Multiple spatial representations of touch: an fMRI adaptation paradigm

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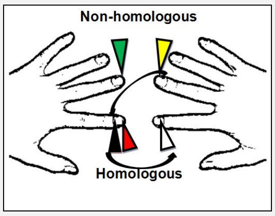
Introduction

We used fMRI adaptation (Grill-Spector et al., 2006) for studying SI and SII cortices to address the issue of spatial reference frames for touch (finger homology vs. body side). When two tactile events repeat on exactly the same region of skin, all neurons that have a strictly somatotopic response would reduce their activity. These neurons should instead show no reduction of activity if the stimulation repeats over two distinct regions of skin. The crucial question, in relation to the issue of reference frames for touch, is whether some population of neurons in the brain can adapt to stimulation that repeats over distinct region of skin, when some other aspect of spatial coding is in fact identical. This can occur for instance when the repeated stimulation is delivered to **homologous body parts** (e.g., the fingertips of the right and left index), because the finger is identical although the stimulated region of skin differs.

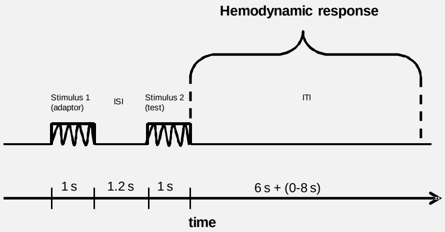
Present study

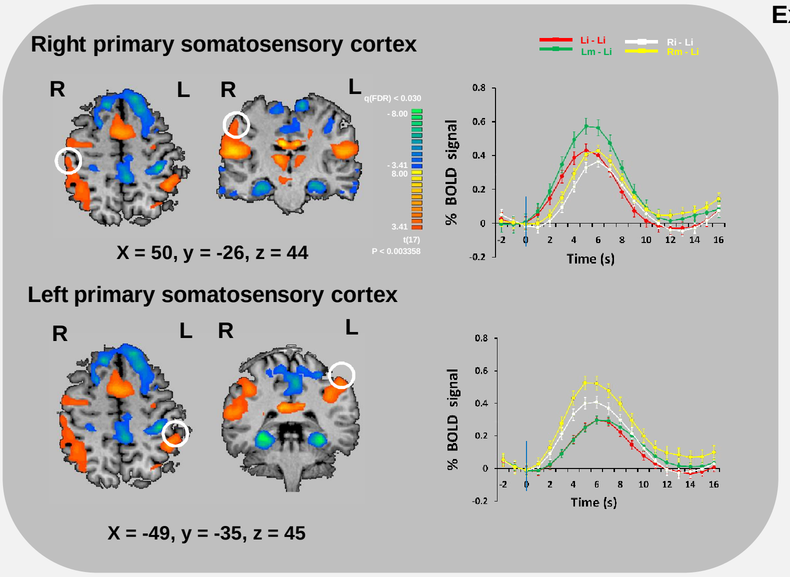
We examined fMRI adaptation to tactile stimulation delivered in sequence within or between hands, to **homologous** or **non-homologous f**ingers. Participants received a test stimulus at the index or middle finger of either the left or right hand, followed by an adaptation stimulus delivered always to the left index finger.

Design



Adaptors (coloured), test stimulus (black)





Stimulation & Data Acquisition

- 4T Bruker Medspec Head Scanner
- Stimulus (vibrotactile, 20 Hz)
- Event-related design
- 18 participants
- 4 conditions repeated 12 times each run, 4 runs
- TR 2200ms, TE 33ms, FA 75
- voxel resolution 3x3x3 mm

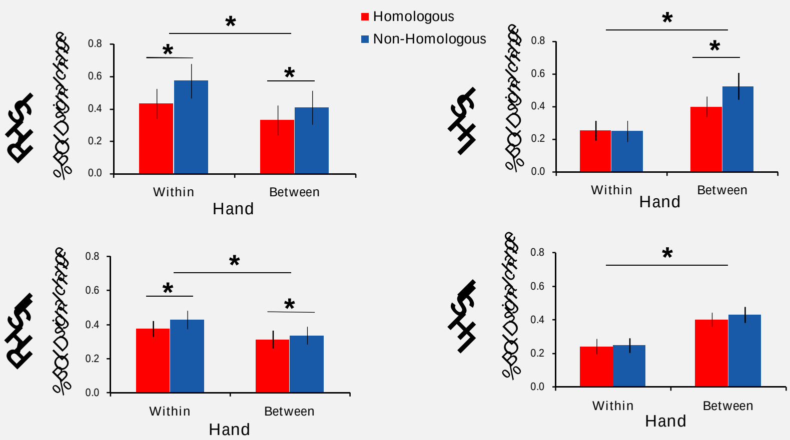
Experimental Conditions

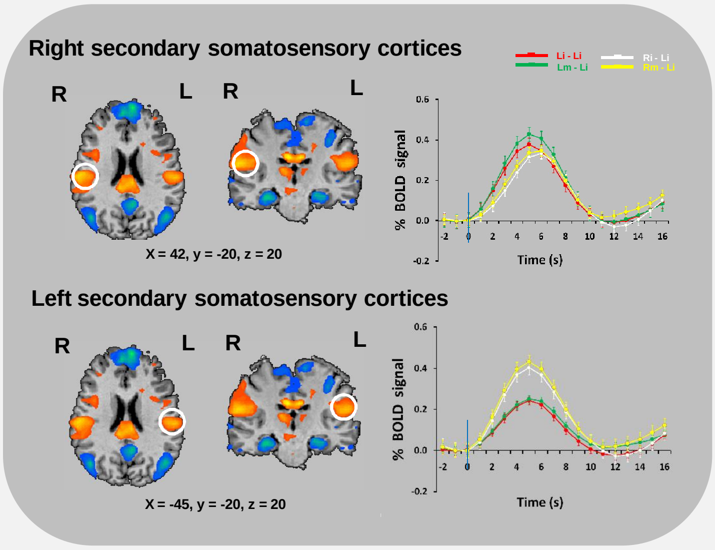
- **Li – Li** Left index twice
- **Lm – Li** Left middle, left index
- **Ri – Li** Right index, left index
- **Rm – Li** Right middle, left index

Analysis

- BrainVoyager QX 2.4
- Random Effects Analysis (**RFX**)
- **ROI analysis:** SI & SII of both hemispheres identified on the basis of anatomical location

Analysis of Variance on the peak of activation by ROIs





Results and Conclusions

The results showed stronger adaptation (i.e., a lower BOLD effect) at the level of SI when stimulation repeated over same (i.e., homologous) in comparison to different (i.e., non-homologous) fingers, regardless of whether stimulation occurred within or between hands. These results imply that SI contributed to a spatial representation of the tactile stimuli that was segregated more with respect to the body region rather than the body side. This pattern of results is less clear in SII in which the spatial representation of tactile stimuli seems to be segregated also with respect to body sides (Ruben et al., 2001). These results suggest human SI may code touch at the fingers bilaterally, in agreement with neurophysiological data on monkeys (Iwamura et al., 2001).

References

Grill-Spector, Henson & Martin, (2006). Trends in Cognitive Sciences, 10, 1, 14-23. **Iwamura, Taoka & Iriki, (2001)**. The Neuroscientist, 7, 419-429. **Ruben, Schwiemmann, Deuchert, Meyer, Krause, Curio, Villringer, Kurth & Villringer (2001**). Cerebral Cortex, 11, 463-473.

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