of times parents provided the label of the pictured objects and the number of times they asked their child either to identify the object (“what is that?”) per visit per book. As we found in Experiment 1, parents more often supplied the name of the object when their children had few words in their productive vocabulary than when they had many, $F(2, 57) = 9.561, p = .003$. In addition, parents more often encouraged children with larger vocabularies than children with smaller vocabularies to label the objects themselves as indicated by the increase in the number of “what” questions they asked when children had many words, $F(2, 57) = 5.104, p = .009$. The changing pattern of parents’ behavior shown in Fig. 11 is thus consistent with the results of Experiment 1.

In sum, the findings of this second experiment replicate those of Experiment 1. Errors in naming rise sharply when children have 50 to 150 words in their spoken vocabulary—a range that marks the start of rapid acquisition of words in productive vocabulary. Furthermore, the specific character of the naming errors suggests that interference from recently retrieved words is the source of the error. This disturbance in word retrieval processes, however, is only temporary. As children continue to add new words to their productive vocabulary, the number of errors declines.
GENERAL DISCUSSION

The study of children’s naming errors during a time of accelerated vocabulary growth provides a unique opportunity to investigate developmental changes in lexical processing that may emerge in the course of early word learning. The principal contribution of the present research is the discovery of a close temporal relation between a transitory increase in naming errors and the initial jump in productive vocabulary growth. During this time, children not only attempt to name objects more often but they also do so in closer temporal succession. Our results strongly suggest that these errors in naming are retrieval errors—errors in retrieving the correct word from a rapidly expanding lexicon.

We found in the longitudinal study of Experiment 1, that the errors consisted of words previously heard and spoken by the child. Moreover, in both Experiments 1 and 2, the incorrectly named word was often one that the child had said just prior to the error’s occurrence. The fact that these errors are often perseverations of a previously uttered word provides compelling support for the interpretation of the errors as retrieval errors. Apparently, at this point in development, a previously activated word sometimes interferes with access to a currently sought word. The results of Experiment 1 and 2 thus suggest that word retrieval processes become more robust and that these changes occur rapidly over a matter of weeks and months.

Why might word retrieval be particularly vulnerable to interference at this point in development?

The Rise of Errors as a Function of Changes in Vocabulary

There are many possible though not mutually exclusive accounts for the rise in children’s errors. First, errors might be expected to rise as the size of the lexicon increases because of the greater number of opportunities for interference from lexical competitors. This account fits well with what we know about lexical processes in mature speakers. In particular, studies of the lexical effects of neighborhood density (Charles-Luce & Luce, 1990) predict that naming errors should increase as the recent acquisition of many new words leads to increases in the density of items in the productive lexicon. These errors may involve the incorrect retrieval of a neighboring lexical item which is either phonologically similar or semantically/perceptually similar. In the present study, errors that were conceptually close in lexical space were found to be considerably more frequent than those that were phonologically overlapping in space. This result parallels recent findings of adults’ speech production errors indicating that naming is semantically rather than phonologically mediated (Vitkovitch, Humphreys, & Lloyd-Jones, 1993).

Second, the lexicon is not only expanding in size as children acquire many more new words. Children are also increasingly saying the words they know and thus words are being accessed more often and in closer temporal succes-
sion. Consistent with findings of adult speakers in studies of experimentally-induced errors (MacKay, 1971), children should produce more errors as the rate of speaking increases. This suggests that the probability of an error is jointly affected by both the conceptual space and time between lexical utterances; incorrect naming is more likely to occur when object words belong to the same semantic category and when the naming time between two utterances is brief.

According to current models of speech production (Dell, 1986), several factors will contribute to the increase in retrieval errors with faster rates of speaking. Key among these factors is the relative activation strengths of individual units and the rate at which the activation level of a previously activated item decays. Further, the familiarity of a word is known to be a potent variable in the accessibility of a word, with highly practiced words being more resistant to interference from possible competitors than words of lower frequency (e.g., Forster, 1990). For young children at the start of the vocabulary spurt, however, all words (by adult standards) are essentially unpracticed. Thus the rise in retrieval errors may reflect the effects of the general fragility of all words in the child’s emerging lexicon and the increased competition that will necessarily arise with rapid vocabulary growth and increased retrieval attempts.

The Decline in Errors as a Function of Changes in Lexical Processing

Although the rise in errors is easily understandable in several ways, their rapid decline is more puzzling. In the period after the initial jump in vocabulary growth, children are still acquiring words and are doing so at increasingly rapid rates. They also are more often speaking the words they know. Yet they do not continue to make retrieval errors with the same frequency. Why do children’s naming errors decline as productive vocabulary continues to grow?

One likely factor is the absolute activation strength of individual words. Initially, the activation strength of these newly established words should be weak. However, as children practice retrieving and producing individual words their strength should increase. Thus, the very act of talking more may, itself, lead to greater resistance to interference and to a decline in errors.

A second possible factor is the deactivation of previously retrieved words. Many models of word production in adults pay close attention to the post-activation of words (Dell, 1986). That is, after a single word has been selected for production, its activation returns to resting level and the speed and processes through which it does so are critical in explaining word production (and errors) in adults. Stemberger (1989) extended these ideas to an explanation of children’s naming errors. In a naturalistic study of spontaneous naming errors, he observed a high rate of perseveratory errors in children under the age of three, relative to adult speakers. Stemberger attributed children’s greater perseveratory errors to a slower rate of decay, that is, to lingering activation
of a previously retrieved word. The critical developmental change causing the decline in children’s naming errors, then, could be these deactivation processes and their speed. More efficient deactivation could be the product of practice in retrieving words or it could derive from gains in more general and independent inhibitory processes.

The extant evidence is at present insufficient to distinguish among these possibilities. One recent study of adult perseveratory errors suggests that practice may limit perseveratory errors primarily through increasing activation strengths. Dell, Burger, & Svec (1997) gave adult speakers extended practice repeating difficult tongue twisters. This practice led to a decrease in both perseveratory errors and other types of errors (e.g., word substitutions), a result that points to the general effect of practice on increasing connection strengths. However, the role of practice on limiting errors in the highly similar motor acts that underlie tongue twisters may not be the same as that in establishing first words in the lexicon. Some recent advances in neurodevelopment, for instance, might be taken as pointing to the role of developmental changes in inhibitory processes that are independent of practice in a specific task. Growing evidence from a variety of tasks indicates marked changes in children’s ability to inhibit prepotent responses during this time and these changes are often attributed to the maturation of the dorsolateral prefrontal cortex (Diamond, 1989; but see also, Thelen & Smith, 1994). Clearly, the processing system that underlies word retrieval is not stationary during this developmental time; it seems certain that both broader developmental changes and productive vocabulary growth and use interact in the creation of these changes.

A related issue concerns the lexical and developmental specificity of the underlying changes. First, do the changes in retrieval occur on a word by word basis, with interference declining as individual words become more practiced? Or is there systemwide change so that after some point in development even newly learned words are resistant to interference? The developmental brevity of the phenomenon is consistent with systemwide changes, a fact that might be interpreted in terms of general developmental change not specific to word learning. However, systemwide change could, in principle, derive from the simultaneous increase in the strength of many individual items (see Plunkett & Marchman, 1993). Second, are these transient naming errors specific to this one point in development, to first word learning? One possibility is that the curvilinear pattern of errors occurs in many domains and at many points in development. For example, although we know of no evidence suggesting such a phenomenon, a curvilinear pattern of vulnerable word retrieval may characterize adults’ initial learning of a second language or a 3-year-old’s learning of the names for the letters of the alphabet. However, it is also possible that the various processes that conspire to make this particular kind of naming error at the start of the spurt in vocabulary are, in combination, unique to the initial learning of a very first corpus of words by a developmentally immature individual.
Clearly, there are many unresolved issues about how and why these errors arise for so brief a period and then decline. We believe that the discovery of these errors contributes by raising these empirical questions; resolving them should lead to new insights about the origin of lexical processes, their emergence in development, and their relation to more general learning processes.

Production, Comprehension, and Overextensions

Our two principal measures in these experiments—naming errors in the laboratory and productive vocabulary growth concern the words children say, not the words they understand. The relation between receptive and productive vocabulary growth is complex and not well understood. Early in word learning, receptive vocabulary clearly outstrips productive vocabulary (Huttenlocher, 1974). Later in word learning, the discrepancy is not so clear; 3-year-old children who hear a word used once begin immediately to use it productively (e.g., Jones, Smith, & Landau, 1991). Moreover, there is some evidence to suggest that the rate-shift in productive vocabulary growth also reflects a time of increased receptive vocabulary (Reznick & Goldfeld, 1992). Other evidence indicates that “fast-mapping,” or one-trial word learning (as measured by comprehension) emerges at the same time as the spurt in new word productions (Jones, Smith, Landau, & Gershkoff-Stowe, 1992; Mervis & Bertrand, 1993).

These issues are important to understanding the cause of the transient period of errorful naming observed here. One possibility is that the rise in naming errors strictly reflects changes in productive vocabulary growth and naming and is best predicted by these changes. This possibility is consistent with our finding in Experiment 1 that the period of errorful naming occurred at the same time as maximal change in the rate of new word productions and the temporal proximity of retrieval attempts. Another possibility, however, is that the rise in errors is more closely tied to and best predicted by changes in receptive vocabulary—by the number and density of words in lexical memory. Resolution of these issues requires both more empirical work and a better understanding than currently exists of the potentially changing developmental relations between receptive and productive vocabulary growth.

The present findings also may provide new insights into the phenomenon of overgeneralizations in early word productions. Many observers of early language report that for a subset of known words, young children sometimes extend a word to members of other similar categories, for example, calling a horse “dog.” The reported rate of overextensions varies in the literature. Rescorla (1980) found that 33% of the words children produced between 12 and 18 months were overextended; others report lower rates (Dromi, 1987; Gruendel, 1979). Moreover, the literature is unclear on whether there is a developmental period specific to the errors. Many suggest that these overgeneralizations are particularly characteristic of the vocabulary spurt (Macna-
NAMING ERRORS

Three different interpretations of overgeneralization errors have been considered. The first is that these errors reflect category mistakes, beliefs on the child’s part, for example, that horses and dogs are the same kind of thing (Clark, 1973; Vygotsky, 1962). The second is that children misname because they have lexical gaps; there are objects to which they want to refer but for which they have no name and so they borrow the name for a neighboring category (Bloom, 1973). The third account is that these overextensions reflect retrieval errors; that children have difficulty retrieving knowledge about the sound properties of words in memory and so retrieve words that are highly familiar and semantically related (Huttenlocher, 1974; Naigles & Gelman, 1995; see also Dapretto, 1995). The discrepancies between comprehension and production support this last idea, as do the present results. It is quite possible, however, that overgeneralizations are not a unitary phenomenon—that is, they may sometimes reflect retrieval errors, sometimes category errors, and sometimes pragmatic solutions to lexical gaps. Tracking closely the developmental trend in the retrieval of known object names and the production of overgeneralizations to novel objects may provide a method to disentangling these possibilities.

CONCLUSION

In this research, we found a curvilinear trend in the frequency of naming errors—with the peak in errors situated at a developmental point at which children are acquiring many new words and are beginning to produce those words with greater frequency and in closer temporal proximity. We suggest these changes put pressure on retrieval processes making them subject to increased interference from a previously retrieved or semantically similar word. Intriguingly, this vulnerability is short-lived. As children acquire more words, talk more, and retrieve words in close proximity to each other they must also develop more robust and less fragile word representations.

Our finding that naming is briefly errorful at this time of great change in language fits with classic ideas of instability and variability at major transitions (Alibali & Goldin-Meadow, 1993; Church & Goldin-Meadow, 1986; Piaget, 1954; Thelen & Smith, 1994). We believe that the close study of this brief period of instability provides a new opportunity for understanding the processes that accompany rapid vocabulary growth. Moreover, by studying the temporary disruption in naming behavior, we may be able to come closer to unraveling the processes that make rapid and efficient spoken language possible.

APPENDIX A

Page by Page Description of Books Used in Experiment 1

My Little Golden Word Book
hammer, pencil, shoe, sock
apple, flower, fork, clock
saw, leaf, ball, bat
umbrella, glasses, block, hat
kettle, lemon, glove, toy boat
toothbrush, ruler, horn, coat
candle, doll, cookie, nail
locomotive, onion, shovel, pail
fireman’s hat, walnut, lamp
scissors, cup, brush, stamp
airplane, puppet, orange, spoon
window, outside, stars, moon

*Brown Bear, Brown Bear*
brown bear
red bird
yellow duck
blue horse
green frog
purple cat
white dog
black sheep
gold fish
mother
children

*Corduroy*

Note: This book involves the story of a stuffed bear living in a department store who loses the button to his overalls and sets out to find it after the store closes for the night. Several objects are shown on each page. Only the most salient ones are listed here.

costume, bunny, bear, doll, giraffe
dog, lion, bunny, bear, doll, giraffe, rocking horse, child, salesperson, customers, girl, mother, escalator
bunny, bear, girl, mother
bear, girl, mother
bear
bunny, bear, box, ball, doll, giraffe
bear, escalator
bear, escalator
bear, escalator
bear, sofa, lamps, chairs, beds, tables
bear, bed, lamp
bear, bed, button, lamp
bear, bed, button, lamp
bear, lamp
night watchman, flashlight, escalator
night watchman, flashlight, lamp
bed, pillow, ears
covers, pillow, bear, night watchman, flashlight
night watchman, bear, escalator
doll, bunny, bear, clown
girl, bear
turtle, salesperson, lion, bunny, bear, dog, girl
salesperson, girl, bear, escalator
girl, bear, steps
girl, bear, chair, bed, window, rug, dresser
girl, bear, chair, button, needle, thread
girl, bear

APPENDIX B
Page by Page Description of Book Used in Experiment 2

What Does Bunny See?

apple
fast car
shiny fish
jacket
good dog
pretty house
big chair
blue bird
yellow sun
long spoon
baby
mommy

REFERENCES


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