

# Neurocardiac dynamics initiate emotional processing through parasympathetic afferents

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## SUMMARY

We investigated the functional brain-heart interplay under emotion elicitation and estimated the bidirectional brain-heart interplay with a computational model based on synthetic data generation of EEG and ECG signals. The observed neural dynamics showed that **the heart prompts emotions**, supporting causation theories of physiological feelings. The ascending **parasympathetic modulations to the brain correlate with the reported arousal** and triggers a cascade of cortical activations. Our results demonstrate that the **emotional experience raise from the mutual interplay between brain and body**.

## INTRODUCTION

A century-long debate on bodily states and emotions persists. While the involvement of bodily activity in emotion physiology is widely recognized, the specificity or causative role of such activity has not yet been demonstrated <sup>1</sup>. We hypothesize that the peripheral neural control of cardiovascular activity prompts and sustains brain dynamics during an emotional experience.

## METHODS

We investigated the functional brain-heart interplay under emotion elicitation in publicly available data from 62 healthy participants <sup>2,3</sup>. The estimation of the bidirectional brain-heart interplay was assessed with a computational model based on synthetic data generation of EEG and ECG signals <sup>4</sup>. The output of the model are time-varying coupling coefficients, for either ascending or descending interplay, between EEG bands and heartbeat's spectral estimators of sympathovagal activity (HF and LF).

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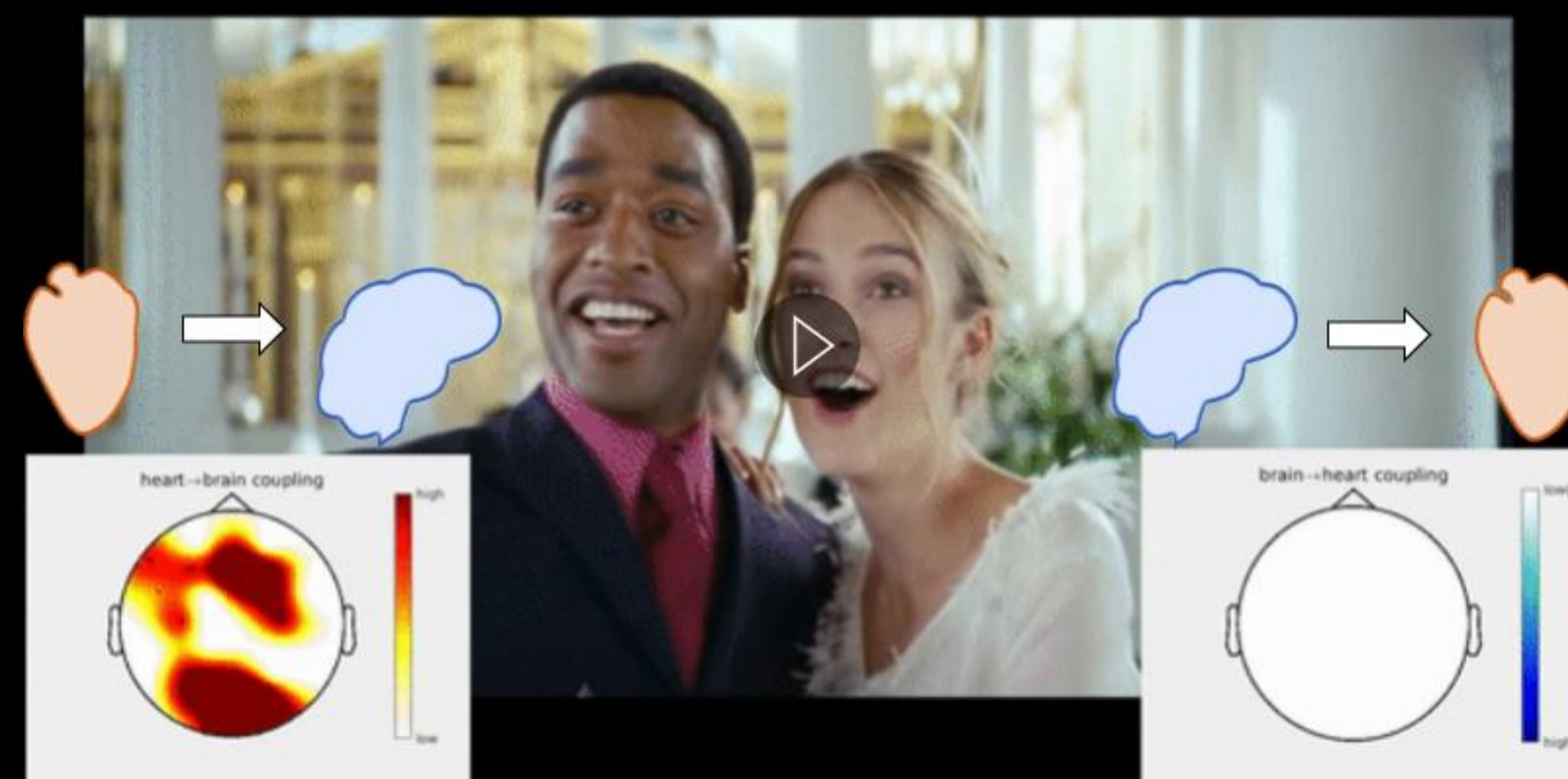


Fig. 1. Exemplary case of a pleasant trial which triggered ascending interplay from heart to brain, found as clustered effect compared against rest. Video: *Love Actually* by Richard Curtis, Universal Pictures.

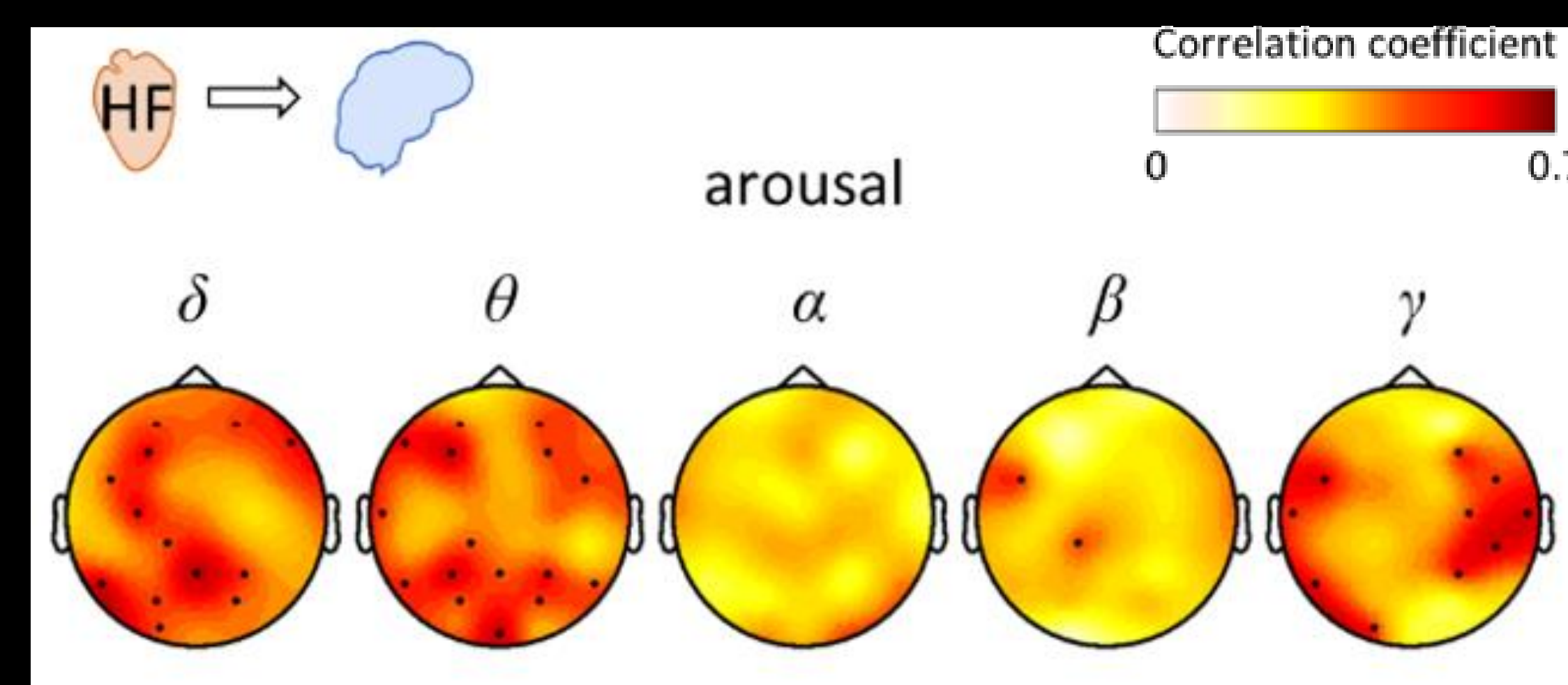


Fig. 2. Group-wise correlation between HF-to-brain interplay and reported arousal

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## RESULTS

Our findings show that parasympathetic activity plays a leading and causal role in initiating the emotional response, in which ascending modulations precede the descending modulations in the bidirectional communication measurements (Fig.1) . Furthermore, we found the existence of a bidirectional interplay between central and peripheral neural dynamics in emotional processing, and the average ascending interplay measured during the whole trial is correlated to the reported level of arousal (Fig. 2).

## DISCUSSION

The observed neural dynamics showed that the heart prompts emotions, supporting causation theories of physiological feelings <sup>1</sup>. Our results demonstrate that the emotional experience raise from the mutual interplay between brain and body. The brain receives afferent autonomic information, triggering a cascade of cortical activations <sup>5</sup>. In turn, the brain performs directed neural control onto the heart. The observed ascending pathway of parasympathetic activity towards cortical regions suggests that emotion processing is an integration of physiological inputs in the brain <sup>6</sup>, rather than an interpretation of the physiological changes.