

Lexical Input as Related to Children's Vocabulary Acquisition: Effects of Sophisticated Exposure and Support for Meaning

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A corpus of nearly 150,000 maternal word-tokens used by 53 low-income mothers in 263 mother-child conversations in 5 settings (e.g., play, mealtime, and book readings) was studied. Ninety-nine percent of maternal lexical input consisted of the 3,000 most frequent words. Children's vocabulary performance in kindergarten and later in 2nd grade related more to the occurrence of sophisticated lexical items than to quantity of lexical input overall. Density of sophisticated words heard and the density with which such words were embedded in helpful or instructive interactions, at age 5 at home, independently predicted over a third of the variance in children's vocabulary performance in both kindergarten and 2nd grade. These two variables, with controls for maternal education, child nonverbal IQ, and amount of child's talk produced during the interactive settings, at age 5, predicted 50% of the variance in children's 2nd-grade vocabulary.

Two striking facts about child language development are the rapidity of lexical acquisition and the variability in total vocabularies across children of any given age. The average child of 30 months has a vocabulary of 570 words as assessed with the Communicative Development Inventory (CDI; Fenson et al., 1994). Past estimates of the vocabularies of children entering first grade range from as low as 3,000 words (Dolch, 1936) to as high as 24,000 words (Shibles, 1959). Recent estimates vary less widely; Chall (1987) suggested that the average first grader has acquired about 6,000 words, and Carey (1978) estimated 14,000, pointing out that this would imply that children acquire about 8 words a day between the ages of 18 months and 6 years. Nagy and Herman (1987) estimated an annual rate of growth of 3,000 words for the average school-aged child.

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Lexical acquisition is not, however, equally rapid for all children. Research has shown that there are marked individual differences in rates of vocabulary growth. Normally developing 30-month-olds show an interquartile range from 450 to 625 words on the CDI—in other words, 25% of 30-month-old children have vocabularies smaller than 450 words and 25% have vocabularies larger than 625 words, with the child at the 99th percentile scoring above 680 words.

Evidence from a variety of sources strongly supports the hypothesis that a major factor explaining differences in vocabulary size for young children (prior to the acquisition of literacy) is the amount of language input to which they have been exposed at home during the first few years of life. Huttenlocher, Haight, Bryk, Seltzer, and Lyons (1991) found that the best predictor of rate of vocabulary growth in 22 middle-class children aged 14 to 26 months was density of maternal input, measured as number of words per unit of time. Hart and Risley (1995) estimated that by the age of 3, children of professional parents in their sample had heard nearly 40 million words, whereas children of working-class parents had heard 20 million words, and children of parents on welfare had heard only 10 million words; the children with the greatest lexical input also had the largest vocabularies. Many studies have confirmed that working-class children have smaller and less diverse vocabularies than middle-class children (Hoff-Ginsberg, 1991; Jones & Wepman, 1966; Templin, 1957). It has also been consistently found that working-class mothers differ from middle-class mothers more radically on measures of amount of speech produced than on measures reflecting quality of interaction (Hoff-Ginsberg, 1992; Schachter, 1979).

Although it seems clear that the amount of vocabulary input can be an important determinant of children's vocabulary outcomes, it is also possible that the nature of vocabulary input is important. Larger amounts of input do not necessarily mean a richer variety or greater diversity of vocabulary input; children may hear more words without hearing more low-frequency vocabulary of the type

often termed “abstract,” “literacy,” “semantically complex,” or “sophisticated.” Recently, a newly developed mathematical model for measuring and quantifying vocabulary diversity has shown that as the amount of language input increases, the diversity of new words that can be introduced to the conversation steadily decreases (McKee, Malvern, & Richards, 2000; Richards & Malvern, 1997). Although amount of lexical input is clearly a factor in children’s vocabulary development (Anderson & Freebody, 1981; Thorndike, 1973), researchers have also found a strong association between preschoolers’ vocabulary knowledge and their exposure to low-frequency vocabulary (i.e., words that neither fell within nor were derived from the 3,000 most common words) during everyday mother–child conversations, both in the home (Beals, 1997; Beals & Tabors, 1995) and in the preschool classroom during teacher–child interaction in daily activities (Dickinson, Cote, & Smith, 1993). This finding suggests that the effect of more vocabulary input may be mediated by its association with more low-frequency vocabulary input. At some limit, larger vocabularies must reflect the presence of a greater variety of lexical input and thus a higher proportion of relatively infrequent lexical items. Typically, the first words children learn are the most frequent words in the input (Hart, 1991), and words beyond the most common 3,000 represent more sophisticated as well as less frequently encountered meanings (Hall, Nagy, & Linn, 1984). Thus, it becomes important to supplement the kind of information presented by Hart and Risley (1995) on the amount of vocabulary input to children with information about the nature of the vocabulary items children are exposed to and how that relates to their own vocabulary development.

Conditions of exposure also relate to efficiency of lexical acquisition. Social-constructivist learning theory (Rogoff, 1990; Vygotsky, 1978) and evidence concerning social support for vocabulary learning (Ninio & Snow, 1988) and effective vocabulary instruction (Mezynski, 1983; Nagy, 1988; Stahl & Fairbanks, 1986) suggest several conditions that promote lexical acquisition. Early vocabulary development has been linked to participation in social interactional routines, in particular to book reading (Ninio, 1980, 1983; Ninio & Bruner, 1978) and to routinized games between mother and young child (Bruner, 1975, 1983; Ratner & Bruner, 1978), in which the child has predictable expectations and interpretable contexts in which to use new lexical items. Scaffolded social and personal instruction within the child’s zone of proximal development can contribute critically to a child’s vocabulary acquisition (Vygotsky, 1978).

Preschool children can learn something about words from a single incidental exposure, but without further exposures they typically learn only incomplete word meanings (Carey, 1978; Dickinson, 1984; Rice, 1990). Children who are exposed to more sophisticated vocabulary in contextually supportive settings such as book reading (Feitelson, Goldstein, Iraqi, & Share, 1993; Hayes & Ahrens, 1988; Ratner, 1988) or joint attention episodes (Tomasello, 1992; Tomasello & Farrar, 1986) learn vocabulary faster and better than do other children. In a study of the same families reported on in this article, Beals (1997) found that children received information about the meanings of unfamiliar words from interactions in which family members invoked physical context, social context, prior knowledge, or semantically related information.

Research with school-aged children has shown that talk focused on the meaning of stories read from books fosters vocabulary learning (Feitelson et al., 1993). Likewise, Elley (1989), who studied teachers reading stories to 7-year-olds, found that repeated and varied exposure to each unfamiliar word and helpful and meaningful verbal and pictorial contexts, along with the child’s involvement in the task, facilitated the learning of low-frequency vocabulary. Similarly, vocabulary interventions with school-aged children have been found to generate the greatest gains when the meanings of the words are discussed directly or otherwise processed in many and varied exposures (Mezynski, 1983; Stahl & Fairbanks, 1986). Vocabulary instruction that promotes word consciousness, a sense of curiosity about word meanings, appreciation of nuances of meaning, and independence of word analysis appears to be superior to conventional instruction (Anderson & Nagy, 1991). However, large-scale vocabulary growth comes about through a combination of incidental encounters with words and meaningful exposure and instruction (Gray & Holmes, 1938; Mezynski, 1983; Nagy, 1988; Stahl & Fairbanks, 1986). In the present study, naturally occurring verbal interactions with 5-year-olds in low-income families were analyzed for evidence that interactive features like those described in these various studies supported children’s learning of novel words.

Goals and Research Hypotheses

The present study was motivated by the hypothesis that variation in early vocabulary acquisition may be associated with individual differences in quality as well as quantity of lexical input at home. In other words, children acquire larger vocabularies as a result of exposure to a rich, diverse, and sophisticated vocabulary in the preschool years, not just as a result of exposure to a lot of talk.

The first goal of the present study was to provide basic descriptive information about the nature of vocabulary input to low-income 5-year-olds across a variety of interactive settings. We approached this goal by attempting to answer two specific research questions: (a) What proportion of maternal lexical input to 5-year-olds consists of sophisticated words? (The term *sophisticated words* is used in this article to refer to words in general use by the language community that fall outside the 3,000 most common words of English and their various inflected forms.) (b) What is the quality of the verbal interaction that takes place between the low-income mother and her child when encountering a sophisticated word?

The second goal of the study was to relate children’s access to vocabulary input, especially sophisticated vocabulary, and their access to supportive pedagogical interactions surrounding such sophisticated words, to their own vocabulary outcomes. This goal generated the following specific research question: Do exposure to sophisticated vocabulary and the quality of mother–child interaction available to 5-year-olds predict vocabulary scores at the end of kindergarten and in second grade? We approached this research question by formulating two independent yet interrelated hypotheses: (a) the lexical sophistication hypothesis—that early exposure to a rich, varied, and sophisticated vocabulary is associated with children’s vocabulary development, over and above the effect of exposure to a large amount of lexical input and (b) the interactive support hypothesis—that exposure to a rich, varied, and sophisti-

cated vocabulary in the context of linguistic interactions that provide interactive support for rich attribution of meaning is associated with children's vocabulary development over and above the effect of exposure to sophisticated lexical input.

Method

Participants

The participants in this study consisted of 53 low-income mother-child dyads; the children were 5-year-olds who had participated in the Home-School Study of Language and Literacy Development (Snow, Dickinson, & Tabors, 1989). Originally, 86 English-speaking low-income families had been recruited at the time their children were 3 years old. These children attended Head Start or other preschool programs serving low-income families living in large urban centers in the northeastern United States. In the present study, we focused on a subsample of 53 of those low-income children (25 girls and 28 boys) for whom complete data were available for the home visit at age 5 and for the child vocabulary outcome measures at the end of kindergarten and second grade.

Families

The families were all English speaking and were recruited from programs serving low-income children. However, they represented a range of socioeconomic, cultural, racial, and educational backgrounds. Forty were White, 9 were African American, and 4 were of Hispanic heritage. A quarter of the mothers reported that they had not finished high school. About half of the mothers reported that they had graduated from high school. The remaining quarter reported that they had received some post-high-school education. In addition, half of the families were single-parent families. Half cited a parent's earnings as their primary source of income, and the other half depended on welfare programs (i.e., Aid to Families with Dependent Children). At recruitment, parents were asked to participate in a long-term project that involved observation and testing of the children at home and at school. Data collection, which commenced at age 3, involved annual home and school visits to conduct interviews, to collect observational data, and to elicit talk during specific types of tasks involving mothers and children at home and teachers and children at school. Achievement data, consisting of a variety of literacy, language, and vocabulary tests, were collected starting at age 5 and annually thereafter during each year of elementary schooling.

Data Sources

Data for the predictor variables were collected during a home visit conducted when the children were 5 years old (mean age = 5 years 7 months; range = 5 years 3 months to 5 years 8 months). Interactions at age 5 were analyzed to determine relationships between lexical input and roughly contemporaneous child vocabulary measures (the first child assessments were carried out at the end of kindergarten) as well as later vocabulary. The mothers and children were asked to engage in five specific types of interactions while the experimenter audiotaped their conversations, took context notes, and provided the toys and the books. These interactive settings were selected to sample a range of types of talk; thus we included three activities that mothers in this sample told us they typically engaged in with their children (playing with toys, reading storybooks, and eating at mealtimes) and two that were designed specifically to elicit more sophisticated discourse (playing with magnets and reading information books). A total of 263 recorded mother-child conversational interaction sessions were transcribed and verified (by a second transcriber) in full using the Codes for the Human Analysis of Transcripts (CHAT) transcription system, available through the Child Language Data Exchange System (CHILDES; MacWhinney, 1995). Two conversations were not success-

fully recorded, which yielded only 51 sessions of reading for one book. The five conversational settings were as follows:

Toy play. Mothers were asked to engage their children in free play using a set of toys brought by the experimenter. The toy-play conversations were stimulated by toys such as a tea set, animals, cars, people, or blocks from which the mother and child chose.

Magnet play. Mothers were asked to engage their children in educational play using a powerful magnet and a collection of disparate objects that were or were not attracted to the magnet. No instructions were given other than "Play with these toys," which left open the possibility that these dyads could use the magnet as a focus for object manipulation, fantasy play, or scientific problem solving (see Snow & Kurland, 1996).

Mealtime. Mothers were asked to record a typical family mealtime, without an observer present, and to send the tape in. Recordings of mealtime conversations thus provided a source of more natural talk. In many cases, although mealtime was a family event, the mealtime analyses reported here involved only the child and the mother even when other family members participated in the conversations (see Beals, 1993, 1997).

Information book. Mothers were asked to read an expository book with their children: *Animals in the Wild: Elephant* by Hoffman (1983). This is a relatively long¹ picture book that describes various factual aspects of the life of Asian and African elephants.

Storybook. Mothers were asked to read a narrative book with their children: *What Next, Baby Bear!* by Murphy (1983). This is a relatively short² picture book appropriate for preschoolers with a fantasy narrative about a little bear's travel preparations for a trip to the moon (see De Temple & Snow, 1996).

A total of 2,634 min of mother-child conversational interactions were analyzed—nearly 44 hours. The length of the conversations varied greatly within each of the five interactional settings and across settings. Toy-play, magnet-play, and mealtime conversations combined took a total of 80% of the time—34 hours 21 min—whereas only 20% of the time—9 hours 33 min—was taken by the two book-reading sessions. The shortest conversations occurred during book reading, with the information-book conversation averaging 7 min in length and the storybook conversation averaging 4 min. The longest conversations with the largest variation occurred during mealtime conversations, which averaged 20 min in length and ranged from 1 to 47 min. The toy-play conversations averaged 11 min and the magnet-play conversations, 8 min.

Outcome Measures

Children's vocabulary was measured with the Peabody Picture Vocabulary Test—Revised (PPVT-R), a standardized receptive vocabulary test (Dunn & Dunn, 1981), which was scored in the conventional fashion and yielded both raw scores and standard equivalent scores related to the national norms. The reported reliability for the PPVT-R ranges from .71 to .89. The PPVT-R was administered to each child individually twice, once in kindergarten and again in second grade. The child's standard score equivalents on the PPVT-R Form L in kindergarten and Form M in second grade were used as the vocabulary outcome measure in our analyses.

The analyses explored two predictors: lexical sophistication in relation to total input and the nature of the interactions in which sophisticated items occurred. Both kindergarten and second-grade analyses included two control variables, maternal education and child nonverbal IQ at age 5 (assessed with the Test of Nonverbal Intelligence [TONI; Brown, Sherbenou, &

¹ The total number of word-tokens in the text is 654, and the total number of different word-types is 307; the type/token ratio is 0.469, indicating that the story is not told with repetitive text.

² The total number of word-tokens in the text is 315, and the total number of different word-types is 165; the type/token ratio is 0.524, indicating that the story is not told with repetitive text.

Johnsen, 1982)), to ensure that the effects found were not simply caused by general maternal or child factors. Furthermore, as a final check on the power of maternal input to influence child vocabulary performance in second grade, two additional control variables, child's kindergarten PPVT-R score and child's amount of talk during the interactive settings, were introduced in the second-grade analyses. In what follows, we introduce the predictors, provide a general description of the computerized Child Language Analysis (CLAN) procedures used to create them, and explain why each predictor measure is important to this inquiry. We begin by outlining the procedure for developing the lists of sophisticated words because it lays the foundation for the predictor measures.

Developing the Lists of Sophisticated Words

The CLAN program *FREQ* was used to generate comprehensive maternal word-token and word-type lists. The updated version of the Dale-Chall (Chall & Dale, 1995; Dale & Chall, 1948) word list, comprising the 3,000 words teachers judge as known to most fourth graders, was the basis for screening out the common words and for identifying high-frequency words from each child's corpus (see Beals & Tabors, 1995). For ease in automatic searching, we expanded the computerized version of the Dale-Chall list by adding all linguistic forms of the base words (e.g., the derivationally inflected forms include 's, s, es, ies, d, ed, ied, ing, r, est, ier, iest) to create a list of 7,875 common word forms. Each mother's list of all different word-types, in each of the five settings, was subjected to an automatic search that deleted words on the expanded Dale-Chall list. Further editing was necessary to remove words of low frequency in the larger language community that were not, however, sophisticated or infrequent within the child's family: for example, proper names of family members, forms of address such as *Mommy* or *Honey*, dialectal forms such as *ain't*, incorrect forms such as *brang*, child culture terms such as *Power Rangers* or *tummy*, and informal forms such as *Hi*. The resulting lists were then considered to contain words that were sophisticated for 5-year-olds. For each mother separately, we divided the number of the resultant sophisticated word-types by the total number of the initial unabridged word-types to determine the proportion of the sophisticated word-types used.

The resulting lists contained only the different sophisticated word-types used by the mothers. However, we were also interested in identifying how many times a particular sophisticated word was used by each mother and in coding the pedagogical supportiveness of the context in which each sophisticated word occurred. The CLAN programs *FREQ* and *KWAL* were used in these analyses. The book-reading analyses were further refined to capture the mothers' natural vocabulary input separately from the vocabulary drawn from the textbook and read by the mother. Although books are a rich source of sophisticated words, we were interested in the sophisticated vocabulary that was introduced into the book-reading conversations spontaneously by the mothers. Therefore, analyses of sophisticated vocabulary were conducted separately for the 30 sophisticated word-types drawn from the two book texts combined and for the 87 sophisticated word-types introduced into the book-related conversations by the mothers.³

Analyzing the Mother-Child Verbal Interactions

Once the sophisticated low-frequency items had been identified in each transcript, each occurrence of one of these lexical items was coded to reflect the amount of support for learning available in its context. Overall, 1,111 mother-child interactions in the five conversational settings were analyzed. The coding scheme was designed to reflect two aspects of the mother-child interactions during which sophisticated words emerged: the amount of information about word meaning available from the talk and the degree of communicative support for the child's learning available in the interaction. The coding scheme was thus developed to examine what was discussed when the mother and her child encountered a sophisticated word and how it was discussed. These two aspects are interrelated.

The *what* aspect of the verbal interaction surrounding a sophisticated word was coded to reflect the amount of information about the word's meaning available in the talk; informativeness was coded as falling into one of the following three categories: (a) *directly informative*—a sophisticated word emerged in the conversation and was discussed in such a way that explicit information about its meaning or syntactic function was provided by the mother; (b) *indirectly informative*—a sophisticated word emerged in the conversation and was embedded in the conversation in such a way that information about its meaning or syntactic function was provided implicitly; or (c) *not informative*—a sophisticated word emerged in the conversation but in a context that did not limit its possible meaning and that provided only minimal information about its conditions of use.

The *how* aspect of the mother-child interactions was coded to assess the quality of the interactive scaffolding within which the information about word meaning was presented. Coders noted the occurrence of physical and communicative scaffolding, procedures for guiding attention, and procedures for providing feedback. These were defined as follows:

Physical scaffolding was coded if the interaction was nested in a physical context that was explicitly relevant to the sophisticated word, for example, if the word meaning was indicated by demonstration of an object or action, by graphic illustration involving a picture or gestures, by pointing, or by auditory illustration. *Communicative scaffolding* was coded if the mother elicited active participation and actively established a joint focus of attention; speech elicitation included questions, exact or modified repetition of child utterances, paraphrasing, and recasting. *Feedback* was coded if the mother expressed explicit approval, agreement, correction, or disagreement with a child utterance. *Attention guidance* was coded if the mother directed the child's attention to the target word using strategies of orientation and/or clarification; such routines promote word consciousness, a sense of curiosity about word meanings, and appreciation of nuances of meaning.

The occurrence of these elements was noted in all the mother-child interactions that had been coded as directly or indirectly informative. If the interactions were directly informative and had extensive communicative-scaffolding elements, they were coded as *instructive*. If they were indirectly informative and had some facilitative interactive features, they were coded as *helpful*. If no interactive scaffolding was present, even with indirectly informative maternal utterances, then the interaction was coded as *neutral*. Typically, of course, the directly informative interactions also were characterized by a number of different scaffolding strategies, whereas the noninformative interactions were often characterized by no support scaffolding, as is illustrated in the examples that follow.

Interrater reliability was estimated for 228 (20%) of the mother-child interactions. We computed the reliability of coding using Cohen's kappa, a measure of reliability corrected for chance occurrence, in each of five conversational settings. The Cohen's kappa statistics for the coding of the storybook and the toy-play conversations were .93 and .86, respectively, indicating "very substantial" agreement (Landis & Koch, 1977); these were followed by a kappa of .80 for the magnet-play conversation, indicating "substantial" agreement (Landis & Koch, 1977). Finally, the Cohen's kappa for both the mealtime and the information-book conversations was .73, indicating "substantial" agreement. The Cohen's kappa for the five settings combined was .81, indicating overall "very substantial" agreement (Landis & Koch, 1977). In addition, as an input to the coding, we compiled an inventory of the hard-to-decide instances and how they were coded. The

³ The information book *Animals in the Wild: Elephant* contains 26 different sophisticated word-types in its text; 64 additional sophisticated word-types were introduced into conversations about this book by the mothers. The storybook *What Next, Baby Bear!* contains four different sophisticated word-types in its text, and 23 additional sophisticated word-types were introduced into the conversations connected with its reading by the mothers.

coder then referred back to it and used it as a frame of reference for further consistent coding.

The following examples illustrate interactions that were coded as instructive, helpful, or neutral:

1. Example of an *instructive* interaction including *directly informative* talk providing definitional knowledge and considerable *physical scaffolding*.

Conversational setting: magnet play

Sophisticated word: *vehicle*

- Mother: What's that? (*attention guidance, question*)
 Child: Car!
 Mother: And what is that one? (*attention guidance, question*)
 Mother: Oh!
 Action: [mother lines up cars on table] (*physical scaffolding*)
 Mother: Guess they're both cars.
 Mother: That look like a [pause] some type of a *vehicle*. (*explicit information about referents*)
 Child: Truck.

In this example, the mother used the superordinate *vehicle* in direct reference to items the child called *car* and *truck*, thus demonstrating the existence of another level of classification. The mother generated questions guiding the child toward definitional knowledge and prompted the child to answer. The mother taught her child explicitly to classify different yet related items into the same category. She used the physical context by lining up vehicles on the table to engage her child in play.

2. Example of an *instructive* interaction including *directly informative* talk with supportive *physical* and *communicative scaffolding*.

Conversational setting: book reading

Sophisticated word: *tusks*

- Mother: This is a female Asian elephant.
 Sister: Daddy! Elephant daddy! Elephant.
 Mother: That is the daddy elephant.
 Mother: "Asian elephants are not as tall as their African cousins."
 Mother: "They also have smaller ears and *tusks*."
 Mother: "The lady, called the cow, often has no *tusks* at all."
 Mother: See, yep, that is the daddy because here is the *tusks*, see that? (*physical scaffolding using picture to identify referent, attention guidance by pointing*)
 Child: Yeah.
 Mother: Here is the big, um, the big *tusks*. (*physical indication of referent*)
 Mother: And that the that must be the mommy one because there is no *tusks*. (*attention guidance, contrast*)

In this example, the mother used the sophisticated word *tusks* five times, twice while reading the text of the book *Animals in the Wild: Elephant* to her child and three times after reading it. The mother referred to the illustration in the book several times, and the word was discussed repeatedly, meaningfully, and explicitly by the mother. The mother drew the child's attention to the sophisticated word, provided semantic and pictorial cues, and used inferences and explanations.

3. Example of a *helpful* interaction involving *indirectly informative* talk with some *supportive scaffolding*.

Conversational setting: mealtime

Sophisticated word: *cholesterol*

- Mother: No, you've had enough.
 Mother: You're not supposed to eat a lot of chicken skin like that.
 Mother: It's not good for you.
 Mother: There's, there's *cholesterol* in it. (*draws attention to the word*)
 Mother: Can you say *cholesterol*? (*requesting repetition*)

Mother: Let me see you say it.

Sister: *Cholesterol*.

Mother: Yeah but now you say it, [Child]. (*repeats request*)

Mother: Take that out of your mouth and say it.

Child: *Cholesterol*.

In this example, the mother used the sophisticated word *cholesterol* twice. The word emerged in an implicitly informative context; the mother even asked the child to say the word out loud. Yet with all these supportive actions and varied exposures, there was no direct referential information about the word. The attributes mentioned provided only indirect semantic cues about the word—that it is an ingredient in food.

4. Example of a *helpful* interaction involving *indirectly informative* talk and considerable *physical scaffolding*.

Conversational setting: mealtime

Sophisticated word: *gulping*

- Child: [makes gulping noise in throat]
 Mother: Please stop. (*clear reference, no sophisticated word*)
 Child: Okay.
 Brother: They love me up there.
 Mother: xxx done, Honey Pie?
 Mother: Were you planning to eat more?
 Child: No.
 Mother: We kinda wasted some of that first piece of chicken there.
 Mother: Don't you think?
 Child: No.
 Child: [makes strange noises]
 Mother: Stop it now. (*attention to referent*)
 Child: Okay.
 Mother: Now you're gonna have to roll up your sleeves [pause] and wash your hands and your face.
 Mother: Try not to get your pajama top [pause] wet.
 Mother: See how you do.
 Mother: You can wash your face with the face cloth.
 Child: Okay.
 Mother: Don't you make that *gulping* noise. (*explicit naming of referent*)
 Child: [laughs for a while]

In this interaction, the mother drew attention to the referent twice before naming it, thus scaffolding the child's attentiveness; then when she did name it, she provided indirect information that the word *gulping* referred to a noise the child produced.

5. Example of a *neutral* interaction (*noninformative* talk, *no scaffolding*).

Conversational setting: mealtime

Sophisticated word: *predictability*

- Brother: Amazing.
 Mother: [laughs]
 Mother: The *predictability* of it all. (*The word is used in a way that provides only indirect information about its meaning and with no scaffolding of attention to it*)
 Brother: Some of the people in this house are.
 Child: I'm gonna eat everything on my plate!
 Mother: Good!

The mother used the sophisticated word *predictability* with no cue or comment about it. This sophisticated word had nothing to do with the child but was spoken by the mother during dinner to someone other than the child.

6. Example of a *neutral* interaction (*noninformative, no scaffolding*).

Conversational setting: toy play

Sophisticated words: *certainly, conversationalist*

Child: Hello, [Brother].
 Sister: Pick it up xxx.
 Brother: Bye!
 Mother: Well he's *certainly* not a *conversationalist* is he, [Child]?
 Child: What?
 Brother: Lookit.
 Mother: What are you going to make?

In this example, the mother used two sophisticated words in the same sentence. It is clear that the child did not understand these words. He asked, "What?" but the conversation continued with no cue and with no comment by the mother about the words. Given the evidence that children learn words from single, incidental exposures, we are not saying that no-support interactions offer no potential for learning—simply that they offer no clear pedagogical support.

Predictor Measures

For the analysis, we devised two sets of predictor measures, adjusting for differences across mothers in the amount of lexical input: exposure-density measures and interaction measures.

The exposure-density measures were designed to reflect the relative availability of common and sophisticated vocabulary. *Density of sophisticated vocabulary tokens* was the number of sophisticated word-tokens used by the mother per 1,000 word-tokens. *Density of sophisticated vocabulary types* was the number of sophisticated word-types used by the mother per 1,000 word-types. To illustrate, density of sophisticated vocabulary tokens is higher if a certain sophisticated word is used repeatedly per 1,000 words than if it is used once. Likewise, density of sophisticated vocabulary types is higher if different sophisticated word-types are used per 1,000 word-types than if only one sophisticated word-type is used per 1,000 word-types.

The interaction predictor measures were designed to focus on qualitative differences in the pedagogical nature of the mother-child interactions in which the sophisticated words emerged: (a) *Density of instructive interactions* was the number of interactions providing directly informative talk with extensive communicative scaffolding divided by the number of interactions containing sophisticated words; (b) *density of helpful interactions* was the number of interactions providing indirectly informative talk with

some communicative scaffolding divided by the number of interactions containing sophisticated words; (c) *density of neutral interactions* was the number of interactions providing noninformative talk and no support scaffolding divided by the number of interactions containing sophisticated words; and (d) *density of instructive and helpful interactions* was the number of interactions falling into either Category (a) or Category (b) above per 1,000 word-tokens.

Results

Maternal Vocabulary Input

The lexical input to young language learners can be described in terms of quantity—number of words heard—or in terms of richness—the occurrence of sophisticated, relatively infrequent vocabulary items. Accordingly, two subsets of exposure measures were computed that reflected the overall amount of input and the relative frequency of sophisticated words in the input.

Lexical quantity and time. Mothers used 149,872 word-tokens in the interactions analyzed here. As can be seen from Figure 1, the average amount of exposure to maternal lexical input varied widely across the settings. The mealtime and the information-book conversations generated the largest amount of maternal talk, a sample mean of nearly 800 word-tokens. The other settings—toy play, magnet play, and the storybook—each generated overall a similar amount of maternal talk, approximately 400 word-tokens per conversation. The average length in minutes of mother-child conversational sessions also varied across settings. The mealtime and the information-book conversations, though equal in number of words used, varied greatly in length. The mealtimes spanned an average of 20 min, whereas the information-book reading took just 7 min, but mealtime conversations produced only a third as many words per minute. Mealtime conversations generated relatively sparse maternal input—only 40 word-tokens per minute, compared with 112 word-tokens per minute for the information-book conversations.

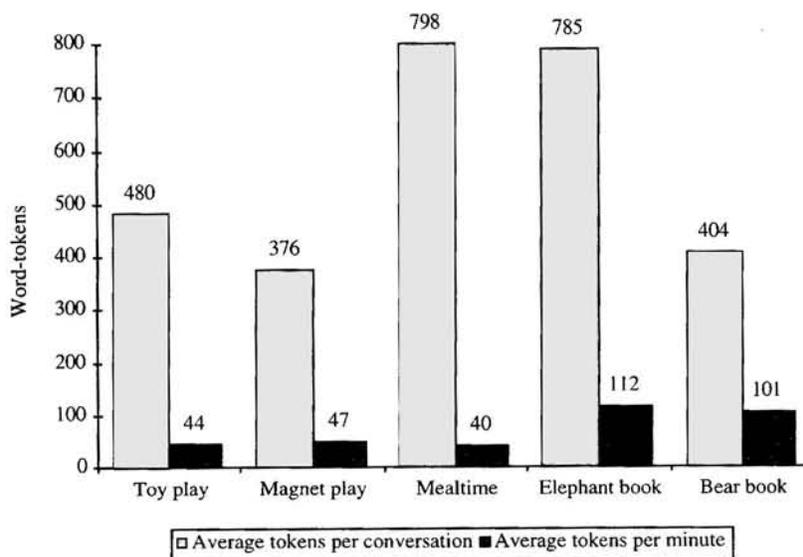


Figure 1. Average number of word-tokens per conversation and average number of word-tokens per minute to which low-income children were exposed, by setting.

Lexical sophistication. A major goal of this study was to identify the sophistication of the vocabulary used by mothers when addressing children of the same age in the same social settings. The following questions were of interest: (a) To what extent do mothers use the frequent core vocabulary items in a given conversational setting? (b) What percentage of maternal lexical input is composed of the sophisticated vocabulary? The answers to these questions shed some light on the instances in which young children are exposed to any of the 600,000 English words that lie beyond the 3,000 most common words.

Overall, these 263 mother-child conversations generated 587 different sophisticated word-types; a total of 1,211 sophisticated word-tokens were used by all mothers. Table 1 provides a perspective on the sophistication of maternal vocabulary input.

Exposure to common and sophisticated word-tokens. The word-token entries reflect the authentic structure of maternal lexical input. As can be seen from Table 1, a strikingly tiny proportion of maternal language consisted of sophisticated vocabulary items, when calculated using either tokens or types. Pooling across settings, we found that children were exposed, on average, to 2,871 word-tokens, only 23 of which were sophisticated. Over 99% of maternal lexical input consisted of words that fall within the 3,000 most common words in English. During mealtimes, toy play, and magnet play combined, only slightly more than 1% of the words in the input lexicon fell outside this common lexicon.

There was great variation across settings in exposure to sophisticated word-tokens. Mealtime conversations, perhaps because

they were the least time-constrained and the most open in terms of possible topics of discussion, generated the highest average number of sophisticated word-tokens—11 per conversation. The book-reading settings generated the highest quantity of lexical items overall, the largest number of words per minute, and the highest exposure to sophisticated vocabulary, most of which derived from the books' texts. In the information-book readings, exposure to sophisticated word-tokens ranged from 0 to 61, with a mean of 34.

Focusing only on the mothers' spontaneously used vocabulary, however, we note that mothers introduced few sophisticated words—only one or two, on average—to the book readings. The toy-play, magnet-play, and mealtime settings together generated 20 sophisticated word-tokens—nearly seven times as many sophisticated word-tokens as generated in the book-reading settings.

Exposure to common and sophisticated word-types. Inspection of Table 1 reveals that across all five settings, on average, children were exposed to 1,073 word-types and a bare 19 sophisticated word-types. Only 1.77% of all the word-types used by the mothers, on average, fell outside the core lexicon of the 3,000 most familiar words in the English language. During book readings, children heard, on average, only one or two sophisticated word-types beyond those used exclusively in the text. The mealtime conversations generated the largest proportion of maternal sophisticated word-types (3.47%), followed by the toy-play (2.76%) and the magnet-play (2.11%) conversations.

Table 1
Means and Variability in Exposure Measures to All and to Sophisticated Word-Tokens and -Types and Length of Conversations

Setting	N	Number of words used by mother						Length (hr:min)
		Word-tokens			Word-types			
		All	Sophisticated	% Sophisticated	All	Sophisticated	% Sophisticated	
Toy play	53							
<i>M</i>		480	5	1.04	181	5	2.76	0:11
Range		98-1,198	0-16		50-334	0-12		0:05-0:18
Magnet play	53							
<i>M</i>		376	4	1.06	142	3	2.11	0:08
Range		31-949	0-19		28-234	0-9		0:03-0:14
Mealtime	53							
<i>M</i>		798	11	1.38	259	9	3.47	0:20
Range		3-2,287	0-48		3-595	0-42		0:01-0:47
Information book	53							
Mother <i>M</i>		785	2	0.25	301	2	0.66	0:07
Mother range		14-1,610	0-13		11-469	0-12		0:01-0:14
All <i>M</i>		785	34	4.3	301	22	7.3	0:07
All range		14-1,610	0-61		11-469	0-38		0:01-0:14
Storybook	51							
Mother <i>M</i>		404	1	0.25	181	1	0.55	0:04
Mother range		31-600	0-5		30-243	0-5		0:02-0:10
All <i>M</i>		404	7	1.49	181	5	2.8	0:04
All range		31-600	0-12		30-243	0-9		0:02-0:10
5 settings	263							
Mother <i>M</i>		2,871	23	0.80	1,073	19	1.77	0:50
Mother range		900-5,779	1-78		381-1,636	1-68		0:28-1:30
All <i>M</i>		2,871	61	2.1	1,073	43	4.0	0:50
All range		900-5,779	6-123		381-1,636	4-99		0:28-1:30

Note. "Mother" represents analyses of maternal sophisticated vocabulary only; sophisticated words drawn from the book texts are excluded. "All" represents analyses of sophisticated vocabulary from the book text and the mother combined.

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Density of Exposure

Exposure-density measures capture the relative frequency with which the sophisticated words were used by the mothers in spontaneous conversations. In other words, density of sophisticated vocabulary tokens rises as a certain sophisticated word-type is repeated and as new sophisticated word-types are introduced within any stretch of talk. Table 2 summarizes the univariate distribution of the exposure-density measures across children, by setting.

The density of sophisticated vocabulary types was higher than the density of sophisticated vocabulary tokens, because the most frequent tokens, the function words, are of course used again and again, thus expanding the baseline for token but not type density. Thus, the token-density measure mirrors the natural structure of maternal lexical input in oral language and is more comparable to measures of text difficulty in written language, which are based on the density of difficult lexical items. For that reason, the token-density measure may be more telling than the type-density measure in predictive analyses.

Quantitative differences across settings observed earlier for exposure to total tokens and to sophisticated tokens simply disappear when one considers token density. This trend is mostly apparent across the toy-play, magnet-play, and mealtime settings; in each of these settings, the mother used an average of 10–11 sophisticated word-tokens per 1,000 word-tokens. However, the ranges indicate much greater variability for the magnet-play (0–44) and mealtime (0–49) settings than for the toy-play setting (0–29). The book-reading settings resulted in the highest means for token density, when sophisticated words from the book text were included in the analysis (see Footnote 3). This pattern is consistent for the type-density exposure measures.

Table 2
Means and Variability in Measures of Density of Exposure to Sophisticated Types and Tokens

Setting	Exposure to sophisticated maternal vocabulary					
	Token density			Type density		
	<i>M</i>	<i>SD</i>	Range	<i>M</i>	<i>SD</i>	Range
Toy play	11	8	0–29	24	15	0–55
Magnet play	10	11	0–44	18	15	0–48
Mealtime	11	8	0–49	26	19	0–72
Information book: Mother	2	3	0–16	6	7	0–33
Information book: All	39	15	0–63	68	24	0–97
Storybook: Mother	2	3	0–9	4	5	0–21
Storybook: All	17	4	0–28	25	7	0–42
5 settings: Mother	7	4	1–17	16	8	2–42
5 settings: All	21	6	5–31	38	11	8–61

Note. Token-density entries are expressed as sophisticated word-tokens per 1,000 tokens used by the mother. Type-density entries are expressed as sophisticated word-types per 1,000 types used by the mother. All fractions were rounded to whole numbers in order to represent complete words. "Mother" represents analyses of maternal sophisticated vocabulary only; sophisticated words drawn from the book texts are excluded. "All" represents analyses of sophisticated vocabulary from the book text and the mother combined.

Associations Among Length of Conversation, Quantity of Input, and Density of Exposure

As can be seen from the top half of Table 3, the length of mother-child conversations in time and the amount of maternal lexical input were highly correlated. However, length was only mildly associated with frequency of sophisticated vocabulary and was associated with density of sophisticated vocabulary only in some settings, which suggests that longer conversations can generate more talk without producing more diverse lexical input. Mealtime conversations, however, and to a lesser extent reading the information book, deviated from this generalization. Longer mealtimes were characterized by a higher density of sophisticated words, presumably because they allowed for the emergence of more interesting conversational topics.

The bottom half of Table 3 shows relationships between the quantity and the sophistication of maternal lexical input. The amount of maternal talk was strongly related to the number of word-types and to the number of sophisticated types and tokens. Again, mealtime conversations and reading the information book differed from the other settings in generating a denser use of sophisticated tokens if they went on longer.

Interestingly, longer conversations or larger amounts of spontaneous maternal talk did not systematically result in denser sophisticated lexical input. Clearly, children may hear more words without hearing more low-frequency vocabulary. If a mother does not control sophisticated lexical items in her own vocabulary, she is likely to be a poor source of sophisticated input regardless of how long or how much she talks.

Description of Mother-Child Interaction

The second research question focused on the pedagogical support that characterizes mother-child interactions when sophisticated words appear—specifically, on the amount of information provided about the word meaning and the quality of the interactive scaffolding within which the information about the word meaning was presented. The central assumption behind this question is that vocabulary acquisition is rooted in the microprocess of particular interactional routines—as shown by Bruner (1975, 1983) and Tomasello (1992) for younger children. In focusing on the differences in the level of pedagogical support that characterizes mother-child interactions during which sophisticated words appear, the following two questions were of interest: How often are 5-year-olds in low-income families exposed to support for learning the meanings of the sophisticated words they hear? What is the density of such potentially instructive or helpful interactions per 1,000 word tokens in a given conversation?

Table 4 displays the proportional frequency of various levels of interactional support in the 1,111 instances of sophisticated word-token use by the mothers. When one pools across all five settings, a striking profile is revealed; sophisticated vocabulary items were most likely to occur in the context of instructive or helpful interactions. Half of the sample interactions were instructive, involving directly informative talk and considerable interactive scaffolding. One third of all interactions were helpful, involving indirectly informative talk with medium scaffolding, and less than one fifth were neutral, providing neither information nor interactive scaffolding. In fact, once these low-income mothers and their children

Table 3
Estimated Correlations Between Length of Mother–Child Conversations and Exposure Measures and Between Amount of Lexical Input and Exposure Measures

Exposure measure	Toy play	Magnet play	Mealtime	Information book	Storybook
Length of conversation (in minutes)					
Total word-tokens	.44***	.60***	.73****	.89****	.50***
Total word-types	.38**	.60***	.74****	.83****	.40**
Sophisticated word-tokens	.29*	.33*	.75****	.71****	.09
Sophisticated word-types	.32*	.34*	.72****	.67****	.15
Sophisticated token density	.16	.18	.54****	.30*	-.24
Sophisticated type density	.03	.06	.69****	.40**	.06
Quantity of lexical input (in total word-tokens)					
Total word-types	.94****	.92****	.96****	.96****	.96****
Sophisticated word-tokens	.56****	.56****	.90****	.88****	.55****
Sophisticated word-types	.57****	.65****	.89****	.84****	.58****
Sophisticated token density	.03	.16	.47***	.53****	-.12
Sophisticated type density	.16	.38**	.76****	.63****	.29*

* $p < .05$. ** $p < .01$. *** $p < .001$. **** $p < .0001$.

launched into an interaction surrounding a sophisticated word, features that directly or indirectly support word learning were brought into play in a remarkable 83% of interactions.

The measure of interaction density captures the relative frequency with which mothers provided support for word learning in spontaneous conversations. As can be seen from Table 4, the density of support was lowest during book reading, and the quantitative differences observed earlier across the toy-play, magnet-play, and mealtime settings disappeared. In each of these settings, instructive and/or helpful interactions surrounding sophisticated words occurred, on average, 8–9 times per 1,000 word-tokens. The estimated ranges indicate great variation among low-income mothers, however. The book-reading settings produced only 2–3 instructive or helpful interactions per 1,000 word-tokens.

Prediction of Child Vocabulary Outcomes

The central question motivating this work was whether exposure to sophisticated vocabulary in maternal speech rather than simply

quantity of maternal input predicted child vocabulary outcomes, and whether embedding of maternal sophisticated vocabulary in teaching interactions contributed to the explanation of variance in vocabulary outcomes. To address this question, we begin with a univariate analysis describing the vocabulary outcome measures, turn to the correlational analyses to detect possible predictor–outcome relationships, and then report the results of fitting appropriate regression models.

Vocabulary outcomes. The standardized vocabulary test (PPVT–R) generated a mean score of 94.8 in kindergarten and a slightly higher mean (98.6) in second grade. These means are similar to the medians, indicating that the scores are distributed symmetrically across the entire range of scores. The range of standard scores—69–133 in kindergarten and 63–126 in second grade—indicates a wide variation among children. Although the sample means are slightly below the population mean of 100, the PPVT–R scores in kindergarten and in second grade extended into the highly proficient range. Bivariate correlations indicated that the

Table 4
Frequencies and Proportions of Mother–Child Interactions, Means and Variability in Measures of Vocabulary Support, and Means and Variation of Measures of Interaction Density

Setting	Instructive				Helpful				Neutral				Density ^a	
	Frequency	Sample %	M	Range	Frequency	Sample %	M	Range	Frequency	Sample %	M	Range	M	Range
Toy play	154	60	3	0–11	68	27	1	0–4	34	13	1	0–3	9	0–26
Magnet play	103	57	2	0–10	45	25	1	0–4	33	18	1	0–4	8	0–32
Mealtime	201	39	4	0–17	209	41	4	0–18	105	20	2	0–42	8	0–32
Information book	67	58	1	0–7	33	29	1	0–4	15	13	1	0–5	3	0–19
Storybook	30	68	1	0–4	7	16	0	0–2	7	16	1	0–1	2	0–19
5 settings	555	50	11	0–32	362	33	7	0–32	194	17	4	0–42	6	0–14

^a Entries reflect the total number of instructive and/or helpful interactions per 1,000 word-tokens used by the mother.

PPVT-R scores in kindergarten correlated highly ($r = .76, p < .001$) with the PPVT-R scores in second grade.

Control variables. The child nonverbal IQ (the TONI) at age 5 generated a mean score of 100 in kindergarten, with a range of 67–136 indicating a wide variation among children. Maternal education was coded as falling into one of three categories: 0 represents no high school diploma, 1 represents high school or GED completion, and 2 represents high school completion plus some additional education. On average, the mothers had only 12 years of schooling. Additional models tested further included two controls, the kindergarten PPVT-R vocabulary score and the sheer amount of child's talk, in word-tokens, produced during the interactive settings. Child use of word-tokens ranged from a low of 149 to a high of 2,112, with a sample mean of 1,077 and a standard deviation of 427, indicating wide variation across children.

Correlations with predictors. Associations exist between density of sophisticated lexical input and vocabulary achievement. A casual glance at the estimated correlations in Table 5 suggests that the majority of predictor–outcome relationships are clustered during mealtime and playtime conversations. The estimated correlations indicate that the child's scores at age 5 on vocabulary are linked to exposure to a greater density of sophisticated word-tokens in the mother's speech during mealtimes, magnet play, and toy play. These relationships persisted to second grade, when the correlation pooled across these settings was $.56 (p < .001)$. Thus, when quantity of input is held constant, sophistication of vocabulary input correlates with vocabulary outcomes.

Quality of Mother–Child Interaction and Vocabulary Achievement

Table 5 also demonstrates the extent to which later vocabulary success is linked to frequency and density of instructive and helpful interactions. Again, the strongest relationships were found within the toy-play, magnet-play, and mealtime settings. However, some moderate associations between maternal helpful interactions and the child vocabulary scores emerged for the narrative book reading.

Density of instructive and helpful interactions, particularly during mealtime conversations, was strongly related to vocabulary scores in kindergarten ($r = .53, p < .001$) and in second grade ($r = .47, p < .001$). Toy-play and magnet-play conversations generated moderate positive relationships.

Anticipating the regression analyses, we also estimated correlations between two control variables and the vocabulary scores in both kindergarten and second grade. We considered the value of controlling for maternal education and child nonverbal IQ (the TONI) at age 5, bearing in mind the strong possibility that these might predict maternal vocabulary use and child vocabulary outcomes through alternative causal pathways. The correlation between maternal education (in years) and PPVT-R score in kindergarten was $-.02$; that between maternal education and PPVT-R score in second grade was $-.16$. Child nonverbal IQ related $.19$ to PPVT-R score in kindergarten and $.27$ to PPVT-R score in second grade. None of these correlations reached significance, but we

Table 5
Estimated Correlations Between Vocabulary Outcomes and Predictors Reflecting Exposure and Predictors Reflecting Interactive Support

Vocabulary outcome	Toy play	Magnet play	Mealtime	Information book ^a	Storybook ^a	5 settings
Exposure predictor: Density of sophisticated vocabulary tokens						
Kindergarten PPVT-R	.34**	.36**	.48***	.07	.14	.26
Grade 2 PPVT-R	.30*	.36**	.47***	.01	.05	.18
Exposure predictor: Density of sophisticated vocabulary types						
Kindergarten PPVT-R	.34*	.37**	.38**	.09	.17	.28*
Grade 2 PPVT-R	.25	.37**	.50***	.02	.01	.29*
Interaction predictor: Instructive						
Kindergarten PPVT-R	.41**	.41**	.32*	.14	.08	.42**
Grade 2 PPVT-R	.38**	.28*	.40**	.14	-.25	.39**
Interaction predictor: Helpful						
Kindergarten PPVT-R	.11	.29**	.44***	.30*	.28*	.45***
Grade 2 PPVT-R	.17	.35**	.48***	.31*	.25	.49***
Interaction predictor: Neutral						
Kindergarten PPVT-R	.16	.24	.08	.14	.07	.01
Grade 2 PPVT-R	.07	.19	.39**	.06	.03	.36
Interaction predictor: Density of instructive and/or helpful interactions						
Kindergarten PPVT-R	.37**	.43***	.53***	.24	.01	.52***
Grade 2 PPVT-R	.34*	.33*	.47***	.22	-.18	.51***

Note. PPVT-R = Peabody Picture Vocabulary Test—Revised.

^a Represents analyses of sophisticated vocabulary from the book text and the mother combined.

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

Table 6
Predicting Kindergarten and Second-Grade Vocabulary From Exposure and Interaction Density Measures: Summarizing the Results of Fitting a Taxonomy of Regression Models Controlling for Maternal Education and Child Nonverbal IQ

Model	Mother education			Child nonverbal IQ			Exposure density			Interaction density			R^2
	Estimated β	SE	t	Estimated β	SE	t	Estimated β	SE	t	Estimated β	SE	t	
Kindergarten PPVT-R													
1	-4.36	3.11	-1.40	0.16	0.12	1.32							.07
2	-3.33	2.65	-1.26	0.19	0.10	1.8	1.6	0.35	4.50***				.34
3	-3.65	2.65	-1.38	0.12	0.10	1.13				2.04	0.45	4.52***	.35
4	-3.45	2.65	-1.30	0.15	0.10	1.14	0.80	0.77	1.02	1.12	1.01	1.09	.36
Grade 2 PPVT-R													
1	-3.25	3.19	-1.02	0.22	0.13	1.77							.09
2	-2.32	2.67	-0.87	0.22	0.10	2.04	1.6	0.37	4.40***				.39
3	-2.12	2.88	-0.73	0.15	0.11	1.36				1.80	0.54	3.60***	.29
4	-2.76	2.66	-1.04	0.28	0.11	2.46*	2.92	0.99	2.94**	-1.88	1.34	-1.40	.42

Note. PPVT-R = Peabody Picture Vocabulary Test—Revised.

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

included these control variables in the regression in any case to minimize the effects of maternal education and child IQ.

Of course, the possibility that children who talk more or who use more varied vocabularies both elicit more sophisticated vocabulary use from their mothers and continue to develop vocabulary rapidly, independent of their mothers' input, cannot be excluded. To test this hypothesis, we estimated correlations between child word-token production at age 5 and PPVT-R score in second grade. Across the mealtime, magnet-play, and toy-play settings, the estimated correlation was highly significant ($r = .44, p < .001$).

Prediction of Vocabulary Outcomes in Kindergarten and in Second Grade

As shown in the previous section, strong positive relationships were found between child vocabulary and density of exposure to sophisticated vocabulary as well as density of instructive and helpful interactions. Accordingly, simple and multiple regression models were fitted⁴ in which children's scores on subsequent vocabulary outcomes were regressed on these two measures in order to address the hypotheses concerning the impact of lexical sophistication and of interaction type on vocabulary outcomes. As noted above, we included as controls two factors that could introduce confounds into the analysis: maternal education and child nonverbal IQ scores. These two control variables were introduced together, as a block, as the first step in the regressions. We also introduced singly two additional controls, the child's kindergarten PPVT-R score and the child's token production, to assess the degree to which differences in quality and quantity of maternal input were related to second-grade outcomes independent of the child's earlier vocabulary status and talkativeness.

The results of the kindergarten and second-grade regression analyses are summarized in Table 6. The model testing the impact of density of sophisticated tokens accounted for 34% and 39% of the variation in children's PPVT-R scores in kindergarten and in second grade, respectively (see Model 2). The control variables did not emerge as explaining a significant change in R^2 in this model. Interpretation of the individual parameter (slope) estimates indi-

cated that in Model 2, 1 additional sophisticated word per 1,000 maternal tokens was associated with a 1.6-point difference in the PPVT-R standard score in kindergarten and with a 1.6-point difference in the PPVT-R standard score in second grade.

Similarly, the model testing the density of instructive or helpful interactions provided by the mother in a given conversation accounted for 35% and 29% of the variation in children's PPVT-R scores in kindergarten and in second grade, respectively (see Model 3). The control variables did not explain a significant amount of variation in this model. Interpretation of the individual parameter (slope) estimates indicated that in Model 3, 1 additional instructive or helpful interaction per 1,000 maternal tokens was associated with a 2.0-point difference in the PPVT-R standard score in kindergarten and with a 1.6-point difference in the PPVT-R standard score in second grade.

When density of exposure and density of support were used simultaneously as predictors, the multiple regression analysis resulted in a slightly better prediction. The frequency with which sophisticated word-tokens were used by the mother and the frequency with which they were embedded in an instructive or helpful interaction together accounted for 36% of the variation in children's PPVT-R scores in kindergarten and 42% of the variation in second grade (see Model 4). Although the control variables had no impact on the amount of variance explained in predicting kindergarten PPVT-R scores, the increment to R^2 test indicated that including them had a significant impact on the amount of

⁴ The relationships under consideration were plotted and examined. All schematic plots of the studentized residuals were examined for evidence of nonlinearity. No signs of violations or any unusual patterns were uncovered through inspection of the scatterplots. However, influence statistics indicated the presence of two influential points (one point seems low on the exposure-density measure, whereas another point seems high on the interaction-density measure). Sensitivity analysis, by removing the effects of these points, did alter the parameter estimates for both the exposure-density measure and the interaction-density measure, but the model as a whole retained its predictive power.

variance explained for second-grade PPVT-R outcomes ($p < .03$). Nonetheless, the amount of variance explained by the control variables themselves was quite small. Although nearly one third of the variation in vocabulary performance was attributable to each of the two predictors—exposure density and interaction density—combining them improved the prediction by only a small amount. This is a classic case of collinearity; these two predictors relate strongly to one another ($r = .88, p < .001$). Thus we should not attempt to interpret the separate parameter estimates (slopes) in the multipredictor models.

Prediction of Second-Grade Vocabulary Outcomes

The above regressions are consistent with the interpretation that parental styles of talking influence children’s vocabulary development, but of course they do not warrant a causal inference. An alternative interpretation, that linguistically sophisticated children elicit sophisticated talk from their parents and as a result show a faster vocabulary growth, cannot be excluded. Thus, as a final check on the power of maternal input to influence child vocabulary outcomes in second grade, we entered the amount of the child’s talk during the interactive settings and the child’s PPVT-R score, at age 5, singly into the regression models predicting second-grade PPVT-R scores. The results of these regression analyses are summarized in Table 7. As can be seen from Model 1, the effect of child’s word production is in and of itself statistically significant, so it stands to reason that its inclusion in the models will increase the R^2 statistic. The models testing the impact of density of exposure and density of support singly and jointly with the three control variables (see Models 3–5) resulted in a better prediction than the models that omitted child word production (see Models 2, 3, and 4 in the bottom half of Table 6). Although maternal education and child nonverbal IQ scores had no impact on the amount of variance explained in predicting second-grade PPVT-R scores, the amount of child talk emerged as explaining a significant increase in the R^2 in these models. More important, the inclusion

of the amount of child talk as a control variable did not reduce the effect of the main predictors to nonsignificance.

As expected, the inclusion of kindergarten PPVT-R score in the regression models (see Models 6–10) caused the effect of maternal sophisticated exposure and support for meaning to fall to nonsignificance. Although the models testing the impact of density of exposure and density of support singly and jointly all accounted for over 60% of the variation in children’s PPVT-R scores in second grade (see Models 8–10), only the age 5 PPVT-R score emerged as a significant predictor in these models. Obviously, the age 5 PPVT-R score absorbs most of the variance in the age 7 PPVT-R score. The PPVT-R, a standardized receptive vocabulary test, is designed to be a stable measure over time, and there was a very high correlation between the age 5 PPVT-R score and the age 7 PPVT-R score ($r = .76, p < .001$). This result suggests that differences in maternal input between age 5 and age 7 cannot be linked to varying rates of change in PPVT-R scores. But, of course, the age 5 PPVT-R scores were themselves arguably a product of variations in the quality and quantity of maternal input (see Hart & Risley, 1995). Furthermore, the quality and quantity of sophisticated vocabulary input in this group of mothers have been shown to be stable over the age range from 3 to 5 years (Tabors, Beals, & Weizman, in press).

Discussion

This study generated two sets of findings. The first reveals profound quantitative and qualitative differences in early vocabulary exposure among low-income preschoolers. The second set of findings demonstrates that there is a powerful linkage between early exposure to sophisticated vocabulary—even if it constitutes as little as 1% of total maternal input—during mealtime and playtime conversations and later vocabulary performance at school.

Table 7
Predicting Second-Grade Vocabulary (PPVT-R) From Exposure and Interaction Density Measures: Summarizing the Results of Fitting a Taxonomy of Regression Models Controlling for Maternal Education, Child Nonverbal IQ, Child Amount of Talk, and Child’s Kindergarten PPVT-R

Model	Mother education			Child nonverbal IQ			Child word production			Exposure density			Interaction density			R^2
	Estimated β	SE	t	Estimated β	SE	t	Estimated β	SE	t	Estimated β	SE	t	Estimated β	SE	t	
1							0.02	0.01	3.23**							.20
2	-4.18	2.86	-1.46	0.21	0.11	1.89	0.02	0.01	3.46***							.30
3	-3.12	2.53	-1.23	0.21	0.10	2.12*	0.01	0.00	2.51**	1.3	0.37	3.60***				.47
4	-3.11	2.70	-1.15	0.16	0.11	1.54	0.01	0.01	2.71**				1.36	0.52	2.59**	.40
5	-3.57	2.51	-1.42	0.27	0.11	2.57*	0.01	0.01	2.55**	2.6	0.94	2.78**	-1.89	1.26	-1.50	.50
Child kindergarten PPVT-R																
6							0.72	0.09	7.77***							.58
7	1.37	2.27	0.60	0.08	0.09	0.91	0.68	0.10	6.68***							.59
8	1.36	2.23	0.61	0.08	0.09	0.94	0.58	0.12	4.92***	0.56	0.35	1.59				.62
9	1.23	2.28	0.54	0.07	0.09	0.81	0.63	0.12	5.41***				0.40	0.48	0.84	.60
10	1.77	2.24	0.80	0.11	0.09	1.23	0.58	0.12	4.95***	1.42	0.77	1.84	-1.27	0.02	-1.25	.63

Note. PPVT-R = Peabody Picture Vocabulary Test—Revised.
 * $p < .05$. ** $p < .01$. *** $p < .001$.

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Quantitative and Qualitative Differences in Input

The 5-year-old children in this study heard an average of nearly 3,000 word-tokens over an aggregate of about 50 min distributed over five conversational settings. Though all mothers received the same instructions, some produced as little as 30 min of talk and as few as 900 word-tokens, whereas others produced 90 min of talk and as many as 6,000 word-tokens. Differences in the amount of talk produced were also attributed to setting. Maternal speech was 2.5 times as dense on average during book reading as during playtime and mealtime.

Differences in quantity related to differences in vocabulary diversity. The average 5-year-old in this study heard nearly 1,100 word-types during the 50 min recorded. However, whereas some children heard as many as 1,650 word-types, others heard fewer than 400 word-types.

Other estimates of the total number of words heard by young children per unit of time are consistent with these. Hall et al. (1984) measured 5-hour sessions of speech to children between the ages of 4 years 6 months and 5 years and reported 2,000 words per hour. Hart and Risley (1995) reported considerable differences associated with socioeconomic status in the amount of parental speech addressed per hour to 13- to 36-month-olds: 2,100 words per hour in the average professional family, 1,200 words per hour in the average working-class family, and 600 words per hour in the average welfare family. The higher word production by low-income mothers in our sample may relate to the fact that the children were older (Hayes & Ahrens, 1988) or to the more managed nature of the observations we carried out.

Lexical input to these 5-year-olds was dominated by the most common words in English, a finding that replicates the results of Beals and Tabors's (1995) analysis of conversations with these same children at a younger age (ages 3 and 4) in similar settings. It is startling how meager maternal sophisticated vocabulary input was—only 1% of all the words produced. Sophisticated words were used with greater probability during mealtime and playtime than during book reading, which suggests the importance to children's language environments of the activities the children engage in with adults. Some children in this sample heard no sophisticated words, whereas others heard as many as 45 sophisticated words per 1,000 word-tokens during play time and as many as 50 during mealtime.

These profound differences in exposure to maternal common and sophisticated vocabulary among children of the same age, from the same social class, in the same conversational settings are alarming when one thinks of their accumulation over time. An examination of maternal vocabulary input across ages 3, 4, and 5 confirms that the variation described here is neither random nor idiosyncratic; use of sophisticated vocabulary is quite consistent over time (Tabors, Beals, & Weizman, 2001), particularly for mealtimes and toy play.

Once the mother and the child encountered a sophisticated word, there was a great likelihood (83%) that the mother would provide both information about word meaning and interactive scaffolding supporting the child's attentiveness and capacity to process the new information. The range reveals, however, great variation among low-income mothers in their efforts to teach their children something about a sophisticated word's meaning and its use. Some children had no experience with pedagogically supportive interac-

tions. Some mothers provided their children with as many as 30 instructive or helpful interactions per 1,000 word-tokens. Verbal interaction, according to Bruner (1983), "is not a shower of spoken language but a highly interactive affair shaped by some sort of an adult language acquisition support system" (p. 39). There are many examples in these data of what Bruner (1983) characterized as the "management of joint attention," and "fine tuning" to the child's current vocabulary level, or *frontier*. All of these findings, incidentally, belie the stereotypical view of low-income mothers as unable to contribute to their children's vocabulary development.

Relationships Between Early Vocabulary Exposure and Later Achievement

The second set of findings indicated that a child's vocabulary performance at age 5 was linked strongly (a) to early exposure to a greater number of sophisticated words used by the mother per 1,000 word-tokens and (b) to the frequency with which instructive or helpful interactions were provided by the mother. Remarkably, these relationships carried over into the early school years. Each of these predictors accounted for nearly one third of the variation in the children's vocabulary scores in kindergarten and later in second grade.

No changes in either the magnitude of the effect or the significance of the predictors occurred upon the addition of maternal education and child nonverbal IQ as control variables in the regression models predicting kindergarten PPVT-R scores. However, including child nonverbal IQ did slightly increase, to 42%, the variance explained in the model predicting second-grade PPVT-R scores. As expected, the inclusion of age 5 PPVT-R scores absorbed most of the variance in age 7 PPVT-R scores. However, the addition of the amount of child talk did not reduce the predictive power of maternal input appreciably.

The Importance of Vocabulary

Lexical learning is the aspect of language acquisition most uncontroversially related to input characteristics. The fact that lexical input at home contributes to children's vocabulary success should not surprise anyone, but the magnitude of the effects associated with the relatively small differences in input we report here may be surprising, as well as alarming in light of the enormous variability in quantity and quality of input across an even wider range of children.

The results reported here suggest that descriptions of vocabulary input must involve three fundamental elements: lexical quantity, lexical sophistication, and conversational support. Hart and Risley (1995) focused on estimates of absolute numbers of words parents used with their children. Our findings, like those of Beals and Tabors (1995), suggest that knowing which words are used is also important, as is knowing what conversational support the adult produces when an unknown word is encountered (see Beals, 1997).

Considerable previous work has suggested that exposure to larger amounts of adult language predicts the size of children's vocabularies (e.g., Hart & Risley, 1995; Huttenlocher et al., 1991). The study presented here amplifies and explicates this finding by specifying the importance of the occurrence of sophisticated low-frequency vocabulary in the language input and by describing the

interactive contexts that support the utility of sophisticated language input. In other words, the difference between the inputs to children with larger and smaller vocabularies may reflect the quality as well as the quantity of the words they hear and the informativeness and interactive scaffolding available in interactions rather than just the amount of maternal speech.

It is unclear precisely what the relationship is between the amount of language heard and the sophistication of that language. In principle, it would be possible for children to hear rather little total language but a high density, and thus a relatively high frequency, of sophisticated vocabulary. In fact, though, middle-class families, in which the parents are likely to control a relatively sophisticated vocabulary, also produce more total language in interaction with their children than do working-class families (Hoff-Ginsberg, 1991, 1992), which suggests that quantity and lexical sophistication of talk may co-occur. In addition, we found here that longer mealtimes produced a higher density of sophisticated word-tokens, and other analyses have revealed that rare vocabulary during mealtimes is more likely to occur in the context of extended discourse segments—types of talk that by their very nature are unlikely to occur during brief conversational interactions (De Temple, 1991).

The power of exposure to sophisticated vocabulary items found in this study is especially striking given the socioeconomic and educational status of the mothers studied. These women had, on average, only 12 years of schooling and were themselves products of families with limited education and nonprofessional employment. Thus, the vocabulary items identified as sophisticated in this analysis were, on the whole, only moderately infrequent (Weizman, 1995) and not terribly sophisticated. The majority of the sophisticated words fell within the 9,000 most-frequent words in the English language (Johnson, Moe, & Baumann, 1983). Children are expected to know most of these words by the time they reach the upper elementary grades (Grades 4–6). Nonetheless, children whose mothers used these words themselves had larger vocabularies and thus, given the robust relationship between vocabulary and reading comprehension (Anderson & Freebody, 1981; Carroll, 1977; Chall, 1983, 1987; Davis, 1972; Thorndike, 1917), were presumably better prepared for academic success.

Implications for Practice

The most straightforward implication of this study is that for the improvement of children's vocabulary, there can be no substitute for ample cumulative experience with lexically rich, naturally occurring conversations early in life. Mealtime and playtime constitute contexts in which interesting, engaging, and vocabulary-expanding conversations occur. Policymakers concerned with children whose literacy is at risk should consider instructional policy that will promote vocabulary learning as early as the preschool years.

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