



# ERP Measures Response to Violations of Voicing Agreement Constraint

Jane Chandlee (janemc@udel.edu) and Arild Hestvik (arild@udel.edu)  
Department of Linguistics and Cognitive Science, University of Delaware



## 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)

- VC<sub>1</sub>C<sub>2</sub> 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 C<sub>2</sub>.
- Effect was significant for coronal C<sub>1</sub> 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 C<sub>1</sub> 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

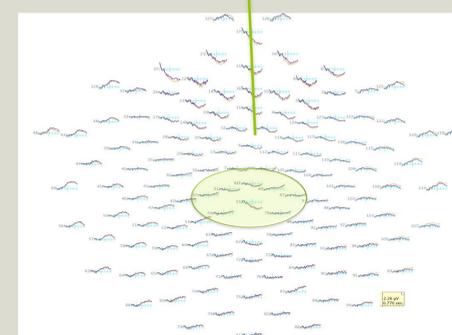
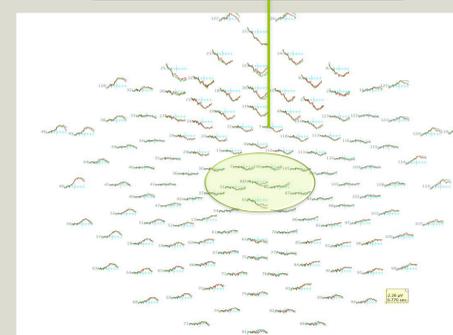
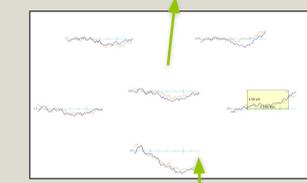
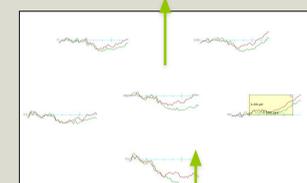
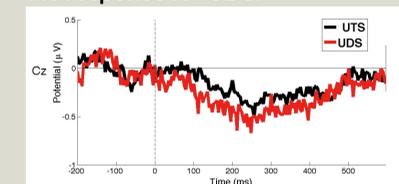
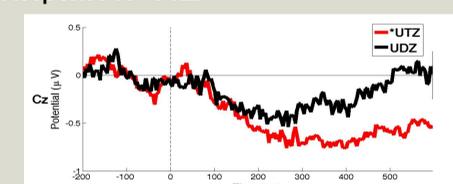
- Unable to replicate findings of Monahan et al. (2009): response to incongruent stimuli supports underspecification of voiced, not voiceless consonants.
- Compared to behavioral results, ERP finding suggests that this measure may be useful for detecting sensitivity to phonotactic violation at an earlier 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

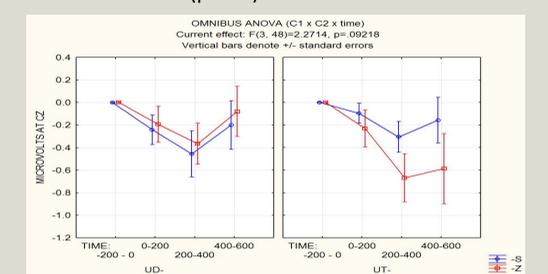
- Sensitivity to phonotactic violation is detectable at early stages of processing, though as in previous studies an asymmetry was observed in the direction of the incongruency.
- Previous study found a significant effect only for coronals, and the current results found (non-significant) differences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

## UNDERSPECIFICATION

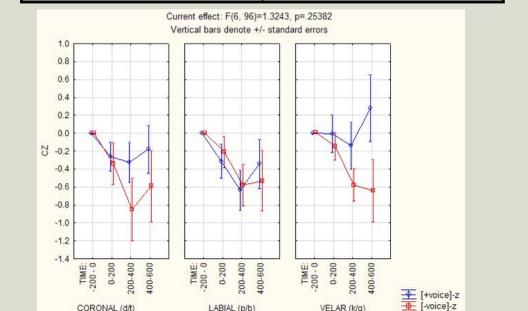
	-Z $\left\{ \begin{matrix} ub \\ ud \\ ug \end{matrix} \right\} \xrightarrow{\text{predicts } z} (*s)$		-S $\left\{ \begin{matrix} up \\ ut \\ uk \end{matrix} \right\} \xrightarrow{\text{predicts } s} (*z)$	
Empirically (surface phonetics):				
<b>Hypothesis 1:</b> /t/ is underspecified, and /d/ is specified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



Congruent  
Incongruent



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



## 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*.

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