Modeling Gradient Speech Errors in Articulatory Phonology

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The phonetic properties of speech errors reflect a gradient combination of the intended target and the error outcome (e.g., Goldrick, Baker, Murphy & Baese-Berk, 2010; Pouplier & Goldstein, 2010). We consider this phenomenon within the framework of Articulatory Phonology (AP; Browman & Goldstein, 1986 et seq.). AP models utterances as a set of articulatory goals (gestures) which are coordinated with one another. Using an AP-based computational model of speech motor control (Nam, Goldstein, Saltzman & Byrd, 2004), we model two cases of speech errors. Our analyses reveal that these error types require distinct patterns of gestural competition.

Case 1: Independent gestures. Pouplier and Goldstein (2010) explored speech errors induced by quick repetitions of *cop top*. Within AP, these onsets differ in terms of independent gestures (tongue tip vs. tongue dorsum closure). They found that in many onset errors, articulatory gestures of both the target and the intruding consonant were present. However, the intruding consonant was of lesser spatial magnitude than corresponding cases of intended production, and the intruding gesture had a shorter duration than the intended target. We find that both the magnitude and relative timing patterns can be modeled as a superposition of a partially activated intruding gesture onto the intended target. Critically, our results suggest that for this type of speech error, the intruding gesture tends to be weakly activated relative to the intended target.

Case 2: Distinct coordination relations. Goldrick et al. (2010) examined tongue twisters that induced errors on initial voiced and voiceless stops (e.g., *pin bin bin pin*). AP assumes that these onsets differ in the coordination relation between (a) the closure gesture for the onset consonant and (b) the gesture for the aspiration between the onset and the vowel. We model these errors as reflecting a weighted average of the coordination relations for the voiced and voiceless targets. A new analysis of the voicing error data from Goldrick et. al. suggests that in these errors the intruding sound is more active than the intended target. To produce the empirically observed voice onset time distributions of errors, we find that the error outcome must receive a much higher weight than the intended target (mean weight across participants: 0.84)

Conclusions. Within the AP framework, speech errors can be modeled as the superposition of the gestural scores of the intended target and error outcome. While intended gestures tend to be more active for errors involving the intrusion of a distinct gesture (e.g., /t/ intruding on /k/), they are less active when the intruding gestural score differs only in the coordination relationships between gestures (e.g., /t/ intruding on /d/). We will discuss possible sources of these distinct patterns.

References

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