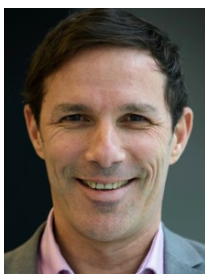
Narratives drive the Brain-Body Dynamical System

Jens Madsen

Samantha Cohen

Jason Ki

Maximilian Nentwich

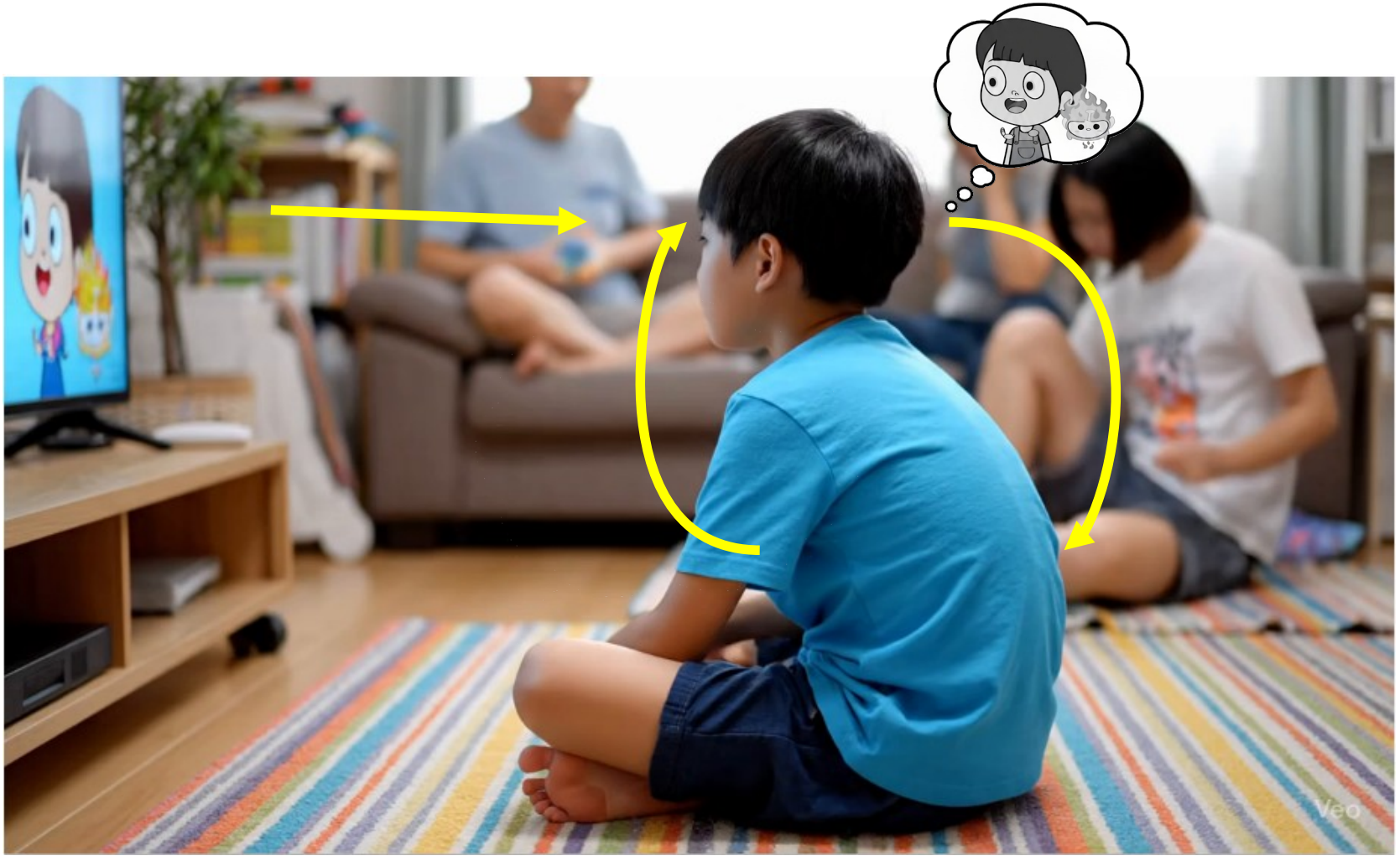


Lucas Parra

The City College of New York

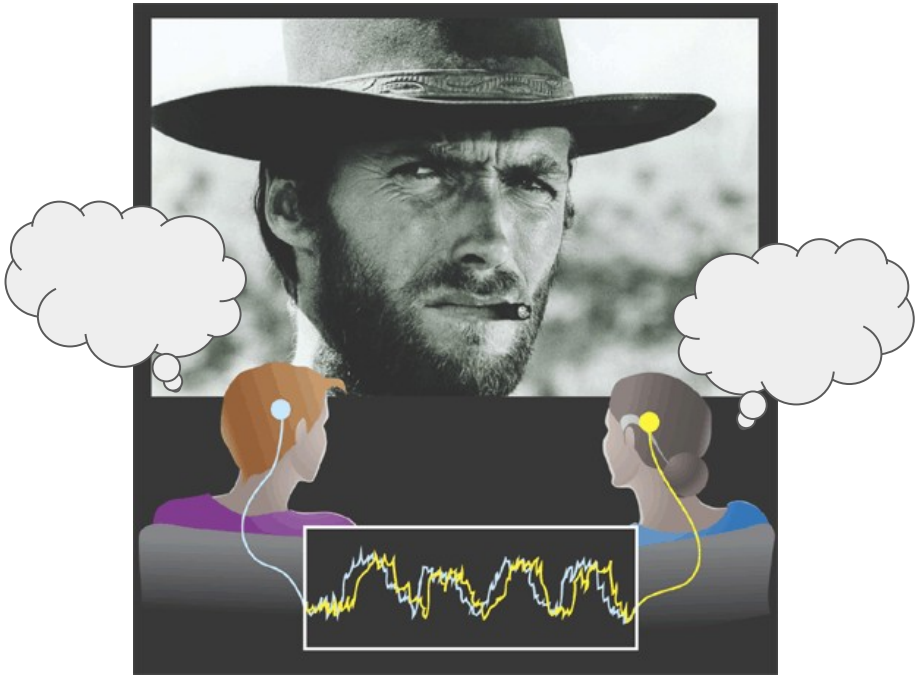
February 2026

Veo



Why and how is this kid sitting still?

Brains on Video



Brains work alike

The story matters

fMRI

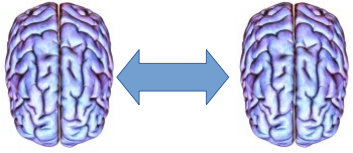
Pioneered by Hasson and Heeger (2004)

Inter-subject correlation

Inter-subject correlation in EEG

Jacek Dmochowski

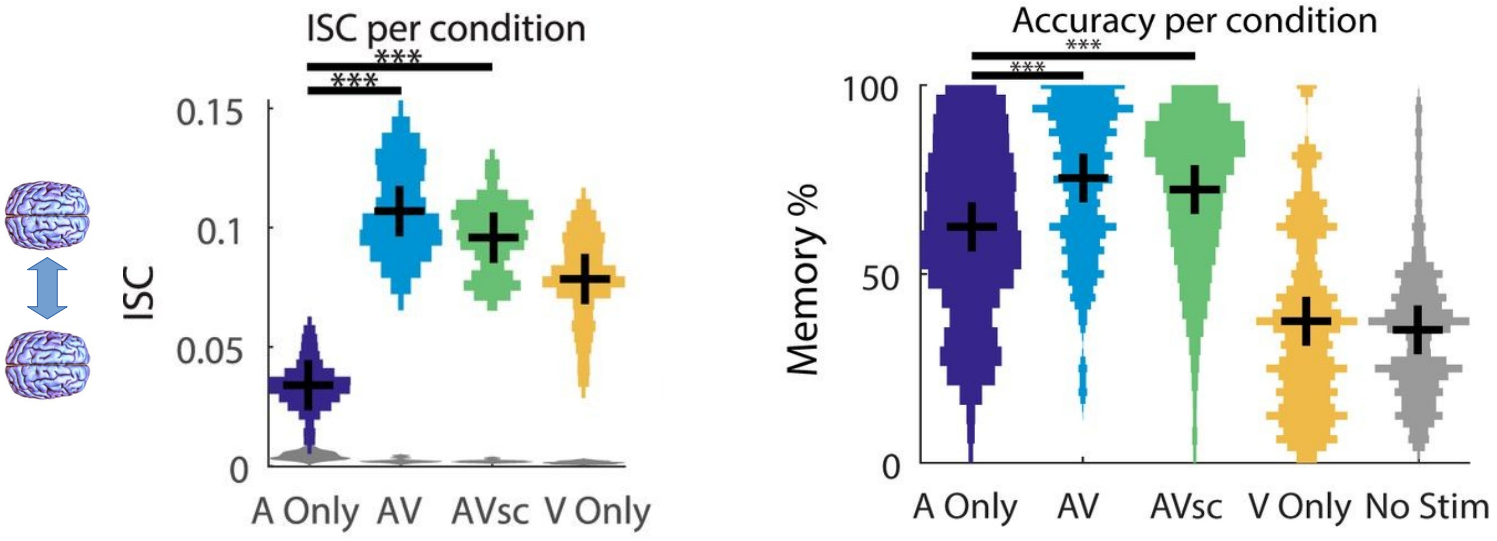
ISC



Dmochowski, Frontiers, 2012

Visuals alone matter

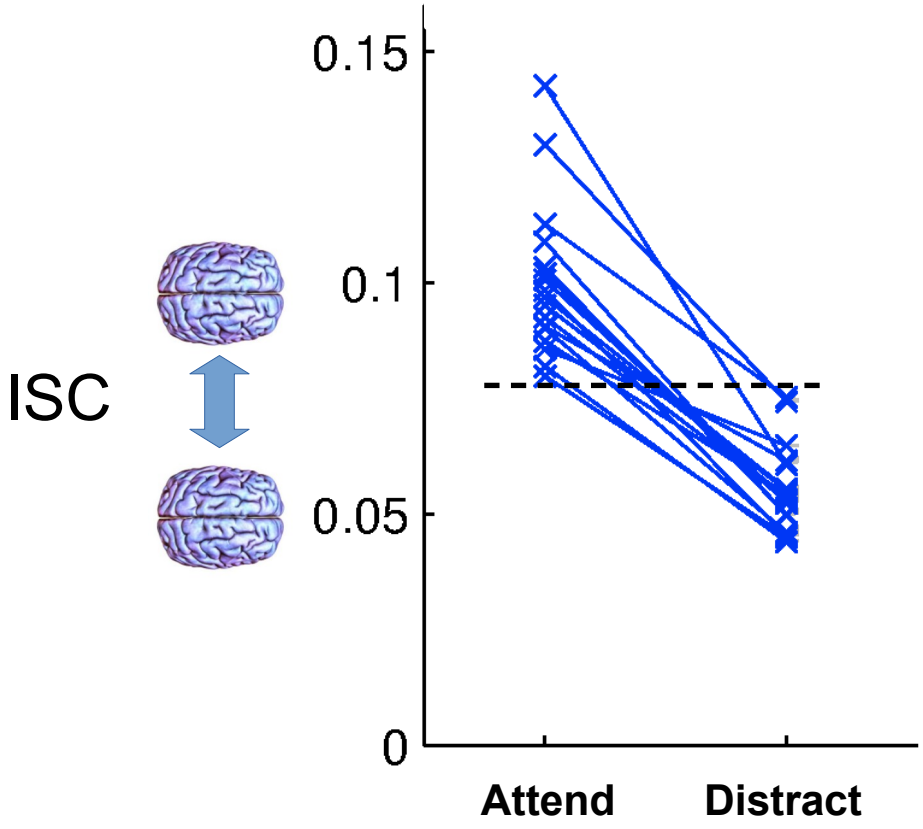
Samantha Cohen



Cohen, Parra, eNeuro, 2016

Attention matters

Jason Ki



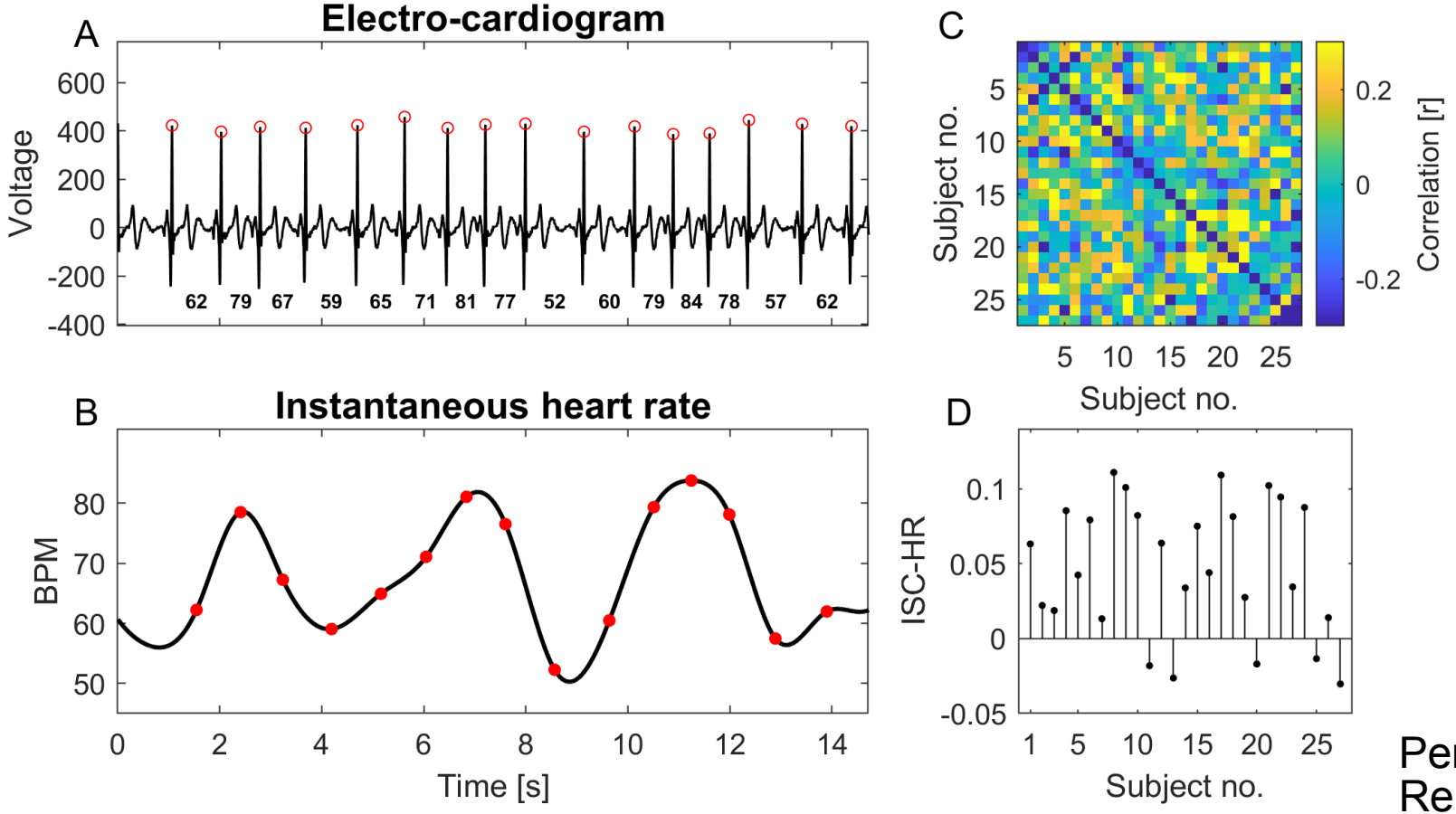
Hitchcock video

Ki, Kelly, Parra, J Neuroscience, 2016

Heart rate during narratives

Jaco Sitt

Jens Madsen

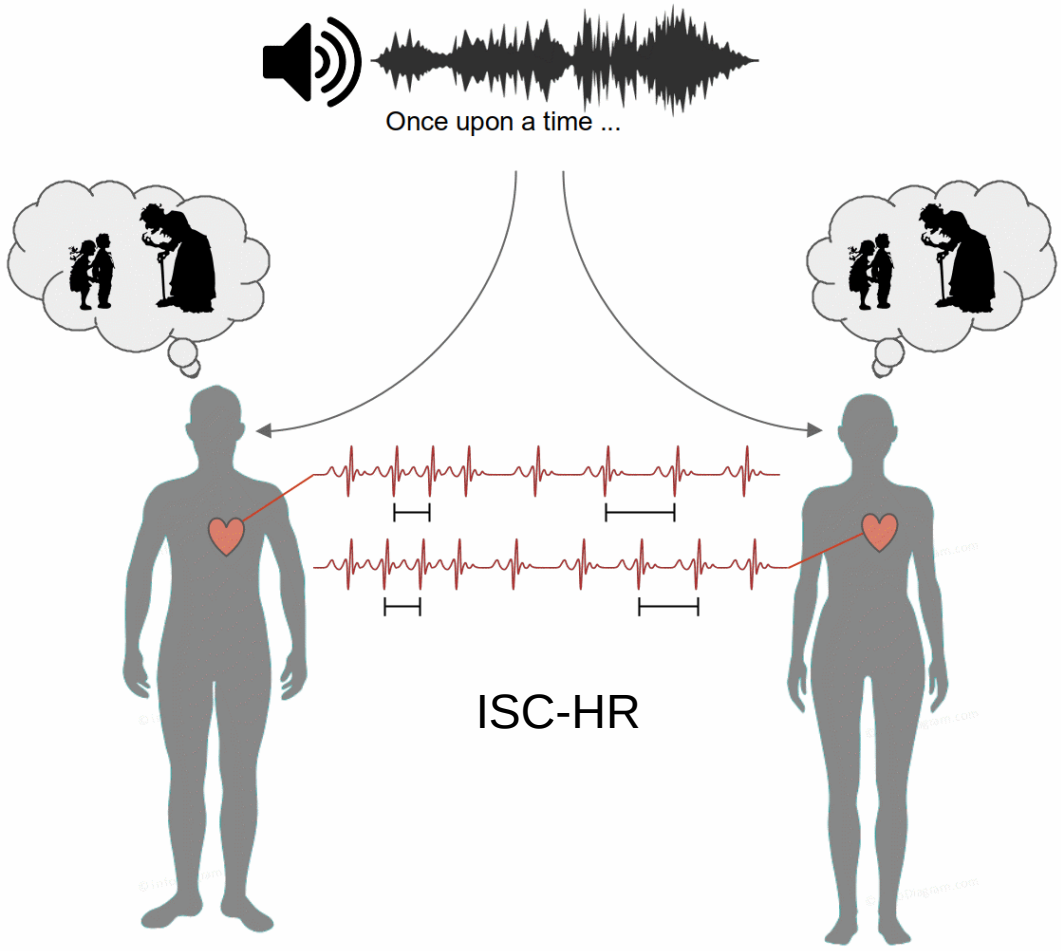


Perez, Madsen, Cell Reports, 2021

Narratives synchronizes our heart (rates)

Jaco Sitt

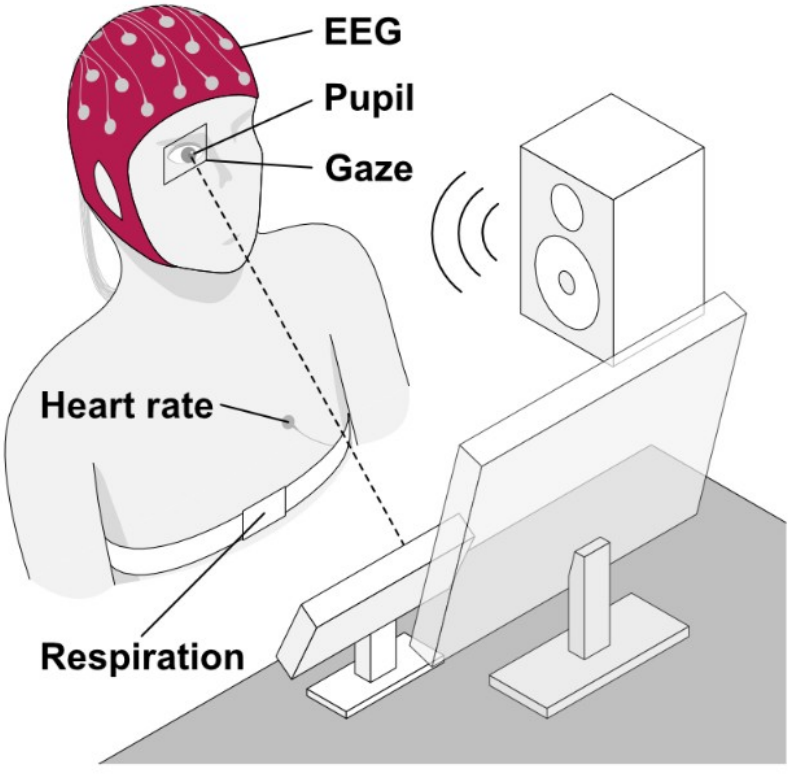
Jens Madsen



Perez, Madsen, Cell Reports, 2021

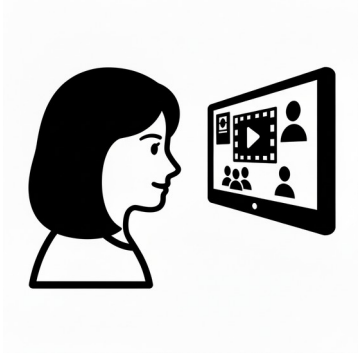
Brain, and Body?

Jens Madsen



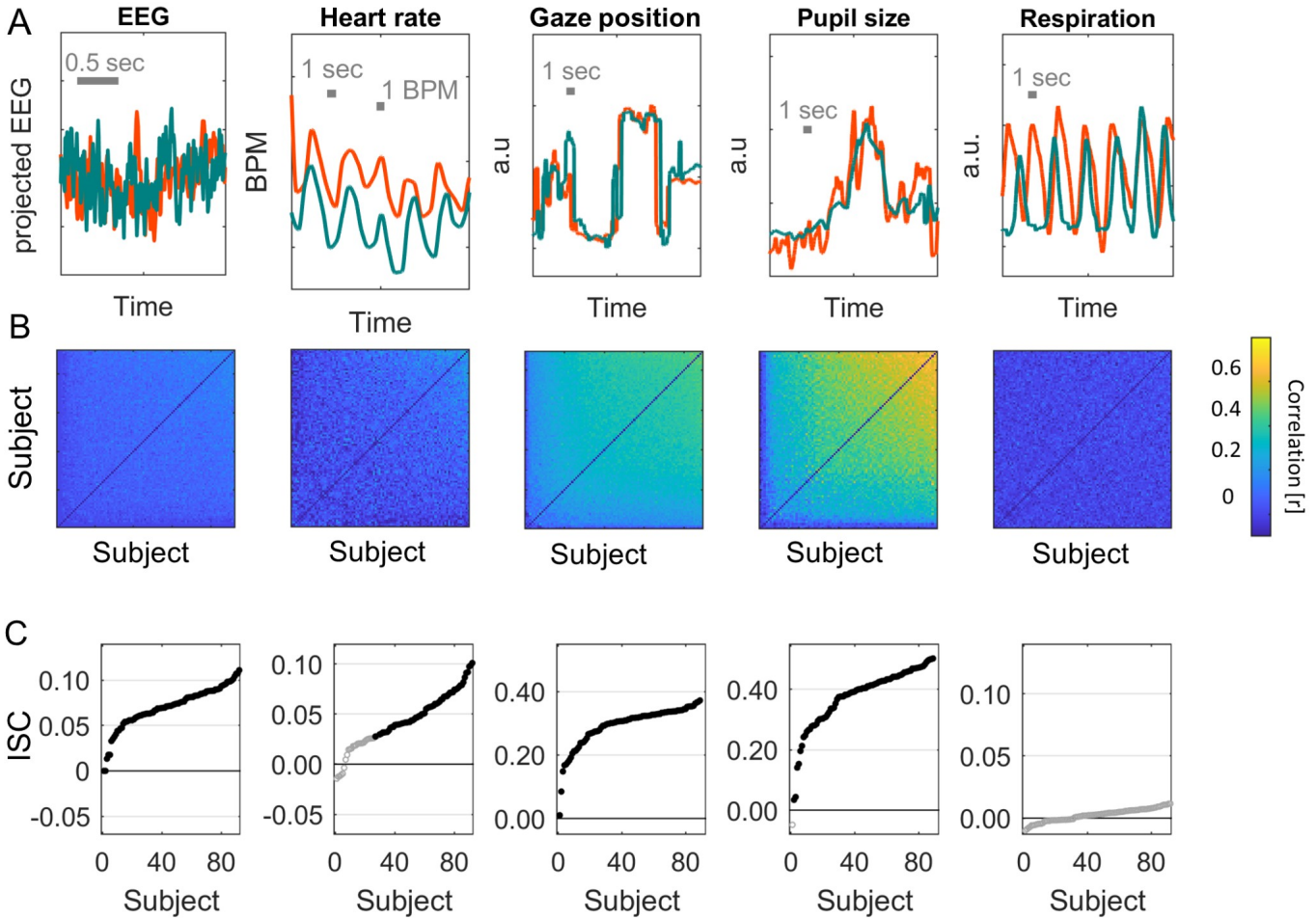
Listening to Audiobooks

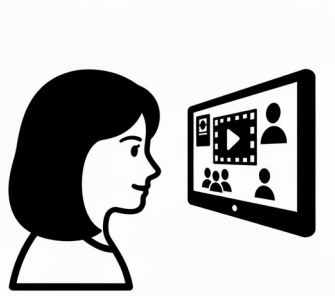
Watching Video



Brain and Body synchronize during videos

Jens Madsen

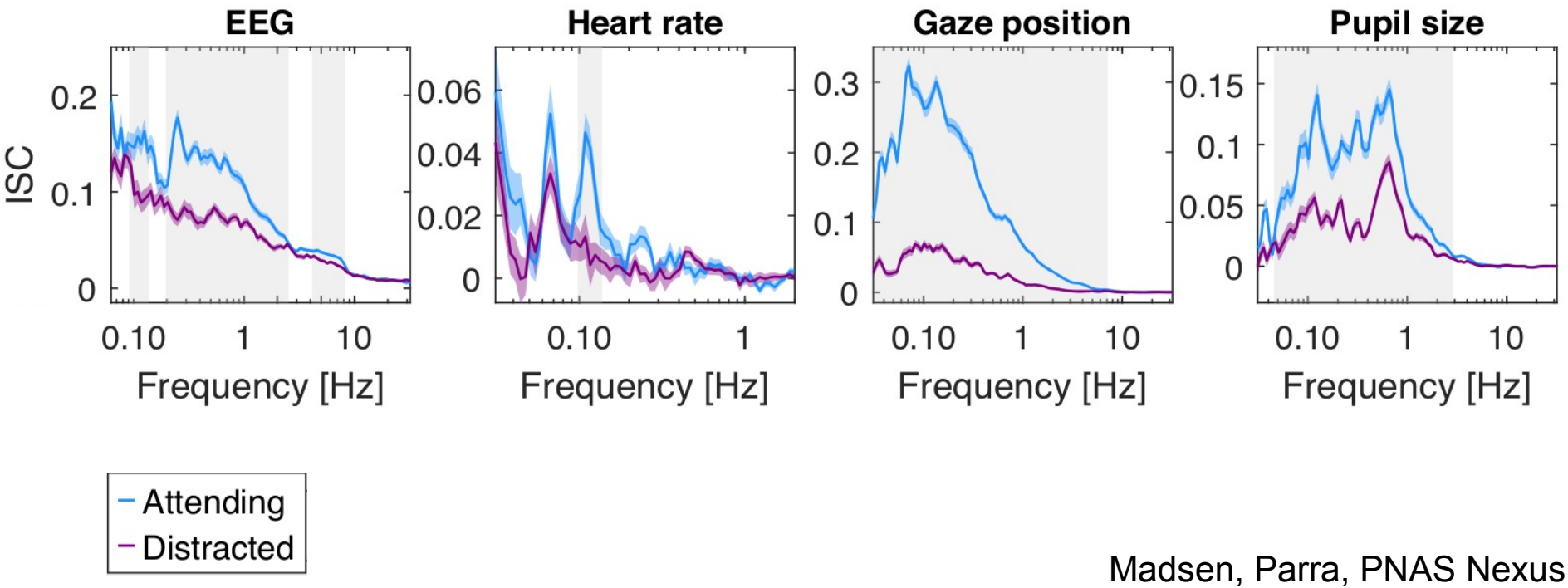




Madsen, Parra, PNAS Nexus, 2022

ISC of body and mind are slow 1s-10s

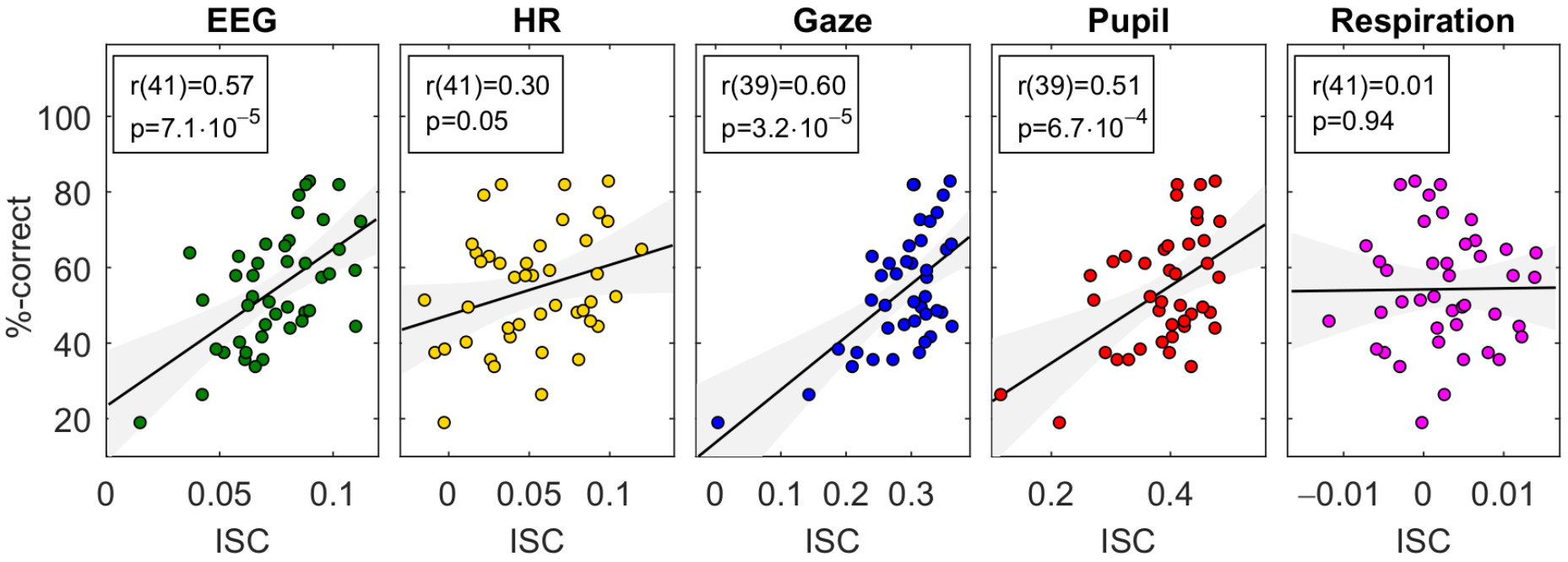
Jens Madsen



Madsen, Parra, PNAS Nexus, 2022

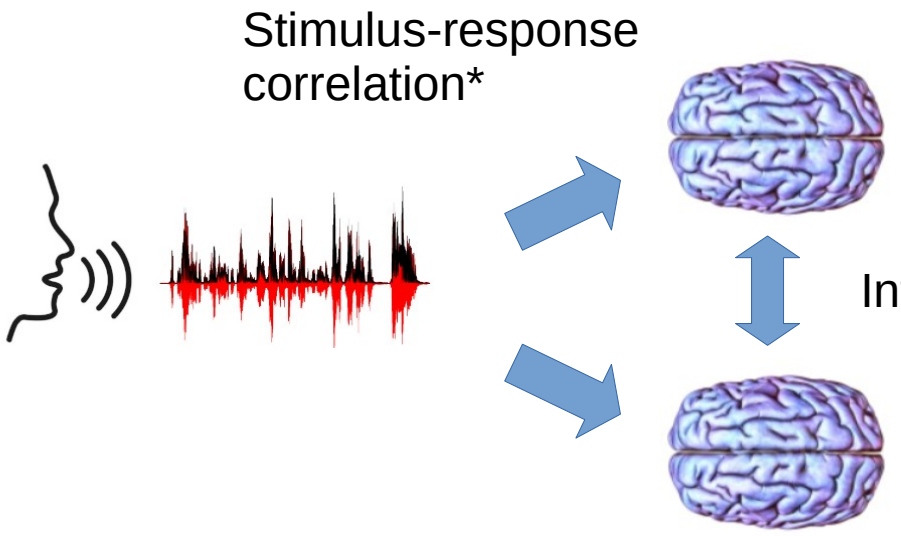
ISC predicts memory

Jens Madsen



Madsen, Parra, PNAS Nexus, 2022

Two ways to measure response to a stimulus

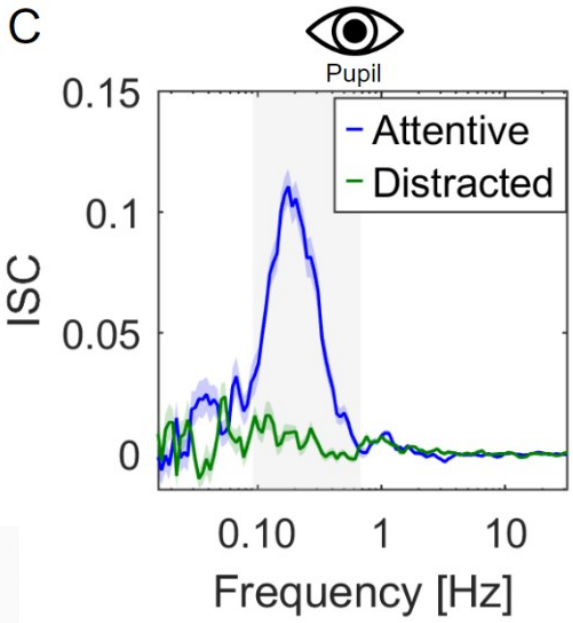


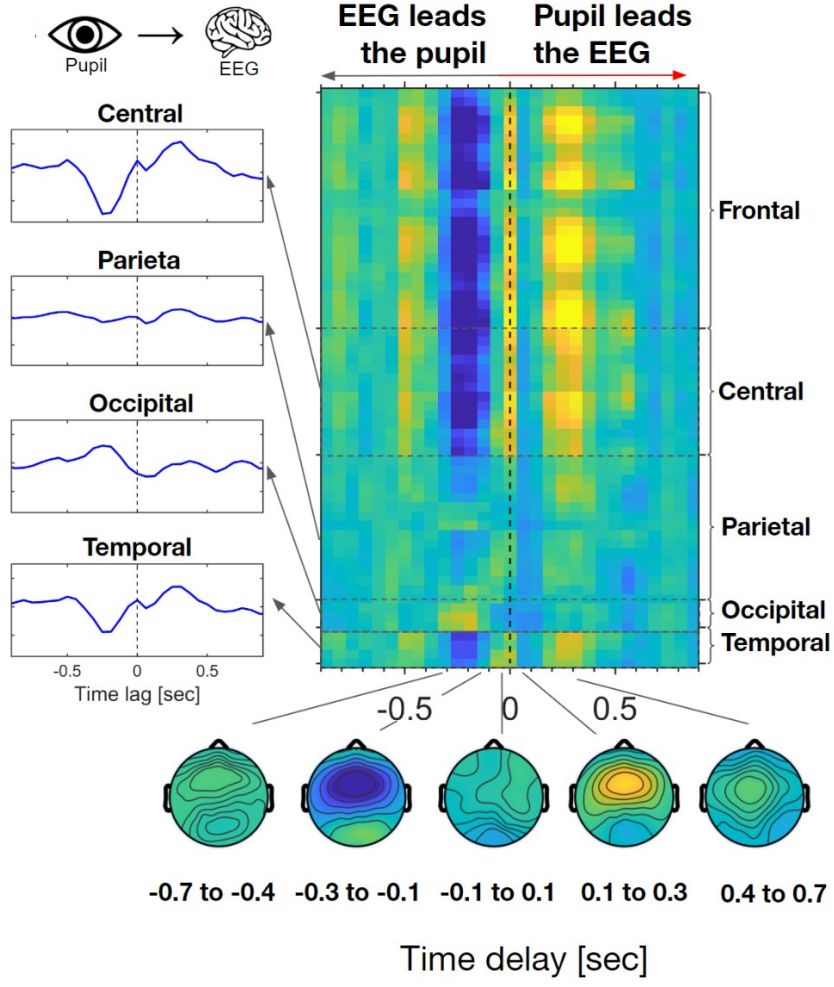
* linear encoding (GLM)
* decoding (SVM, LDA, etc)
* delayed response (TRF, Lalor)
* delayed encoding/decoding (CCA, Dmochowski)

** responses can be non-linear
delayed, recurrent ... anything

Pupil entrains to narrative, and predicts EEG

Jens Madsen

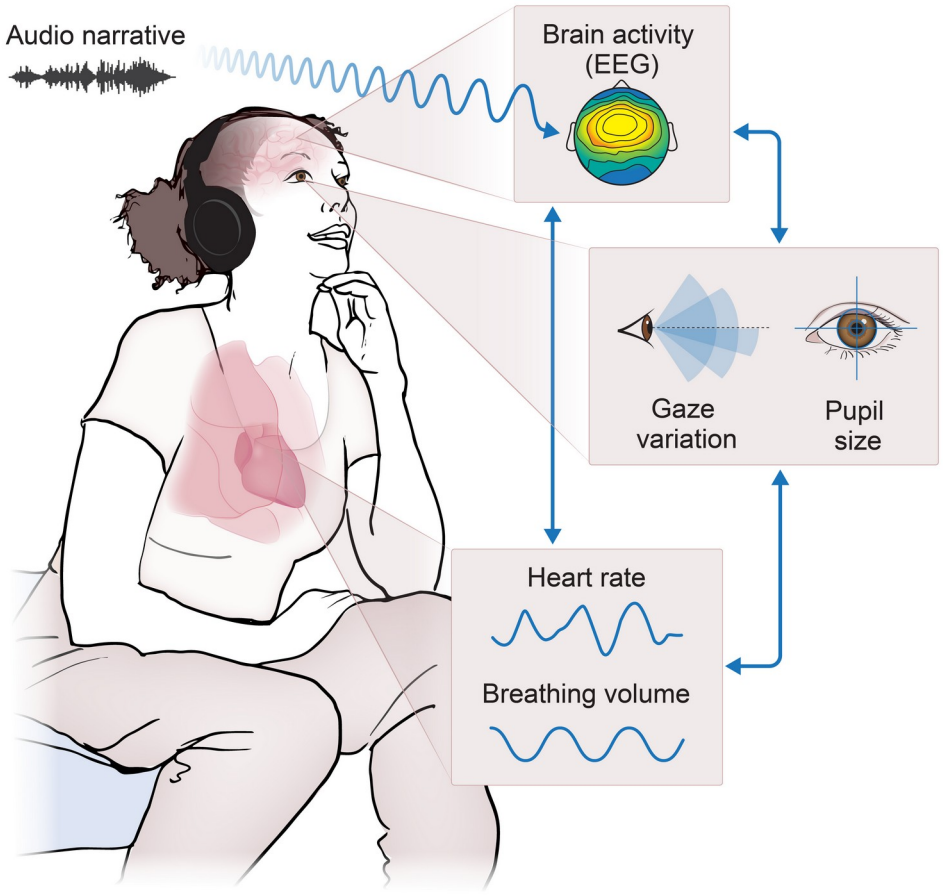




Madsen, Parra, *Cell Rep*, 2024

Brain-body effects are bidirectional

Jens Madsen



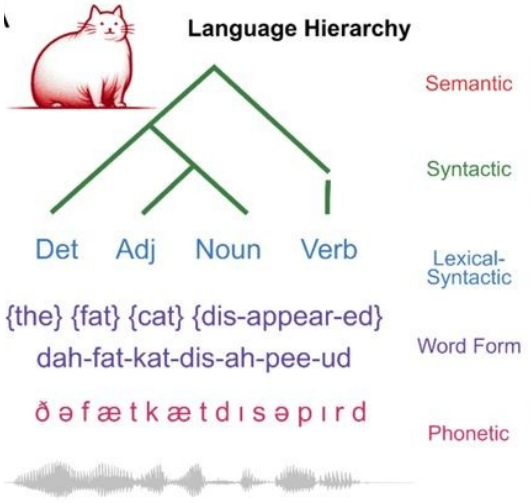
Who affects whom?

We need new tools to analyze this chicken-and-egg.

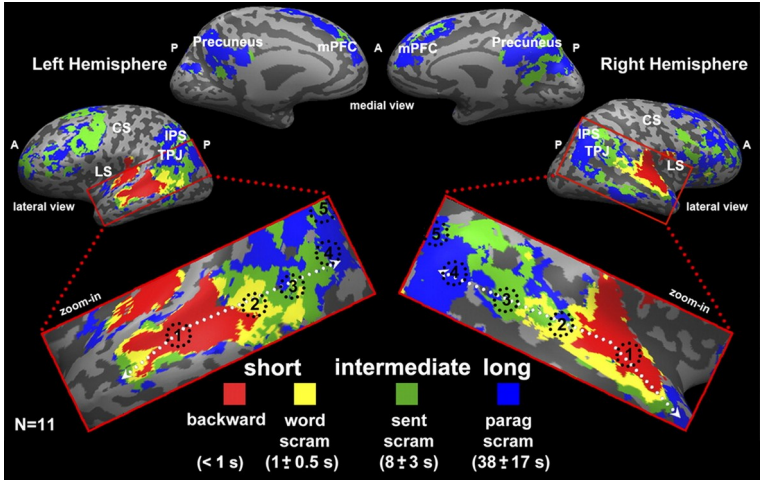
“Brain” = cognition, largely cortical
“Body” = autonomic, largely subcortical

Madsen, Parra, Cell Rep, 2024

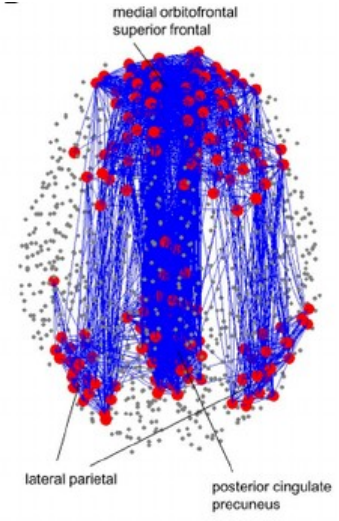
Time dependence and temporal integration



Laura Gwilliam, 2025



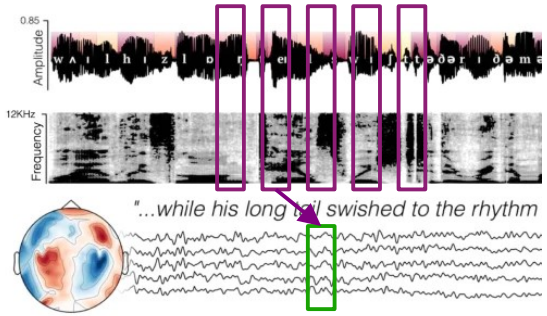
Lerner, Honey et al 2011



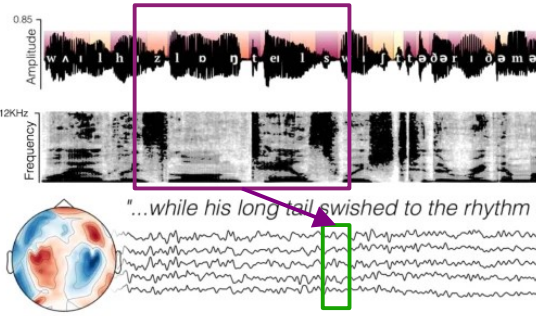
Honey 2009

Models of time dependence during narratives

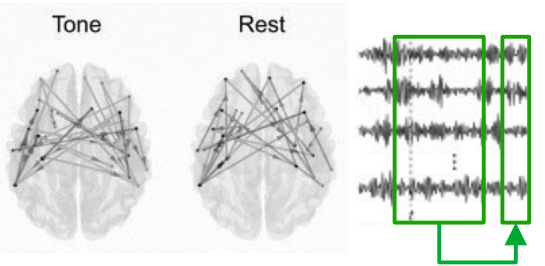
Gwilliam/King
(decoding/encoding)



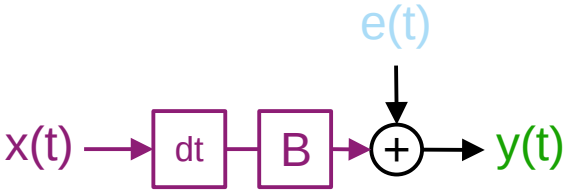
Lalor
(Temporal Response Function)



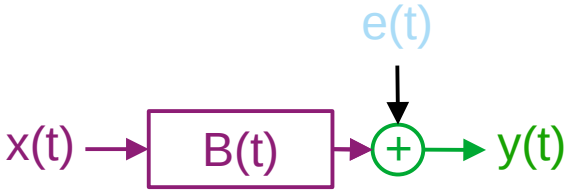
Babadi
(Granger Causality)



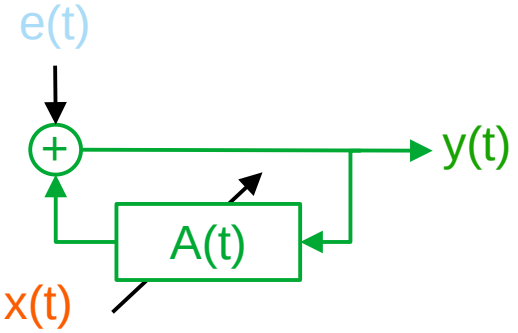
Time shift



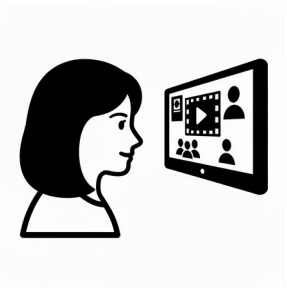
Convolution

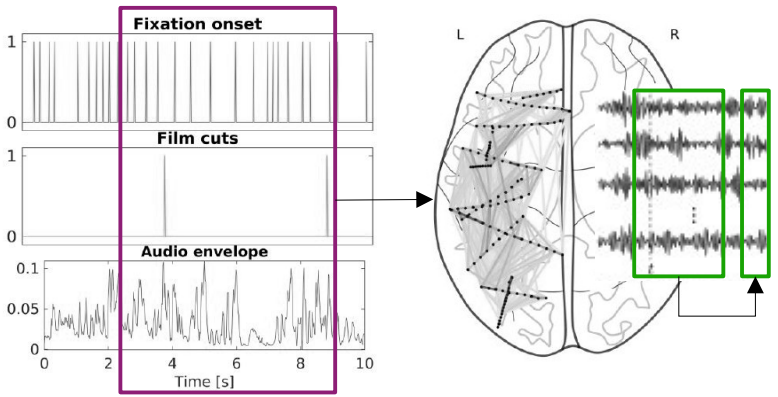


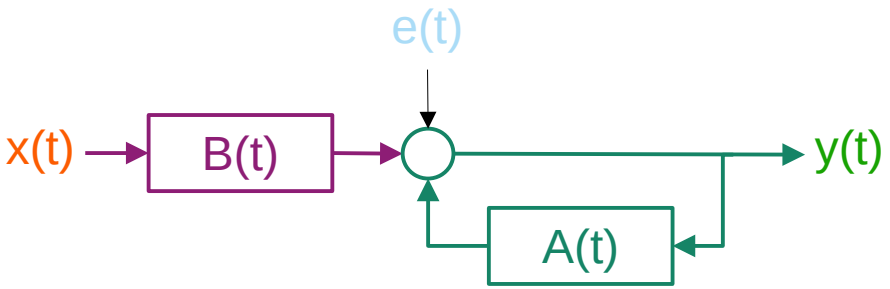
Recurrence



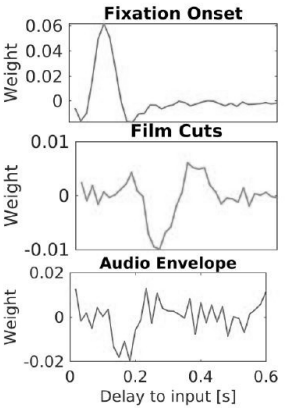
Recurrence with input (VARX)



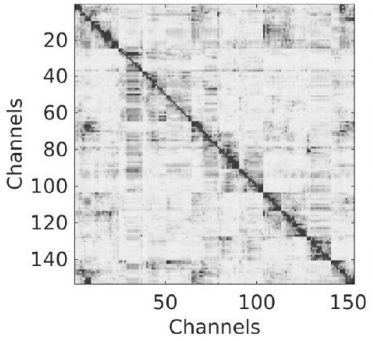




Extrinsic drive Intrinsic dynamic



B(t)



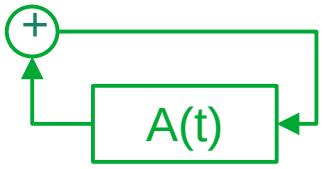
A(1)

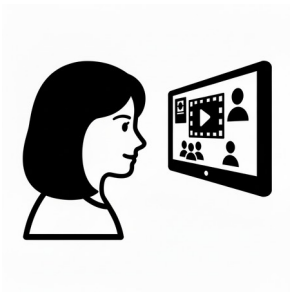
Maximilian Nentwich

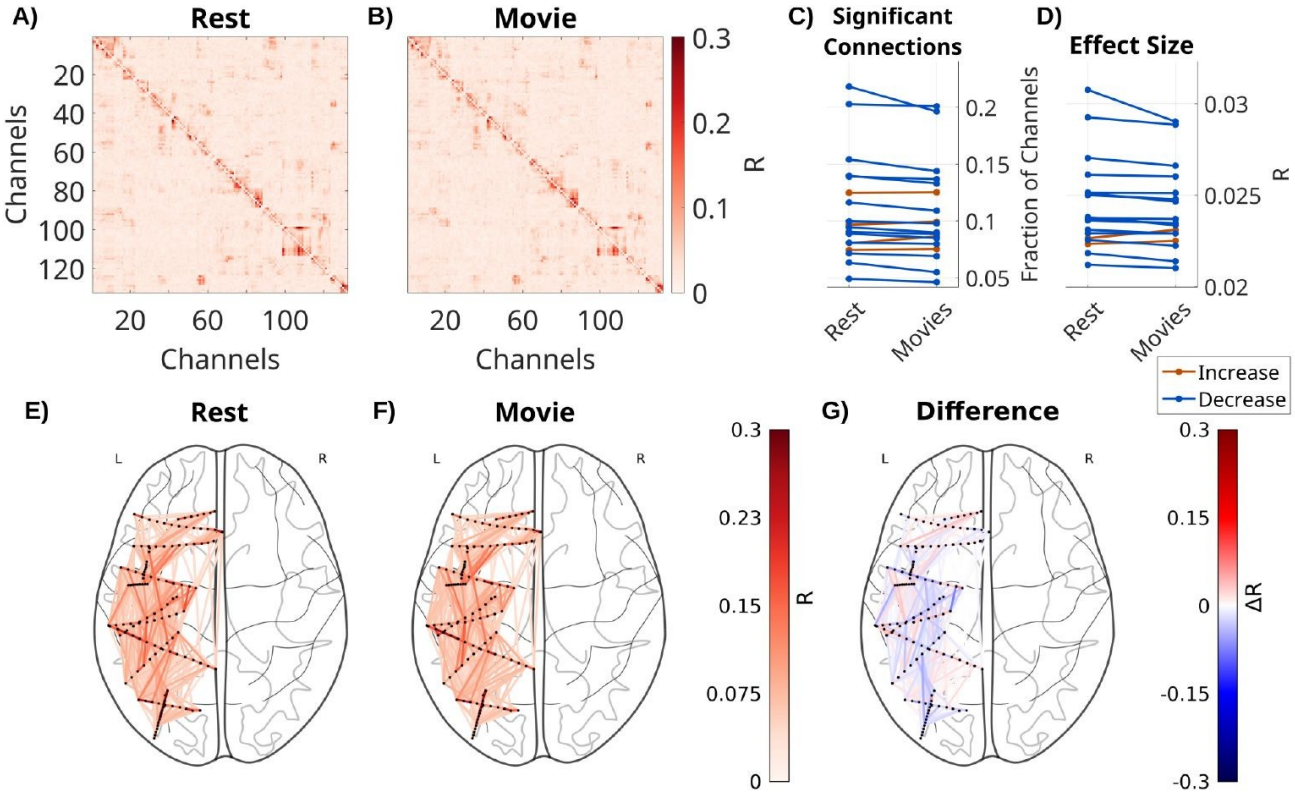
Parra, et al., PlosOne, 2024 code

Intrinsic dynamic barely altered by watching movies

Maximilian Nentwich



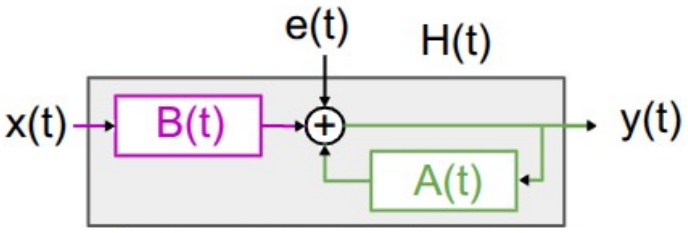




Nentwich, eLife 2025

Response dominated by intrinsic dynamic

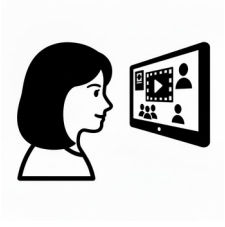
Maximilian Netwich

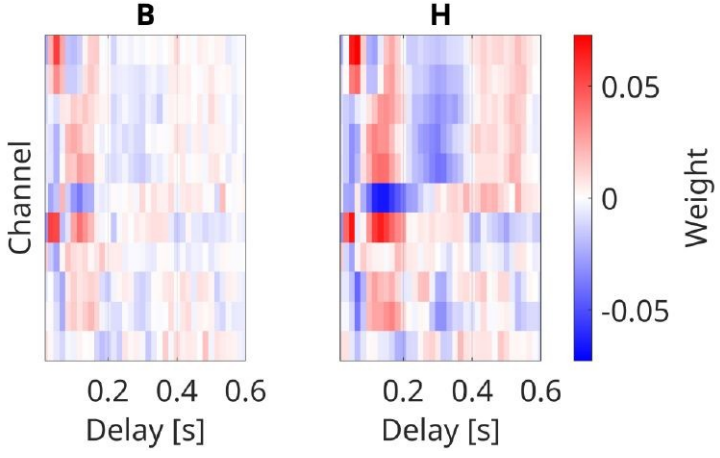


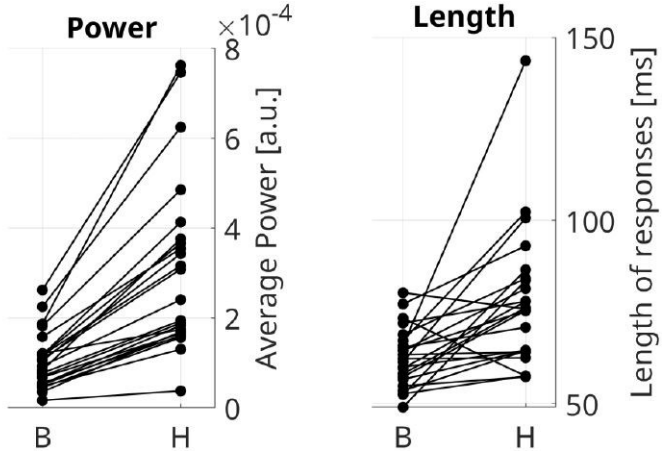
Impulse Response

$H = (1-A)^{-1}B$

“Temporal Response Function”





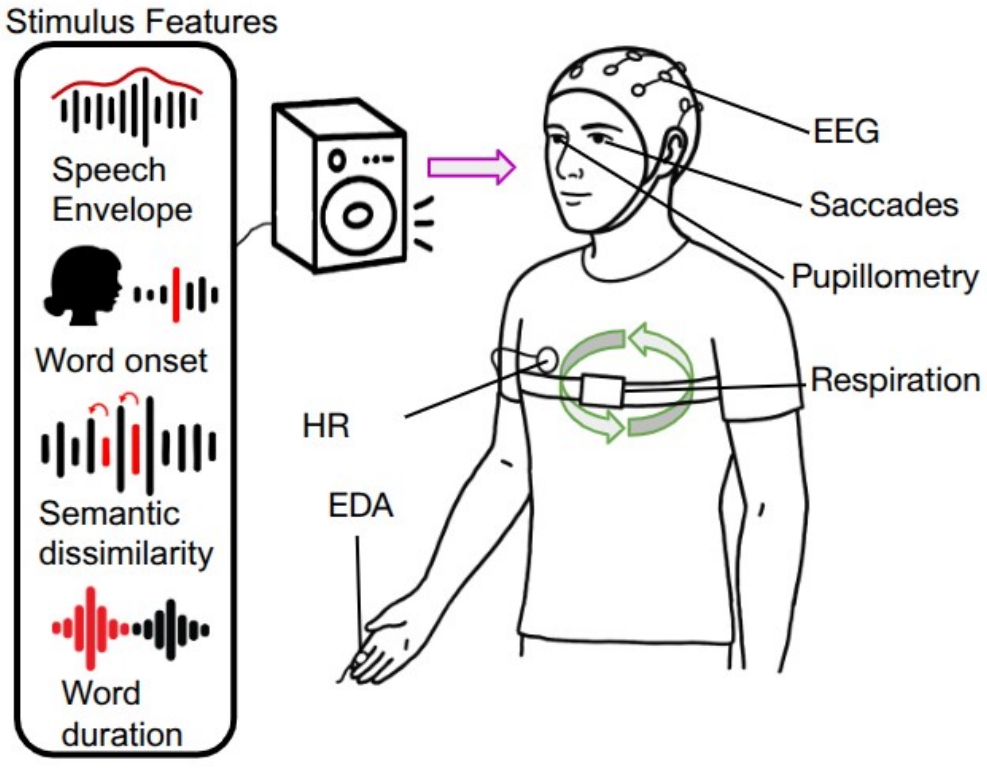


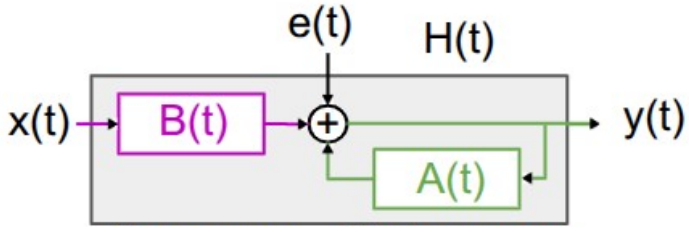
Nentwich, eLife 2025

Intrinsic brain dynamic dominates response – stimulus only drives, but does not alter the dynamic.

How brain-body dynamic couples to narratives

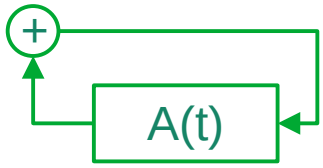
Jens Madsen

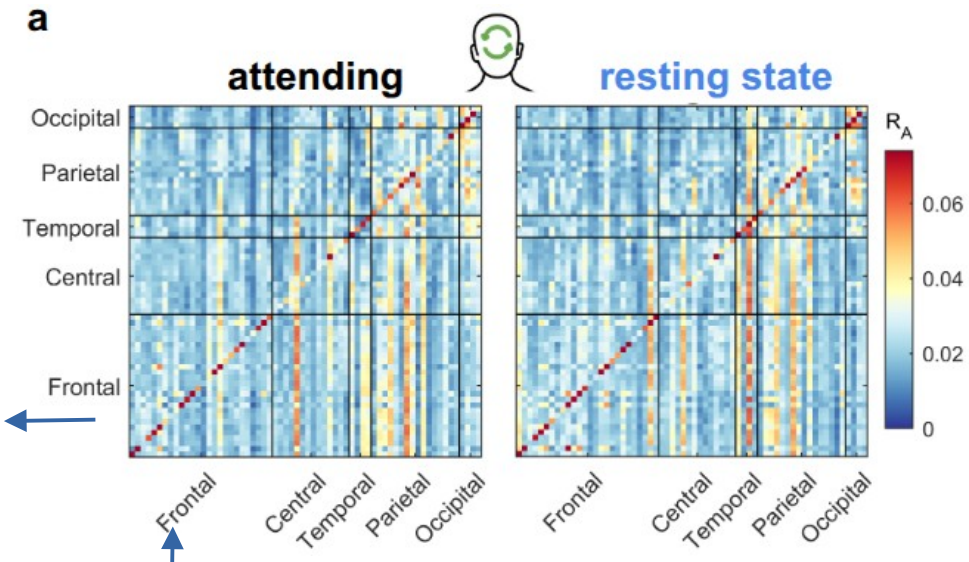




Intrinsic brain-body dynamic is stable

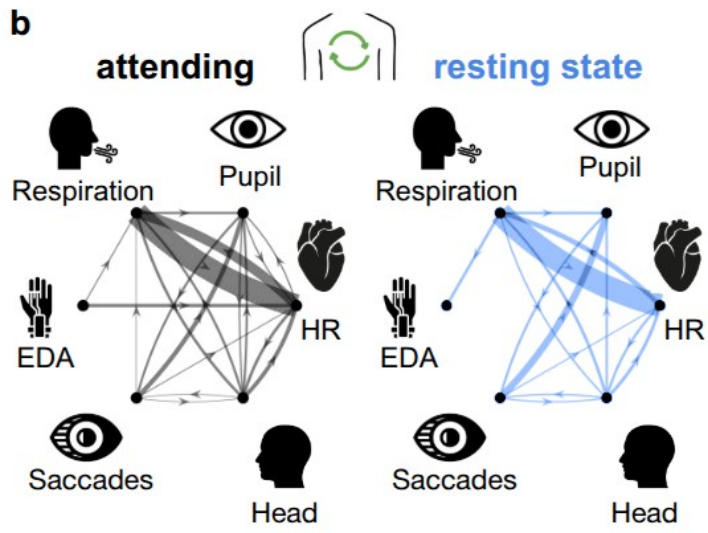
Betash Babadi





Predicted "effect"

Predictor "cause"

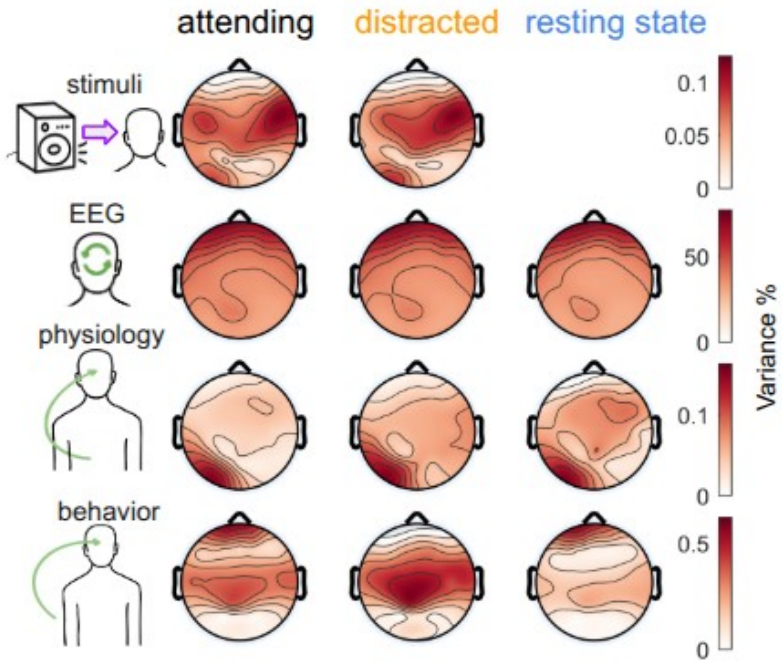


Madsen, et al. BioRxiv, 2025

Variance explained:

… brain, behavior, physiology, stimulus

Betash Babadi

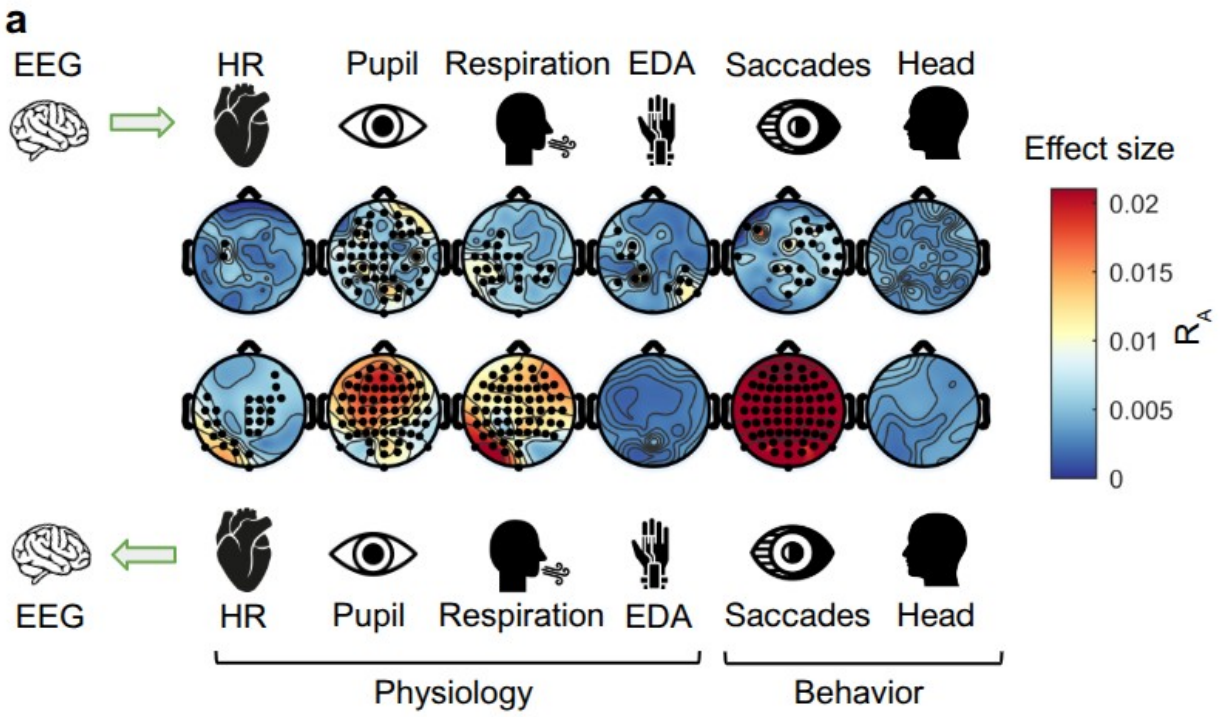


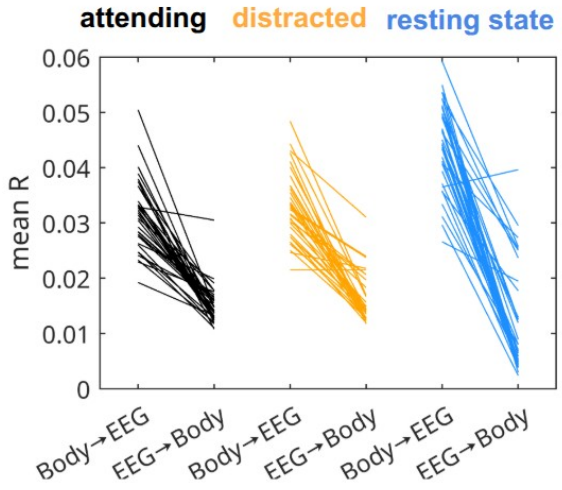
Madsen, et al. BioRxiv, 2025

Brain-body dynamic is Asymmetric

… mostly, the Body drives the Brain

Jens Madsen

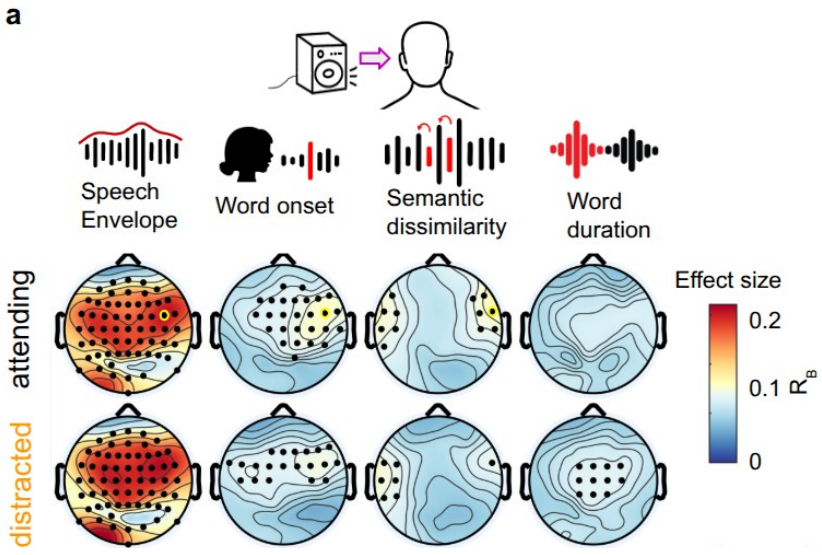


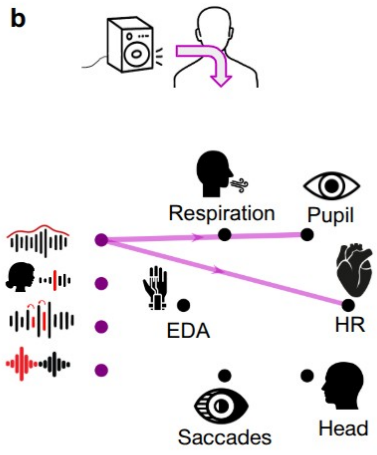


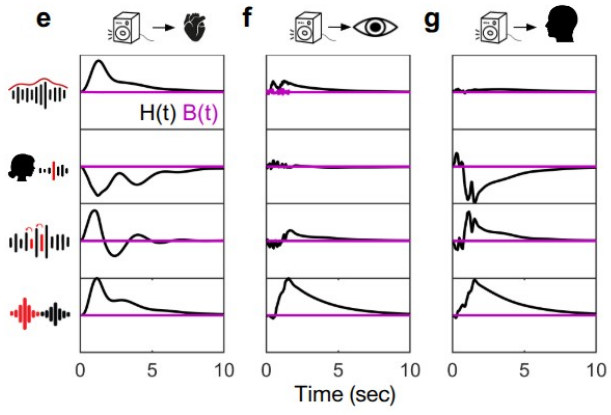
Madsen, et al. BioRxiv, 2025

Audio stimulus drives body via cortex

Jens Madsen



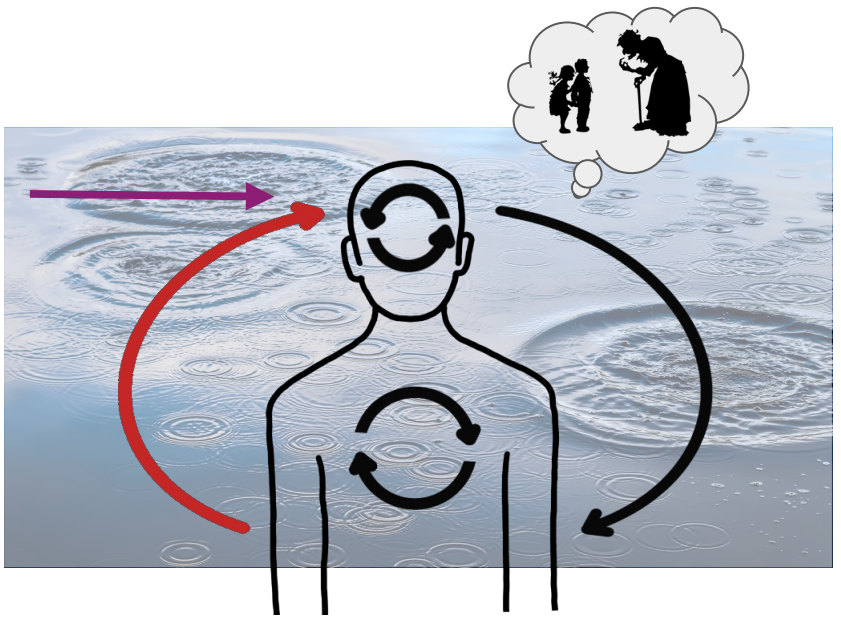




Madsen, et al. BioRxiv, 2025

The external world reverberates within us

Once upon a time ...



Brain↔Body is constant.

Body → Brain effect is strongest.

Audio → cognition → physiology, mostly.

Acknowledgments

Jens Madsen

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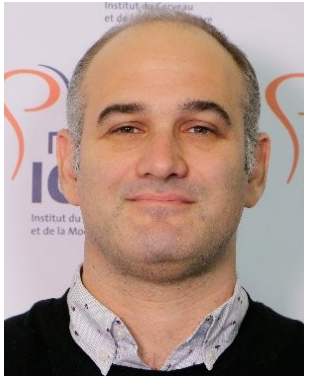

Jacobo Sitt

Betash Babadi

parralab.org