

Brain mechanisms underlying empathy arising from emotional voices

Project “Listening to others’ emotions.
Neural representations underlying empathy arising from emotional voices”
funded by Riksbankjubileum fond (P22-0574, 2023-2026)

Gláucia Laís Salomão

Co-applicant

- Örjan de Manzano, Max Planck Institute for Empirical Aesthetics.

Research assistants,

- Christoffer Forbes Shieche (Aug/2023 – Jan/2024)
- Naira Sardarian (Nov/2023 – Jun/2024)
- Aleksandra Adler (Apr/2024 – to date)

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- Oumeng Li, KTH (Apr/2024 – to date)
- Giuseppina Santo, University of Padova (Sep/2024 – Nov/2024)
- Michael Ioussaidene, University of Franche-Comté (Jan/2025 – May/2025)

Student

- Jonatan (November-December, 2024)

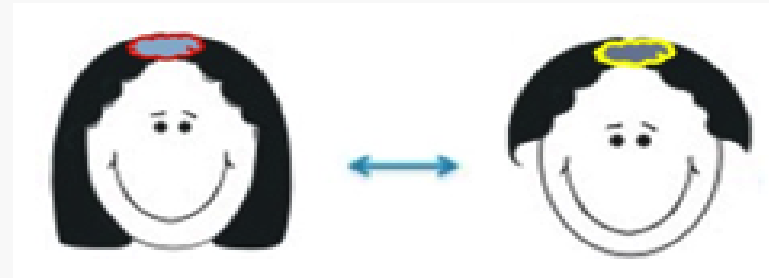
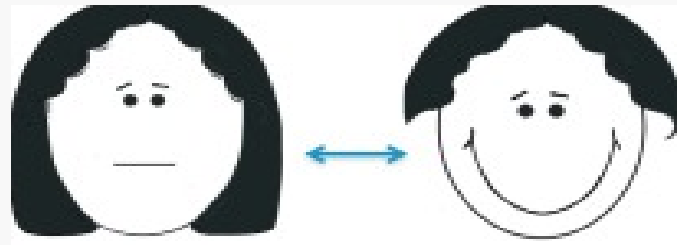
Empathy

Human capacity to understand and share another person's emotion without confusing it with one's own emotional state.

Klimecki O & Singer T, 2016

Previous fMRI studies investigating empathy

Experiencing others' emotions triggers the same areas of the brain involved in directly experiencing the same emotion



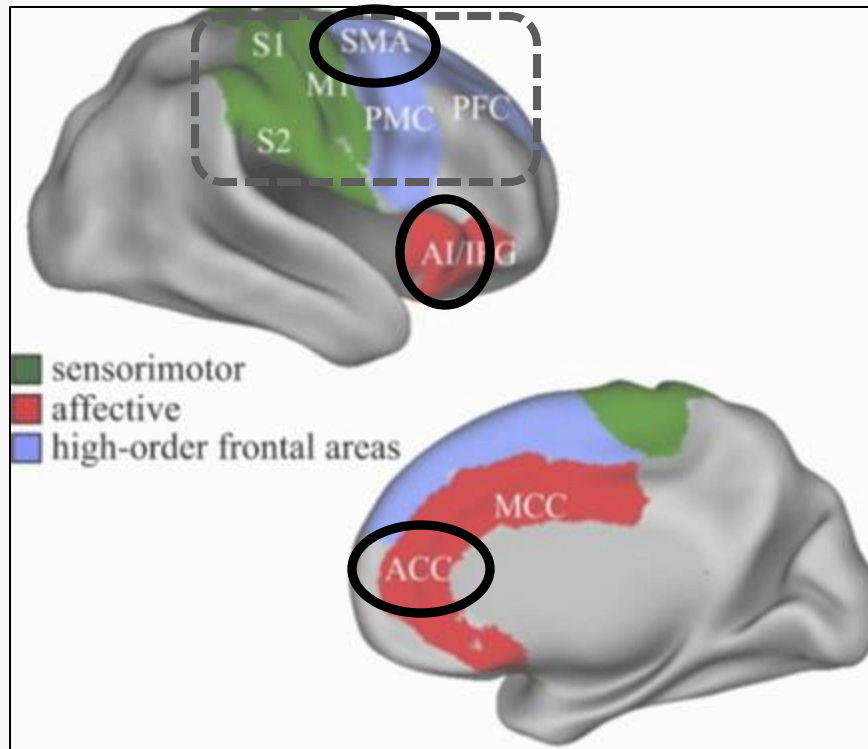
This assumption has been called the “**shared-neural-representation**” hypothesis

(Singer & Lamm, 2009; Lamm & Majdanzic, 2015)

Previous fMRI studies investigating empathy

Core neural network
underlying
the ability to share
others' emotions

AI: anterior insula
ACC: anterior cingulate cortex
SMA: supplementary motor areas



Additional neuroactivations
related to the specific
domain from which
empathy arises

Areas involved in the neural network underpinning empathy for pain

Betti V, Aglioti SM (2016)

Ding R, Ren J, Li S, Zhu X, Zhang K, Luo W (2020)

Research question

Is the 'shared neural representations' hypothesis also relevant in explaining empathy arising from emotional voices?

Are there shared neural representations activated when we listen to and empathize with emotional voices, as well as when we express—or even imagine expressing—emotions vocally?

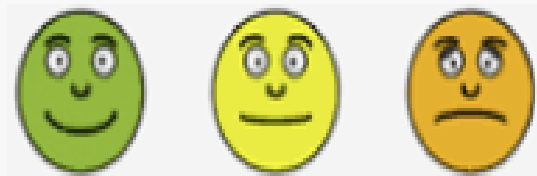
HYPOTHESIS

- Core neural network that underlies empathy?
 - Auditory processing of emotional voices?
- Motor execution or imagination of vocal expression of emotions?

The kind of data we are collecting



The MR camera at SUBIC. Photo by Lena Katarina Johansson

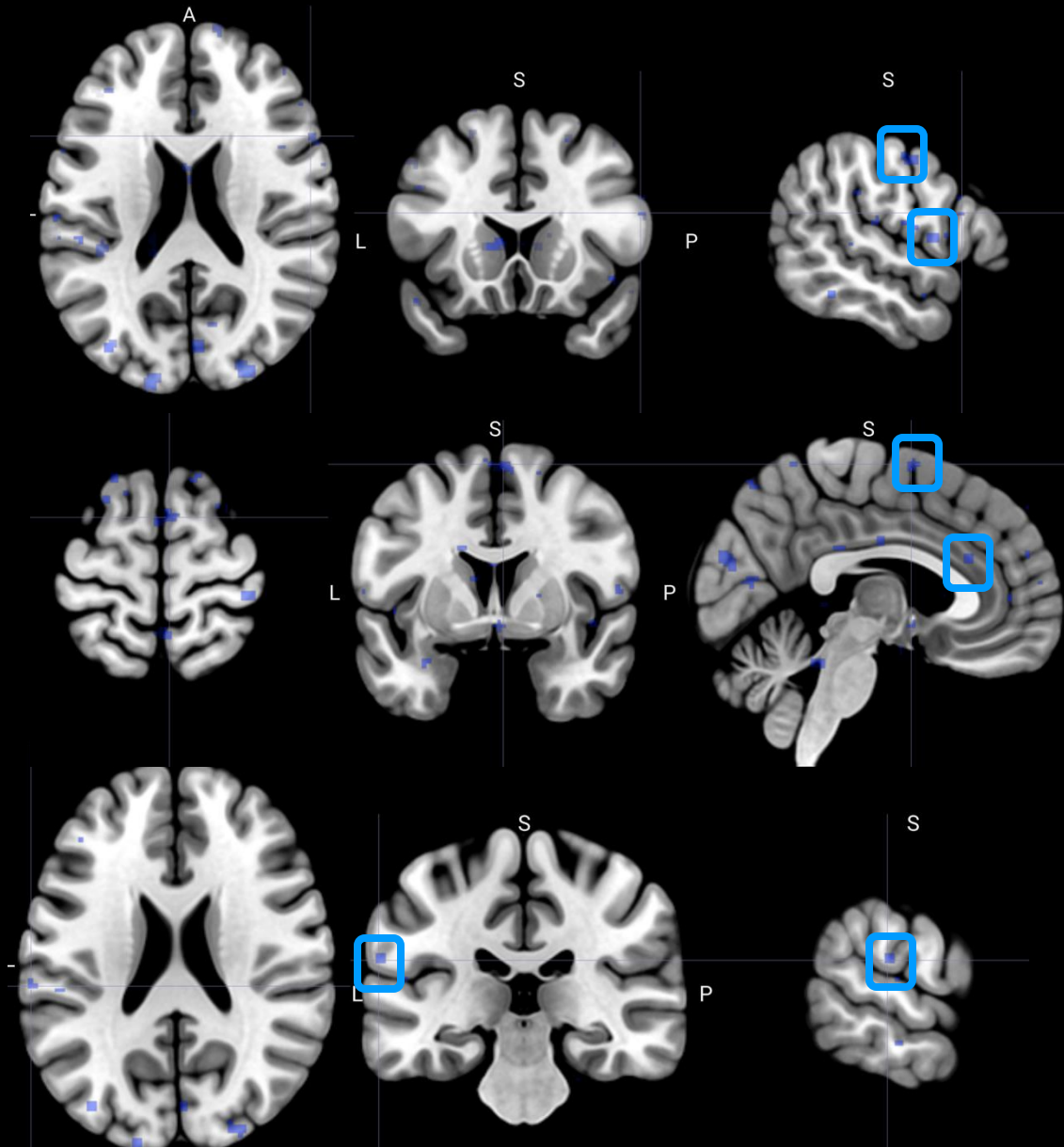


The kind of data we are collecting

“Emotional voices”:
brief, nonverbal vocalizations
that have little or no phonemic structure



Multivariate Pattern Analysis (MVPA), preliminary results of a pilot study



Precentral gyrus
Inferior frontal gyrus

Supplementary Motor Areas
Anterior Cingulate Cortex

Superior temporal gyrus (R)
the 'human voice areas' (Berlin, 2000)

Model imagine emotions vs rest
Balanced accuracy: 80,21%
p: .0010

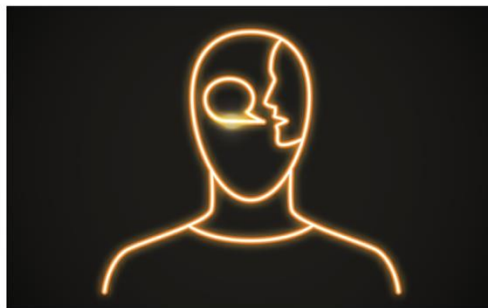


Research project

Listening to other's emotions. Neural representations of emphaty arising from emotional voices

Stockholm University < Research < Research projects

This project investigates empathy arising from emotional voices, using functional magnetic resonance imaging (fMRI), galvanic skin response (GSR) and information about the participants' own experiences.



Research project

Denna sida på svenska

THEME

Brain Research Psychology and Human Behaviour
Language and Language Learning

CONTACT PERSON AT SU

Gláucia Salomão
Researcher



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OVERVIEW

Project period

01-03-2023 - 28-02-2026

Responsible

> Department of Linguistics

Participants

Karolinska Institutet, KI
Max Planck Institute for Empirical
Aesthetics

Research subjects

Phonetics

Status

Shaping emotional voices: a study of vocal-tract configurations during expressive vocalizations

A new study aims to understand the motor behavior underlying emotional voices

Department of Linguistics < News

Gláucia Laís Salomão, doctor of Linguistics and a researcher at the Department of Linguistics, has been awarded a “time grant” from Stockholm University Brain Imaging Centre (SUBIC) for her research on the vocal communication of emotions.

The grant includes free access to the magnetic resonance imaging scanner at SUBIC as well as any necessary technical support, and will allow the collection of pilot data for Gláucia's upcoming research.

Time grant, SUBIC

THANK YOU FOR YOUR ATTENTION



Language is not enough for brains in conversation

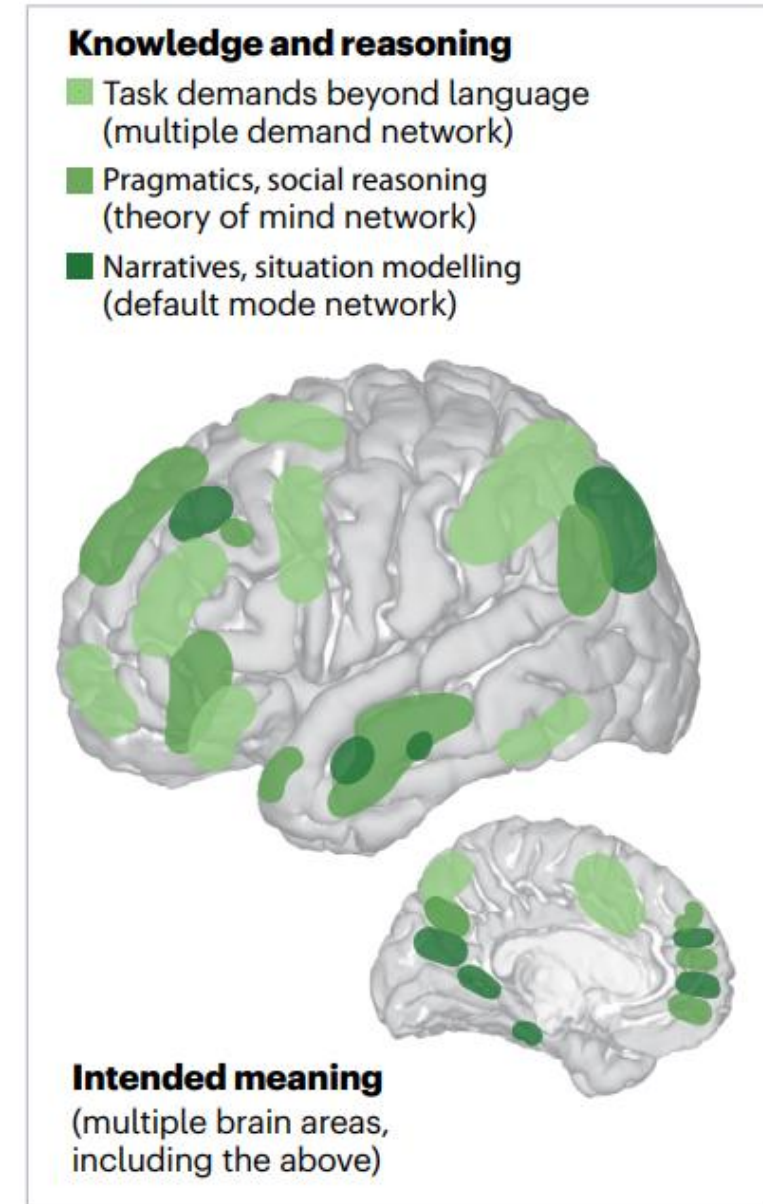
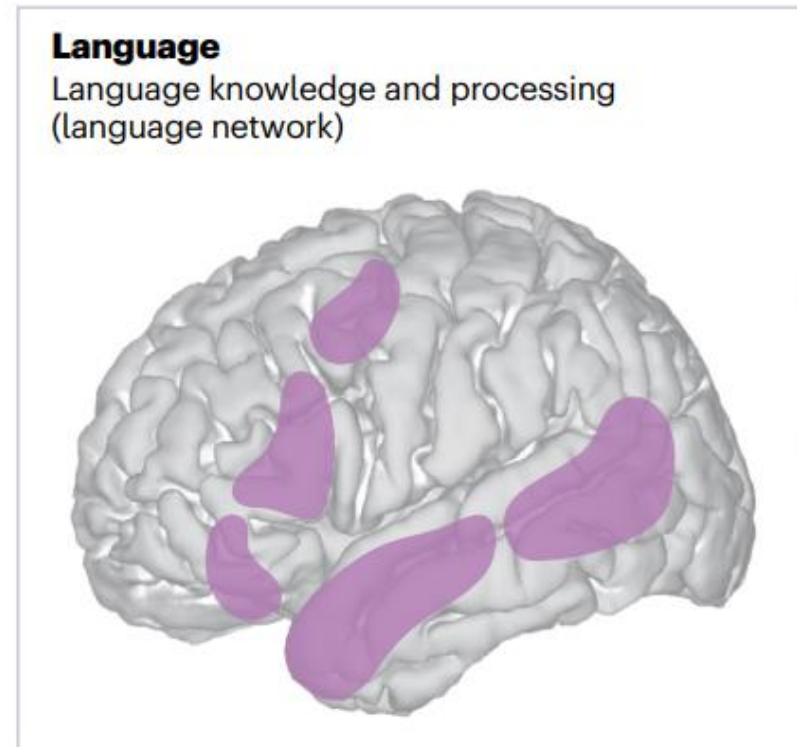
Stockholm University, October 17, 2024

Julia Uddén, Associate Professor/Docent

Department of Psychology and Department of Linguistics
Stockholm University

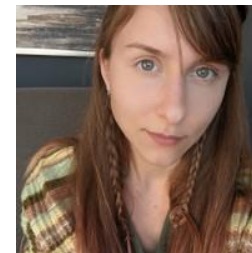
Single-brain comprehension-in-isolation

- 2010-now, From sentences to narratives
- The "shared systems view" of comprehension vs production
- What will come next? lateral to midline focus



Conversational production and comprehension using fMRI

Caroline Arvidsson, Ekaterina Torubarova, André Pereira,
Julia Uddén, Cerebral Cortex, 2024



Data and design

- **Open data-base**, with 23 participants
- **Audio-video link**, between participant in the scanner and agent outside
- 12 x 1 min **human-human conversations** per participant
- Participants discussed initial pictures (anthropomorphic fruit)

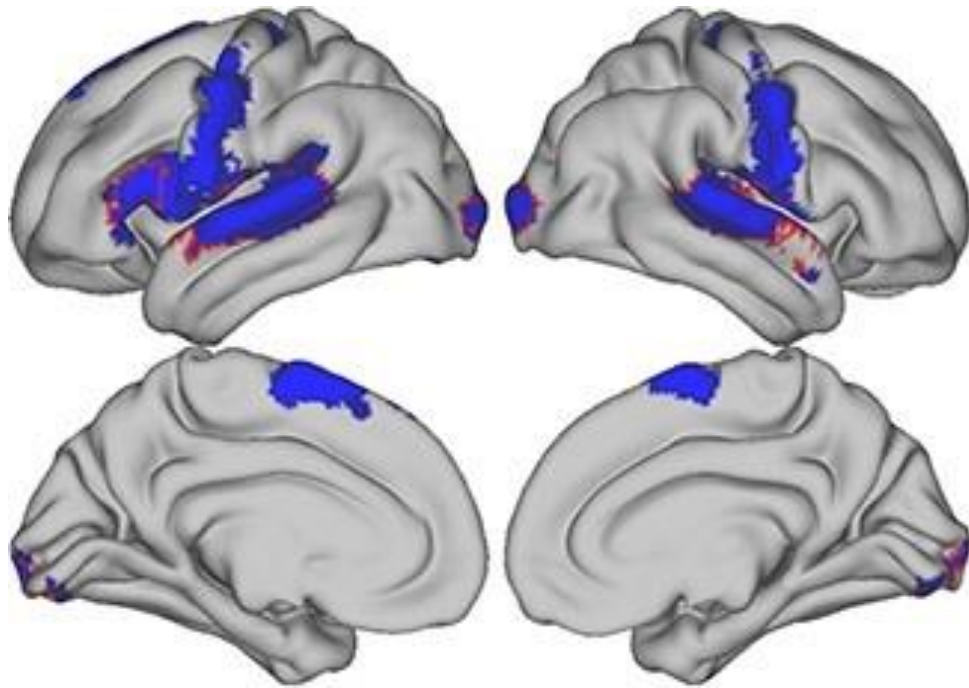
The mean number of production and comprehension events per participant.

	Production	Comprehension
<i>N</i> events	133	129
Mean duration (s)	2.07	1.77
SD duration (s)	1.68	1.39
Range duration (s)	0.3–10.43	0.3–9.96

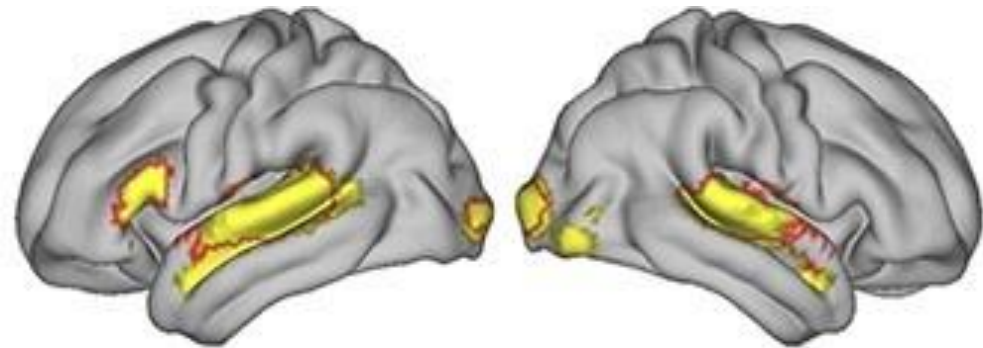
Events shorter than 0.3 s removed

Results

Production > fixation

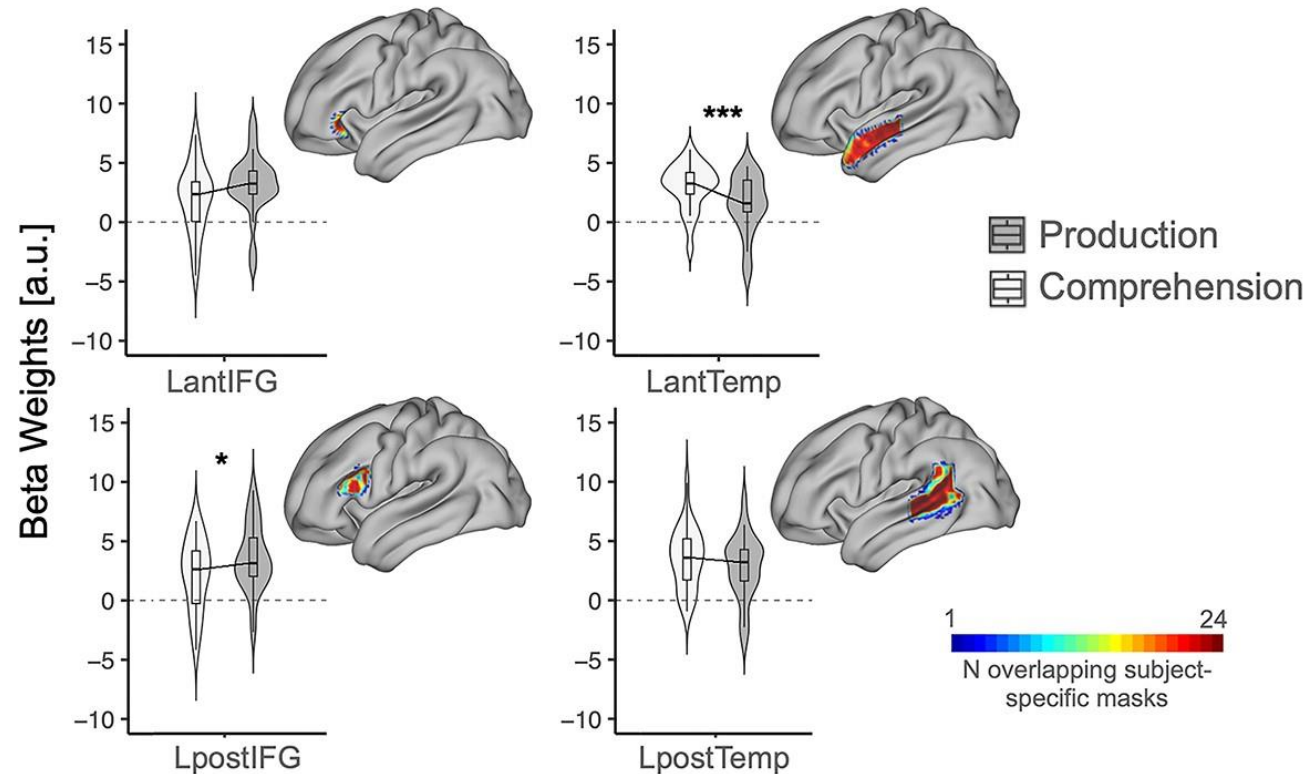
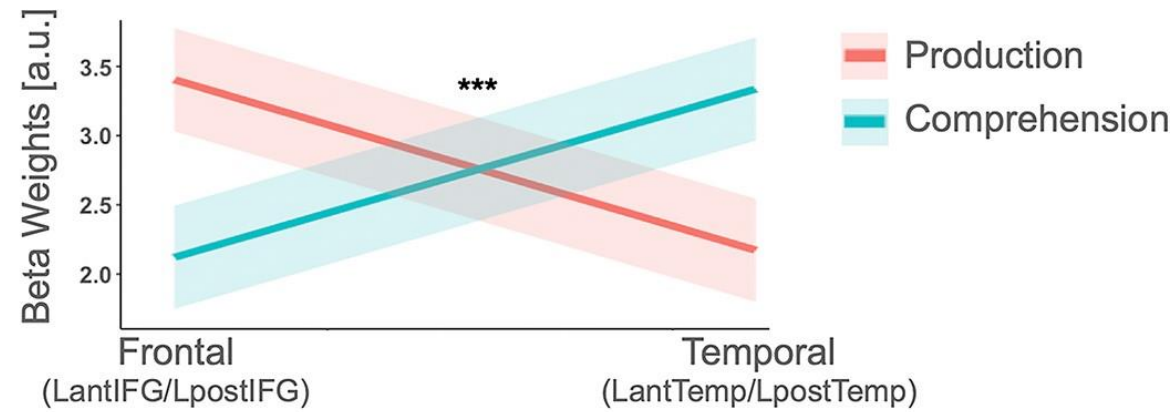


Comprehension > fixation

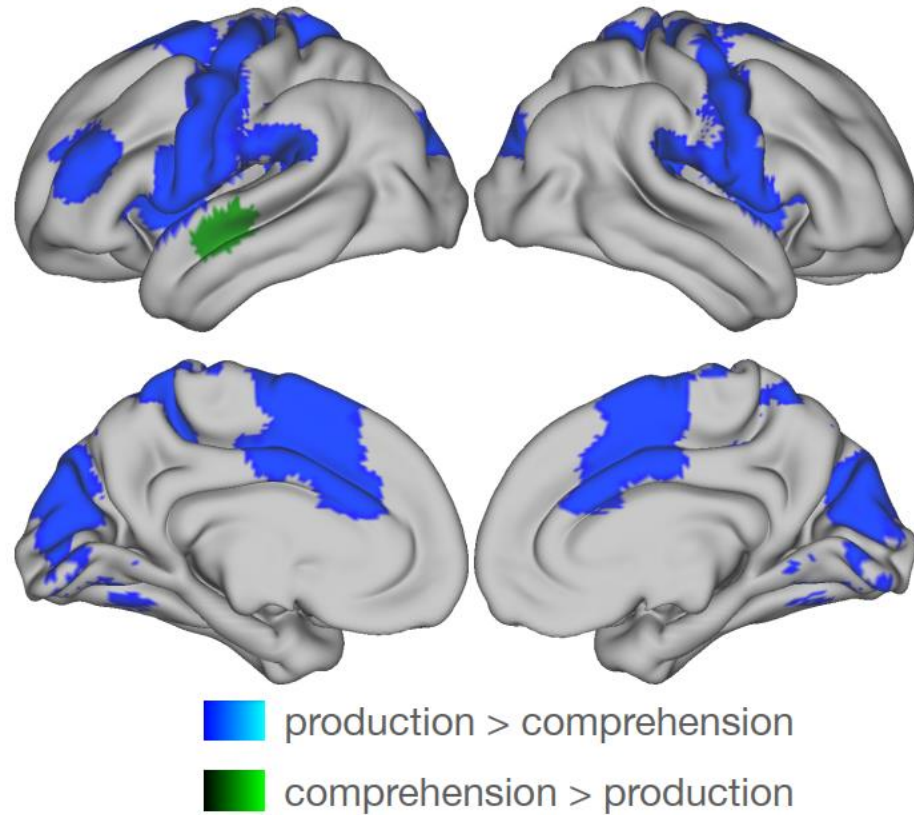


 Conjunction (Overlap)

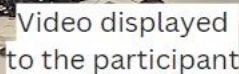
ROI results
against
shared view
rather
Broca-
Wernicke



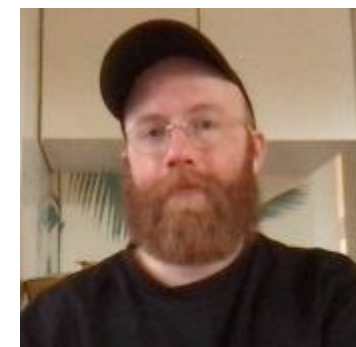
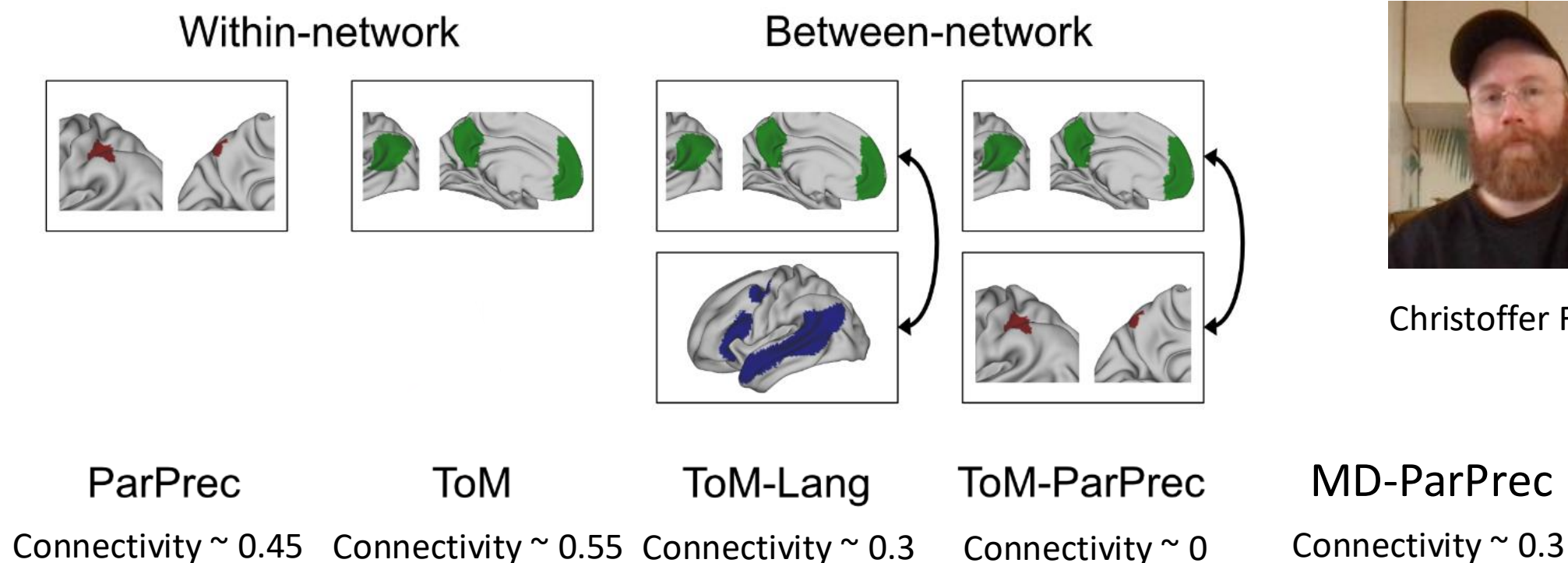
Direct comparison – “moving Wernicke’s area” in the anterior direction



Noise-cancelling headphones and microphone (Optoacoustics)



Dissociation of pragmatics from ToM using fMRI



Christoffer Forbes Schieche

Thank you for your attention!

Current PhD-students



Caroline Arvidsson



Christoffer Forbes Schieche



Ekaterina Torubarova

Alumni/co-authors



Dr. David Pagmar



Dr. Katarina Bendtz



Dr. André Pereira

Stockholm
University



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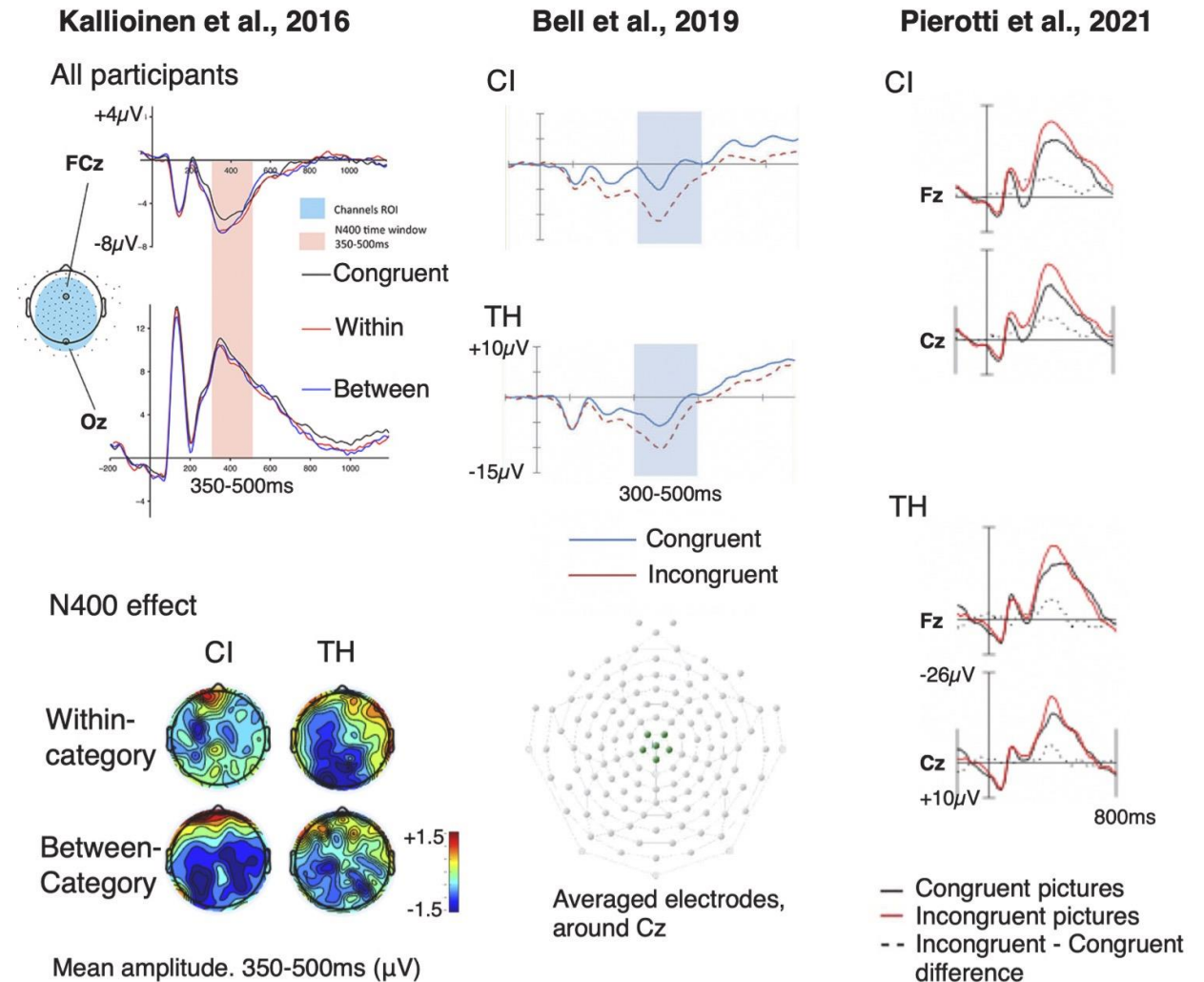
SWEDISH
COLLEGIUM
for ADVANCED STUDY

Compensatory semantic processing in adverse hearing situations

Petter Kallioinen

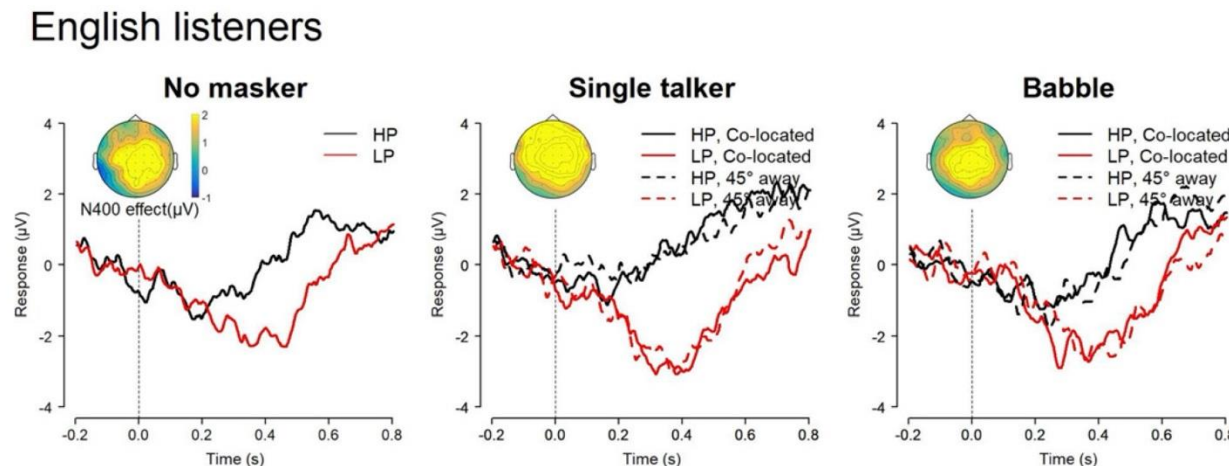
Large N400 in children with Cochlear Implants

When bottom-up processing of speech is compromised, such as in a noisy environment, semantic context can give cues that help identifying words. In children with cochlear implants (CI) such compensatory semantic processing has been linked to large responses in the N400 component (Kallioinen et al., 2023)



Diverse N400 results in typically hearing (TH) individuals in adverse hearing conditions

- Larger N400 for 6 band noise vocoded speech and gestures (Drijvers et. al., 2018), but reduced N400 with 4 band noise vocoding (more degradation, no gestures. Obleser et. al., 2011). Larger N400 where a distractor voice is the same as the target voice (Song et. al., 2020), i. e. semantic content is more precisely targeted.
- Smaller N400 in response to more degraded speech: speech in noise with SNR of 3 or 5, or 4 band noise vocoding (Aydelott et. al., 2006; Chan et. al., 2020; Obleser et. al., 2011; Silcox et. al., 2021).



Song, J., Martin, L., & Iverson, P. (2020). Auditory neural tracking and lexical processing of speech in noise: Masker type, spatial location, and language experience. *The Journal of the Acoustical Society of America*, 148(1), 253–264.

Conclusion and outlook

I intend to write a grant application for studying compensatory semantic processing as seen in the N400 component in TH populations. The aim is to map out the conditions for effective compensatory processing. Conditions indicated in the literature reviewed here:

- Light degradation of speech
- Tasks that promote semantic processing

Other themes in the planned application

- Naturalistic stimuli (stories)
- Measuring effort

Thanks!

References

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Mechanisms of visual working-memory limitations and flexibility

Rita Almeida

October 2024

SUBIC
Stockholm University
Brain Imaging Centre



Stockholm
University

Working memory (WM)

WM is the ability to temporarily maintain and manipulate in mind a limited amount of information.

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- ▶ WM is a fundamental component of many cognitive tasks.

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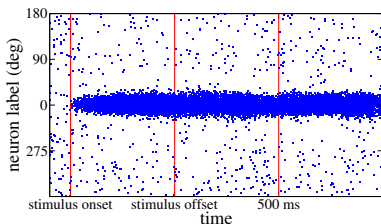
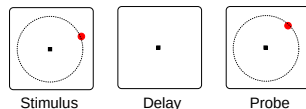
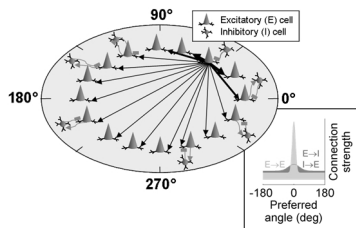
- ▶ WM is a fundamental component of many cognitive tasks.
- ▶ Performance on WM tasks predicts performance on many other cognitive tasks.

Working memory (WM)

WM is the ability to temporarily maintain and manipulate in mind a limited amount of information.

- ▶ WM is a fundamental component of many cognitive tasks.
- ▶ Performance on WM tasks predicts performance on many other cognitive tasks.
- ▶ WM deficits are associated with abnormal cognition in several conditions.

Neuronal network models of WM

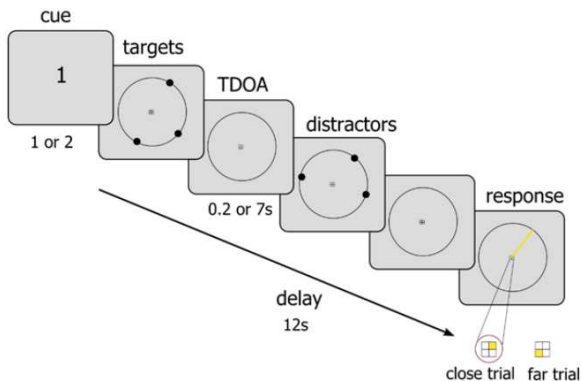


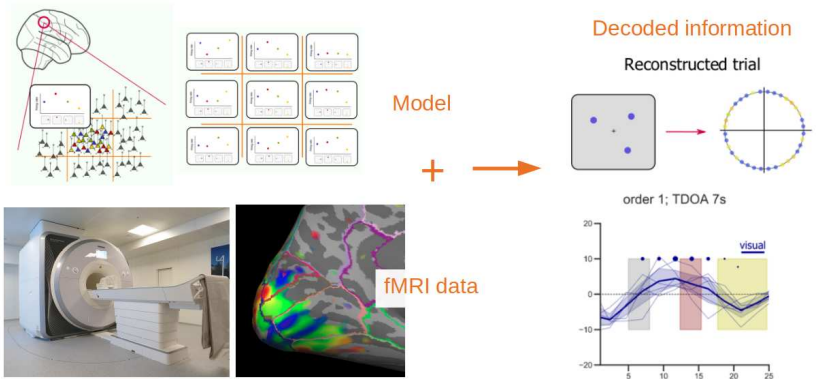
- ▶ network of excitatory and inhibitory neurons
- ▶ topological connectivity
- ▶ continuous attractor network

- ▶ model reproduces neuronal activity
- ▶ activity can be related to behavior and neuroimaging

WM limitations and flexibility

WM is the ability to temporarily maintain and manipulate in mind a limited amount of information.





- ▶ Decoding information from various brain regions during the memory phase in single trials.
- ▶ Study the involvement of different brain regions in the limitations and flexibility of WM.