



UNIVERSITA'
DEGLI STUDI
DI TORINO



Società Italiana di Psicofisiologia e Neuroscienze Cognitive

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Does the belief of owning a body gate tactile awareness?

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Somatosensory information
arising from the skin contributes to
discriminate one's own from others' bodies

de Haan and Dijkerman, *Trends Cogn Sci* (2020)



Yet it is *unclear* whether the ***sense of body ownership*** (the feeling that body parts actually belong to me) affects ***tactile awareness*** (the conscious experience of tactile events occurring on my body)



Neuropsychological evidence supports the role of body ownership in shaping the tactile awareness.



Brain-damaged patients affected by Pathological Embodiment systematically misidentify someone else's hand as their own and when they see the other's (embodied) hand being touched, they firmly report to feel tactile sensations on it.

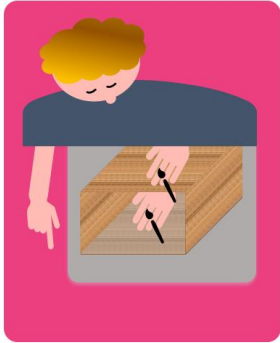
Garbarini et al., *Curr Biol* (2014); Fossataro et al., *Sci Rep* (2016); Fossataro et al., *Cortex* (2018); Pia et al., *Cortex* (2020)



The belief of owning the stimulated body part can induce a tactile experience on it, also revealing that the brain is endowed with the inner potentiality of sensing a 'visual touch'.



Does the sense of body ownership gate *tactile awareness*?

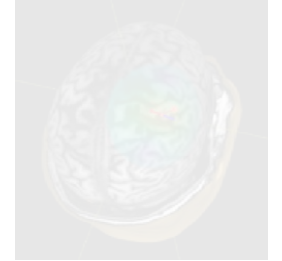


Rubber Hand Illusion
to experimentally manipulate
the sense of body ownership



Tactile perception
to explore the subjective
experience of touch during
real- and visual-touch

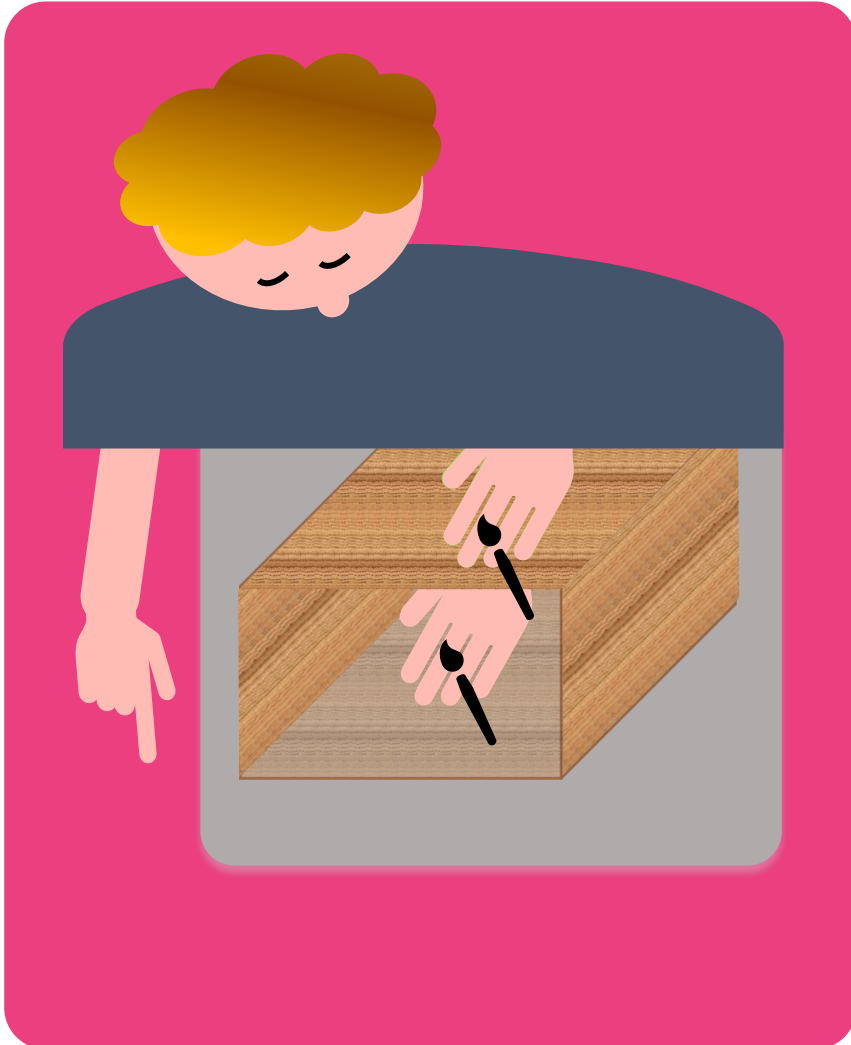
EXP 1



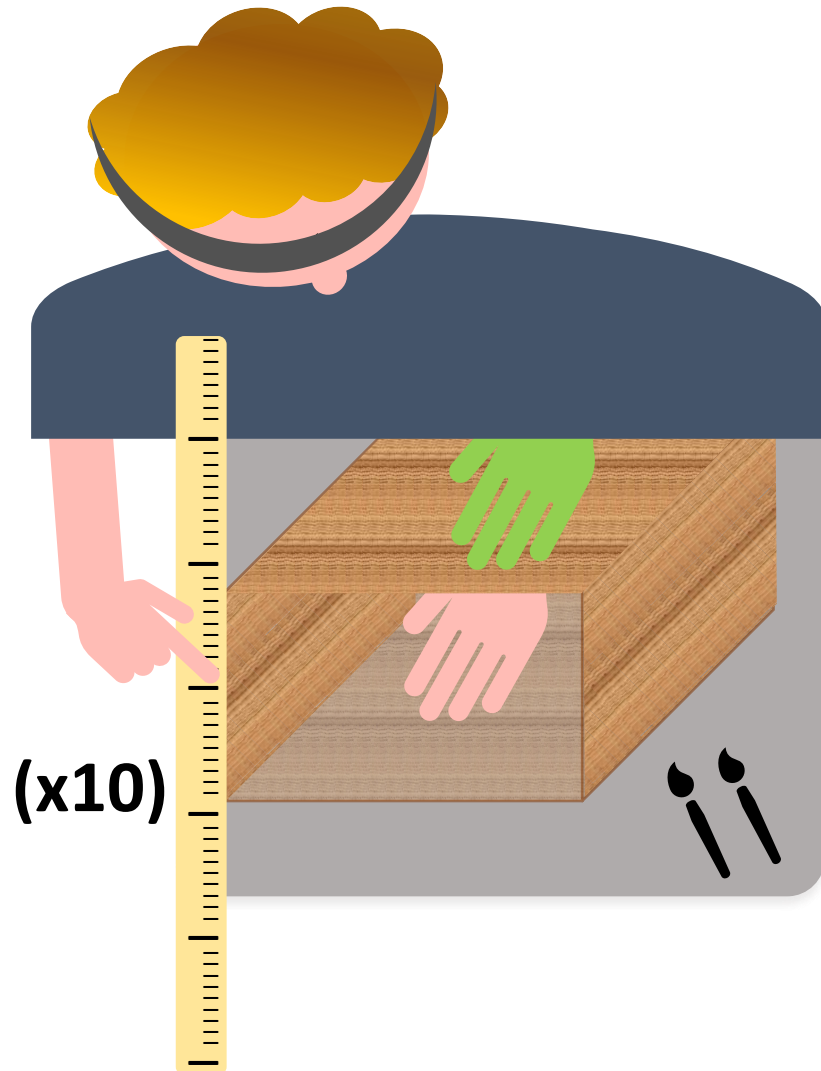
TMS-EEG
to explore the S1 activity and
its connectivity network
during real- and visual-touch

EXP 2

SYNCHRONOUS condition



PROPRIOCEPTIVE DRIFT

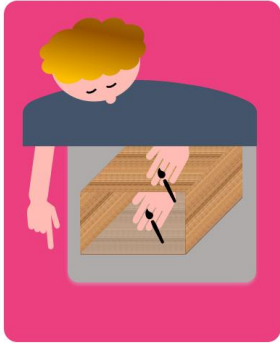


EMBODIMENT QUESTIONNAIRE

- *It seemed as if the rubber hand was my hand*
- *It seemed as if the touch I felt was caused by the paintbrush touching the rubber hand*
- *It seemed as if I were sensing the touch of the paintbrush in the location where I saw the rubber hand touched*



Does the sense of body ownership gate *tactile awareness*?

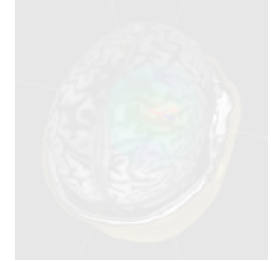


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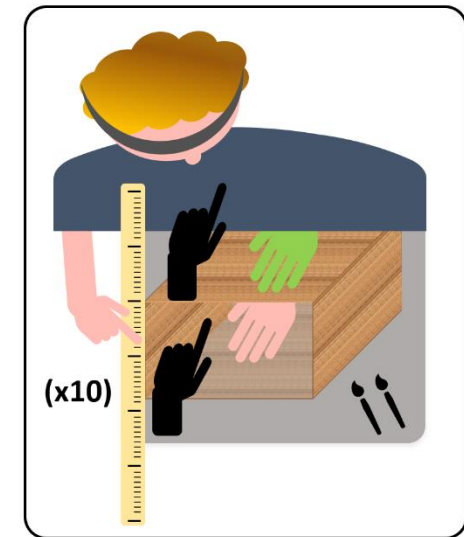
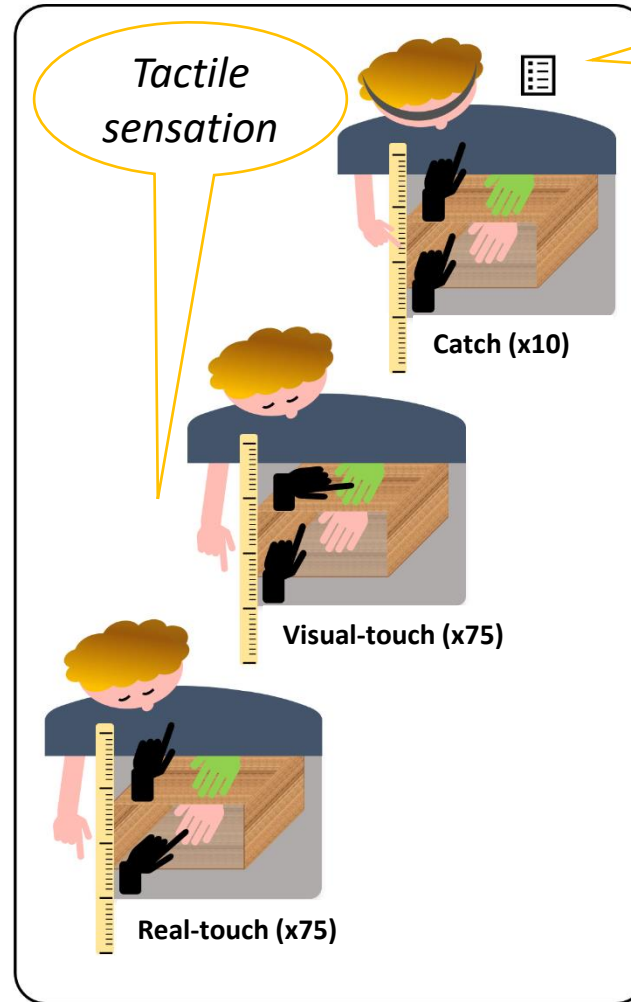
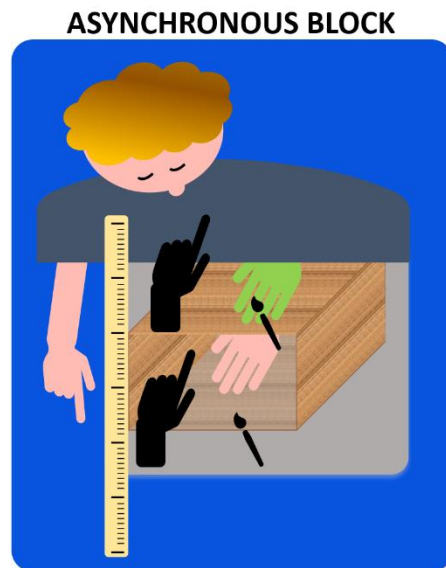
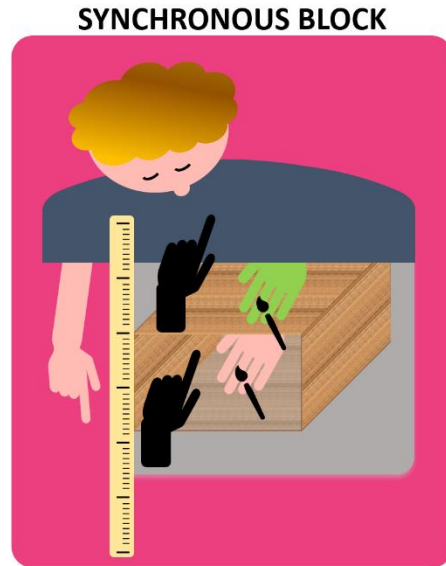
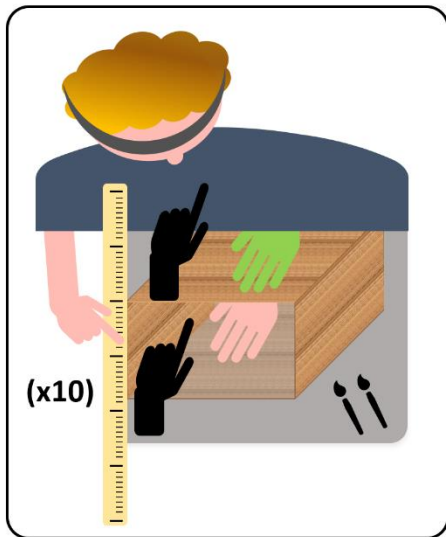
EXP 1



EXP 2

TMS-EEG
to explore the S1 activity and
its connectivity network
during real- and visual-touch

To test whether a) the **embodiment** of the rubber hand may induce participants to experience an enhanced tactile sensations during **visual-touch**
and b) the **disembodiment** of the own hand may induce participants to experienced a reduced tactile sensation during **real-touch**



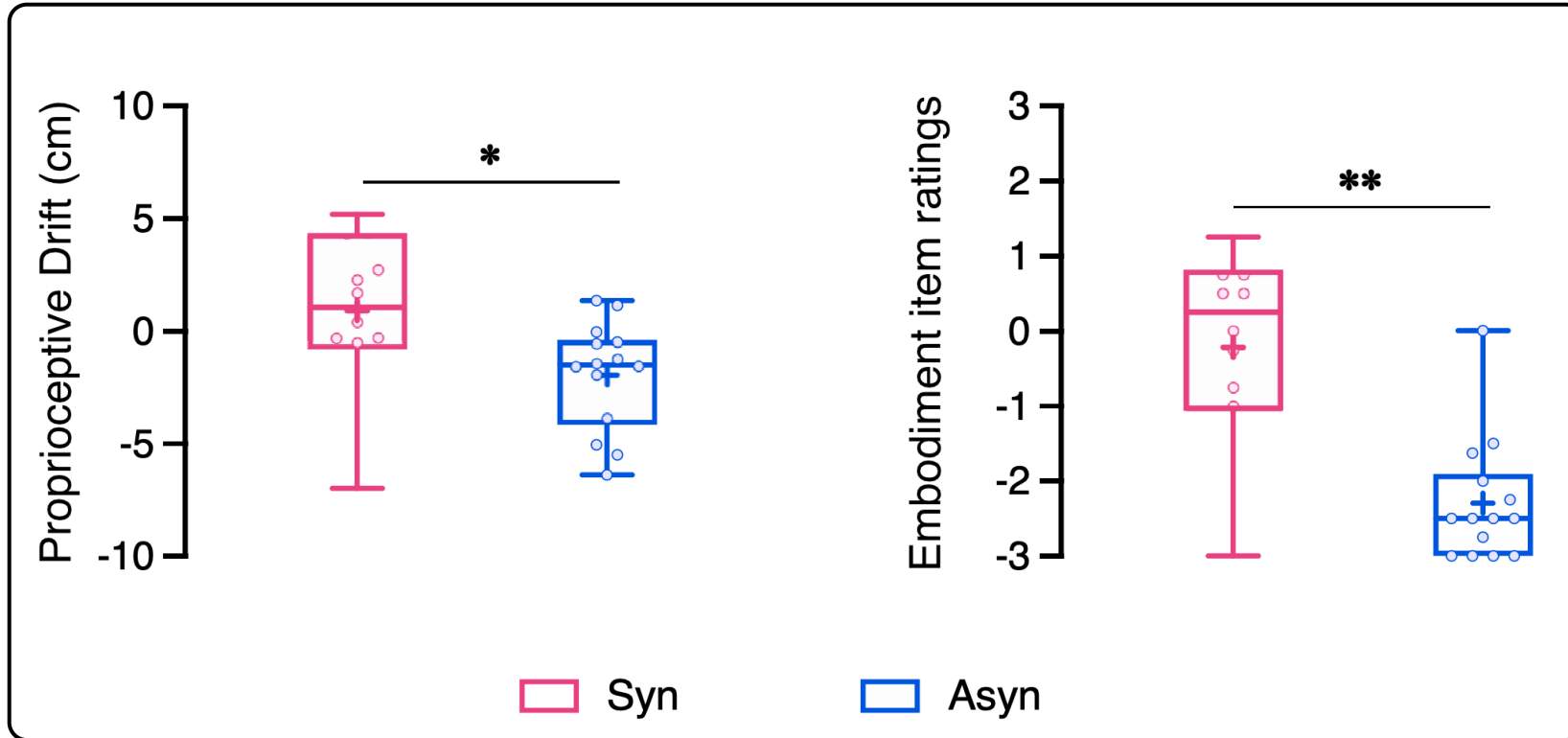
Proprioceptive Judgments PRE

9 seconds of RHI Stroking

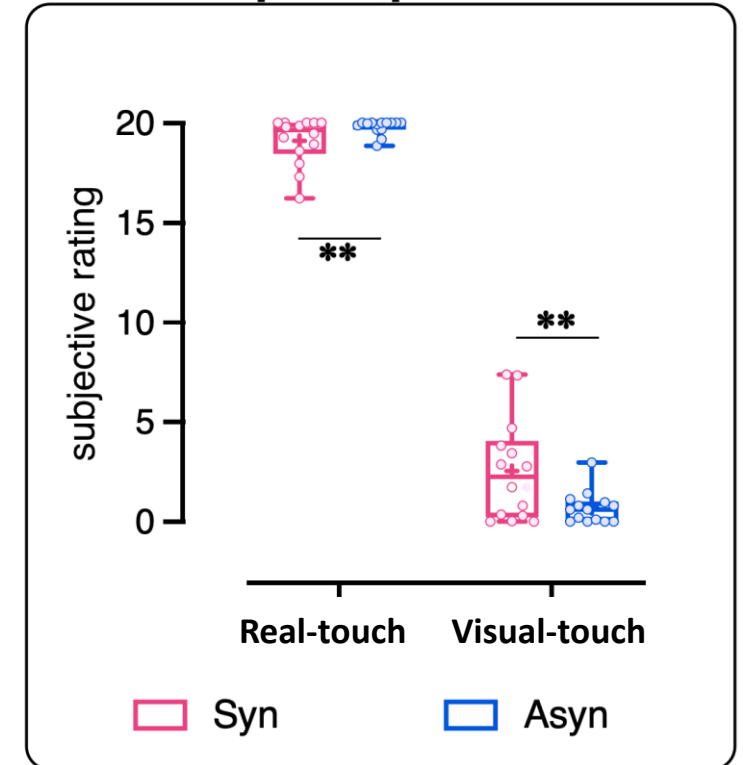
Experimental trials

Proprioceptive Judgments POST

RHI results

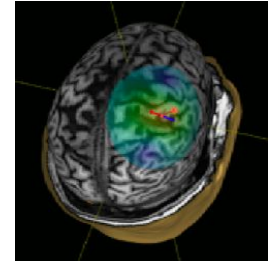
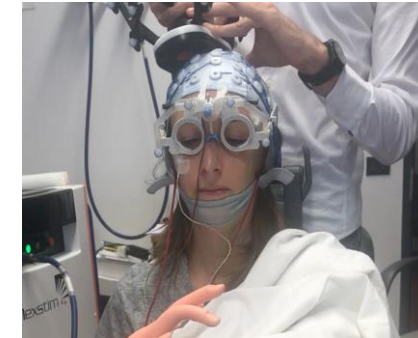


Tactile perception results





Does the sense of body ownership gate *tactile awareness*?



EXP 1

EXP 2

Rubber Hand Illusion

to experimentally manipulate the sense of body ownership

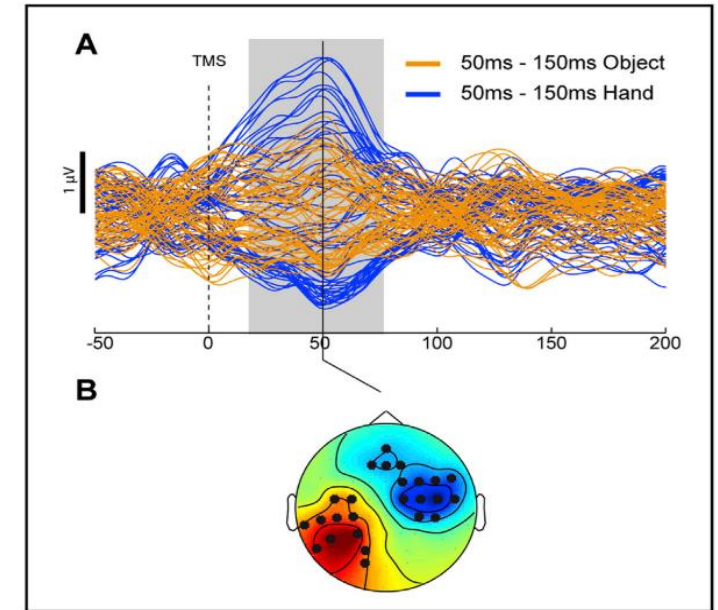
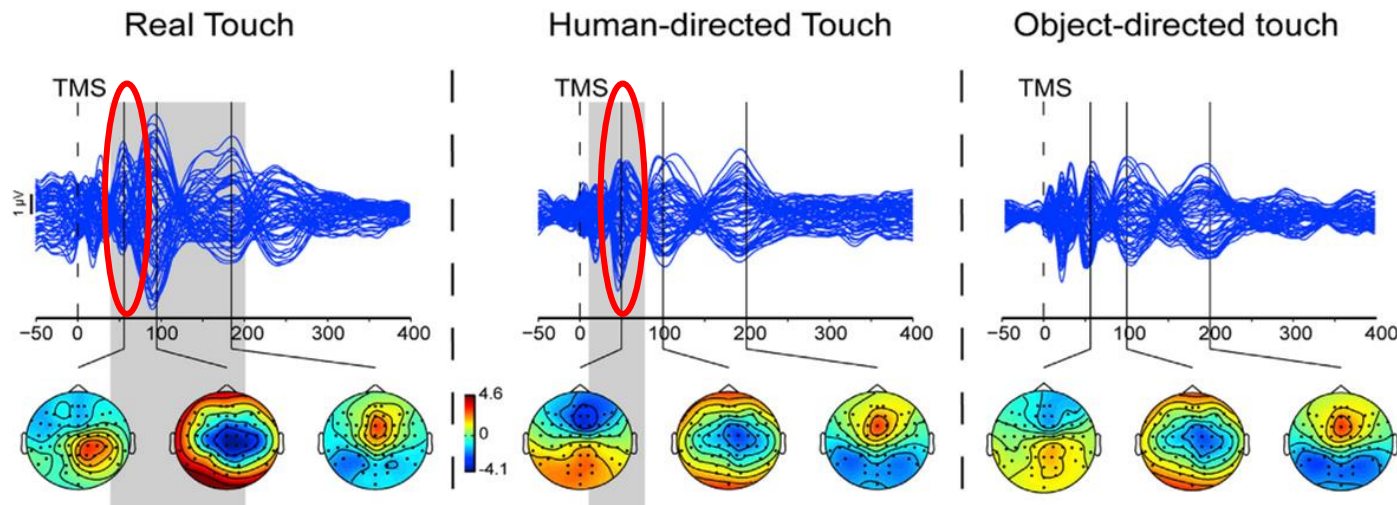
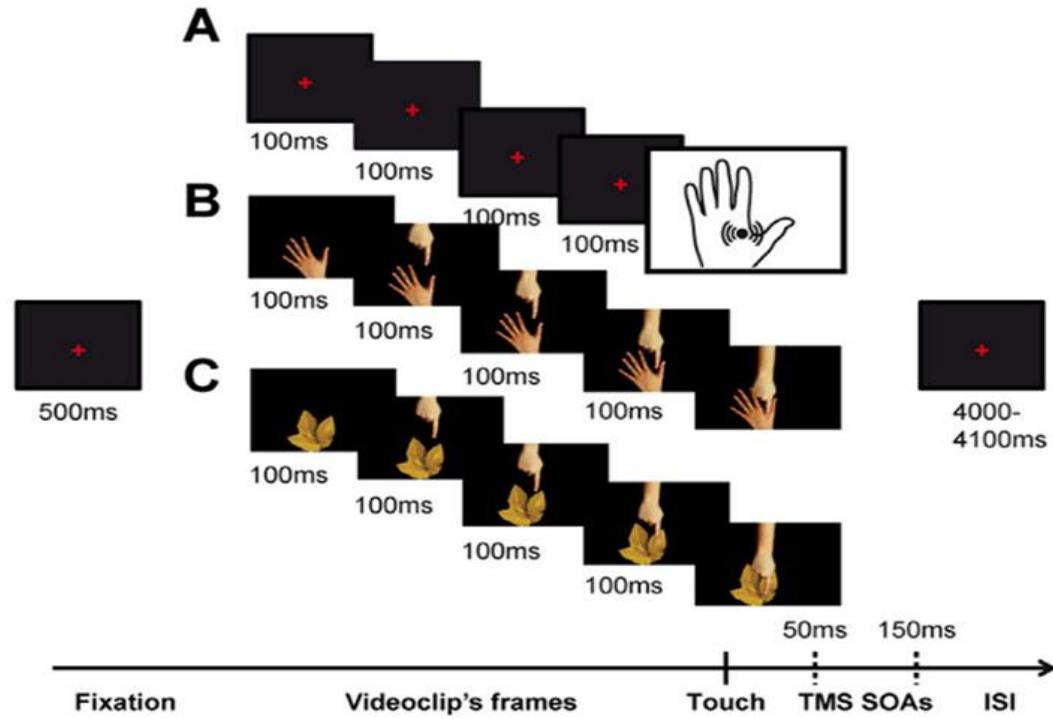
Tactile perception
to explore the subjective experience of touch during real- and visual-touch

TMS-EEG

to explore the S1 activity and its connectivity network during real- and visual-touch

To test whether the embodiment of the rubber hand may alter the participants' tactile perception during real- and visual-touch at neural levels

TMS-EEG recordings were performed during tactile perception and observation, looking for differences in **cortical activation** and **connectivity** between **felt** and **seen** touch



S1 activity in the early component (50 ms) is common between felt and seen touch

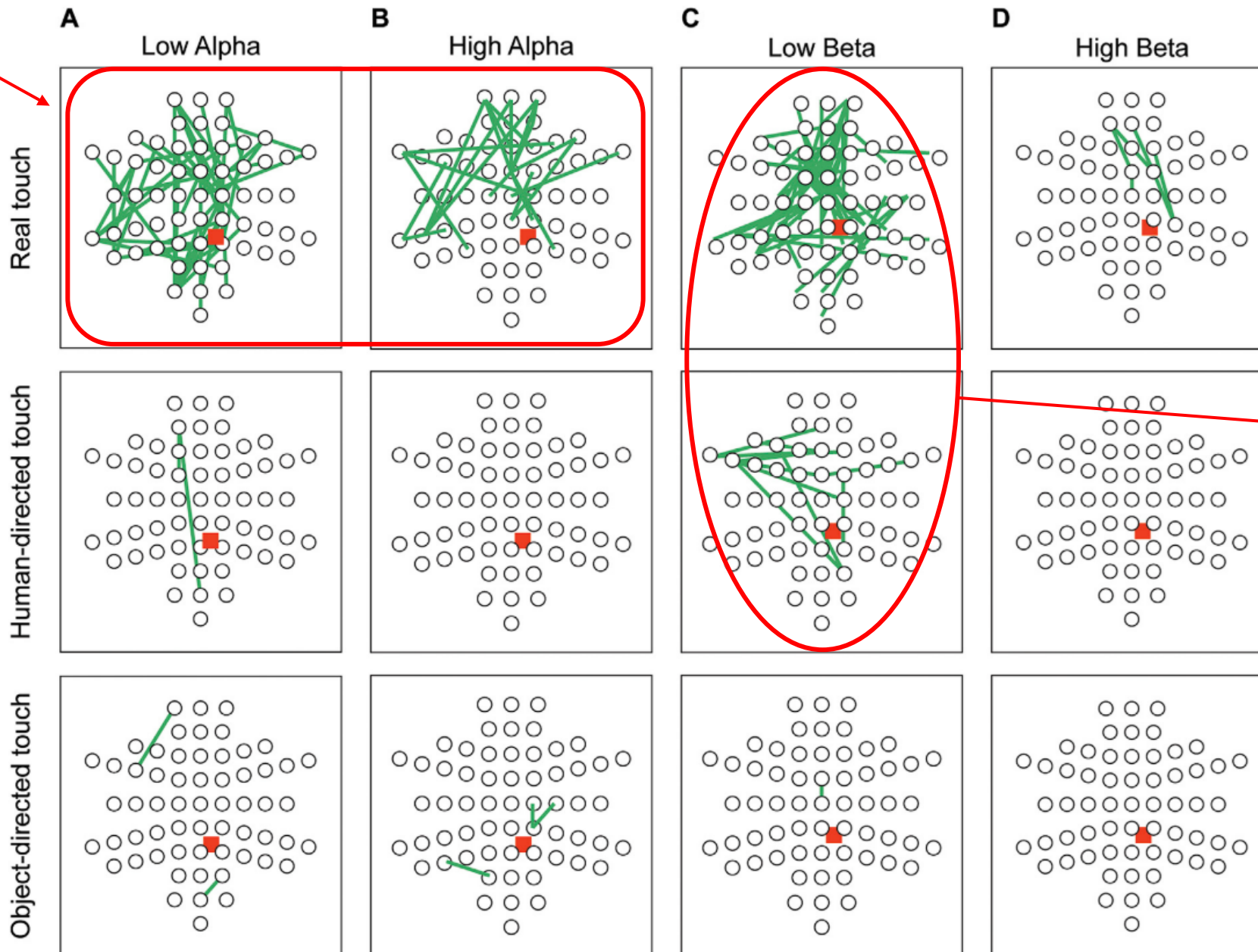
S1 is active during the observation of another's body being touched!



Segregates real- and visual-touch

Alpha-band connectivity is a marker of conscious tactile perception

Palva et al. (2005)

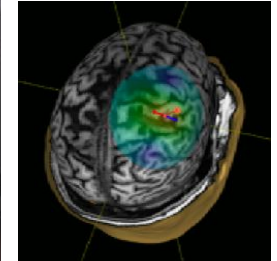
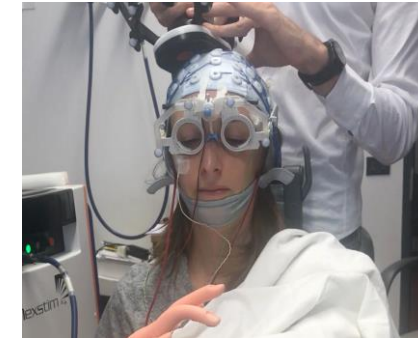


Shared between real- and visual-touch

Beta-band connectivity reflects the mirroring of visual-touch... Without awareness



Does the sense of body ownership gate *tactile awareness*?



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EXP 2

Rubber Hand Illusion

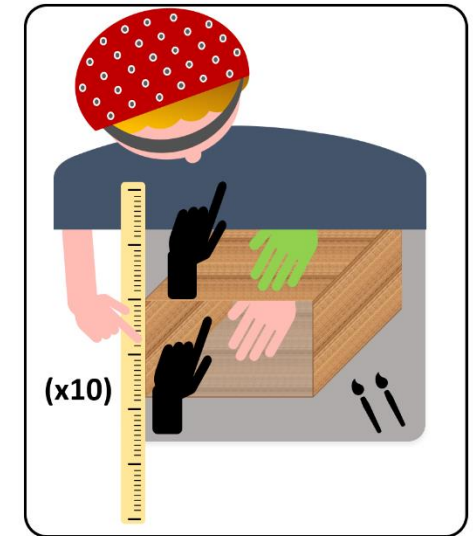
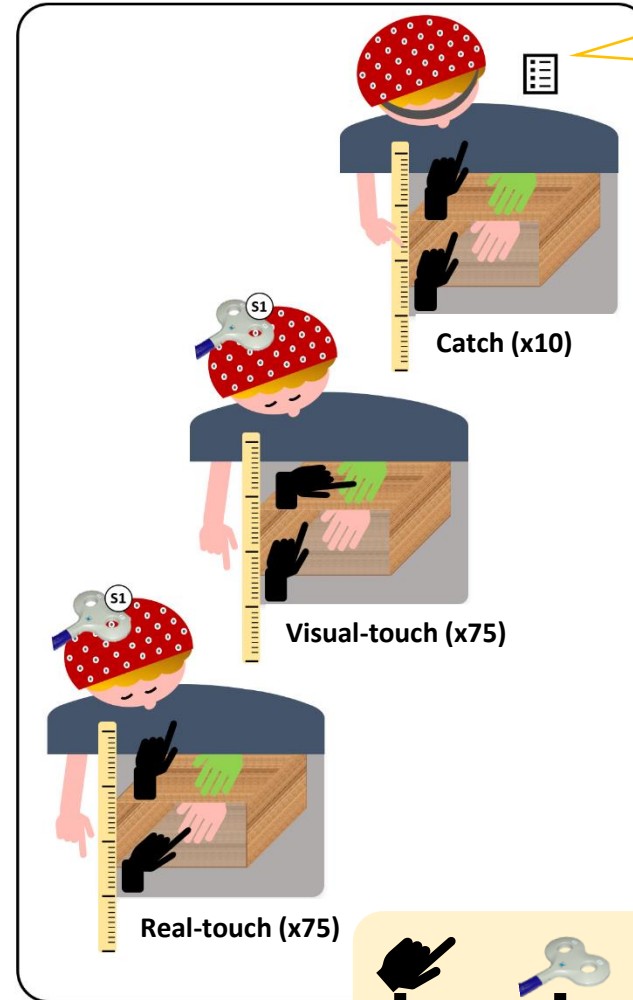
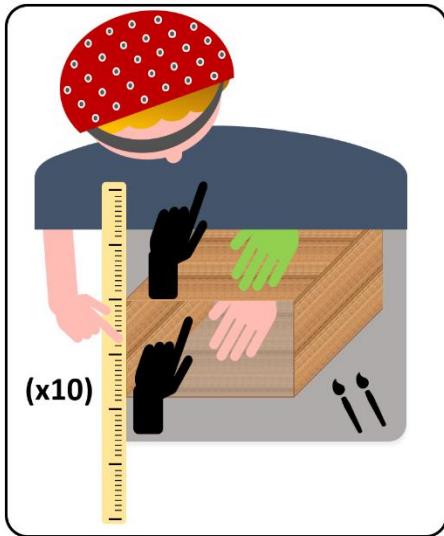
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TMS-EEG

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To test whether a) the **embodiment** of the rubber hand may enhanced the S1 activity and the alpha-band connectivity during **visual-touch**
and b) the **disembodiment** of the own hand may reduced the S1 activity and the alpha-band connectivity during **real-touch**



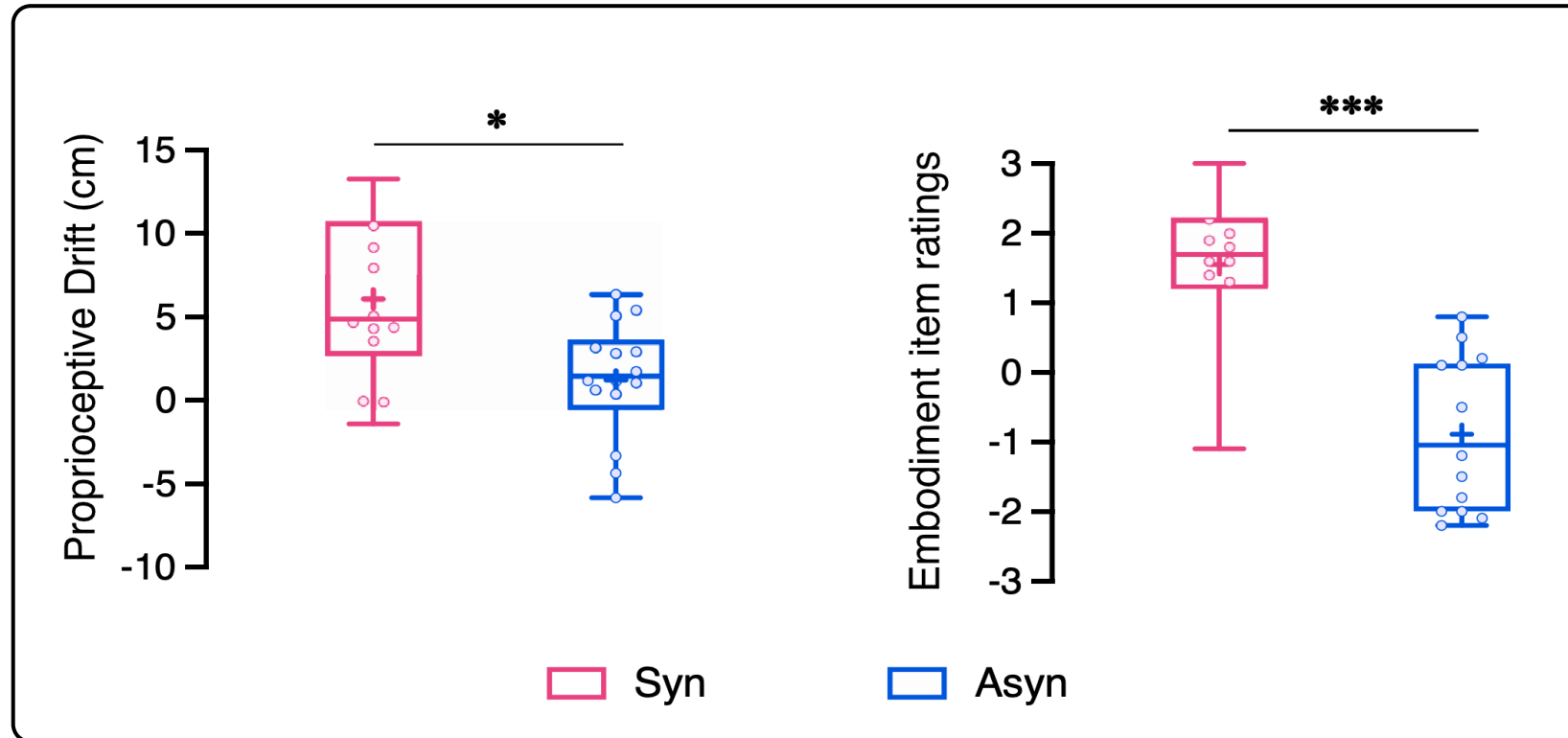
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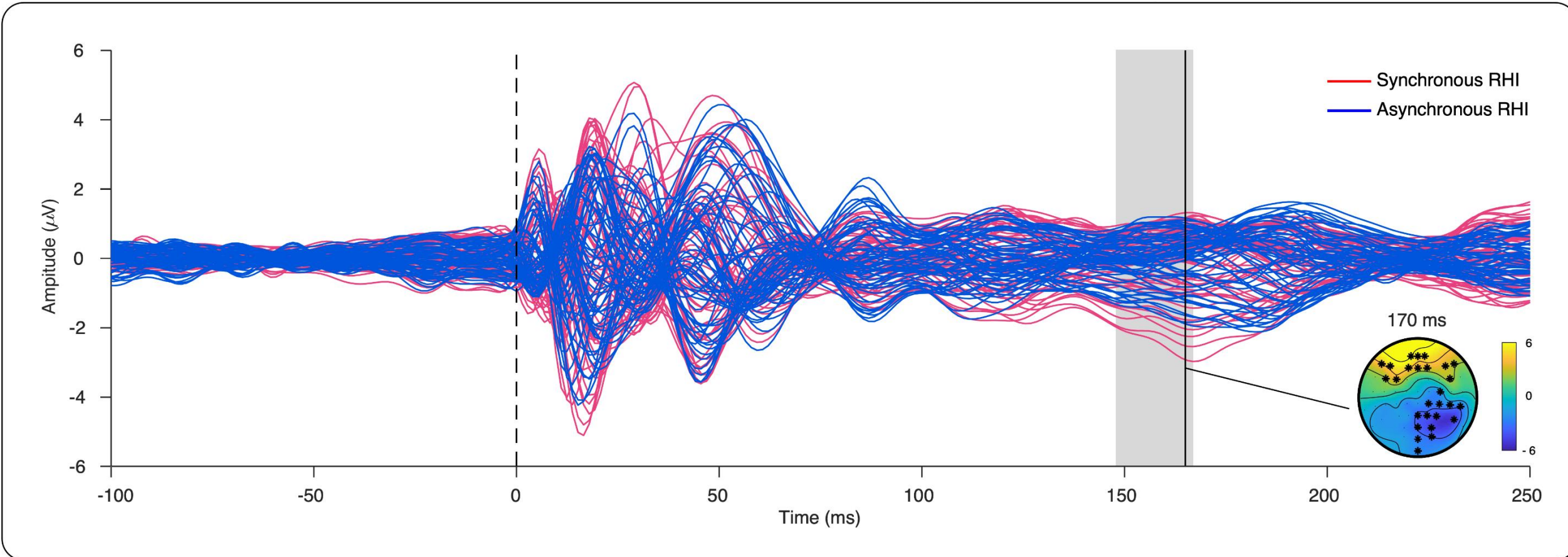
Experimental trials

Proprioceptive Judgments POST

RHI results



Visual-touch: TEP correlation with embodiment item ratings (Synchronous – Asynchronous)



The greater the embodiment, the greater is the S1 activity during visual-touch trials

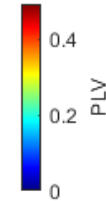
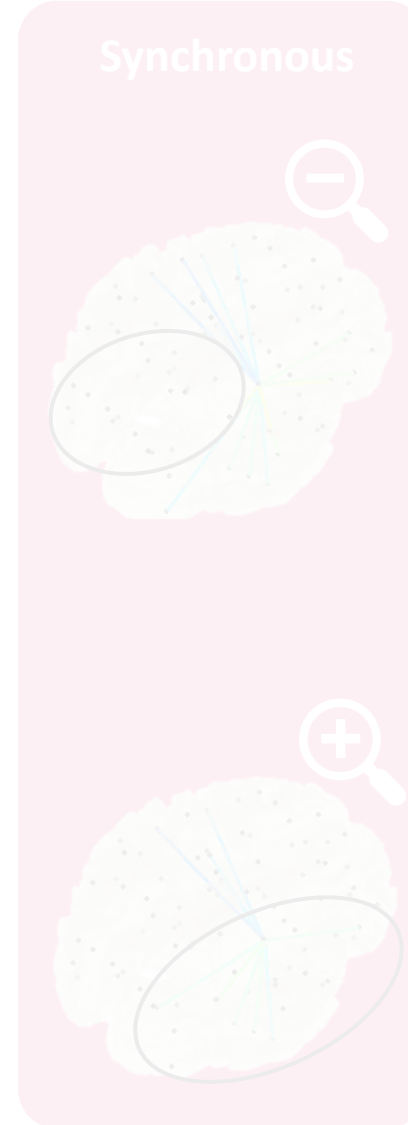
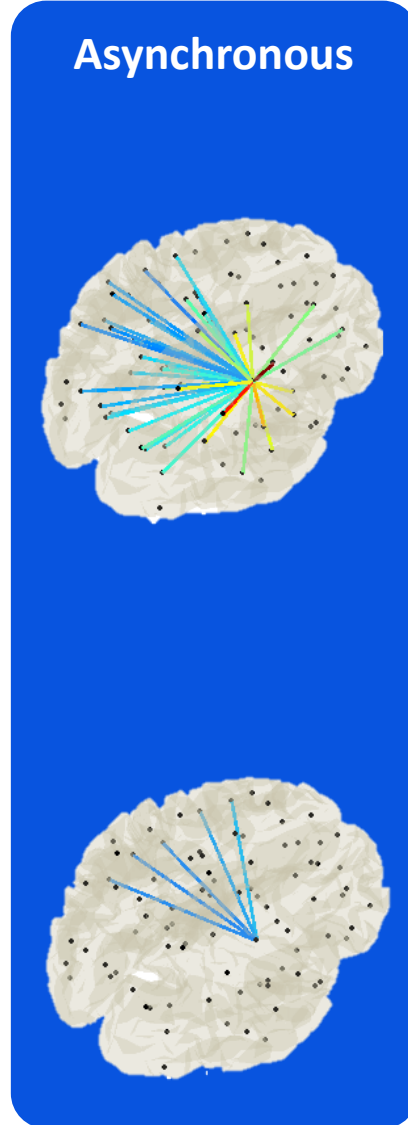
Source connectivity alpha-band S1 to other areas



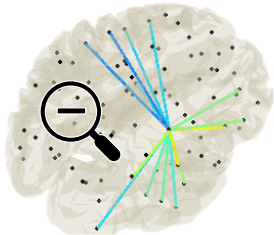
Real-touch



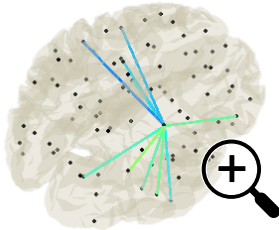
Visual-touch



When the rubber hand is embodied and the own hand disembodied...



Real-touches induce an **attenuated tactile perception** and a **reduced alpha-band connectivity**.



Visual-touches induce a **higher tactile perception** and **enhanced the alpha-band connectivity**.



Taken together these findings provide evidence for a top-down body ownership-dependent modulation of tactile awareness,

supporting the view that

'I feel a body perceiving tactile sensations because I believe it to be mine'.

Thank you for your attention!



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FUNDAÇÃO
Bial

Institution of public utility



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Source connectivity alpha-band S1 to other areas

Source connectivity Beta-band S1 to other areas

Real-touch

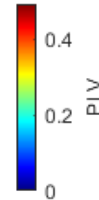
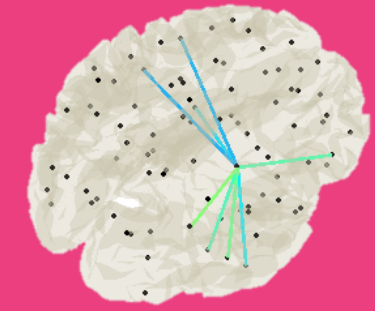
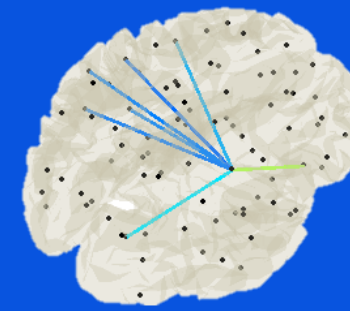
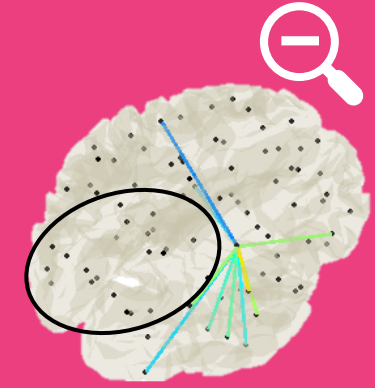
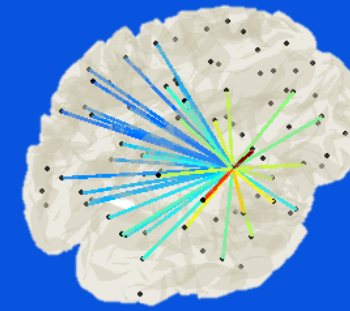
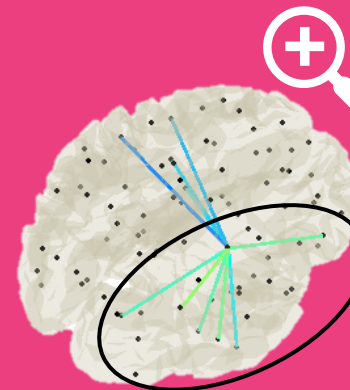
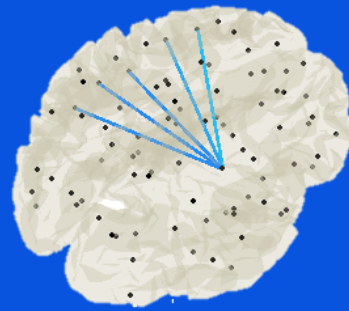
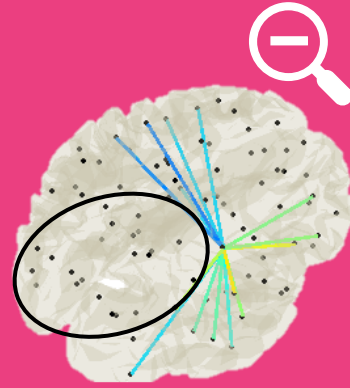
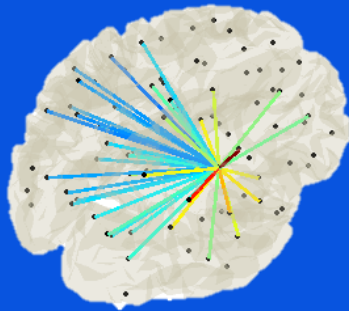
Visual-touch

Asynchronous

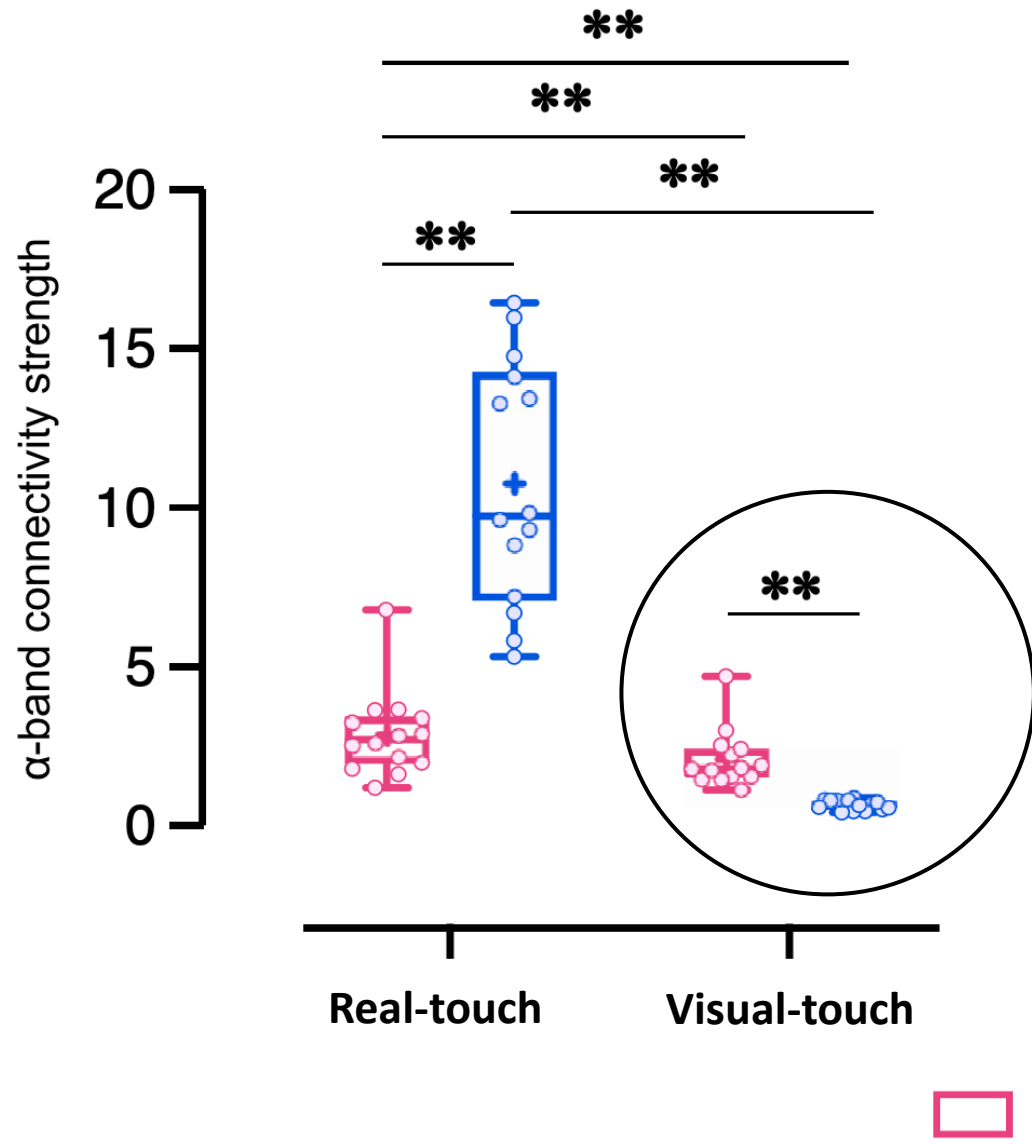
Synchronous

Asynchronous

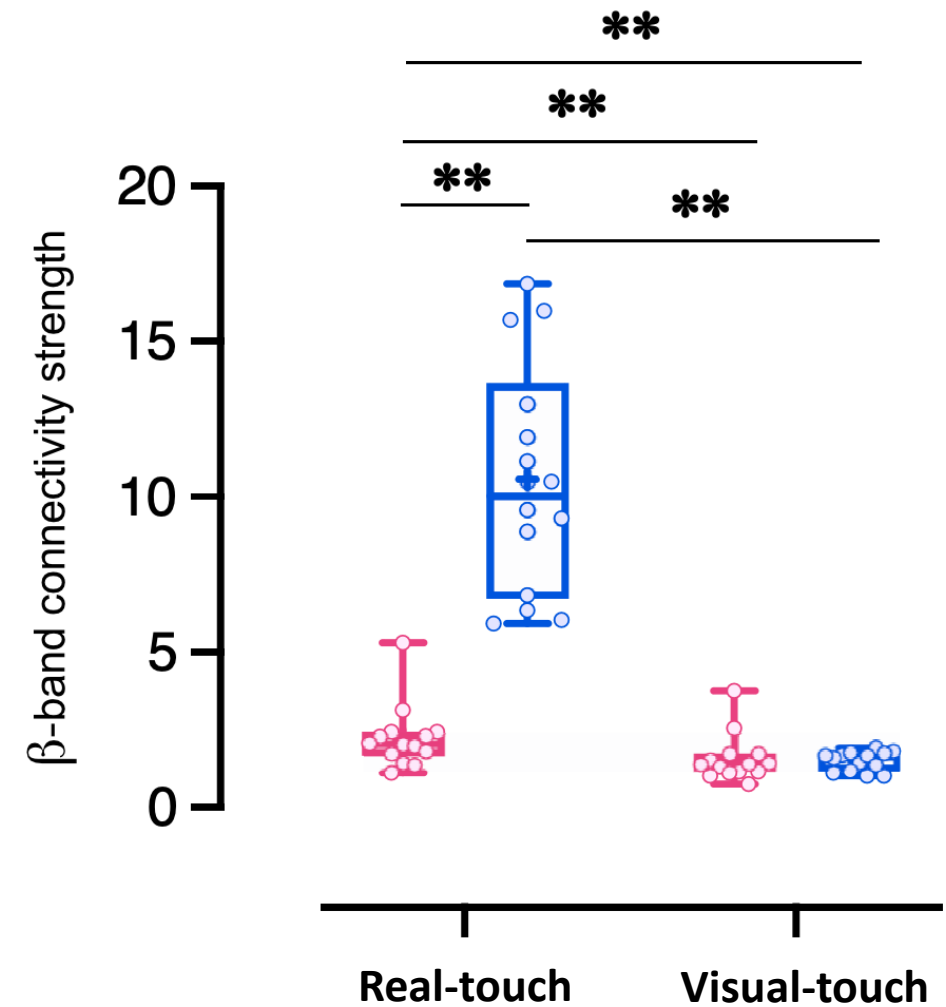
Synchronous

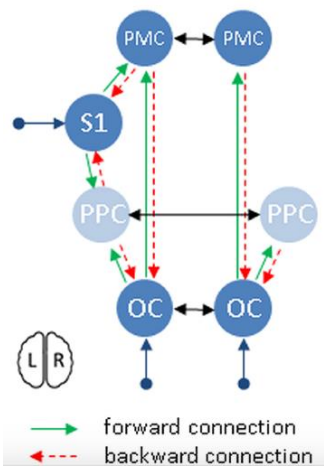


Alpha-band connectivity strength



Beta-band connectivity strength





Zeller et al. (2016)

According to the predictive coding account, the illusory feeling of embodiment arising during the RHI can be explained as the result of the reduction in somatosensory precision in order to reduce the prediction error caused the mismatch between the view of the rubber hand being stroked and the feeling of the stroking coming from one's own hand.

Multisensory areas such as PMC act to downregulate somatosensory afferences by modulating the intrinsic connectivity in S1, and to ***dispense more weight to visual input by upregulating the connectivity from visual areas to the PMC.***



Taken together these findings provide evidence for a ***top-down body ownership-dependent modulation of tactile awareness***, supporting the view that ***'I feel a body perceiving tactile sensations because I believe it to be mine'***.