Distinguishing Function Words from Content Words in Children’s Oral Reading

CAROL LORD, ROBERT BERDAN, AND MICHAEL FENDER
California State University, Long Beach

BY THE TIME they enter first grade, children acquiring language in a home where English is spoken typically show the English prosodic pattern in which content words receive stress but function words do not. However, when some of these children read text aloud, it is perceived as choppy, awkward, and word-by-word, without meaningful phrasal groupings and lacking appropriate expression, as if they are reading a word list (Weber 2006). A major factor contributing to the impression of word-by-word reading appears to be the lack of a stress distinction between content words and function words.

To investigate this interpretation, we performed acoustic analyses on recordings of samples of oral reading by nonfluent children, fluent children, and adults. We measured nuclear vowels in monosyllabic function words and content words for acoustic correlates of stress, including vowel length, intensity, pitch, and vowel quality. We found that the nonfluent children’s function words tended to be relatively longer, louder, and higher in pitch, and their vowels were less likely to be reduced to schwa. Compared with the proficient readers, there was less distinction between their pronunciations of function words and content words.

Prosodic Features of Function Words
In many languages, possibly all, there is a distinction between lexical categories and functional categories. In English, lexical categories include nouns, verbs, and adjectives—that is, content words that carry the dominant semantic weight of utterances. Functional categories include prepositions, articles, auxiliaries, modals, complementsizers, and conjunctions as well as other particles; these signal relationships among content words. Content words contain at least one stressed syllable. If a function word appears in a list, it receives the same stress as a content word; for example, for and four are pronounced the same, as are him and hymn and to and two. However, in discourse context the function words typically occur without stress; exceptions occur when the function word is focused or phrase-final (Bolinger 1975; Selkirk 1996; Sweet 1891).

Perception of stress in English appears to depend on a few major acoustic correlates: vowel duration, intensity, and pitch (Fry 1955, 1958; Hayes 1995; Tamburini
and Caini 2005). Unstressed vowels in English typically are reduced to schwa, as in the first syllable of about and connect, and in the last syllable of comet and medicine (Shi et al. 2005). These are the acoustic correlates we examined and compared in function words and content words in this study.

Function Words and Fluent Reading
Once a reader is able to recognize individual words quickly and automatically, cognitive resources can be focused on text comprehension (LaBerge and Samuels 1974). In order to read a text aloud with appropriate stress patterns and intonation, the reader needs to group words into phonological phrases and to structure the syntactic and semantic elements to create a mental parse (Chafe 1988; Dowhower 1991; Kintsch 1998; Kuhn and Stahl 2003; Miller and Schwanenflugel 2006).

Prosodic patterns in oral speech provide information that helps the hearer construct a mental parse. In oral speech, function words are typically distinguished by lack of stress; however, English orthography provides the reader with no overt marking indicating presence or absence of stress. Function words constitute a significant portion of English discourse. Although there are only a few hundred function words in English, they make up at least 50 percent of the word tokens in everyday speech (Cutler 1993).

Evidence suggests that fluent readers may process function words differently from content words. In letter detection tasks conducted during reading, mature fluent readers are much better at noticing and marking a target letter (e.g., t) in content words than in function words. In contrast, younger novice readers do not show a distinction between content and function words on these tasks (Greenberg, Koriat, and Vellutino 1998; Saint-Aubin, Klein, and Landry 2005). Research with fluent readers using eye-tracking shows that function words are much more likely to be skipped than content words (Saint-Aubin, Klein, and Landry 2005). They are less likely to receive direct eye fixations, and they receive much shorter fixations (Rayner and Pollatsek 1989; factors such as word length and word frequency may account for some of these differences). Overall, studies suggest that fluent reading shows rapid lexical access for function words compared with content words (Segalowitz and Lane 2004).

In contrast, children learning to read may find function words difficult to master. One study found that children read function words less accurately than content words, whether in lists or in connected text (Blank 1985). Beginners as well as older delayed readers may read orally word-by-word, giving uniform stress to content and function words, due to difficulties in word identification or integration of meaning (Clay and Imlach 1971; Pinnell et al. 1995).

In reading research, reading fluency has been measured in terms of judgments of a reading sample, using a rubric with a four- to six-point scale (Kuhn and Stahl 2003; Pinnell et al. 1995; Rasinski 2003). Most recently, the Oral Reading Fluency Study of the National Assessment of Educational Progress (NAEP) used a four-level holistic rubric for rating fourth-grade oral reading fluency, focusing on three key elements: (a) grouping of words in phrases (manifested by intonation and pausing); (b) adherence to the author’s syntax, indicating an awareness of the ideas expressed in the text; and (c) presence of expressive interpretation (Daane et al. 2005). With this rubric, a key element in student success is the use of appropriate stress patterns on function words.
Comparing Fluent and Nonfluent Readers
In this study, reading samples were collected from adults and children, and prosodic features of function words and content words were analyzed.

The children in our study were third graders in an urban public school in California. The school’s average reading scores were at the thirty-eighth percentile on state reading assessments, and most of the children qualified for free or reduced-price school lunches, based on family income level. Six children were identified by their teachers as falling in the lower two quartiles in reading proficiency, with reading speed ranging from approximately seventy-five to one hundred correct words per minute. In addition, teachers identified six children with reading achievement scores at or above grade level. All children were classified as either native speakers of English or English proficient. The six adult readers were all college graduates. There was a mix of gender and ethnicity in all three groups.

The subjects were asked to read aloud two short narratives of about 250 words each; these were Dynamic Indicators of Basic Early Literacy Skills (DIBELS) passages at the second-grade reading level (Hintze, Ryan, and Stoner 2002). Digital recordings were made. In each narrative we identified thirty monosyllabic function words: the first ten prepositions, the first ten instances of infinitival to, and the first ten articles (a, an, the). We also identified thirty monosyllabic content words (nouns, verbs, and adjectives).

Using Praat software’s acoustic display, we demarcated the beginning and end of the vowel nucleus of each target function word and content word (Boersma and Weenink 2007). Then, for each word, we made computational measures of vowel duration, intensity, pitch, and vowel quality. Vowel duration measures were in milliseconds. Intensity was measured in decibels at the midpoint of each vowel. To compensate for different recording levels across reading sessions, the mean intensity was calculated for each reading/recording session. This value was then subtracted from the midpoint vowel intensity of each token to produce the intensity values analyzed here. For each vowel, peak pitch was measured in hertz; these frequencies were subjected to a log transformation to linearize the scale and then standardized for each reader, giving a distribution of values for each reader with a mean of 0 and a standard deviation of 1. For vowel quality judgments, raters listened to all instances of the to infinitive and judged whether the vowel quality was a tense [u] or a reduced, centralized schwa vowel. Tense vowels were coded as 1 and all others as 0; each reader’s score was the proportion of [u] pronunciations in his or her story. To obtain a comparable acoustic measure of extent of vowel reduction, we plotted formant 1 values against formant 2 values.

Results
Differences between adults and nonfluent children were found in comparisons of content and function word duration, intensity, pitch, and vowel quality.

**Vowel Duration**
For all three reader groups, the vowels of function words were shorter than the vowels of content words. However, the difference between content and function words was greatest for the adults. For these readers the duration of function word vowels was about 41 percent that of content words. For the fluent children the duration was
about 60 percent, and for the nonfluent children it was about 72 percent. The mean duration values in milliseconds are shown in table 4.1.

Analysis of variance for group by word class by story \((3 \times 2 \times 2)\) shows all main effects to be highly significant. The group effect \((f[2, 204] = 183.5, p < .0001, \eta^2 = .643)\) shows significant difference in mean vowel length across the three groups of readers. Post hoc analysis (Scheffé) shows each group of readers to be significantly different from the other two groups: nonfluent readers with the longest mean vowel duration, adults with the shortest vowels, and fluent children in between. For all three groups, word class is also significant \((f[1, 204] = 304.4, p < .0001, \eta^2 = .599)\): Vowels in the function words are shorter than vowels in the content words. The two-way interaction of word class and group is also significant: Adults shorten vowels of function words more than children do. Vowel length for function words is essentially unchanged across the two stories.

The relative duration of content word and function word vowels is shown in figure 4.1, where the slope of the lines shows that the greatest difference between content words and function words is for adults.
Vowel Intensity

Measures of vowel intensity show that all readers produced louder vowels in content words than in function words (see table 4.2).

The difference among the reading groups in mean vowel intensity was significant ($f[2, 204] = 20.43, p < .0001, \eta = .167$). Post hoc analysis (Scheffé) shows that this difference is between the adults and the two groups of children, with children showing greater vowel intensity, relative to the full reading session, than the adults. There is also a significant effect for word class ($f[1, 204] = 61.07, p < .0001, \eta = .230$): Vowels in content words are spoken with greater intensity than vowels in function words. This differential is greater for adults than for either of the two groups of children. The story effect is not significant.

As figure 4.2 illustrates, the content words were louder than function words for all readers; however, the difference was greater for the adults.

Vowel Peak Pitch

A comparison of the peak pitch of content word and function word vowels showed that the function words were spoken at a lower pitch by the adults and the nonfluent.
children; the difference between content and function words was smaller for the nonfluent children (see table 4.3).

Analysis of variance of the transformed pitch variable showed no significant effects for group of readers, for word class, or for story. In the interaction between reader group and word class ($F[2, 204] = 5.184, p = .006, \text{eta} = .048$), adults and nonfluent children showed quite similar behavior, each with lower mean pitch on function words than on content words. The fluent children, however, show exactly the opposite relationship, with higher mean pitch on function words than on content words.

As the difference in the slope of the lines in figure 4.3 illustrates, adults made greater pitch distinctions between content and function words than did the nonfluent children.

<table>
<thead>
<tr>
<th>Group</th>
<th>Content</th>
<th>Function</th>
<th>Content + Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonfluent (6)</td>
<td>.099 (.534 SD)</td>
<td>−.023 (.600 SD)</td>
<td>.038</td>
</tr>
<tr>
<td>Fluent (6)</td>
<td>−.122 (.401 SD)</td>
<td>.157 (.570 SD)</td>
<td>.017</td>
</tr>
<tr>
<td>Adults (6)</td>
<td>.159 (.480 SD)</td>
<td>−.029 (.326 SD)</td>
<td>.065</td>
</tr>
<tr>
<td>All (18)</td>
<td>.045</td>
<td>.034</td>
<td>.040</td>
</tr>
</tbody>
</table>

Figure 4.3 Peak Vowel Pitch by Group and Word Class
Vowel Quality

Pronunciation of the \([u]\) vowel in infinitival \textit{to} differed strikingly across the three reader groups, as shown in table 4.4. Adults consistently reduced the vowel, and non-fluent children did not.

Analysis of variance shows large and significant differences in the mean proportion of \([u]\) pronunciations across the three reading groups ($f[2, 204] = 104.948, p < .0001, \eta = .875$). For the nonfluent readers, about 95 percent of the vowels were unreduced \([u]\), and examination of individual readers shows that half of the children in this group used \([u]\) categorically. The fluent children used \([u]\) just under half of the time, and the adults used the unreduced form in only about 7 percent of the instances of infinitival \textit{to}. Each group of readers is significantly different from the other two groups. Figure 4.4 illustrates the large differences between reader groups.

A representation of the extent of vowel reduction using Praat acoustic measures is shown in figure 4.5. Normalized values for formant 1 are on the vertical axis, with formant 2 on the horizontal axis. The resulting scatterplot approximates relative position on a vowel quadrilateral, with centralized/reduced instances appearing on the lower left. The circles represent adult pronunciations, and the squares represent non-

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean Proportion of ([u])</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonfluent (6)</td>
<td>.955 (.069 SD)</td>
</tr>
<tr>
<td>Fluent (6)</td>
<td>.487 (.231 SD)</td>
</tr>
<tr>
<td>Adults (6)</td>
<td>.073 (.071 SD)</td>
</tr>
<tr>
<td>All (18)</td>
<td>.505</td>
</tr>
</tbody>
</table>

Table 4.4

Vowel Quality in Infinitival \textit{to}, by Group

Figure 4.4 Mean Proportion of \([u]\) by Group
fluent child pronunciations. As the figure shows, many of the adult vowels were significantly reduced, while the nonfluent children’s were not. (For reasons of graphic clarity, we have not included the fluent children’s pronunciations in this display; their formant values showed reduced, unreduced, and intermediate instances.)

Discussion
This study found that adults reading aloud consistently differentiated function words from content words with respect to measures that are considered to be acoustic correlates of stress: duration, intensity, and pitch. Function word vowel nuclei were shorter, not so loud, and lower in pitch than content word vowel nuclei. The results also showed that the differences between function and content words along these parameters were greater for adults than for children and that the differences were greater for the nonfluent children than for the fluent children. The difference between adults and children was strongest for vowel duration. For pitch, there was a small difference between adults and nonfluent children; however, the results for the proficient children are puzzling and bear further investigation, since they do not follow the trend of the other measures. The complex algorithm for pitch measures could have led to computational errors (Tamburini and Caini 2005).

The measures of vowel quality for infinitival to showed that adults typically reduced the vowel toward schwa, according to the pattern for unstressed syllables in English. In sharp contrast, nonfluent children rarely reduced the vowel, and fluent children showed a mixed pattern.

In identifying the nature and extent of differences in stress on function words, this study has served to clarify a key contributor to the perceived pattern of word-by-
word prosody in the oral reading performance of nonfluent readers. These are the students who receive low ratings on our current national assessments of reading fluency.

How can we account for the word-by-word reading pattern? Function words in English are short, high-frequency lexical items, but they are more likely than content words to be spelled in ways that violate phonics generalizations (consider, e.g., function words the, of, to). Students are often drilled on these as “sight words,” but, nevertheless, students who can read them readily in word lists often show the patterns we have described when reading them in connected text.

Some insight may be found from studying what these children are looking at while they are reading aloud. To read fluently with appropriate stress, a reader must be looking ahead in the text in order to construct appropriate phrasal word groups. In pilot studies using eye tracking, we have found consistent differences between fluent and nonfluent readers. In our limited sample, the eyes of fluent readers are generally two to four words ahead of the voice. However, for the nonfluent third graders that we have been observing, the eyes are often fixated on the word that follows the word being spoken. This may be an indication that cognitive resources are focused on next-word recognition and that there are too few words in the look-ahead queue to assign phrasal groupings.

A child takes approximately 400–600 ms to say a one-syllable content word. With a one-word look-ahead, if the reader spends 400–600 ms saying the word, this allows 400–600 ms to recognize the following word, which is apparently sufficient, for a child reading at a rate of 60–80 words per minute. A fluent adult takes only 75–150 ms to say a one-syllable function word. If the nonfluent child takes only 75–150 ms to say a word, the strategy of eyes-on-the-next-word is unlikely to provide adequate time for next-word recognition. Thus, by failing to de-stress function words, the child is able to maintain the spoken word stream and minimize between-word pauses in his or her oral performance.

The absence of a stress distinction between function words and content words by nonfluent readers deserves further study, particularly as these children gain in fluency, so that we can better understand the child’s reading process. With clearer understanding, we may be able to assist reading professionals in developing more effective interventions.

NOTE
The authors acknowledge and appreciate the assistance of Nancy Caplow and Hide Okuno on this study.

REFERENCES


