Neural Processes Underlying Context-Sensitive Cognitive Flexibility Adjustments

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Background

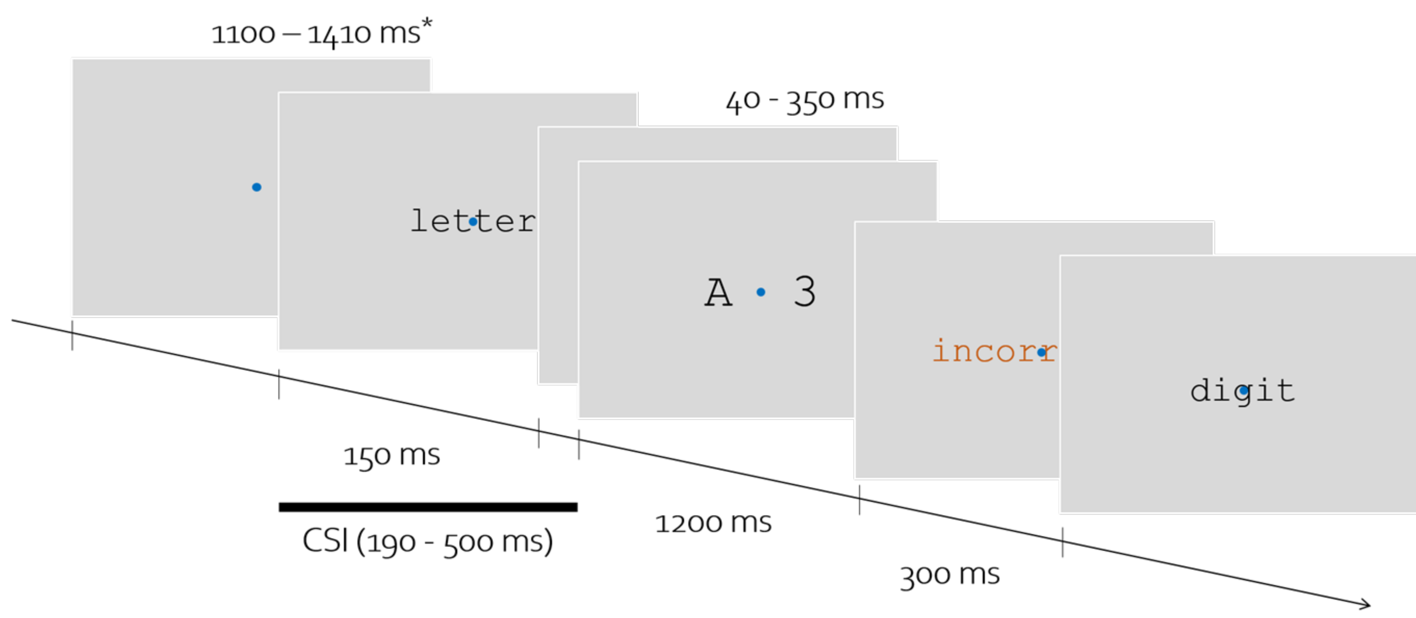
- Adaptive behavior requires finding the optimal set-point between stability and flexibility based on context[1]

- Context sensitive adjustments of flexibility: people switch between tasks with greater ease, i.e. exhibit lower switch costs, in contexts where they switch more frequently[2]
- Previous studies identify 'neural switch costs' or cue and stimulus-locked ERP amplitude differences in response to switch v. repeat trials[3,4]

Question

How are contextual adjustments of flexibility reflected in neural processing?

Cued Task-Switching (N = 30)



30% v. 70% switch frequency blocks

2 tasks

- Cue = Letter/abcdef
  Consonant or Vowel?
- Cue = Digit/Number
  Odd or Even digit?

61 trials x 16 blocks

Cue-stimulus interval (CSI)

- Jittered 190 ms to 500 ms
- Constant response-stimulus interval (RSI)

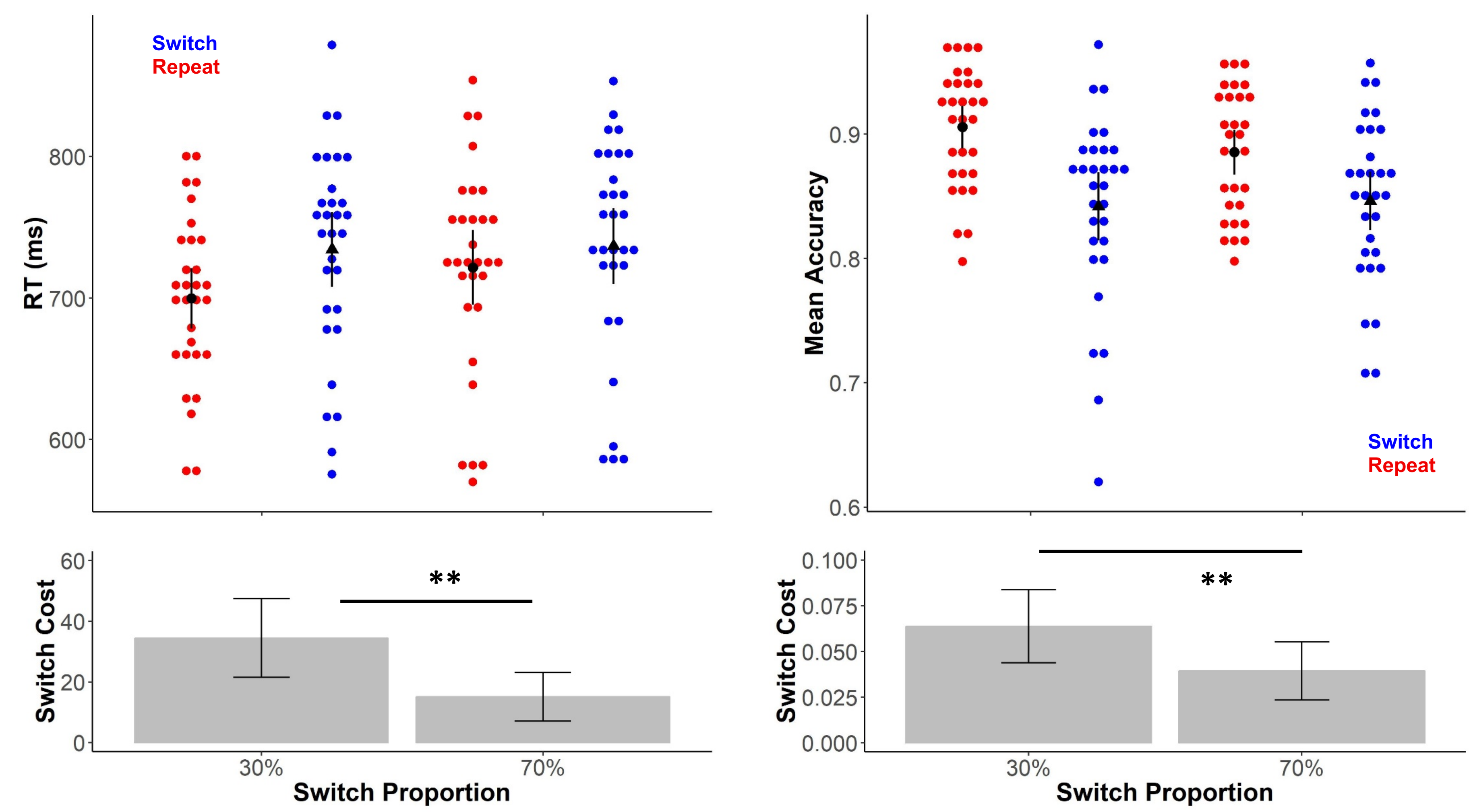
Catch trials (cue-only)

EEG Preprocessing & Analyses

Data is resampled to 250 hz and filtered at 0.05 to 30 hz. and referenced to average mastoids after interpolating noisy channels. ICA was used to remove blinks, eye movements and heart beats. Epoched between -500 and 1500, baselined from -300. Artifact rejection was conducted with an absolute thresholds between -+75 and -+95,

Statistical testing: dependent-samples two-tailed t test with a nonparametric cluster-based Monte Carlo permutation test (10,000 repetitions) to correct for multiple comparisons

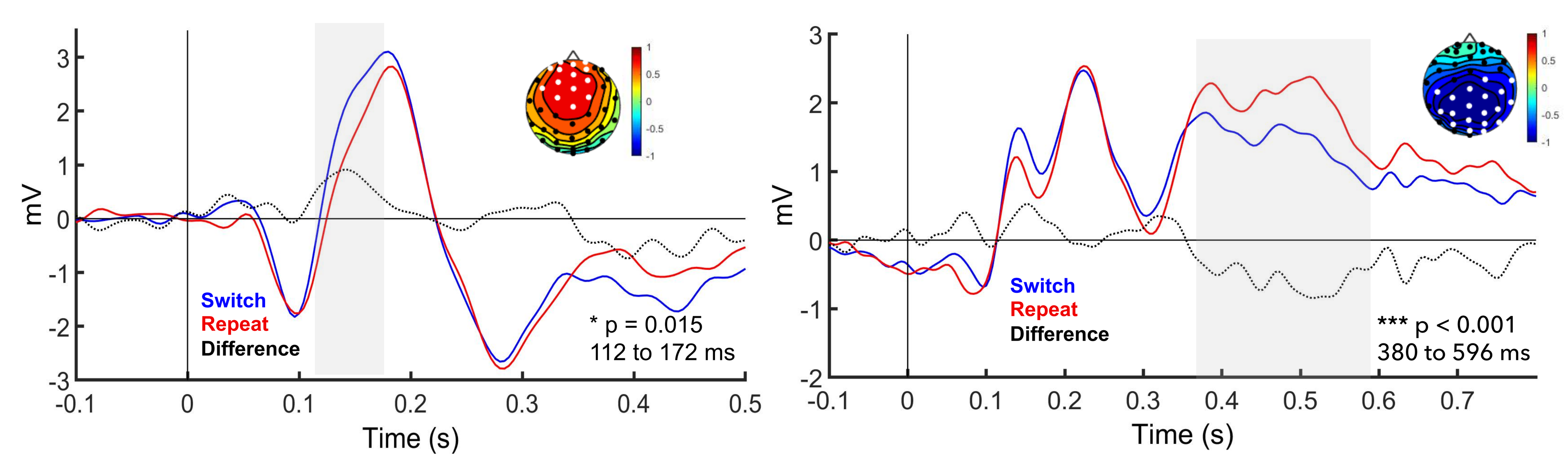
Behavioral Results



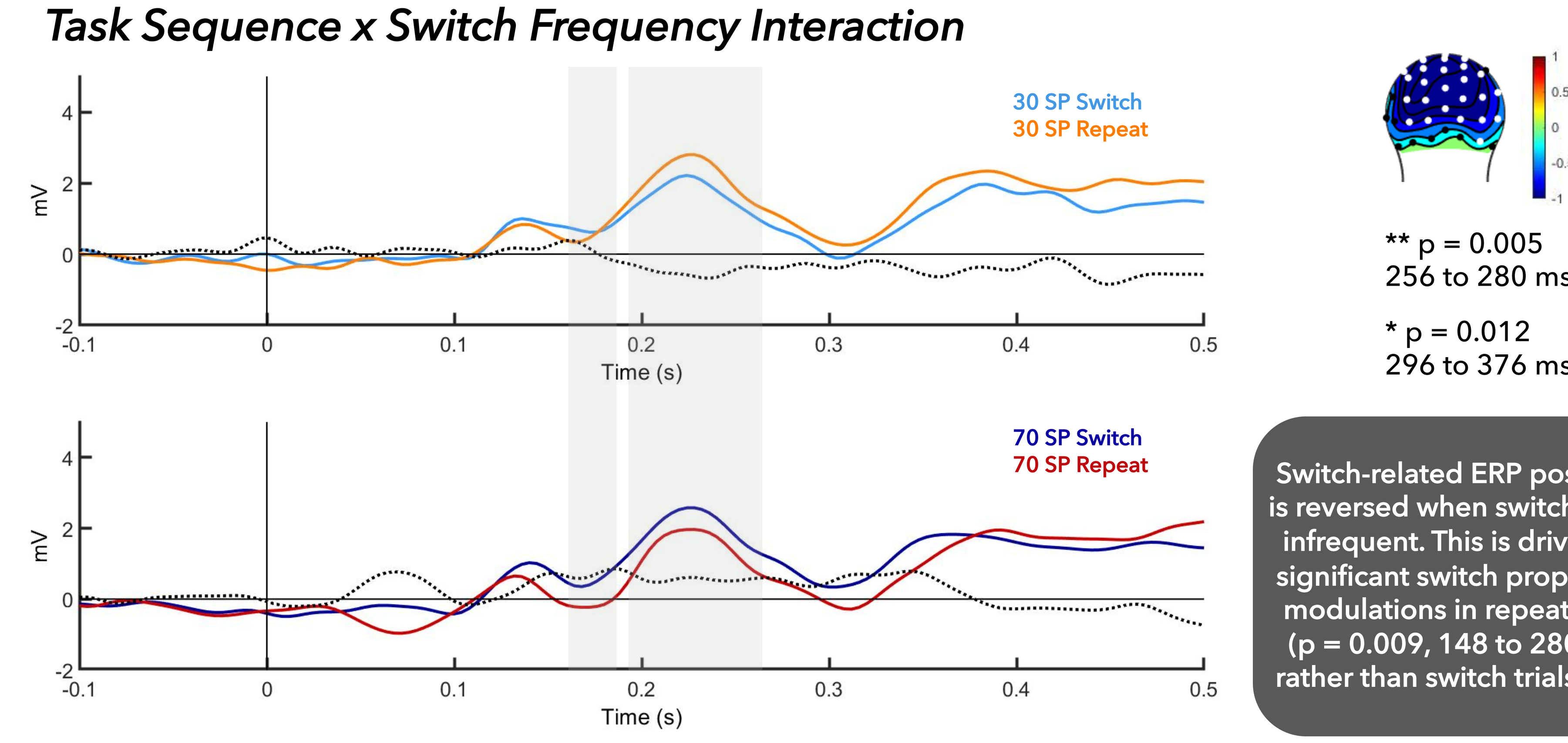
Switch costs scale inversely with switch frequency, reflecting strategic adaptation of cognitive flexibility.

Cue-Locked Analyses

Switch - Repeat



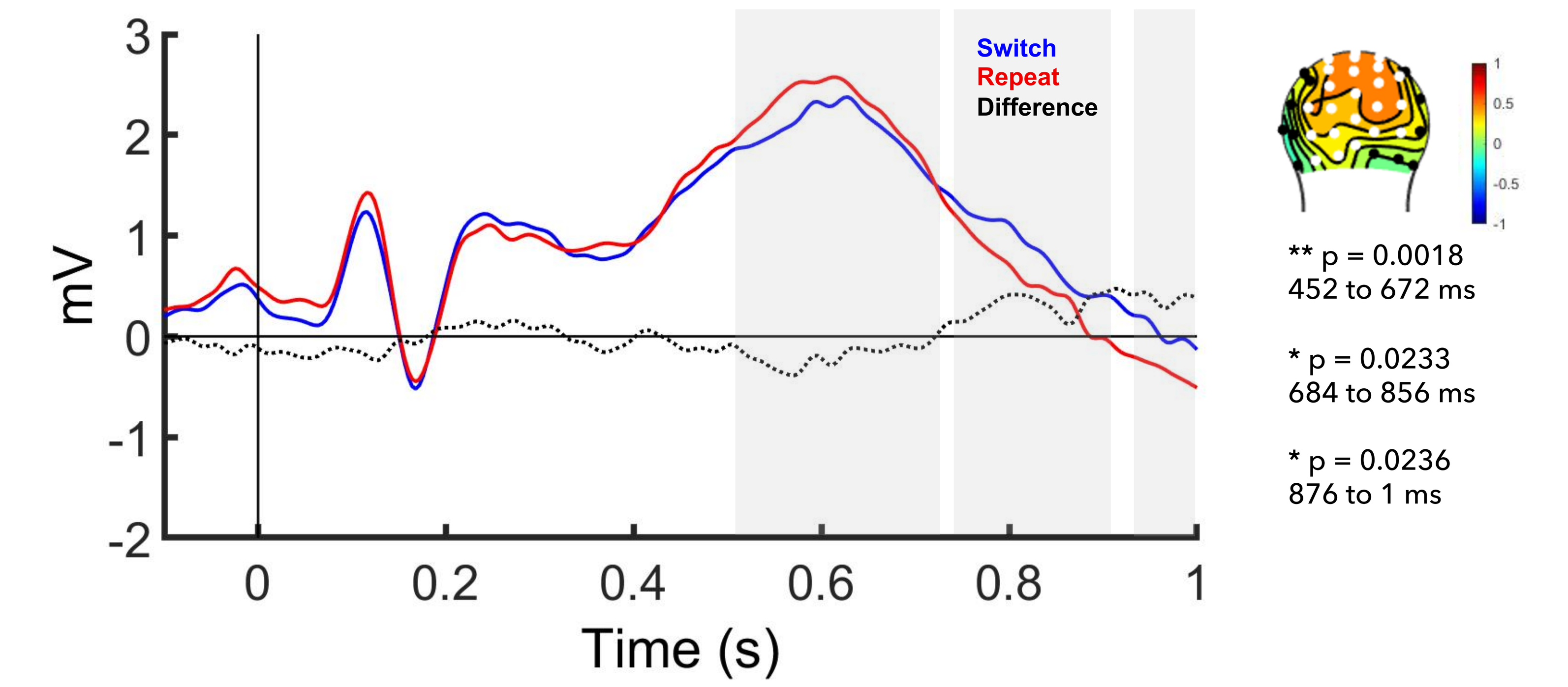
Task Sequence x Switch Frequency Interaction



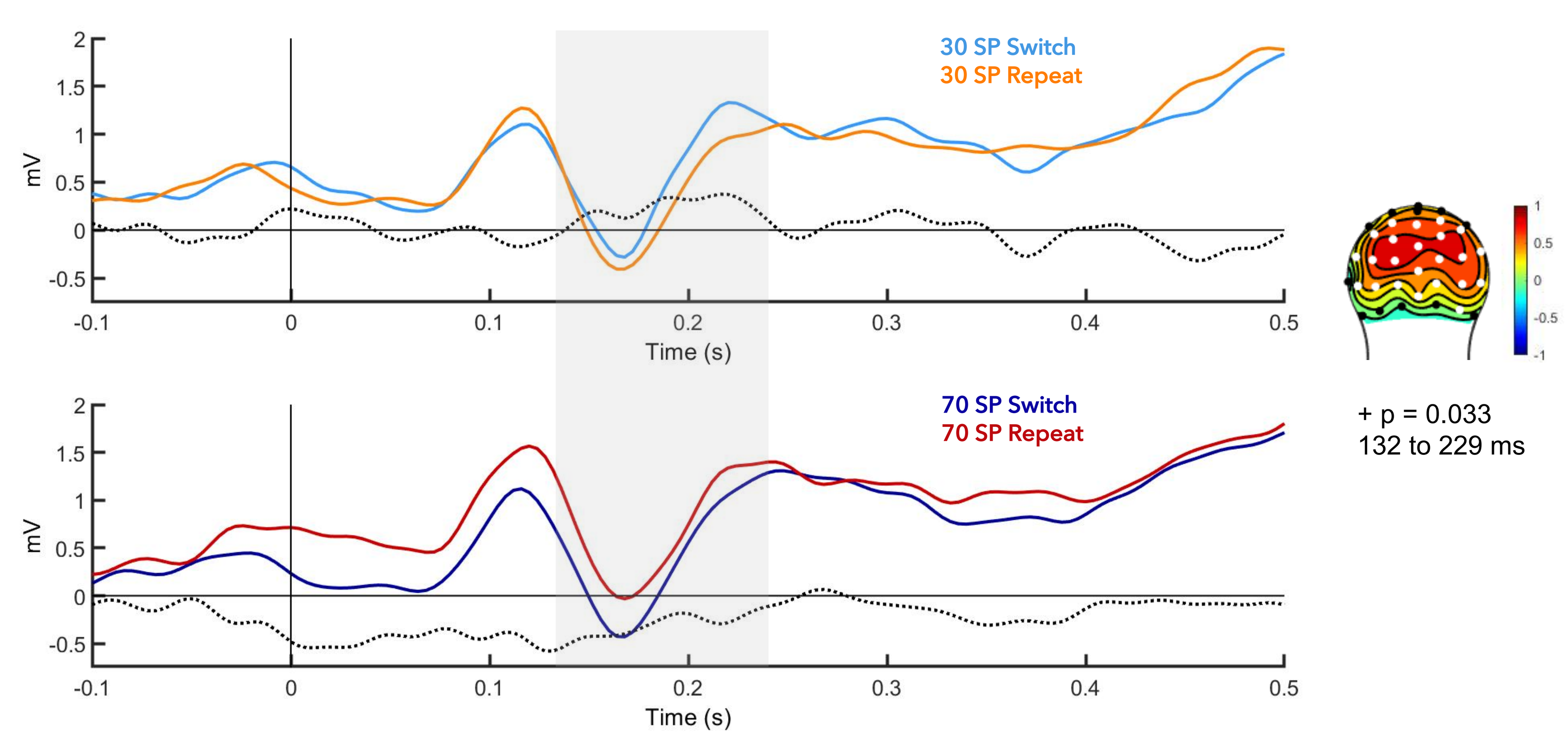
Switch-related ERP positivity is reversed when switches are infrequent. This is driven by significant switch proportion modulations in repeat trials (p = 0.009, 148 to 280 ms) rather than switch trials (NS).

Stimulus-Locked Analyses

Switch - Repeat



Task sequence x Switch Frequency Interaction



Target locked switch-related positivity is reversed around average response time onset. As before, marginally significant interaction effect shows switch-related polarity inversion in infrequent switch blocks.

Conclusions

- Switch frequency modulates the relationship between switches and repeat trial ERP signatures at both the cue and stimulus processing stages
- These effects are mainly driven by repeat trial changes across switch frequency conditions, mirroring behavioral results
- Future directions: Time frequency analyses[5] of frontal theta, or MVPA decoding[6] of task rules or switch frequencies post-cue v. post-stimulus

References

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