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Function Morphemes in Young Children's Speech Perception and Production

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Function morphemes or functors (e.g., articles and verb inflections) potentially provide children with cues for *segmenting* speech into constituents, as well as for *labeling* these constituents (e.g., noun phrase [NP] and verb phrase [VP]). However, the fact that young children often fail to produce functors may indicate that they ignore these cues in early language acquisition. Alternatively, children may be sensitive to functors in perception, but omit them in production. In 3 experiments, 2-year-olds imitated sentences that contained English or non-English functors and that were controlled for both suprasegmental and segmental factors. Children omitted English functors more frequently than non-English functors, indicating perceptual sensitivity to familiar vs. unfamiliar elements. The results suggest that children may be able to use functors early in language acquisition to solve the segmentation and labeling problems.

How do children come to treat the incoming speech stream as composed of linguistic units, such as clauses and phrases? How are they able to distinguish among different types of these constituents? We shall refer to these as the *segmentation* and *labeling* problems, respectively. Recent discussions have begun to focus on the importance of function morphemes in guiding young children to segment speech and to label grammatical categories (Gleitman & Wanner, 1982; Maratsos, 1982; Morgan, Meier, & Newport, 1987; Valian & Coulson, 1988). However, children learning English and other languages typically omit function morphemes in their spontaneous and imitative speech, suggesting that these cues may not be used in the earliest stages of learning. In this article, we examine the alternative possibility that young children detect and analyze functors even though they omit them in their speech. More specifically, we assess the possibility that functors are analyzed with sufficient detail to support both segmentation and labeling.

In English and in other languages, syntactic units such as noun phrases (NPs) and verb phrases (VPs) usually contain function morphemes, such as articles and verb inflections. These morphemes have systematic distributional properties that make them ideally suited as potential cues to the existence and identity of phrases. For example, functors occur in fixed positions relative to the syntactic class they mark (in English, articles occur before nouns, and verb inflections occur after stems). They are usually monosyllabic and compose a small set of phonemes (in English, /ə/, /w/, /ð/, and /s,z/). In stress-timed languages (like English and German), functors receive weak stress and tend to undergo cliticization (Chomsky & Halle, 1968). Finally, individual functors are extremely frequent in speech.

These properties could make function morphemes salient to children who are searching for repeated patterns in the utterances that they hear. In fact, although the induction of a phrasal rule system is not contingent on the presence of such elements, adults show significantly better learning and generalization of structural rules when markers are present (Morgan et al., 1987; Valian & Coulson, 1988). Although the same could be true of children, very little is known about their ability to exploit functor cues. In part, this is because children in the early stages of language learning typically omit these elements from their spontaneous speech (Bloom, 1970; Bowerman, 1973; Braine, 1963; Brown & Bellugi, 1964; Gregoire, 1937). Children also omit functors in their imitative speech (Brown & Fraser, 1964; Eilers, 1975; Scholes, 1970). On the whole, these observations suggest that children may not even detect functors in incoming utterances. If children cannot detect functors, they certainly cannot analyze them, and in turn cannot use functors for either segmentation or labeling.

Why do these omissions occur? One possibility is that young children fail to encode function morphemes from the speech stream. This failure may occur for one of two reasons. Children may attend only to familiar content words with real-world refer-

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ents (Brown, 1973; Brown & Bellugi, 1964; Eilers, 1975; Ingram, 1974; MacNamara, 1982; Pinker, 1984; Scholes, 1970; Sinclair & Bronckart, 1972), or children may be biased to notice and fully analyze strongly stressed syllables and, therefore, be less likely to detect and analyze weakly stressed function morphemes (Blasdell & Jensen, 1970; Brown, 1973; Du Preez, 1974; Gleitman & Wanner, 1982). Another possibility exists, however. Children may both detect and analyze functors but omit them from their speech due to *speech production* limitations.

Very different accounts of language learning would follow from evidence on the source of children's omissions. A referentially based approach would suggest that children initially attend exclusively to content words with real-world referents, and only later do they treat utterances as a hierarchical arrangement of syntactic categories. In this view, the fact that children initially omit function morphemes is entirely consistent with the notion that they do not encode them.

Another possibility, as to why omissions occur, is that children initially use information contained in the speech stream to segment utterances and organize them into major syntactic units, such as phrases and clauses. Segmentation might be accomplished on the basis of suprasegmental cues coupled with grammatical morphology (Gleitman, Gleitman, Landau, & Wanner, 1987; Gleitman & Wanner, 1982; Morgan et al., 1987). For example, clause boundaries in adult to adult speech are known to correlate with suprasegmental cues such as resetting of fundamental frequency, increased pause duration, and final vowel lengthening (Cooper & Paccia-Cooper, 1980). These cues tend to be exaggerated in speech to infants and young children (Fernald, 1985; Morgan, 1986; Snow, 1972), and infants appear to be highly sensitive to a number of them (DeMany, McKenzie, & Vurpillot, 1977; Fernald, 1985; Fernald & Kuhl, 1981; Hirsch-Pasek, Kemler-Nelson, Jusczyk, Wright, & Druss, 1987; Sullivan & Horowitz, 1983). Hence, it is reasonable to think that young children may be able to use suprasegemental cues to divide incoming speech into clauses and perhaps phrases.

In addition to supporting the segmentation of utterances, function morphemes could permit children to label these phrases syntactically. For example, articles always occur in initial position in noun phrases, and verb inflections always follow the verb stem. To the extent that children are able to use suprasegmentals and function morphemes to assign syntactic structures to the sentences they hear, the amount of work to be done by referentially based learning is decreased (Gleitman & Wanner, 1982; Gleitman et al., 1987; Landau & Gleitman, 1985). It therefore is important to determine whether children who omit functors are still able to detect and analyze them.

Several studies are consistent with the notion that very young children are indeed sensitive to function morphemes. Two studies have shown that children who omitted functors from their speech were nevertheless more likely to respond appropriately to strings containing functors ("Give me the ball") than to strings without functors ("Give ball"; Petretic & Tweney, 1977; Shipley, Smith, & Gleitman, 1969). This suggests that these children at least differentiate utterances with and without function morphemes. Comprehension studies with 18–24-month-olds have demonstrated that these children could use the presence or absense of a determiner to differentiate between common and proper nouns ("a dax" vs. "Dax"; Gelman & Taylor, 1984; Katz, Baker, & MacNamara, 1974). Finally, an experiment using an imitation task showed that the ratio of children's functor omissions to content word omissions was considerably reduced in strings with scrambled word order (Eilers, 1975). This suggests that functors are selectively omitted only when they are performing as functors, that is, when they occupy the correct phrasal positions. Each of these findings suggests that early omissions may signal some recognition of English functors as functors, coupled with a speech production constraint specific to morphemic output.

Table 1
Design and Sample Strings for Experiment 1

Content word	Functor	String
English	English	1a Pete pushes the dog
English	Nonsense	1b Pete pusho na dog
Nonsense	English	1c Pete bazes the dep
Nonsense	Nonsense	1d Pete bazo na dep

In the three experiments that follow, we examined young children's imitations in order to ascertain the bases for function morpheme omissions. In particular, we investigated the roles played by stress and referential status and attempted to determine whether omissions are due to limitations on encoding or on speech production.

Experiment 1

In all of the experiments, children were asked to imitate the four-syllable string that composed the V–NP portion of a sentence they had just heard. The strings were all of the form V-inflection–article–N. In one half of the sentences, both function morphemes (verb inflection and article) were English, and in the other half, these positions were filled by weakly stressed nonsense syllables. This allowed us to ask whether children selectively preserved or omitted English functors or whether they omitted any weakly stressed element occupying the same position. In addition, one half of the sentences contained English nouns and verbs, and the other half contained nonsense syllables in the same positions and receiving the same strong stress (see Table 1). This allowed us to ask whether children selectively preserved English nouns and verbs or any strongly stressed element occupying the same position.

If children fail to encode weakly stressed syllables, then all strongly stressed items should be preserved and all weakly stressed items should be omitted, regardless of whether any of these items is English or nonsense. If children attend to words with familiar referents, then English content words should be preserved and items without referents—nonsense content words and both functor types—should be omitted. Finally, if children's functor omissions are due in part to their recognition of these elements as separable morphemes, then English and nonsense functors should be differentially omitted.

Method

Subjects. A total of 9 girls and 7 boys, ranging from 23 to 30 months of age (M = 26 months), were tested. All of the subjects were normal monolingual English speakers living in Manhattan. An additional 8 children were eliminated from the study either because they refused to imitate any strings at all ($n = 6$) or did not meet the criterion of fully or partially imitating at least two tokens of each string type ($n = 2$). These children were younger than the children who did meet the criterion ($p < .05$, Fisher's exact test).

Mean length of utterance (MLU) in morphemes was calculated from spontaneous utterances produced during the experiment. One half of the children were designated low MLU (1.30–2.00, $M = 1.73$) and the other half were high MLU (3.16–5.02, $M = 3.91$). The MLUs were calculated in the manner described by Brown (1973, p. 54), with the exception that utterances consisting solely of "yes" or "no" were not counted. We excluded these forms, which accounted for 5–41% of children's utterances ($M = 28\%$), in order to make MLU a more accurate measure of children's function morpheme use. For most of children's utterances, the MLU is a good predictor of the degree to which functors are preserved in speech because an utterance that contains function morphemes receives a higher morpheme count than the telegraphic version of the utterance (e.g., "The dog bites" contains four morphemes, whereas "Dog bite" contains only two; see Brown, 1973). However, numerous "yes/no" utterances included in the calculation decrease MLUs' predictive value for two reasons: First, responding simply "yes" or "no" to a class of questions is appropriate for adults as well as for children and does not reflect linguistic sophistication. Second, frequent "yes/no" responses reflect more about the linguistic style of one's conversational partner than about one's own linguistic abilities. In our studies, many parents asked questions that required "yes/no" responses in order to elicit speech from their children, whereas other parents did not. Including "yes/no" utterances would have decreased the MLUs of children with "eliciting" parents in relation to those of other children. Note that excluding these utterances results in our subjects having a higher average MLU than same-aged children in other studies in which MLU was calculated in the standard manner.

Materials. Children were tested on four tokens of each of the four string types. These sentences contained either English or nonsense function morphemes and English or nonsense content words (see Table 1 for examples and Appendix A for a full list). Each sentence had the form NP–V–NP.

English functors were always /əz/ ("-es," third person singular verb inflection) and /ðə/ ("the"), and nonsense functors were always /ow/ and /nɑ/. The verb inflection /əz/ was chosen because it is syllabic but does not require a copula (which might have made the strings too long for young children to imitate). The article /ðə/ was chosen because it is the most frequent function word in English (Kucera & Francis, 1967) and therefore one that children would be familiar with if they were able to detect it. The nonsense functors were selected to be phonologically unrepresentative of the class of English function morphemes: /ow/ and /nɑ/ had full (nonreduced) vowels and consonants that are infrequent in English functors. Hence, they provided a distinct contrast set to English function morphemes, increasing the likelihood that children might differentiate familiar from unfamiliar elements. English content words were monosyllabic nouns and verbs found in children's early spontaneous vocabulary (Bloom, 1970; Brown, 1973; Gentner, 1978; Huttenlocher, Smiley, & Charney, 1983; Nelson, 1973), and nonsense content words were closed consonant–vowel–consonant (CVC) monosyllables.

Subjects were randomly assigned to one of four different orders of the 16 test strings. Each string type appeared once in each quarter list. Nouns and verbs were paired randomly with the restriction that English noun–verb sequences made pragmatic sense.

Procedure. The experimenter visited each child in his or her home. At the beginning of the visit, she showed the child a bag of toys that she had brought and encouraged the child to talk about them. After about 20 min of playing with the toys, the child was asked, "Do you want to play a game? First I'll tell you something Pete [a puppet brought by the experimenter] can do, and then you try to say what I said, OK?" If the child refused, the experimenter tried again up to two more times. If the child agreed, the experimenter read the first string and asked the child to repeat the four-syllable V–NP portion. For example, the experimenter said "Pete pushes the dog. Can you say that?—'pushes the dog'." After the child imitated the utterance, the experimenter said "Good" and continued to the next string until the child had been asked to imitate all 16 strings.

Because it was plausible that attention to the utterance would be enhanced by providing an explicit referent, one half of the strings were accompanied by a brief enactment of the sentence by the experimenter. For example, in "Pete pushes the dog," the experimenter made the puppet push a toy dog. Sentences containing nonsense content words were enacted using objects and actions that corresponded to English content words in sentences that were not enacted.

All of the sentences were spoken with normal English prosody. Therefore, nouns and verbs and their nonsense counterparts received heavier stress (higher pitch and amplitude and longer duration; Lehiste, 1970) than did function morphemes and their nonsense counterparts.[1]

The experimenter transcribed each string immediately after a child's imitation. In addition, the session was tape-recorded, and a second transcription of the imitations was made. When the two transcripts differed (4% of the strings), the tape-based one was used for obtaining data. When strings could not be transcribed from the tape (7%), the experimenter's initial transcription was used. An independent judge, trained in phonemic transcription and blind to the experimenter's hypotheses, transcribed three randomly chosen selections of each child's tape-recorded imitations and agreed with the experimenter's transcription on 97% of the strings.

Coding

Children produced imitations for 97% of the strings (3% refusals). Imitations were first coded for the number of functor or content elements omitted (maximum = 2 each per string). Note that if preserved elements were not exactly imitated, it was difficult to determine which syllable(s) had been omitted. Therefore, the following scoring criteria were devised: *function morpheme omissions, content word omission,* and *accurate content words.*

Function morpheme omissions. Function morpheme omissions were defined as those imitations in which both content words were accurately imitated (83% of all strings; see the definition for accurate content word imitations) and from which one or both function morphemes had been omitted. Because children often produce functors as filler syllables (usually schwa) in spontaneous speech (Bloom, 1970; Peters, 1983), functors that were imitated as schwa were not counted as omitted. If one of the functors was present, the string received a score of 1 (functor omitted), and if neither of the functors was present, the string received a score of 2. Using these criteria, 22% of all function morphemes were omitted.

Content word omissions. Content word omissions could occur in principle if the functors alone were imitated. This never occurred, however. The only cases of content word omissions were recency responses, in which the child imitated only the

[1] The stress levels of these stimuli were not physically measured, so it is possible that differences existed between the English and nonsense items. We address this issue in the discussion, and we systematically control stress in Experiment 2.

Table 2
Functors Omitted and Accurate Content Words in Experiment 1

String type		Functors omitted		Accurate content words	
Content word	Functor	Low MLU	High MLU	Low MLU	High MLU
English	English	41	13	84	100
English	Nonsense	33	11	92	92
Nonsense	English	33	13	80	97
Nonsense	Nonsense	20	9	75	95
M		32	11	83	96

Note. All scores are percentages.

last (content) syllable. These accounted for 8% of the responses. Because so few content word omissions actually occurred, the segmental accuracy of content word imitations was also examined.

Accurate content words. Accurate content words were scored as imitations of content words that matched the target exactly or deviated from it by a single phoneme. For example, /dIm/, /bIn/, and /bæm/ would all be considered accurate imitations of the nonsense syllable /bIm/. Also, because children commonly reduce consonant clusters to single consonants (Smith, 1973), an entire cluster was counted as accurate if a child produced any one of its consonants. Thus /ræz/ would be counted as an accurate imitation of /skrætʃ/ because /r/ counts as an accurate imitation of the cluster /skr/, the vowel matches the target, and the substitution of /z/ for /tʃ/ causes the imitation to differ from the target by one phoneme. If only one content word was accurately imitated, the string received a score of 1 (accurate content word), and if both content words were accurately imitated, the string received a score of 2. Using these criteria, 90% of all content words were accurately imitated. (The percentage of accurate content words, 90, was larger than the percentage of strings in which both content words were accurately imitated, 83%, because an imitation could contain a single accurate content word.)

Results

A preliminary analysis revealed no effects of providing a referential context in the task. Therefore all analyses were collapsed over this factor. The proportions of functor omissions are shown in Table 2, and the data for low MLU children alone are illustrated in Figure 1a. Low MLU children omitted significantly more functors than did high MLU children (32% vs. 11%, respectively), $t(14) = 1.82, p < .05$, one-tailed. A two-way analysis of variance (ANOVA) (2 functor × 2 content word) revealed that low MLU children reliably omitted more English functors than nonsense functors (English 37%, nonsense 27%), $F(1, 7) = 8.27, p = .02$, with no effect of content word (English 37%, nonsense 27%), $F(1, 7) = 1.01$, *ns*, and no interaction, $F(1, 7) = 0.11$, *ns*. The same analysis for high MLU children demonstrated no significant effects for functor (English 13%, nonsense 10%), $F(1, 7) = 0.26$, *ns;* content word (English 12%, nonsense 11%), $F(1, 7) = .05$, *ns;* or Functor × Content, $F(1, 7) = 0.13$, *ns*. Finally, to determine if children differentially omitted functors from one position relative to the other, we examined identifiable single functor omissions. These were imitations from which a single functor had been omitted and in which the remaining functor was imitated in full (and not as schwa). Low MLU children reliably omitted more functors from second position (/ðə/ and /nɑ/, 12%) than from first position (/əz/ and /ow/, 3%), $F(1, 7) = 6.67, p = .04$. High MLU children showed no such effect for first position (5%) and second position (12%), $F(1, 7) = .47$, *ns*.

The proportions of content word omissions were very low (English 9%, nonsense 7%), whereas the proportions of phonetically accurate content words were strikingly high for both English (92%) and nonsense elements (87%; see Table 2). A two-way ANOVA on the content word accuracy of low MLU children failed to show any significant effects for functor (English 82%, nonsense 84%), $F(1, 7) = .07$, *ns;* content word (English, 88%, nonsense, 77%), $F(1, 7) = 2.47$, *ns;* or Functor × Content, $F(1, 7) = 1.12$, *ns*. The corresponding analysis for high MLU children revealed that their content word imitations were more accurate when the surrounding functors were English than when they were nonsense (English 98%, nonsense 94%), $F(1, 7) = 5.73, p = .05$, but revealed neither a significant effect of content word (English 96%, nonsense 96%), $F(1, 7) = 0$, *ns*, nor a significant interaction, $F(1, 7) = .58$, *ns*. For discussion of analyses by items, see Footnote 2.

Discussion

The characteristics of children's imitative speech paralleled those of their spontaneous speech, with more functor omissions by low MLU children than by high MLU children. And as in spontaneous speech, there were striking differences in the proportions of omissions for the different elements. The strongly stressed syllables—English content words and their nonsense counterparts—were virtually never omitted by the high MLU children and quite infrequently omitted by the low MLU children. These elements were also imitated quite accurately. Hence, the degree of stress a syllable receives affects the likelihood that it will be preserved in children's imitative speech. The fact that children systematically and accurately produced nonsense content words indicates that young children readily encode and produce items that have strong stress and occupy the positions of nouns and verbs, even if these items do not have familiar referents. Children may have even believed that the nonsense content words were novel nouns and verbs—a reasonable hypothesis because they hear many new nouns and verbs every day. Thus, it appears that strong stress, and not familiarity of reference, promotes inclusion in production. This finding agrees with previous suggestions from other researchers (Blas-

[2] The design of Experiment 1 did not allow analyses of the materials by items within subjects. However, subjects were nearly randomly assigned to conditions, as there were eight (4 lists × 2 orders of contextual support) conditions and only 2 subjects per condition. Therefore, the study is not subject to the language-as-fixed-effect fallacy (Clark, 1973).

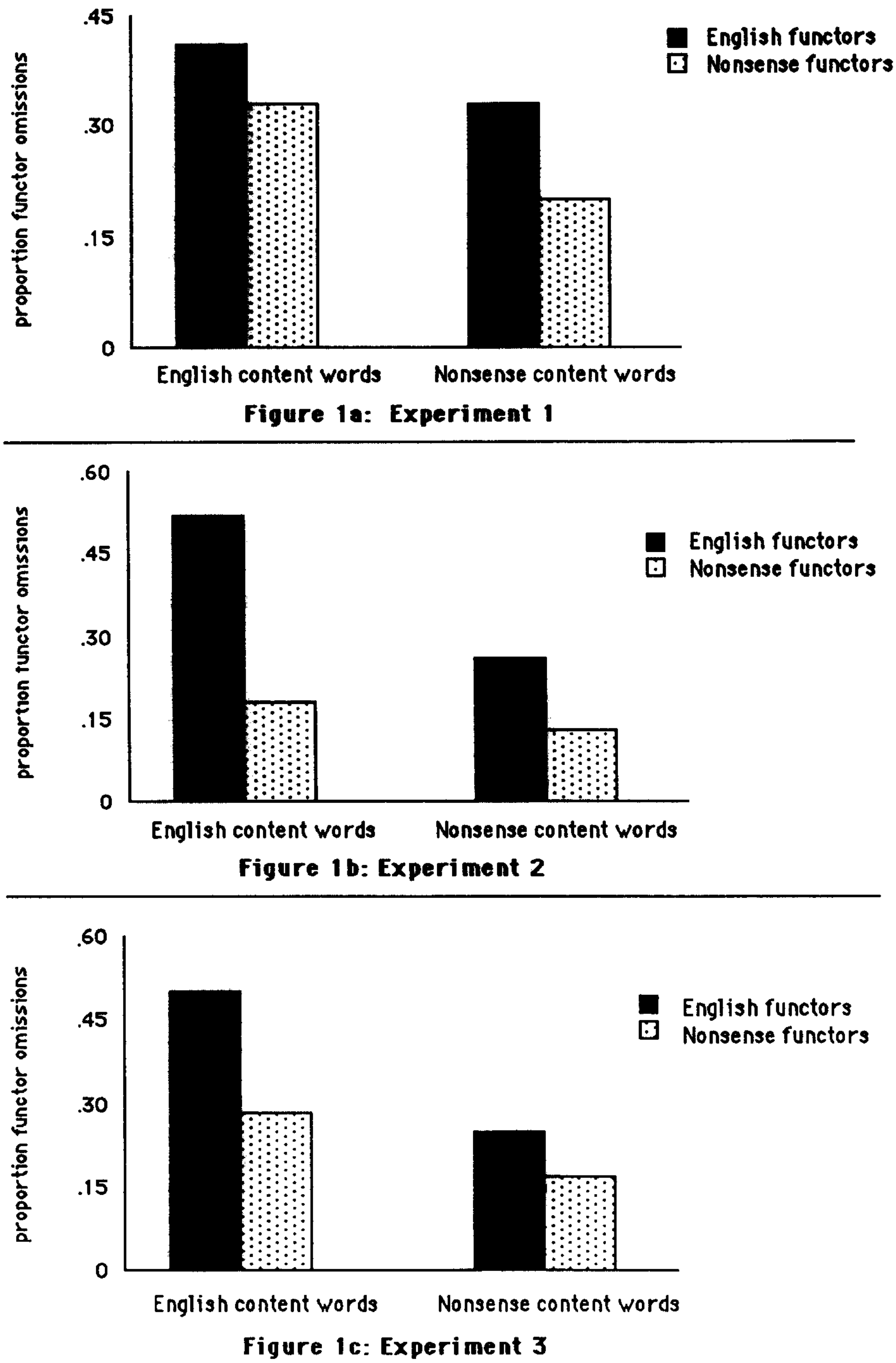

Figure 1. Functors omitted by low mean length of utterance (MLU) children.

dell & Jensen, 1970; Gleitman & Wanner, 1982; Pye, 1983; Slobin, 1973).

In contrast to content word imitations, there were frequent omissions of English functors and their nonsense counterparts, especially by the low MLU children. This again indicates that weak stress promotes omissions. But omissions within the set of weakly stressed syllables also depended on the particular type of element in functor positions. The low MLU children omitted English function morphemes significantly more often than nonsense syllables receiving similar stress and occurring in corresponding positions. Perhaps this is because they treated English functors as separate morphemes that added to the morpho-syntactic complexity of the sentence, whereas they treated nonsense functors as simply extra syllables that did not increase structural complexity (Gerken, 1987a, 1987b). Although high MLU children omitted all morphemes less frequently (as in their spontaneous speech), they too showed an effect of functor type. The presence of English functors helped them imitate the content words more accurately.

Because we used an imitation paradigm, the children included in the study were, by definition, reasonably willing imitators. From observations of individual differences in language learning style (see Bates, Bretherton, & Snyder, 1988), it appears that *"holistic"* children, who are likely to produce unfamiliar and unanalyzed items, also tend to frequently imitate adults. Conversely, *analytic* children, who are likely to produce only well-analyzed items, are also more likely to avoid imitation and thus may not have met the criteria for inclusion in the study. Therefore, our study may have been biased toward subjects who are unlikely to distinguish between familiar and unfamiliar items. If this is the case, the fact that subjects distinguished between English and nonsense functors suggests that even children who are relatively holistic in their production style are nevertheless sensitive to familiar function morphemes in speech perception.[3]

Our results are consistent with the hypothesis that children encode and analyze functors in speech perception and that omissions are due to speech production limitations. The data suggest clear discrimination by young children between the English and nonsense function morphemes used here. The high MLU children must have detected and analyzed English functors, because they omitted them infrequently and used their presence to imitate content words more accurately. The low MLU children also must have discriminated English from nonsense function morphemes, as reflected in the fact that their rate of omission of these two types of elements differed significantly.

In addition, the finding that low MLU children omitted the second functor more frequently than the first in both English and nonsense function morpheme sequences is consistent with a view of children's speech production offered by Allen and Hawkins (1980). They argued that very young children have less difficulty producing a trochaic pattern (a weakly stressed syllable that directly follows a strongly stressed one; e.g., PUSHes) than an iambic pattern (a weakly stressed syllable preceding a strongly stressed one; e.g., the DOG).

However, an alternative explanation for the configuration of results in this study is possible. Because the stimuli were read aloud to children by the experimenter, it is possible that nonsense functors were uttered with greater stress than English functors. Hence, children may have omitted English functors more frequently because the experimenter made them less perceptually salient than their nonsense counterparts. Experiment 2 investigates this possibility.

Experiment 2

To rule out possible differences in stress between English and nonsense functors, synthesized speech stimuli were produced that equated the degree of stress given to the two functor types. In addition, the stimuli were controlled to conform to the intonation pattern of normal English declaratives. Children were asked to imitate this "robot talk." All other procedures remained the same as in Experiment 1, except as noted.

Method

Subjects. Subjects were 8 boys and 7 girls, ranging from 24 to 30 months of age (M = 26 months), were tested. On the basis of the method of calculating MLU described in Experiment 1, 7 of the children were designated as low MLU (1.57–2.60, M = 2.07), and 8 were high MLU (2.96–4.27, M = 3.72). The mean MLU of these children was not reliably different from that of the children in Experiment 1, $t(29) = .33$, *ns*. An additional 16 children were eliminated from the experiment because they either refused to imitate the practice string (n = 14) or did not meet the criterion of imitating, in part or in full, at least two tokens of the six string types (n = 2). These children were significantly younger than those who participated in the experiment ($p < .005$, Fisher's exact test).

Materials. The sentence types were parallel in structure to those in Experiment 1, with two exceptions. First, two sequences of nonsense functors were created in which the order of vowels was counterbalanced. Second, the consonant /k/ was substituted for /n/ in the nonsense functor sequences because counterbalancing would have yielded the sequence /now/ ("no"), which is an English word. Thus, one nonsense sequence was /owkɑ/ (e.g., Pete pusho ka dog) and the other was /ɑkow/ (e.g., Pete pusha ko dog; see Gerken, 1987a). The combination of two content word types (English, nonsense) and three functor types (English, nonsense-1, nonsense-2) resulted in six string types. Subjects were tested on three tokens of each type. Three lists of the 18 strings were constructed, with a different functor sequence assigned to a content word pair on each list. Each string type appeared once in every one third of a list (see Appendix B for lists).

The sentence lists were produced by the DECtalk text-to-speech synthesizer (Version 2.0, voice mode = Perfect Paul). DECtalk derives acoustic parameters for a terminal analog synthesizer by analyzing the letter-to-sound correspondences in the text of an input string. In addition to the segment level templates that control the synthesis of consonants and vowels, DECtalk exploits phrase rules to adjust the segment synthesis, producing stress differences between syllables, as well as natural meter and intonation. Its rules operate according to norms of adult perception (Klatt, 1976). By relying on DECtalk to generate the strings for subjects to imitate, we could be reasonably certain that the list items would exhibit uniform acoustic realizations of stress levels, meter, and intonation. (See Allen, 1985, for a discussion of MITalk, the conceptual model for DECtalk.)

The synthetic stimuli were recorded in the form "Pete scratches the horse, scratches the horse, scratches the horse, scratches the horse." A total of 10 adult listeners who heard the strings found them to be intelligible.[4]

Procedure. The child was introduced to a toy robot and was told that it was going to say "something about Pete." A practice string was then played, and the child was asked what the robot said. No referential context was provided. If the child imitated a portion of the sentence correctly, the test stimuli were presented. If the child did not do so, a prompt was given: "I think he said 'scratches the horse.' Can you say

[3] We thank an anonymous reviewer for pointing out the importance of considering individual differences, particularly with regard to the imitation task.

[4] In order to determine if the recordings of the synthetic speech were intelligible, 10 adult subjects listened to and transcribed the 54 (18 strings per 3 lists) strings. They were able to report 93% and 66% of all English and nonsense content words, respectively. The most common errors were to miss the target by a single phoneme (72% of the errors) or to interpret a nonsense content word as a phonologically similar English word (17% of the errors). They correctly reported 82% of all functors. In sum, the strings were intelligible to adult listeners.

Table 3
Functors Omitted and Accurate Content Words in Experiment 2

String type		Functors omitted		Accurate content words	
Content word	Functor	Low MLU	High MLU	Low MLU	High MLU
English	English	52	15	88	94
English	Nonsense	18	7	65	81
Nonsense	English	26	13	71	69
Nonsense	Nonsense	13	5	46	64
M		27	10	68	77

Note. All scores are percentages.

that?" Children who failed to imitate a portion of the practice string after three such attempts were not included in the study.

An independent judge transcribed three imitations from each child and agreed with the experimenter's transcription on 91% of the strings.

Results

No differences between the two nonsense functor sequences were found; hence, all of the analyses collapse over this factor.

The proportions of children's functor omissions are shown in Table 3, and the data for low MLU children alone are illustrated in Figure 1b. Low MLU children omitted marginally more functors than did high MLU children (27% vs. 10%, respectively), $t(13) = 1.51$, $p < .08$, one-tailed. Two-way ANOVAs by subjects and by items (2 functor × 2 content word) showed that low MLU children omitted reliably more English functors than nonsense functors (39% vs. 15%, respectively), $F_S(1, 6) = 9.70$, $p = .02$; $F_I(1, 16) = 16.14$, $p = .001$. Neither the main effect of content word nor the interaction was reliable by both subjects and items—content word: English 35%, nonsense 20%, $F_S(1, 6) = 3.06$, *ns*, $F_I(1, 16) = 5.81$, $p = .03$; and Functor × Content: $F_S(1, 6) = 5.82$, $p = .05$, $F_I(1, 16) = 1.66$, *ns*. Parallel analyses for high MLU children revealed no significant effects—functor: English 14%, nonsense 6%, $F_S(1, 7) = 2.10$, *ns*, $F_I(1, 16) = 1.19$, *ns;* content word: English 11%, nonsense 9%, $F_S(1, 7) = .44$, *ns*, $F_I(1, 16) = .59$, *ns;* and Functor × Content: $F_S(1, 7) = 0$, *ns*, $F_I(1, 16) = 0$, *ns*. Neither low nor high MLU children differentially omitted functors from the first position relative to the second position in the functor sequences—low MLU: first position 3%, second position 1%, $F_S(1, 6) = 1.78$, *ns*, $F_I(1, 17) = 1.00$, *ns;* and high MLU: first position 2%, second position 3%, $F_S(1, 7) = .07$, *ns*, $F_I(1, 17) = .01$, *ns*.

As in Experiment 1, there were very few content word omissions (English 2%, nonsense 2%), and the proportion of phonetically accurate content words remained quite high (English 82%, nonsense 63%), even though the stimuli in Experiment 2 were produced synthetically (see Table 3). Two-way ANOVAs demonstrated that low MLU children imitated content words more accurately when the accompanying functors were English than when they were nonsense: English 80%, nonsense 56%, $F_S(1, 6) = 12.09$, $p = .01$, $F_I(1, 16) = 7.14$, $p = .02$. In the analysis by items, low MLU children imitated English content words significantly more accurately than nonsense content words. This was only a trend in the analysis by subjects: English 77%, nonsense 59%, $F_S(1, 6) = 5.03$, $p = .07$, $F_I(1, 16) = 12.93$, $p = .002$. There was no significant interaction between functor and content word, $F_S(1, 6) = .55$, *ns*, $F_I(1, 16) = .19$, *ns*. High MLU children imitated English content words significantly more accurately than nonsense content words in the analysis by subjects, but only demonstrated a trend in this direction in the analysis by items: English 88%, nonsense 66%, $F_S(1, 7) = 59.13$, $p = .0001$, $F_I(1, 16) = 3.55$, $p = .08$. No other effects were significant by subjects or by items—functor: English 81%, nonsense 72%, $F_S(1, 7) = 1.87$, *ns*, $F_I(1, 16) = 1.24$, *ns*, and Functor × Content: $F_S(1, 7) = .34$, *ns*, $F_I(1, 16) = .25$, *ns*.

Discussion

The results of Experiment 2 replicated the major findings of Experiment 1. Children tended to retain strongly stressed elements whether they were English or nonsense, and tended to omit weakly stressed functor elements. Low MLU children omitted reliably more English functors than nonsense functors. This finding is even more striking in view of the fact that utterances with English and nonsense functors were presumably equivalent perceptually in meter, stress pattern, and intonation.[5]

Several differences were found between Experiments 1 and 2. First, in Experiment 2, both low and high MLU children accurately imitated more English content words than nonsense content words. This probably occurred because familiar items suffered less deterioration in encoding or recall than unfamiliar items, given the increased processing load associated with synthetic speech (Luce, Feustel, & Pisoni, 1983). Second, in Experiment 2, low MLU children imitated content words more accurately in the context of English functors, as did the high MLU children in Experiment 1. Once again, this suggests that English functors performed a segmenting function for these listeners, although the fact that the effect did not occur in both MLU groups indicates that it is not entirely robust. Finally, there was no significant effect of functor position in Experiment 2 as there was for the low MLU children in Experiment 1.

In sum, the data from Experiments 1 and 2 are consistent with the view that young children encode and analyze English function morphemes. But what is the basis for children's distinction between the English and nonsense functors? One possibility concerns the differing vocalic composition of English and nonsense functors. Because English functors typically receive weak stress, they are usually produced with the reduced vowel schwa. For this reason, we chose English functors that contained schwa in Experiments 1 and 2, and in order to provide a maximally distinct contrast set, we created nonsense functors

[5] The acoustic adjustments DECtalk makes are based on adult perceptual norms, so that English and nonsense functors should have been perceived as equally stressed by adults. However, it is possible that a different set of adjustments would be necessary to create perceptual equivalence for children. We know of no studies that could resolve this issue; therefore, we assume an equivalence with the caveats already expressed.

that contained the full vowels /ow/ and /ɑ/. Hence, it is possible that children were not responding to English functors per se, but rather to weakly stressed syllables containing schwa. This hypothesis is supported by the fact that young children often produce functors as schwa in the early stages of language learning (Bloom, 1970; Peters, 1983).

Because functors tend to occur at the periphery of phrases in English, children who perceived all functors as schwa could still use these elements to segment phrases (cf. Gleitman et al., 1987). However, functors perceived as an undifferentiated set (schwa) could not be used in labeling. More detailed segmental information is needed for this purpose, as different functors occur in different phrase types. Thus, in order to determine if children could use these elements in phrase labeling, it is necessary to ascertain the degree to which children segmentally analyze function morphemes. Experiment 3 addresses this issue.

Experiment 3

Our question was whether the segmental composition of the functor sequences would affect children's pattern of omissions. Four functor sequences were composed; they contained either schwa or full vowels, and either consonants which typically do or do not occur in English functors. If children recognize as English functors any weakly stressed syllable containing schwa, they should omit syllables with schwa more frequently than syllables with full vowels, regardless of which consonants these syllables contain. However, if children make use of more detailed segmental information in treating a syllable as a functor, then both vowel and consonant information should affect omissions. All procedures remained the same as in Experiments 1 and 2, except where noted.

Table 4
Functors Omitted and Accurate Content Words in Experiment 3

String type		Functors omitted		Accurate content words	
Content word	Functor	Low MLU	High MLU	Low MLU	High MLU
		Natural speech			
English	English	50	6	100	88
English	Non 1	44	13	75	81
English	Non 2	31	13	88	81
English	Non 3	31	6	88	75
Nonsense	English	44	6	88	69
Nonsense	Non 1	31	6	94	63
Nonsense	Non 2	38	6	88	81
Nonsense	Non 3	19	0	75	44
M		36	7	87	73
		Synthetic speech			
English	English	50	13	88	81
English	Non 1	13	6	56	56
English	Non 2	25	0	69	63
English	Non 3	25	0	56	69
Nonsense	English	6	0	44	56
Nonsense	Non 1	6	0	38	31
Nonsense	Non 2	6	6	25	63
Nonsense	Non 3	0	0	25	50
M		16	3	50	59

Note. Non 1, Non 2, and Non 3 correspond to /əglə/, /uzðɑ/, and /uglɑ/, respectively. All scores are percentages.

Method

Subjects. A total of 6 boys and 2 girls, ranging in age from 24 to 27 months (M = 26 months), were tested using tape-recorded natural speech, and 5 boys and 3 girls, ranging in age from 26 to 30 months (M = 28), were tested using synthetic speech. On the basis of the method of calculating MLU described in Experiment 1, 4 children in each speech condition were designated as low MLU (M MLU = 2.20), and 4 in each speech condition were high MLU (M MLU = 3.67). The MLUs of the children in the two conditions were not significantly different from each other, $t(14) = .47$, *ns*, or from those of Experiments 1 and 2, $F(3, 43) = 0.11$, *ns*. An additional 18 children were eliminated from the study either because they refused to imitate the practice string (n = 14) or failed to imitate at least 12 of the 16 test strings (n = 4). These children were significantly younger than the subjects included in the experiment ($p < .005$, Fisher's exact test).

Design, materials, procedure. The string types were parallel in structure to those in Experiment 1, but incorporated four different functor sequences. These were as follows: (a) one English functor sequence (/əzðə/), (b) one sequence that deviated only by containing full vowels (/uzðɑ/), (c) one sequence that deviated only by containing consonants that are not typical of English functors (/əglə/), and (d) one that deviated in both vowel and consonant (/uglɑ/). Crossing these four sequences with English and nonsense content words yielded a design with eight string types. Each child imitated two tokens of each type, for a total of 16 trials. One set of stimuli was produced with tape-recorded natural speech and the other with DECtalk.

Four lists of test strings were created; in each, a particular content word pair appeared only once. A given content word pair occupied the same position on all four lists, and a different functor sequence occurred with the pair on each list. All four functor sequences appeared in each quarter list (see Appendix C for lists). An independent judge transcribed three imitations produced by each child, and the experimenter and judge transcriptions agreed on 99% of the strings in the natural speech condition and on 95% in the synthetic speech condition. A total of 10 adults listened to the synthetic speech and found it to be intelligible.[6]

Results

The proportions of functor omissions are shown in Table 4, and the data for low MLU children alone are illustrated in Figure 1c. Low MLU children omitted reliably more functors (26%) than high MLU children (5%), $t(14) = 1.92$, $p < .05$, one-tailed. Four-way ANOVAS by subjects and by items (2 speech type × 2 functor vowel × 2 functor consonant × 2 content

[6] To ensure that the computer-generated stimuli were intelligible, 10 adults listened to the strings and repeated them aloud to the experimenter. These subjects correctly reported 85% and 61% of all English and nonsense content words, respectively. The most common errors were to miss the target by a single phoneme (56% of the errors) or to report nonsense content words as a phonologically similar English word (9% of the errors). Adults correctly reported 55% of the functors correctly, with the most frequent error being to report /uzðɑ/ as /əzðə/ (30% of the errors). In sum, the stimuli were intelligible to adult listeners.

word) showed that low MLU children omitted more functors that contained typical English functor consonants than atypical ones. This result was significant by items, but just missed significance by subjects: typical 31%, atypical 21%, $F_S(1, 6) = 5.34$, $p = .06$, $F_I(1, 14) = 4.54$, $p = .05$. In the analysis by items, low MLU children also omitted significantly more functors that co-occurred with English content words than with nonsense content words. This was only a trend in the analysis by subjects: English 34%, nonsense 19%, $F_S(1, 6) = 3.94$, $p = .09$, $F_I(1, 14) = 6.48$, $p = .02$. No other effects were reliable by both subjects and items—speech type: natural 36%, synthetic 16%, $F_S(1, 6) = 2.15$, *ns*, $F_I(1, 14) = 8.76$, $p = .01$; and functor vowel: schwa 30%, full 22%, $F_S(1, 6) = 2.61$, *ns*, $F_I(1, 14) = 2.20$, *ns*.

The corresponding analyses for high MLU children demonstrated no effects that were significant both by subjects and by items—speech type: natural 7%, synthetic 3%, $F_S(1, 6) = 6.82$, $p = .04$, $F_I(1, 14) = 1.30$, *ns*; functor vowel: schwa 6%, full 4%, $F_S(1, 6) = 1.17$, *ns*, $F_I(1, 14) = .19$, *ns*; functor consonant: typical 6%, atypical 4%, $F_S(1, 6) = .69$, *ns*, $F_I(1, 14) = .25$, *ns*; and content word: English 7%, nonsense 3%, $F_S(1, 6) = .79$, *ns*, $F_I(1, 14) = 1.33$, *ns*.

To determine if children omitted English functors more frequently than the three non-English functor sequences, planned comparisons were performed that collapsed over speech type and content word. Low MLU children omitted English functors more frequently than the other three sequences, $t(6) = 2.60$, $p < .025$, one-tailed. High MLU children showed no such effect, $t(6) = .31$, *ns*.

As in Experiment 1, low MLU children omitted reliably more functors from second position (14%) than from first position (0%), $F_S(1, 6) = 34.71$, $p = .001$, $F_I(1, 15) = 8.44$, $p = .01$. Low MLU children who heard natural speech made significantly more identifiable single functor omissions (11%) than did children who heard synthetic speech (3%), $F_S(1, 6) = 10.71$, $p = .02$, $F_I(1, 15) = 8.44$, $p = .01$, and there was a significant interaction between functor position and speech type, $F_S(1, 6) = 10.71$, $p = .02$, $F_I(1, 15) = 8.44$, $p = .01$. Pairwise comparisons among means (Newman-Keuls, $p = .05$) demonstrated that the position effect was only significant for children who heard natural speech. The parallel analyses for high MLU children demonstrated no significant effects—position: first 2%, second 0%, $F_S(1, 6) = 1.00$, *ns*, $F_I(1, 15) = 2.14$, *ns*; speech type: natural 0%, synthetic 2%, $F_S(1, 6) = 1.00$, *ns*, $F_I(1, 15) = 2.14$, *ns*; and Position × Speech: $F_S(1, 6) = 1.00$, *ns*, $F_I(1, 15) = 2.14$, *ns*.

As in Experiments 1 and 2, the proportions of content word omissions were low (English 9%, nonsense 5%), and the proportions of phonetically accurate content words were relatively high (English 77%, nonsense 59%; see Table 4). Four-way ANOVAs performed on children's content word accuracy revealed that low MLU children were more accurate in their imitations of natural speech (87%) than synthetic speech (50%), $F_S(1, 6) = 28.20$, $p = .001$, $F_I(1, 14) = 5.15$, $p = .04$. They also were more accurate in their imitations of English content words (77%) than nonsense content words (59%), $F_S(1, 6) = 7.38$, $p = .03$, $F_I(1, 14) = 5.43$, $p = .04$. This effect interacted reliably with speech type, $F_S(1, 6) = 6.15$, $p = .05$; $F_I(1, 14) = 11.59$, $p = .004$. Pairwise comparisons (Newman-Keuls, $p = .05$) showed that nonsense content words produced synthetically were imitated less accurately than all other content words. No other effects were reliable by subjects or items—functor vowel: schwa 73%, full 64%, $F_S(1, 6) = 1.72$, *ns*, $F_I(1, 14) = .80$, *ns*; and functor consonant: typical 73%, atypical 63%, $F_S(1, 6) = 5.12$, $p = .06$, $F_I(1, 14) = 1.22$, *ns*.

The same analyses for high MLU children revealed that they also imitated English content words more accurately (74%) than nonsense content words (57%), $F_S(1, 6) = 14.24$, $p = .001$; $F_I(1, 14) = 4.77$, $p = .05$. No other effects were reliable by both subjects and items—speech type: natural 73%, synthetic 59%, $F_S(1, 6) = 1.18$, *ns*, $F_I(1, 14) = 1.83$, *ns*; functor vowel: schwa 66%, full 66%, $F_S(1, 6) = 0$, *ns*, $F_I(1, 14) = 0$, *ns*; and functor consonant: typical 73%, atypical 59%, $F_S(1, 6) = 3.71$, *ns*, $F_I(1, 14) = 5.01$, $p = .04$.

Discussion

As in Experiments 1 and 2, children tended to preserve strongly stressed content words and to omit weakly stressed functors. Also, as in the previous experiments, low MLU children selectively omitted English functors, even though these elements bore the same weak stress and occurred in the same position as the non-English elements. And as in Experiment 1, children omitted more functors from the second position in the functor sequence than from the first.

The new findings in Experiment 3 were that children omitted functors containing typical functor consonants more frequently than those with atypical consonants, and they omitted English functors more frequently than the three segmentally similar nonsense functor sequences. These results indicate that children have the ability to represent functors with some segmental detail, and not simply as reduced vowels, as their use of filler syllables in spontaneous speech has suggested (Gleitman & Wanner, 1982). This opens the door to the possibility that children are able to use functors to label syntactic phrases as well as to segment utterances. The possibility of such labeling via functors suggests a strong role for function morphemes during early language comprehension.

Finally, children's omissions were not affected by the type of vowel that appeared in a functor sequence. This might be due to the fact that vowel information is more likely than consonant information to undergo change with speaking rate and dialect. Hence, children may have ignored vowel information in favor of more reliable consonant information.

General Discussion

Children's imitative speech was remarkably similar to their spontaneous speech: Strongly stressed content words were preserved and weakly stressed function morphemes were omitted. The similarity between children's spontaneous and imitative speech is consistent with a range of previous findings (Bonde & Korte, 1983; Brown & Fraser, 1964; Fraser, Bellugi, & Brown, 1963; Leonard, Fey, & Newhoff, 1981; Leonard, Schwartz, Folger, & Wilcox, 1978; Rodd & Braine, 1971; Slobin & Welsh, 1968; Smith, 1973).

It has been suggested that children's function morpheme omissions could be due to a failure to encode or analyze functors; words with familiar referents might be perceived at the expense of nonreferential items, or strongly stressed words might be perceived or analyzed at the expense of weakly stressed ones. Alternatively, and in company with Pye (1983), we suggested that these omissions could be due to a speech production limitation that disrupts production of the functors after they are perceived.

The results of the three experiments cast doubt on the view that children fail to encode or analyze function morphemes. Across all experiments, children preserved words that received strong stress, even when these words had no real-world referents. This means that referential status by itself is unlikely to dictate which elements are not perceived. It also suggests that stress may play a primary role in determining which elements are omitted in early spontaneous speech. This is in accord with experimental and naturalistic data indicating that children omit weakly stressed syllables, regardless of referential status (Blasdell & Jensen, 1970; Pye, 1983).

But weak stress alone cannot completely account for the pattern of omissions either. In all three experiments, low MLU children omitted English functors more frequently than nonsense functors that received the same stress and occurred in the same string positions. This was the case even when the nonsense elements contained schwa. Furthermore, we found that the presence of English functors helped children to imitate content words. This was true even for the low MLU children who were unlikely to produce those functors, and suggests that the functors served as a kind of frame for perceiving and producing content words.

Our interpretation of this pattern of results is that children's omissions are a consequence of a speech production constraint, rather than an encoding limit. The following is a speculative account of a speech production constraint that might account for our data.

Allen and Hawkins (1980) have argued that children in the earliest stages of language acquisition have difficulty alternating between strongly and weakly stressed syllables in speech production. As a consequence of this difficulty, weakly stressed function morphemes and weakly stressed syllables in multisyllabic words are often omitted in spontaneous speech. For example, "elephant" becomes "ephant," and "banana" becomes "nana." Similarly, our subjects omitted weakly stressed functors more frequently than strongly stressed content words. Allen and Hawkins have also argued that when children begin to alternate between strong and weak syllables, they have a preferred production pattern that is trochaic: a strong syllable followed by a weak one. Thus, "giRAFFE" is more likely to be reduced to "raffe" than "MONkey" is to be reduced to "mon," because the former does not correspond to children's preferred production pattern, although the latter does. This is consistent with our findings, in Experiments 1 and 3, that children omitted the second functor in a sequence more frequently than the first. The first functor follows a strongly stressed syllable and thus maintains the preferred pattern (e.g., PUSHes), whereas the second functor follows a weakly stressed syllable (e.g., the DOG; see Footnote 7) and thus violates the trochaic pattern.

In addition to stress pattern, the morphemic status of syllables appears to play a role in omissions. Our explanation for the fact that subjects consistently omitted English functors more frequently than nonsense functors is that they analyzed English functors as morphemes, but treated nonsense functors as part of the adjacent content words. On the basis of this differential treatment of English and nonsense functors, strings with English functors contained four morphemes, whereas strings with nonsense functors only contained two. Hence, children omitted all weakly stressed syllables more frequently than strongly stressed ones, but they omitted weakly stressed morphemes still more frequently because of the additional morpho-syntactic complexity English functors introduced. As both the constraint on stress pattern and morphemic complexity relax over development, omissions become less frequent, as was the case for the high MLU children. This interpretation of the data is consistent with the proposal that children who include functors in their early spontaneous speech may be treating these items like our nonsense functors (i.e., as unanalyzed syllables that are part of the surrounding content words), whereas children who omit functors from their early speech do so because they have analyzed them as separate units (Bates et al., 1988; Peters, 1977, 1983).

Whether or not this specific account of the speech production constraint survives subsequent tests, our results have implications for current theories of language learning. Although everyone would agree that children ultimately come to treat sentences in phrasal units, many investigators have focused on individual content words as the primary units of early acquisition (Bowerman, 1973; Brown & Fraser, 1964; Pinker, 1984; Schlesinger, 1971, 1981). For example, Bowerman (1973) argued that children's early speech can best be described in terms of semantic relations among content words. More recently, Grimshaw (1981) and Pinker (1982, 1984) have argued that children's entry into phrasal categories arises through assumptions about the correspondence between content words with real-world referents and grammatical categories.

The traditional focus on content words as language's building blocks is due, first, to the plausibility of learning some of these words through the mediation of objects and actions in the

[7] The position effect for functor omissions was found only when the test stimuli were natural speech (in Experiment 1 and the speech stimuli in Experiment 3). We can think of two possible explanations for the failure to find the effect with synthetic stimuli. One is that children who heard synthetic speech were more likely than children who heard natural speech to produce functors as a filler syllable (schwa). Therefore, when a single functor was omitted, the remaining functor was identifiable significantly less often by children who heard synthetic speech than by children who heard natural speech. The decrease in speech accuracy associated with synthetic speech can be seen by comparing the proportions of identifiable single functor omissions made by low MLU children who heard natural speech (Experiment 1—7%, Experiment 3—11%) with children who heard synthetic speech (Experiment 2—2%, Experiment 3—3%). Thus, it is likely that children did not show the position effect for synthetic stimuli because they produced too few identifiable single functor omissions in this condition.

The other possibility is that the two functors in a sequence were given different relative stress and pitch levels by human speakers than by DECtalk. A woman read the stimuli in Experiment 1, and a man read in Experiment 3. Thus, if there were differences between human and synthetic speech in the stress levels given to sequential functors, it was not due to an individual human speaker, but rather represented a real difference between natural and synthetic speech. This suggests an interesting area of synthetic speech research.

world. Although the complete account of these relationships will be very complex (Landau & Gleitman, 1985), it seems likely that some content words are learned in conjunction with real-world referents. A second reason for this focus is that content words often predominate in children's early speech—at least the speech of children learning English. Thus, it seems natural to propose that children preferentially attend to familiar content words that were learned in isolation.

Our experiments demonstrate that children's selective production of content words should not be interpreted as evidence that they fail to encode or analyze the omitted functors. On the contrary, young children are sensitive to the existence of function morphemes. This may allow them to segment utterances into phrasal units from the outset, without using content words as the sole starting points. In addition, young children are sensitive to the segmental detail of functors and this may allow them to differentially label the syntactic categories of the phrases they isolate. Thus, although functors are omitted in much of early spontaneous speech, they may nevertheless be involved in the earliest processes of language learning.

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Appendix A

Materials for Experiment 1

	List 1	*List 2*	*List 3*	*List 4*
1.	Pete pushes the dog.	Pete pusho na ball.	Pete lixo na vum.	Pete lixes the sif.
2.	Pete bazo na mof.	Pete bazes the dep.	Pete fixes the boat.	Pete fixo na box.
3.	Pete bounco na ball.	Pete bounces the ball.	Pete reshes the pag.	Pete resho na mof.
4.	Pete tozes the fim.	Pete tozo na vum.	Pete toucho na frog.	Pete touches the dog.
5.	Pete kisses the dog.	Pete kisso na cup.	Pete jasho na sif.	Pete jashes the reb.
6.	Pete nusso na pag.	Pete nusses the fim.	Pete closes the box.	Pete closo na boat.
7.	Pete catcho na drum.	Pete catches the dog.	Pete huzes the wav.	Pete huzo na pag.
8.	Pete goxes the reb.	Pete goxo na mof.	Pete scratcho na ball.	Pete scratches the car.
9.	Pete scratches the box.	Pete scratcho na frog.	Pete goxo na fim.	Pete goxes the reb.
10.	Pete huzo na sif.	Pete huzes the reb.	Pete catches the cup.	Pete catcho na ball.
11.	Pete closo na car.	Pete closes the boat.	Pete nusses the mof.	Pete nusso na dep.
12.	Pete jashes the dep.	Pete jasho na wav.	Pete kisso na dog.	Pete kisses the car.
13.	Pete touches the boat.	Pete toucho na box.	Pete tozo na dep.	Pete tozes the wav.
14.	Pete resho na vum.	Pete reshes the sif.	Pete bounces the car.	Pete bounco na frog.
15.	Pete fixo na cup.	Pete fixes the car.	Pete bazes the reb.	Pete bazo na fim.
16.	Pete lixes the wav.	Pete lixo na pag.	Pete pusho na drum.	Pete pushes the cup.

Appendix B

Materials for Experiment 2

List 1

1. Pete fixes the car.
2. Pete goxa ko fim.
3. Pete pusha ko truck.
4. Pete bazes the dep.
5. Pete catcho ka boat.
6. Pete tozo ka bif.
7. Pete touches the hat.
8. Pete bounco ka ball.
9. Pete nussa ko wav.
10. Pete resho ka pag.
11. Pete lixes the vum.
12. Pete scratcha ko horse.
13. Pete posses the bim.
14. Pete brusho ka cat.
15. Pete kisses the dog.
16. Pete huzo ka reb.
17. Pete jasha ko nug.
18. Pete washa ko cup.

List 2

1. Pete bounces the ball.
2. Pete baza ko dep.
3. Pete fixa ko car.
4. Pete tozes the bif.
5. Pete toucho ka hat.
6. Pete posso ka bim.
7. Pete pushes the truck.
8. Pete kisso ka dog.
9. Pete lixa ko vum.
10. Pete goxo ka fim.
11. Pete reshes the pag.
12. Pete catcha ko boat.
13. Pete nusses the wav.
14. Pete scratcho ka horse.
15. Pete washes the cup.
16. Pete jasho ka nug.
17. Pete huza ko reb.
18. Pete brusha ko cat.

List 3

1. Pete catches the boat.
2. Pete toza ko bif.
3. Pete toucha ko hat.
4. Pete goxes the fim.
5. Pete fixo ka car.
6. Pete bazo ka dep.
7. Pete scratches the horse.
8. Pete pusho ka truck.
9. Pete possa ko bim.
10. Pete lixo ka vum.
11. Pete jashes the nug.
12. Pete bounca ko ball.
13. Pete huzes the reb.
14. Pete washo ka cup.
15. Pete brushes the cat.
16. Pete nusso ka wav.
17. Pete resha kop pag.
18. Pete kissa ko dog.

Appendix C

Materials for Experiment 3

List 1

1. Pete fixes the car.
2. Pete tozuz tha bif.
3. Pete toucheg le hat.
4. Pete bazug la dep.
5. Pete catchuz tha boat.
6. Pete posses the bim.
7. Pete bouncug la ball.
8. Pete resheg le pag.
9. Pete pushes the truck.
10. Pete goxug la fim.
11. Pete kisseg le dog.
12. Pete nussuz tha wav.
13. Pete brushug la cat.
14. Pete jashes the nug.
15. Pete washuz that cup.
16. Pete huzeg le reb.

List 2

1. Pete fixeg le car.
2. Pete tozug la bif.
3. Pete touchuz tha hat.
4. Pete bazes the dep.
5. Pete catchug la boat.
6. Pete posseg le bim.
7. Pete bounces the ball.
8. Pete reshuz tha pag.
9. Pete pusheg le truck.
10. Pete goxes the fim.
11. Pete kissuz tha dog.
12. Pete nussug la wav.
13. Pete brushes the cat.
14. Pete jasheg le nug.
15. Pete washug la cup.
16. Pete huzuz tha reb.

List 3

1. Pete fixuz tha car.
2. Pete tozes the bif.
3. Pete touchug la hat.
4. Pete bazeg le dep.
5. Pete catches the boat.
6. Pete possuz tha bim.
7. Pete bounceg le ball.
8. Pete reshug la pag.
9. Pete pushuz tha truck.
10. Pete goxeg le fim.
11. Pete kissug la dog.
12. Pete nusses the wav.
13. Pete brusheg le cat.
14. Pete jashuz tha nug.
15. Pete washes the cup.
16. Pete huzug la reb.

List 4

1. Pete fixug la car.
2. Pete tozeg le bif.
3. Pete touches the hat.
4. Pete bazuz tha dep.
5. Pete catcheg le boat.
6. Pete possug la bim.
7. Pete bouncuz tha ball.
8. Pete reshes the pag.
9. Pete pushug la truck.
10. Pete goxuz tha fim.
11. Pete kisses the dog.
12. Pete nusseg le wav.
13. Pete brushuz tha cat.
14. Pete jashug la nug.
15. Pete washeg le cup.
16. Pete huzes the reb.

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