Measuring Inter-Brain Synchrony: Methods and Pitfalls

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Today

1) What is inter-brain synchrony?

2) How do we **record** it?

3) How do we **quantify** it?

4) How can we **use** it in studies?

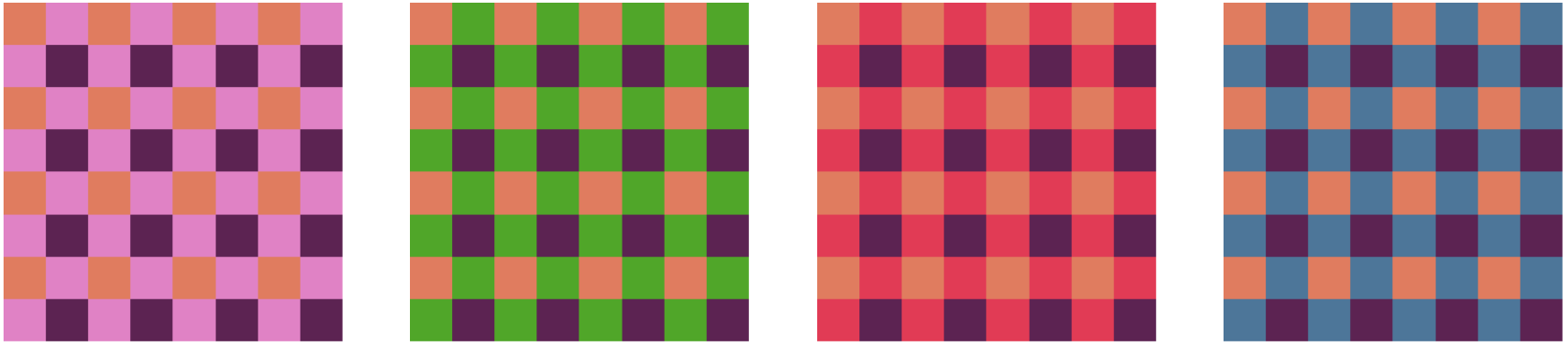
What is inter-brain synchrony?

Inter-Brain Synchrony (IBS)

- Found during social interaction (Konvalinka & Roepstorff, 2012)
- Influenced by
  - Gender (male IBS > female IBS; Cheng et al., 2015)
  - Relationship duration (Dikker et al., 2021; Pan et al., 2017)
  - Autism spectrum disorder (Salmi et al., 2013; Valencia & Froese, 2020)

How do we **record** inter-brain synchrony?

A Tacit Coordination Task



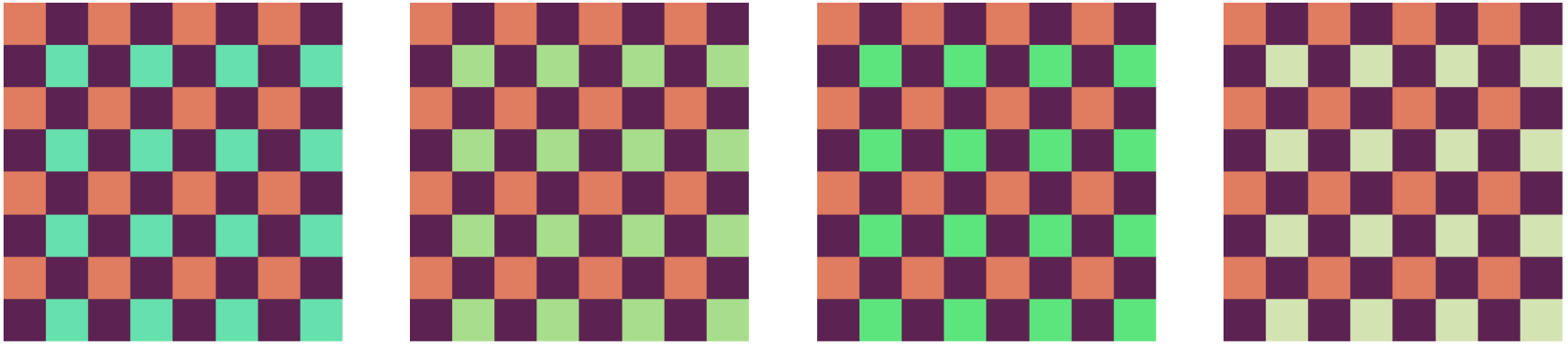
(Newman et al., 2021)

A Tacit Coordination Task

Incorrect

(Newman et al., 2021)

A Tacit Coordination Task

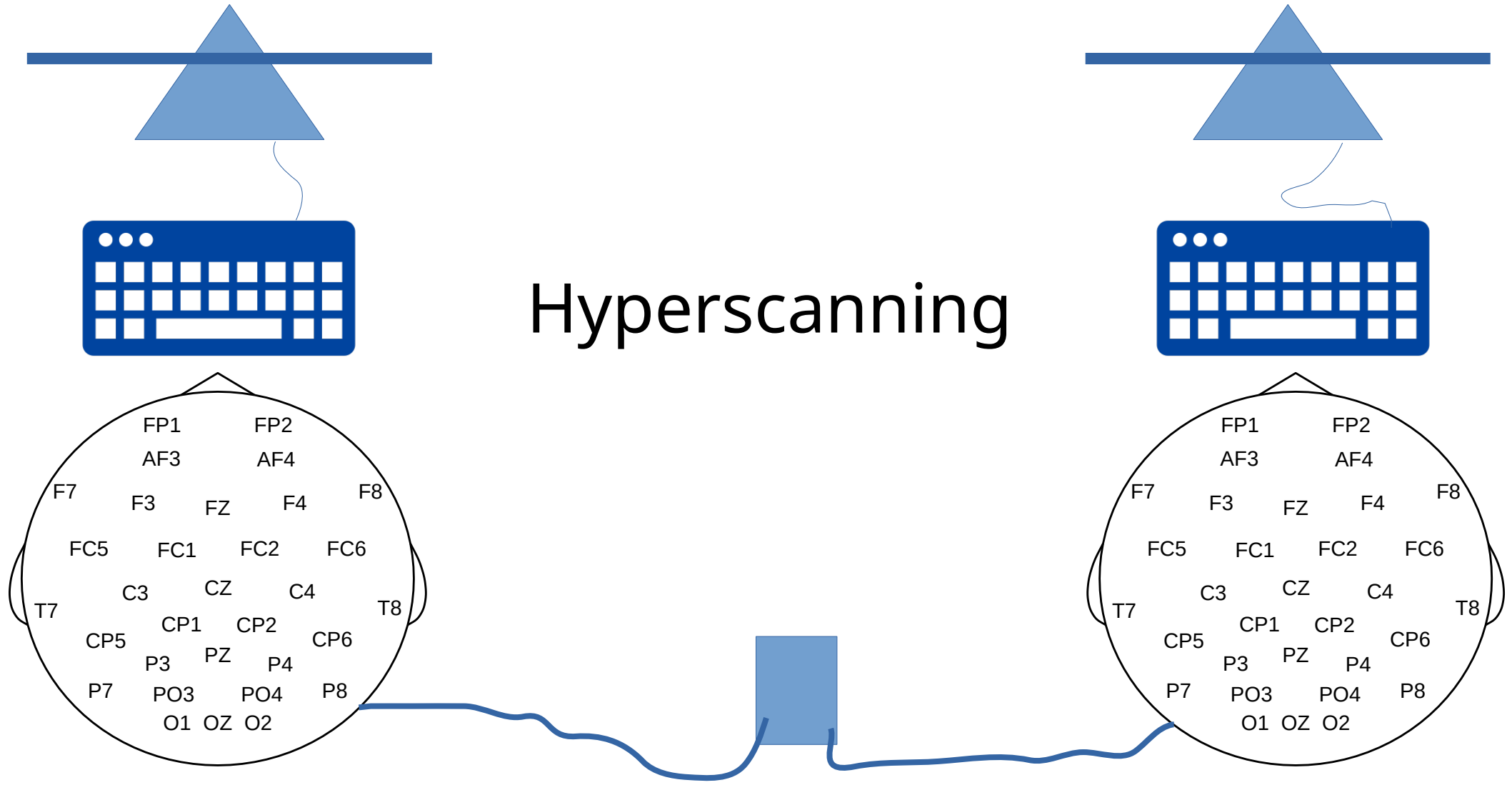


(Newman et al., 2021)

A Tacit Coordination Task

Correct

(Newman et al., 2021)


Hyperscanning
FP1
FP2
AF3
AF4
F7
F3
FZ
F4
F8
FC5
FC1
FC2
FC6
C3
CZ
C4
T7
T8
CP1
CP2
CP5
CP6
P3
PZ
P4
P7
PO3
PO4
P8
O1
OZ
O2

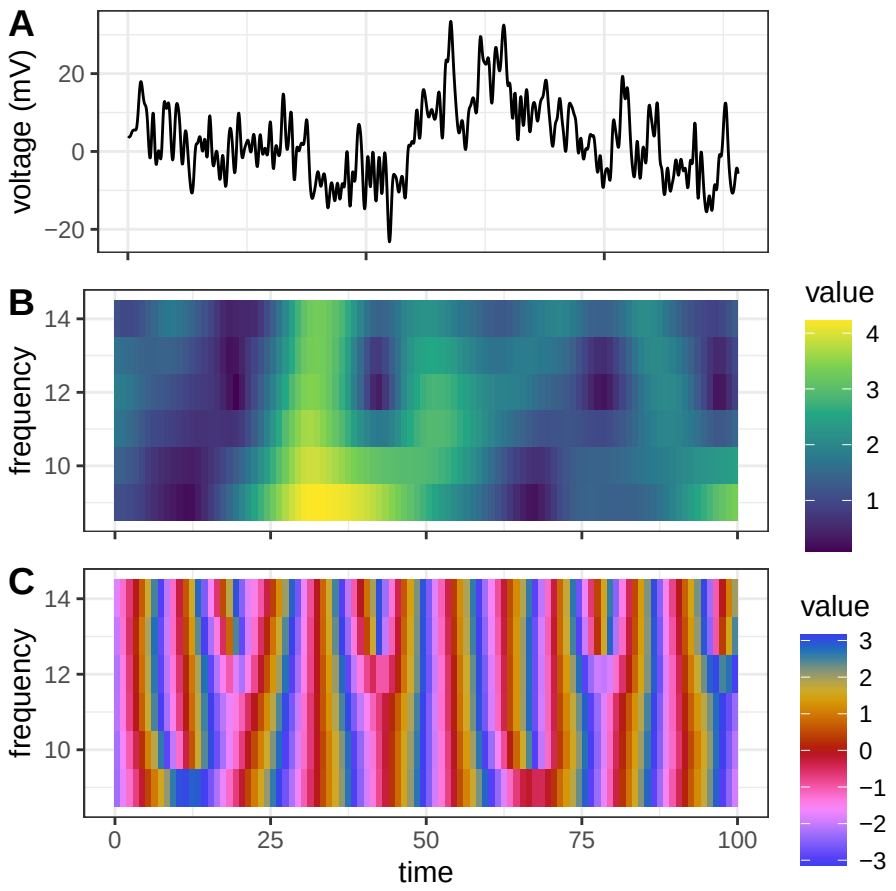
How do we **quantify** inter-brain synchrony?

Time-Frequency analysis

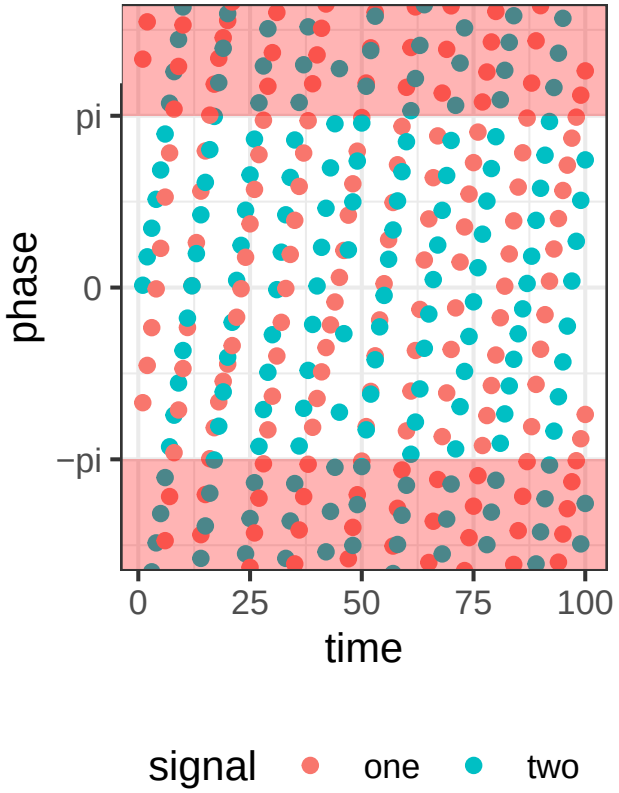
Two signals for each:

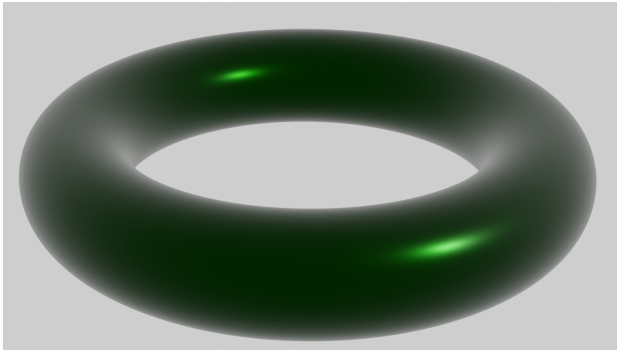
- Electrode
- Trial
- Frequency band (here: alpha)

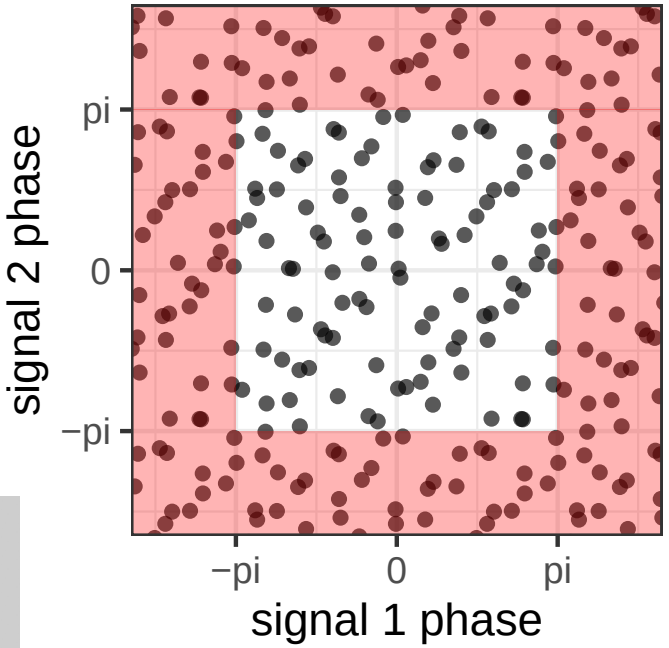
focus



Inter-Brain Synchrony



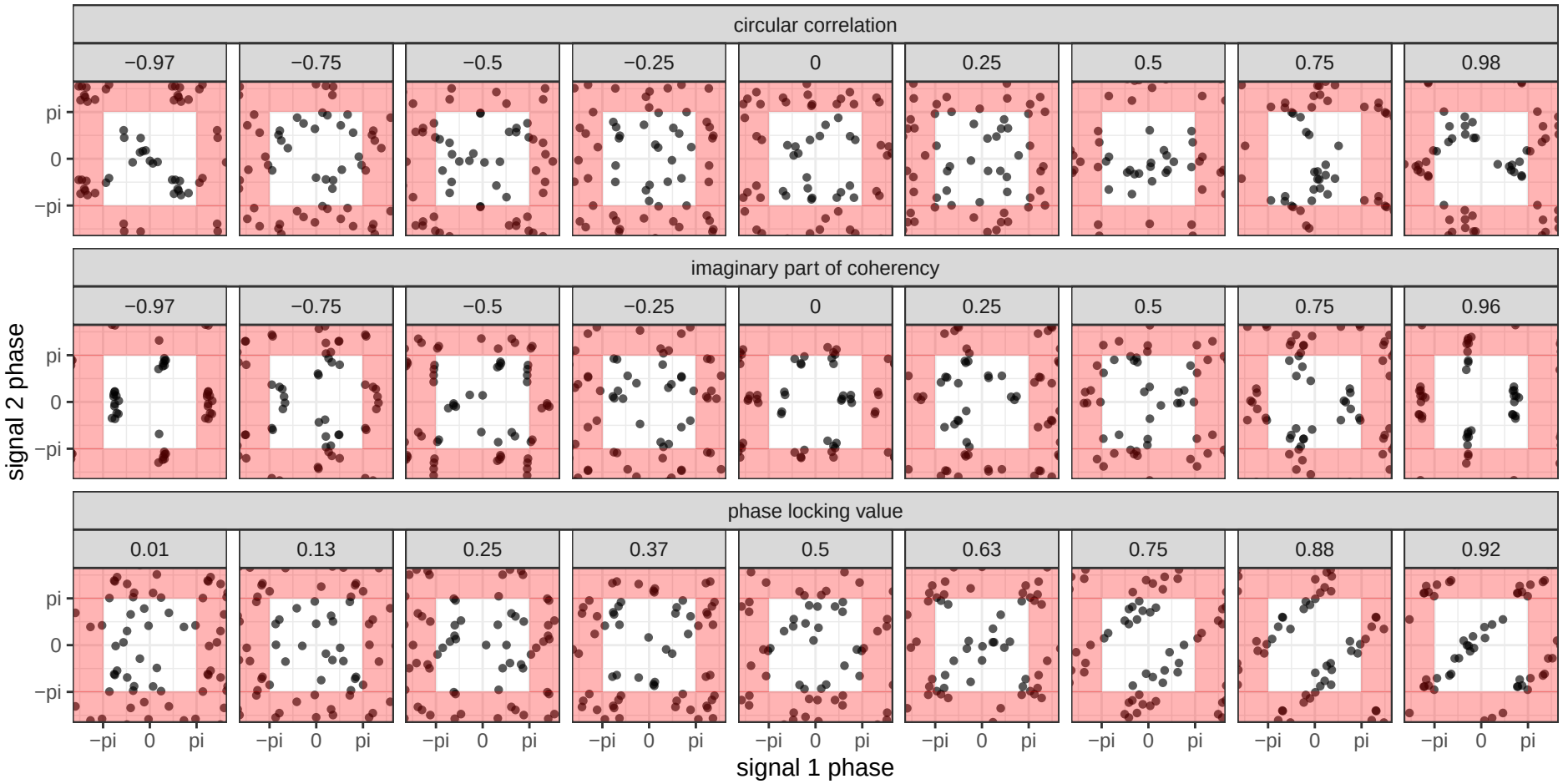




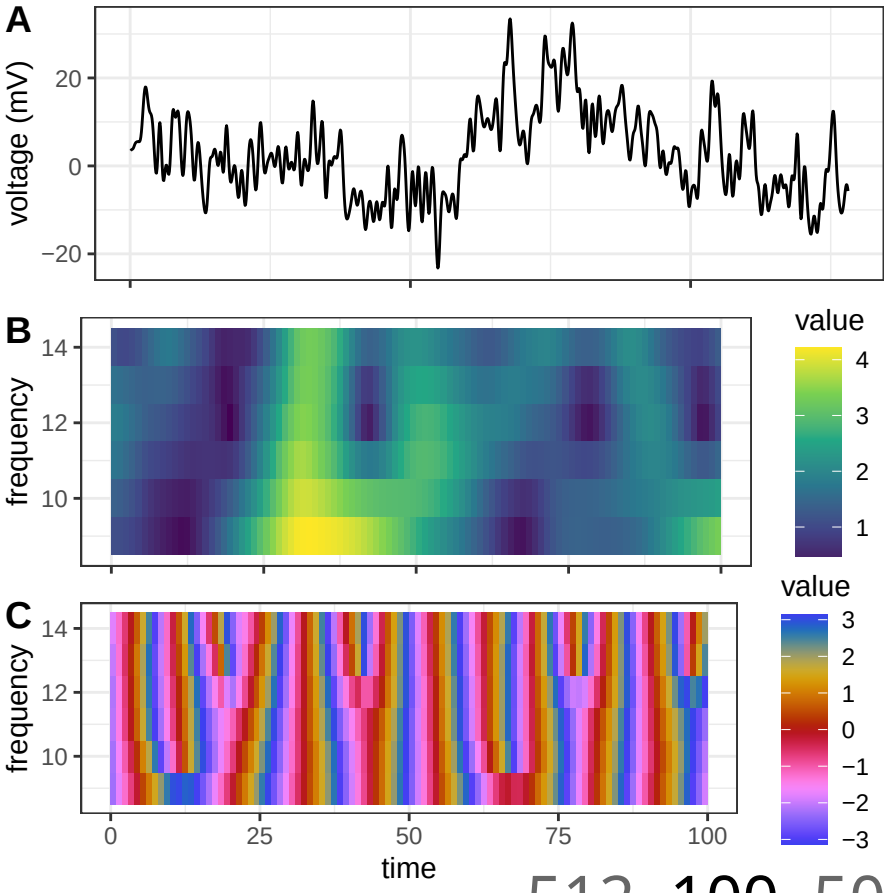
Inter-brain synchrony measures (1)

- Circular correlation (Burgess, 2013)
- Phase Locking Value (Lachaux et al., 1999)
- Imaginary part of coherency (Nolte et al., 2004)

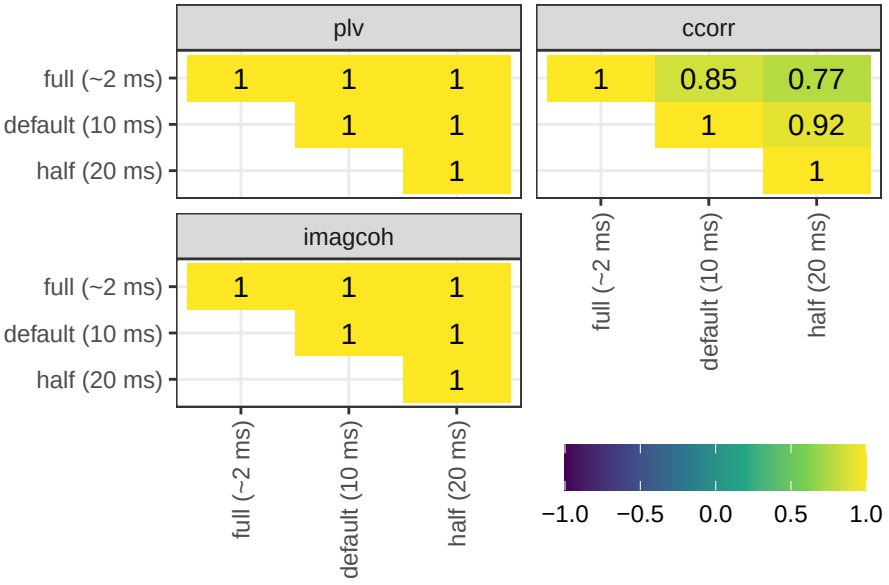
Inter-brain synchrony measures (2)



Frequency analysis resolution effect



512, 100, 50

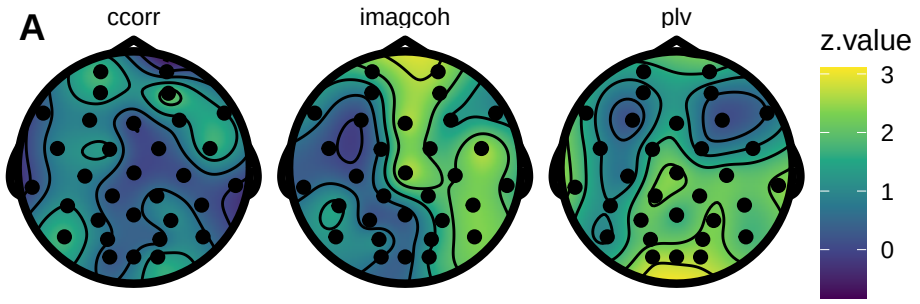


How do we **use** inter-brain synchrony in studies?

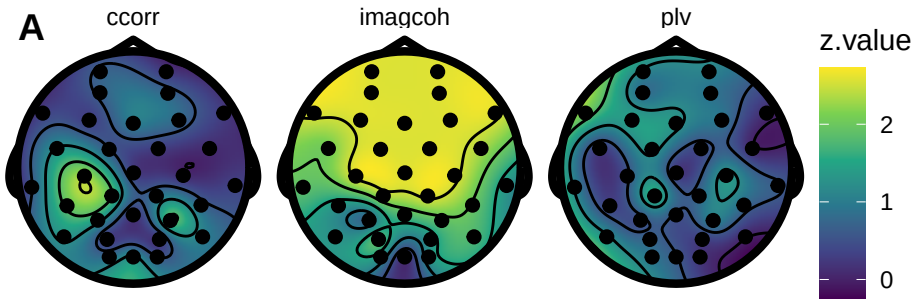
Is the inter-brain synchrony **significant**?

No.

Alpha band

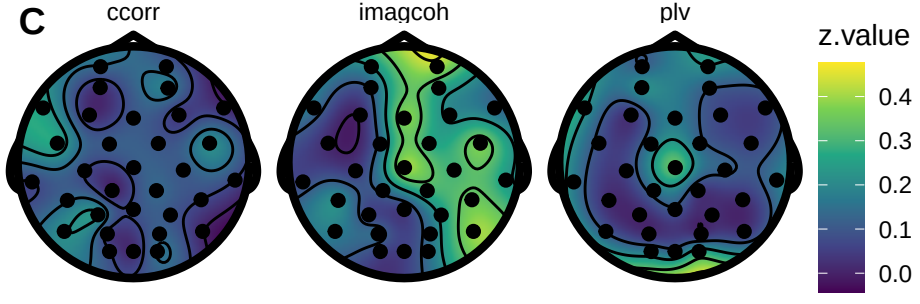


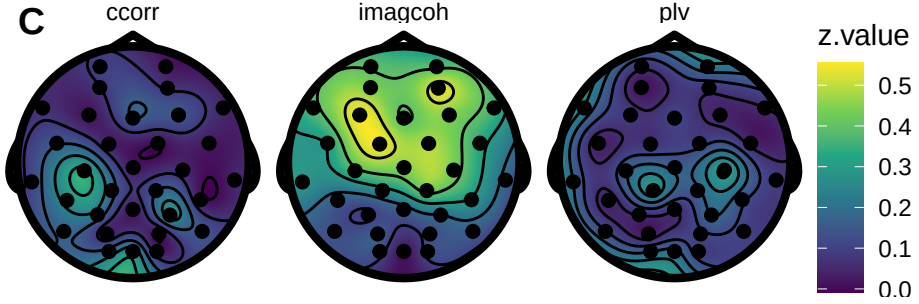
Theta band



Time shuffled

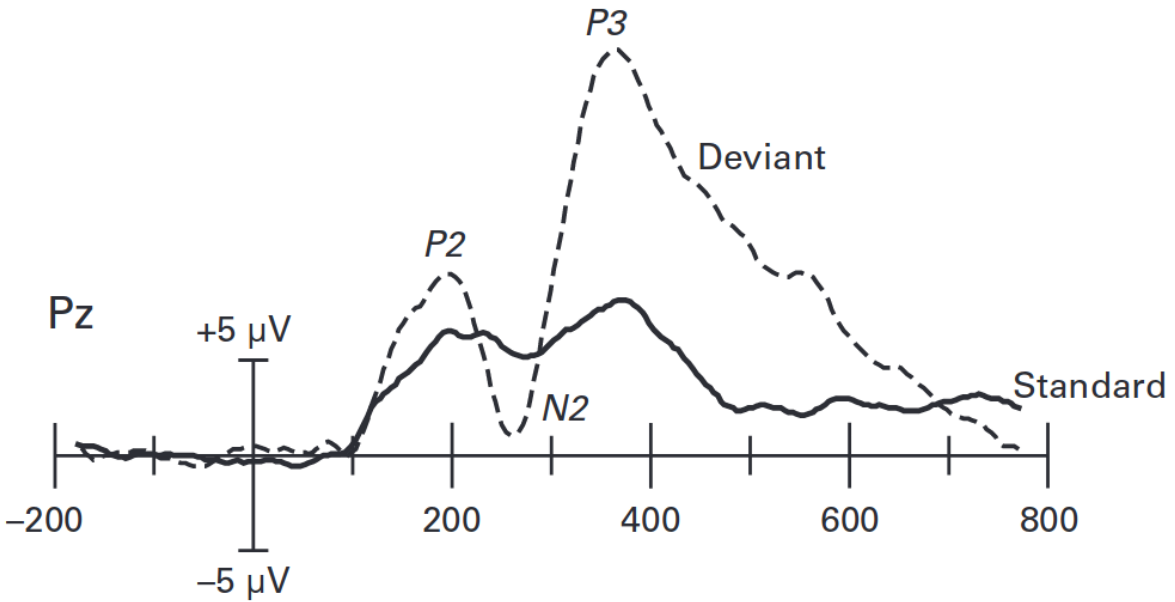
Groups shuffled





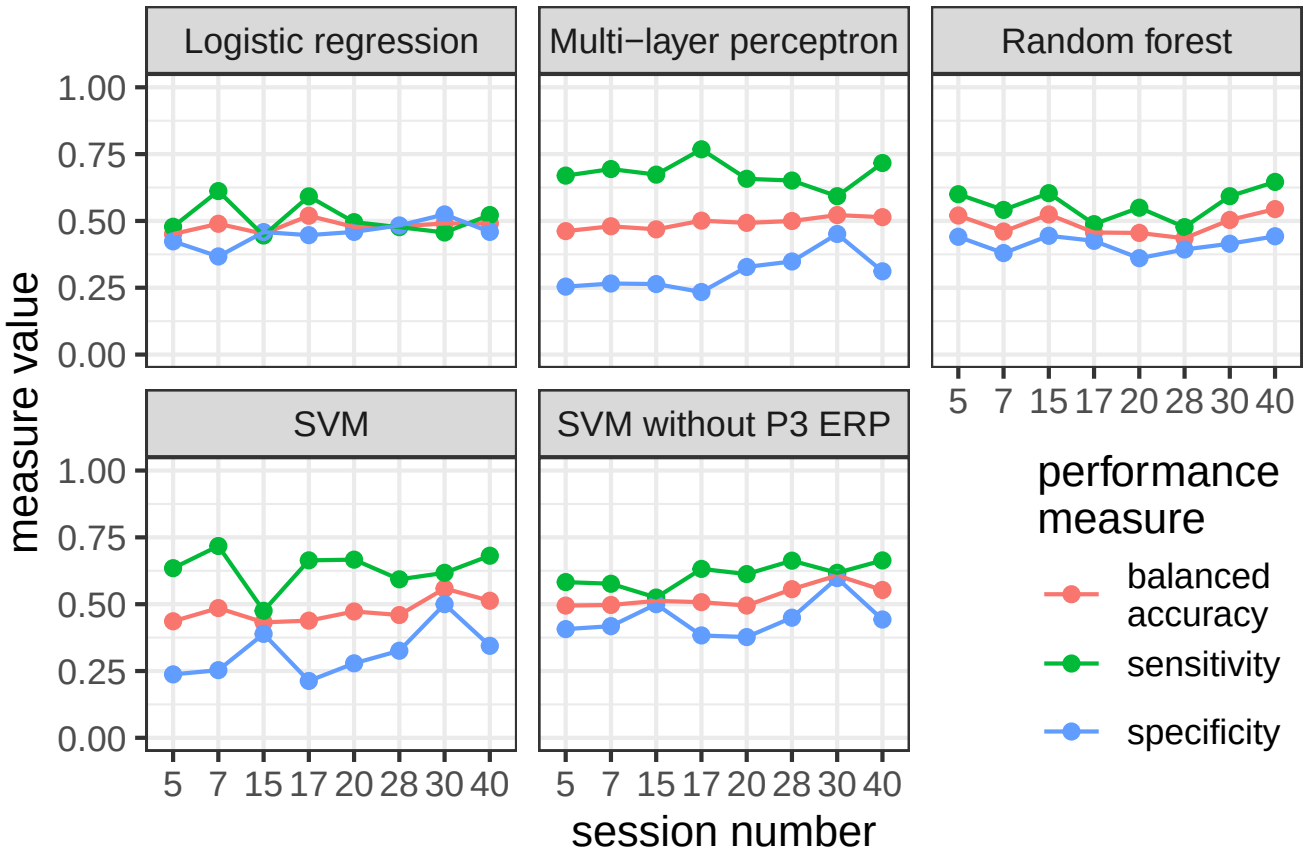
Prediction (1)

P3 Event-Related Potential



Source: Luck, 2014, p.79

Prediction (2)



Look at the red line!

Discussion (1)

Recommended measures:

- Circular correlation
  - Performs well in simulations (Burgess, 2013)
  - But: requires careful interpretation
- Phase locking value
  - Popular
  - Mostly works

Discussion (2)

- No IBS found
- Interpreting Inter-Brain Synchrony values in isolation is risky
- Causal mechanism behind prediction

Future Research

- Amplitude-based measures
  - Projected power correlation (Hipp et al., 2012)
- Information-based measures
  - Kraskov mutual information (Kraskov, 2004)
- Standardization of IBS experiments (Burgess, 2013; Ayrolles et al., 2021)

References

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Image sources

- https://thenounproject.com/icon/brain-206190/
- https://thenounproject.com/icon/keyboard-3204178/
- https://thenounproject.com/icon/measure-2279416/

Thank you for your attention!

Questions?