Non-invasive brain stimulation relieves phantom limb pain in amputees; an fMRI study

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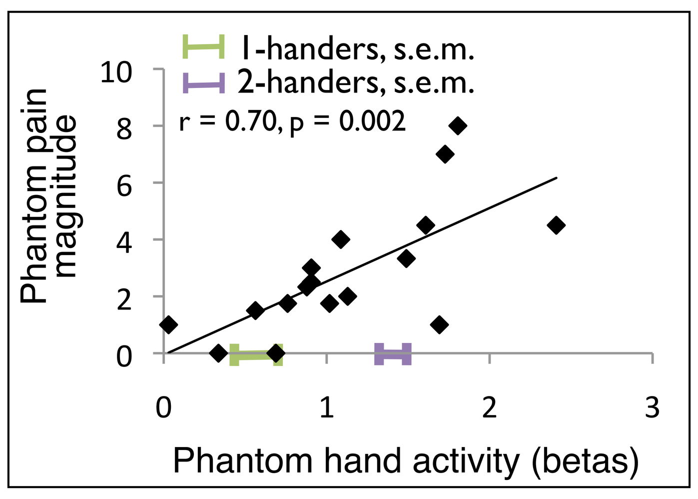
Background

- Up to 80% of upper-limb amputees suffer from chronic phantom limb pain.
- Current analgesic treatments are ineffective.
- Neuropathic pain may be relieved using non-invasive brain stimulation (tDCS).
- We previously showed that chronic phantom limb pain associated with stronger sensorimotor phantom hand representation (see figure).



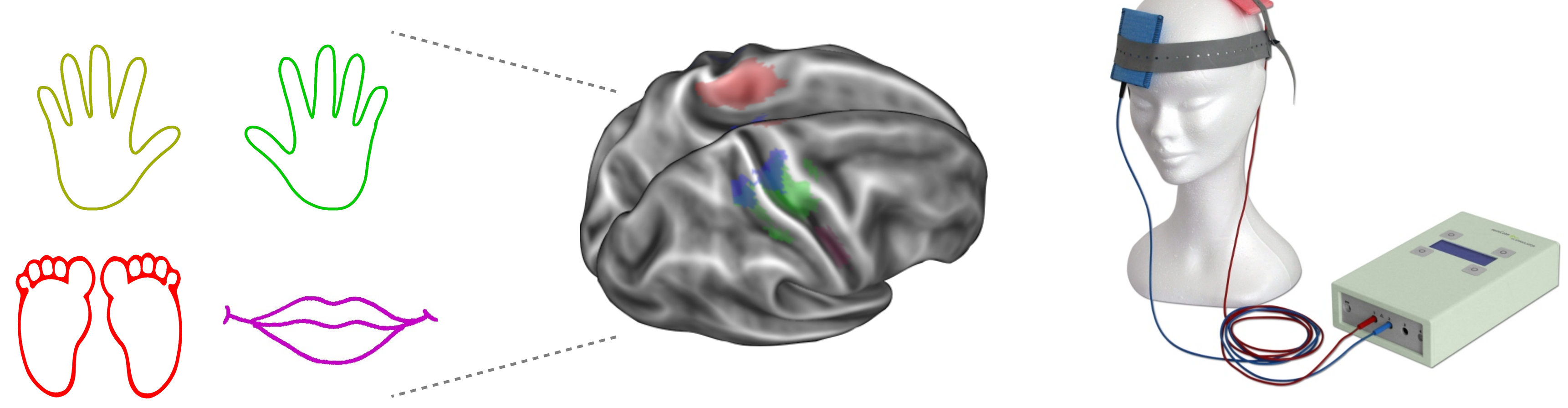
Makin et al., (2013). Nature comm.
Replicated in: Kikkert et al, (Under revisions).

Here:

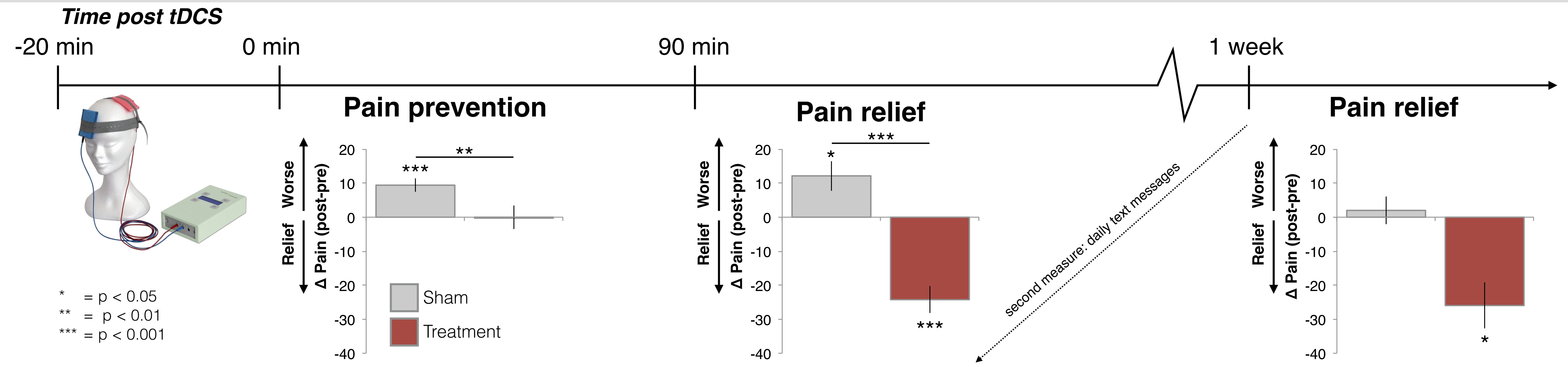
- **Can we relieve phantom limb pain using non-invasive stimulation?**
- **What are the neural mechanisms underlying phantom limb pain relief?**

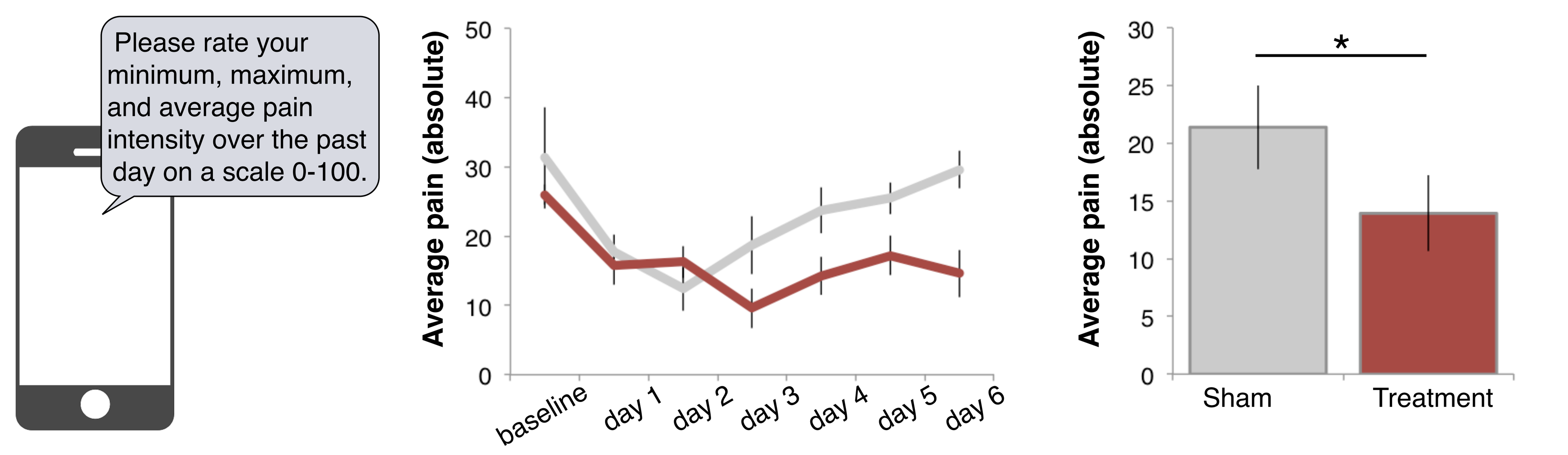
Experimental set-up

- 15 unilateral upper limb amputees suffering from chronic phantom limb pain.
- Sham-controlled, counterbalanced and double-blind design.
- 20 minutes of excitatory non-invasive brain stimulation (anodal tDCS; 1mA) over deprived primary sensorimotor cortex, during phantom hand movements.
- Subjective pain ratings before and after brain stimulation.
- 3 tesla fMRI before, during, and after stimulation.



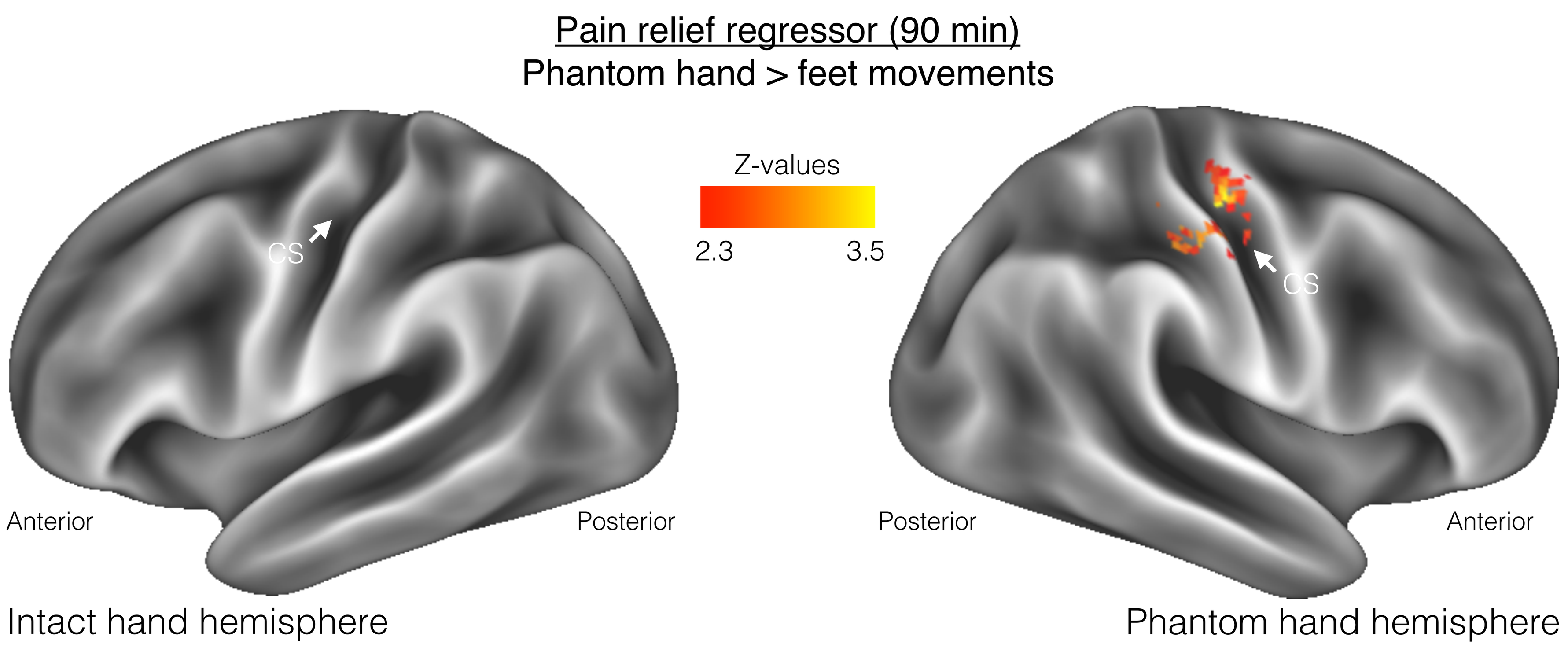
Non-invasive brain stimulation causes lasting phantom limb pain relief





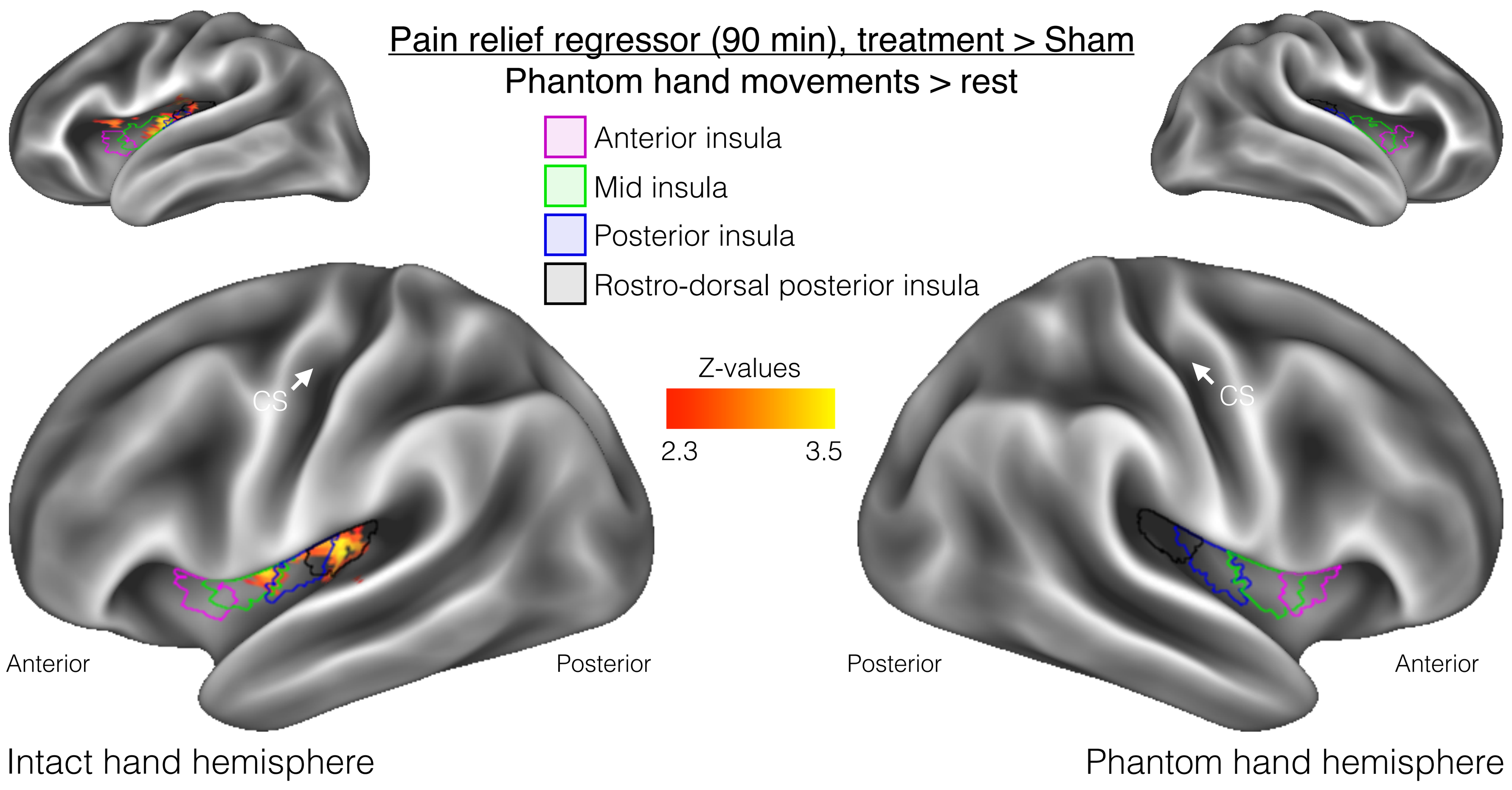
What are the neural correlates of pain relief post tDCS?

Amputees experiencing *less* phantom limb pain post treatment, activate the primary sensorimotor (S1/M1) phantom hand area *less* post treatment.



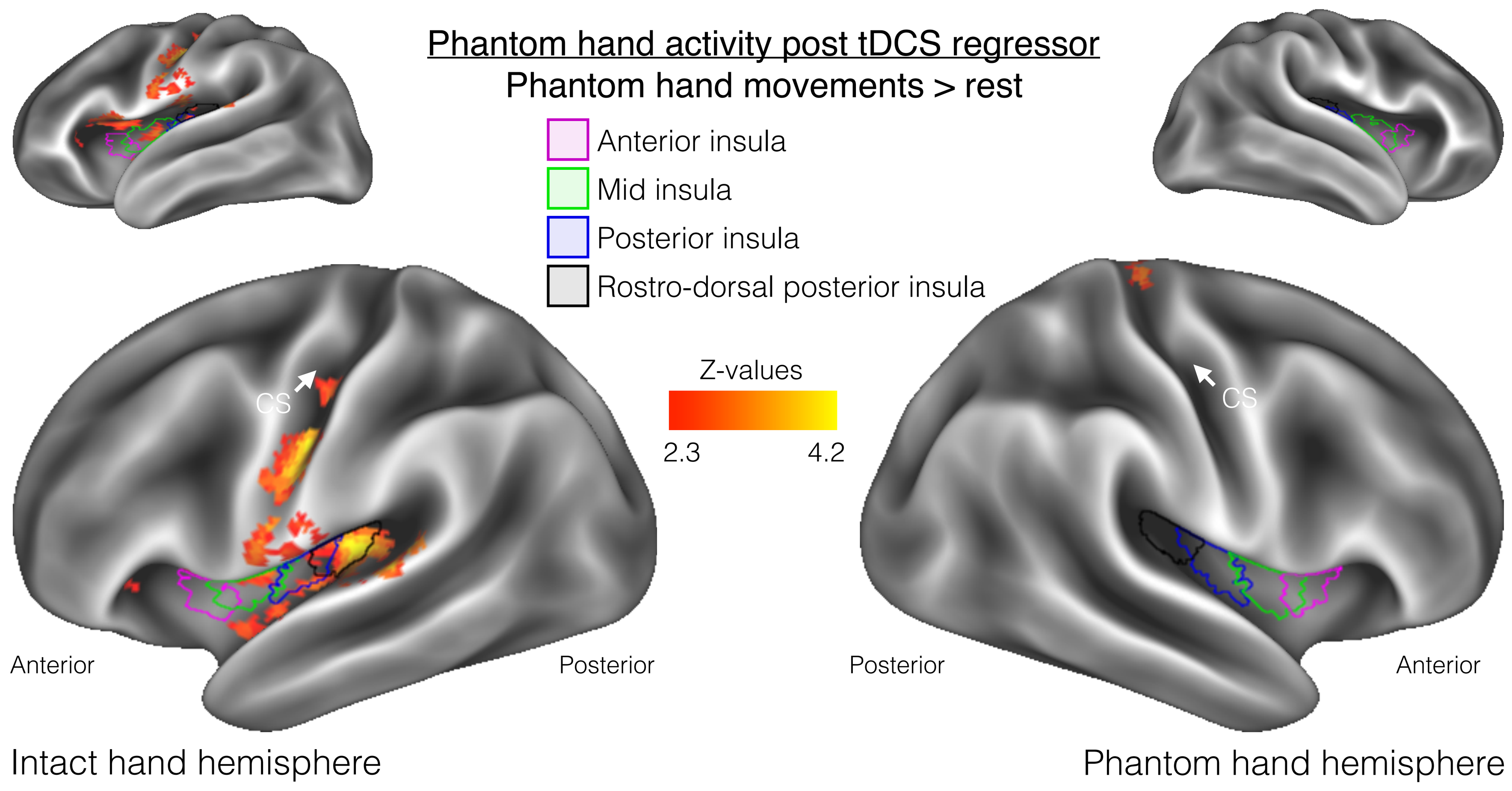
What are the neural correlates of pain relief during tDCS?

Amputees experiencing *less* phantom limb pain post treatment, activate the mid and posterior insula *more* during tDCS.



What happens during tDCS to modulate S1/M1 activity?

Amputees who activate the phantom hand area *less* after tDCS, engage the mid and posterior insula *more* during tDCS.



Conclusions

- tDCS is a promising tool for managing phantom pain: A single 20 min treatment of non-invasive brain stimulation can relieve phantom pain for at least a week.
- Reduced activity in the cortical phantom hand area reflects reduced phantom limb pain after treatment.
- Both reduced activity in the cortical phantom hand area and phantom pain relief rely on increased insula activity during treatment.

Our findings highlight the role or pain-related networks in mediating phantom pain.

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