

# Cardiac phase modulates endogenous and exogenous ERPs and HEP predicts awareness at the visual threshold

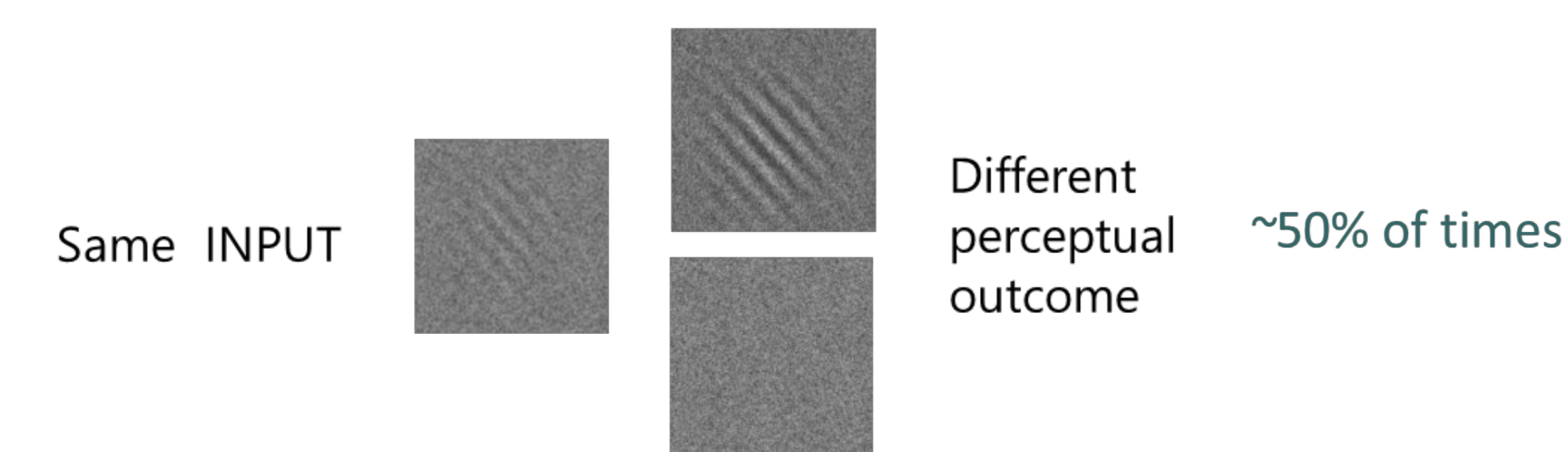


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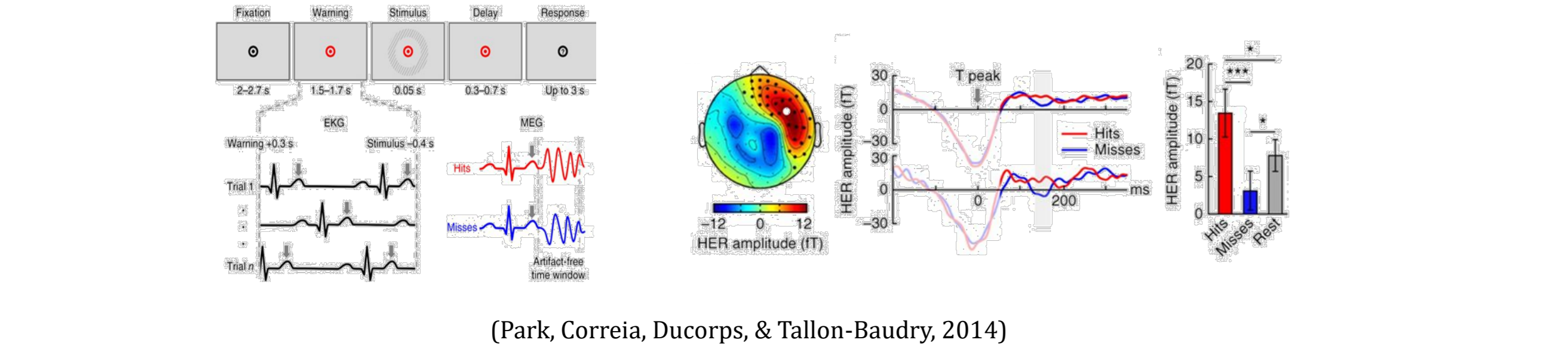
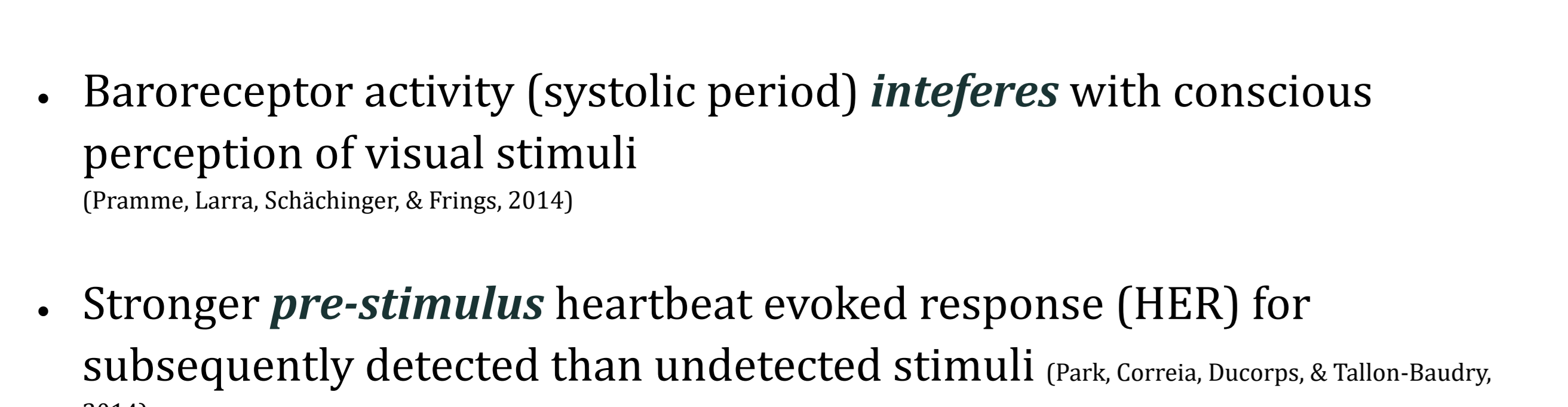
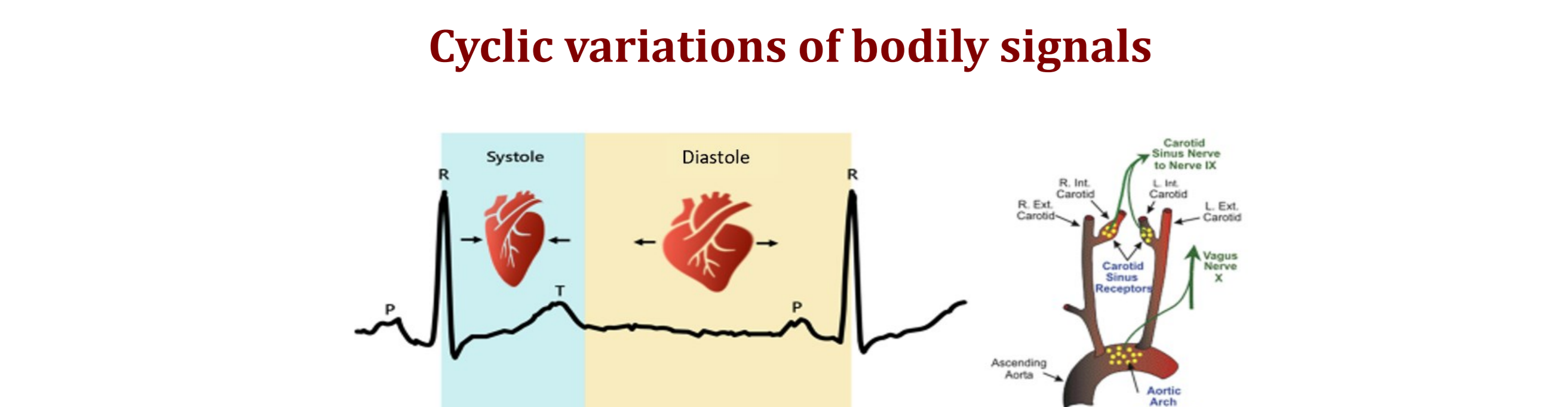
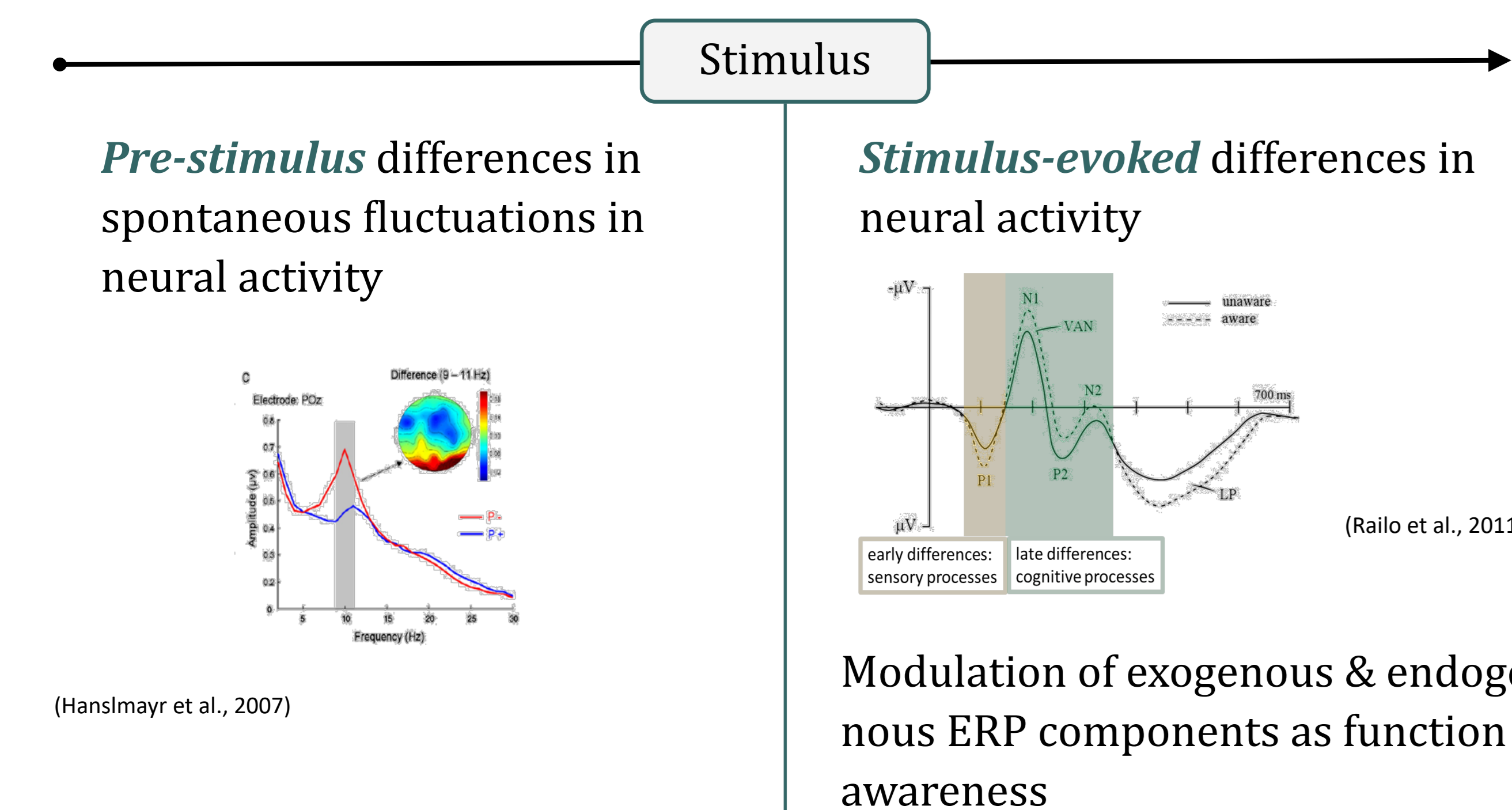
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## Introduction

### Study neural correlates of consciousness



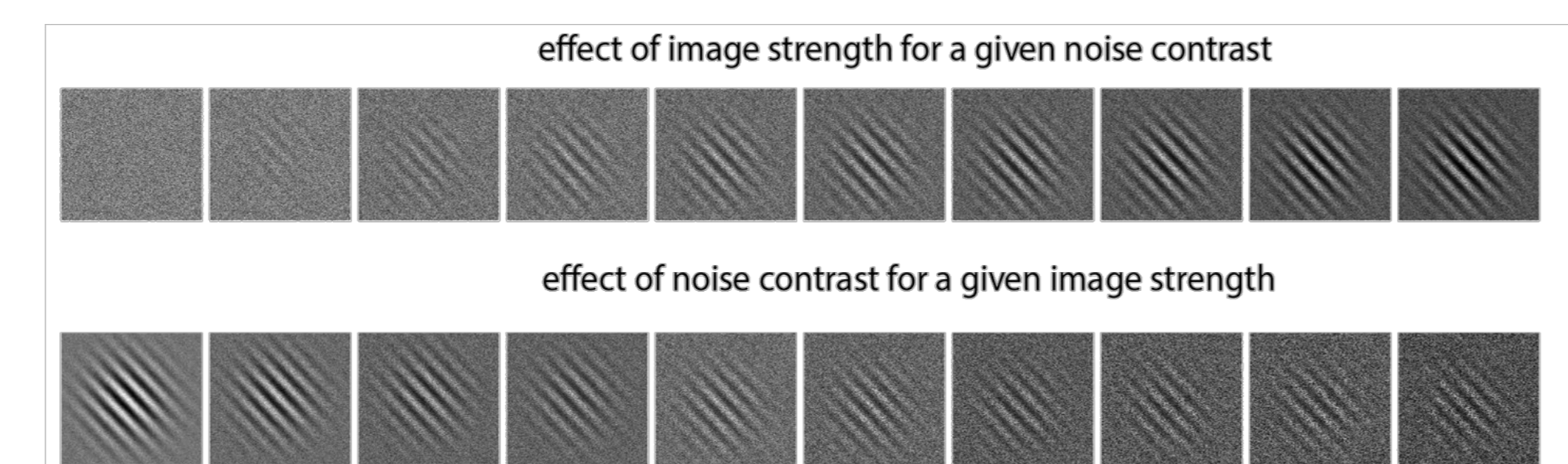
- Experimental dissociation of sensation and perception: Physically identical stimuli can yield different perceptual outcomes
- **Neural correlates of consciousness:** compare brain response for different perceptual outcomes of the same stimulus
- Differences in perceptual awareness can arise from :



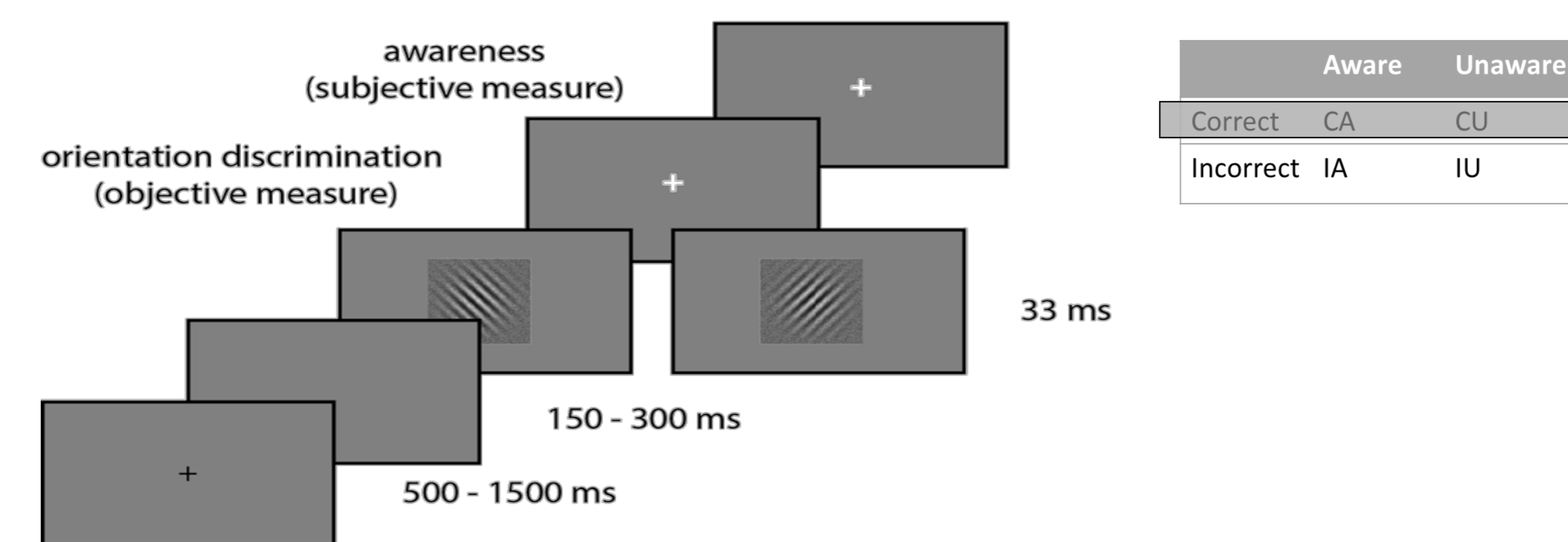
**AIM: Investigate heartbeat and stimulus evoked response as a function of awareness and of the cardiac phase**

## Methods

### Stimuli and experimental procedure



- Behavioral titration of perceptual threshold
- **AIM :**  
**High accuracy rate (> 80%) & 50/50 aware (CA) and unaware (CU) ration**  
**Compare the same physical stimulus when it's correctly identified with and without awareness.**



- ### Participants
- 11 (9 female), young and healthy
- ### Recordings and processing
- EEG (128 ch), ECG (1 bipolar ch), respiration (1 bipolar ch)
  - Sampling rate: 2048 Hz, Downsampling: 256 Hz
  - Band-pass DC: 286 Hz, Band-pass filter: 1-40 Hz
  - Re-reference to common average reference

- ### ERP analyses
- Epochs:**
- **Stimulus-locked potentials**
  - -100:500 ms
  - **HER (time locked to the R-peak and T-wave)**
  - -200:400 ms

- ### Spatio-temporal ERP segmentation
- Stimulus-locked potentials**  
Selective averaging of CA and CU for cardiac phase (separately for systole and diastole)
- HER (time locked to the R-peak and T-wave)**  
Compare CA and CU time-locked to the R-peak and T-wave)
- ### Source space analysis
- Comparison of the Local AutoRegressive Average (LAURA) inverse solutions for the CA and CU conditions

- ### Statistical analysis
- All values were contrasted using t-tests for the CA and CU conditions and corrected for multiple comparisons using the Bonferroni method

## Results I—Behavioural

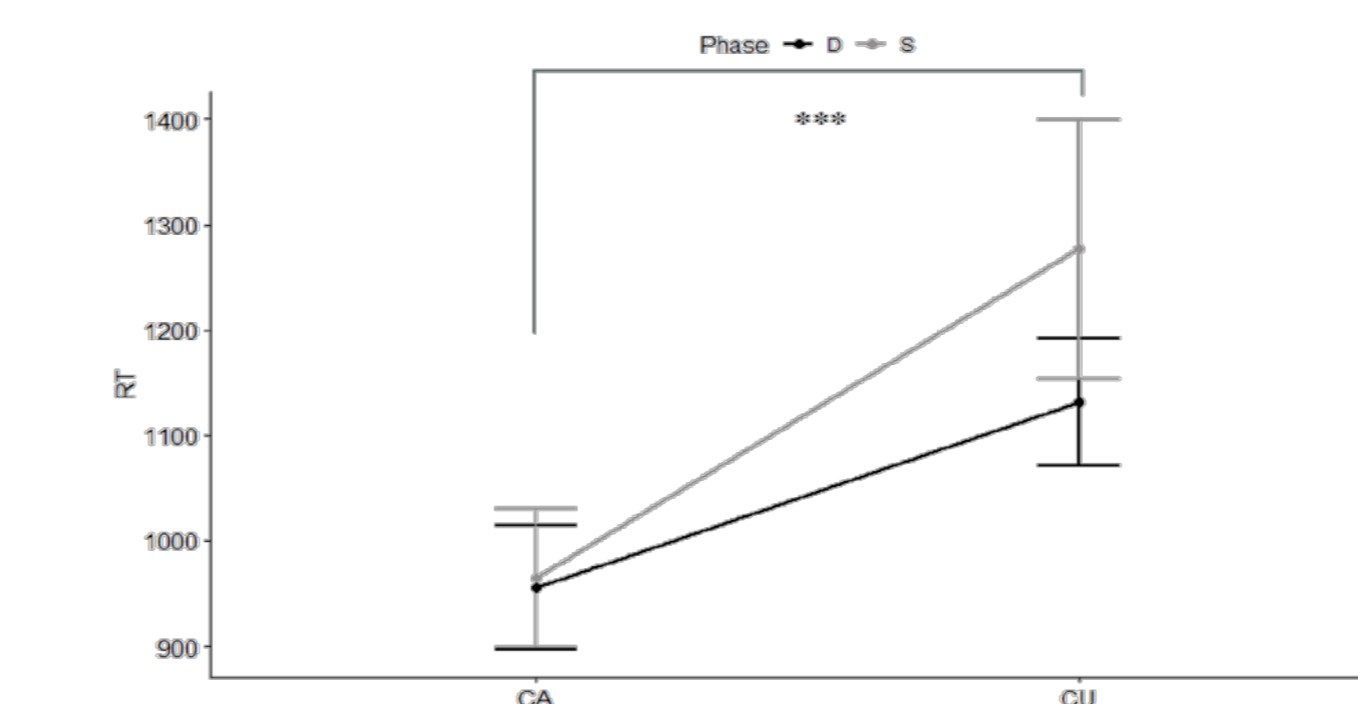


Figure 1. Differences in RT according to the cardiac phase and conscious perception. The \*\*\* indicates significance with  $p < .001$ . The error bars indicate the standard error of the mean.

## Discussion I — Behavioural

- RT are faster when the stimulus is consciously perceived.
- Tendency for **slower responses in the systolic phase** when subjects don't become aware of the stimulus.

## Results II-ERPs

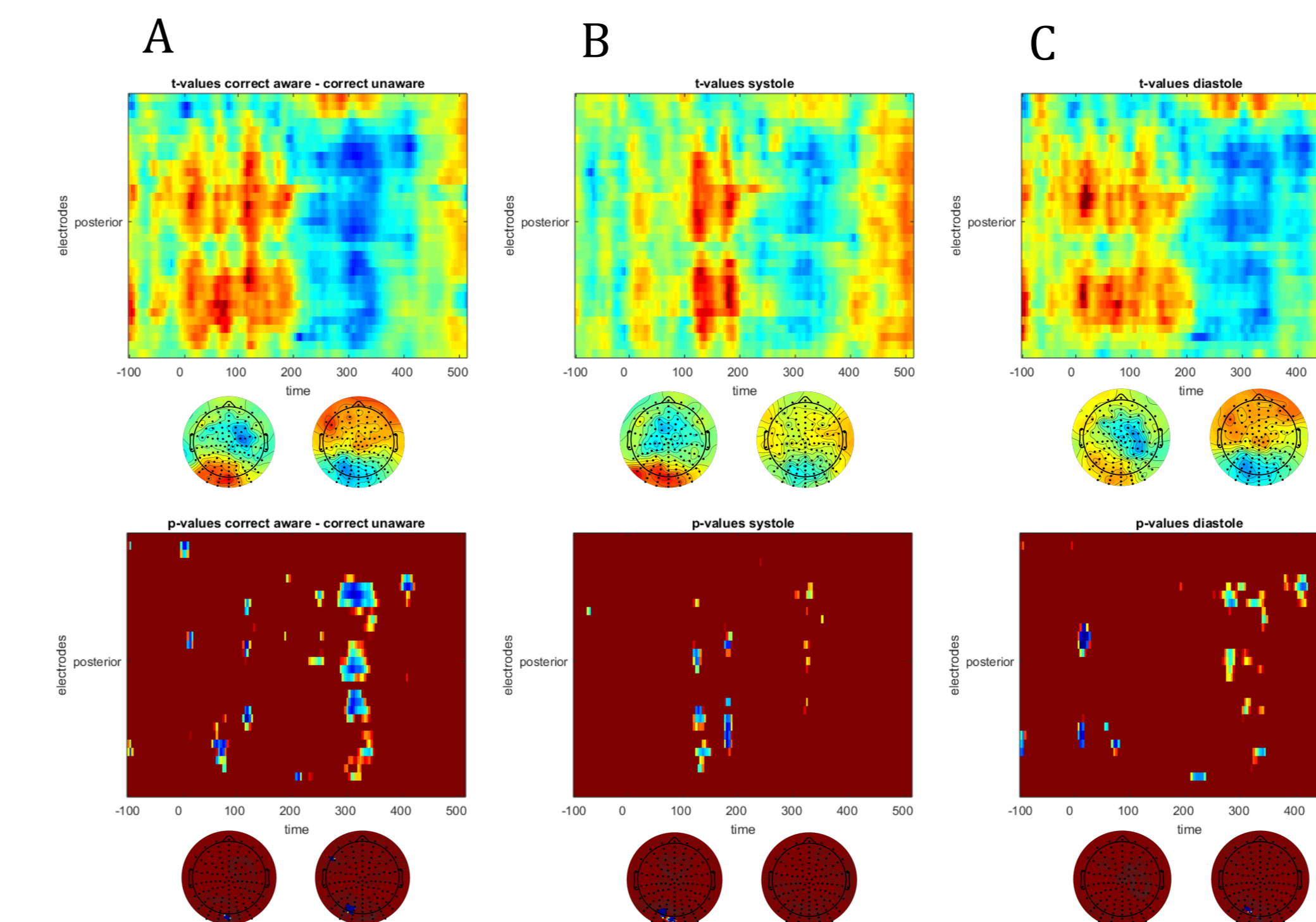


Figure 2. Time course of amplitude differences in the CA and CU conditions in the posterior regions for the whole trials (A), the systolic (B) and diastolic (C) phase respectively. The top section shows the t-values while the bottom section displays significant ( $p < .01$ ) p-values

## Discussion II—ERPs

- ERP amplitude modulation as function of cardiac phase:
- early exogenous potentials are modulated during systole
  - late endogenous potentials are modulated during diastole

**Baroreceptor activity interferes with sensory processing of simple visual stimuli**

## References

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## Results III—HER

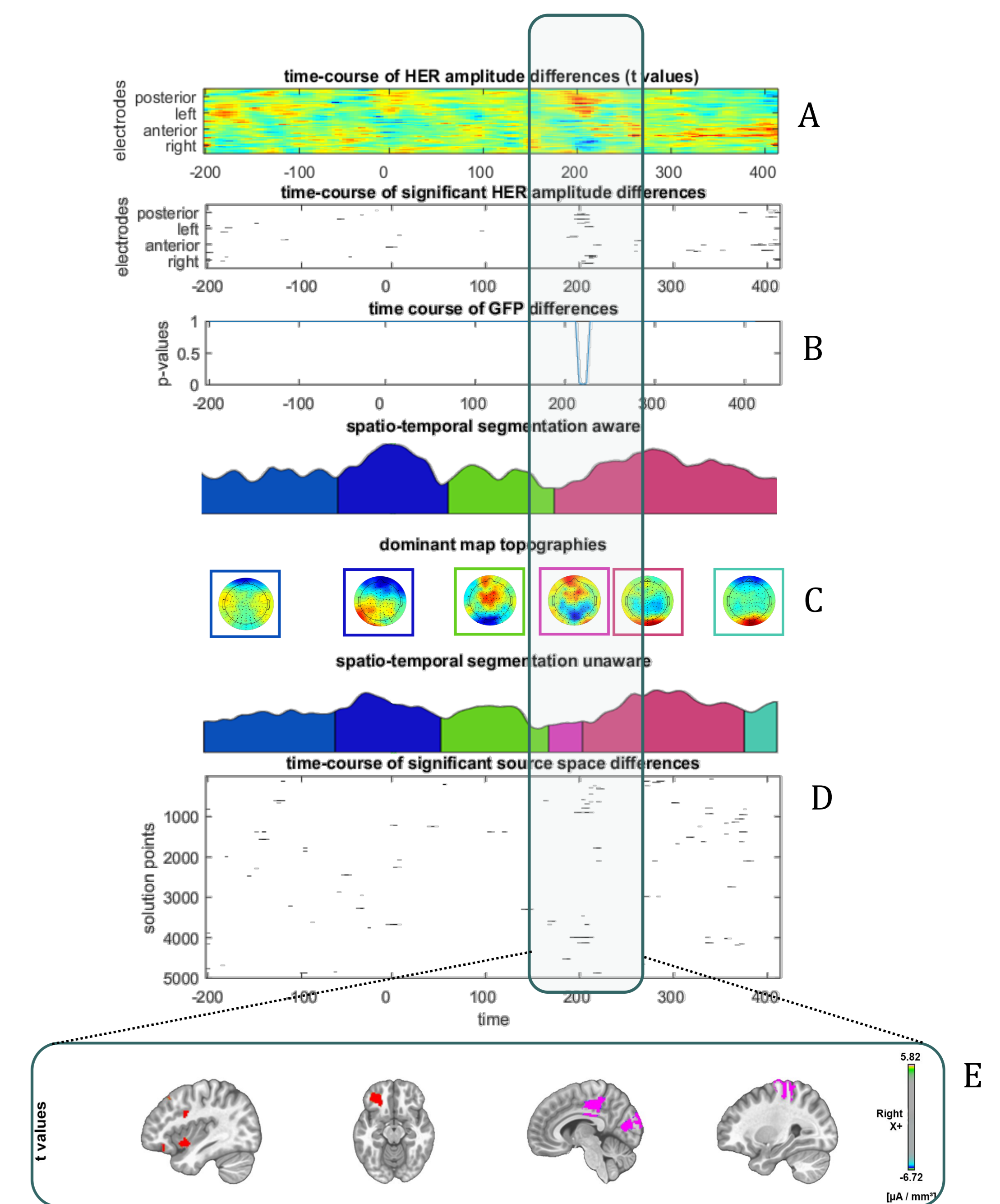


Figure 3. Time course of the T-wave evoked response difference between the CA and CU conditions. A) t (top) and p values for the amplitude differences. P values are displayed at the 0.01 level. B) Significant GFP amplitude differences ( $p < .05$ ). C) Spatio temporal segmentation for the CA (top) and CU condition with respective dominant map topographies. D) Significant inverse solutions points ( $p < .01$ ). E) Location of the differences between conditions. The anterior insula (AI) and orbitofrontal cortex (OFC) are more active during the CA conditions while the posterior cingulate cortex (PCC) and pre-cuneus

## Discussion III—HER

brain response to heartbeat before stimulus onset differs for aware and unaware trials

Increased activity in:

- **SN** predicts correct identification with **awareness**
- **DMN** predicts correct identification **without awareness**

## Take Home Message

**Pre-stimulus HER predicts aware and unaware trials**  
**Cardiac phase selectively affects ERPs reflecting sensory and perceptual processes**

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