

“Laurel & Yanny”: EEG Neural Correlates of an Auditory Bistable Language Stimulus

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Background & Rationale

- Previous EEG studies found a reversal negativity (RN) and late positive component (LPC) linked with perceptual reversals of visual bistable stimuli [1] [2].
- Auditory counterparts (aRN, aLPC) have recently been found for reversals of bistable pitch motion direction [3].

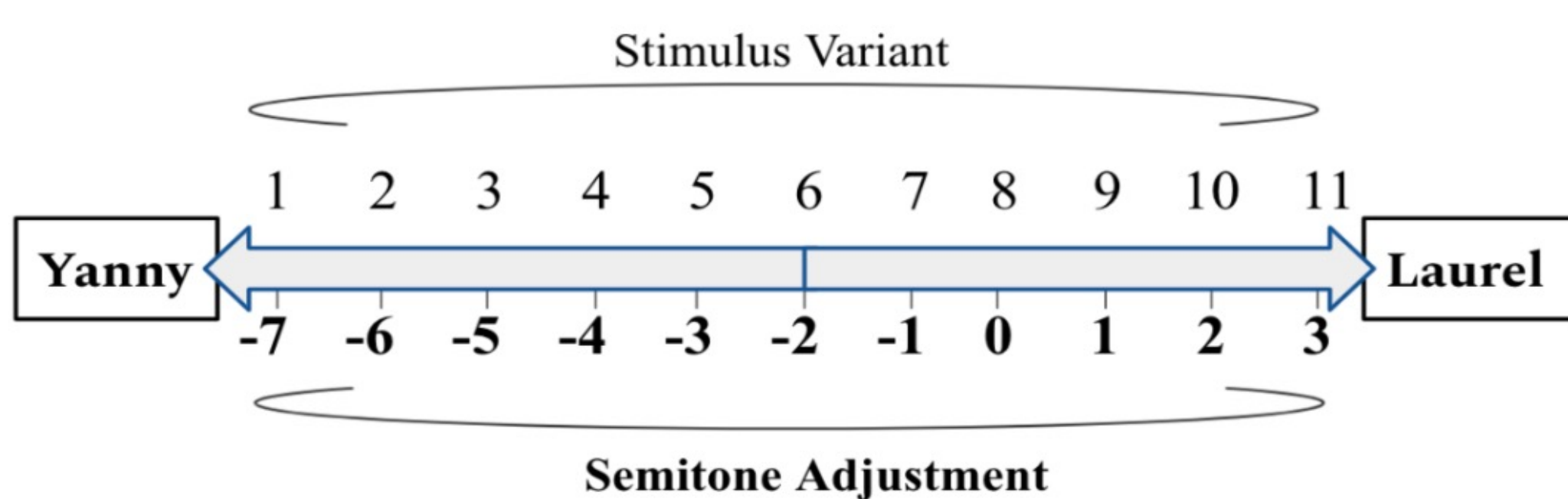
Question:

Will aRN and aLPC be evident for perceptual reversals of the bistable language stimulus: “Laurel & Yanny”?

Methods

Behavioral Pretest (N = 31)

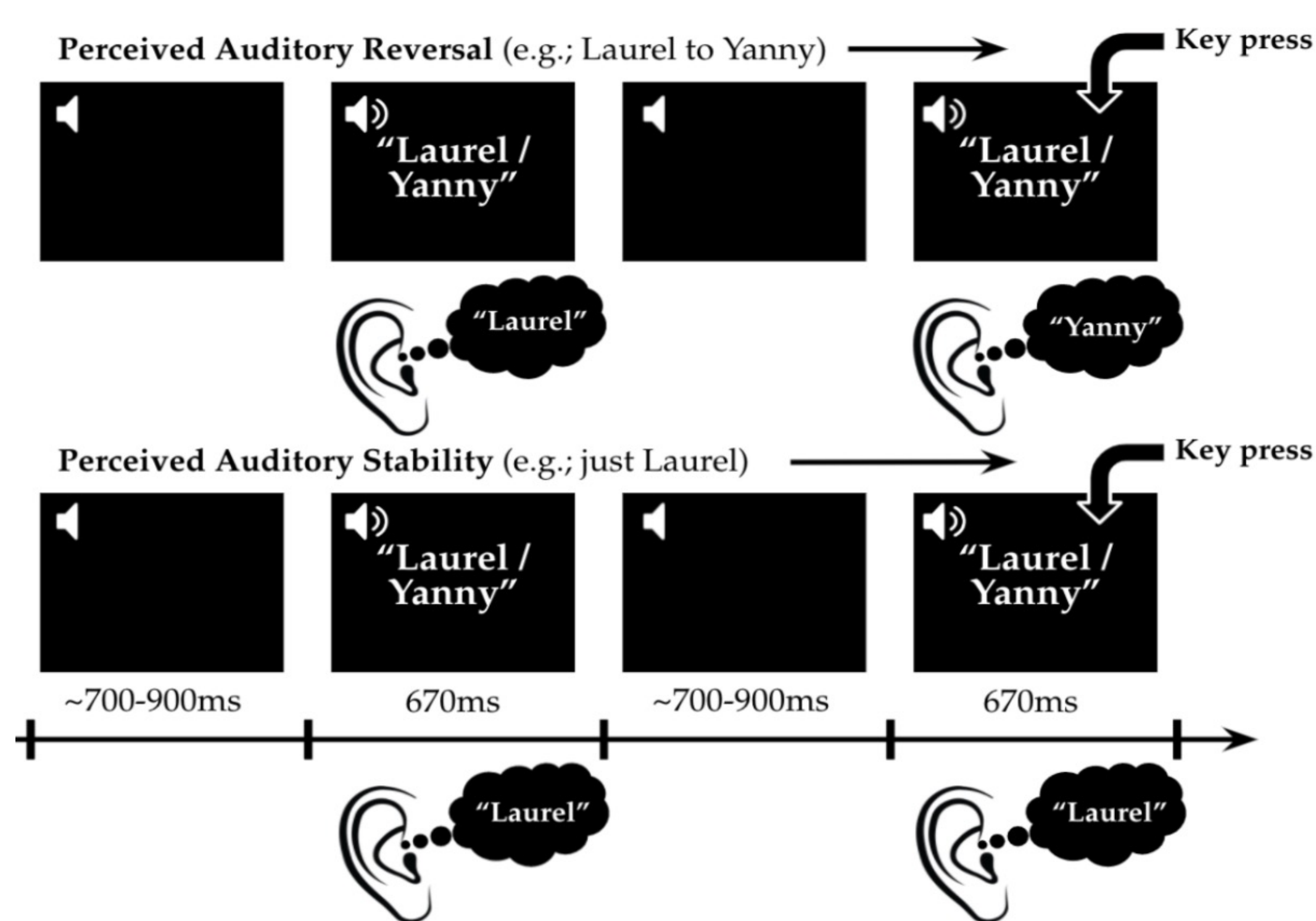
- Goal: Identify each participant’s maximally bistable stimulus for use in the EEG experiment & screen-out participants who experience too few reversals.
- Stimuli: 11 Laurel/Yanny variants with distinct frequencies, each one semitone apart. Each variant was played 25 times in a row in separate blocks. The blocks were presented in a random order.



- Task: report percept (Laurel, Yanny, or mixture/unsure) after each stimulus.

EEG Experiment (N = 19)

- Stimulus: Laurel/Yanny variant deemed most bistable in the pre-test.
- Task: same as pre-test (2 response buttons: Laurel, Yanny; withhold response if mixture/unsure).
- 80 trials per block, 12 blocks, 960 trials total.

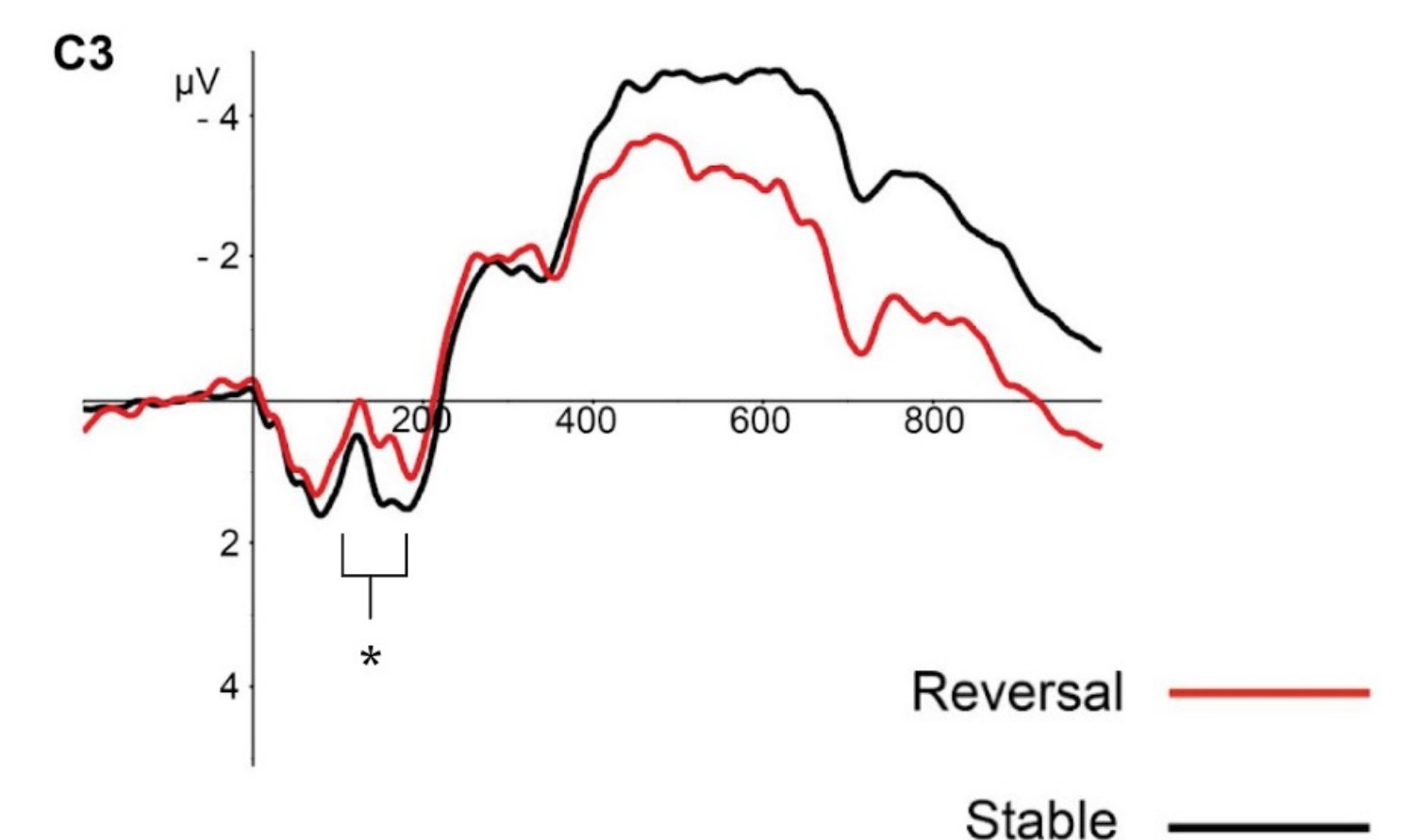
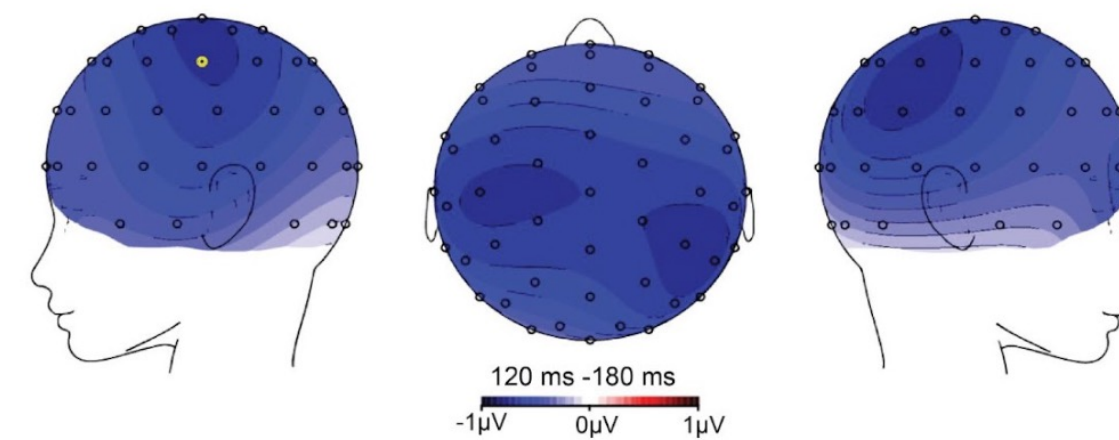


- 64 channel EEG
- 500Hz sampling rate
- time-locked to stimulus onset
- averaged mastoid reference

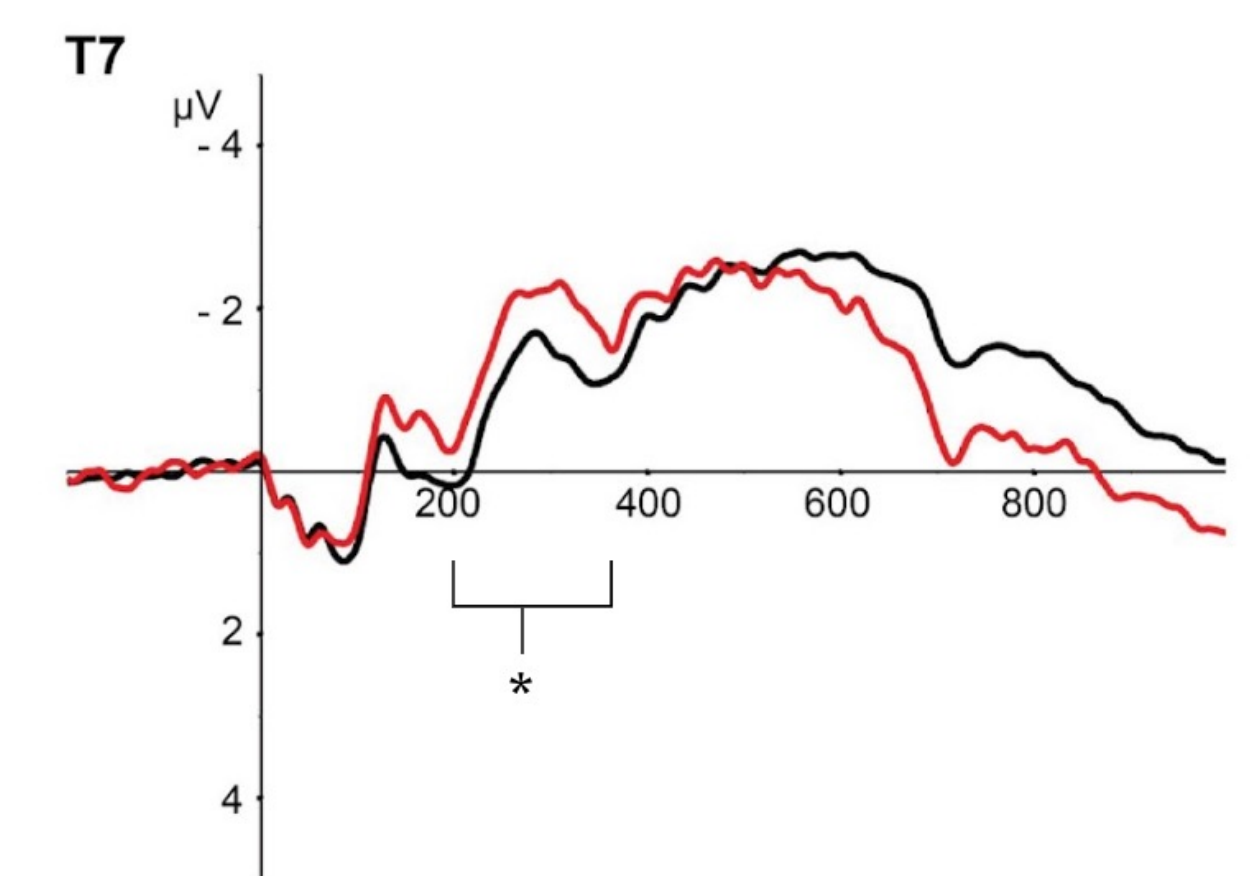
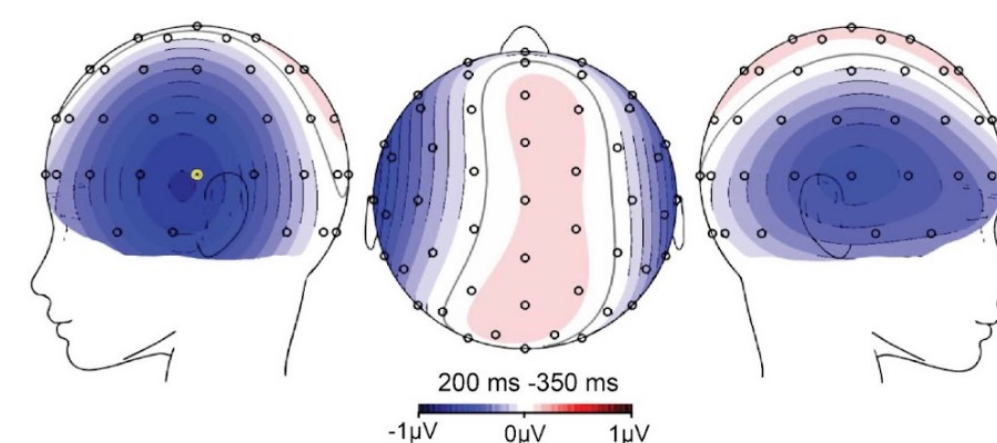
Results

Three differences were found between perceptual reversals & stability:

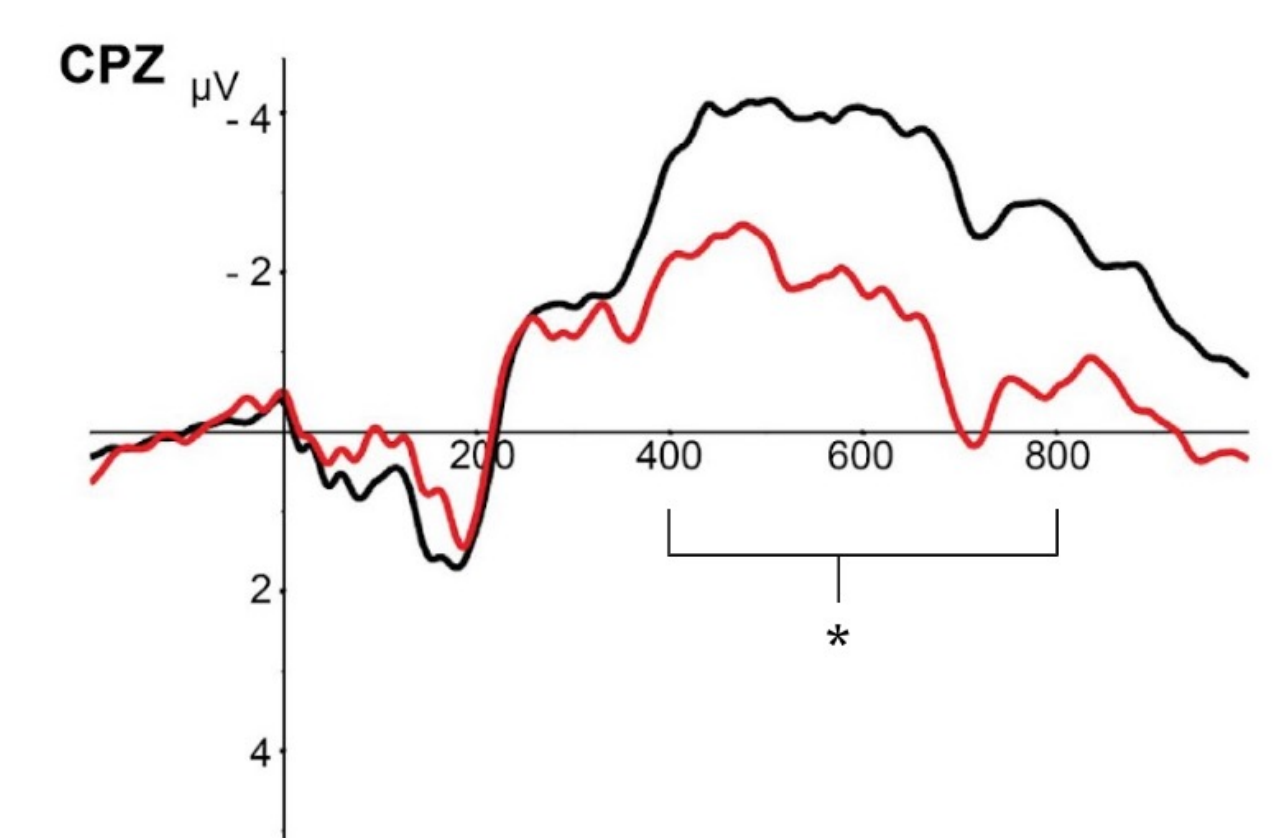
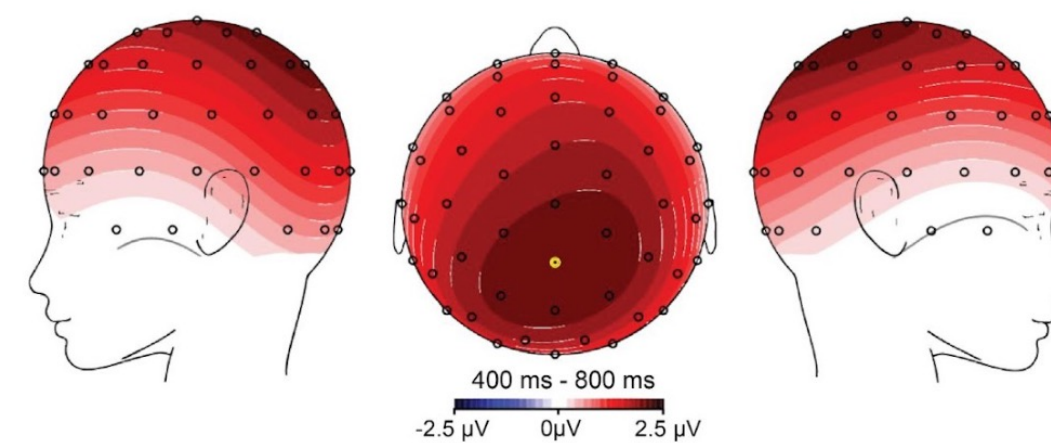
MMN-like effect: 120-180 ms



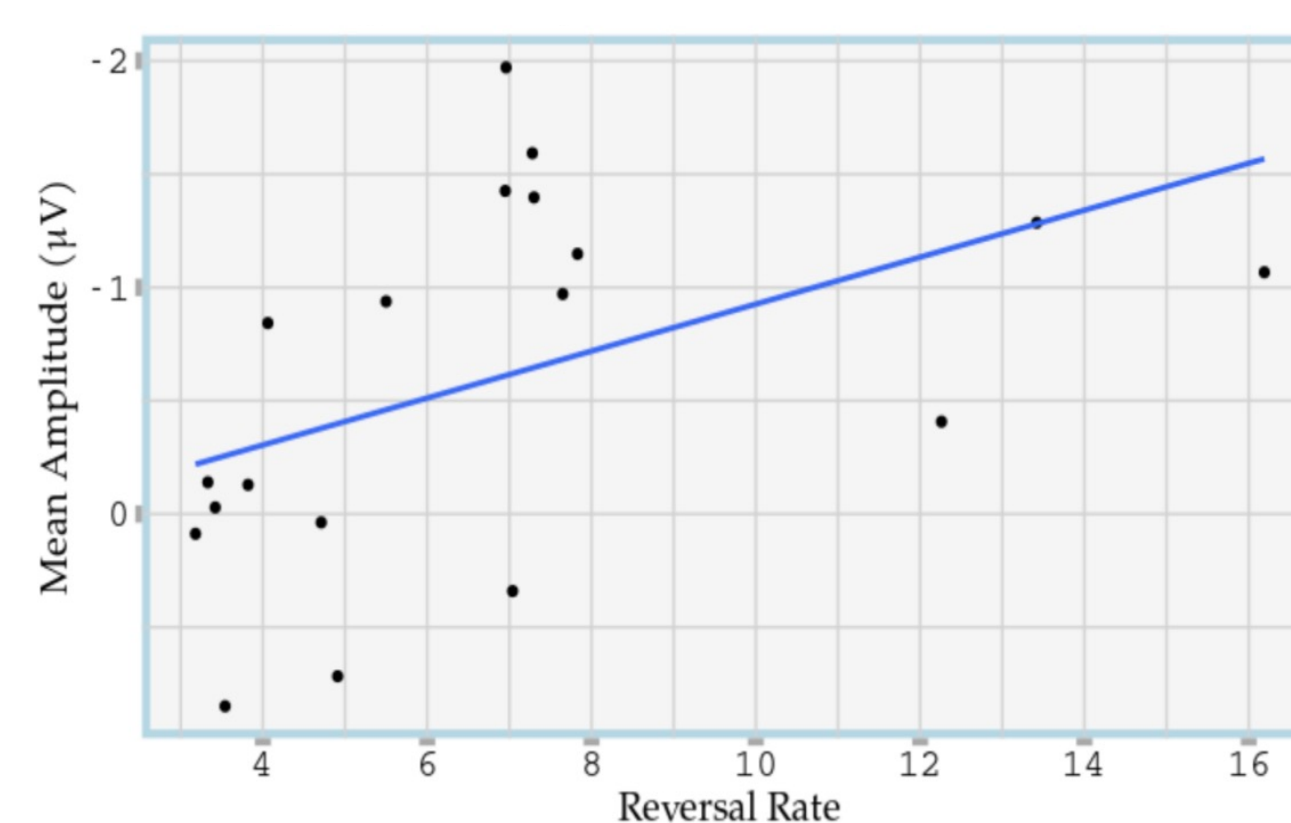
aRN: 200-350 ms



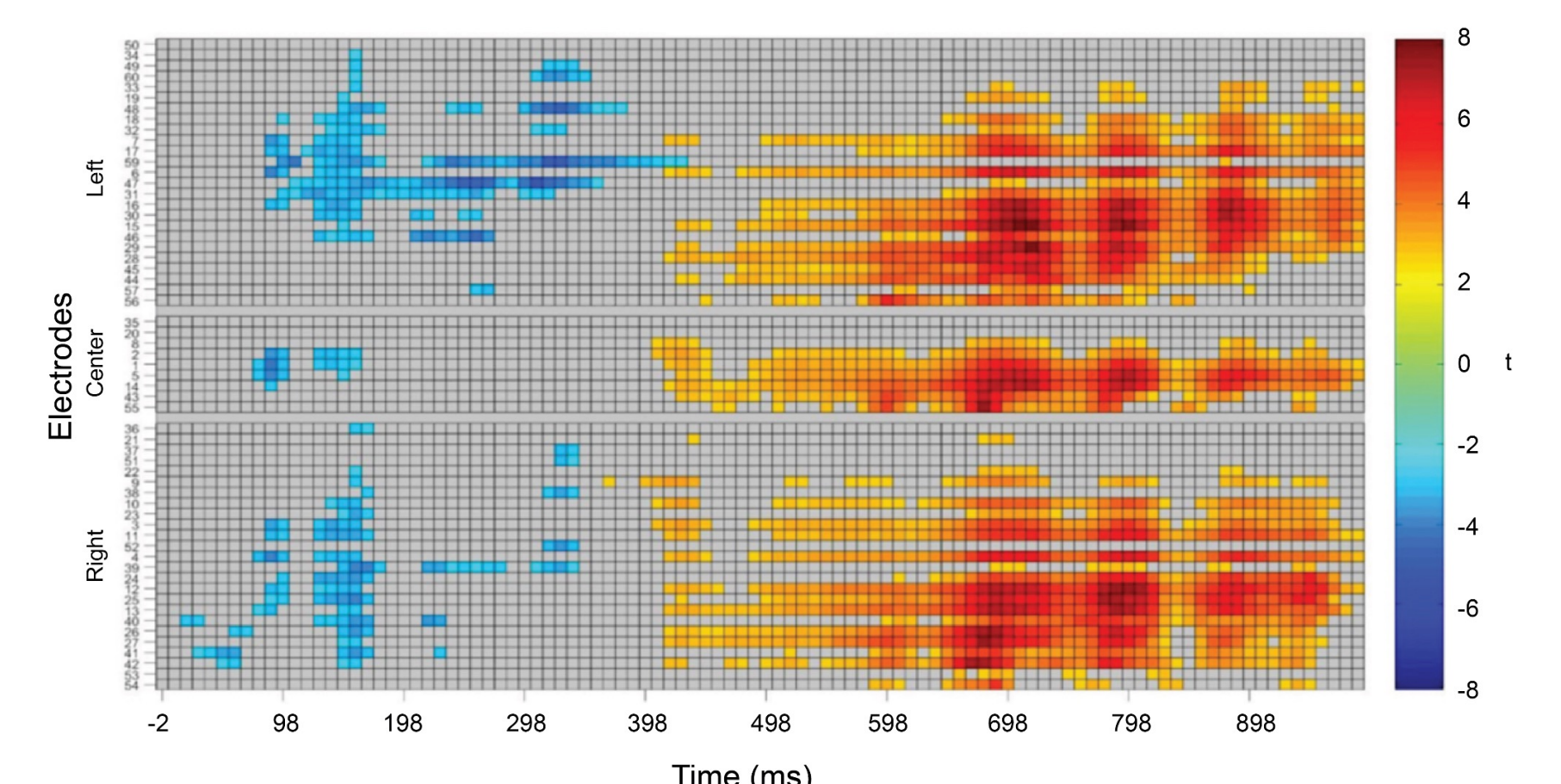
aLPC: 400-800 ms



MMN-like effect: mean amplitude x reversal rate



Mass Univariate Analysis (FDR)



Summary & Open Questions

- aRN & aLPC appear to be auditory analogs of the visual RN & LPC.
- The aRN for Laurel/Yanny was later and more left-lateralized compared to the aRN for bistable pitch motion [3]. aLPC was very similar across studies.
- A mismatch negativity (MMN) was elicited by perceptual reversals, and was larger when reversals were more rare (participants with slower reversal rates) [4].
- Does the MMN reflect an early (pre-conscious) registration of perceptual deviance, while the aRN indexes the experienced change in conscious perception?
- Is the LPC more linked with the perceptual report task than reversals *per se*, i.e., would the LPC disappear in a no-report paradigm?

References

- [1] Kornmeier, J., & Bach, M. (2004). Early neural activity in Necker-cube reversal: evidence for low-level processing of a gestalt phenomenon. *Psychophysiology*, 41(1), 1–8.
- [2] Abdallah, D., & Brooks, J. L. (2020). Response dependence of reversal-related ERP components in perception of ambiguous figures. *Psychophysiology*, 57(12), e13685.
- [3] Davidson, G. D., & Pitts, M. A. (2014). Auditory event-related potentials associated with perceptual reversals of bistable pitch motion. *Frontiers in human neuroscience*, 8, 572.
- [4] Näätänen, R., Lehtokoski, A., Lennes, M., Cheour, M., Huotilainen, M., Ilmoniemi, R. J., Luuk, A., Allik, J., Sinkkonen, J., & Alho, K. (1997). Language-specific phoneme representations revealed by electric and magnetic brain responses. *Nature*, 385(6615), 432–434.