The Relationship between Speech Errors and Prosodic Phrase Boundaries

Speech errors occur when the activation of preceding or subsequent linguistic elements interferes with the activation of a current element (Dell, 1986; Roelofs, 2002). Speech errors have been used to inform models of language production (Dell, 1986; Levelt, 1989; Roelofs, 2002) and theories of phonological structure, typically at the level of the word (Fromkin, 1971;Shattuck-Hufnagel, 1979; Mowrey & Mackay, 1990; Goldstein, et al. 2007). Our goal was to use these errors to understand something about the structure of larger, supralexical units in the speech plan. Accordingly, we investigated the relationship between speech errors and prosodic phrase boundaries. This investigation showed clearly that errors and prosodic boundaries interact.

In order to independently assess errors and prosodic phrasing and then determine how the two might relate, we asked 40 native English-speaking undergraduate students to produce 60 sentences 5 times in random order. The sentences varied in length and in the extent to which certain phonological features were repeated (tongue twisters or not). Participants were instructed to prepare their utterances in advance and then not to hesitate or stop once they started speaking. The goals of the instruction were (1) to ensure the production of well-structured utterances, and (2) to maximize the number of errors a participant might produce, while minimizing the effects that excessive self-correction might have on prosodic structure. The first author and a research assistant then listened to the entire corpus of 12,000 sentences and independently identified the errors, which occurred in about 10% of the sentences. Next, the two authors separately categorized the errors as being ones of anticipation, preservation, lexical substitution, and so on. Errors of anticipation and preservation were identified if the error repeated an element that couldbe found within the phrase. The source of the error was always assumed to be the repeatedelement that was closest to the error. For example, if the speaker produced "*The blig black bugbit the big black bear…*" the error *blig* for *big* was identified as one of anticipation with thesource being the first instance of the word *black*. Finally, the authors listened to the sentencesthat contained errors of anticipation and preservation and prosodically-transcribed strong and weak prosodic boundaries by attending to intonational and durational cues. We will refer to the units defined by these boundaries as intonational units (IU).

The 40 speakers produced a total of 1,634 speech errors, 76.93% of which were errors of anticipation and perseveration. The analyses focused on the distribution of the anticipatory and perseveratory errors within an IU and on the relationship between error position and source position. Although an error and its source were rarely matched with respect to IU position, the distribution of errors provided evidence that the IU is a coherent planning unit (see **Figure 1**). In particular, the number of errors varied as a function of position within a unit such that the fewest errors were found in IU-initial position, more occurred in early-mid position, and even more occurred in late-mid position. We refer to this result as the cumulative error effect. We also noted an IU-final position effect that varied with the position of the IU within a phrase. If the IU occurred in phrase-initial or phrase-internal position, then a disproportionate number of errors occurred in IU-final position. If the IU occurred in phrase-final position, then the number of errors associated with IU-final position was somewhat reduced relative to the number of errors found in late-mid position. The fact that the final position effect varied in this way with the position in a stimulus phrase suggests that the cumulative error effect and final effect were distinct.

The cumulative and final error effects are interpreted as evidence for the IU as the principal planning unit in a hierarchically structured speech plan. Specifically, we propose that the low error rate on initial words within an IU reflects a state of high IU activation, whereas thehigher error rate on subsequently occurring words within the IU reflects a comparably lower state of overall activation. Like the cumulative error effect, the final position effect also provides evidence for the IU as a planning unit. Whereas the cumulative error effect may reflect decaying activation in the IU that is currently being executed, the final error effect likely reflects the activation of a subsequent IU. Specifically, we suggest that the process of inhibiting the past, activating the present, and planning the future—to paraphrase Dell et al.'s (1997) formulation of serial language production—occurs at the level of the IU and that the cumulative and IU-final effects emerge because of this. Final words in phrase-internal IUs are especially error prone because their activation is confounded by the low level of activation within the IU and by the concurrent activation of a subsequent IU that is close to threshold for execution.

ACKNOWLEDGEMENTS

We are grateful to Rachel Crist for helping to identify speech errors in these recordings. This work was supported in part by NIH grant 1R01HD061458-01.

REFERENCES

Dell, G. S. (1986). A spreading-activation theory of retrieval in sentence production. *Psychological Review, 93,* 283-321.

Dell, G.S., Burger, L.K., Svec, W.R. (1997). Language production and serial order: a functional analysis and a model. *Psychological Review*, 104, 123-147.

Fromkin, V. A. (1971). The nonanomalous nature of anomalous utterances. *Language*, 47, 27-52.

Goldstein, L., Pouplier, M., Chen, L., Saltzman, E., & Byrd, D. (2007). Dynamic action units slip in speech production errors. *Cognition, 103*, 389-412.

Levelt, W. J. M. (1989). *Speaking: From intention to articulation*. Cambridge, MA: MIT Press

Mowrey, R. A., & Mackay, I. R. (1990). Phonological primitives: electromyographic speech error evidence. *Journal of the Acoustic Society of America, 88*, 1299-1312.

Roelofs, A. (2002). Spoken language planning and the initiation of articulation. *The Quarterly Journal of Experimental Psychology*, *55A*, 465-483.

Shattuck-Hufnagel, S. (1979). Speech errors as evidence for a serial-ordering mechanism in sentence production. In W. E. Cooper & E. C. T. Walker (Eds.), *Sentence processing: Psycholinguistic studies presented to Merrill Garrett* (pp. 295-342). Hillsdale, NJ: Erlbaum.

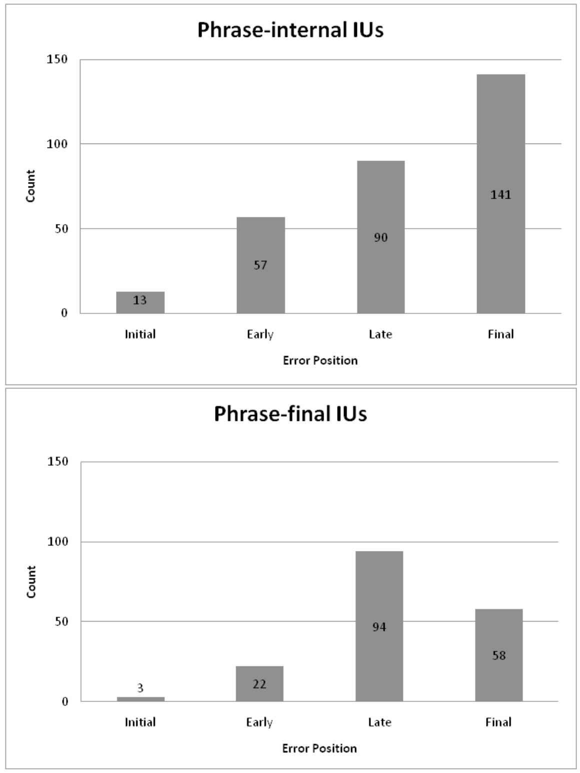

Figure 1. The number of speech errors in medium and long IUs (4+ words) is shown as a function of the position of the words containing speech errors (error position). The top panel shows error counts for phrase-internal IUs and the bottom panel shows those for phrase-final IUs. The error data was collapsed across IUs defined by weak and strong boundaries because the pattern of results was the same for both types of IUs.