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Link to preregistration: https://osf.io/ptbzf/

Heart-evoked potentials reflect interoceptive-exteroceptive predictions, during a paradigm with individual adjustment of cardio-audio delays

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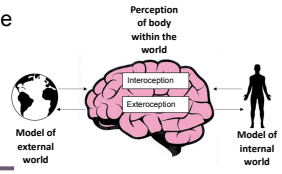
INTRODUCTION

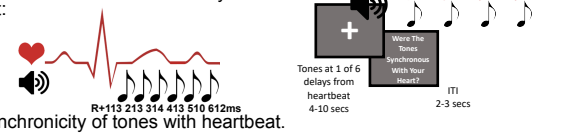
- Integration of internal and external signals important for a unified interactive experience of the body in the external world[1].
- Predictive coding models describe these integrated mechanisms as predictive and precision-weighted[2,3].
- Our previous study found **heartbeat-driven expectations of sounds** and **attentional-precision** modulation of predictive mechanisms reflected in **heartbeat-evoked potentials** (HEPs). However, **no trait-precision** modulation by interoceptive performance was found[4].
- In this study, we **individually-tailored** the cardio-audio delays[5] to more accurately **test precision modulations** of cross-modal predictive mechanisms, determining **if HEPs operate under a predictive coding framework.**



METHOD

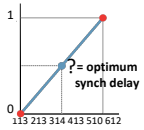
1 Multi-interval heartbeat discrimination

- 120 trials: 5-7 Sounds at 1 of 6 delays from heartbeat:
- Judge synchronicity of tones with heartbeat.



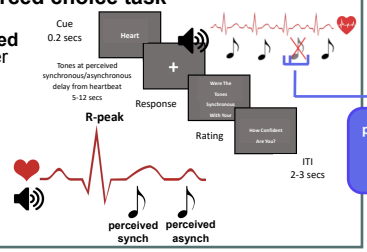
2 Determine perceived synchronous delay

- median of linearly interpolated cumulative distribution of choices from multi-interval task.



3 Individually-adjusted two-forced choice task

- 168 trails: 7-10 sounds at **perceived synchronous** delay or 300ms later **perceived asynchronous** delay from heartbeat.
- 50% include a **omission** (missing sound).
- **Attention** (internal/external) manipulated and **interoceptive ability** measured.

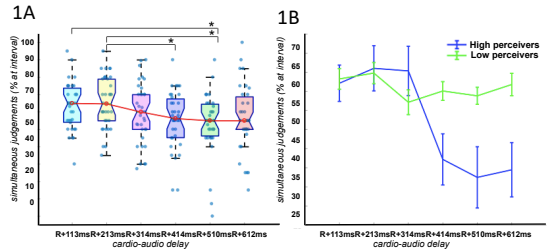


pre/post-omission HEP responses analysed separately

RESULTS

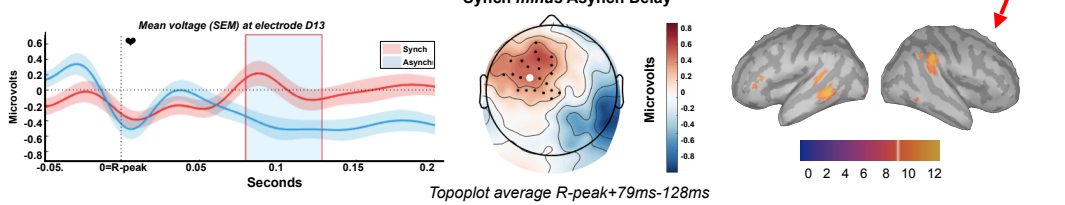
Behavioural results

- Perceived synchrony preference for cardio-audio delays closer to heartbeat (R+113 & R+213ms), than further delays (R+414ms & R+510ms) (Figure 1A).
- Preference effect more pronounced in high heartbeat perceivers, determined by individual Chi2 tests (Figure 1B).



Cardio-audio expectation

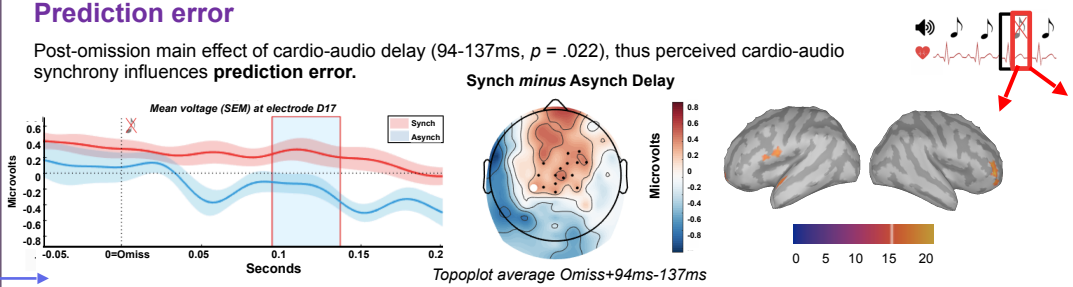
Replicated pre-omission main effect of cardio-audio delay (79-128ms, p = .024), reflecting **cardio-audio expectation** differences.



Topoplot average R-peak+79ms-128ms

Prediction error

Post-omission main effect of cardio-audio delay (94-137ms, p = .022), thus perceived cardio-audio synchrony influences **prediction error.**



Topoplot average Omiss+94ms-137ms

Precision

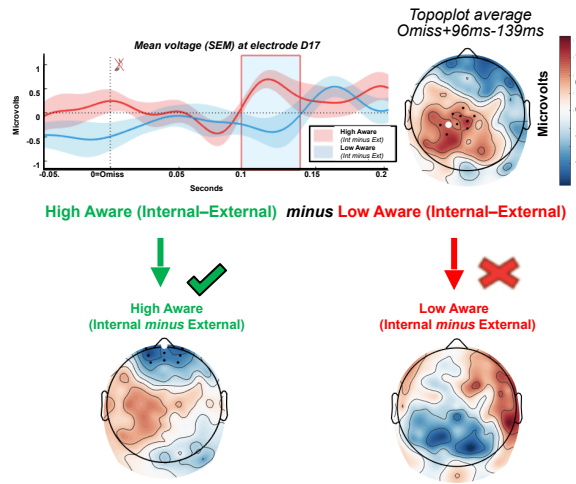
- **No state-precision** modulation of cross-modal predictive mechanisms by **attention.**
- **No trait-precision** modulation of cross-modal predictive mechanisms by **interoceptive ability.**

DISCUSSION

- **No evidence of precision-modulation** of integrated cross-modal predictive mechanisms, despite using a more sensitive individually-adjusted task – thus **HEPs** may **not reflect precision-weighted** predictive responses.
- However, using tailored delays may have enhanced the perception of cardio-audio synchrony, resulting in **less reliance on attentional precision** to boost predictions.
- Also, measuring interoceptive ability is challenging, thus interoceptive performance variations may not reflect variations in trait-precision.
- Nonetheless, the **robust delay effects** observed in both studies **support intero-extero integration in HEPs** – providing a useful tool for assessing the relationship with cognition and clinical groups.

Interoceptive awareness and attention interaction

Post-omission awareness and attention interaction during perceived synchronous trials (96-139ms, p = .014), driven by a attention difference in high heartbeat awareness participants only (105-131ms, p=.019).



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