

The neural signature of phonological variation: a preliminary ERP study of phoneme and allophone violations

Previous research has shown that unexpected variation in speech can incur various processing difficulties on the part of the listener. This has been shown for general regional accents (e.g. [1]), but also specifically for phonological phenomena; the latter particularly in the context of ERPs. Mismatch-negativity studies find that allophone violations incur larger MMN amplitudes ([2,3]); [4] found that generally-accented realizations lead to reduced PMN and N400 amplitudes, specifically when the accent contains salient phonological substitutions (as in the case of a strong foreign accent). As shown behaviorally by [5], such substitutions can be perceptually learned, but not when the substitution crosses a phoneme boundary, and only when the substitution is vocalic rather than consonantal ([6]). The present study investigates whether these effects can also be observed in ERPs.

Participants in the study were 10 Belgian speakers of Dutch who migrated to the Netherlands as part of their university studies, and as 10 Dutch controls. They were presented aurally with 2×300 words, realized once with an ND initial allophone and once with a non-ND initial allophone. ERP responses show two effects. Over all conditions, [4]’s N400 modulation was replicated, but in the opposite direction: the Belgians have a persistently *larger* N400 irrespective of allophone condition, suggesting that this is a response to the (ND-accented) word as a whole (Figures 1a, 2a). The /ε~ε:/ condition revealed a significant P600 response to the non-ND variants *only* for the control group (Figures 1b, 2b). Neither effect underwent significant change over the three sessions. The other vowels did not show significant differences. This suggests that the method was successful, in being sensitive to *phonemic* violations, but that either the method or the brain is not sensitive to *allophonic* violations in vowels (as were manipulated in the other conditions) in the same way (cf. [6]). The fact that the control group was sensitive to the illicit realizations in the /ε~ε:/ condition, while the Belgian group was not, implies that the Belgian students are in the process of restructuring their phonologies, and are currently open even to particularly odd phonological violations. The success of the method underscores that the P600 component, though commonly known for its function in *syntax*, also plays a significant role in the *phonological* grammar.

References

- [1] Floccia, C., Goslin, J., Girard, F., and Konopczynski, G. (2006). Does a regional accent perturb speech processing? *Journal of Experimental Psychology: Human Perception and Performance* 32, 1276
- [2] Steinberg, J., Truckenbrodt, H., and Jacobsen, T. (2010). Activation and application of an obligatory phonotactic constraint in German during automatic speech processing is revealed by human event-related potentials. *International Journal of Psychophysiology* 77, 13–20
- [3] Steinberg, J., Truckenbrodt, H., and Jacobsen, T. (2010). Preattentive phonotactic processing as indexed by the mismatch negativity. *Journal of Cognitive Neuroscience* 22, 2174–2185
- [4] Goslin, J., Duffy, H., and Floccia, C. (2012). An ERP investigation of regional and foreign accent processing. *Brain and Language* 122, 92–102

[5] Witteman, M. J., Bardhan, N. P., Weber, A., and McQueen, J. M. (2015). Automaticity and stability of adaptation to a foreign-accented speaker. *Language and Speech* 58, 168–189

[6] Witteman, M. J., Weber, A., and McQueen, J. M. (2014). Tolerance for inconsistency in foreign-accented speech. *Psychonomic Bulletin & Review* 21, 512–519