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# Content representation of tactile mental imagery in primary somatosensory cortex

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## INTRODUCTION

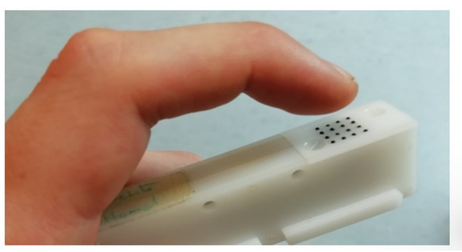
- During mental imagery the brain generates representations of specific mental contents that are accessible to conscious processing
- So far no evidence for the neuronal basis of content representation during tactile mental imagery

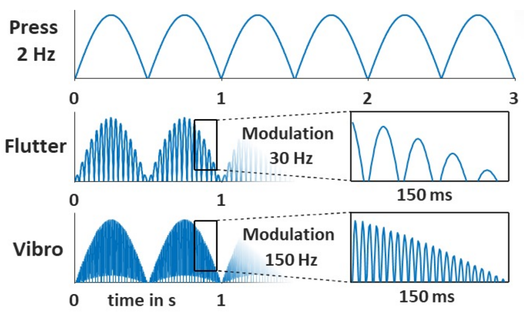
Aim of this fMRI study:

- test for content-specific activity of mental imagery in primary somatosensory cortex (SI)
- More specifically, in its hierarchically highest subregion BA2, as it was recently shown to be involved in mental tactile imagery[1]

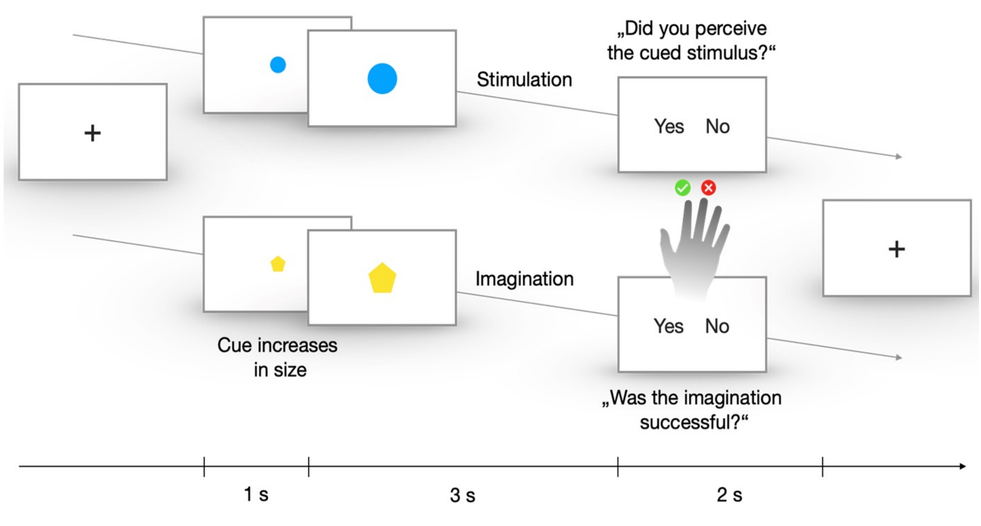
## METHODS

In the Stimulation conditions, one of three vibrotactile stimuli (Press, Flutter, Vibration) was presented to the participants (N = 21) left index fingers.






In the three Imagery conditions, participants were instructed to imagine the corresponding vibrotactile stimulus.

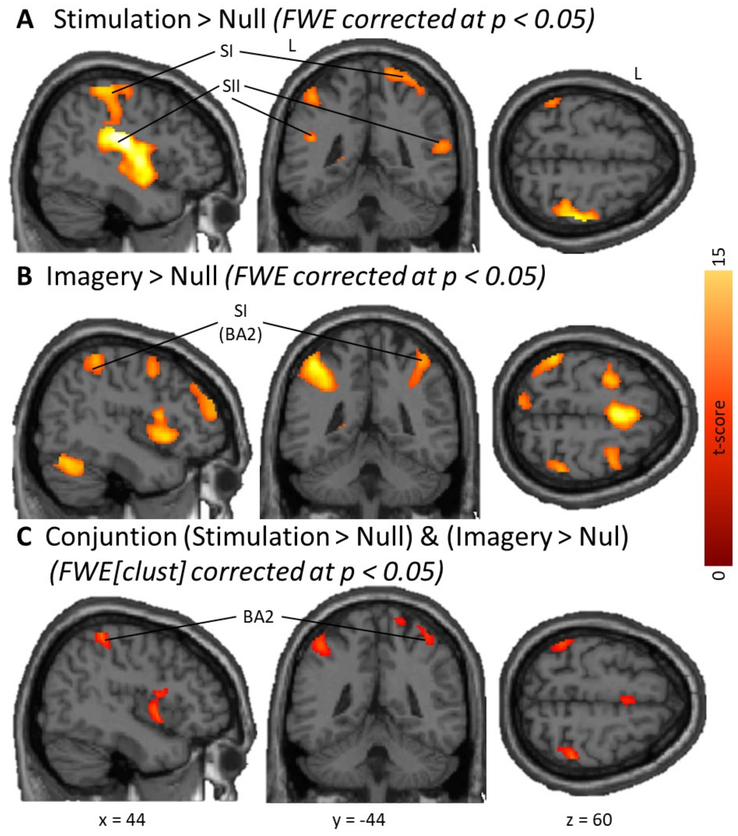



The whole experiment consisted of six runs with six trials per condition. fMRI data were aquired using a 3T TIM Trio MRI scanner. Standard fMRI preprocessing was done with SPM12.
fMRI data analysis:

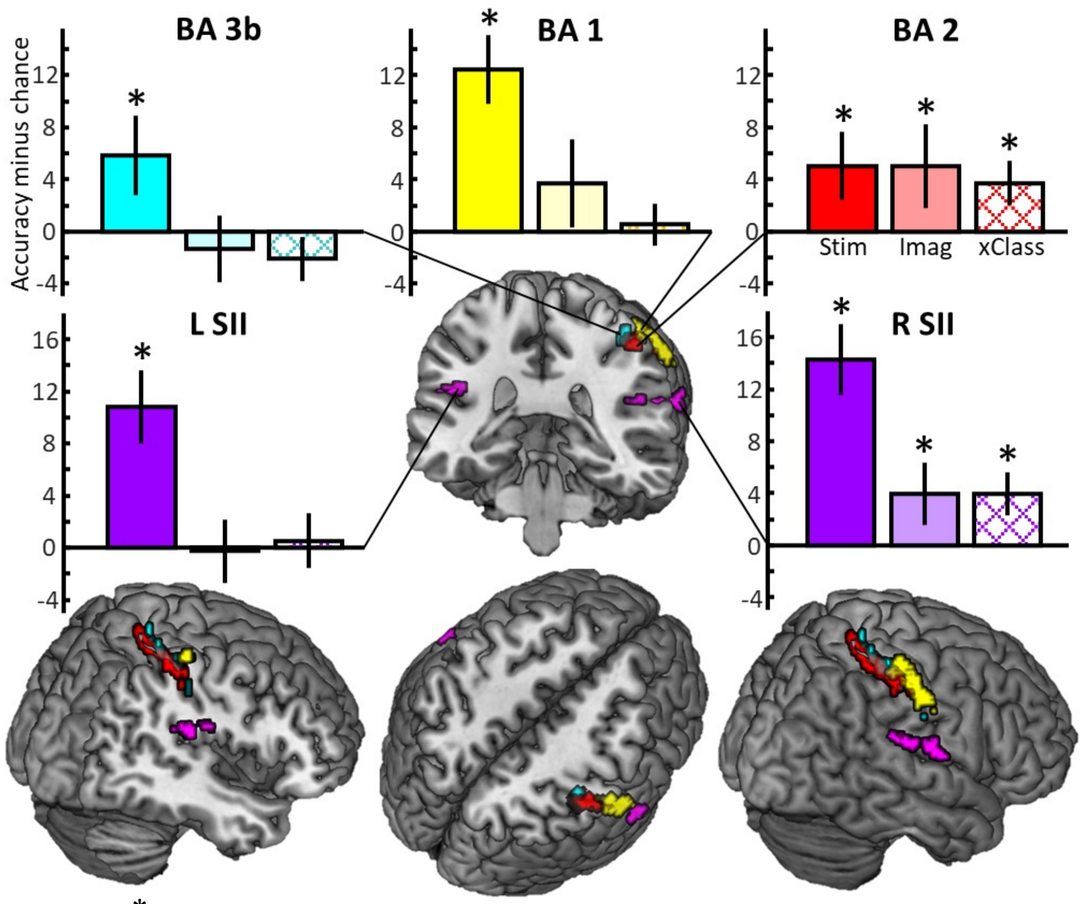
- Univariate analysis, including a conjunction analysis of the Stimulation and Imagery conditions
- Definition of regions of interest (ROIs) via intersecting probabilistic cytoarchitectonical maps with activated brain areas during the Stimulation condition
- Multivariate pattern analysis in these ROIs, utilizing leave-one-run-out cross-validated multiclass support vector machines (SVM) and non-parametric tests in the form of label-permutation

## RESULTS

The left figure shows the result of the univariate contrasts and conjunction analysis. Activations in frontal and parietal areas (including SMA, IFG and IPL), and in contralateral SI were found during tactile mental imagery. Shared activations during Stimulation and Imagery can be found in right BA2, IFG, left IPL, SMA and left temporal pole. The contrasts of the three Stimulus and Imagination conditions against each other, respectively, revealed no significant differences.
The figure below illustrates the predefined ROIs (right BA3b, BA1, BA2 and bilateral SII) as well as the result of the multivariate pattern analyses within these areas.




Decoding Accuracies minus Chance from ROIs




* = significant at p < 0.05, BA = brodman area, L = left, R = right

In these ROIs, we found that the activations during Imagery conditions were decodable in contralateral BA2 and SII. In these two areas, a classifier trained on the Stimulation conditions and tested on the Imagery conditions (cross-classification) also showed accuracies significantly above chance.

## CONCLUSION

- In this study, we observe mental tactile imagery to activate BA2, the hierarchically highest subarea of SI, thus confirming previous findings[1]
- We provide further evidence for sensory recruitment where only very detailed mental imagery activates lower-order sensory areas[2]
- We were able to classify Imagery conditions based on neuronal activation in contralateral BA2 and SII
- Activation patterns during tactile stimuli could be used to identify which Imagery condition was imagined (cross-classification)
- Our results provide for the first time direct evidence that SI activation during mental imagery is specific to a mental content

## References

[1] Schmidt TT, Blankenburg F (2019) The Somatotopy of Mental Tactile Imagery. Front Hum Neurosci 13:10.
[2] Kosslyn SM, Thompson WL (2003) When is early visual cortex activated during visual mental imagery? Psychol Bull 129:723–746

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