



ERP Measures Response to Violations of Voicing Agreement Constraint

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OBJECTIVES

- Test ERP measures of phonetic and phonological sequence predictions by replicating the MEG findings of Monahan et al. (2009) and providing additional evidence for conclusion regarding underspecification.
- Better understand phonotactic processing by testing the hypothesis that grammatical patterns will be perceived differently than impossible or less preferred patterns.

MEG MEASURES OF PHONOTACTIC SENSITIVITY

Flagg et al. (2006)

- VCV stimuli that either obeyed or violated the constraint that nasalized vowels must be followed by nasal consonants.
- Found a significant latency difference in the M50 response to an oral consonant following a nasal vowel, but not to a nasal consonant following an oral vowel - even though both sequences violate the constraint.

Monahan et al. (2009)

- VC₁C₂ stimuli that either obeyed or violated the constraint against syllable-final obstruent clusters that do not agree in voicing.
- Found a difference in RMS amplitude 150 ms after the onset of C₂.
- Effect was significant for coronal C₁ only.
- Only found an effect for voiced-voiceless incongruency, not for voiceless-voiced.
- Take this as evidence of underspecification: if only [+voice] is stored in phonemic representation, only voiced C₁ will create an expectation that the incongruent sequences do not meet.

METHOD: ERP EXPERIMENT

- Stimuli (from Monahan et al. (2009)):

12 types x 150 tokens = 1800 randomized trials

Congruent	Incongruent
[ups]	*[upz]
[uts]	*[utz]
[uks]	*[ukz]

Subjects listened passively and performed a distractor task on filler items.

- 17 subjects (16 female, aged 18-23, 15 right handed) included in analysis.
- EEG recorded with 128-electrode cap
- ERPs epoched with a 200 ms baseline time locked to the onset of the V
- Sibilant occurred 200 ms into the word and was followed by a 600 ms epoch
- Average referenced

METHOD: BEHAVIORAL EXPERIMENT

- Same stimuli as ERP study: 48 randomized trials
- Phonotactic acceptability judgment task: rate on a scale from 1-4 how much the word sounds like a word of English

RESULTS: BEHAVIORAL

- 8 subjects (all female, aged 18-19)
- Subjects were unable to distinguish congruent (M = 2.6) from incongruent (M = 2.4) words.

DISCUSSION

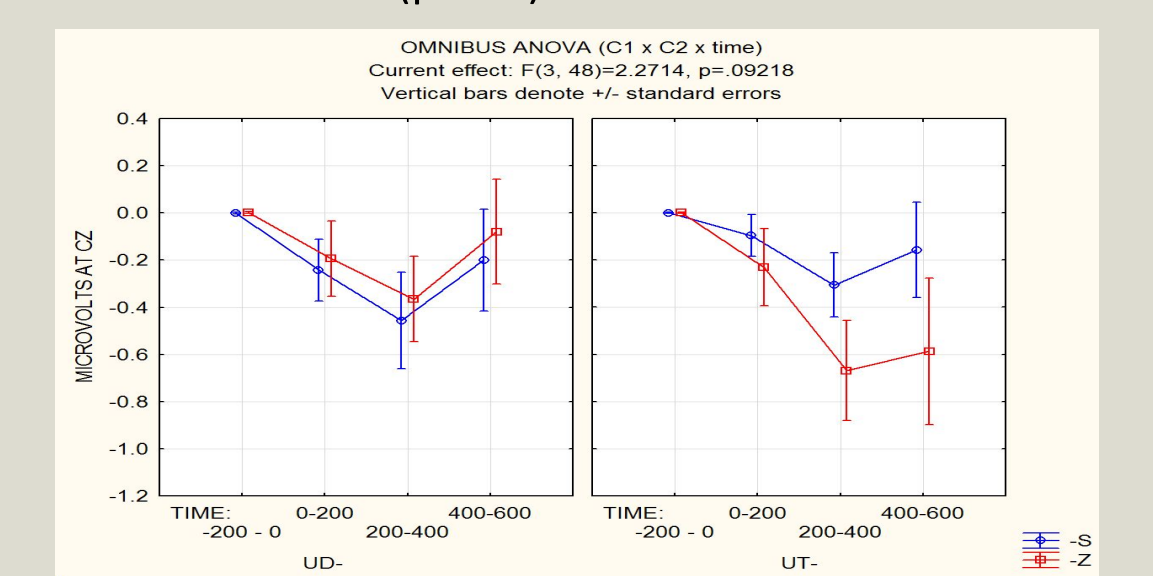
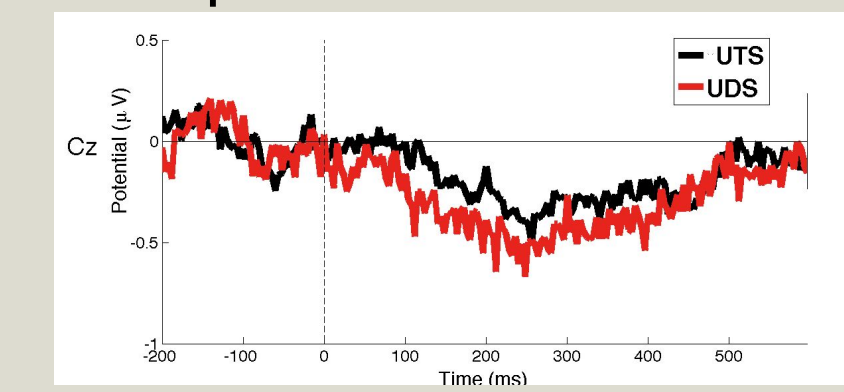
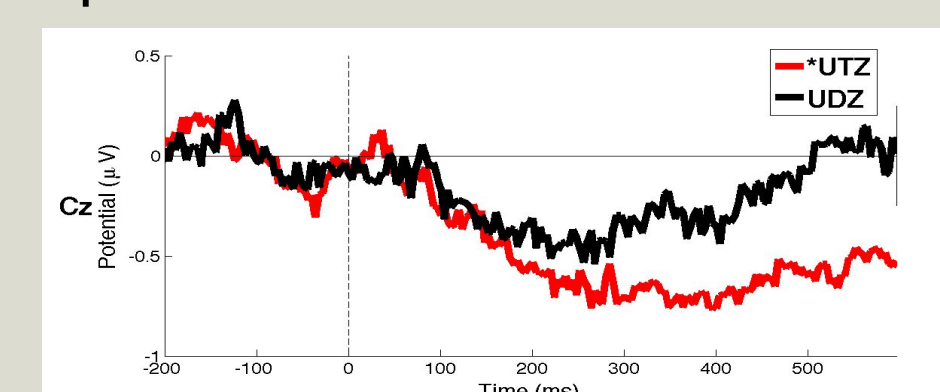
- Unable to replicate findings of Monahan et al. (2009): response to incongruent stimuli supports underspecification of voiced, not voiceless consonants.
- Compared to behavioral results, ERP finding suggests that this measure may be useful for detecting sensitivity to phonotactic violation at an earlier stage of processing; thus the processing of constraint violations at the phoneme-sequence level is available to the perceptual systems that ERPs can access, even though the effect may not extend to the level of cognition used in behavioral experiments.

CONCLUSIONS AND FUTURE WORK

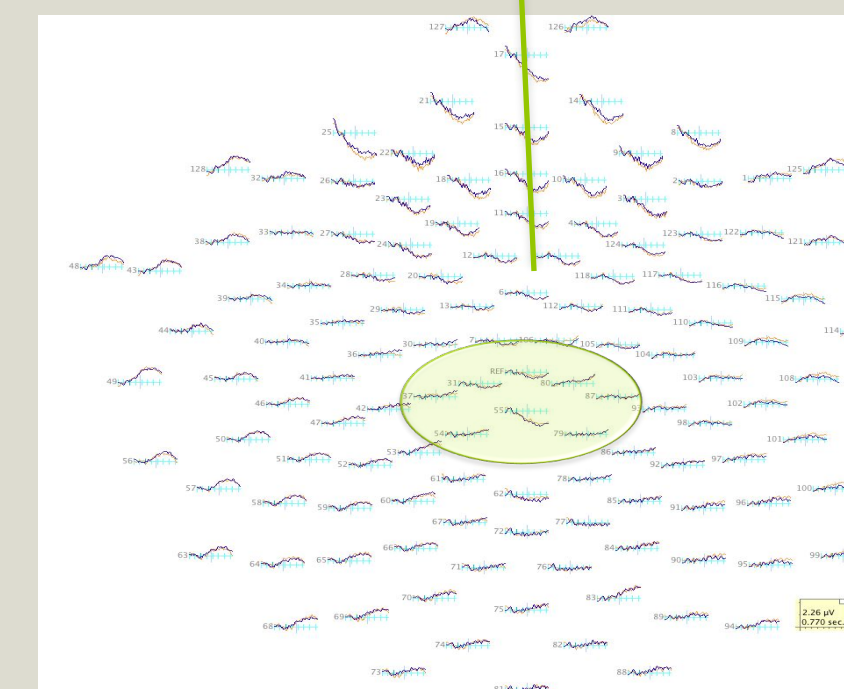
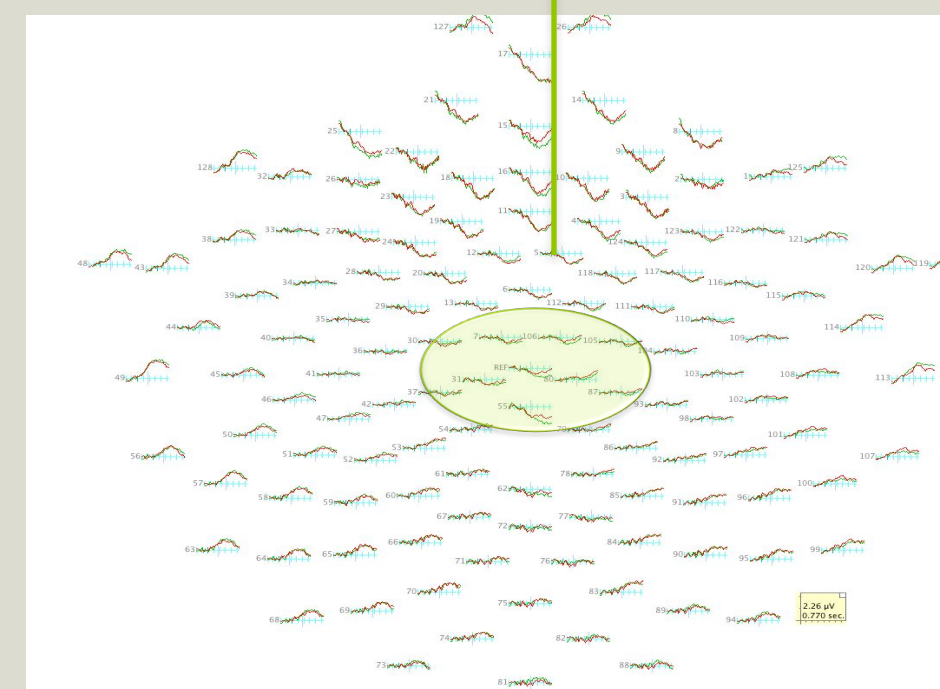
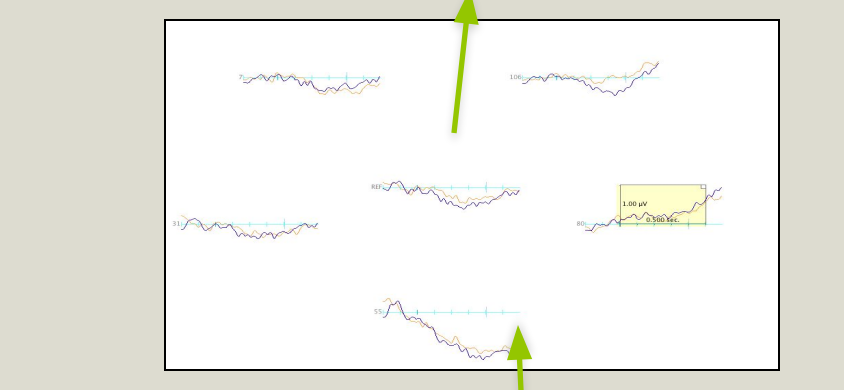
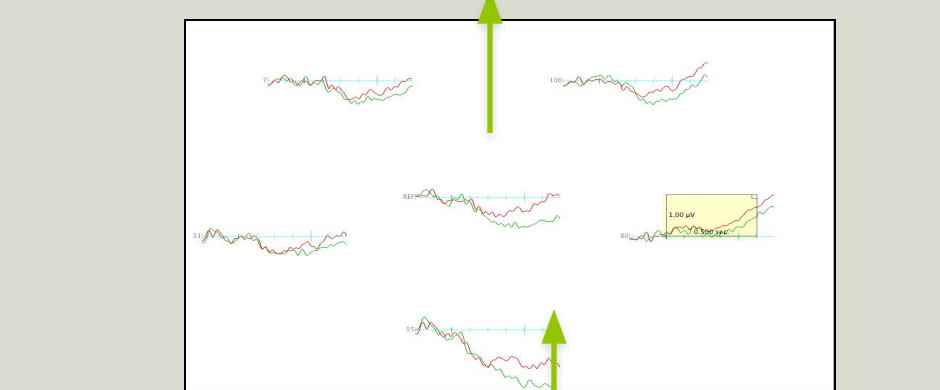
- Sensitivity to phonotactic violation is detectable at early stages of processing, though as in previous studies an asymmetry was observed in the direction of the incongruency.
- Previous study found a significant effect only for coronals, and the current results found (non-significant) differences between labial, coronal, and velar. Yet no p.o.a. difference is expected if the relevant feature is [voice].

UNDERSPECIFICATION

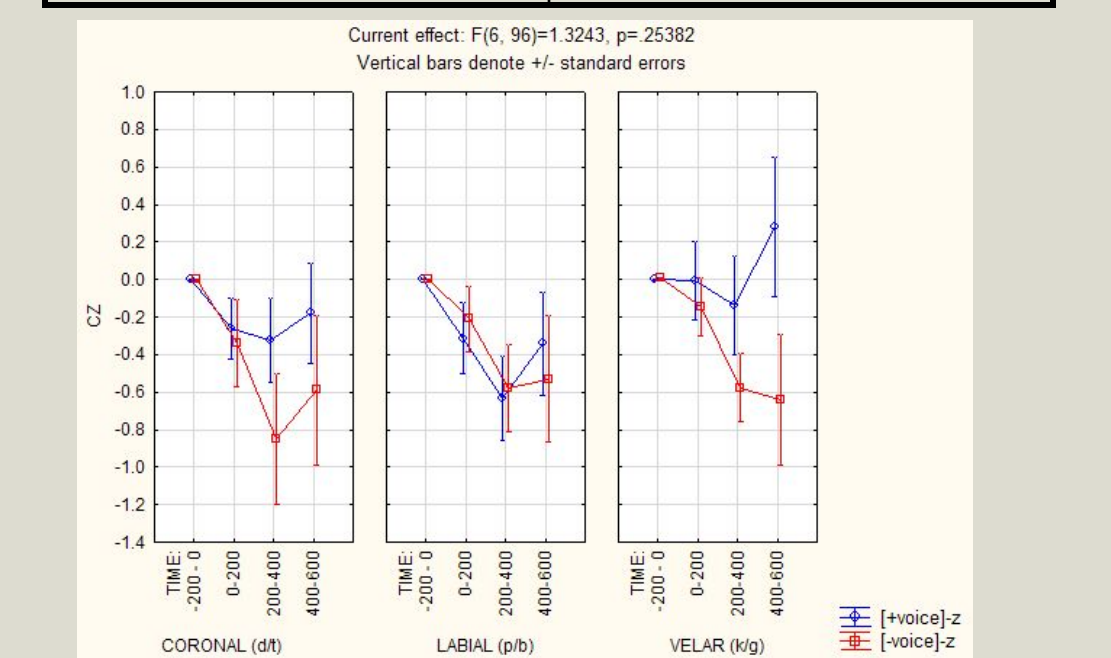
	-Z $\left\{ \begin{matrix} ub \\ ud \\ ug \end{matrix} \right\} \xrightarrow{\text{predicts } z} (*s)$		-S $\left\{ \begin{matrix} up \\ ut \\ uk \end{matrix} \right\} \xrightarrow{\text{predicts } s} (*z)$	
Empirically (surface phonetics):				
Hypothesis 1: /t/ is underspecified, and /d/ is specified as [+voice]	UDS: /d/ predicts [z], [s] should surprise	UDZ: /d/ predicts [z], harmonic	UTS: /t/ makes no prediction	UTZ: /t/ makes no prediction
Hypothesis 2: /d/ is underspecified, and /t/ is specified as [-voice]	UDS: /d/ makes no prediction	UDZ: /d/ makes no prediction	UTS: /t/ predicts [s], harmonic	UTZ: /t/ predicts [s], [z] should surprise



Orthogonal contrast analysis	
*UDS	*UTZ
-200-400ms time window: n.s.	-200-400ms time window: t(16) = 2.28, p = 0.036
-400-600ms: n.s.	-400-600ms time window: t(16) = 2.27, p = 0.036



Congruent
Incongruent



SELECTED REFERENCES AND ACKNOWLEDGMENTS

- Flagg, E., Oram Cardy, J.E., and Roberts, T.P.L. (2006). MEG detects neural consequences of anomalous nasalization in vowel-consonant pairs. *Neuroscience Letters* 397, 263-268.
- Monahan, P. J., Hwang, S-O., and Idsardi, W. J. (2009, under revision) Predicting Speech: Neural Correlates of Voicing Mismatch using MEG. *Brain Research*.

Thanks to Bill Idsardi for providing the stimuli and to members of the Phonetics and Phonology Lab at the University of Delaware for valuable feedback and discussion.