

Self-Other Distinction In Em is Modulated by cTBS on right Supramarginal Gyrus and Dispositional Cognitive Empathy: An rTMS/fMRI Study

Bukowski^{1*}, H., Tik², M., Silani³, G., Ruff⁴, C., Windischberger², C., &
Lamm¹, C.

¹Social, Cognitive and Affective Neuroscience Unit, Department of Basic Psychological Research and Research Methods, University of Vienna, Vienna, Austria

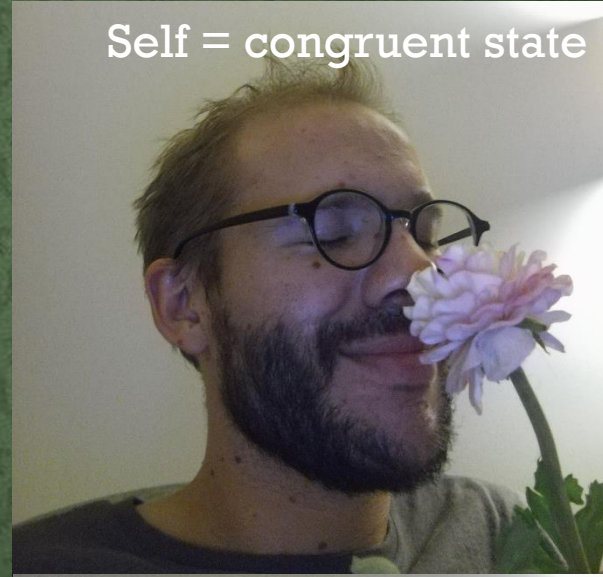
²MR Center of Excellence, Center for Medical Physics and Biomedical Engineering, Medical University of Vienna, Austria

³Department of Applied Psychology: Health, Development, Enhancement and Intervention, University of Vienna, Vienna, Austria

⁴Laboratory for Social and Neural Systems Research, Department of Economics, University of Zurich, Zurich, Switzerland

Are We “Emotional Sponges” ? ...3 Situations

Self = neutral state



Self = **incongruent** state

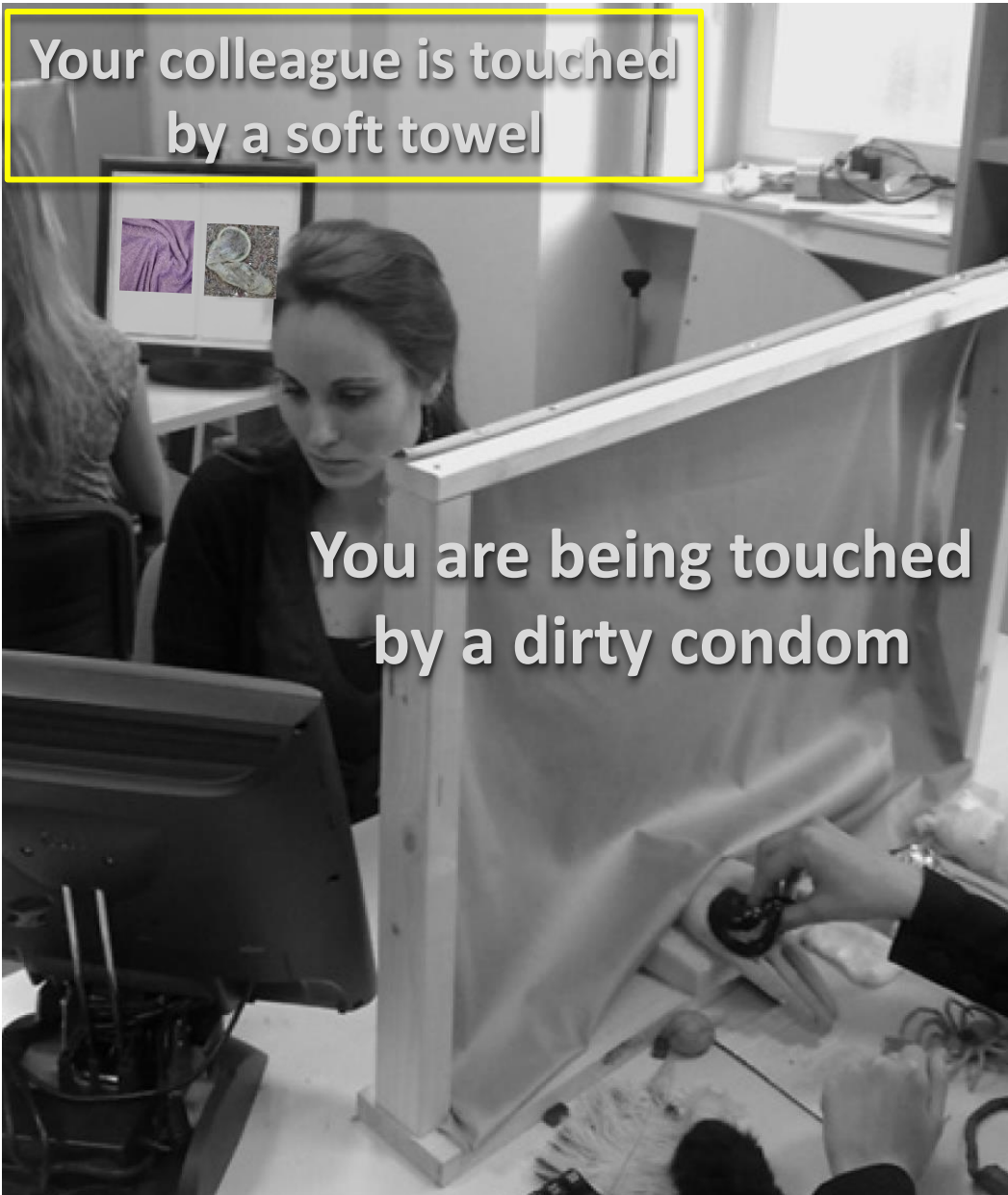
Self-other Distinction (SOD) in Empathy

- prevents us from being:
 - excessively influenced by our own emotional state when inferring the emotion of others → egocentric bias
 - excessively influenced by others' emotions when inferring our own emotional state
→ altercentric bias
- Mechanisms of SOD are largely unknown, namely due to the scarcity of SOD measures.
- **Goal:** Investigate with rTMS and fMRI the neurocognitive mechanism of SOD in empathy.

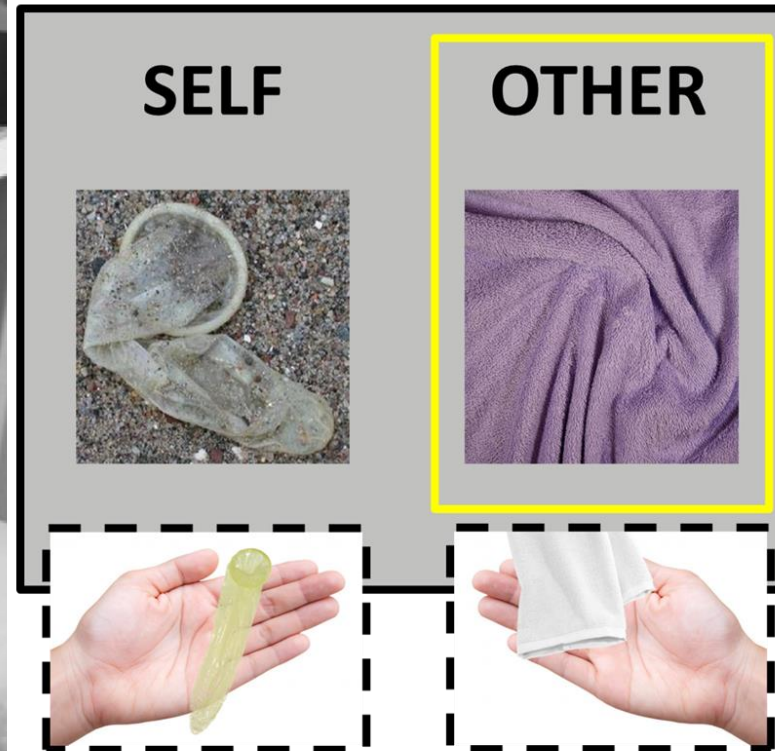
How to measure SOD in Empathy?

- Indirect: Self-report : **Cognitive Empathy** subscale of QCAE (Reniers et al., 2011)
→ dispositional aspect (e.g., “*I am good at predicting how someone will feel.*”)
- Performance-based: **Visuotactile empathy** task (Silani, Lamm, Ruff, & Singer, 2013):
 - You and another person simultaneously experience pleasant or unpleasant visuotactile stimulation.
 - Then report how the other or yourself feel(s). When oneself and another person experience incongruent emotions, SOD is required to avoid being biased (i.e., excessively influenced) by our own or another’s emotion.

Visuotactile empathy task



How does your colleague feel ?



Incongruent emotions condition

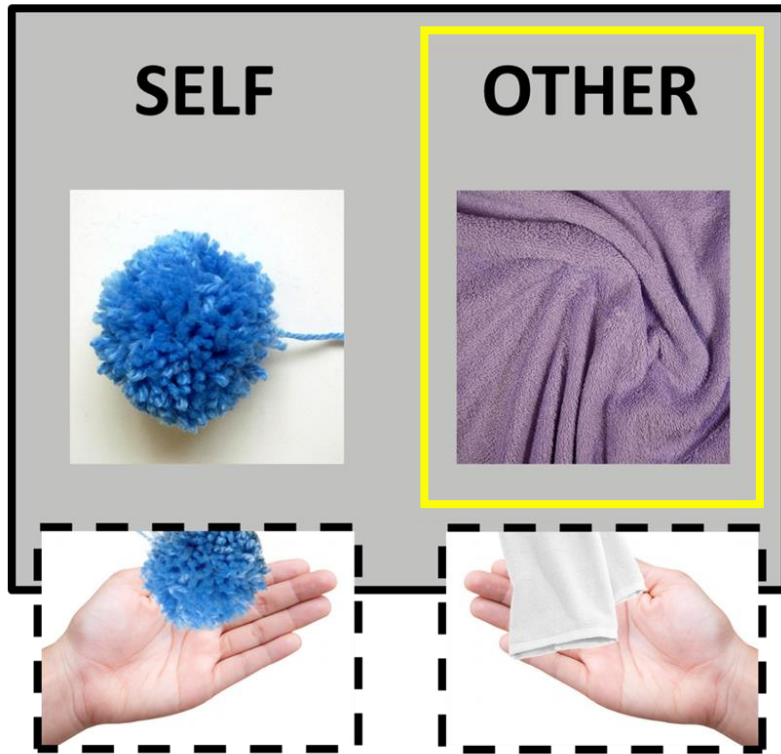


**High bias =
poor SOD
performance**

**= Egocentric
bias**

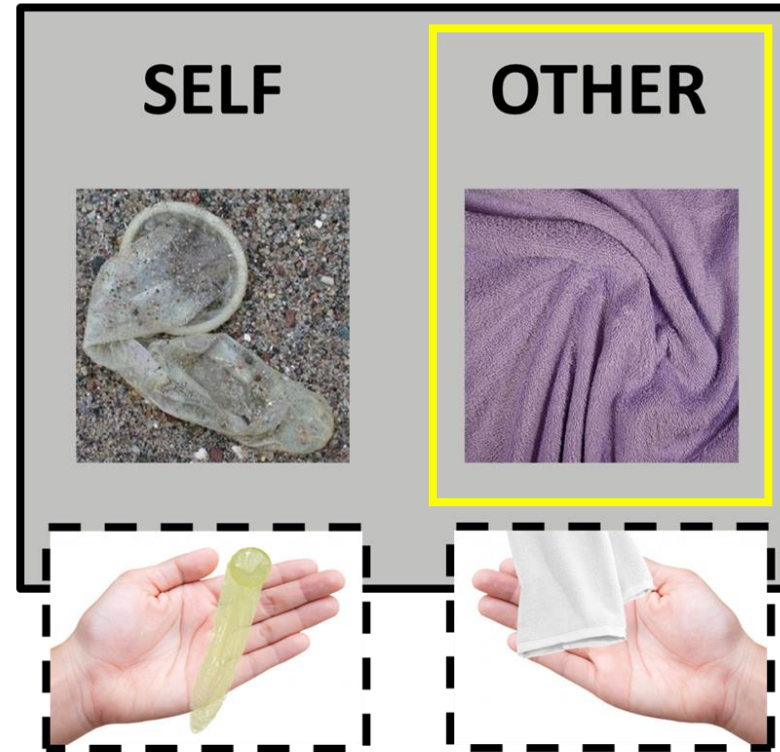
How to measure SOD in Empathy?

How do YOU feel ?



Congruent emotions condition

vs.



Incongruent emotions condition

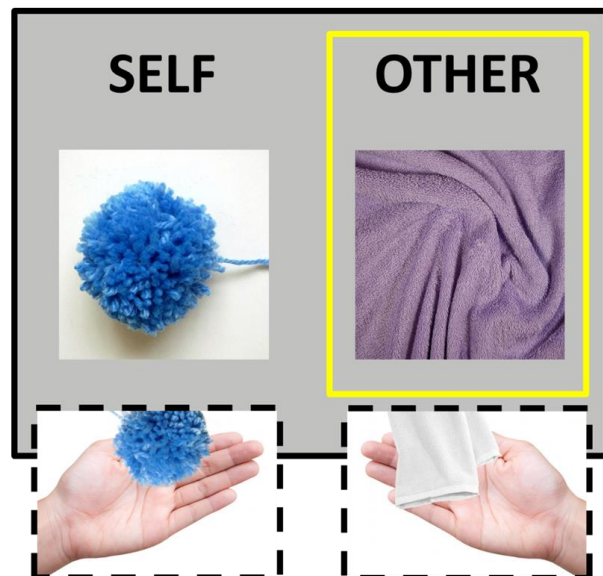
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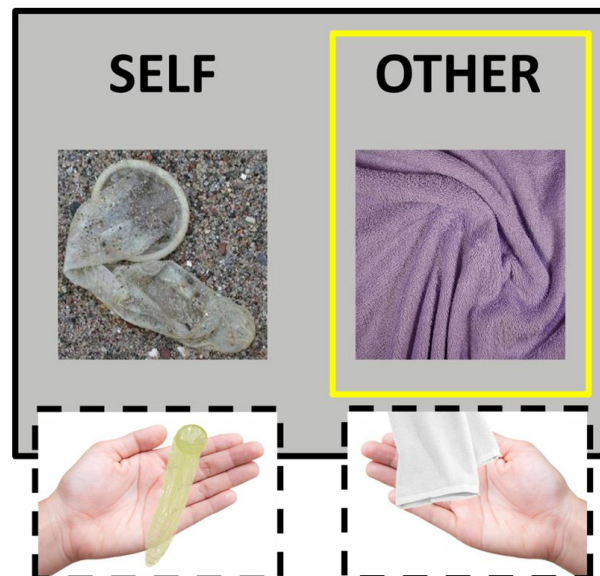
**= Altercentric
bias**

Other-judgment

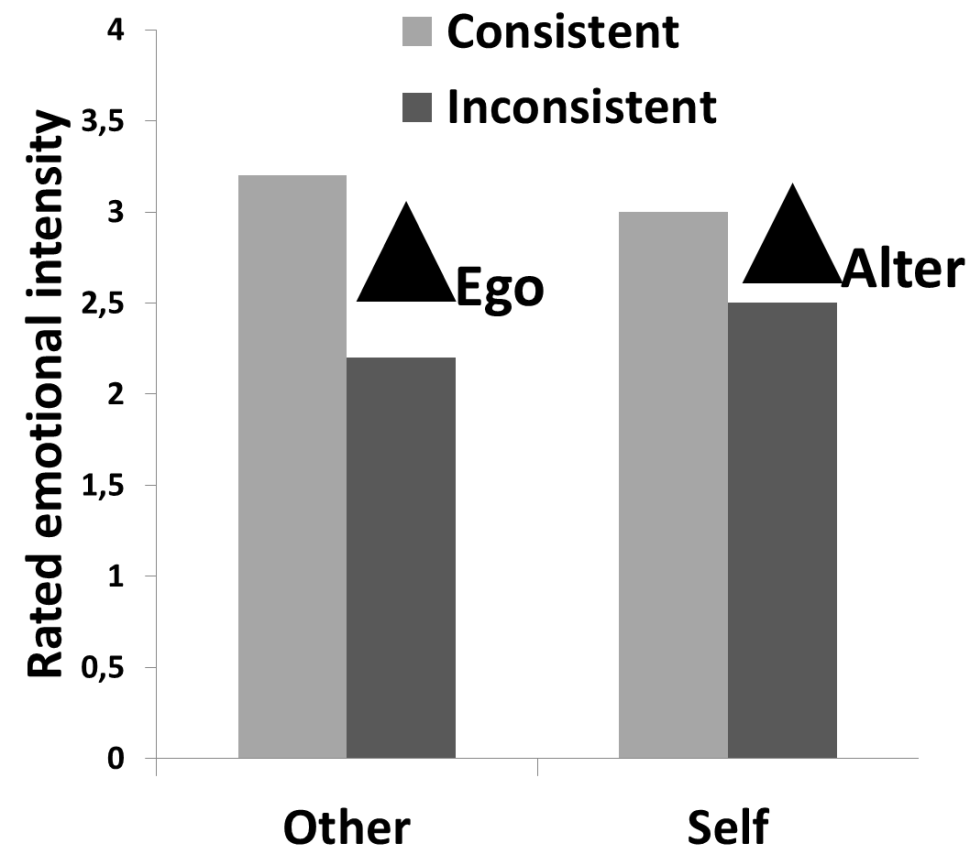
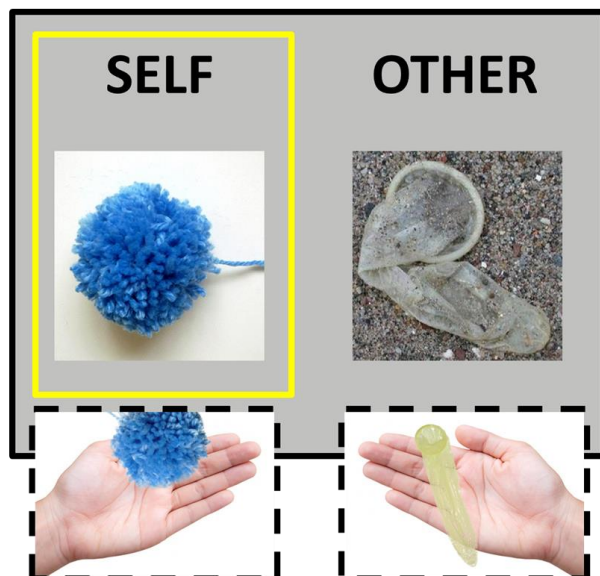
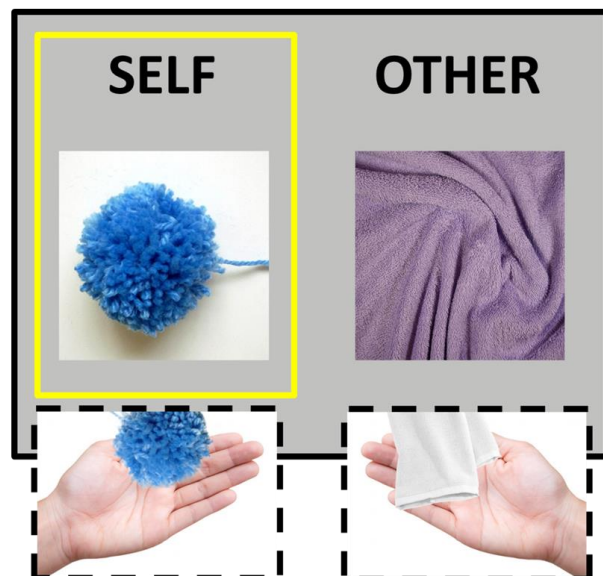
Consistent



Inconsistent



Self-judgment

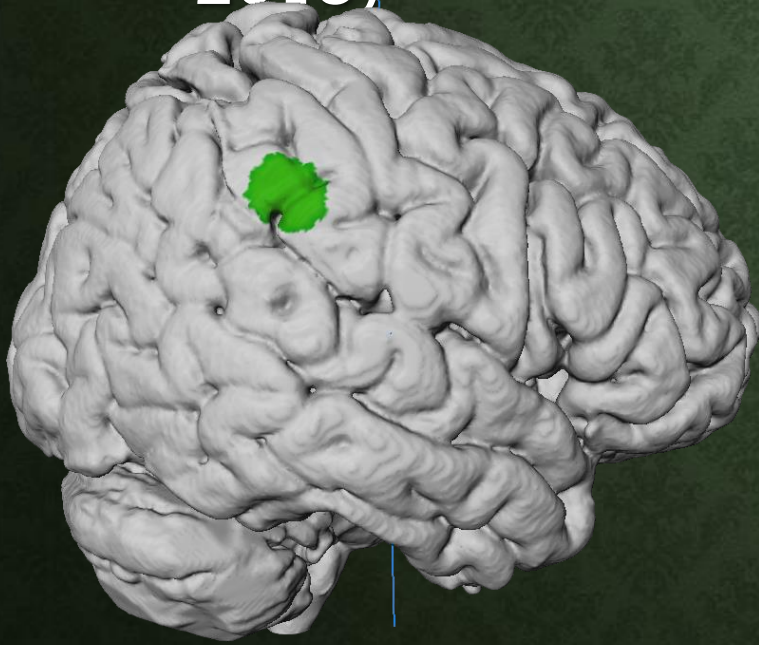


Self-other distinction
performance in empathy

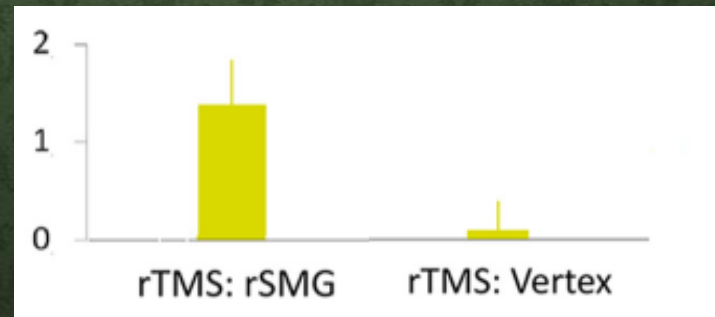
$$= \blacktriangle_{\text{Ego}} + \blacktriangle_{\text{Alter}}$$

PREVIOUS STUDY

- **Right supramarginal gyrus (rSMG; anterior TPJ)** was found more active for emotional egocentricity bias (Silani et al., 2013)



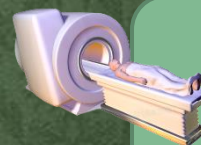
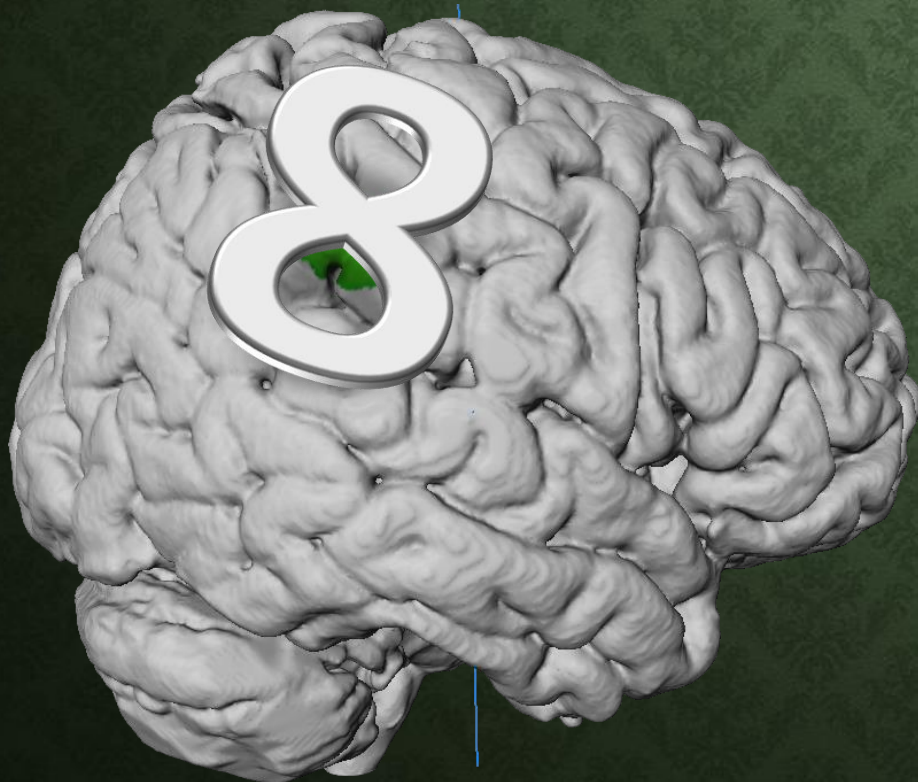
- **Low freq inhibitory rTMS on rSMG** increased emotional egocentricity bias (Silani et al., 2013)



PRESENT STUDY

Combined offline **fMRI-rTMS** study, within-subject design (N=31)

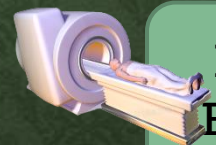
repeated Transcranial Magnetic Stimulation:
continuous theta burst stim (cTBS: 600 stim in 40 sec)



Brain anatomy (T1)
Motor task
Empathy practice



Minimal motor threshold
rTMS - cTBS
on rSMG or Vertex (control site)



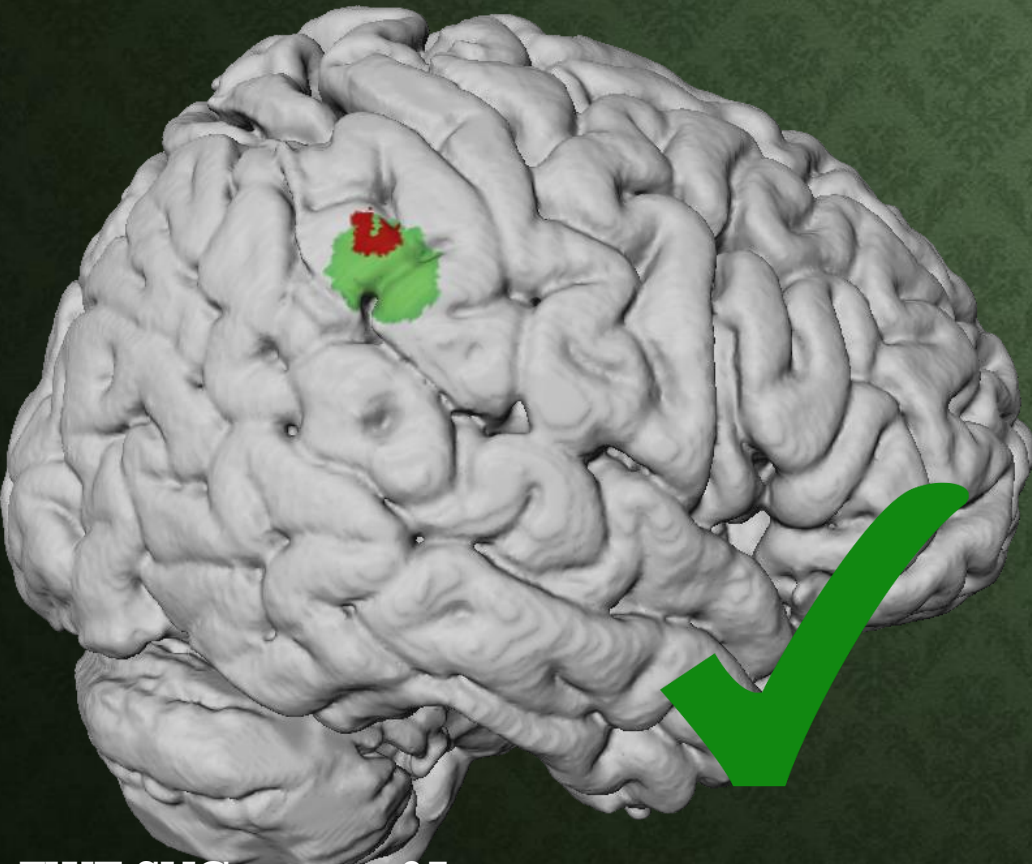
Empathy block 1 (5-25 min)
Empathy block 2 (30-50 min)

x 2 sessions (1 week apart)

RESULT

**Neural correlates of SOD:
Incongruent > Congruent**

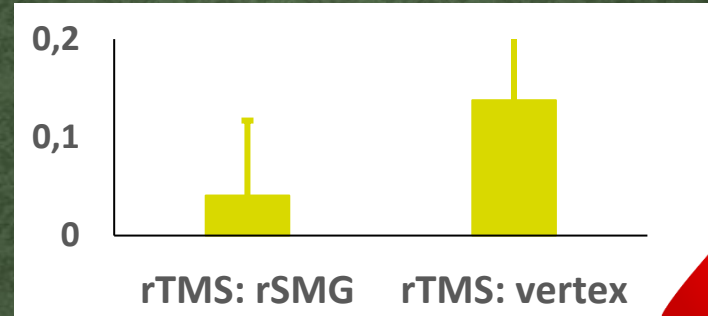
Significant main effect of Congruency ($p = .014$), with a lower mean emotional intensity in the incongruent emotions condition



FWE SVCorr $p < .05$

RESULT

→ **Marginal interaction rTMS site x Congruency ($p = .069$)**



→ Congruency effect (bias) tends to **decrease** ! → **Enhanced** SOD by cTBS on rSMG!

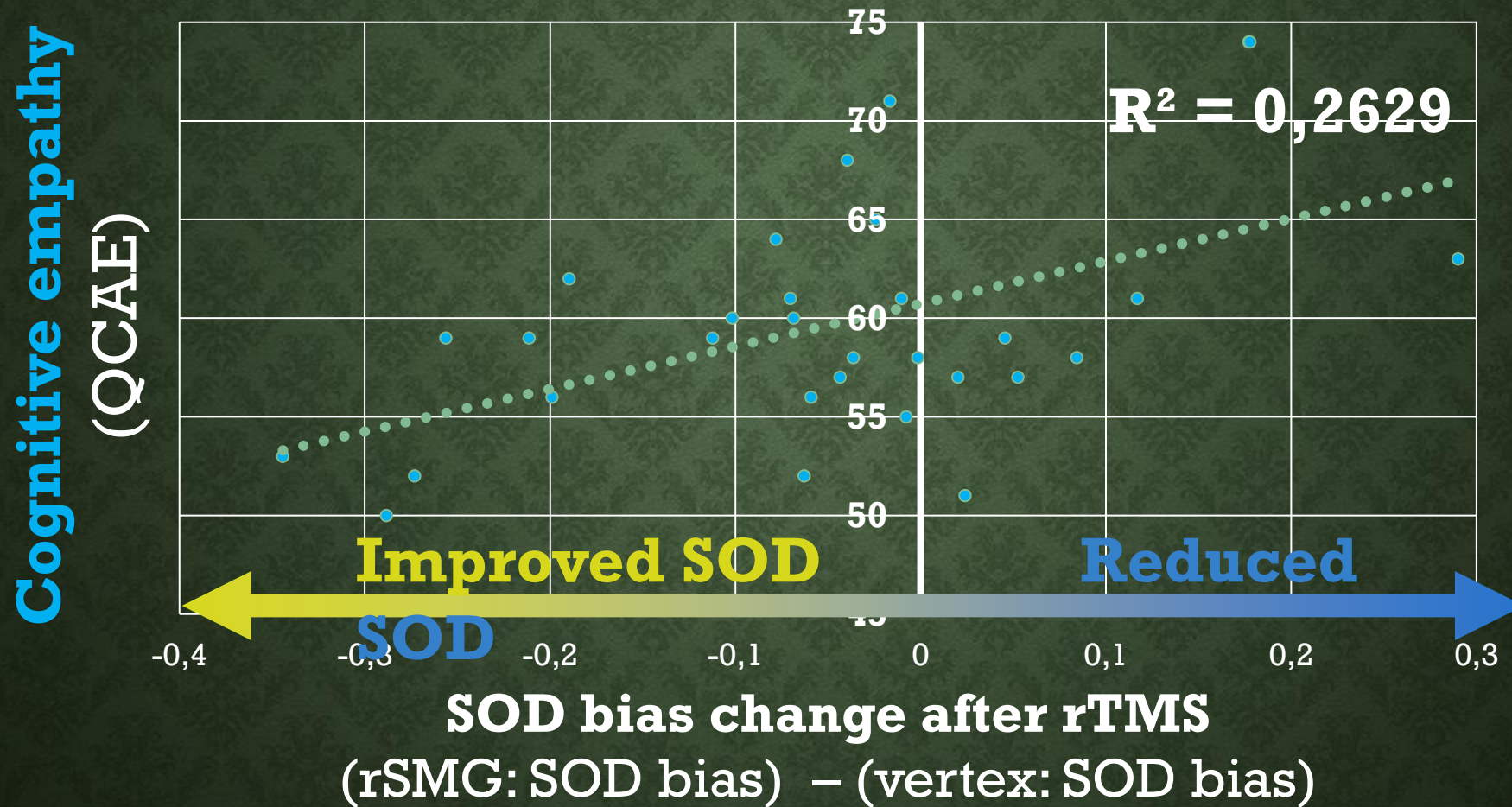
Is the effect of cTBS always disruptive ?

Evidence for highly variable effects of cTBS accounted by individual differences

(e.g., MEP latencies: Huang & Mouraux, 2005; r-sFC: Hartwright et al., 2016)

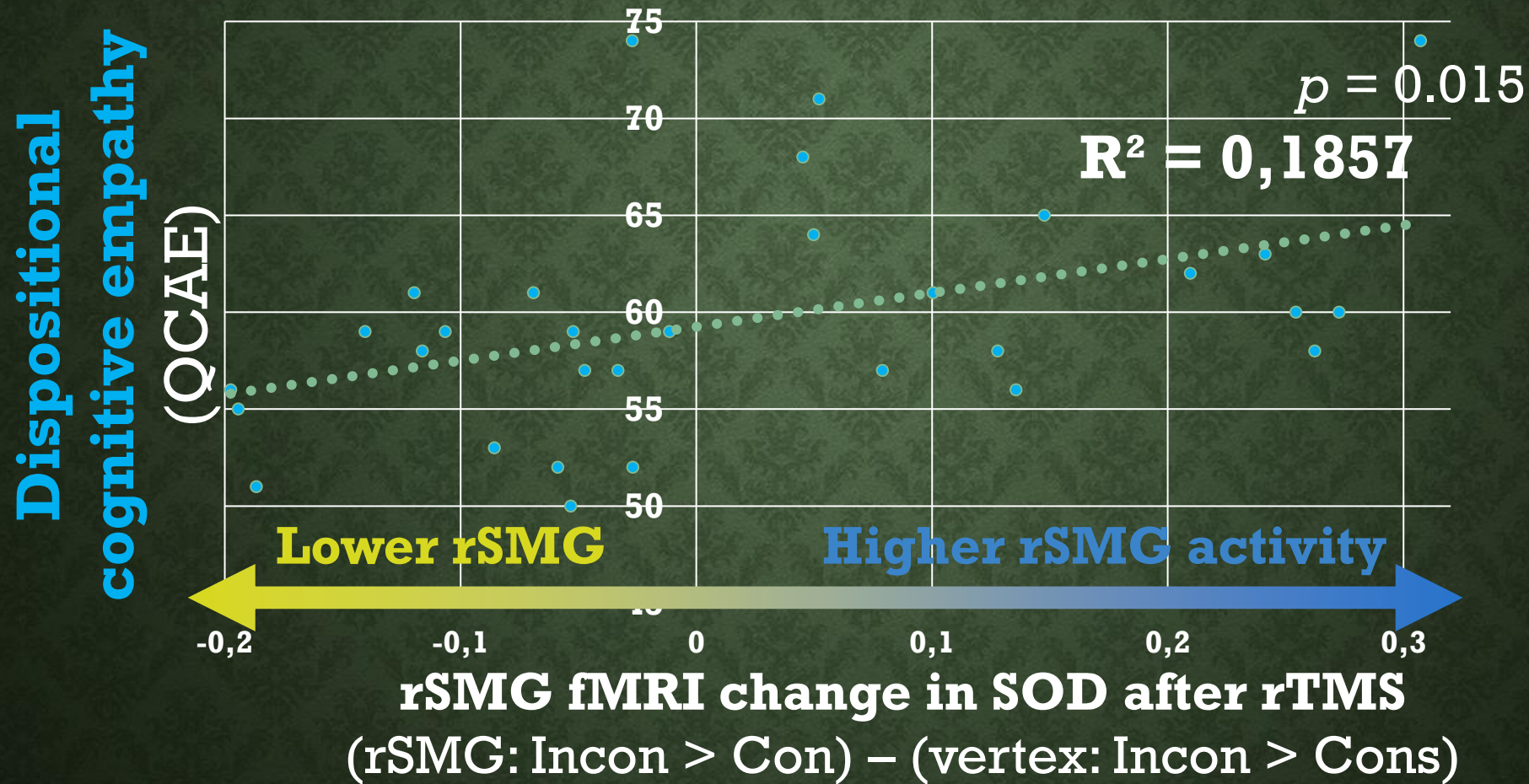
**WHAT IF WE INCLUDE
INDIVIDUAL DIFFERENCES IN
DISPOSITIONAL COGNITIVE EMPATHY
?**

Significant Congruency x rTMS site x **Dispositional Cognitive Empathy** (covariate) interaction ($p = .003$)



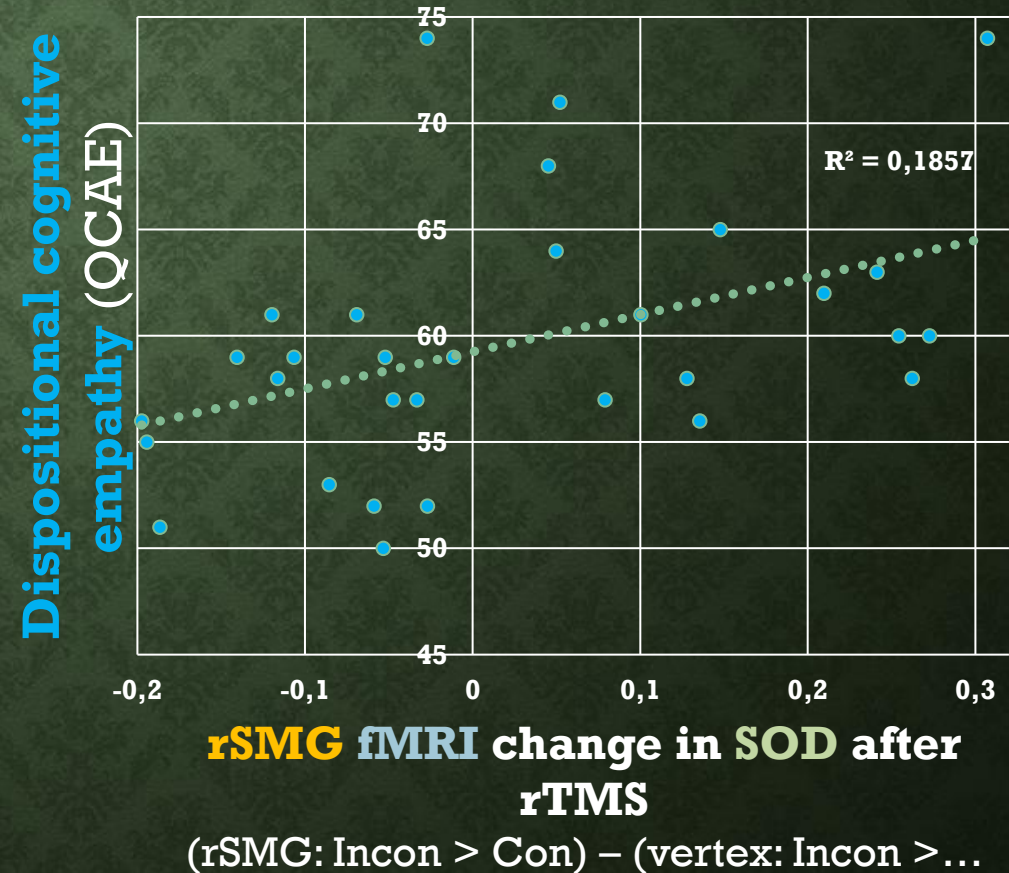
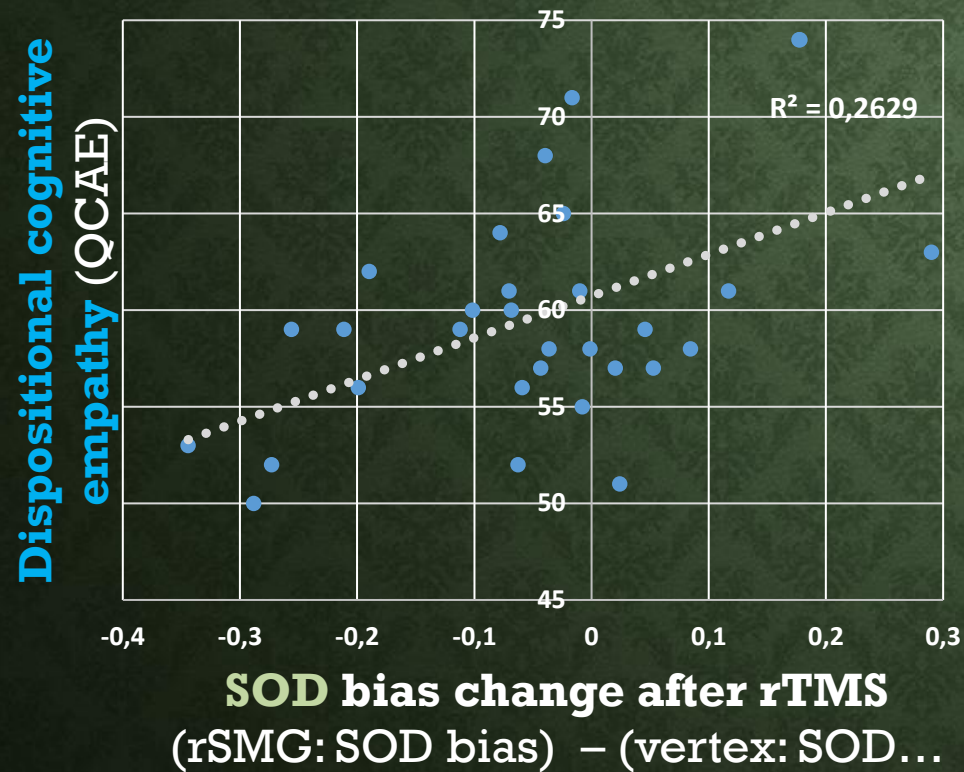
→ **Facilitatory** effect of cTBS rTMS on SOD performance in relation with **lower dispositional cognitive empathy** (“*bads getting good & goods getting bad*”)

Extent of rSMG activity for Incongruent > Congruent (→ SOD)



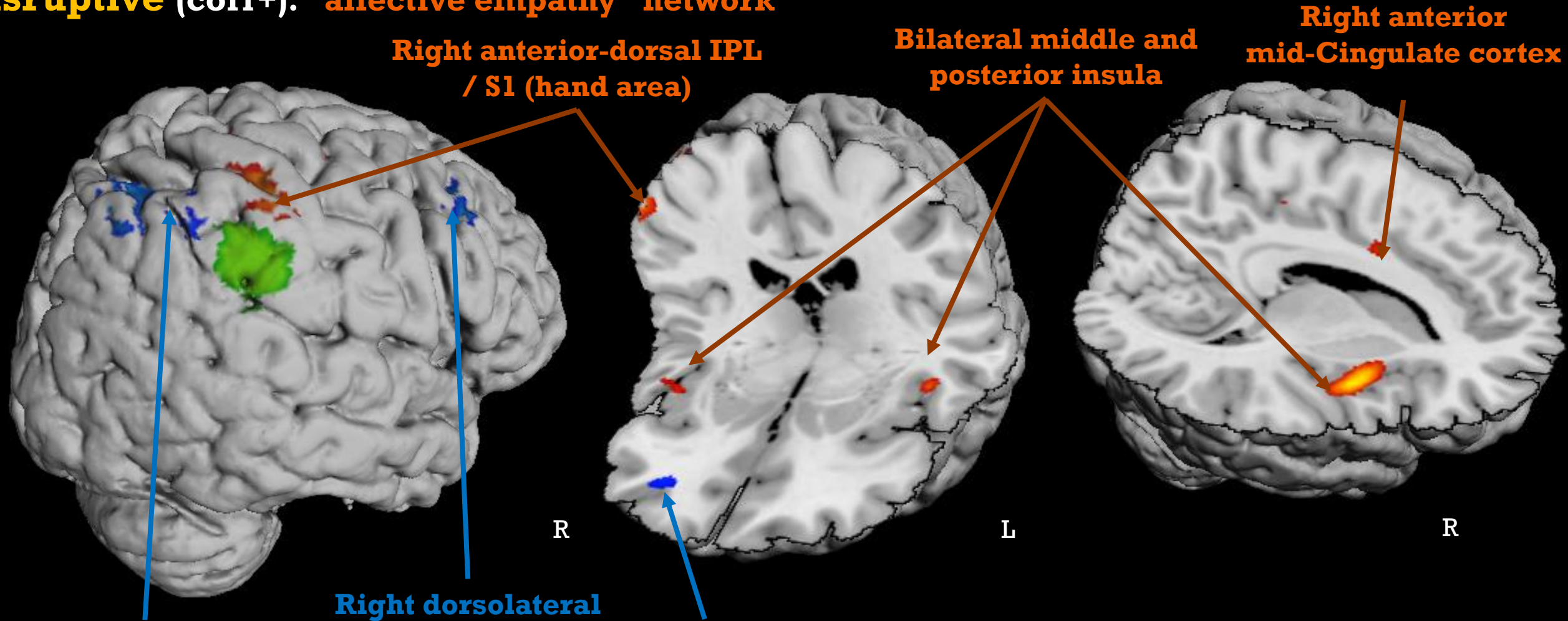
→ **Lower** rSMG activation during SOD after rTMS on rSMG in relation with **lower dispositional cognitive empathy** (“bads getting good need less rSMG & goods getting bad need more rSMG”)

rTMS facilitatory and disruptive effects on behavioral & brain index of SOD have a mirror relation with disp. Cognitive Empathy



rTMS « facilitatory » vs. « disruptive » effects
engage two opposed networks (or strategies?) to perform SOD

disruptive (corr+): “affective empathy” network



N=31; $p < 0.005$ (unc), $k=5$, whole-brain, network labelling from Neurosynth (v4-top)

facilitatory (corr-): “cognitive control” + “decision-making” networks

SUMMARY

- Replicated recruitment of rSMG during Self-other Distinction (SOD)
 - Unexpected marginal « facilitatory » effect of rTMS on rSMG on SOD
 - rTMS effects are modulated by dispositional Cognitive Empathy both at behavioral and brain levels
 - Facilitatory effect for low disp. CE, associated with “cognitive control / decision-making” network
 - Disruptive effect for high disp. CE, associated with “affective empathy” network
-
- ➔ Evidence for a brain-behavior-personality interplay in SOD (cTBS effect on SOD strategy?)
 - ➔ Heterogeneity of rTMS effect seems accounted by personality trait



Henryk Bukowski

@HenrykBukowski

socio-cog-affective-neuro data scientist
specialized for empathy & perspective-
taking

📍 Vienna, Austria

🌐 henrykbukowski.com

📅 Joined June 2016



Adam Bulley

@Adamdbulley

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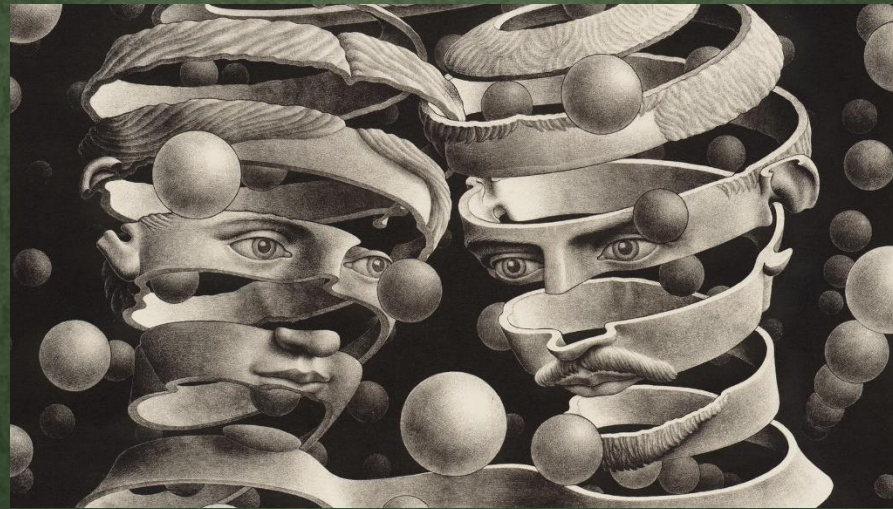
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“From Self-Knowledge To Knowing Others”

Workshop in Brussels on Friday 16th of November

Dr. Giorgia Silani
Pr. Arnaud d'Argembeau
Pr. Dana Samson



Credit: MC Escher

Pr. Claus Lamm
Pr. Marcel Brass
Dr. Henryk Bukowski
& more...

Active participation of young researchers is particularly encouraged via the presentation of a poster and chairing a session. There will be a best poster award.

Registration, food and drinks are free.

More info to come soon...

THANKS

Martin Tik, Giorgia Silani, Claus Lamm, Christian Windischberger,
Christian Ruff

Katrin Zechner, Jakob Neumüller, Daria Grigoryeva, Lukas Lengersdorff, Arabella Brunner, Sabrina
Schetat, Lisa Hođić for their help in

SCAN-Unit

& ESCAN !!



BACKUP SLIDES



SUMMARY & CONCLUSION

- Replicated recruitment of **rSMG** during **Self-other Distinction (SOD)**
- Unexpected marginal « **facilitatory** » effect of cTBS **rTMS** on **rSMG** on **SOD** performance
- rTMS effects **modulated by disp. Cognitive Empathy** both at behavior & brain levels
- **Facilitatory** effect for low **disp. CE**, associated with “**cognitive control/decision-making**” network
- **Disruptive** effect for high **disp. CE**, associated with “**affective empathy**” network

→ First time understanding of the brain-behavior-personality interplay in **SOD**

→ Although exploratory, variable **rTMS** effect seems accounted by personality trait

HOW TO MEASURE SELF-OTHER DISTINCTION (SOD) ?

Self-report-based:

Cognitive Empathy subscale of QCAE (Reniers et al., 2011): Report agreement on 19 statements:

- I am good at predicting how someone will feel.
- When I am upset at someone, I usually try to “put myself in his shoes” for a while.

➔ **Dispositional cognitive empathy**

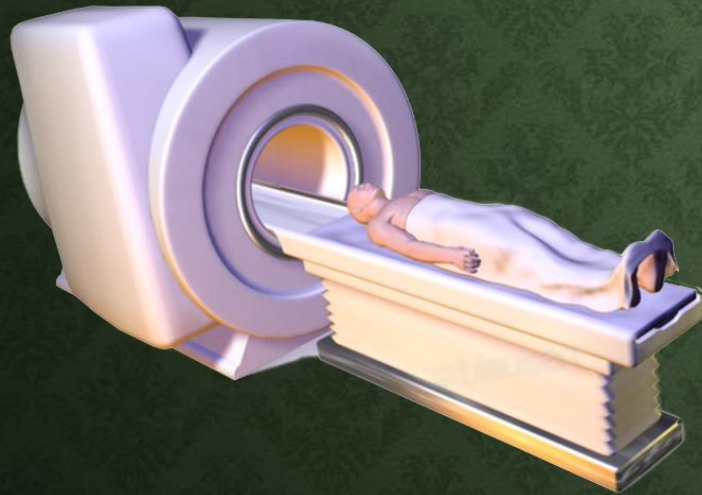
Performance-based:

Visuotactile empathy task (Silani, Lamm, Ruff, & Singer, 2013): Report how other or self feels following emotions induced by

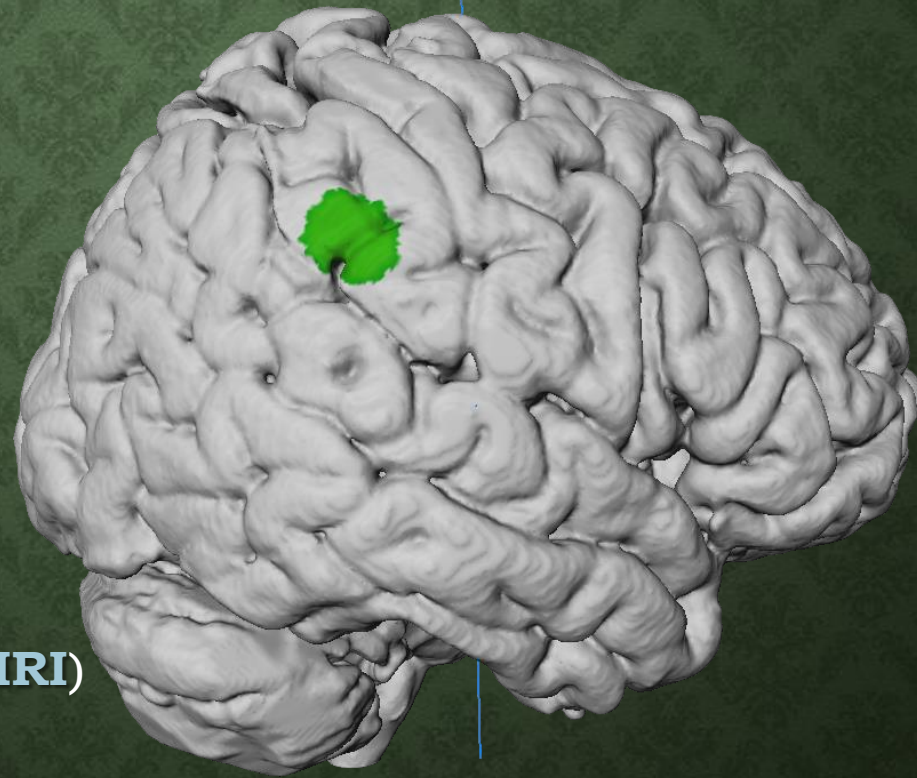


RIGHT SUPRAMARGINAL GYRUS (RSMG) IN SOD – PREVIOUS STUDY

Incongruent emotions > Congruent = SOD



Functional Magnetic Resonance Imaging (**fMRI**)



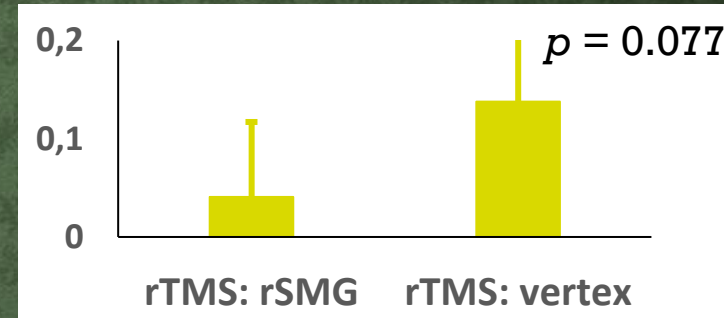
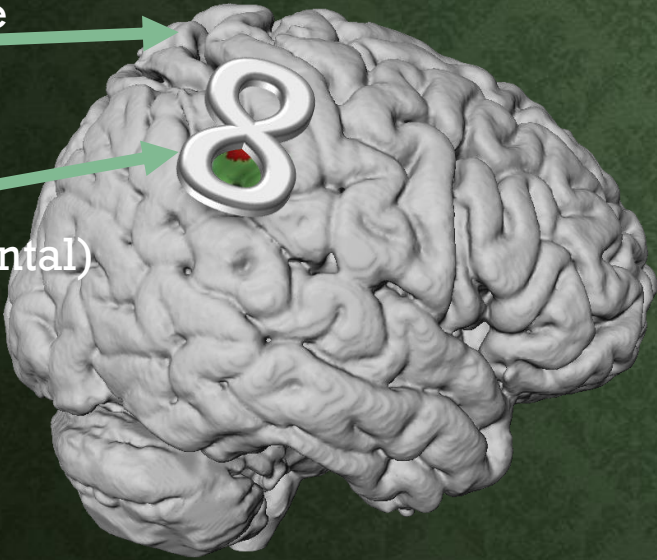
RIGHT SUPRAMARGINAL GYRUS (rSMG) IN SOD – PRESENT STUDY

Combined offline fMRI-rTMS study, within-subject design (N=31)

INCONGRUENT - CONGRUENT = SOD

Vertex site
(control)

rSMG site
(experimental)



→ SOD bias **decreased** !

→ **Facilitatory** effect of **rTMS** on **SOD**
performance !

→ **cTBS rTMS** effect = always **disruptive**?

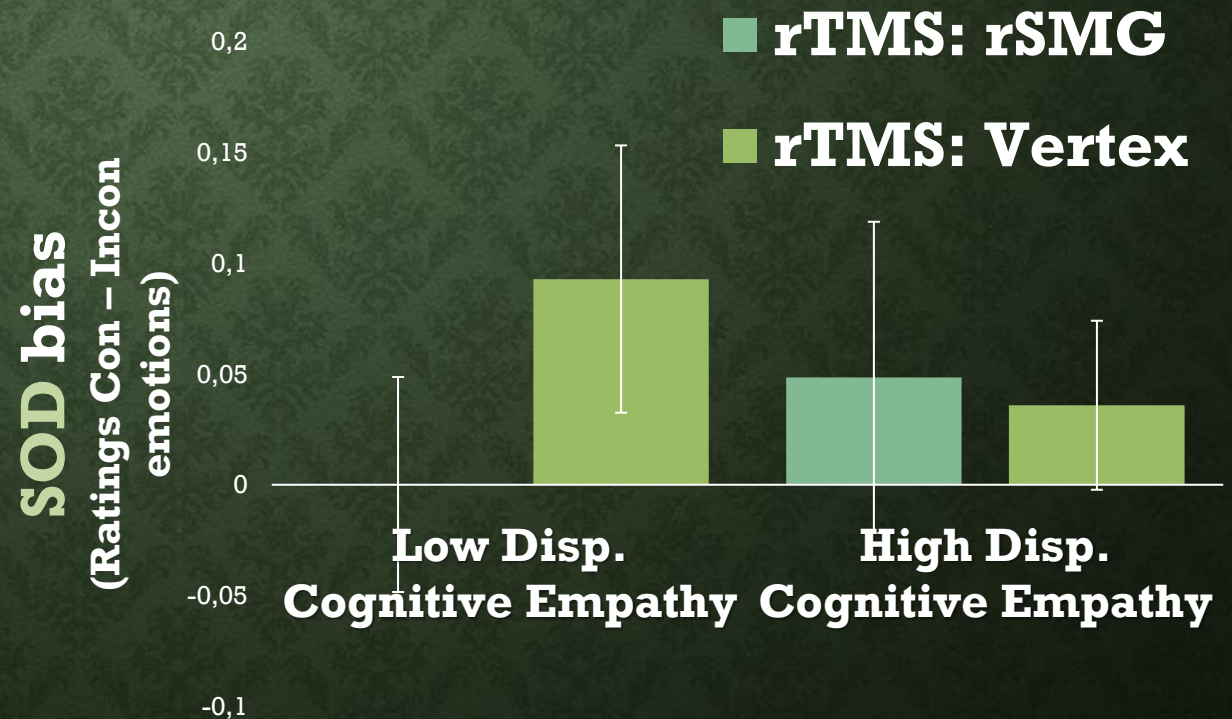
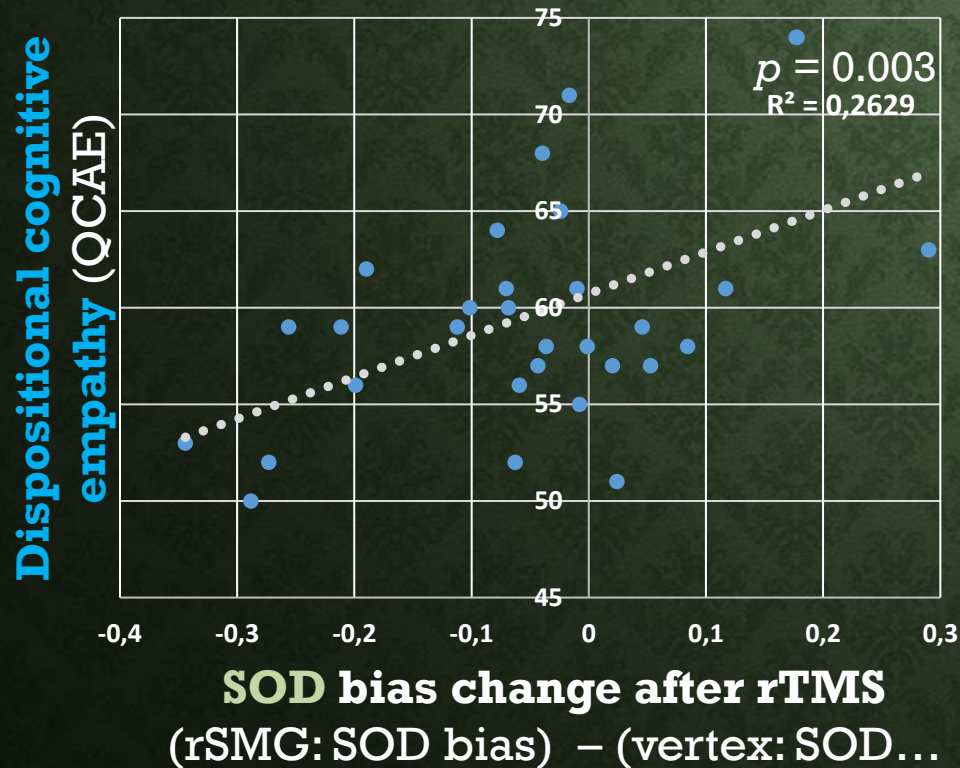
Evidence for highly variable effects of cTBS **rTMS**,
accounted by **individual differences**

(e.g., MEP latencies: Huang & Mouraux, 2005; r-sFC: Hartwright et al.,
2016)

LET'S EXPLORE
POTENTIAL ROLE OF
INDIVIDUAL DIFFERENCES IN
DISPOSITIONAL COGNITIVE EMPATHY

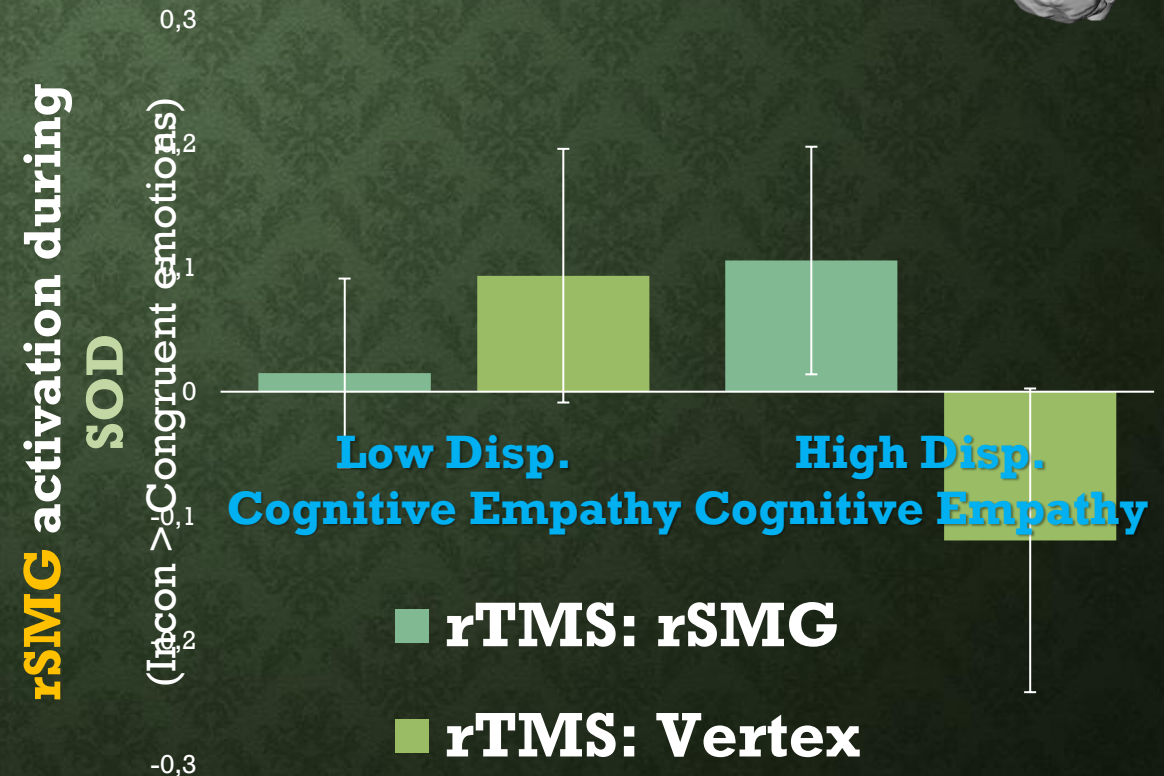
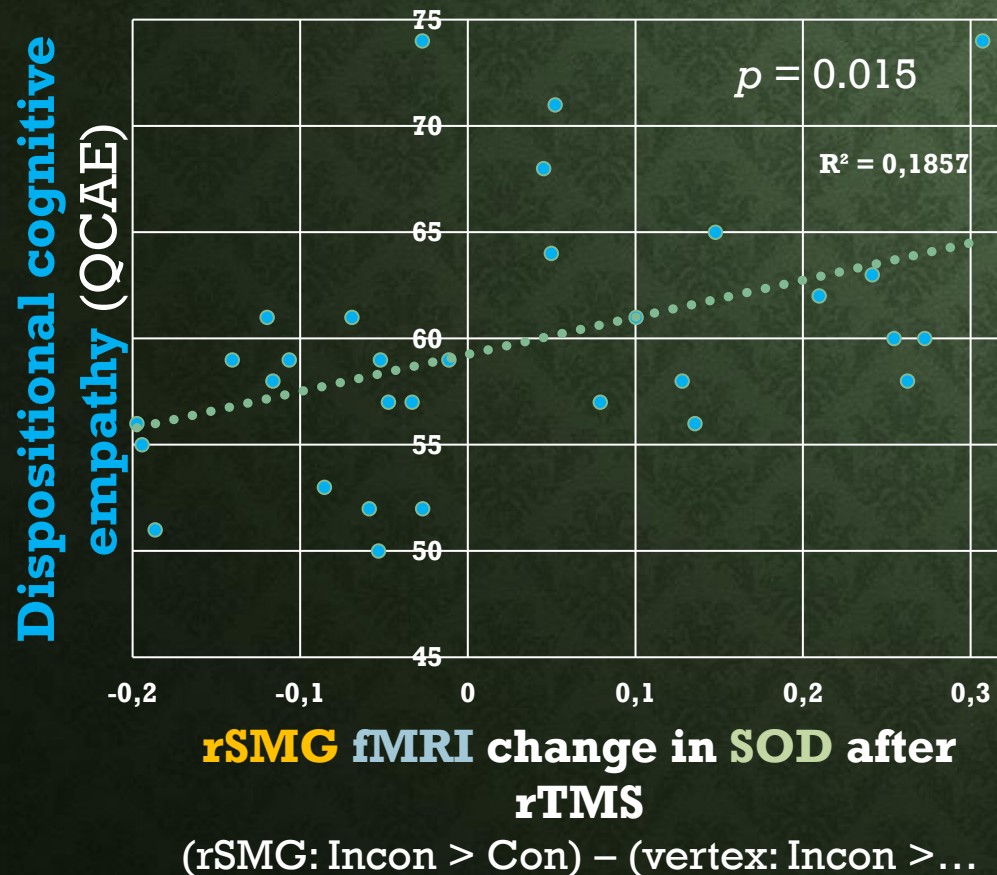
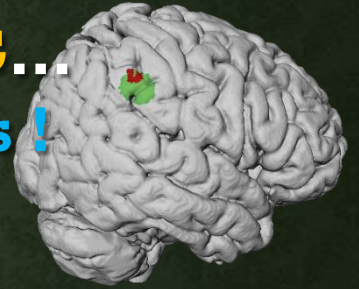
rTMS effect modulated by **Dispositional Cognitive Empathy**

→ **Facilitatory** effect of rTMS on **SOD** performance !
... for **LOW** **disp. Cognitive Empathy** individuals !
(and **disruptive** for **high** **disp. Cognitive Empathy** individuals)

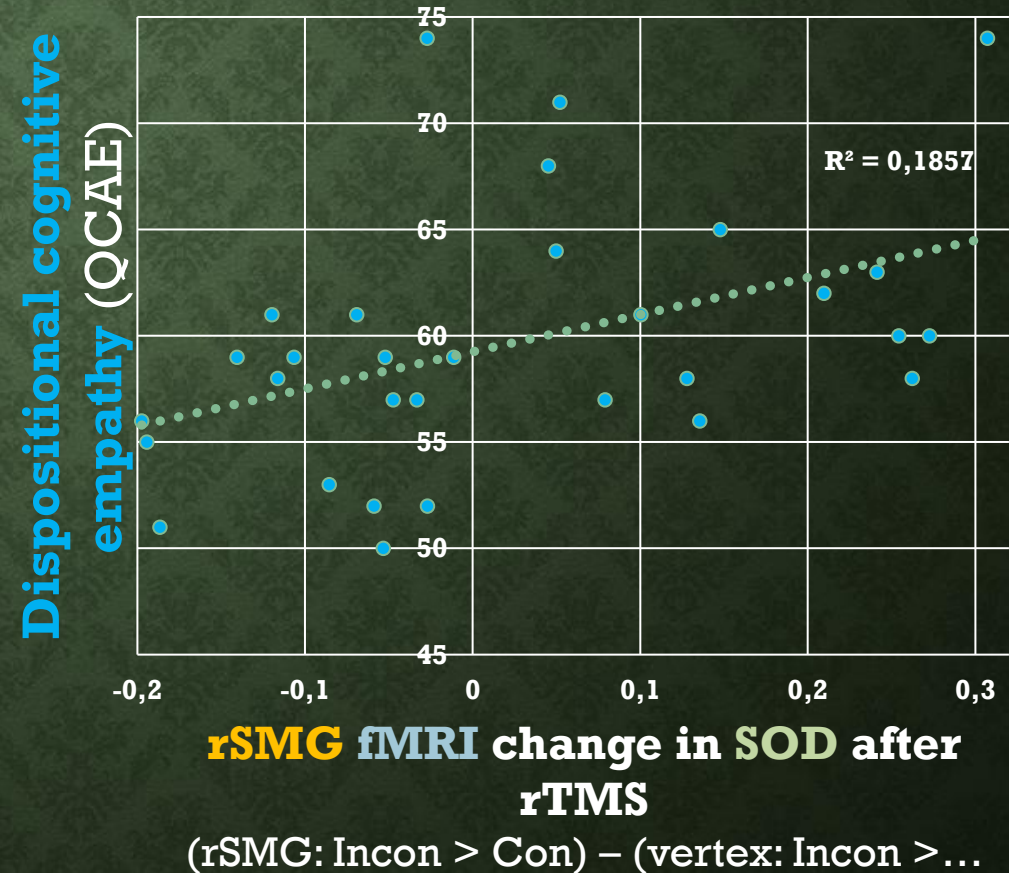
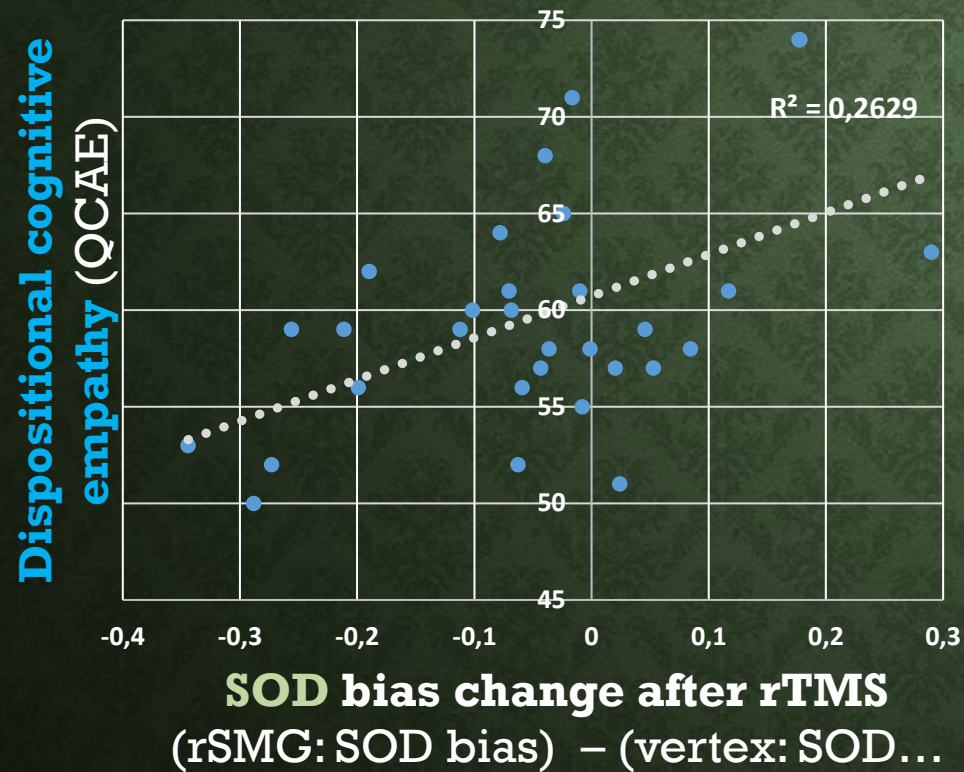


rTMS effect modulated by Dispositional Cognitive Empathy

→ **LOW** rSMG activation during SOD after rTMS on rSMG...
... for **LOW** Dispositional Cognitive Empathy individuals!



rTMS facilitatory and disruptive effects on behavioral & brain index of SOD have a mirror relation with disp. Cognitive Empathy



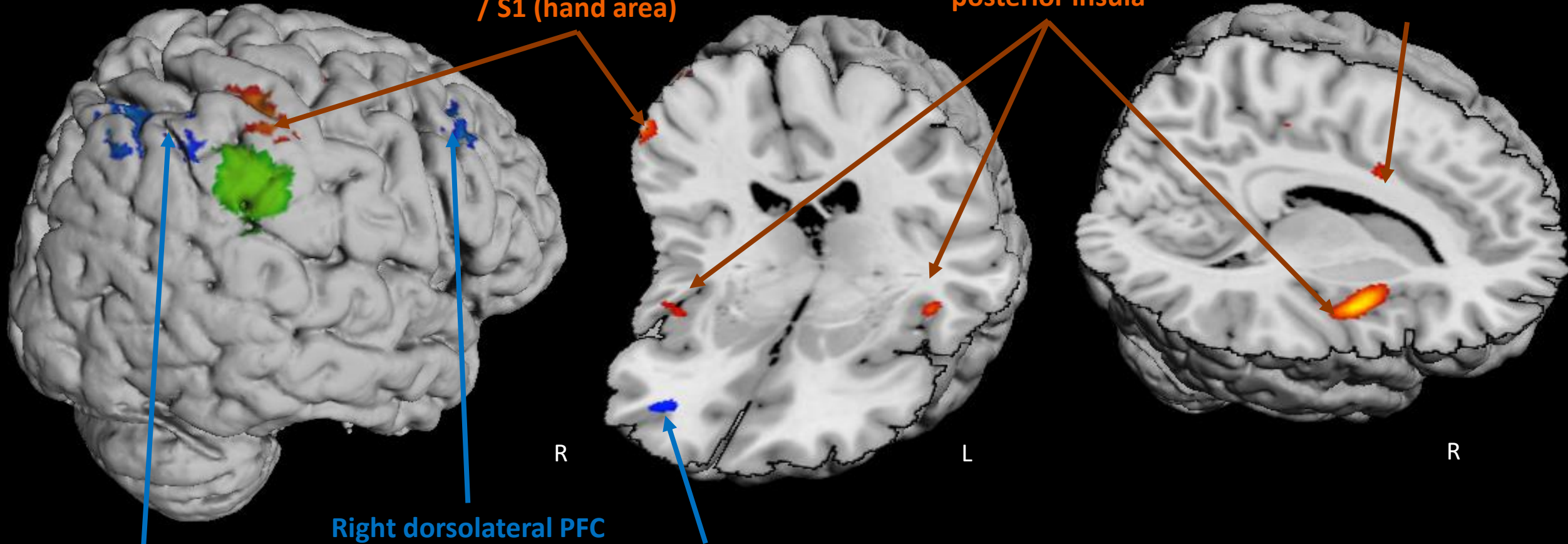
rTMS « **disruptive** » vs. « **facilitatory** » effects engage two opposed networks to perform **SOD**

disruptive (corr+): “affective empathy” network

Right anterior-dorsal IPL
/ S1 (hand area)

Bilateral middle and
posterior insula

Right anterior
mid-Cingulate cortex



Right dorsolateral PFC

Right OFC

facilitatory (corr-): “cognitive control” + “decision-making” networks

N=31; $p < 0.005$ (unc), $k=5$, whole-brain, network labelling from Neurosynth (v4-topics-400)

Right intraparietal sulcus
+ angular gyrus



SUMMARY & CONCLUSION

- Replicated recruitment of **rSMG** during **Self-other Distinction (SOD)**
- Unexpected marginal « **facilitatory** » effect of cTBS **rTMS** on **rSMG** on **SOD** performance
- rTMS effects **modulated by disp. Cognitive Empathy** both at behavior & brain levels
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→ First time understanding of the brain-behavior-personality interplay in **SOD**

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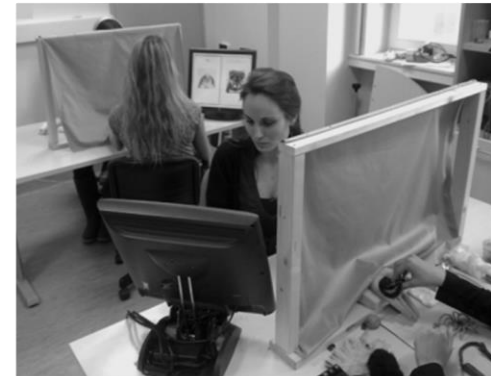
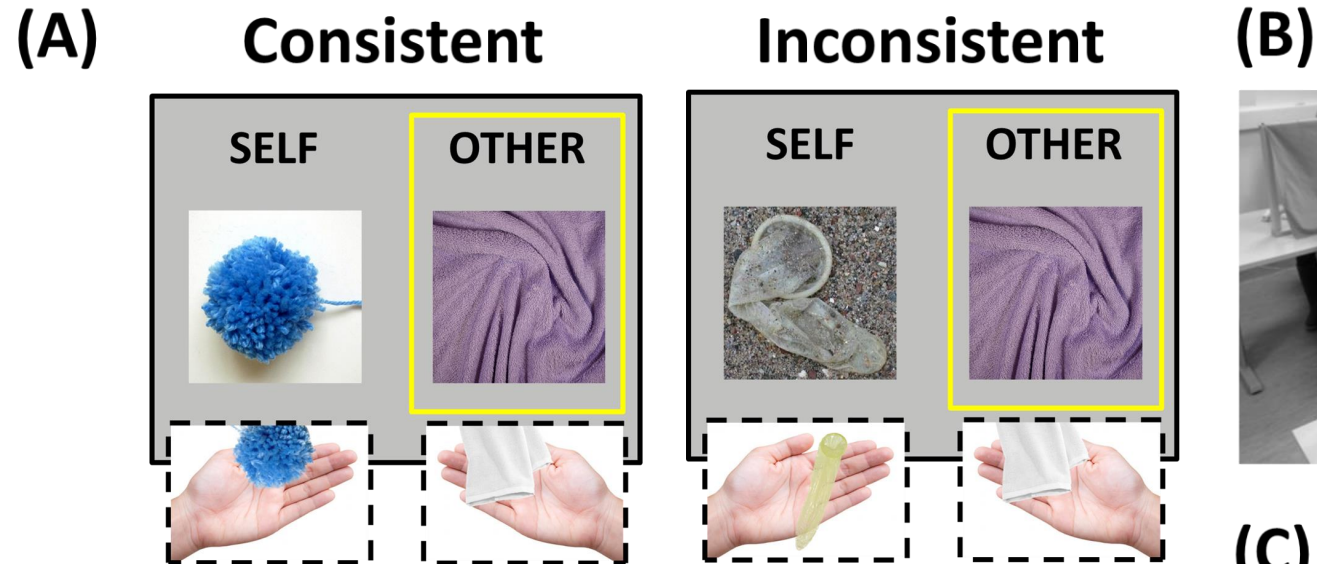
EMPATHY

“Self–other distinction is [...] the ability to distinguish between the representations of our own actions, perceptions, sensations and emotions, and those of others.”
Lamm,
Bukowski, & Silani, 2016.

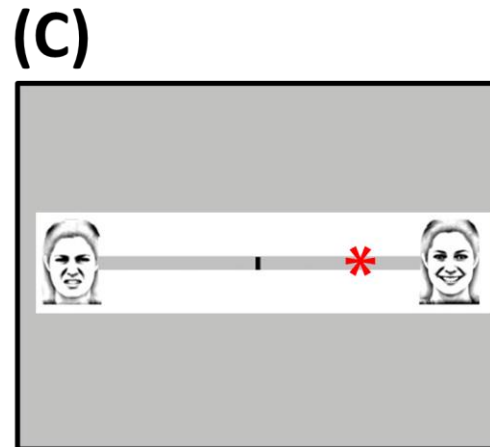
Form of empathy	Mechanism recruited	Phenomenology	Analysis
Affective empathy	Self-Other sharing	Julien is disgusted, I don't enjoy my banana. I love my banana, Julien is not that disgusted.	→ Emotional contagion → Egocentric bias
Cognitive empathy	+ Self-Other distinction	I am not disgusted, I understand he is disgusted. I pity him / I sympathize / I laugh at him.	→ Distinct Self and Other feelings
Cognitive empathy	+ Representational ability	+ I think he is still hungry. I help him.	+ Representational ability

SOD in VISUOTACTILE EMPATHY TASK

S-O sharing vs. S-O distinction



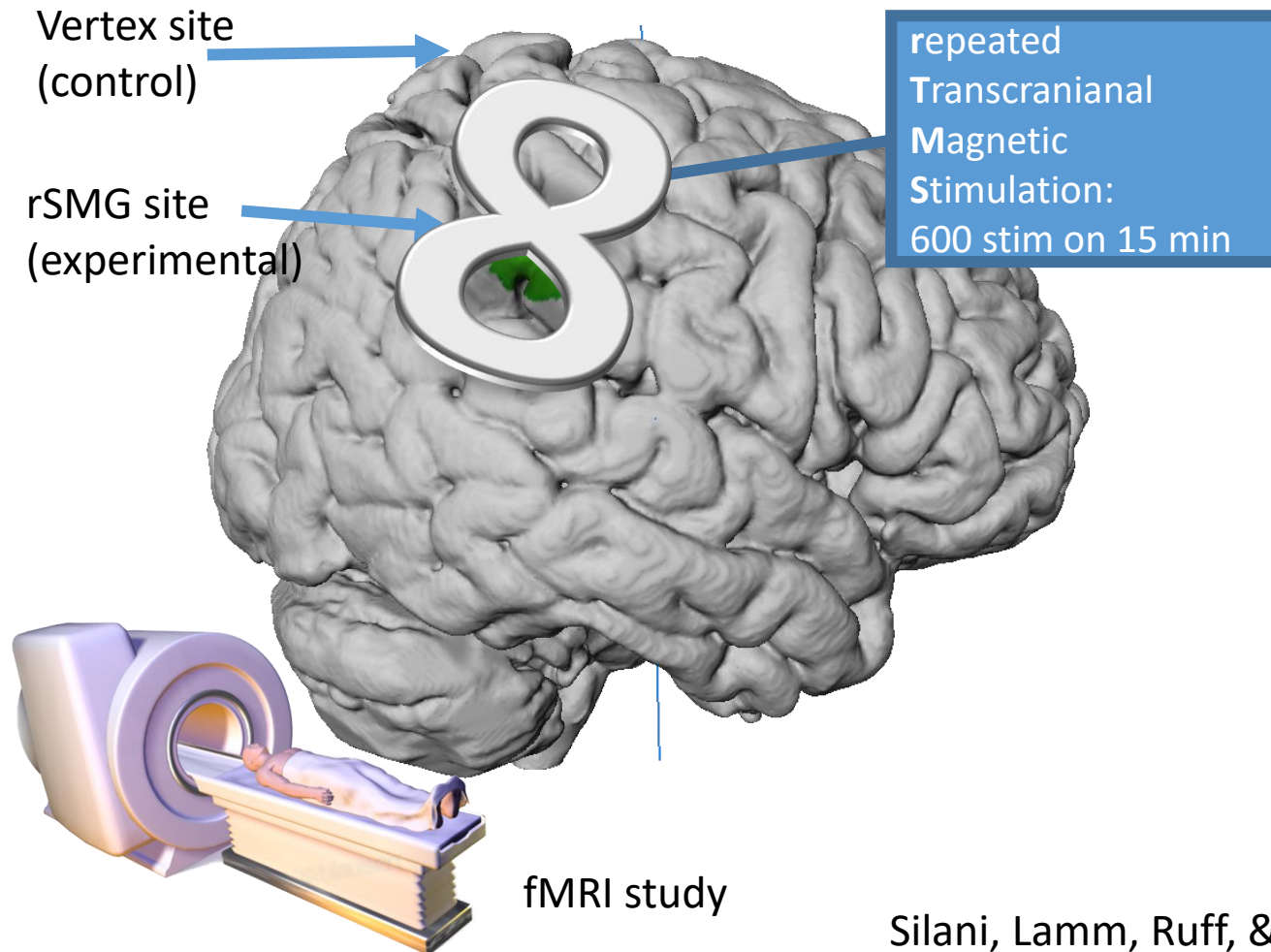
Experimental setup



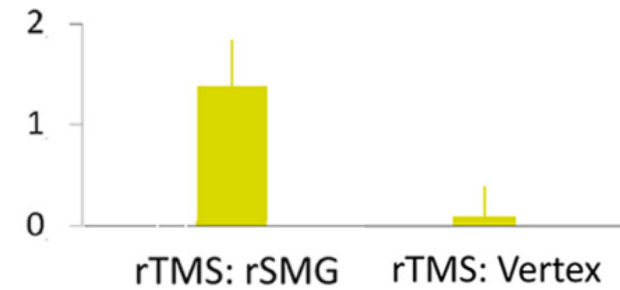
Rating screen

Right SUPRAMARGINAL GYRUS (RSMG) in **SOD** – previous **STUDY**

INCONGRUENT - CONGRUENT = SOD



Between-subjects rTMS behavioral study (N=45)

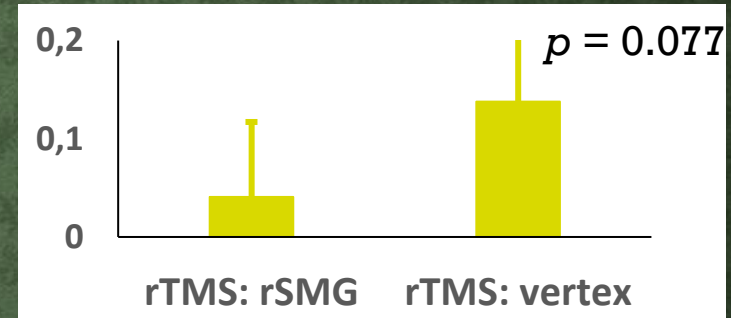
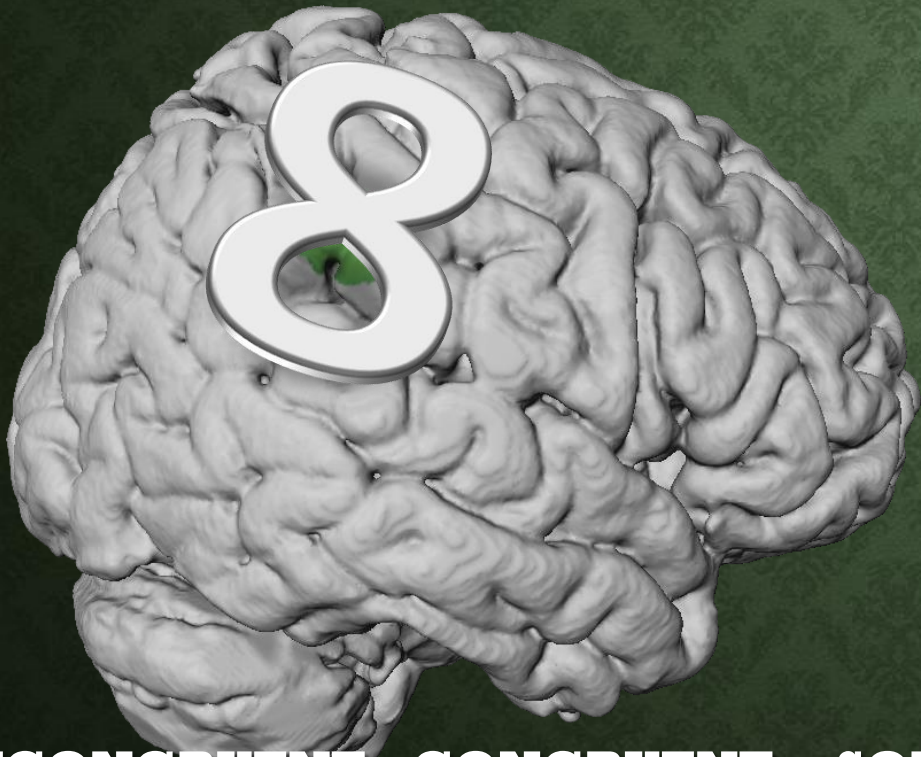


➔ **SOD BIAS INCREASED**

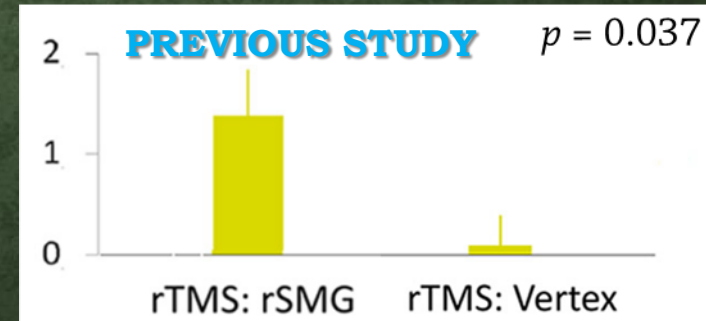
➔ **LOWER **SOD** PERFORMANCE
AFTER RTMS DISRUPTION OF **RSMG****

RIGHT SUPRAMARGINAL GYRUS (RSMG) IN SOD – PRESENT STUDY

Combined offline fMRI-rTMS study, within-subject design (N=31)



→ SOD BIAS **DECREASED**



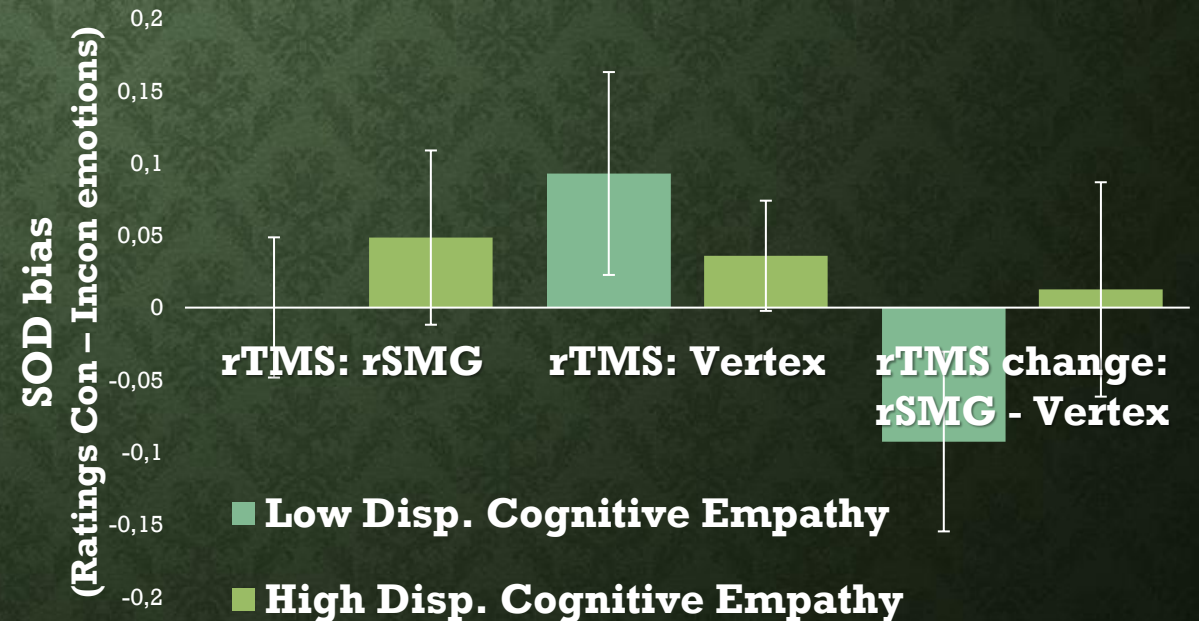
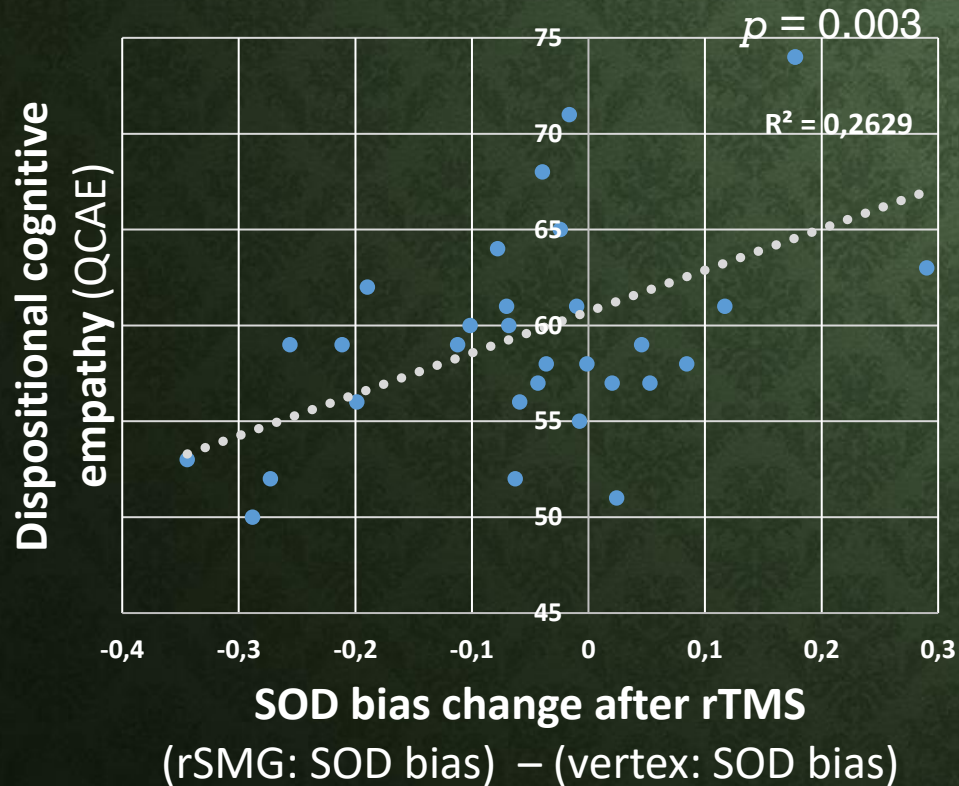
→ SOD BIAS INCREASED

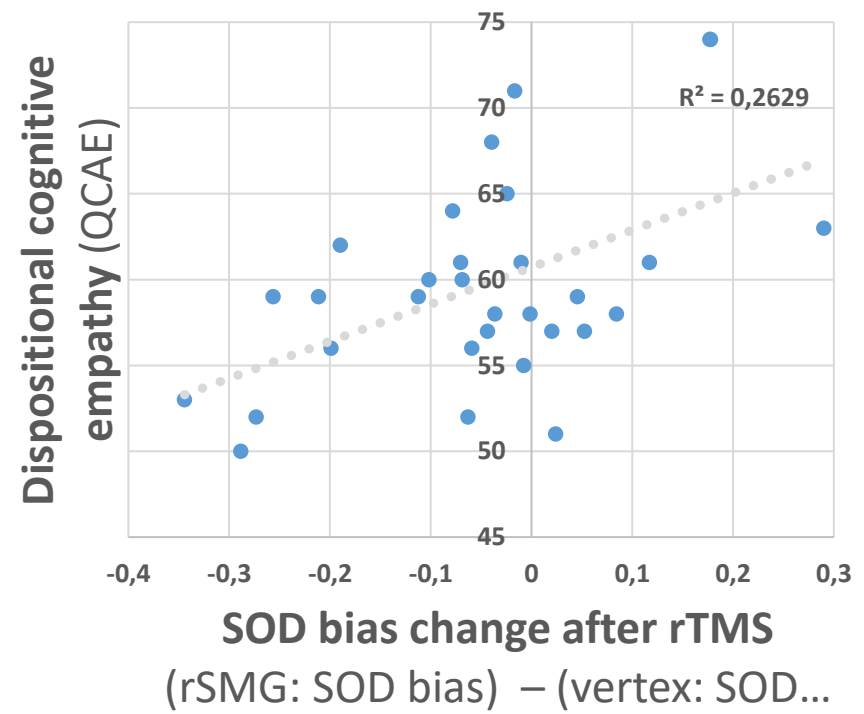
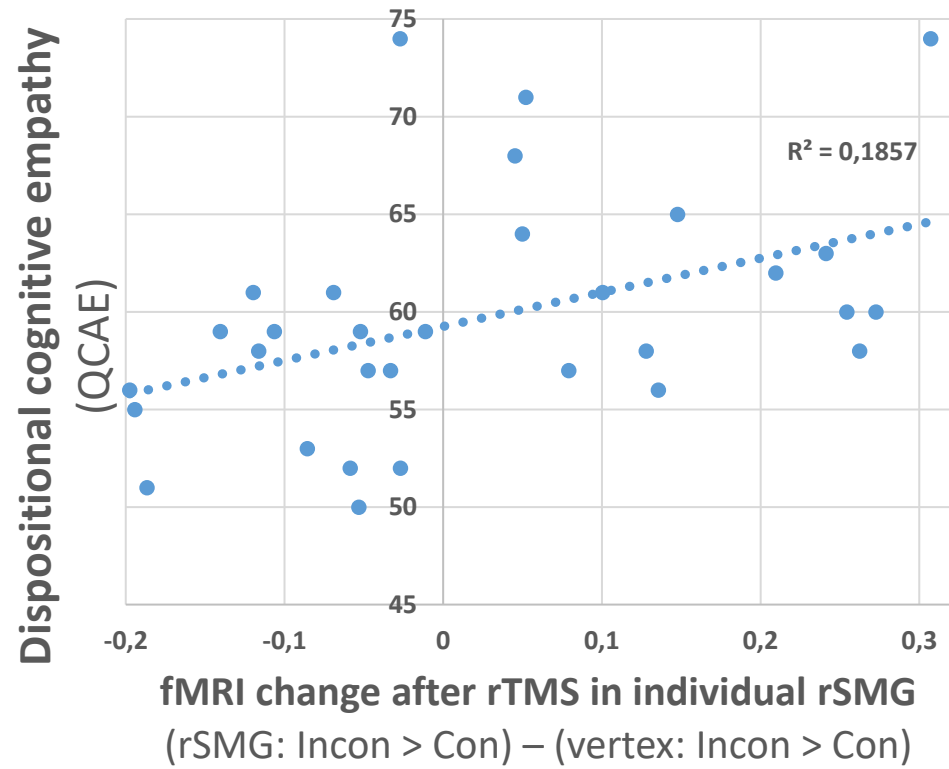
INCONGRUENT - CONGRUENT = SOD

FWE SVCorr $p < .05$

RTMS EFFECT MODULATED BY DISPOSITIONAL COGNITIVE EMPATHY

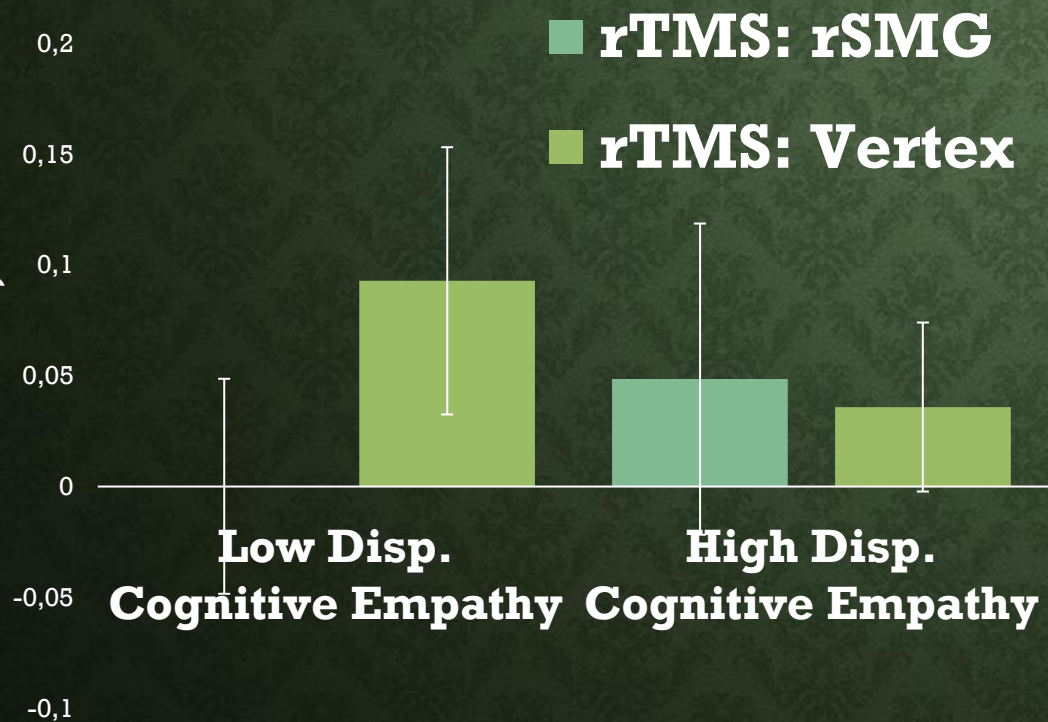
→ **LOW SOD bias** (i.e., better **SOD** performance) after **rtms** on **RSMG**...
... for **LOW Dispositional Cognitive Empathy** individuals !



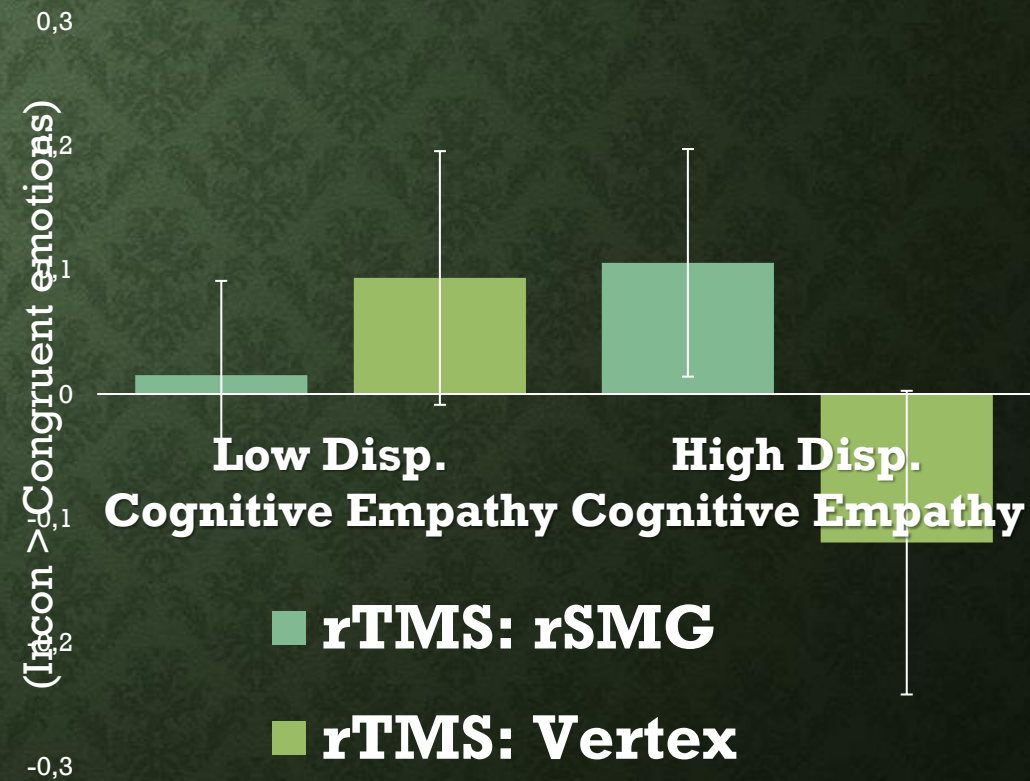


SOD bias

(Ratings Con - Incon emotions)



rSMG activation during SOD



N=31; $p < 0.005$ (unc), $k=5$, whole-brain

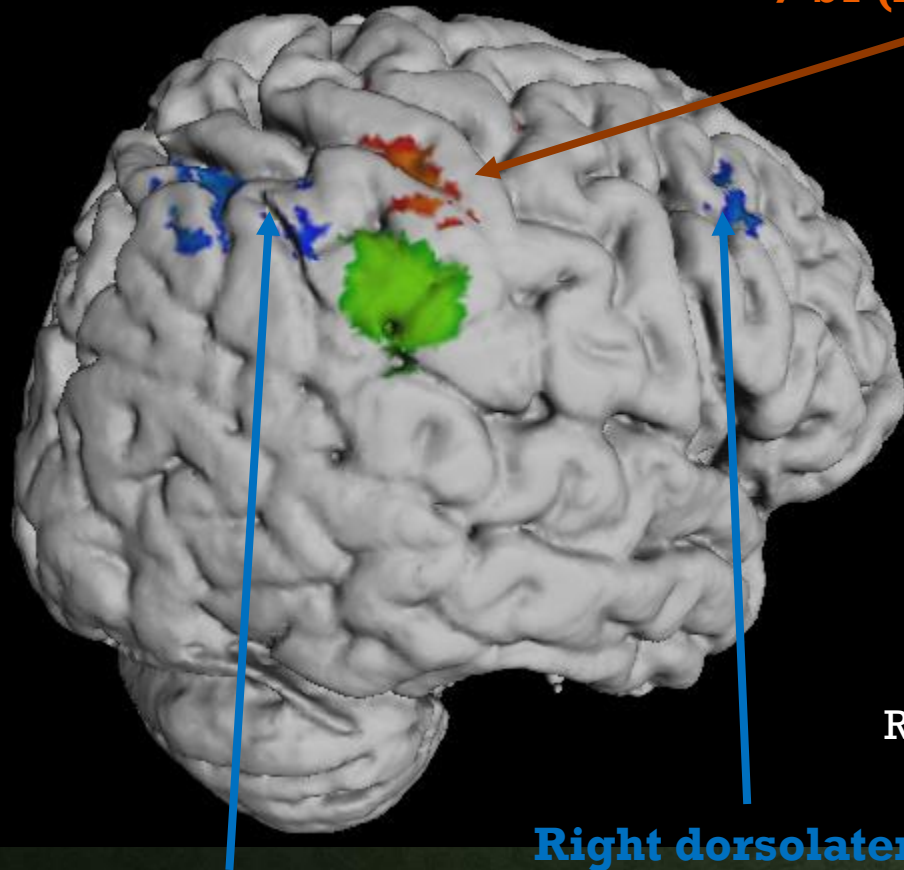
Positive association between Cognitive Empathy trait and rTMS effect on rSMG on self-other distinction
(rSMG: Inc-Con) – (vertex: Inc-Con)

Right SMG
from Silani et al., 2013

Right anterior-dorsal IPL / S1 (hand area)

Bilateral middle and posterior insula

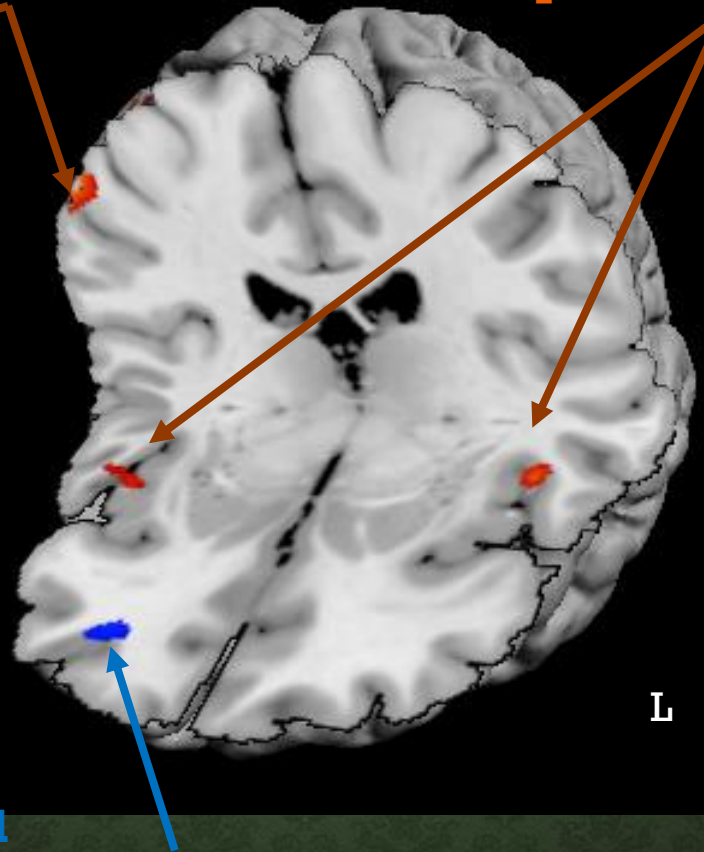
Right anterior mid-Cingulate cortex



R

Right dorsolateral PFC

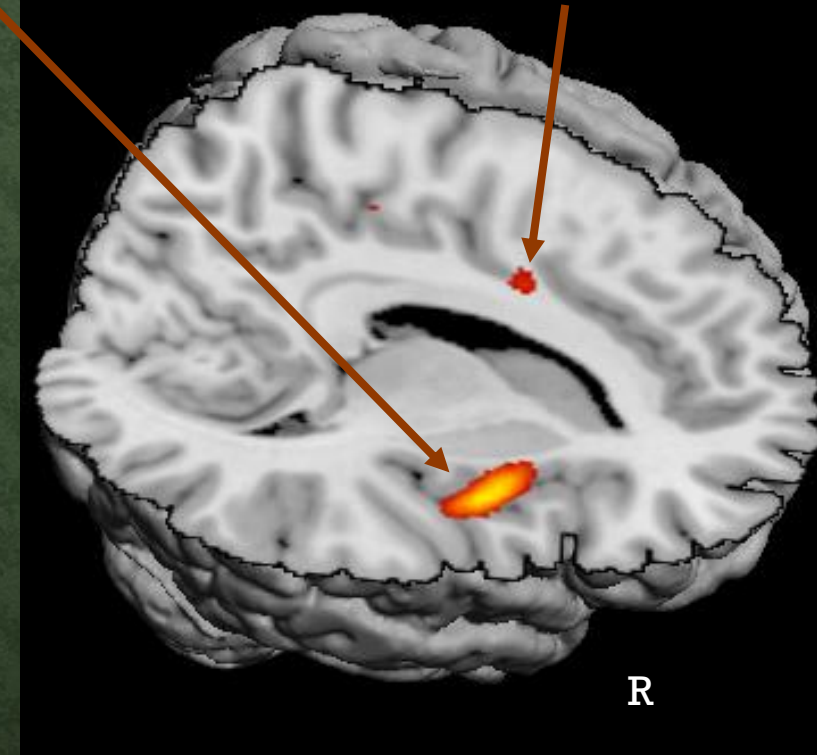
Right intraparietal sulcus + posterior-dorsal IPL (dorsal TPJ)



L

Right OFC

Negative association between Cognitive Empathy trait and rTMS effect on rSMG on self-other distinction
(rSMG: Inc-Con) – (vertex: Inc-Con)



R