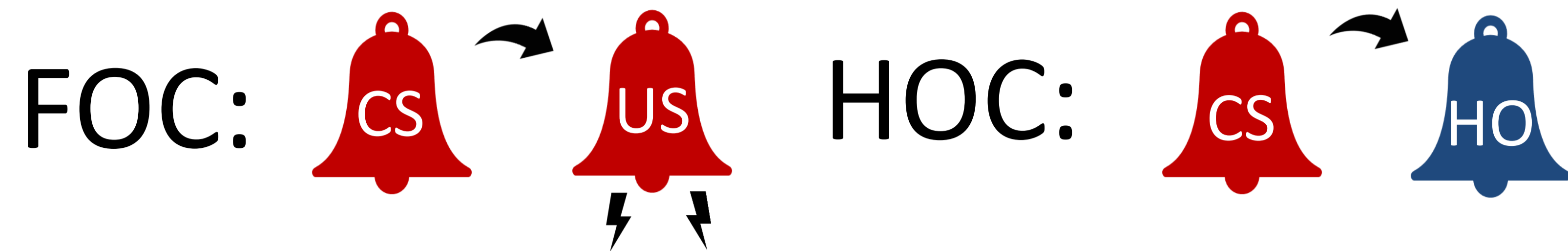


Introduction

Behaviour motivated by higher order associations, rarely first order learning

Higher order (HO) stimuli indirectly associated with a reward/punishment

- HO stimuli acquire value from a first order (FO) stimuli that is directly associated.



Higher order associations are not well understood and difficult to observe in humans.

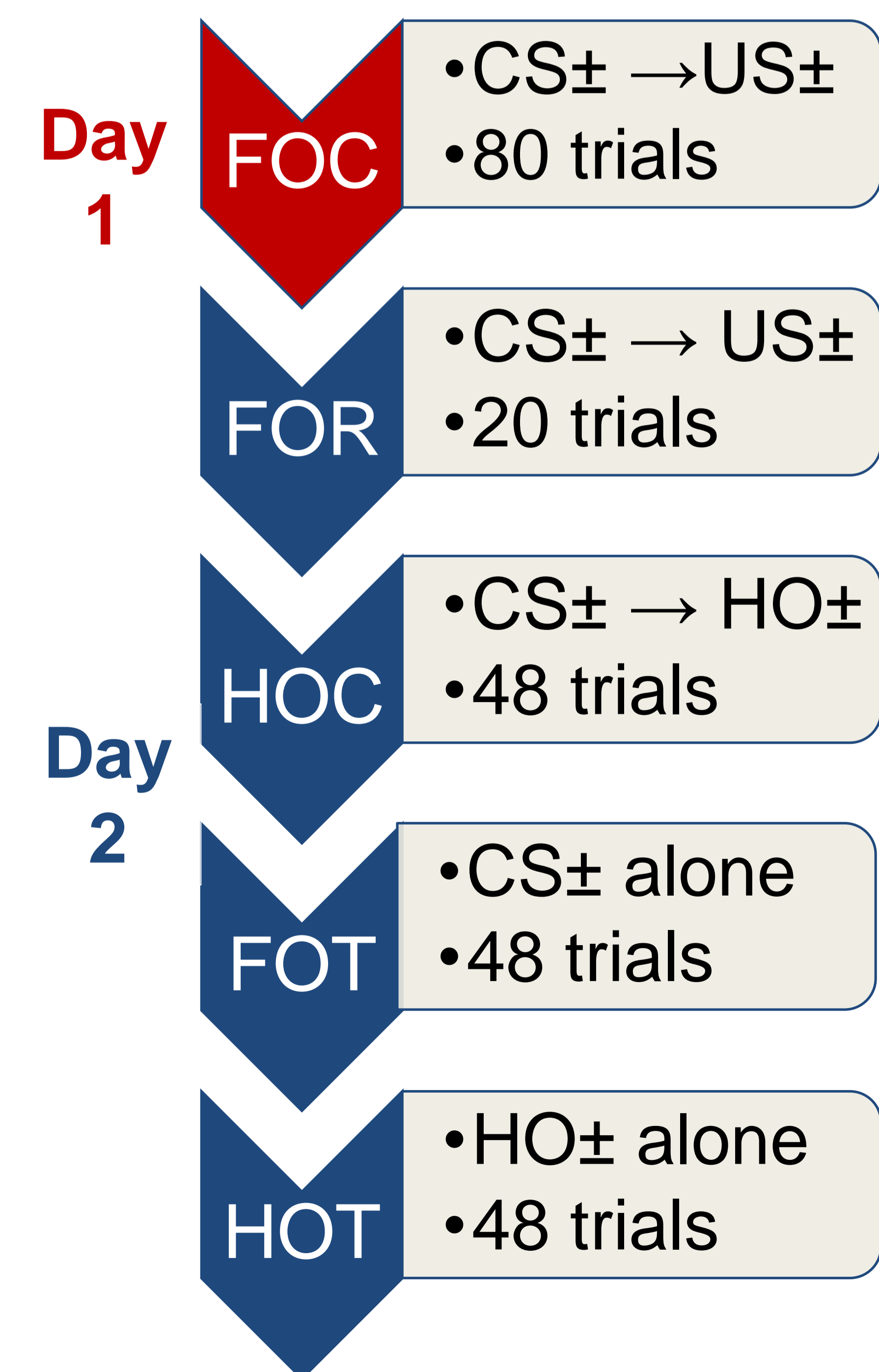
First Order Conditioning and Higher Order conditioning are mediated by distinct neural structures in rodents.

- Hippocampal lesions prevent anterograde and retrograde higher order conditioning only
- Suggests they are distinct processes ⁽¹⁾

Research Question I: Can we establish Higher Order conditioning in Humans?
Research Question II: Do first order and higher order conditioning elicit distinct ERP's?

Method

- Participants hear 2 tones on each trial.
- Participants establish FO conditioning using variable schedule punishment
- 24 hours later for higher order conditioning, first order tone testing and higher order tone testing



- Pupil Dilation to examine autonomic responses to FO± to HO± tones

- ERP to examine neural responses

- n = 13, age = 54.42 years

Stimuli

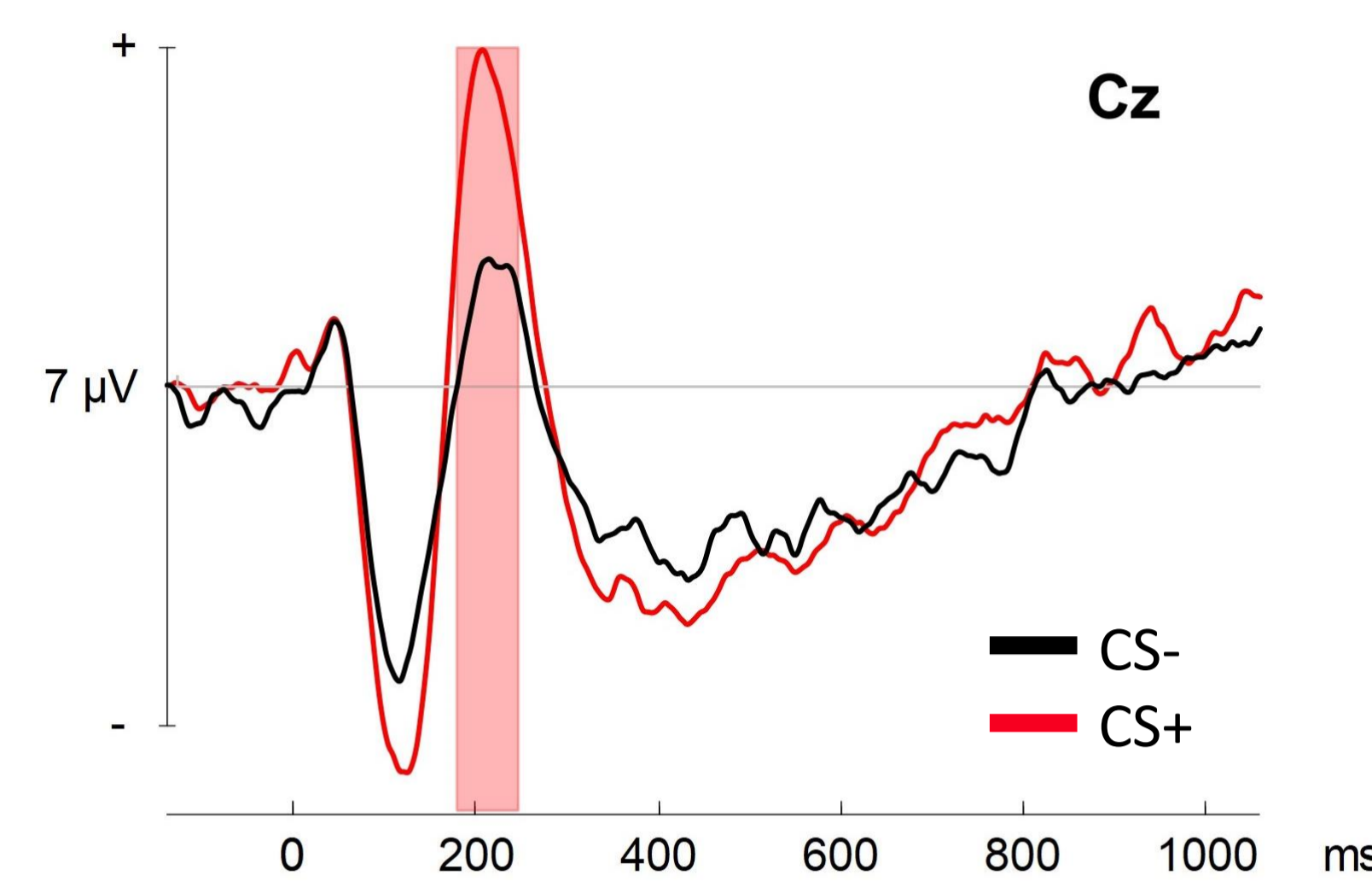
⚡ US+ ⚡	Burst of white noise
CS +	350 Hz Sawtooth Tone
HO +	550 Hz Sawtooth Tone

US -	150 Hz Sawtooth tone
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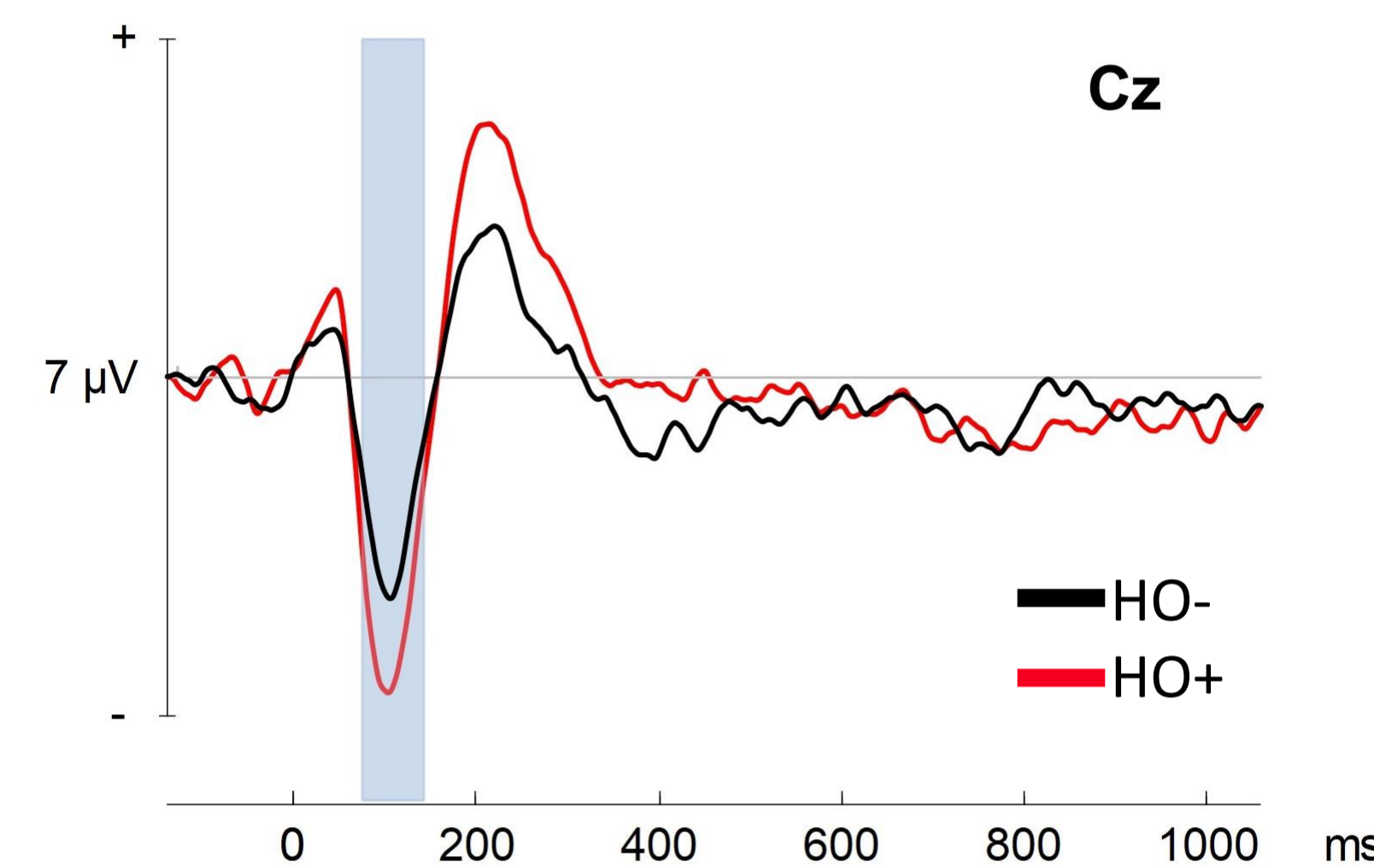
Results

Distinct Timing of ERP responses

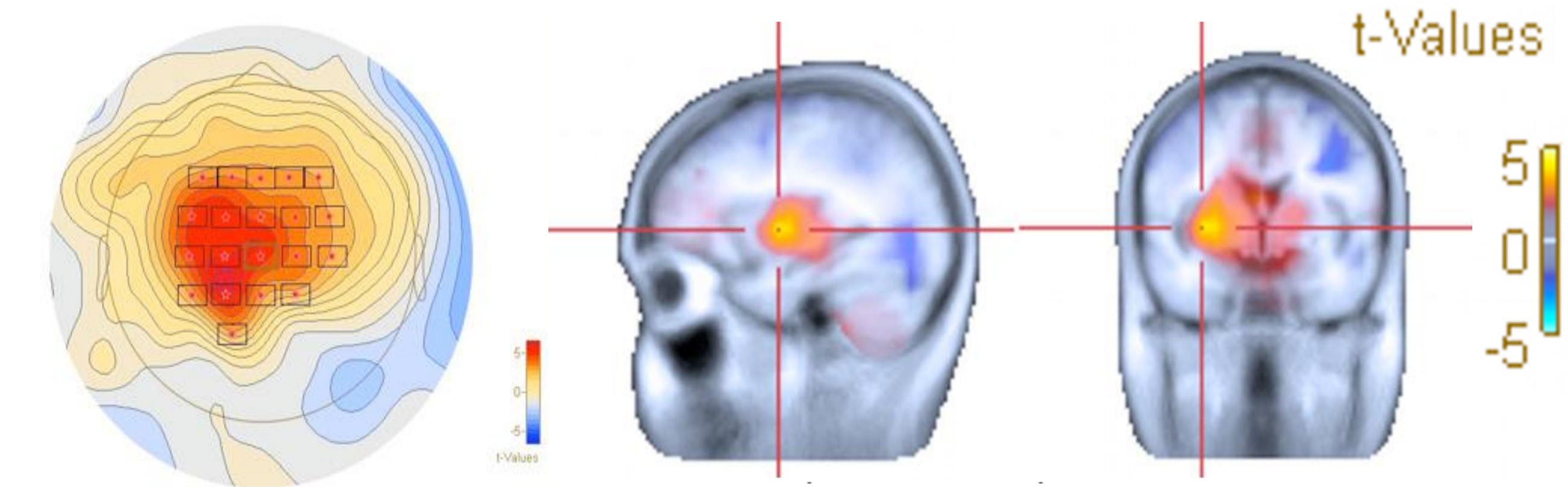
First Order Test



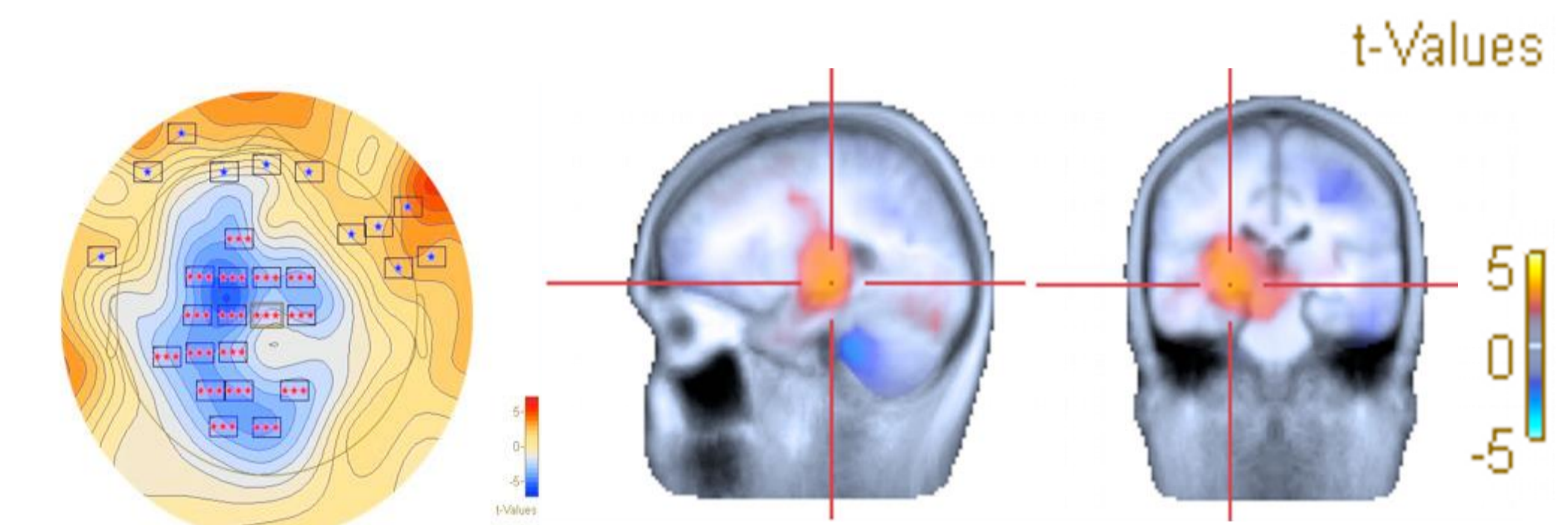
Higher Order Test



CS+ and HO+ Have Distinct Sources

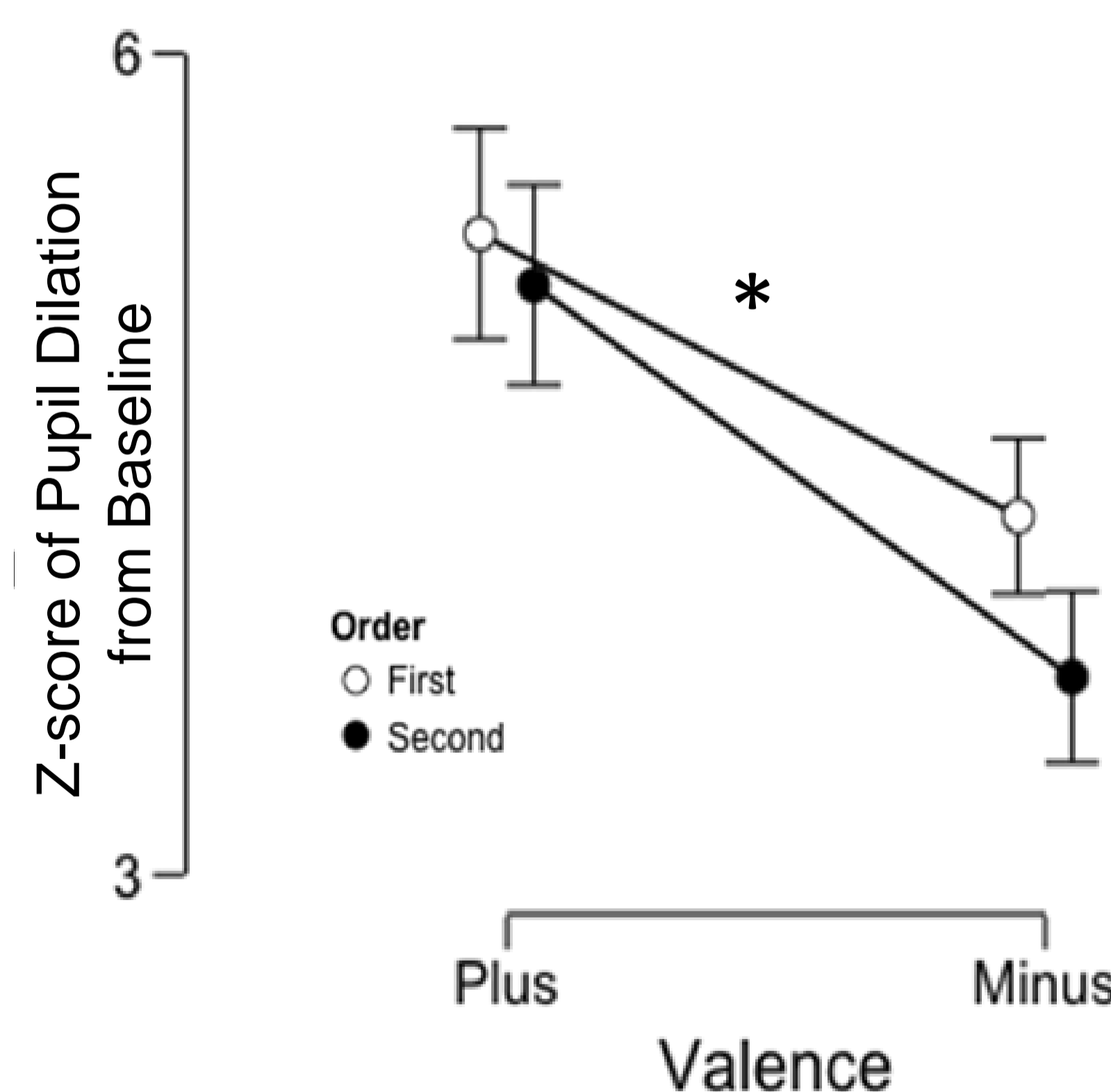


Bootstrap Cluster $p = .002$; Max Right Basal Ganglia/Insula

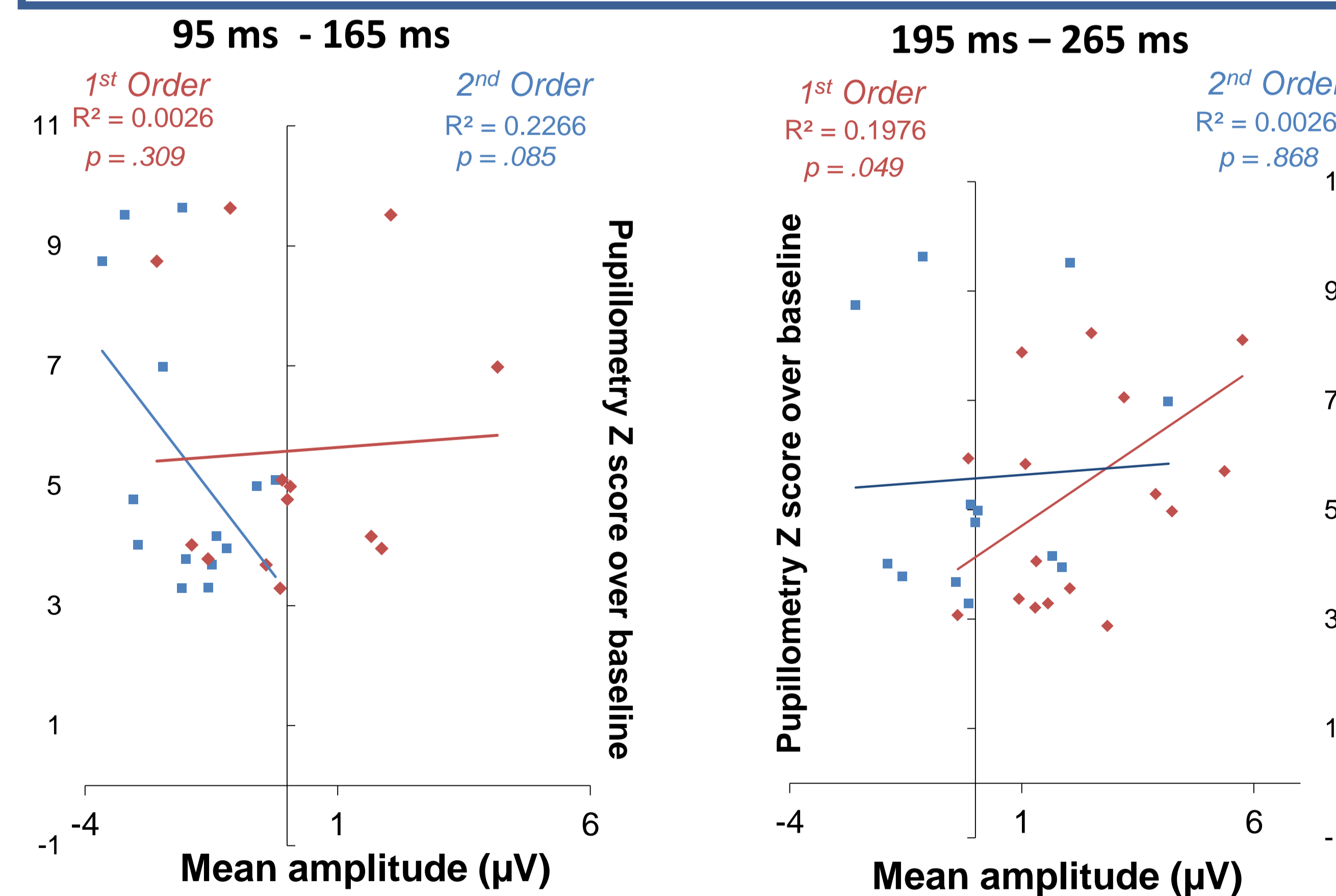


Bootstrap Cluster $p = .04$; Max Right Hippocampus

Greater Pupil Dilation in CS+ and HO+ than CS- and HO-



Correlated Mean ERP Amplitude and Max Pupillometry Z-scores at Early and Late Peak



Conclusions

Research Question I: Participants transferred value from an acquired CS+ to an HO+

- evidence of higher order conditioning in humans

Research Question II: First order and higher order conditioning may elicit distinct ERP's from distinct sources. → Insula for FOC and hippocampus for HOC.

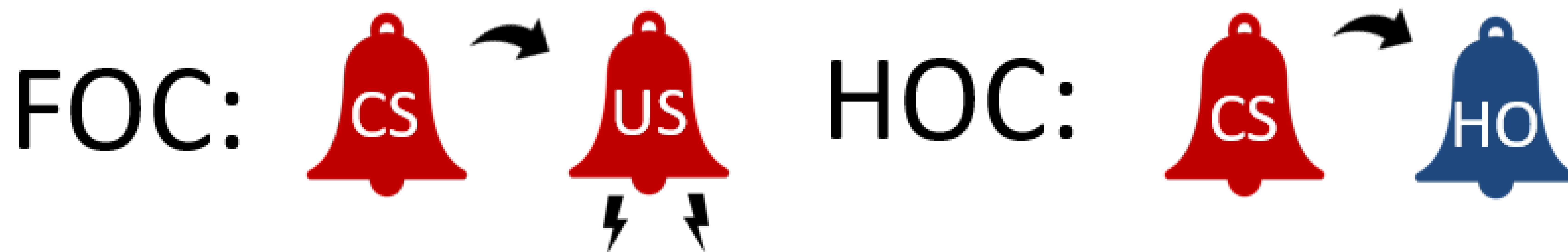
Understanding FOC and HOC as separate processes may help understand instigation of addiction-related behaviours.

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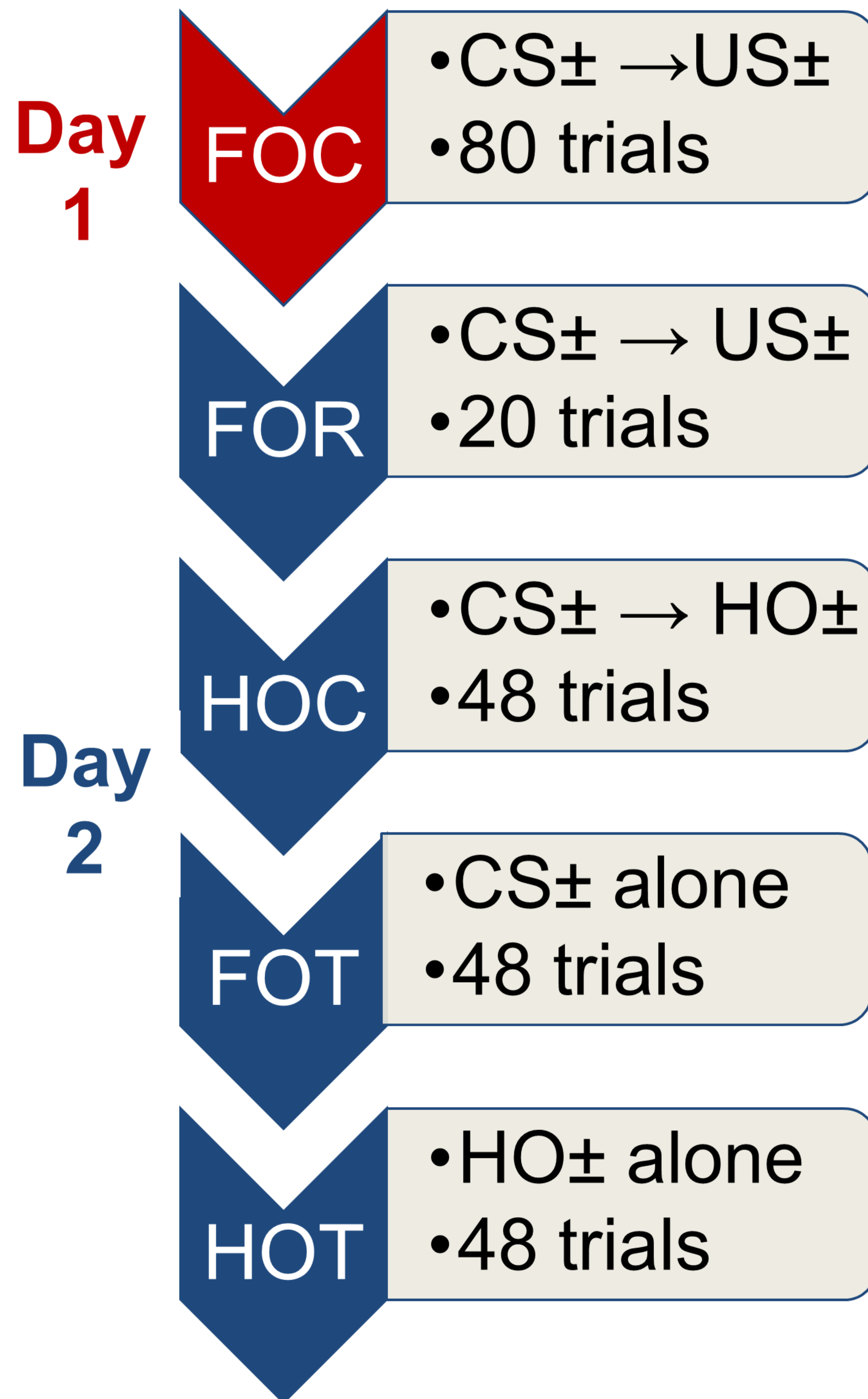
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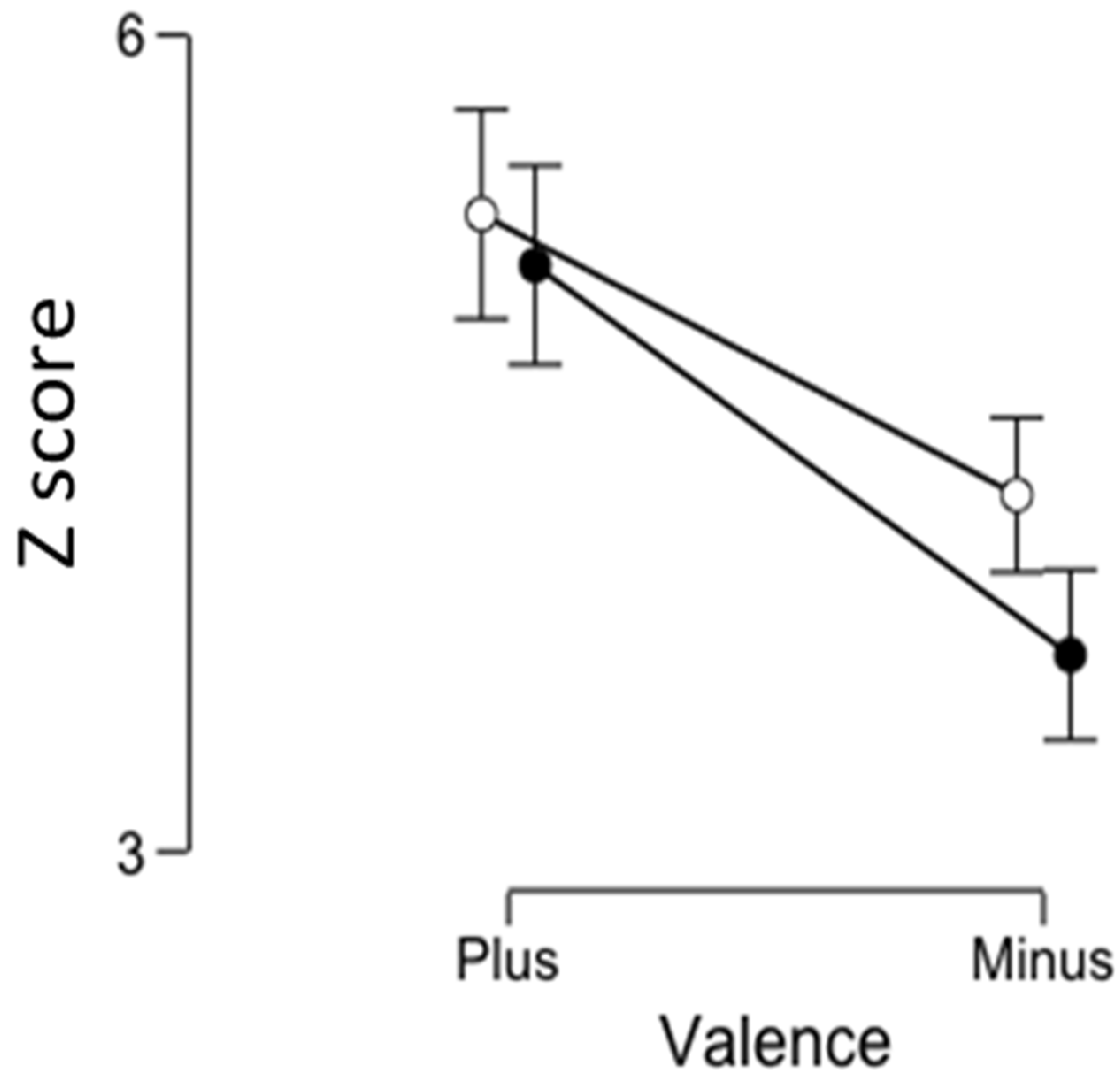
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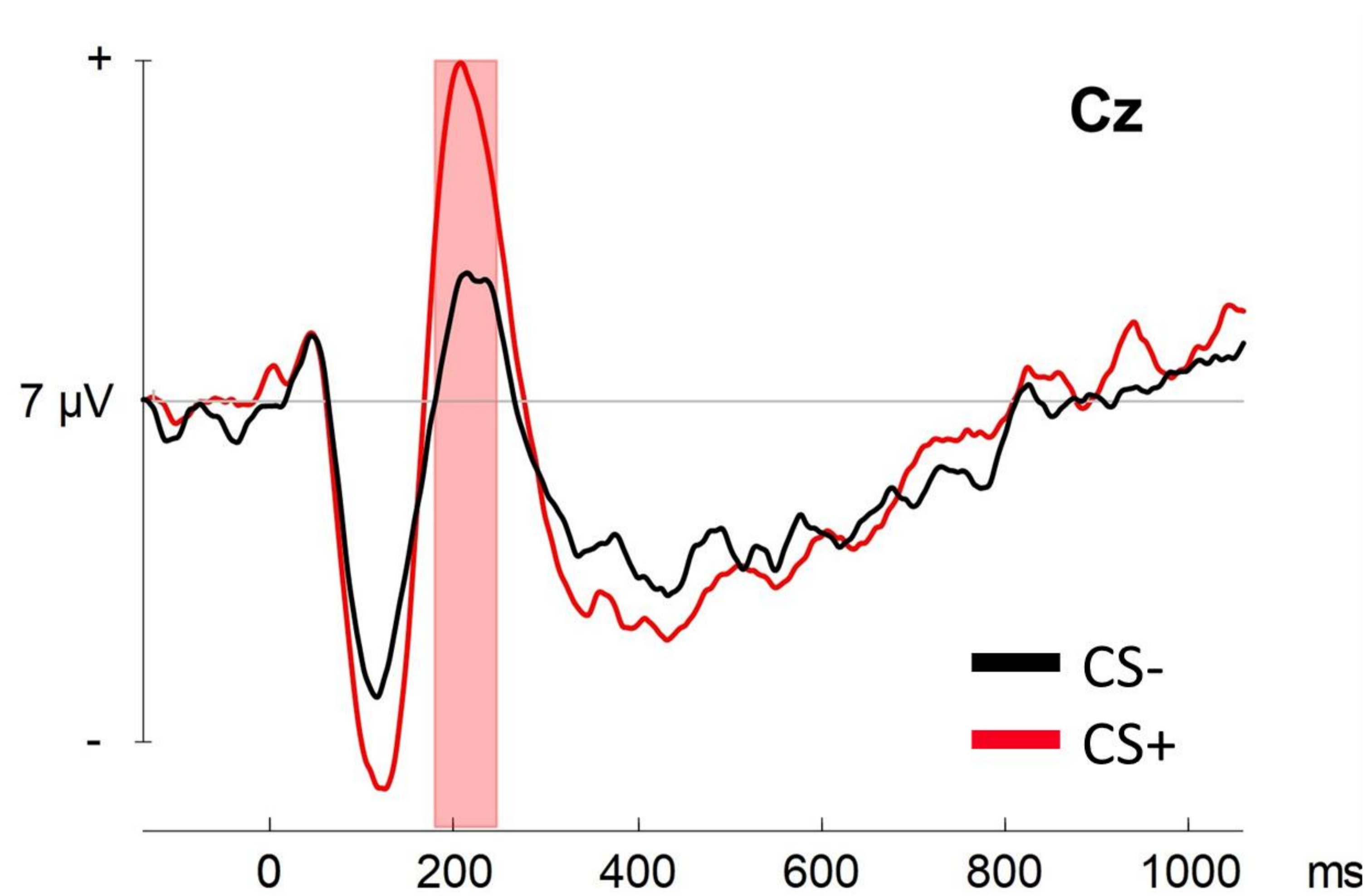
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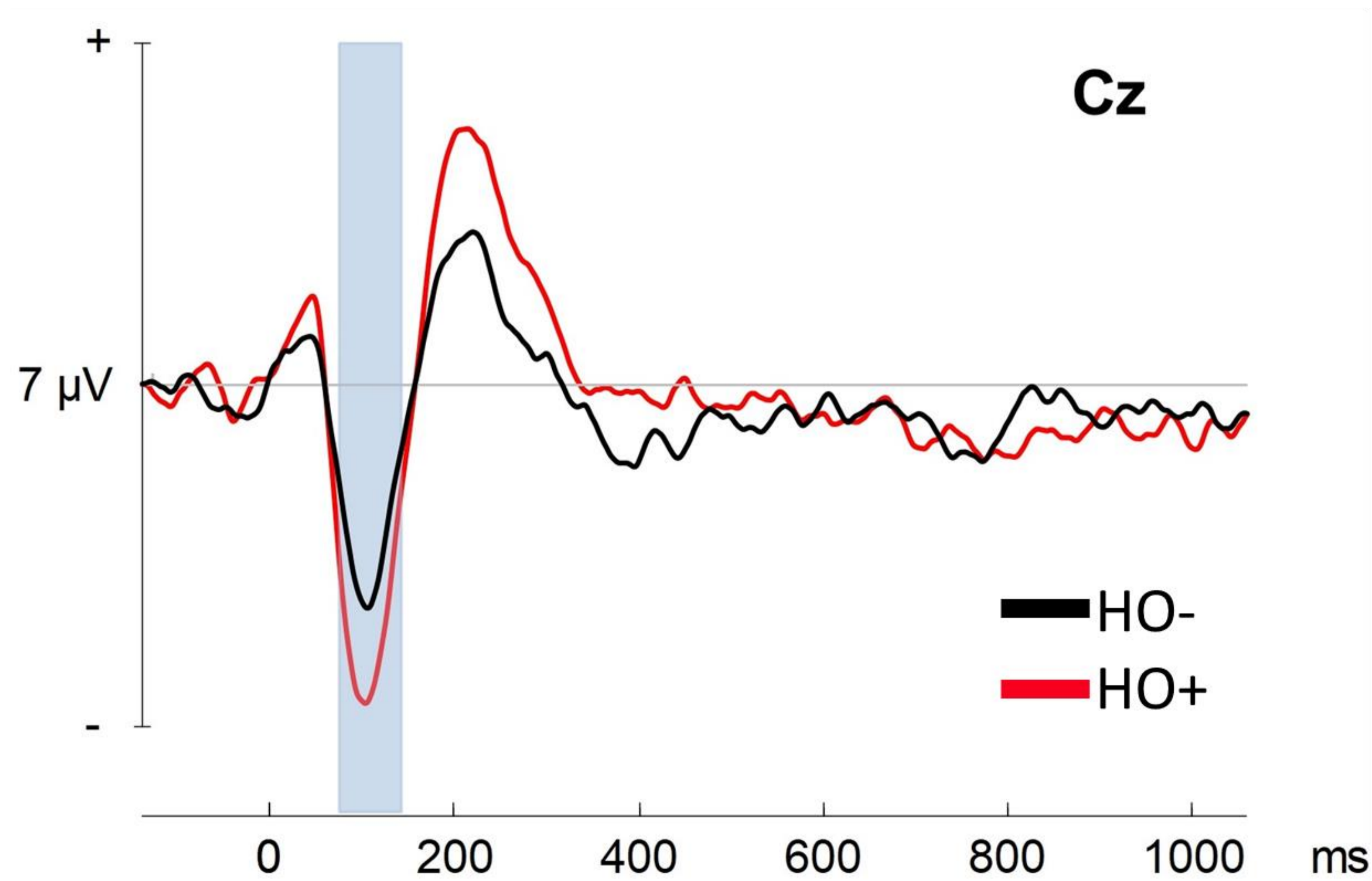
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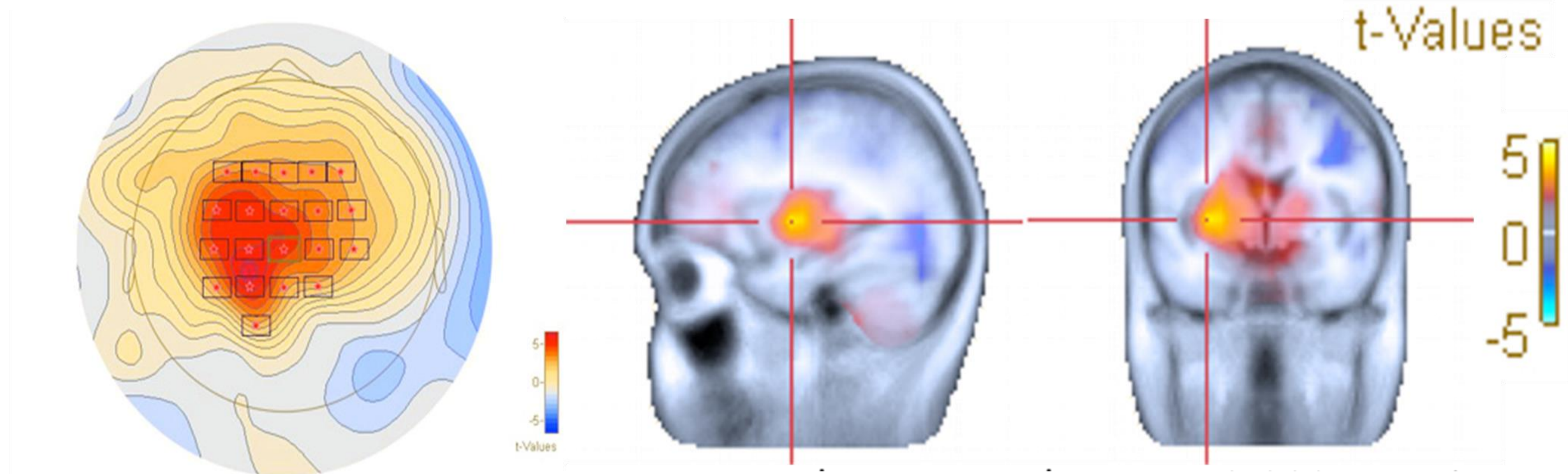
First Order Test



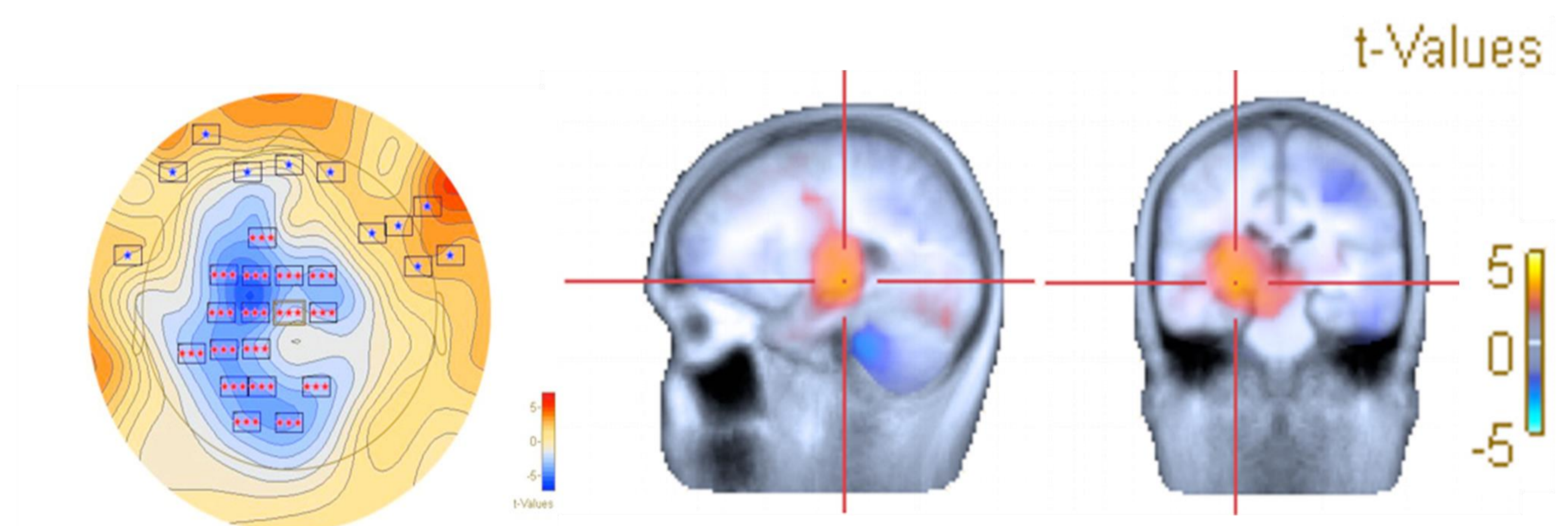
Higher Order Test



CS+ and HO+ Have Distinct Sources



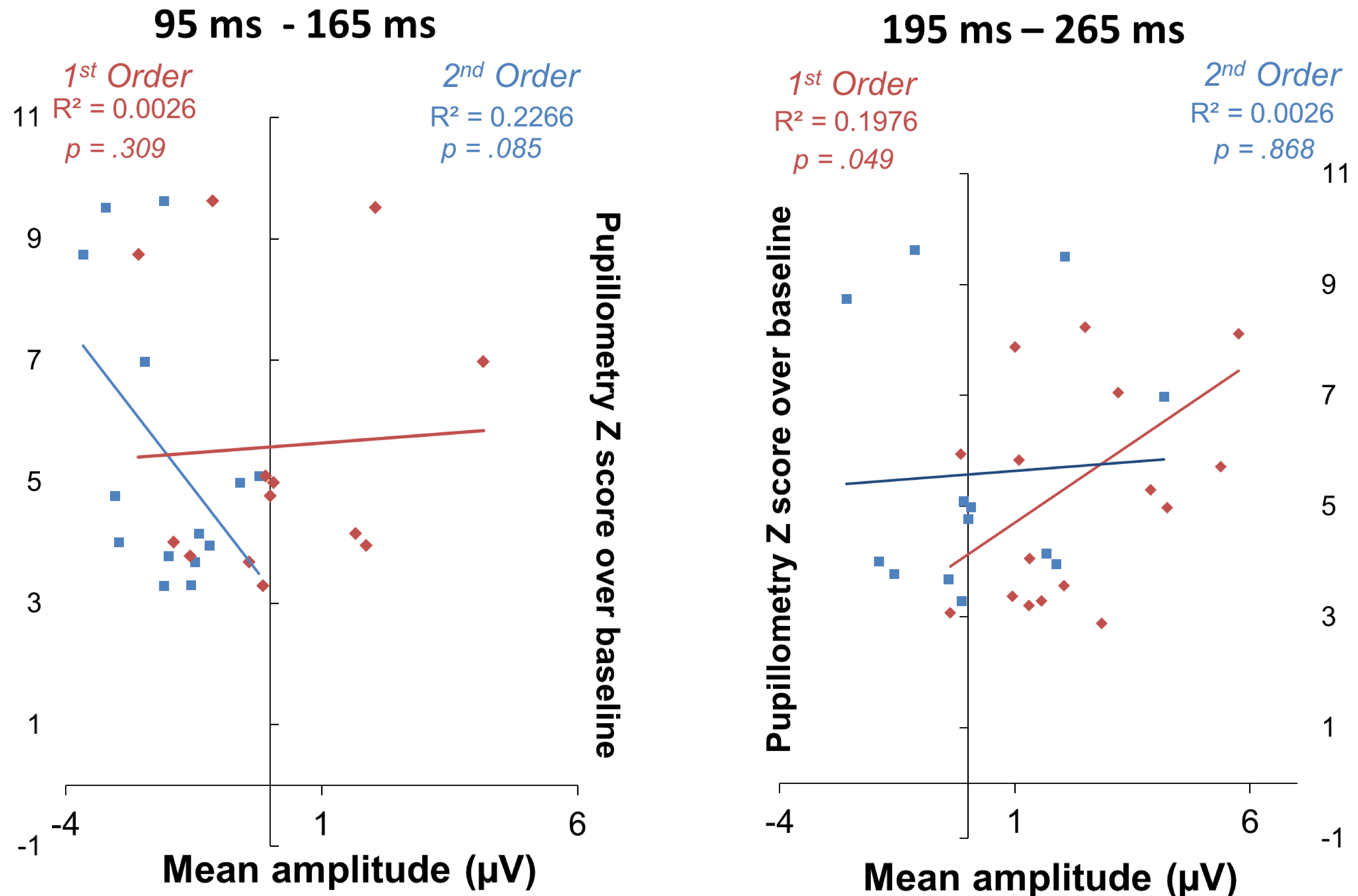
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