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Prosodic production and domain sensitivity in brain-damaged patients

Shari R. Baum,* Veena D. Dwivedi, and Amee P. Shah

School of Communication Sciences & Disorders Centre for Research on Language, Mind & Brain McGill University, Canada

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Whereas a great deal of research has been devoted to defining the neural bases of the segmental aspects of speech processing (see, e.g., Scott & Wise, 2003 for a recent review of neuroimaging data), the neural substrate for prosodic processing has only recently garnered substantial attention. Recently, a *cue lateralization perspective* has been proposed which purports that the LH is specialized for the control of temporal parameters of speech, whereas the RH is specialized for spectral parameters, particularly the processing of pitch (F0) (e.g., Van Lancker & Sidtis, 1992). With the advent of more functional neuroimaging studies of prosodic processing per se, several modifications to such theories have recently been proposed. In particular, Gandour et al. (2003) have posited a distinction among levels of linguistic structure that correspond to relatively short (syllable-sized associated with LH processing) and longer (phrase or sentence-level associated with RH processing) windows or prosodic domains (c.f. Baum & Dwivedi, 2003).

There has recently been a surge of interest in subtle, but important linguistic distinctions that are signalled by prosodic cues (e.g., Baum, Pell, Leonard, & Gordon, 1997). The current experiment adds to this work by examining the use of prosody in syntactic disambiguation for different sentence types which include or exclude intonational phrase level (IPh) prosodic boundaries (Price, Ostendorf, Shattuck-Hufnagel, & Fong, 1991).

Method

Subjects

The subjects included 5 LHD non-fluent aphasic patients, 5 RHD patients, and 5 age-matched non-brain-damaged control subjects. All were native English speakers with hearing within normal limits. The brain-damaged patients, diagnosed by standardized tests, had all suffered a single, unilateral CVA.

Stimuli and procedure

Three sentence types that incorporate or exclude prosodic boundaries were examined: *appositives* vs. integrated phrases, *parentheticals* vs. integrated phrases, and *tags* vs. integrated phrases (Price et al., 1991). Eight pairs of sentences in each of these three sentence types were elicited from speakers following a biasing context sentence. The productions were recorded on DAT tape for acoustic analysis. A perception test was also presented to a group of five unimpaired native-English-speaking listeners to determine whether the contrasts produced by the various speaker groups were perceptible.

Acoustic analyses

Durations of each sentence were computed, as were pre-boundary word durations and pause durations at the boundaries. Word and pause durations were expressed as a proportion of the sentence duration to control for speech rate differences across participants. In addition, peak F0 was computed at the midpoint of the stressed vowel in pre- and post-boundary words; from these values, F0 ratios were calculated as a means of observing changes in intonation contour at the boundaries.

Results

Analyses were conducted for each sentence type separately. For the *parentheticals,* all groups showed a tendency to exhibit pre-boundary lengthening when mean duration proportions were examined; however, statistical analyses revealed that differences reached significance only for the normal control participants. Both normal controls and RHD patients produced parentheticals with longer pauses at the boundary position relative to that same position in integrated phrases. The LHD patients failed to display either pre-boundary lengthening or increased pause duration at the boundary. For the *appositives*, the expected pre-boundary lengthening was found for both normal controls and RHD patients; however, the difference only reached significance for the RHD patients (due to a single NC speaker). Only the NC speakers demonstrated significantly longer pauses when the boundary was present in the stimuli, although all groups again showed a trend in that direction. Finally, for the *tags,* NC speakers produced marginally significant lengthening at the phrase boundary relative to the integrated phrase version of the stimuli. No significant differences in pause duration emerged for any group, although all showed the expected pattern when examining mean proportional duration values. Interestingly, in the integrated phrase conditions—across all sentence types —the LHD patients always produced longer pause durations than either the NC or RHD participants. In other words, the LHD patients appeared to be producing pauses in inappropriate positions.

Analyses of F0 failed to reveal any consistent patterns across the sentence types or speaker groups.

*Corresponding author.
E-mail address: shari.baum@mcgill.ca (S.R. Baum).

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Results of the perception test revealed that listeners experienced greatest difficulty in identifying the presence or absence of boundaries from the speech of the RHD speakers.

Discussion

In keeping with previous findings, LHD speakers exhibited impairments in the control of temporal parameters signalling phrase boundaries, including inconsistent patterns of pre-boundary lengthening and longer-than-normal pause durations in non-boundary sentences (see Baum & Pell, 1999 for review). Despite the relatively normal temporal prosodic patterns produced by the RHD speakers, perception of the contrasts as signalled by these individuals was poor, suggesting a deficit in the control of F0 (or other cues not measured in the present investigation). Under this view, the results are consistent with a cue lateralization hypothesis—in particular, one which specifies that the RH controls F0 cues that span large prosodic domains (i.e., IPh; Baum & Dwivedi, 2003). Because no clear patterns were found for F0 for any of the speaker groups, this interpretation must be considered speculative at present. Future research will help to resolve the equivocal findings.

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