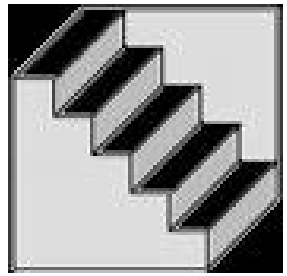
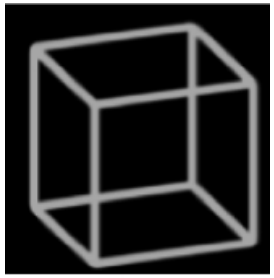
Isolating neural signatures of conscious perception with perceptually bistable stimuli

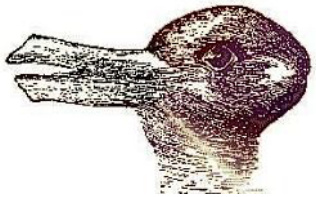
Michael Pitts, Gray Davidson, & Phoebe Bauer

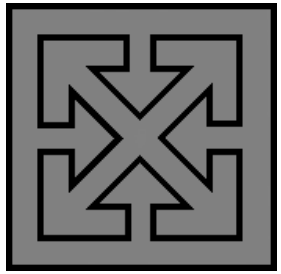
Psychology Department

Reed College





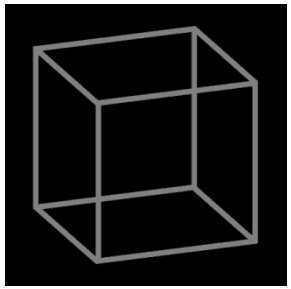


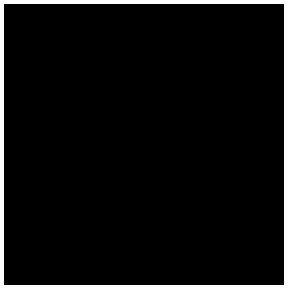


CSAIL 2016

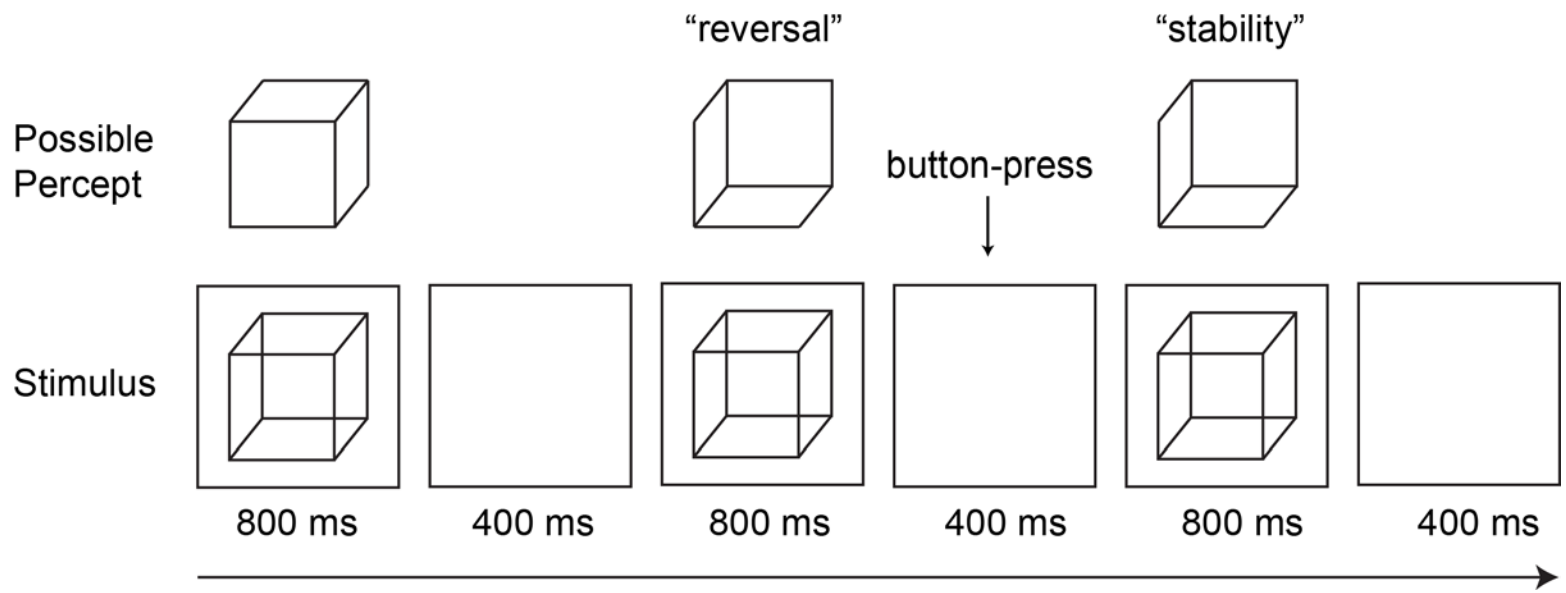
How to measure brain activity during bistable perception

- Stimuli: static
- Task: press button when perception changes
- Analyze brain activity just prior to button-press. (Basar-Eroglu et al., 1993)
  - ERPs: broad positive wave (P3-like) preceding button-press

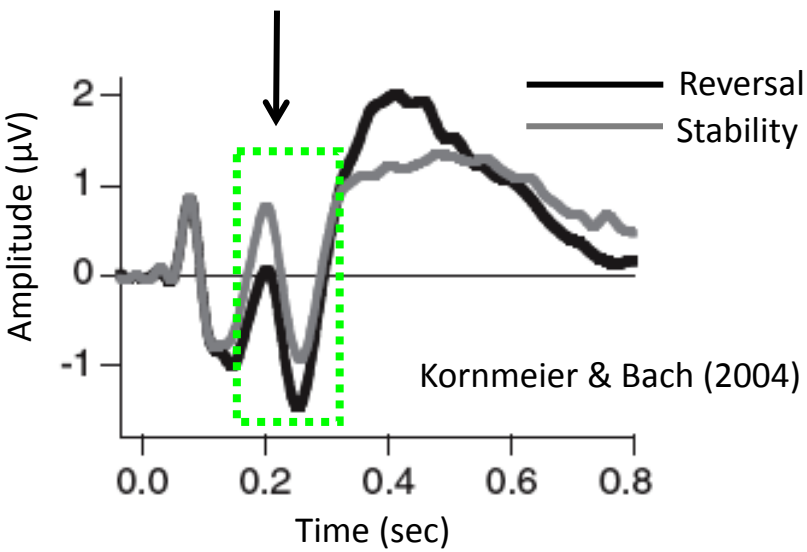




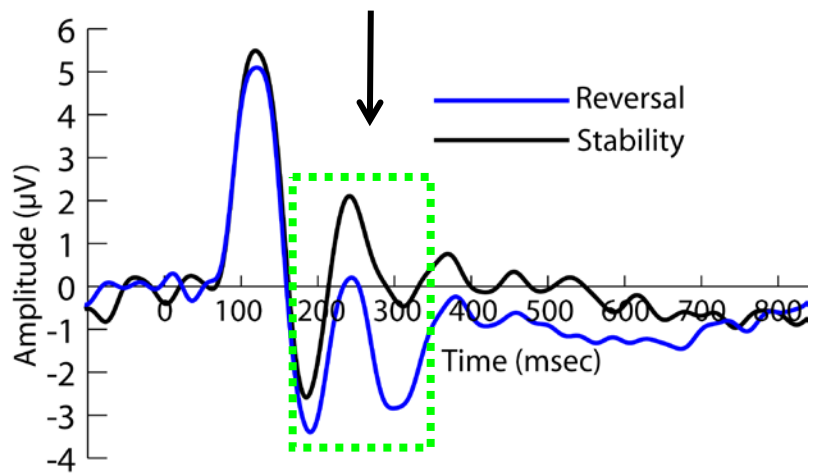
- Stimuli: intermittent
- Task: press button when perception changes
- Analyze brain activity elicited by stimulus. (Kornmeier & Bach, 2004)
  - ERPs: compare perceptual change (“reversal”) vs. no-change (“stability”)



"reversal negativity" (RN)

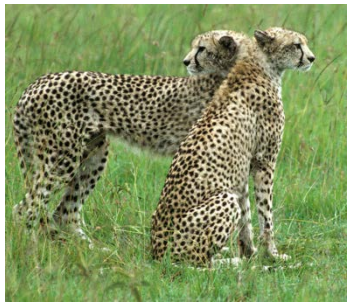


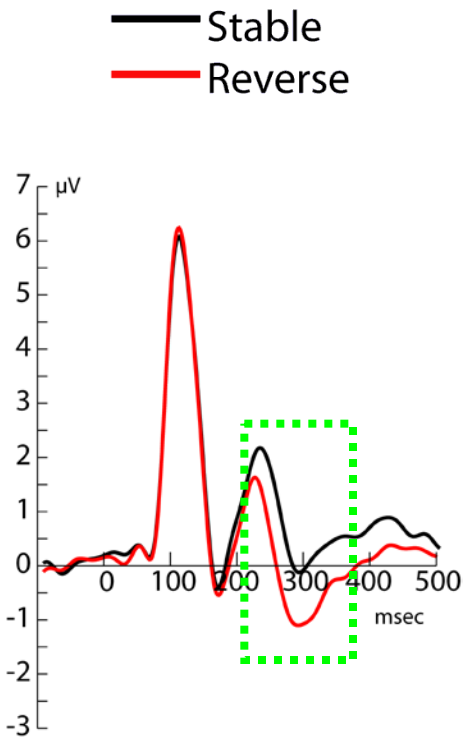
"reversal negativity" (RN)

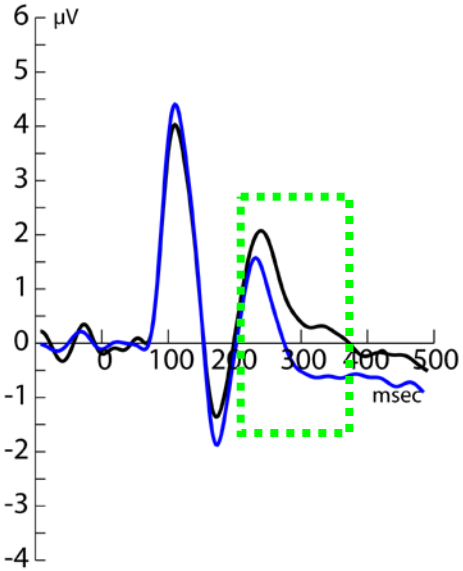


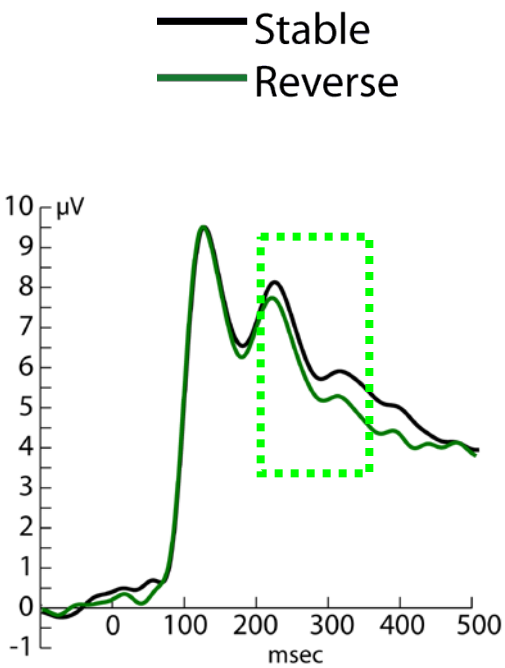
*also late positive component (LPC)

Will the RN generalize to other bistable stimuli?



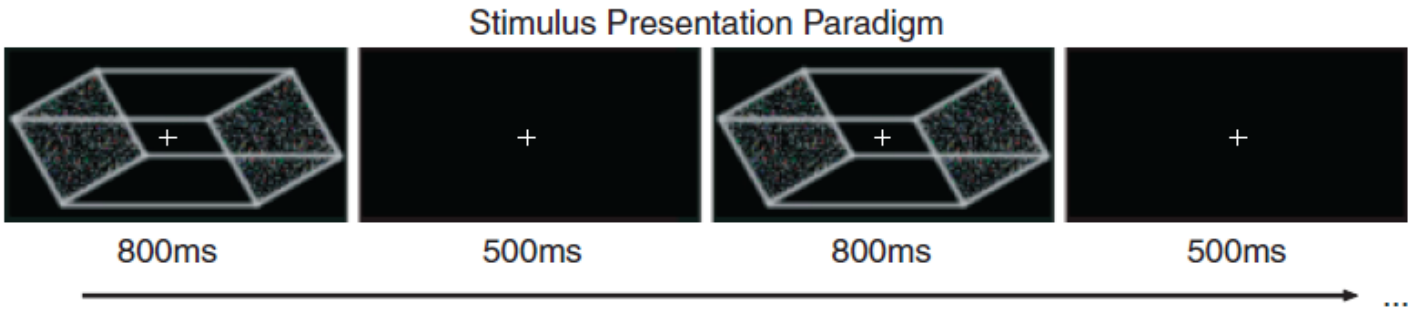




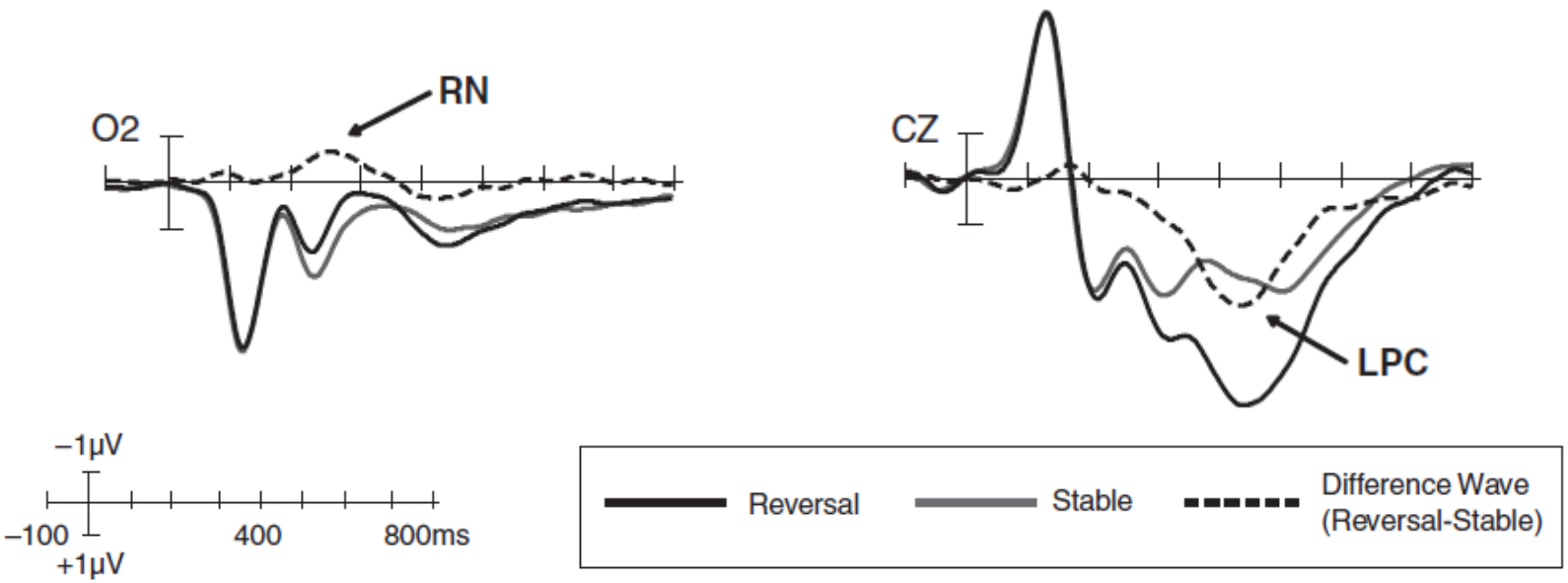


Pitts, Davis, & Nerger (2007) *Journal of Vision*

Are the ERP effects (RN & LPC) related to perceiving or reporting the change?



Task: report percept on each trial (instead of reporting perceptual switches)



Pitts et al. (2009) *Psychophysiology*

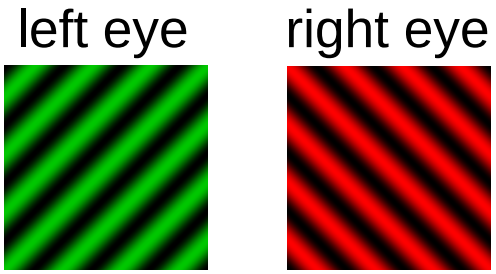
Possible contrasts in bistable perception studies

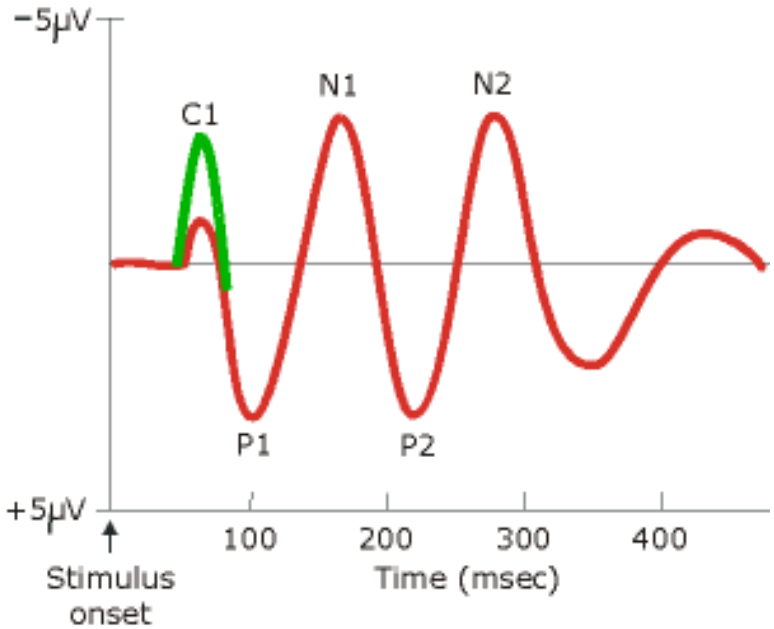
- reversal vs. stability
  - neural correlates of *change* in conscious perception

    [control condition: physical alternation]
- percept A vs. B
  - neural correlates of conscious *content*

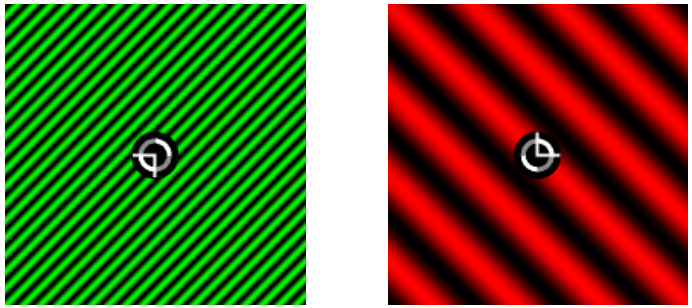
    [control condition: physical alternation]
- ~~bistable perception vs. physical alternation ("replay")~~
  - ~~neural correlates of ambiguity/conflict?~~

Binocular rivalry: percept A vs. B





- C1 = afferent input to V1
- C1 amplitude ↑ for high spatial frequencies



Pitts, Martinez, & Hillyard (2010) *Journal of Vision*

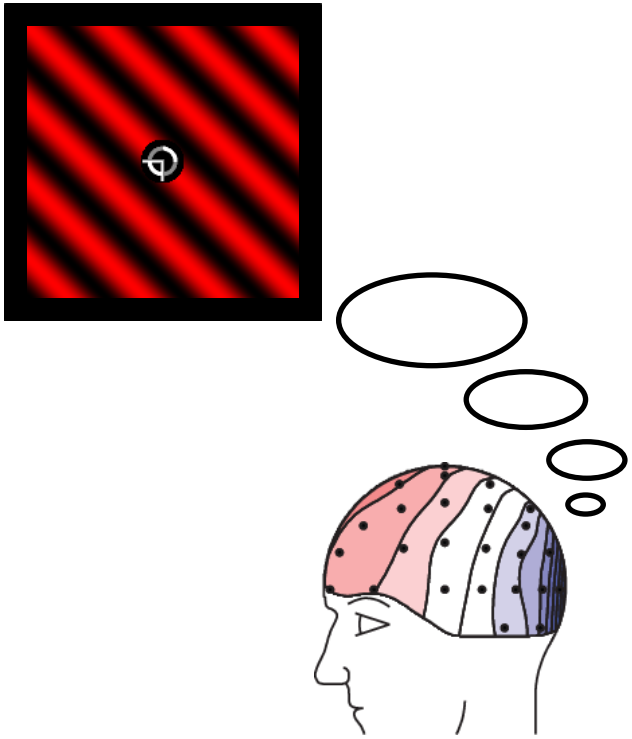
Binocular rivalry: percept A vs. B

Physical Alternation

left eye

right eye

percept



Task: Do you see Red or Green?

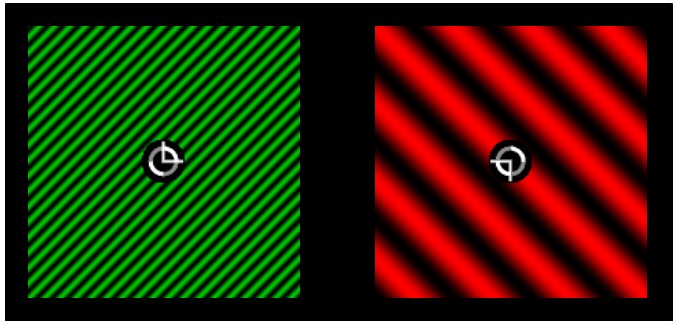
Pitts, Martinez, & Hillyard (2010) *Journal of Vision*

Binocular rivalry: percept A vs. B

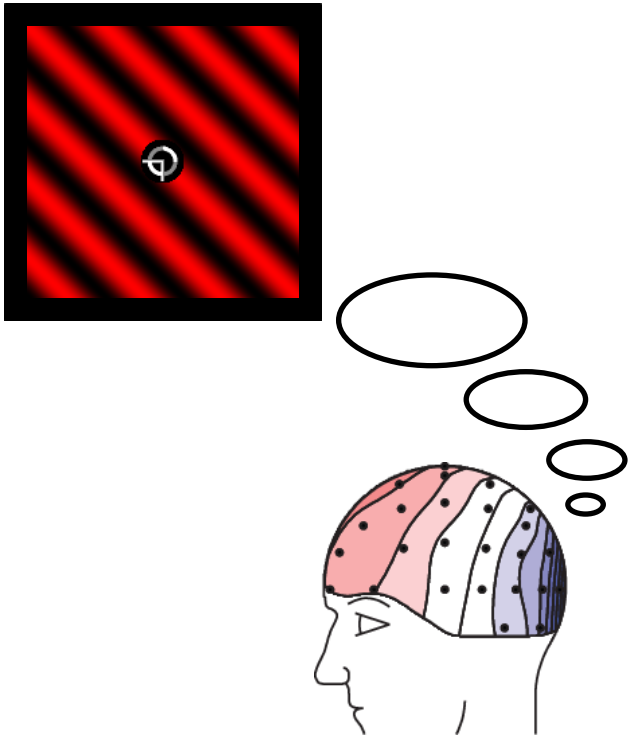
Binocular Rivalry

left eye

right eye



percept



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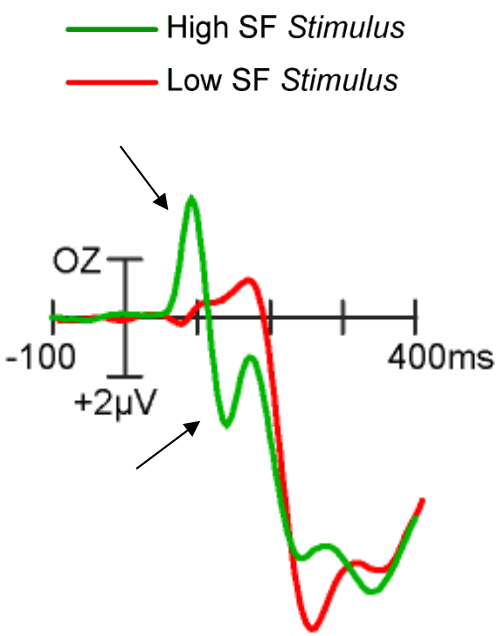
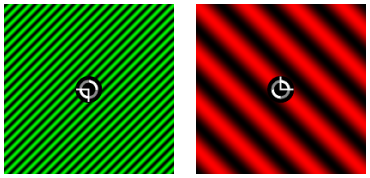
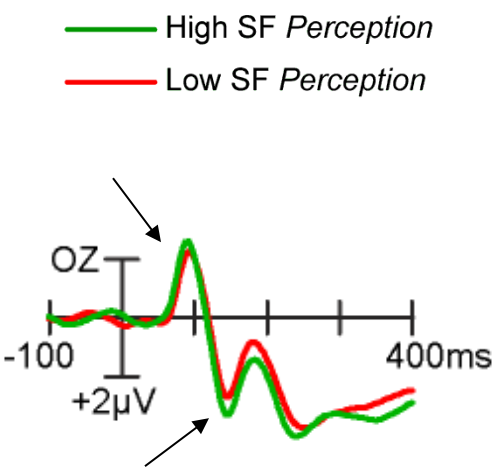
Physical Alternation

Binocular Rivalry

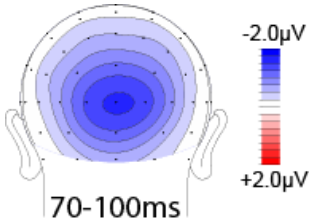


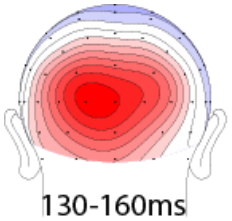




afferent input-to-V1

feedback-to-V1





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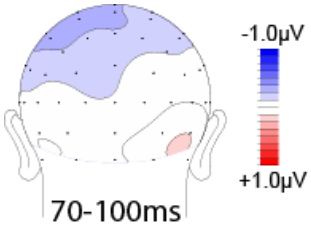
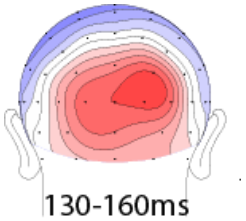
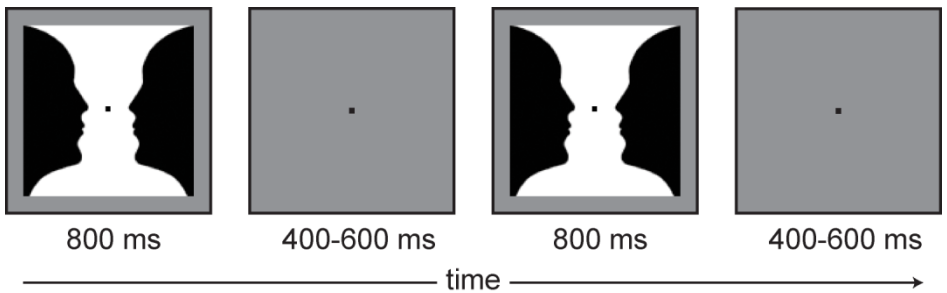


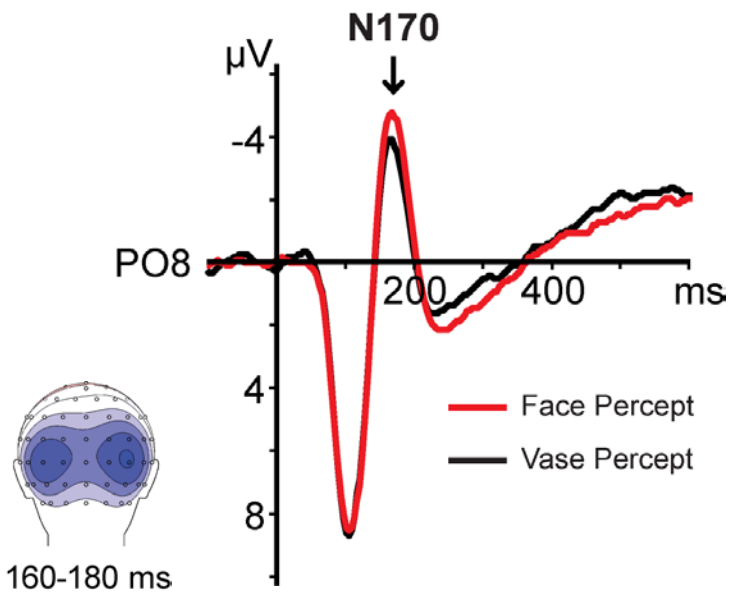


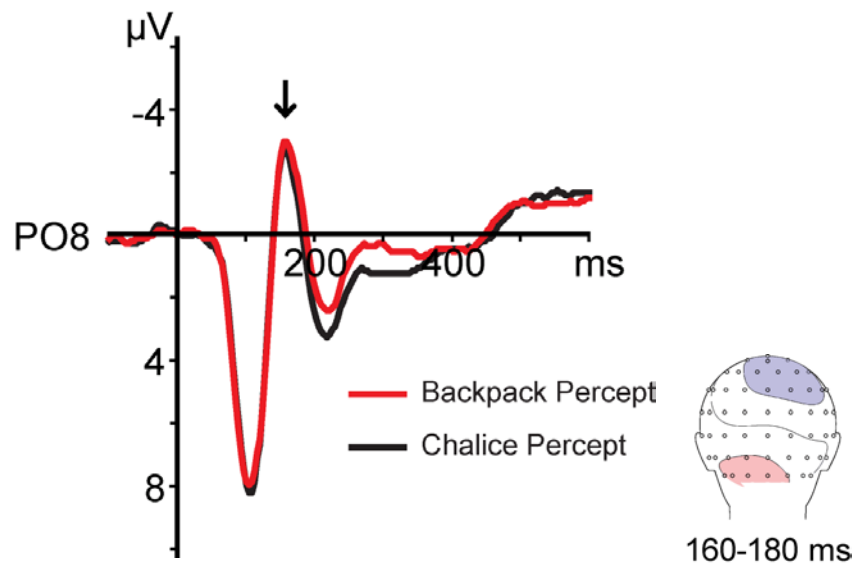
Pitts, Martinez, & Hillyard (2010) *Journal of Vision*

Face-vase: percept A vs. B



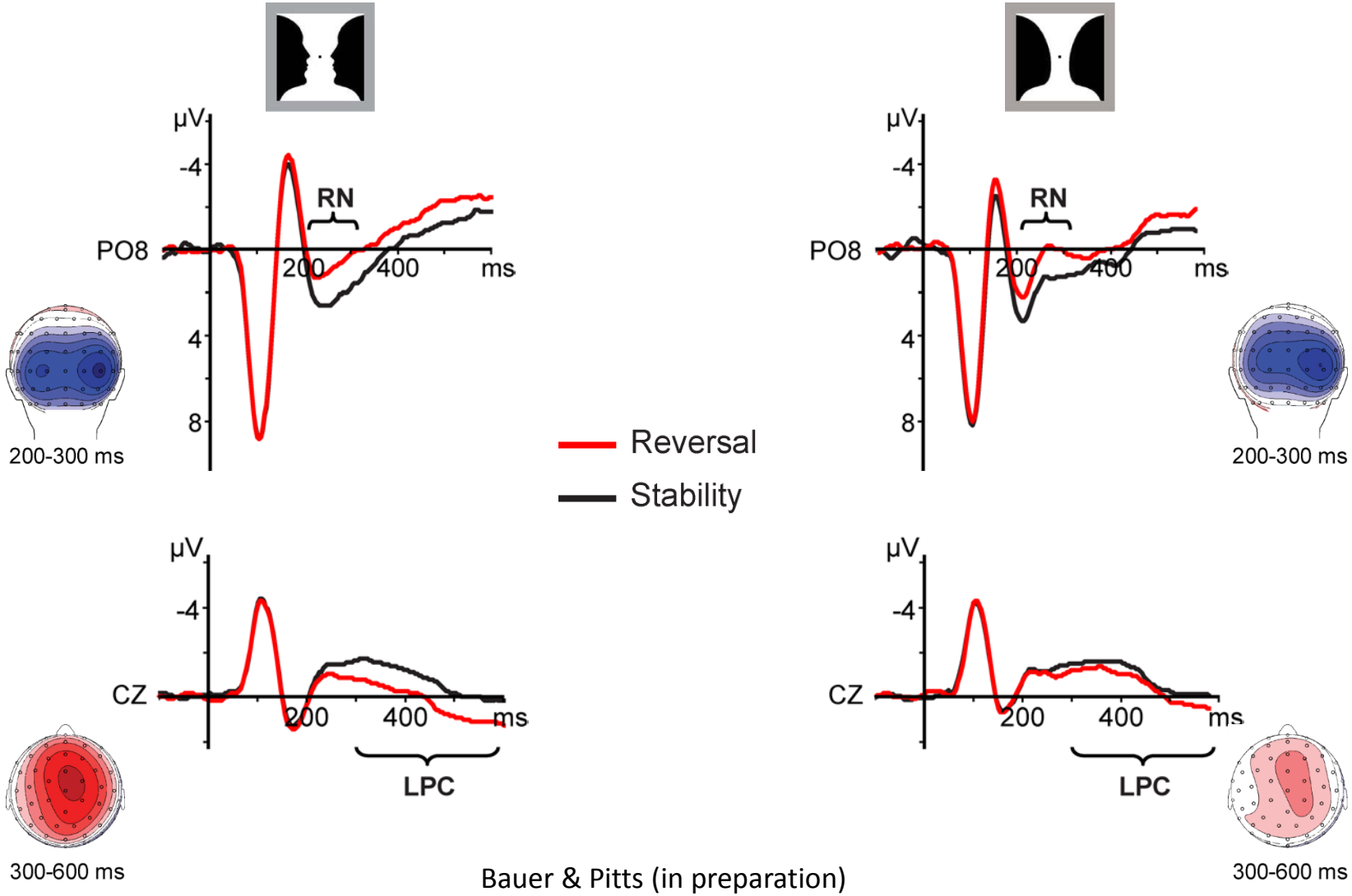
"backpack-chalice"





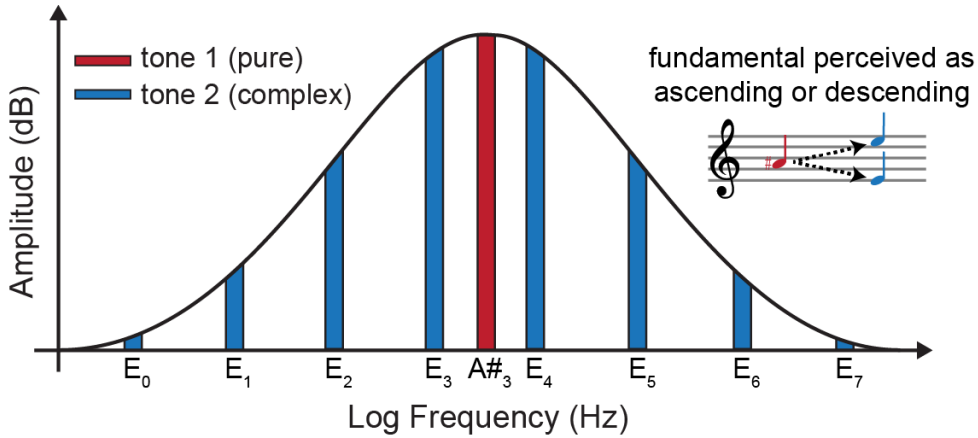
Bauer & Pitts (in preparation)

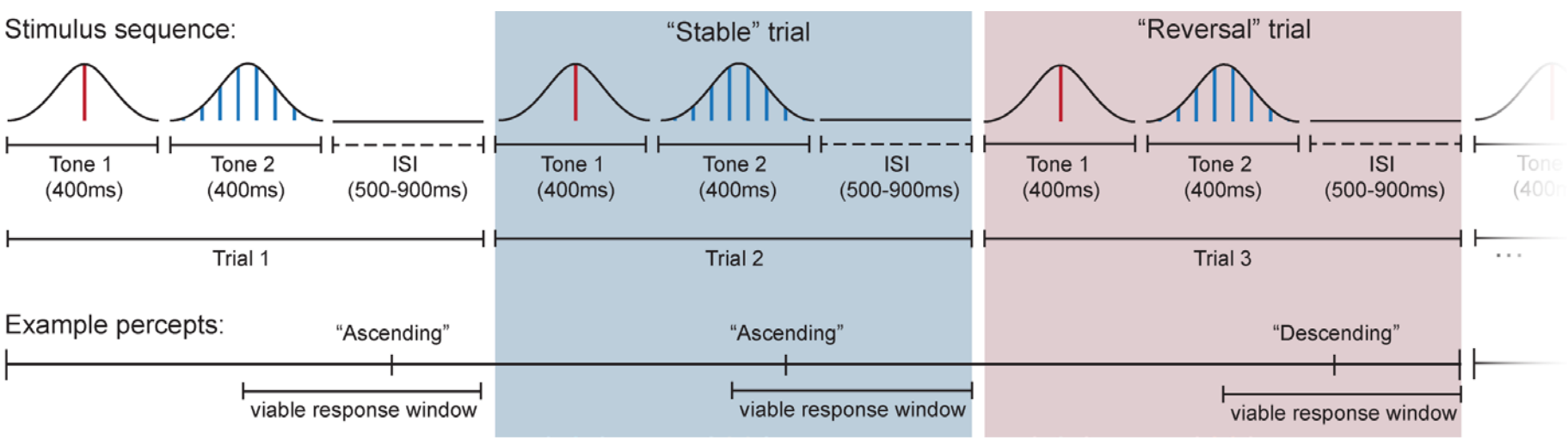
Face-vase: reversal vs. stability



Bauer & Pitts (in preparation)

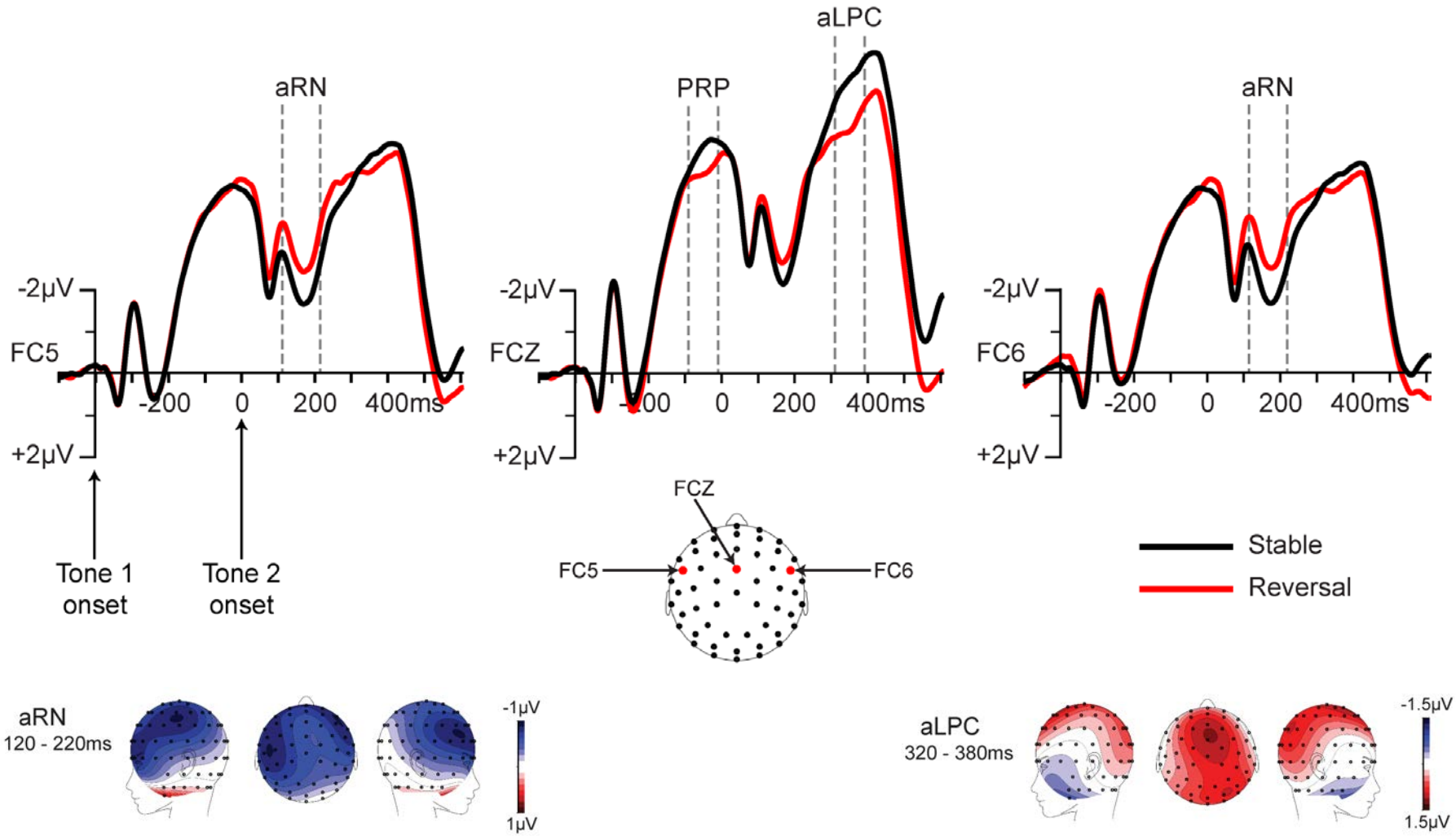
Auditory bistable perception?





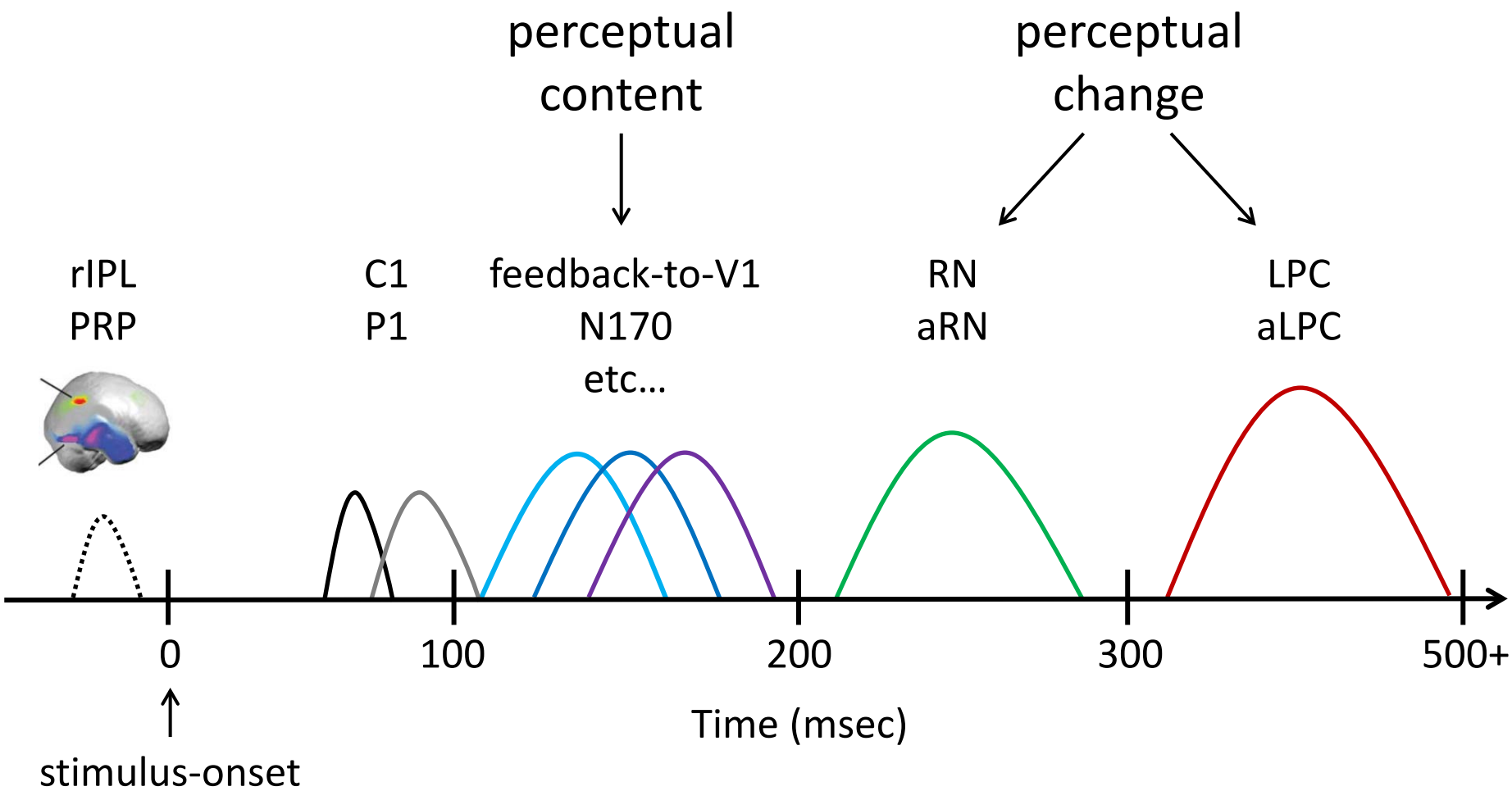
Davidson & Pitts (2014) *Frontiers in Human Neuroscience*

Auditory bistable perception!

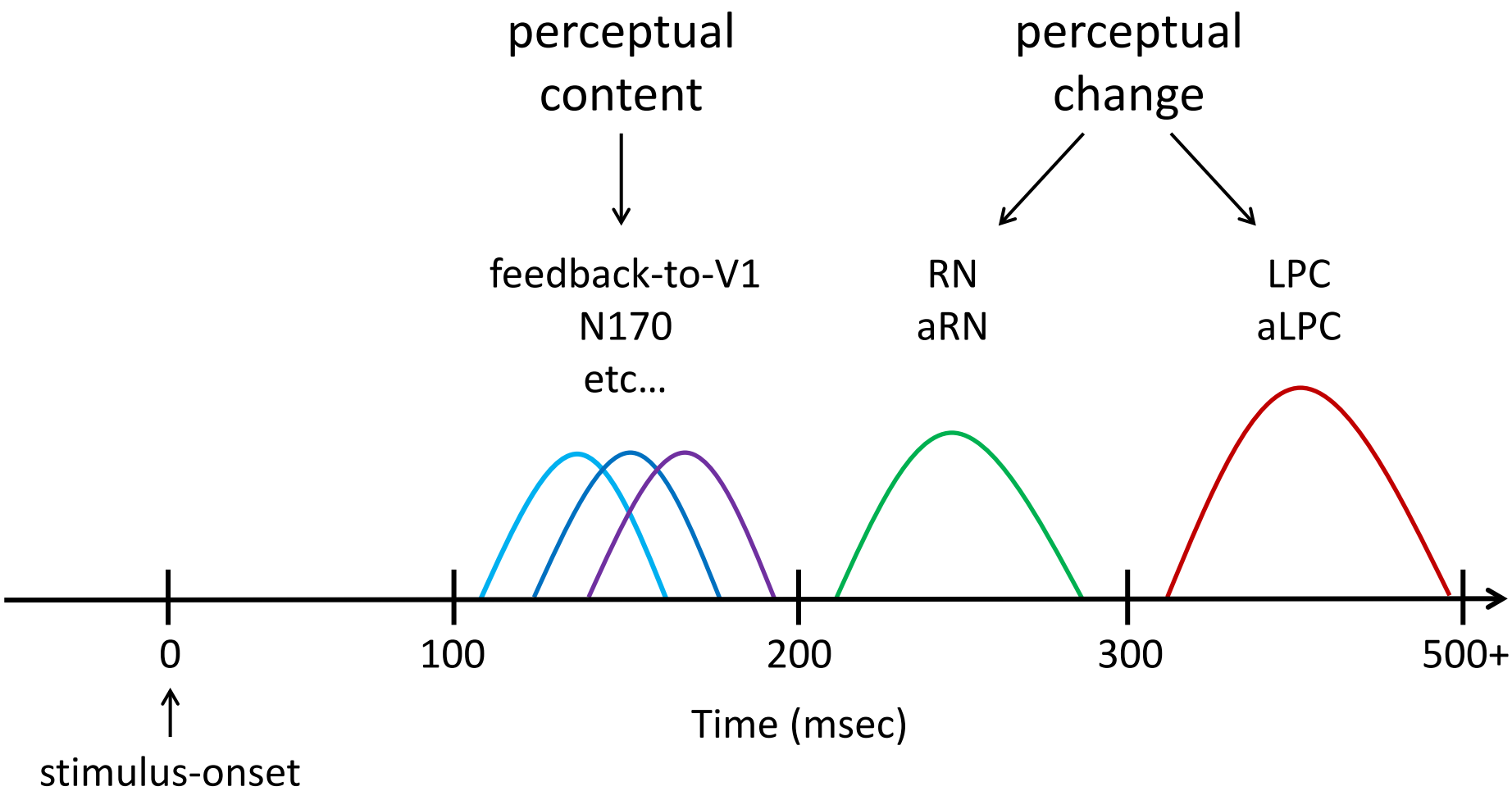


Davidson & Pitts (2014) *Frontiers in Human Neuroscience*

Results summary: stages of processing

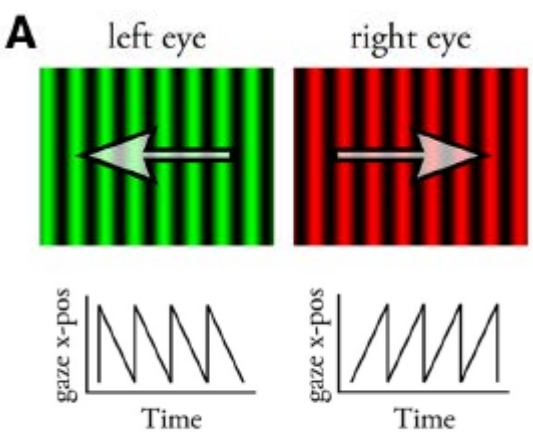


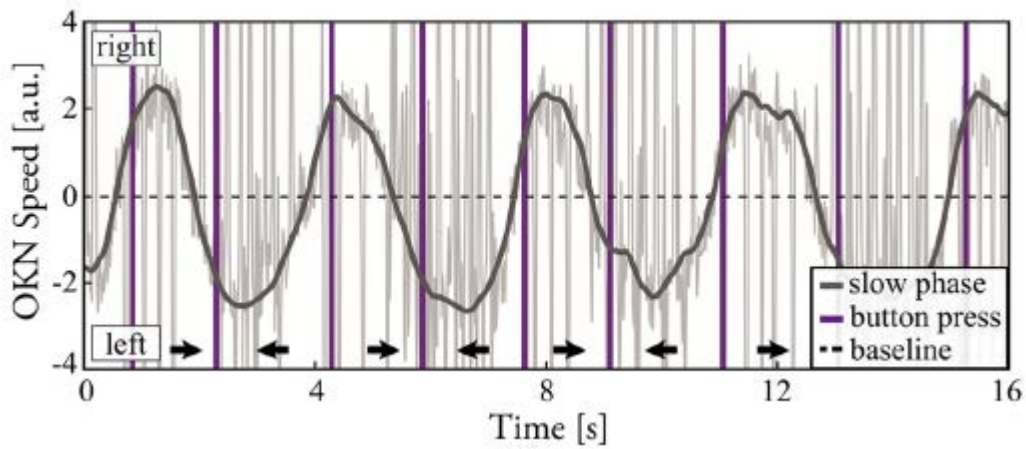
At which stage of processing does perceptual awareness arise? Which are candidate NCCs?



Neural correlates of consciousness or reporting?

- "no-report" paradigms - Tsuchiya et al. (2015) *Trends in Cognitive Sciences*
  - many studies of conscious perception → reporting-task confounds
- binocular rivalry without report - Frässle et al. (2014) *Journal of Neuroscience*
  - set competing stimuli in motion, in opposite directions
  - measure eye movements (optokinetic nystagmus, "OKN")
  - verify OKN in report condition, then use in no-report condition





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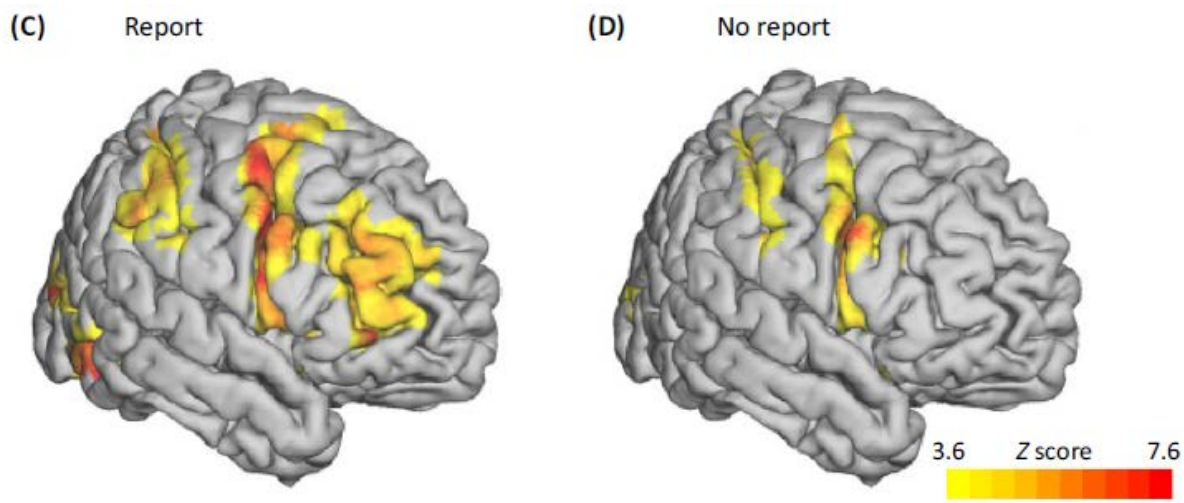
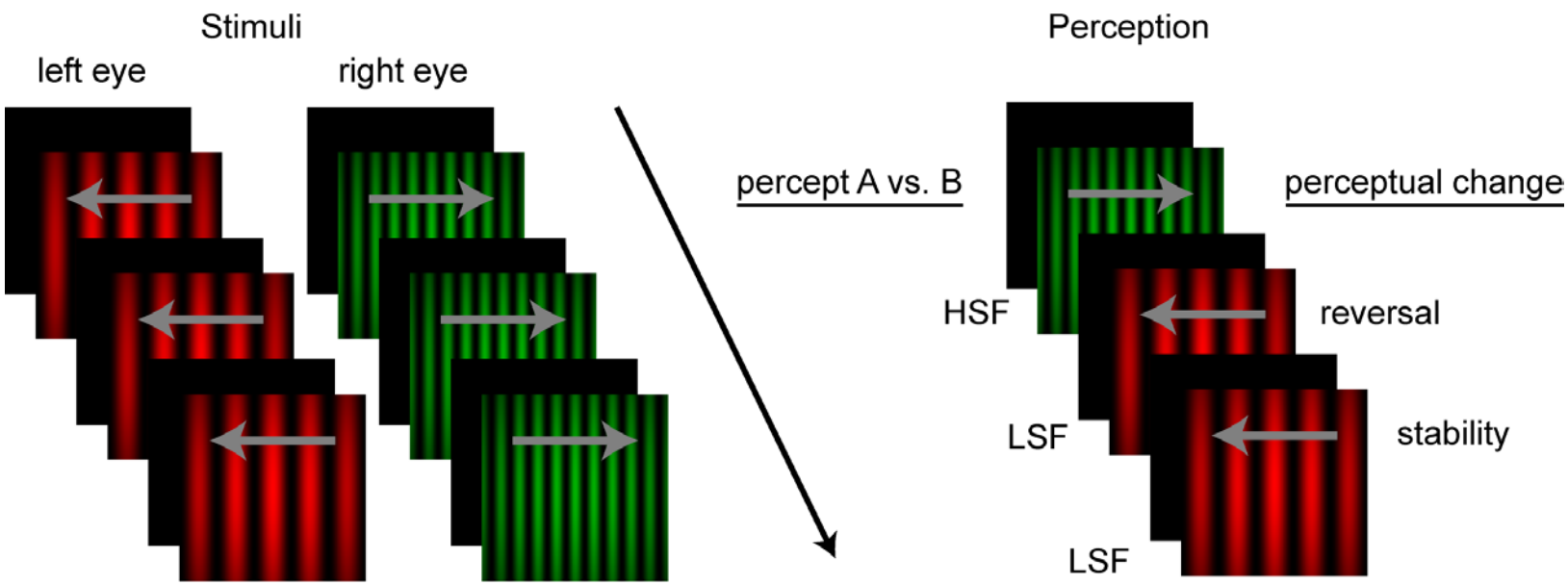


Next steps…

- Combine Frässle et al.'s OKN method with our rivalry paradigm
  - high SF vs. low SF & reversal vs. stability



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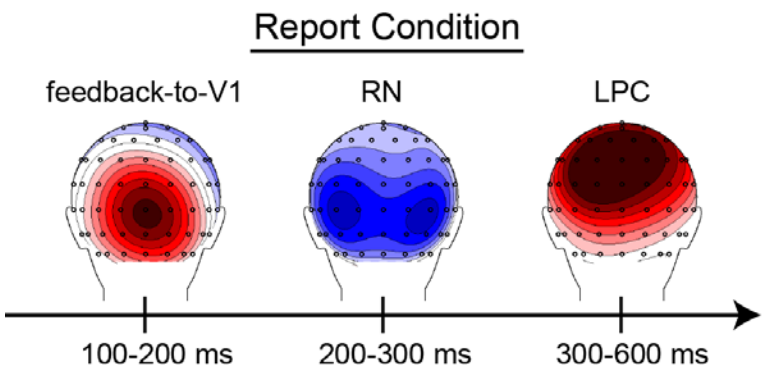
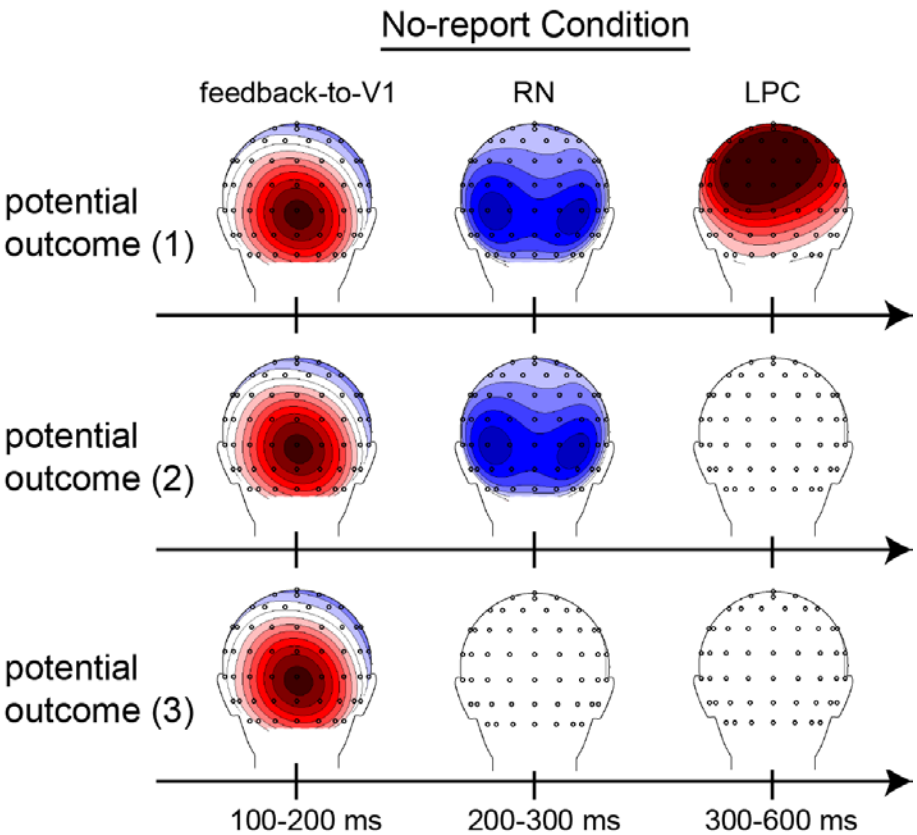




Thank you!

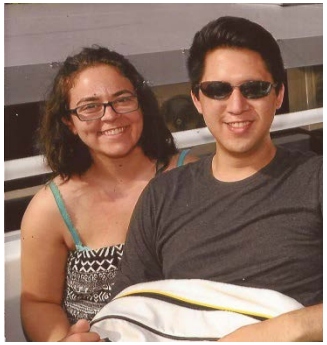
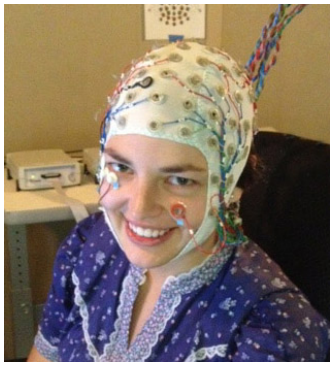
Collaborators:

- Steve Hillyard
- Antígona Martínez
- **Phoebe Bauer**
- **Gray Davidson**
- **Clea Stalmaster**
- **Trevor Davis**
- Jan Nerger

Funding:

- NIMH
- NSF
- Reed College

SCALPLAB

Sensation Cognition Attention Language Perception

www.reed.edu/psychology/scalp