Word and pseudoword processing in the ventral stream

Emily Cibelli, Matthew Leonard, Keith Johnson, Edward Chang
University of California, Berkeley, University of California, San Francisco

Introduction
Neural representations of pseudowords have been studied extensively ([1], [2], [3]), but questions remain about their interaction with the mental lexicon and the degree to which they share or diverge from pathways activated by real words.

Study questions
1. Are differences between word and pseudoword listening observable in temporal lobe activity, and what are the temporal dynamics of those differences?
2. Does the structure of the lexicon mediate word and pseudoword responses along the ventral stream ([4], [5])? As speech unfolds, how does the set of possible lexical forms constrain activity?

Methods
Data: ECoG recordings (high-γ band) from temporal lobe electrodes. 4 subjects; 3 left-hemisphere, 1 right-hemisphere (all language-dominant).
Task: Listening task with long words and phonologically-matched pseudowords (Wilson and Gorno-Tempini), e.g.: ceremony [sɛrəmoni] moanaserry [moˈnasəri] repetition [repəˈtiʃən] piteretion [pɪˈterəʃən]

Analysis
- Spectrotemporal receptive fields (STRFs): model acoustic tuning
- Linear mixed-effects models using growth curve analysis (GCA, [6]) fit to difference of high-y activity – STRF prediction in each electrode
- GCA predictors: Lexicality, cohort size, cohort frequency (residualized by lexicality), 1st – 4th order time terms; interaction of lexical predictors * time terms, interaction of lexicality * cohort size, lexicality * cohort frequency; random effect of stimulus identity

Discussion
1. The timing of differences in response to words and pseudowords varies across the course of listening, as well as across temporal lobe sites. (figures 1, 2, 5) Observed magnitude differences between words and pseudowords depend both on cortical location and on time in the trial.
2. Stored information from the lexicon – cohort size and cohort frequency – mediates responses in the ventral stream, with varying effects at posterior and anterior sites. (figures 2, 4)
3. This data suggests that ventral stream processing relies on stored lexical information, not just sequential phonemic recognition, both for stored lexical items and phonotactically-legal novel wordforms.

References

Acknowledgments: This work has benefited from advice, support, and suggestions from Angela Ren, Connie Cheung, Nima Mesgarani, Kris Bouchard, Stephen Wilson, Susanne Gahl, Shinae Kang, Clara Cohen, Dan Mirman, and members of the UCSF Speech Neurophysiology Lab and the UC Berkeley Phonology Lab.