

STATE ANXIETY MODULATES THE LINK BETWEEN NEURAL PROCESSING OF HEARTBEATS AND SPONTANEOUS FLUCTUATIONS IN SUBJECTIVE AROUSAL

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How are subjective qualities of ongoing experience related to interoceptive processing of heartbeats and state anxiety?

Interoception is neural processing of bodily signals and can be measured using the **heartbeat evoked potential (HEP)**, which involves averaging neural electrophysiological signals time-locked to features of the electrocardiogram (ECG).¹

Subjective arousal is an inner sense of energy or activation, often measured through self report, and is distinct from **physiological arousal**, which is often measured using cardiophysiological measures such as heart rate and heart rate variability.²

Interoceptive processing of heartbeats and subjective arousal spontaneously fluctuate at rest and HEP amplitudes vary based on spontaneous fluctuations in self- or other-referenced thoughts,³ but the link between HEP and spontaneous fluctuations in subjective arousal is unclear.

How HEP interacts with subjective arousal has implications for anxiety

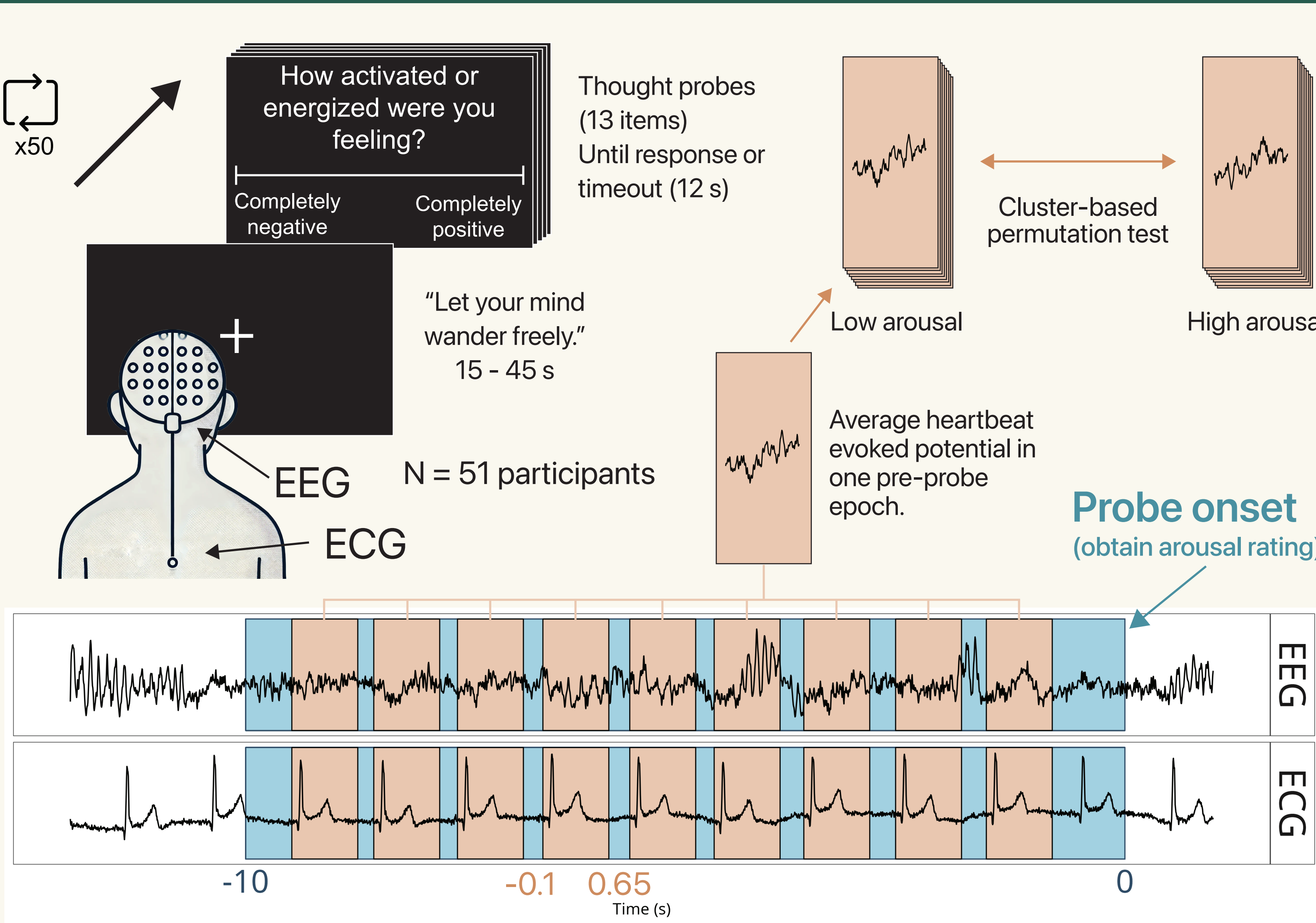
Anxiety involves dysregulated interoception, such as heightened or inconsistent sensitivity to bodily signals.⁴

How anxiety influences spontaneous fluctuations in subjective arousal and HEP is unclear.

Given associations between (i) anxiety and HEP⁵ and (ii) anxiety and abnormal spontaneous thinking,⁶ the interoceptive underpinnings of subjective arousal fluctuations could prove crucial to understanding anxiety.

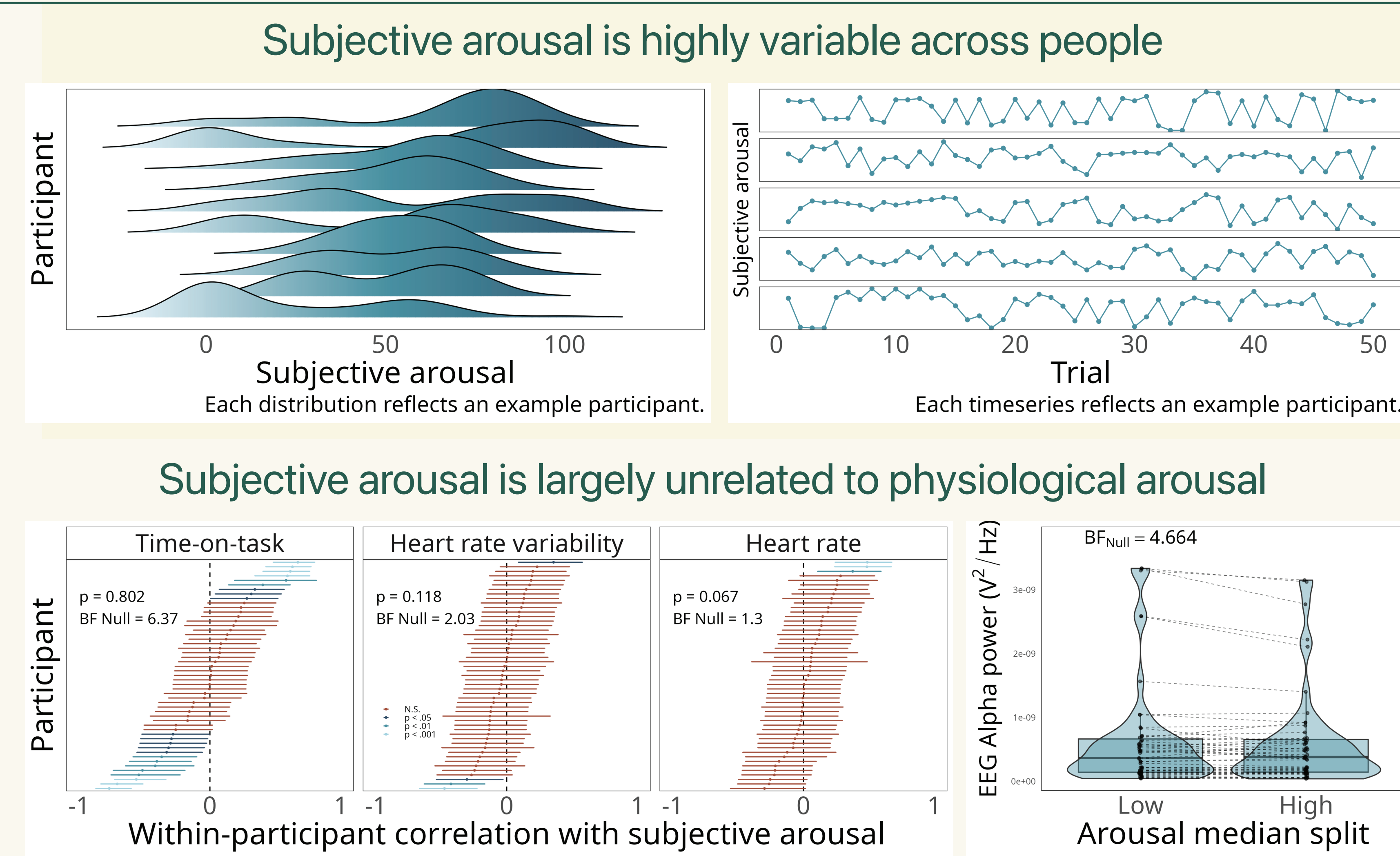
Subjective arousal	How activated or energized were you feeling?	Completely activated ↕ Completely deactivated
Future thinking	Were your thoughts oriented towards the future?	Completely future oriented ↕ Not future oriented
Deliberate thinking	How intentional were your thoughts?	Completely intentional ↕ Completely unintentional
Self-related thinking	Were your thoughts about yourself?	Completely about you ↕ Nothing about you
Difficulty Disengaging	How easy was it to disengage from your thoughts?	Extremely difficult ↕ Extremely easy

Participants let their mind wander and occasionally reported the nature of their experience while we recorded EEG & ECG

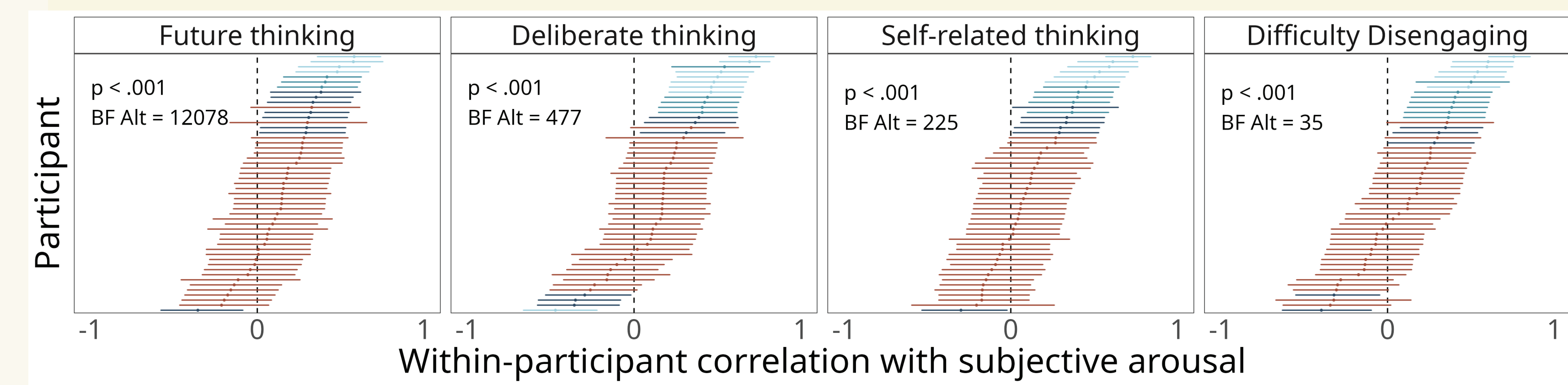


Subjective arousal was inversely related to HEP, a pattern that was amplified for those higher in state anxiety

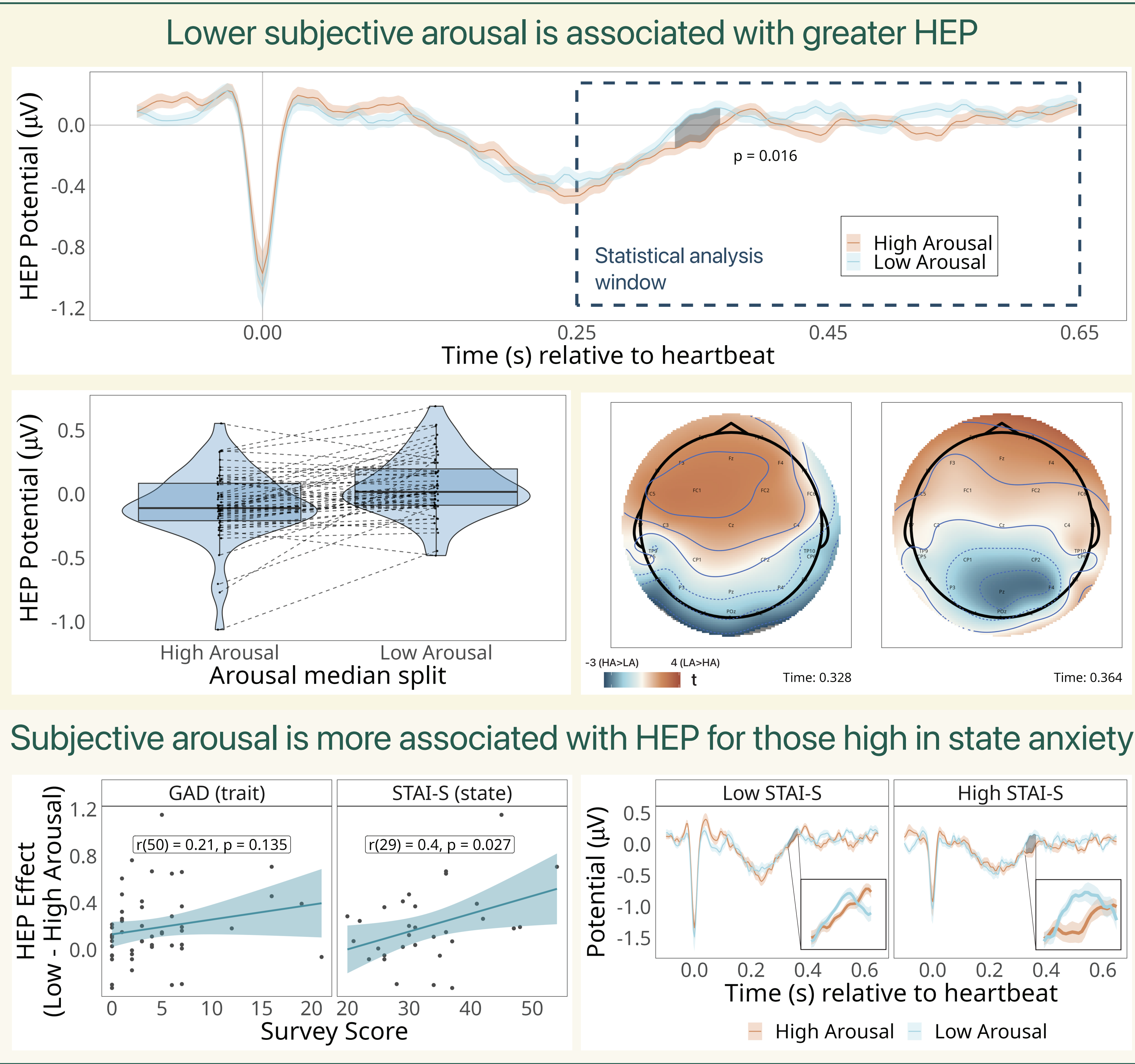
What is subjective arousal?



Subjective arousal is related to several other aspects of ongoing experience



Subjective arousal, interoception, and anxiety



Increased subjective arousal may suppress interoceptive processing of heartbeats, which may be adaptive during state anxiety

The nature of subjective arousal

Lack of associations between subjective and physiological arousal suggest the need to measure both when studying arousal.

Self- and future-thinking tend to cooccur, and may be supported by high arousal.

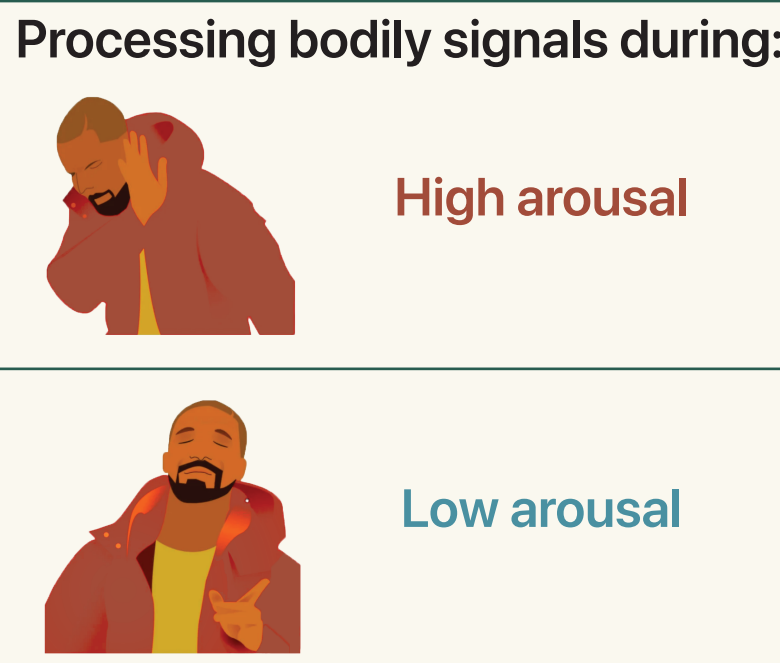


Physiological vs. Subjective Arousal

Increased subjective arousal may suppress processing bodily signals

Higher HEP during lower subjective arousal may reflect downregulation of interoception during high-arousal states.

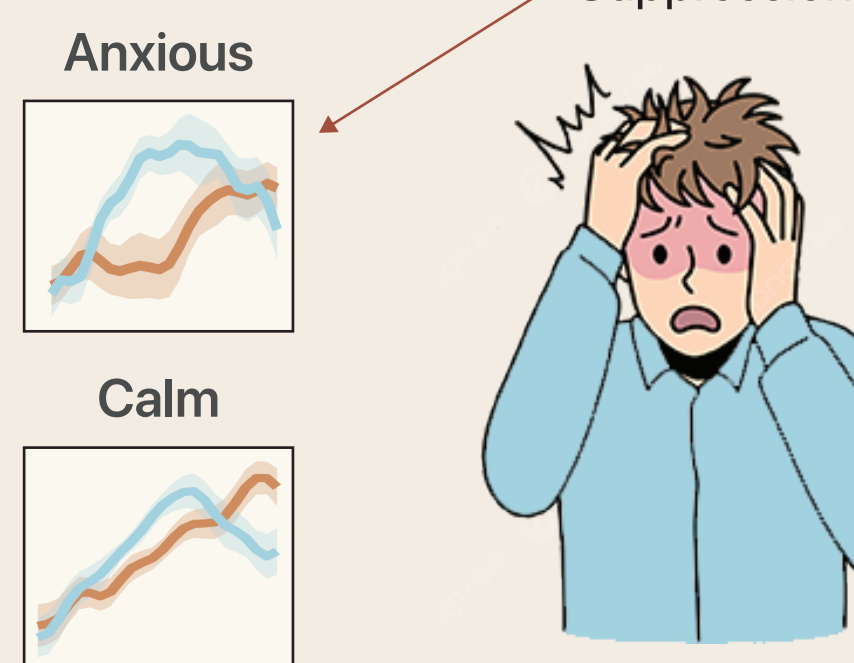
Or low-arousal states may facilitate greater interoception, as with meditation.



This suppression may be adaptive during states of anxiety

Suppressed heartbeat processing is evidenced by reduced HEP amplitude during high arousal for anxious individuals.

Calls into question whether processing heartbeats during anxiety is generally dysregulated* or adaptive.



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Acknowledgements

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