Face to face

Molecular and functional neural mechanisms of social interaction

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“Where is she is looking at?”

“What is she thinking about me?”

“How do I feel when she looks at me this way?”

“Does she love me?”

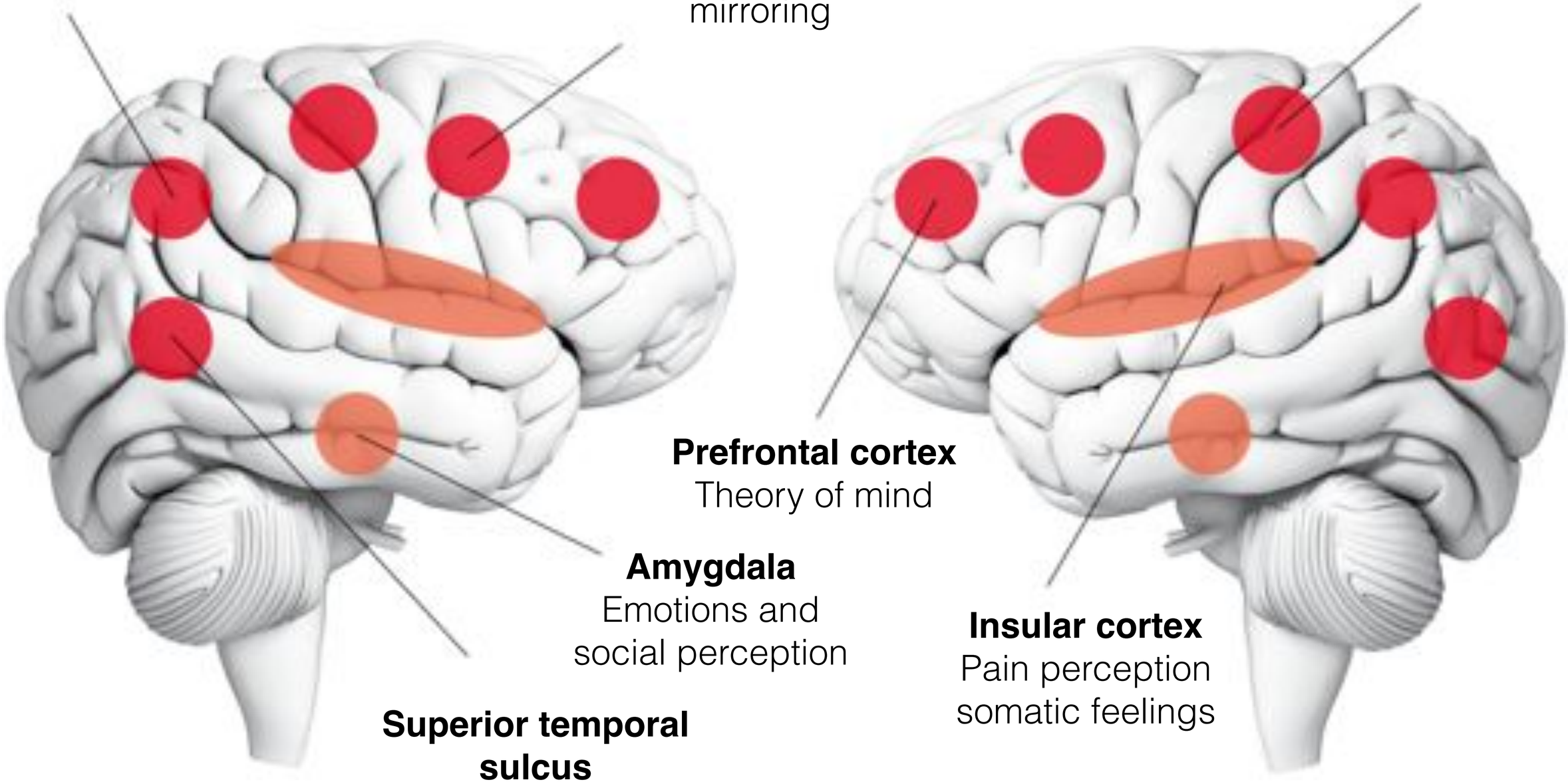
Bridging the gap between the brains

Reinforcing social bonds

Temporoparietal junction:
Theory of mind

Premotor cortex
Motor planning and mirroring

Somatosensory cortex
Somatosensation



Prefrontal cortex
Theory of mind

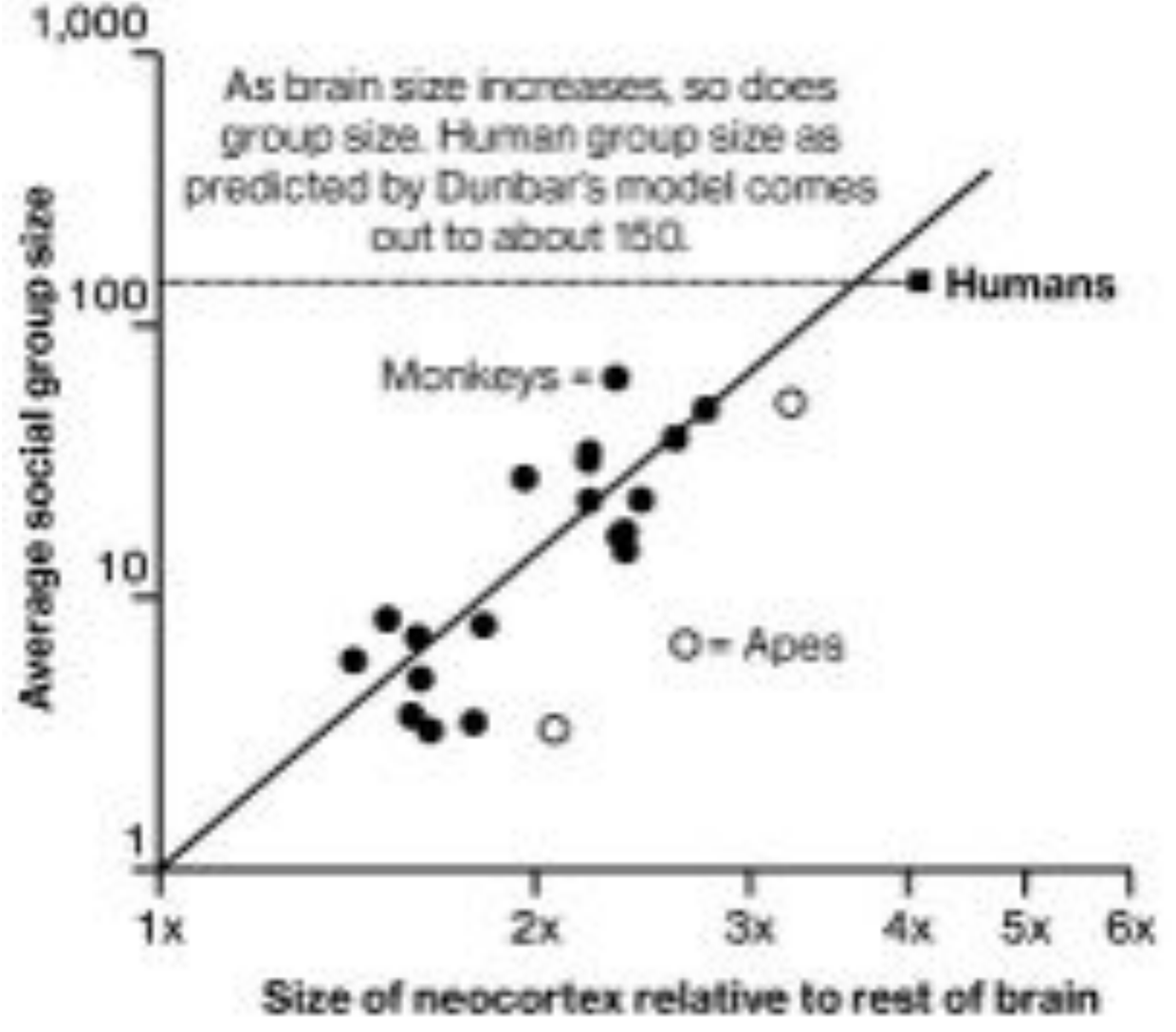
Amygdala
Emotions and social perception

Insular cortex
Pain perception somatic feelings

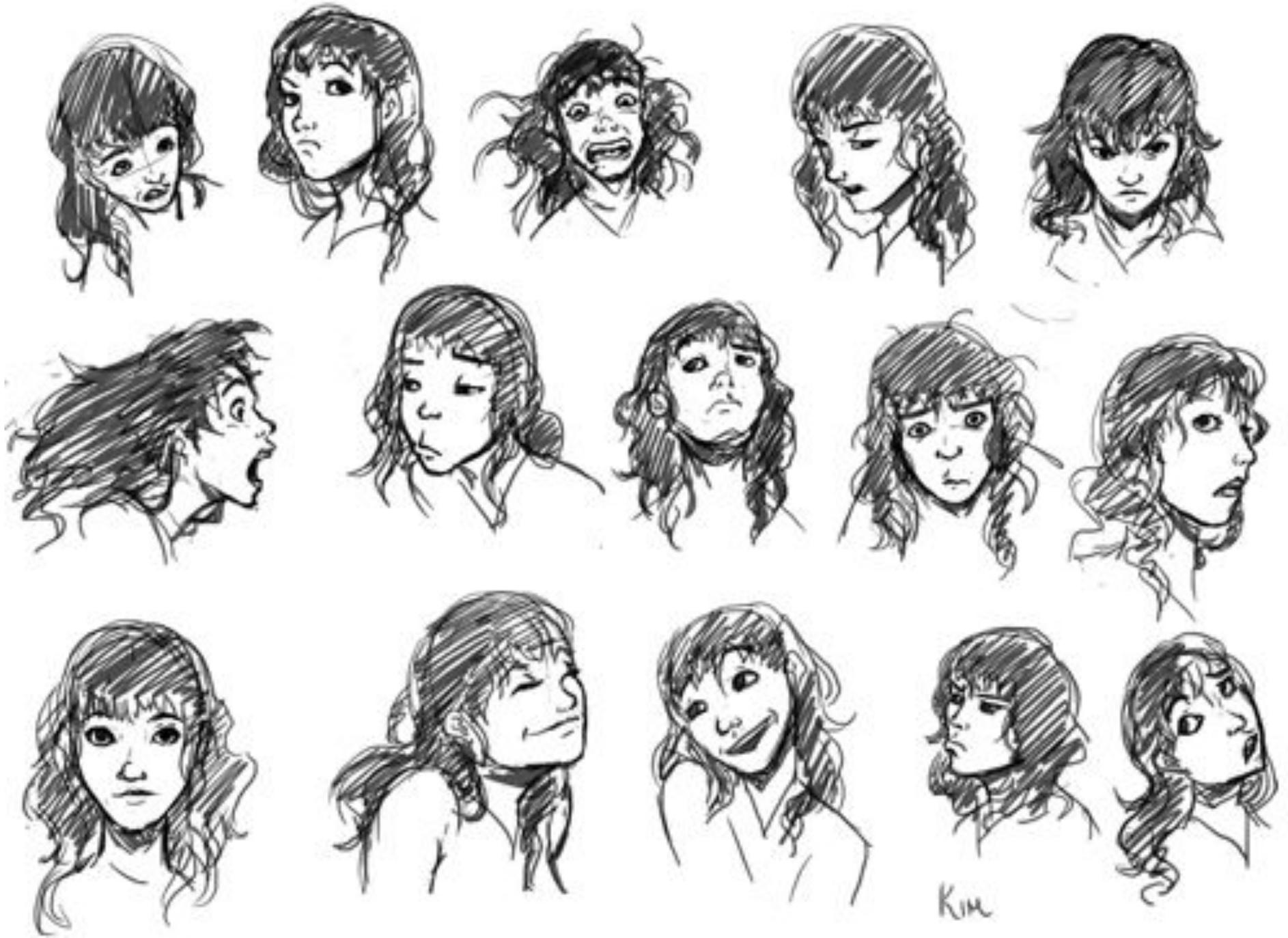
Superior temporal sulcus
Expression and gesture recognition

Nummenmaa & Hari (2014 Tiede)

The Social Cortex



DATA: THE SOCIAL BRAIN HYPOTHESIS, DUNBAR 1998

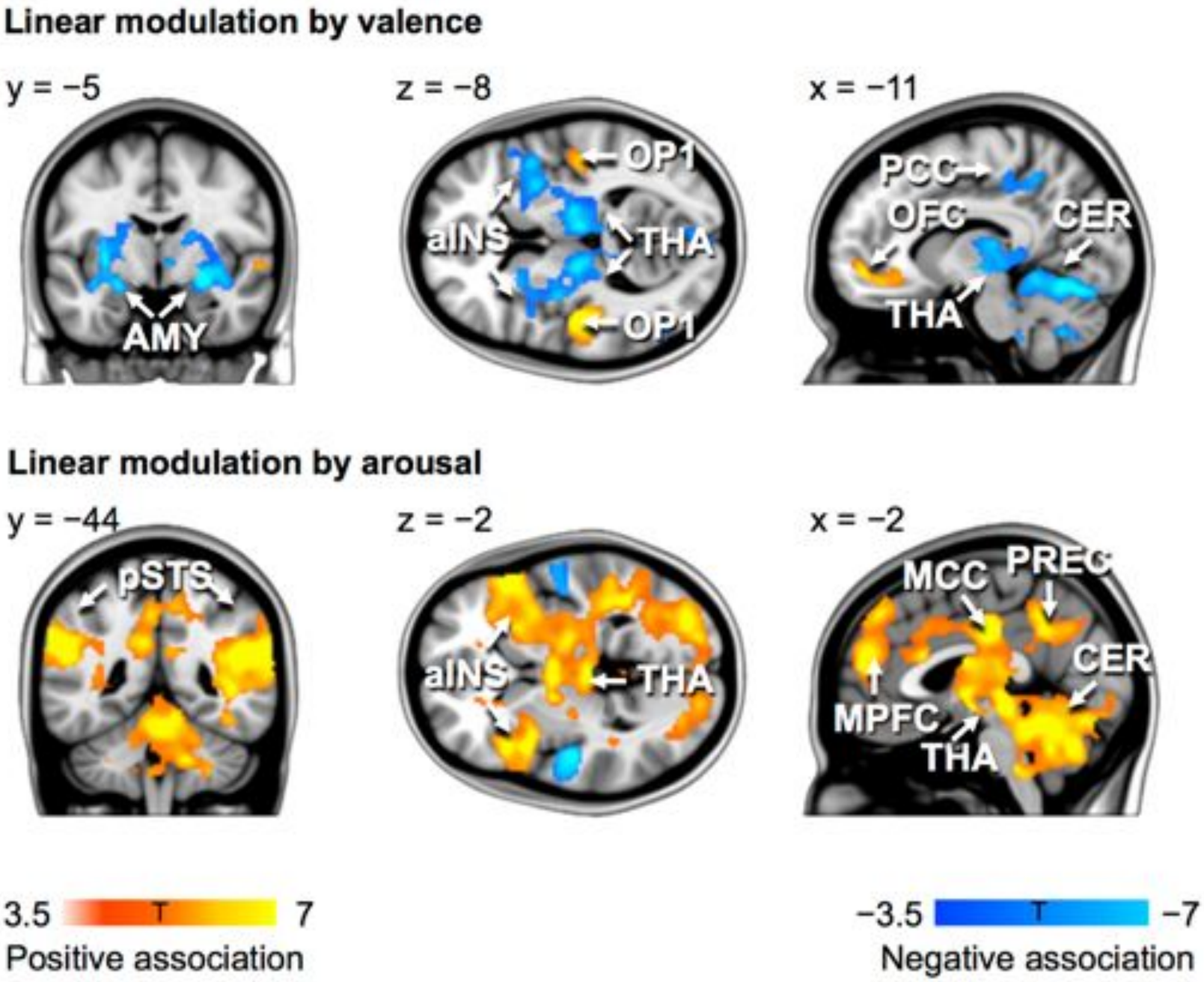

KIM

3.From brain to brain

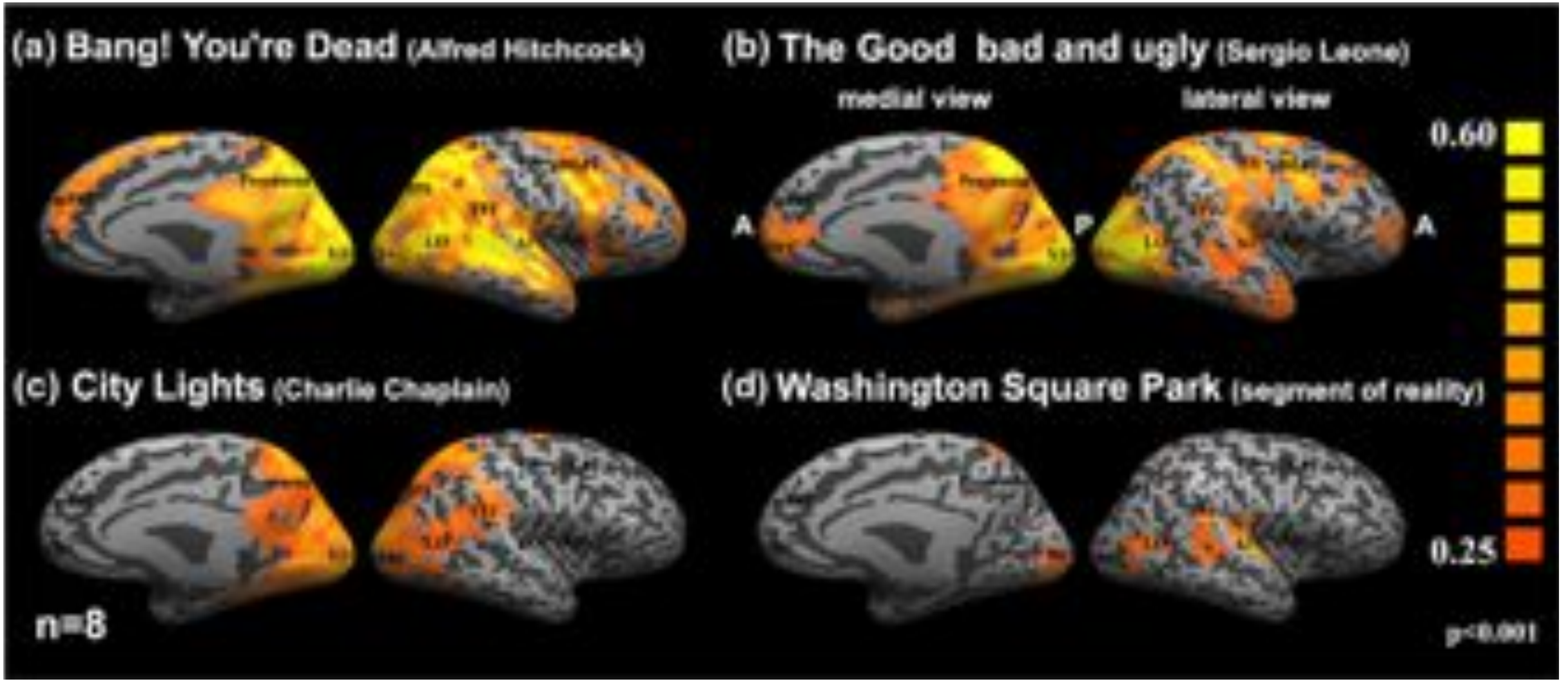
Happy!

2.From brain
to awareness

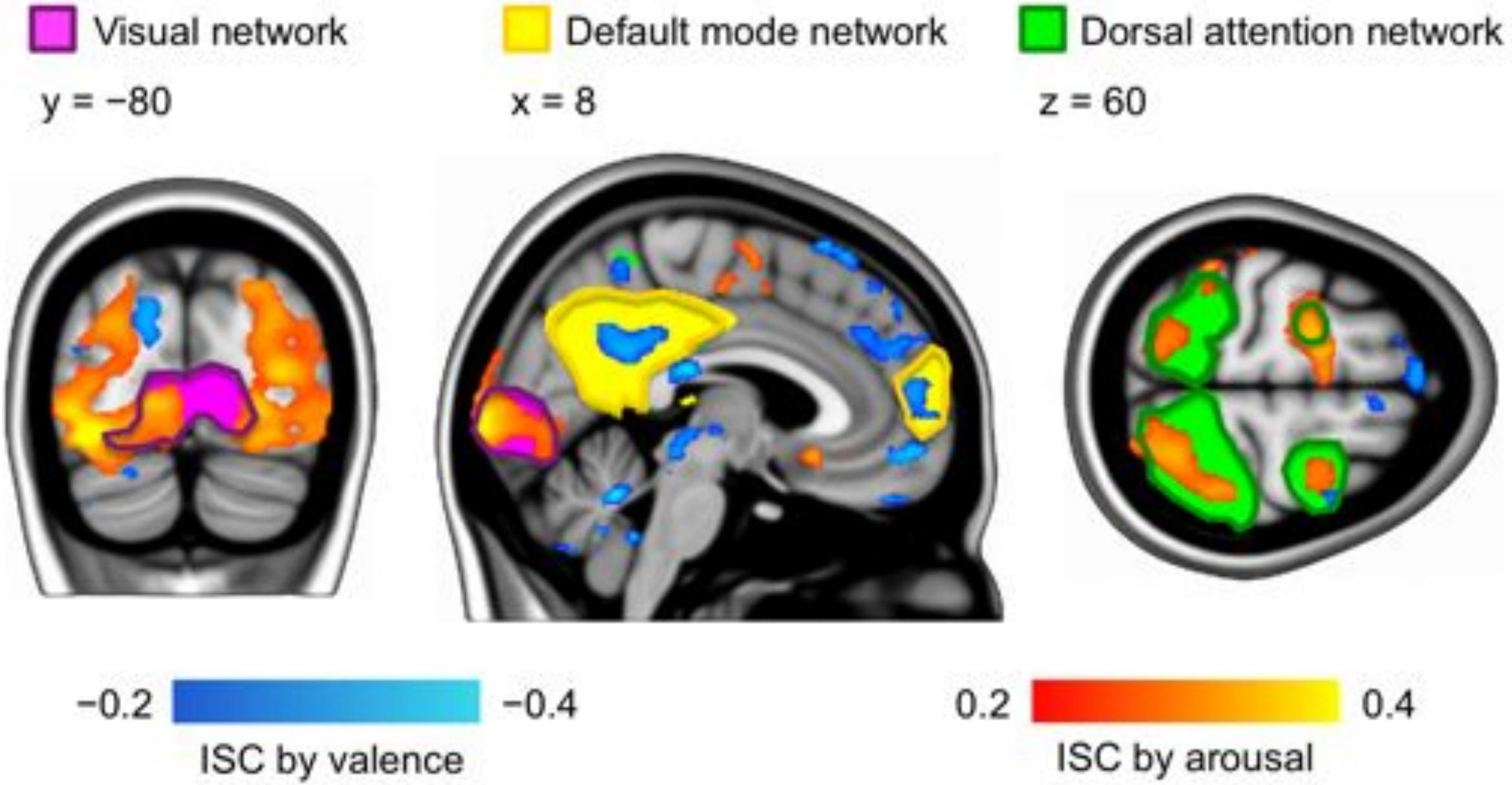
1.From
environment
to brain



Nummenmaa et al (2014 NeuroImage)



Hasson et al (2010 TiCS)



Nummenmaa et al (2012 Proc Natl Acad Sci USA)

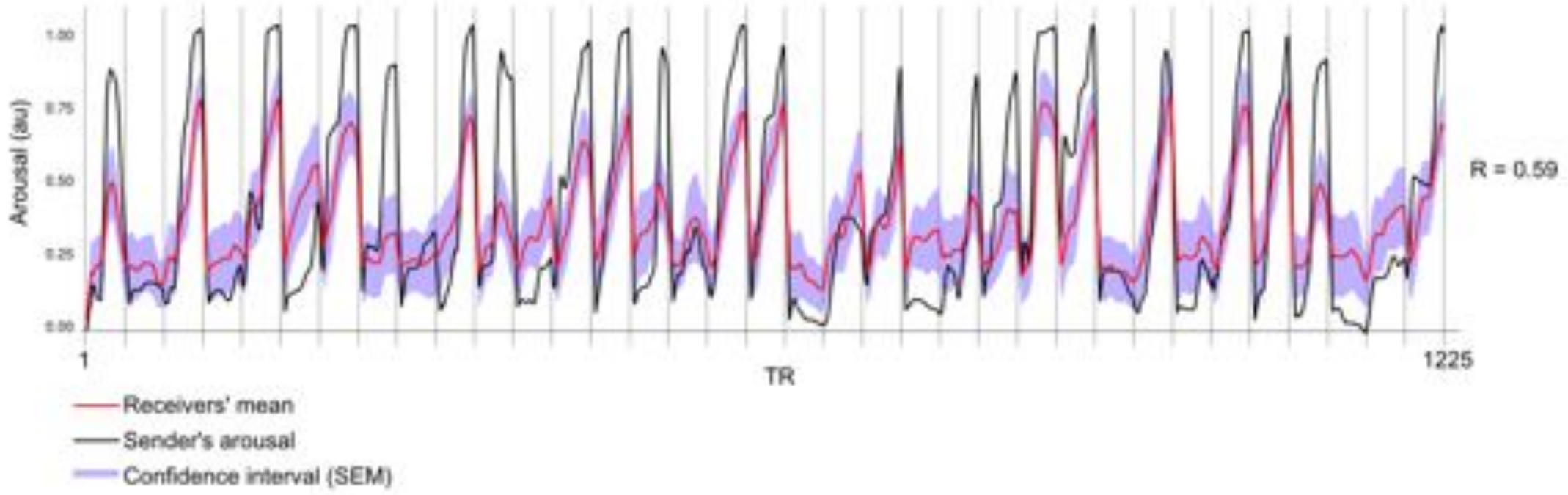
Speakers (n = 2)

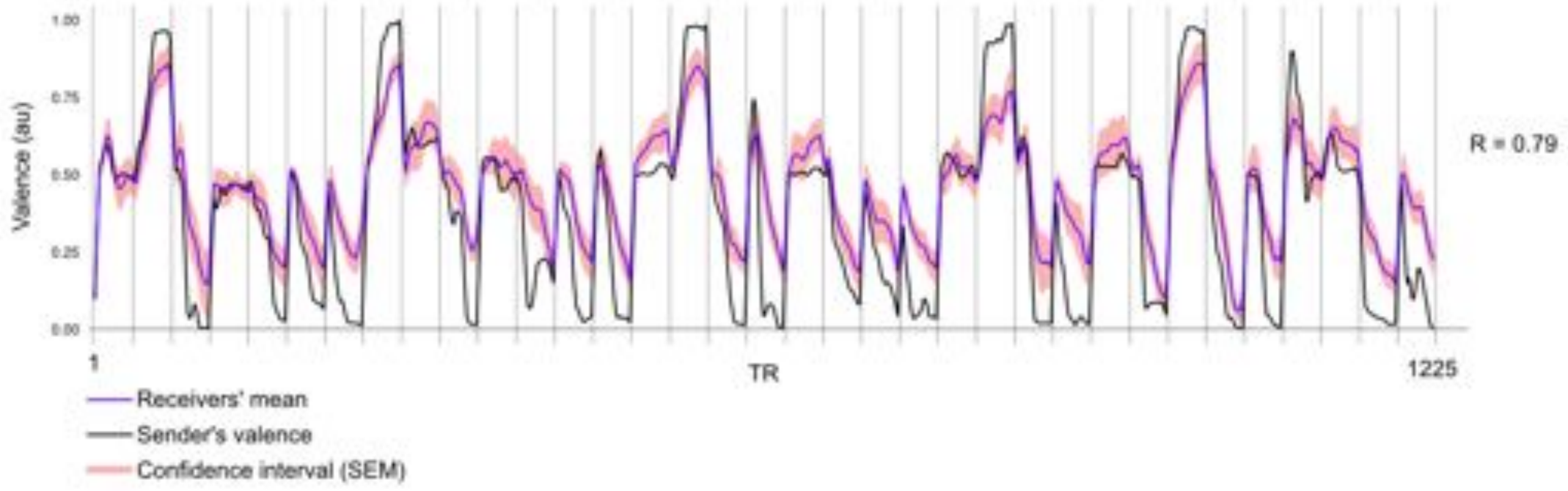
Recall & write up
15 positive
15 negative
15 neutral life events
Each lasting ~45s

fMRI session
Narrate the stories
during fMRI imaging
Recording with noise-cancelling
microphone; off-line denoising
Valence and arousal ratings

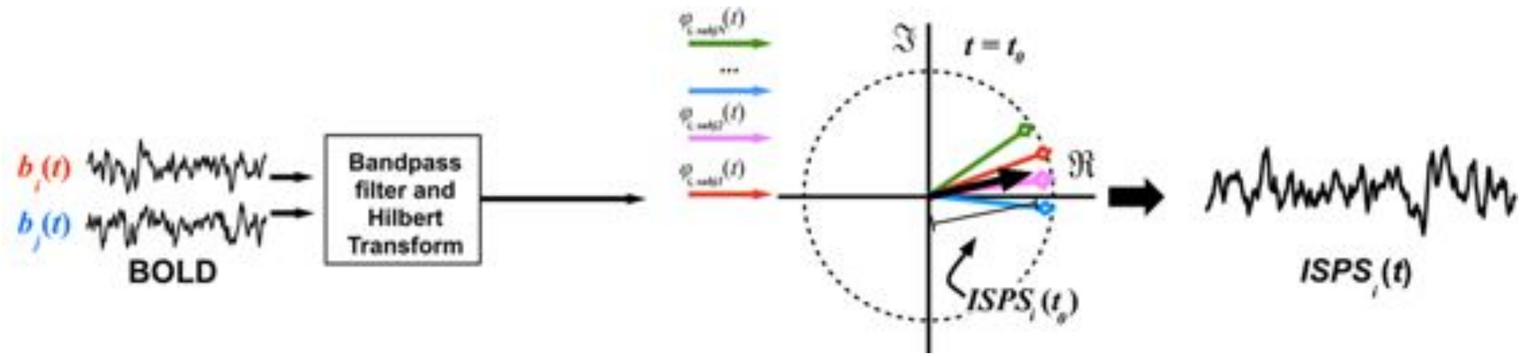
Listeners (n = 16)

fMRI session
Listen to the pre-recorded
stories during fMRI imaging
Total 45 min scan


Arousal (au)
1.00
0.75
0.50
0.25
0.00
1
1225
TR
R = 0.59
Receivers' mean
Sender's arousal
Confidence interval (SEM)


Valence (au)
1.00
0.75
0.50
0.25
0.00
1
1225
TR
R = 0.79
Receivers' mean
Sender's valence
Confidence interval (SEM)

Emotional contagion promotes speaker-listener neural coupling

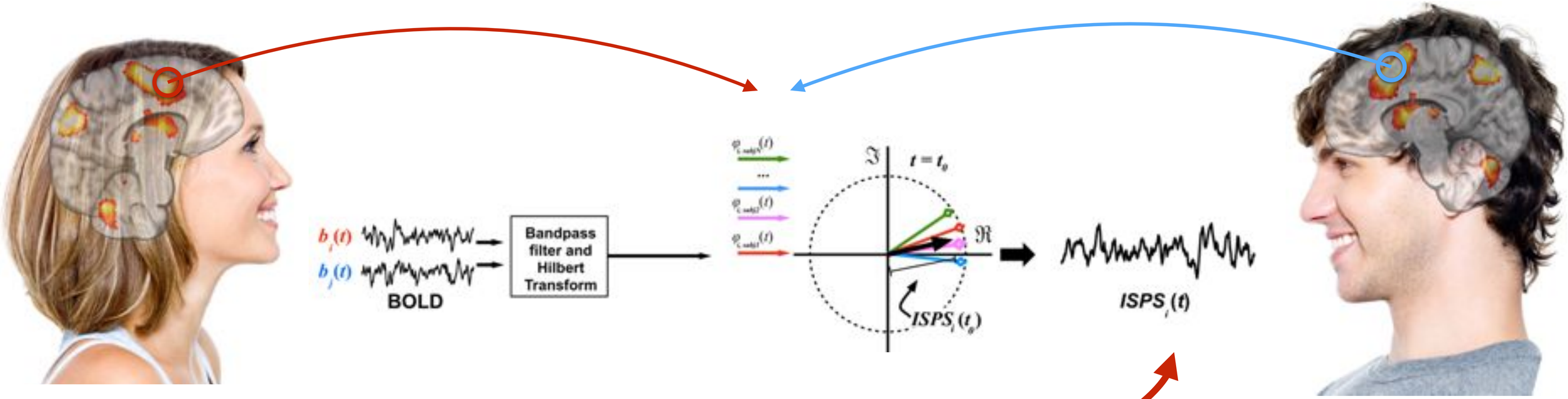


Glerean et al (2012 Brain Conn); Nummenmaa et al (2014 J Neurosci; 2014 NeuroImage)

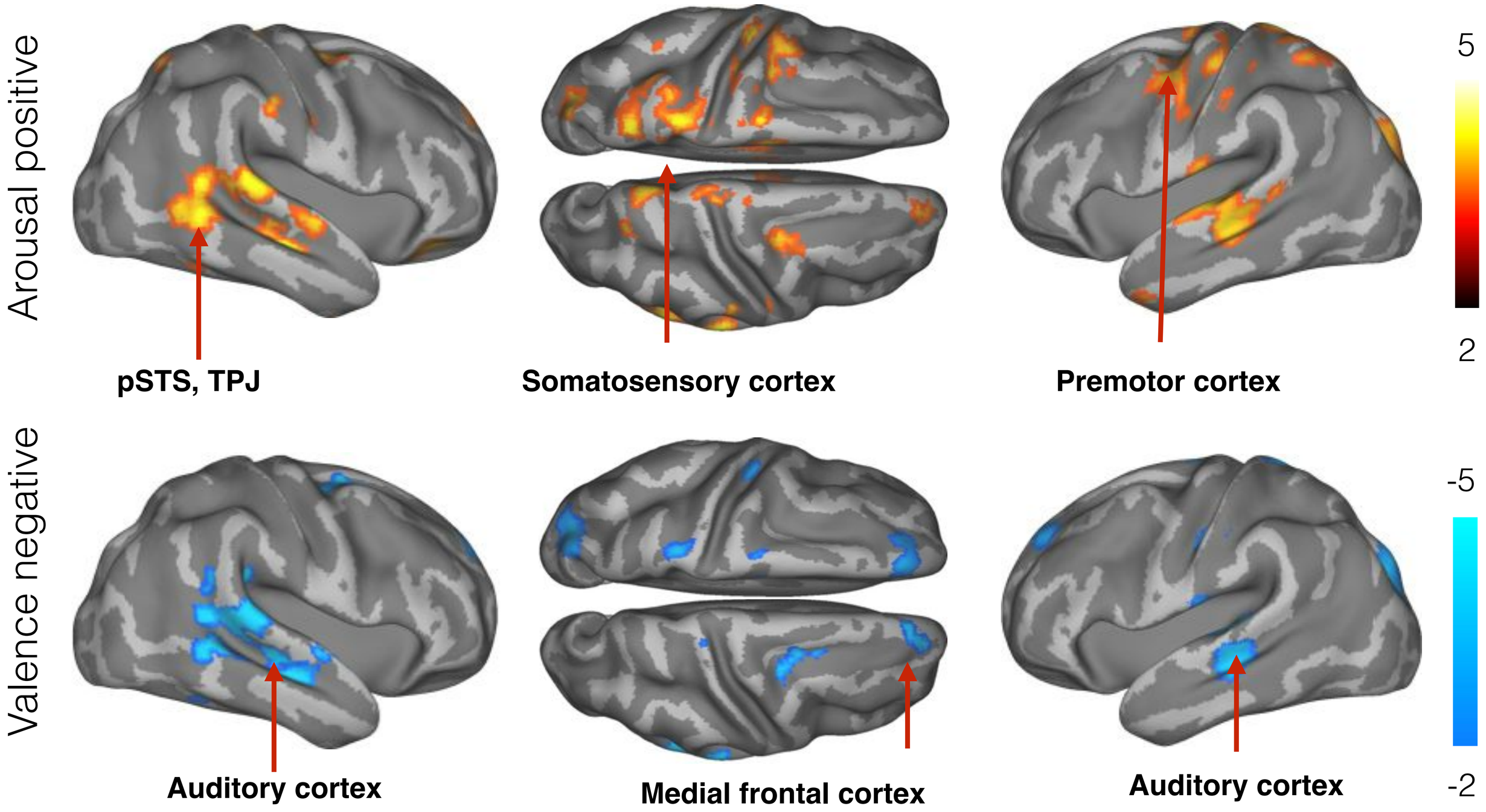
Does emotional contagion promote speaker-listener neural coupling?

Speakers

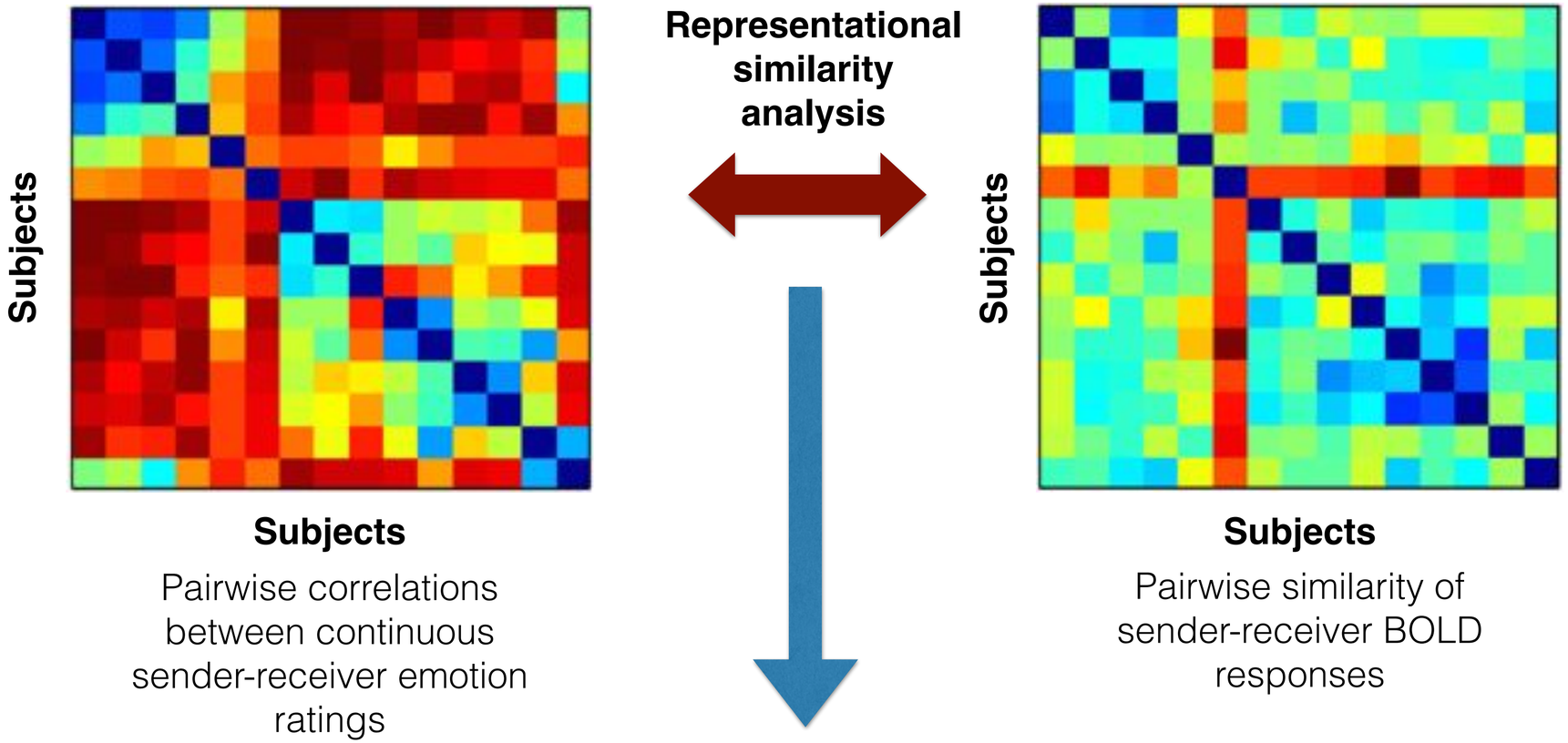
Listeners



Regression with valence and arousal time series

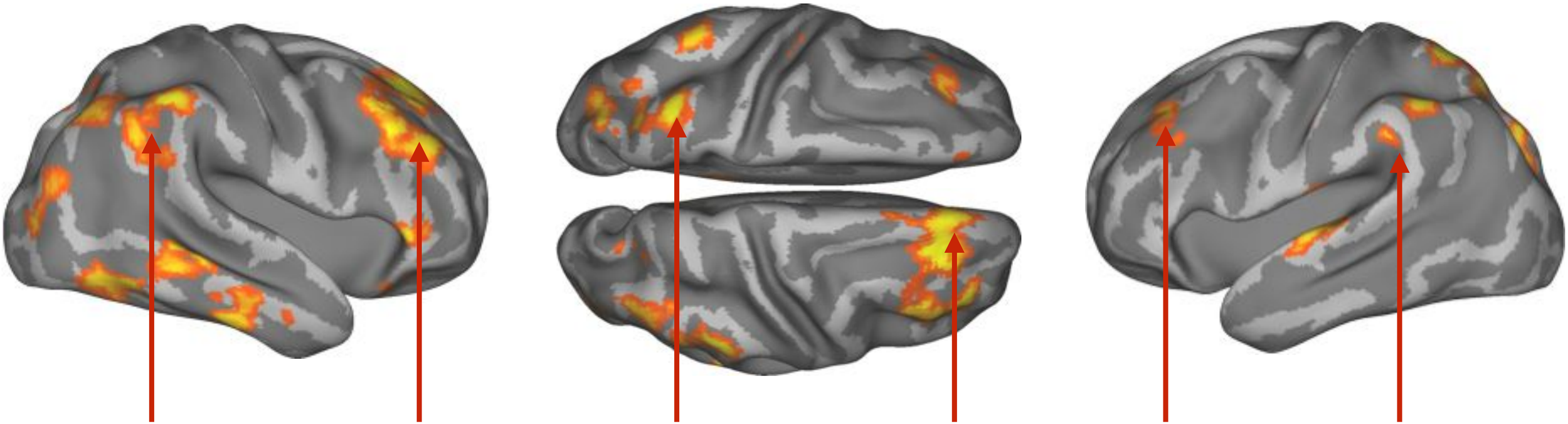

Arousal positive
Valence negative
5
2
-5
-2
pSTS, TPJ
Somatosensory cortex
Premotor cortex
Auditory cortex
Medial frontal cortex
Auditory cortex

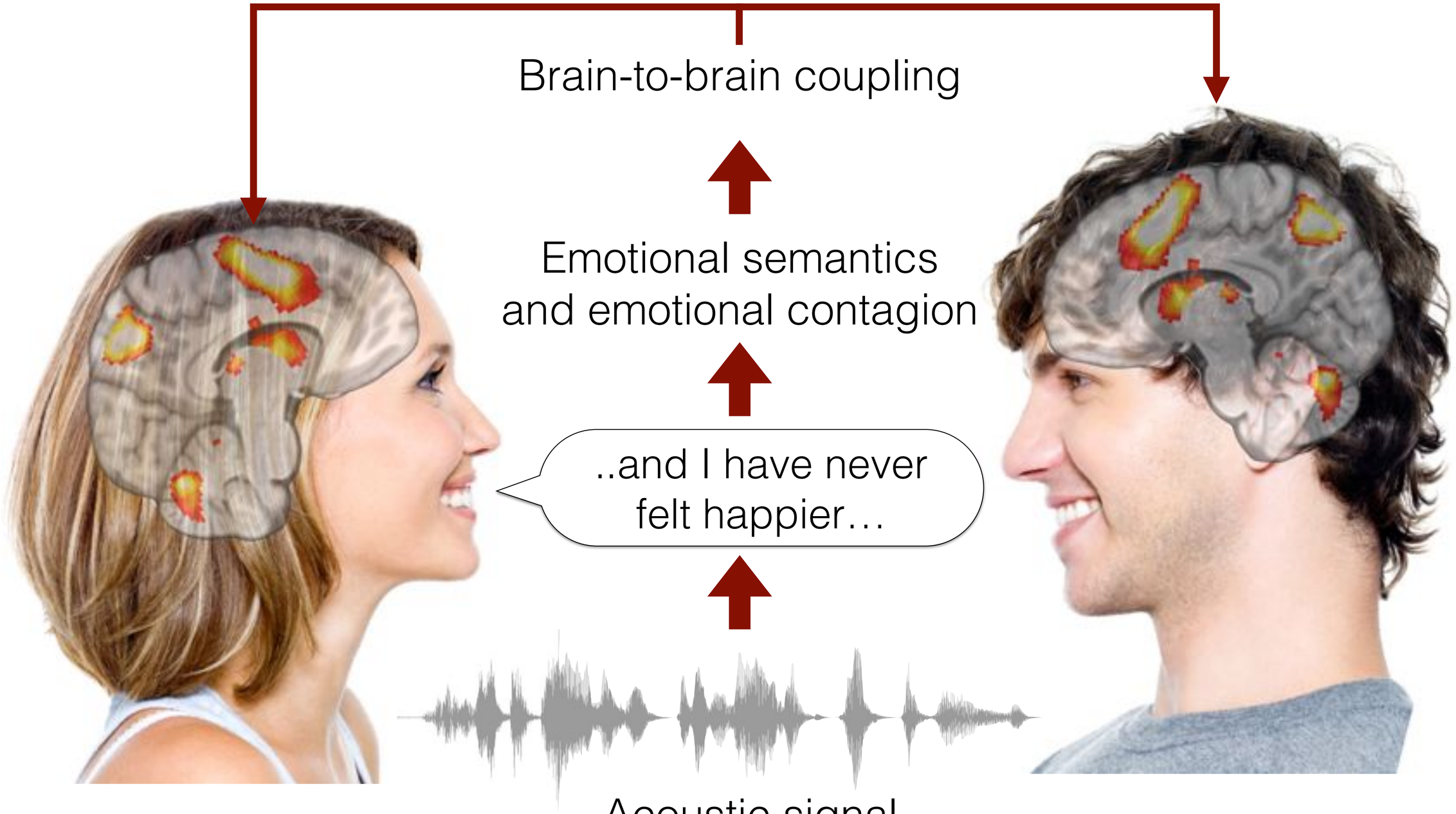
Representational similarity analysis



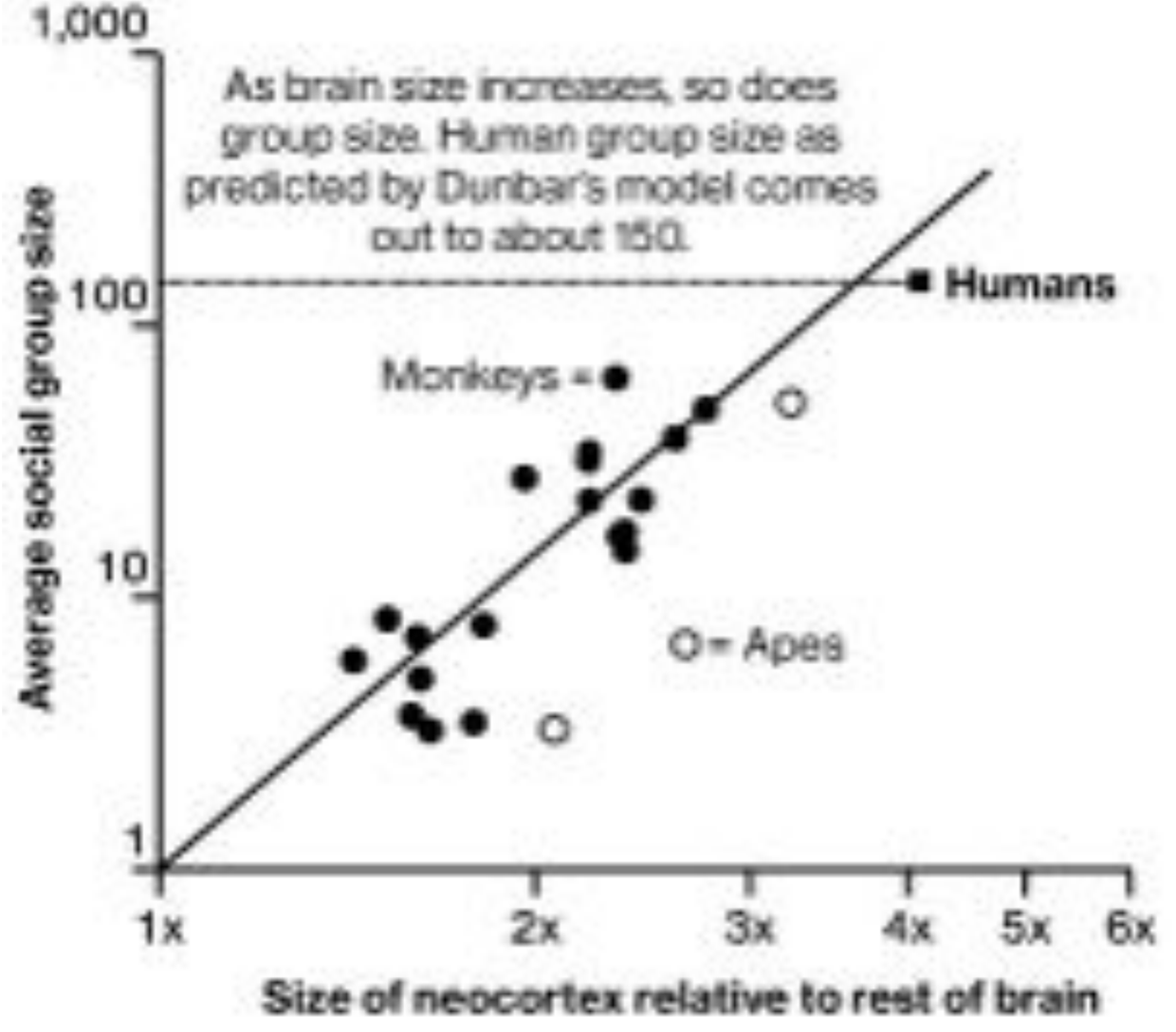
Whole brain correlation map
where the similarity of brain activation matches
intersubject consistency of subjective feelings

Similar mind states are associated with similar brain states




Brain-to-brain coupling
Emotional semantics
and emotional contagion
..and I have never
felt happier…
Acoustic signal

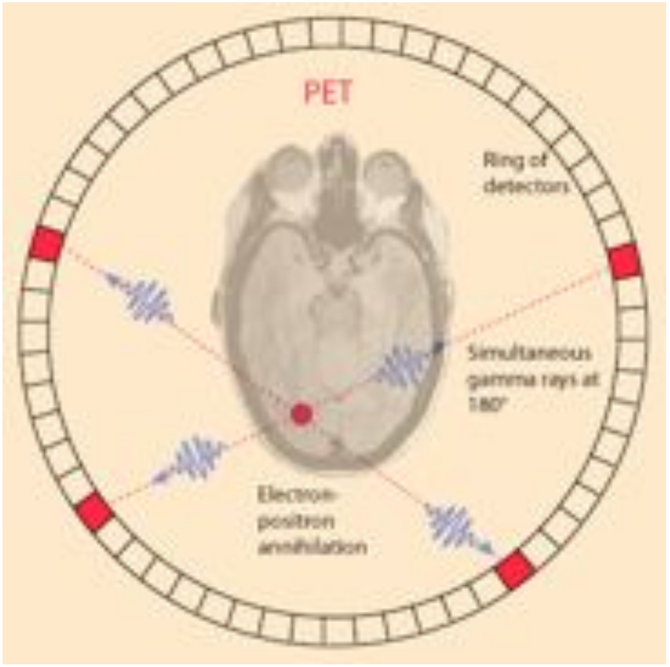
The Social Cortex



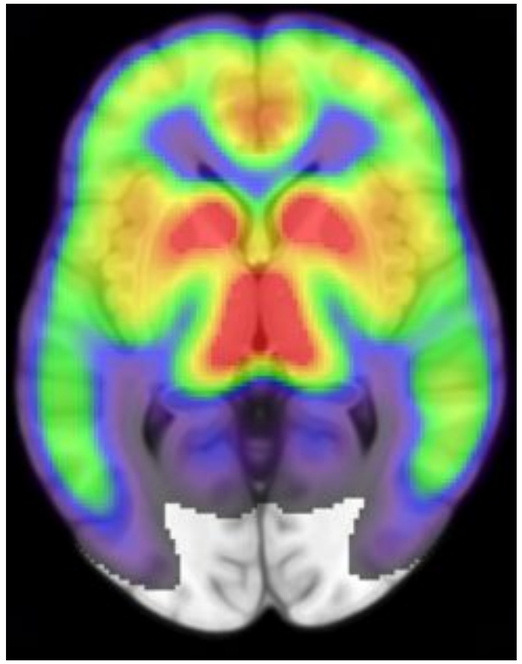
DATA: THE SOCIAL BRAIN HYPOTHESIS, DUNBAR 1998

PET camera

Coincedence detection



Reconstructed image

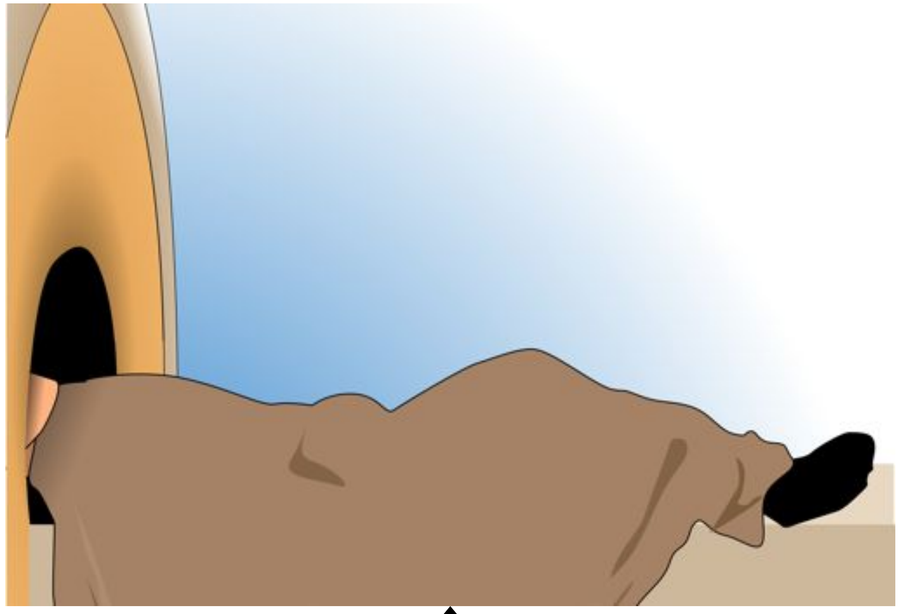


Positron Emission Tomography allows in vivo quantification of the distribution of specific chemical compounds. It can thus be used for studying specific neurotransmitter systems.

51-min social touch scan

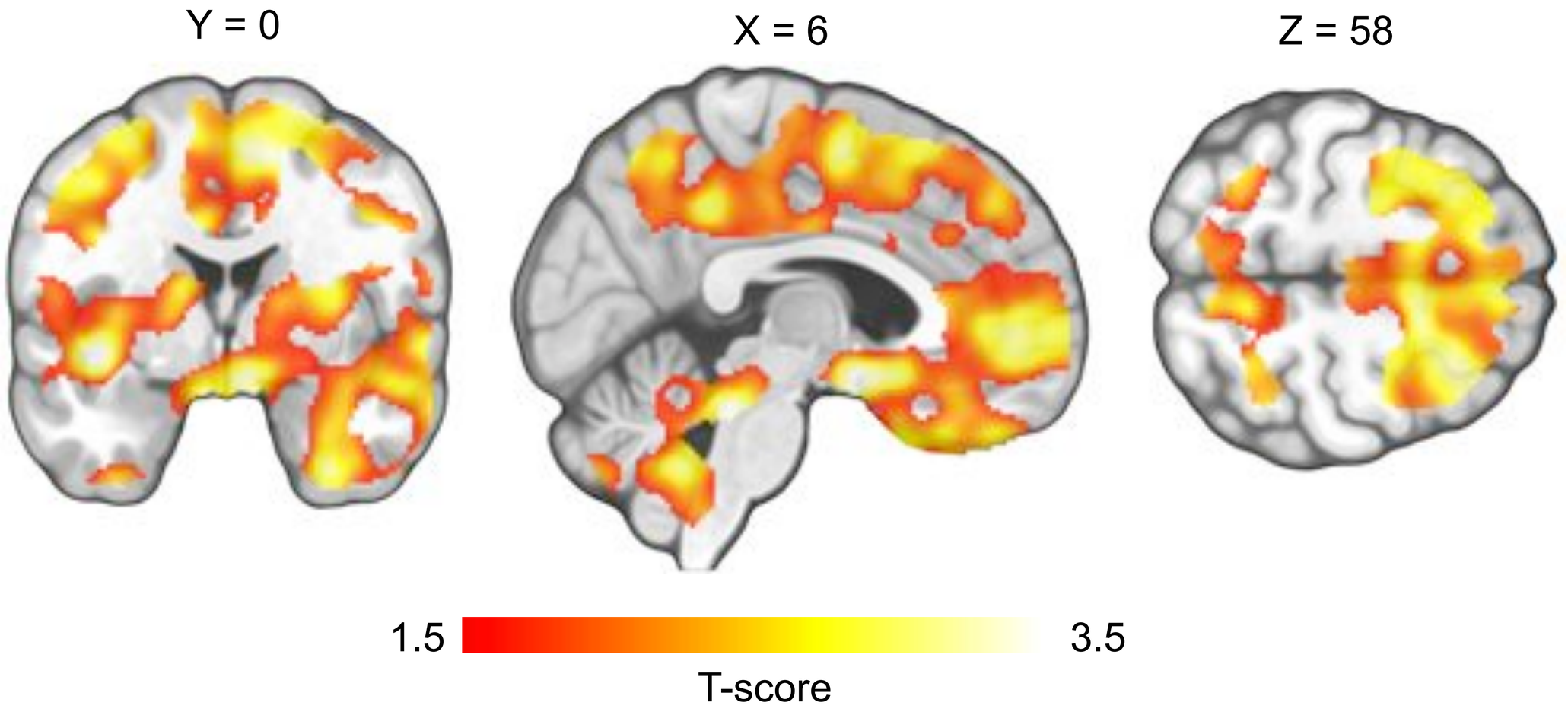
2-hour decay break

51-min baseline scan

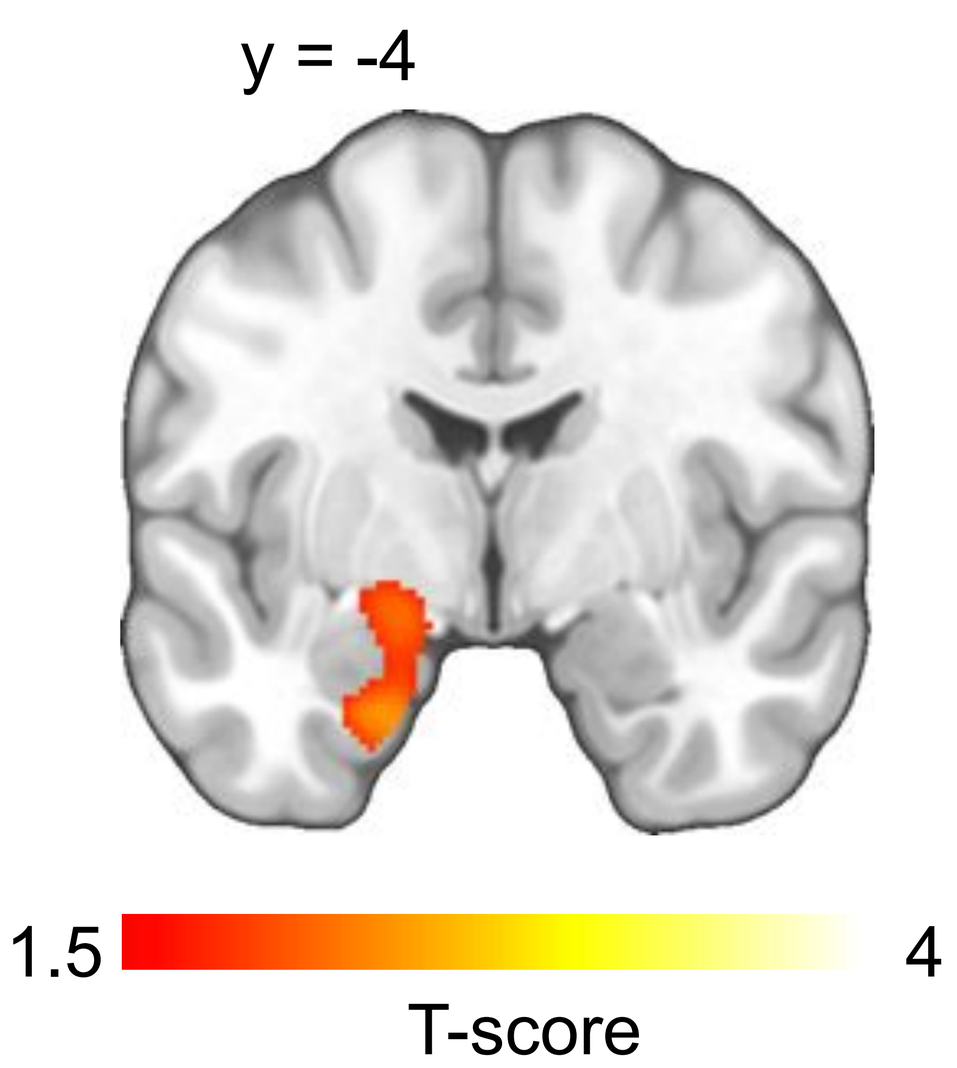


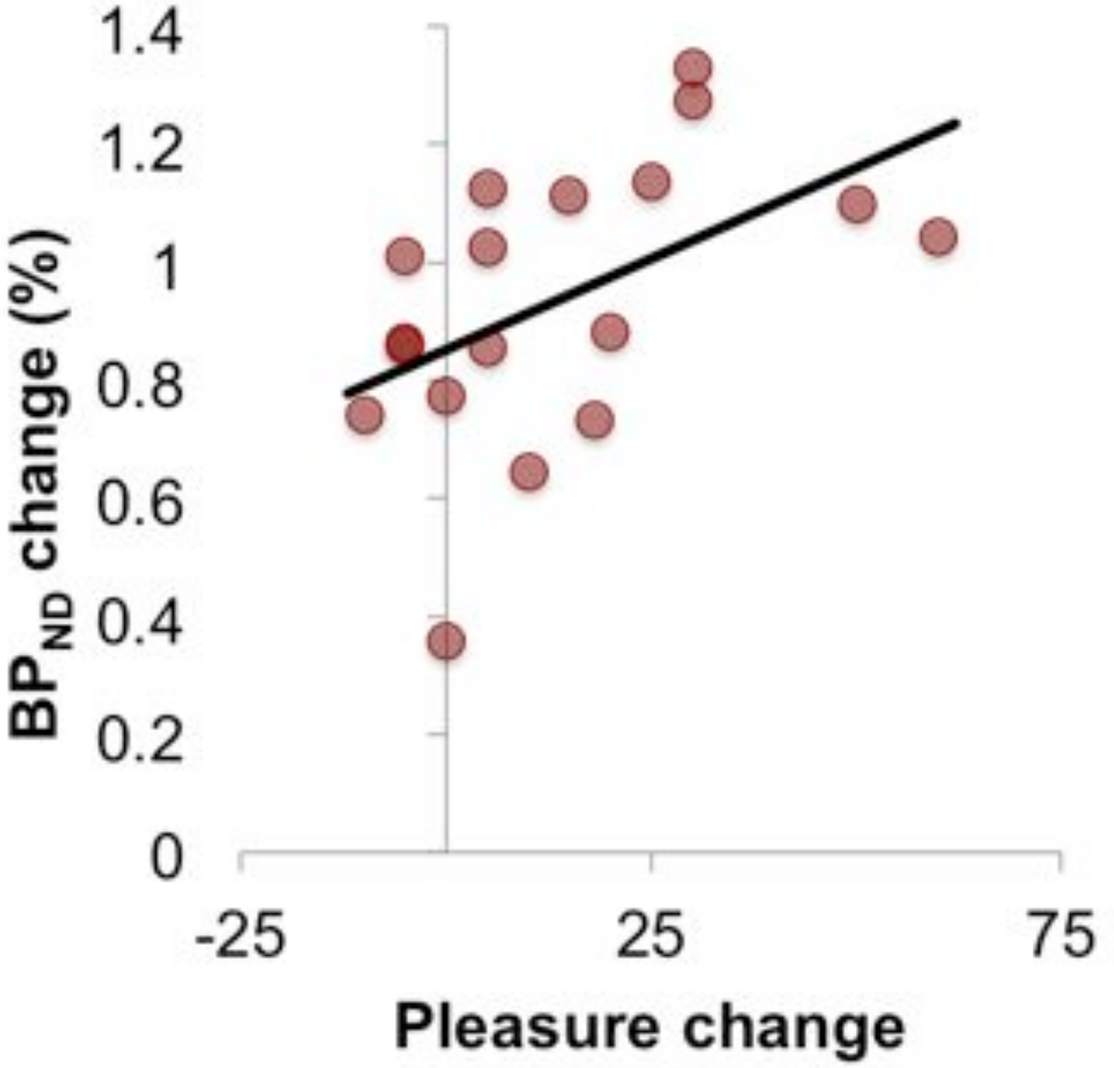
Order counterbalanced across participants

Nummenmaa et al (submitted)

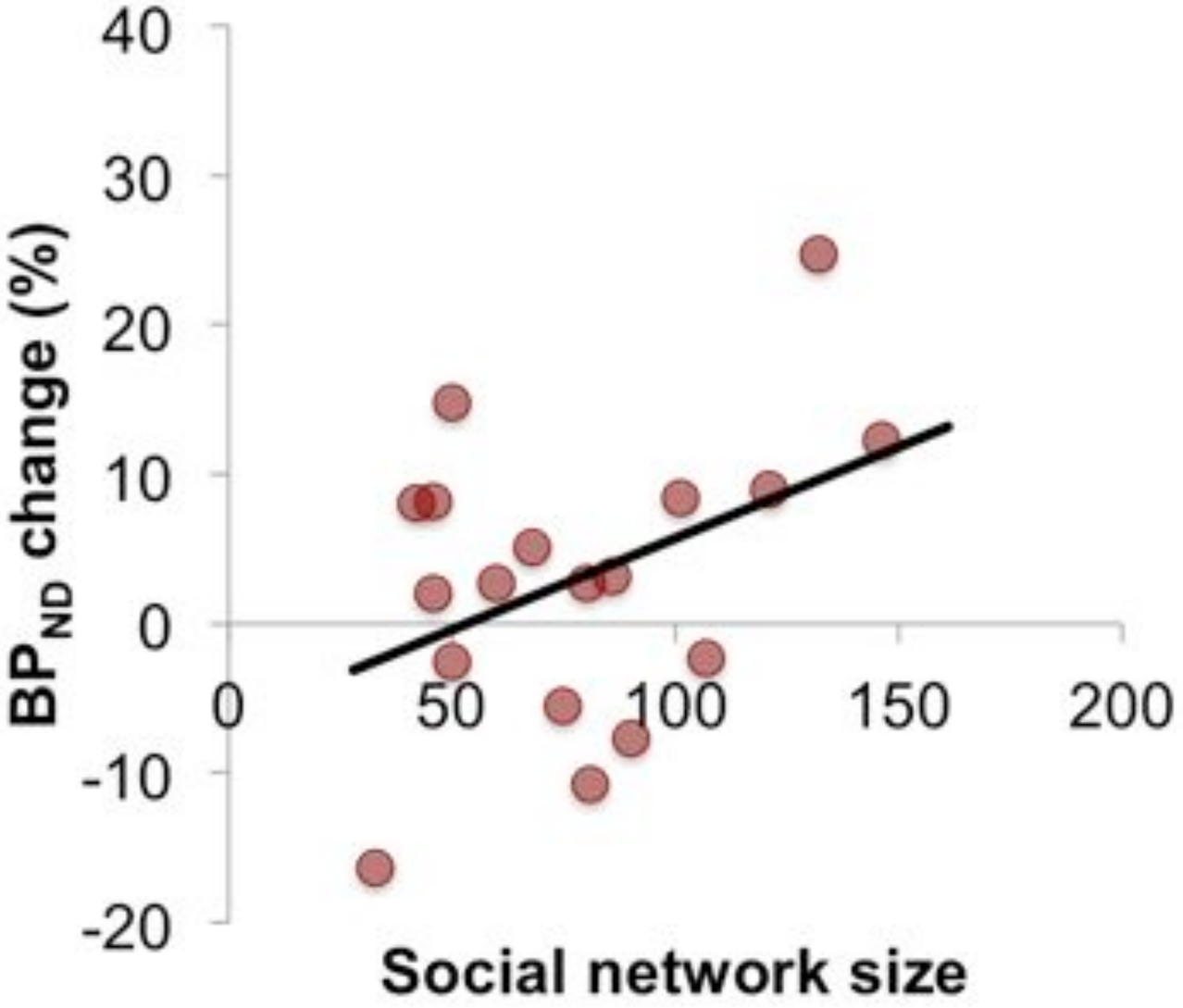


Nummenmaa et al (submitted)

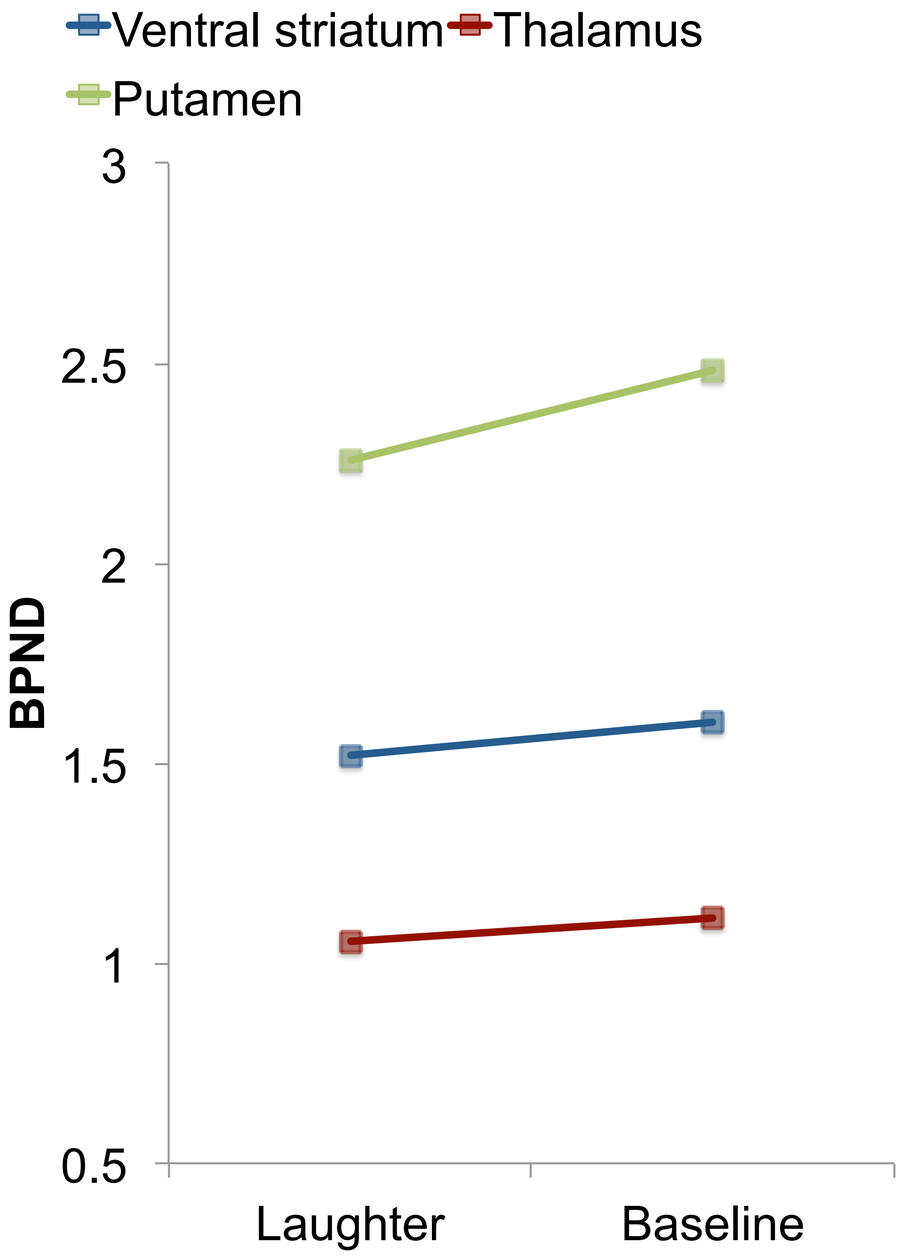


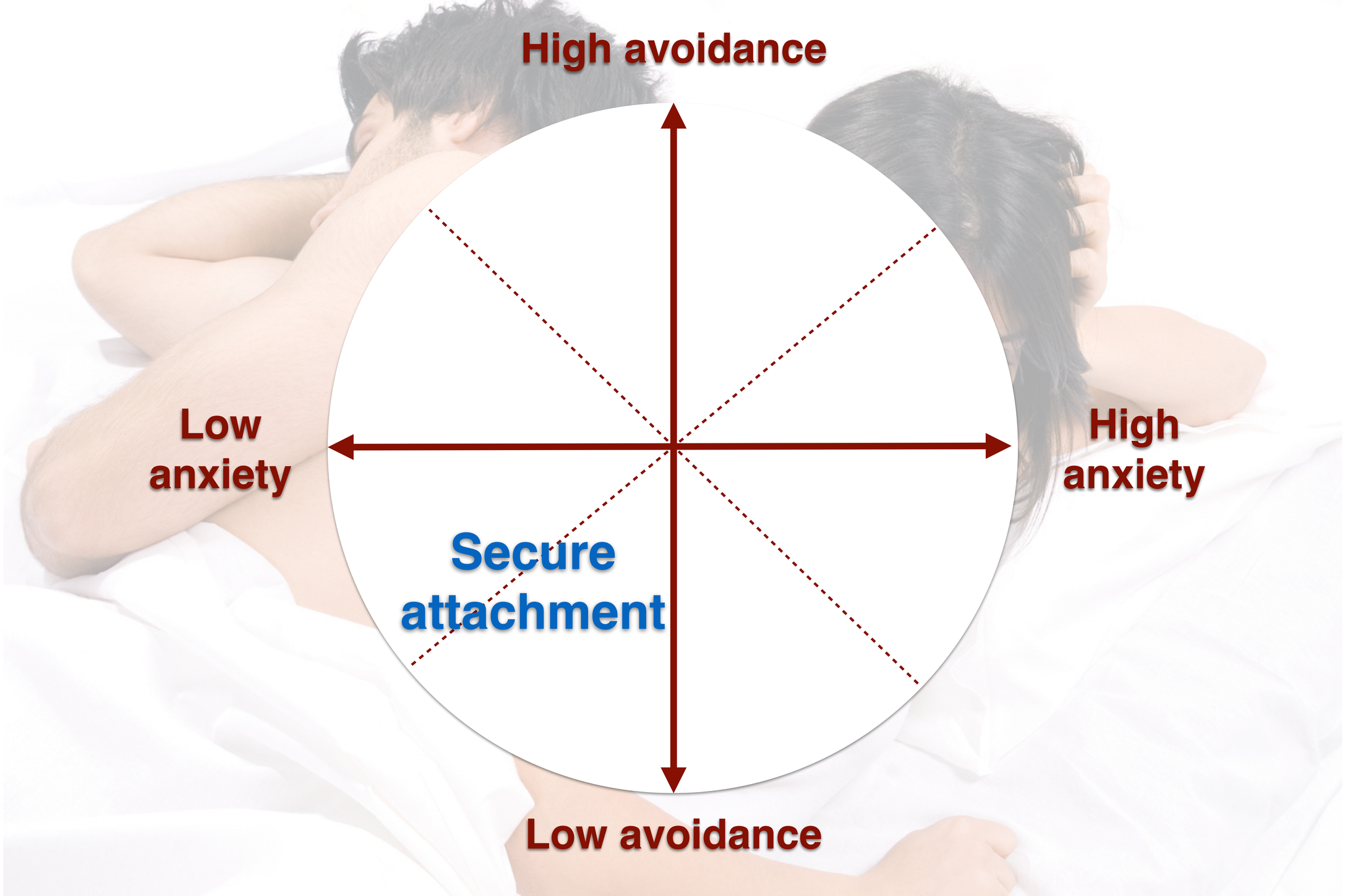


Nummenmaa et al (submitted)



Nummenmaa et al (submitted)


Ventral striatum
Thalamus
Putamen
3
2.5
2
1.5
1
0.5
BPND
Laughter
Baseline


High avoidance
Low anxiety
High anxiety
Secure attachment
Low avoidance

Small social networks

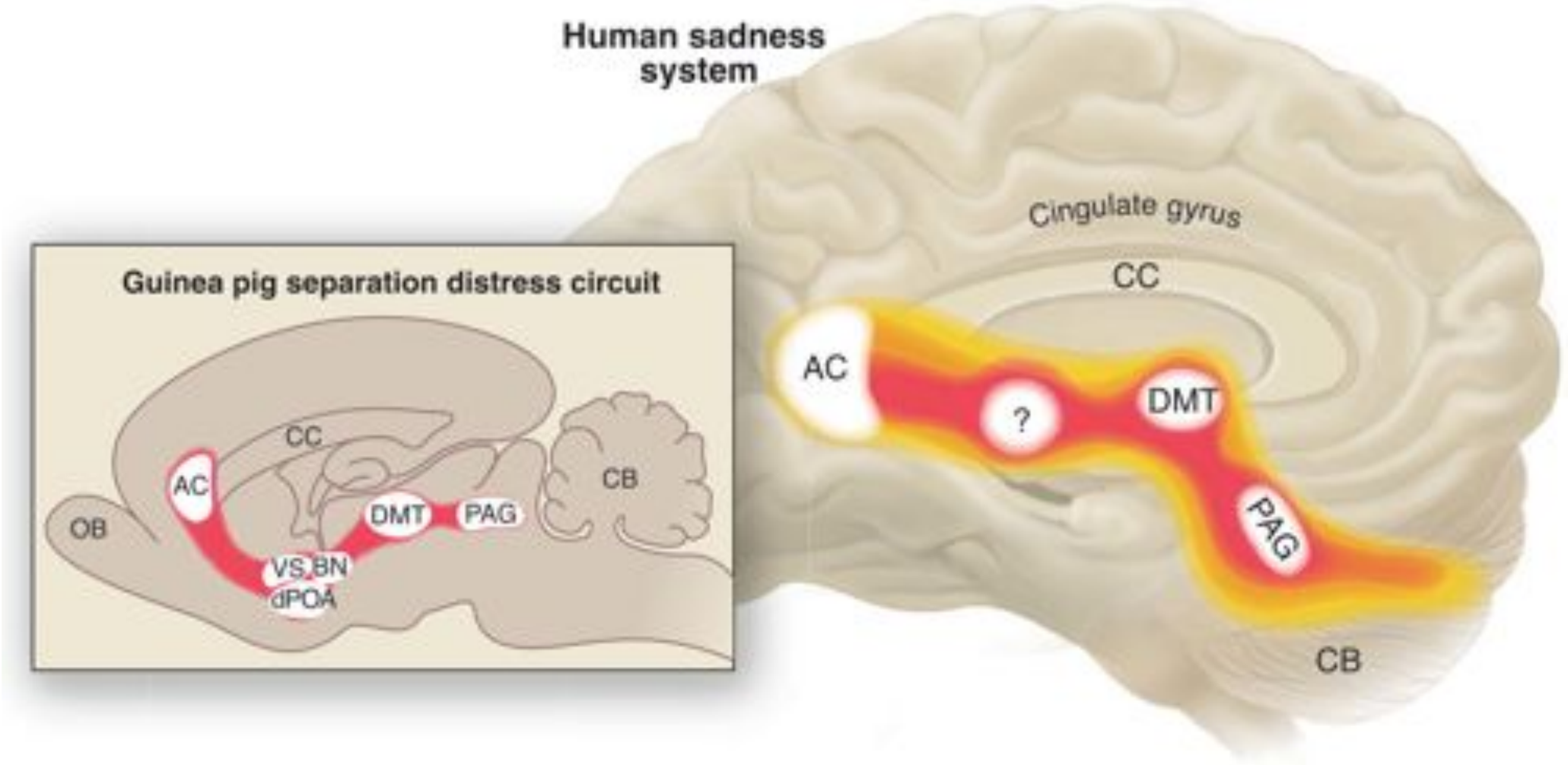
Insecure social relationships

Substance abuse

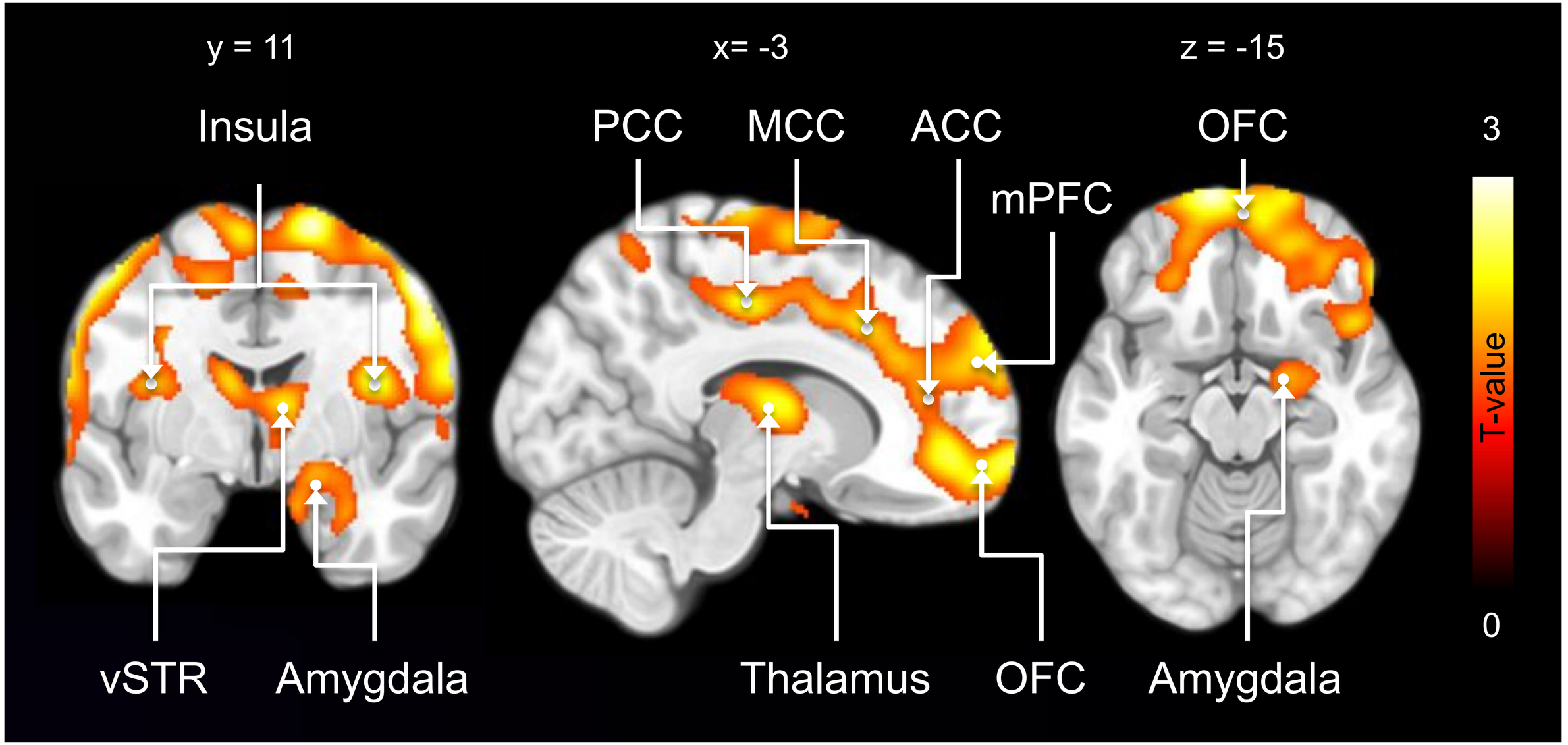
Psychological adjustment problems

Loneliness

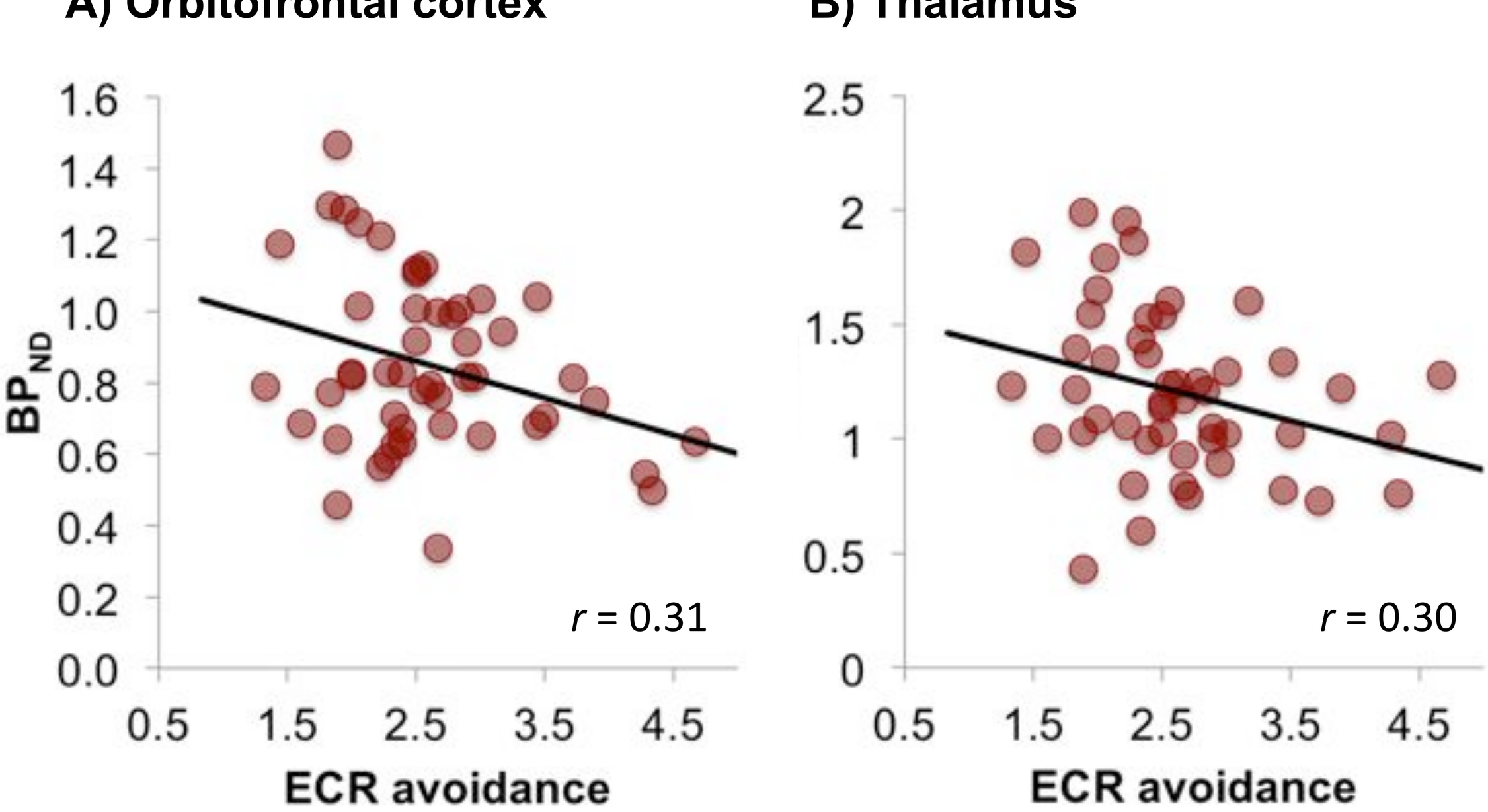
Relationship dissatisfaction



Panksepp (2002 Science)



Manninen et al (2014 NRM)



Manninen et al (2014 NRM)

Conclusions

- Emotional contagion promotes speaker-listener neural coupling
- Endogenous opioid system underlies maintenance of social bonds
- Altered mu receptor tone is associated with insecure adult attachment
- Mu-receptor system could be the prime neurochemical pathway maintaining social relationships

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Please see also our webpages http://emotion.becs.aalto.fi where you can find more information and can participate in our experiments