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Stimulation of single neurons at 7T: studies of the quantal components of touch

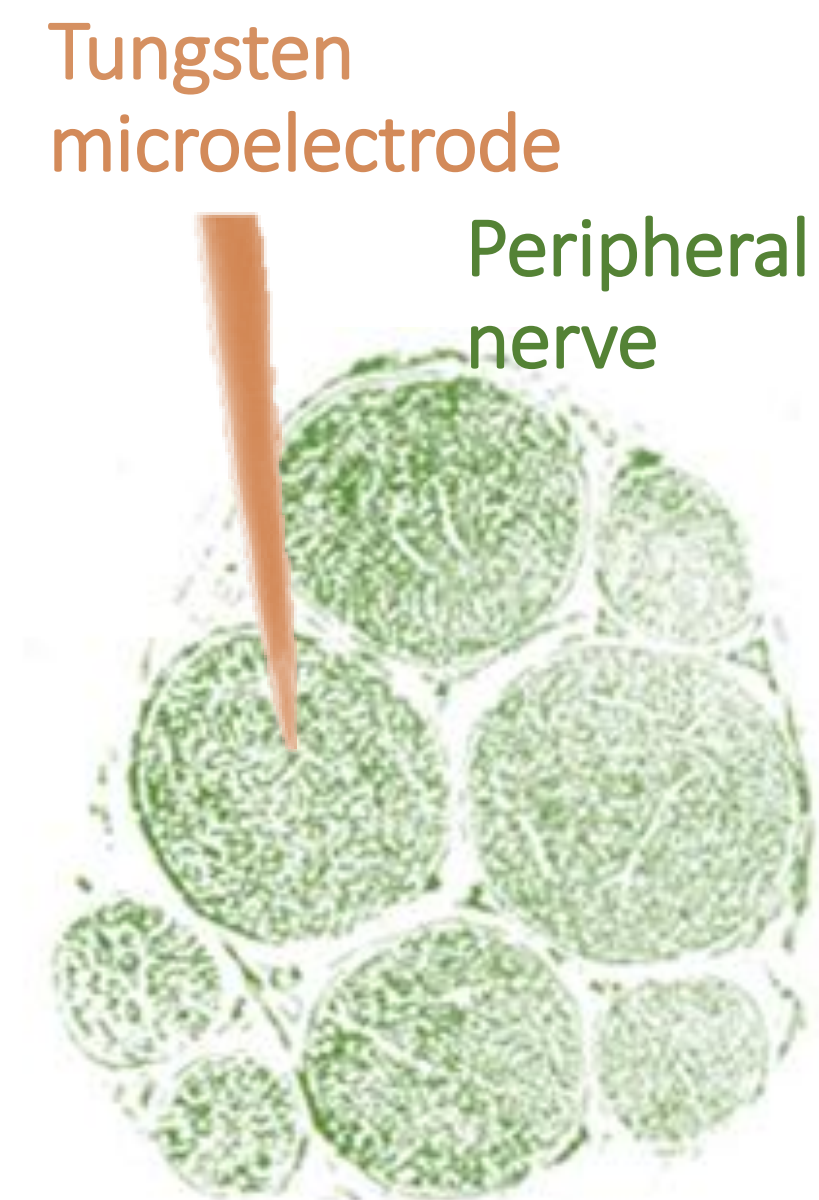
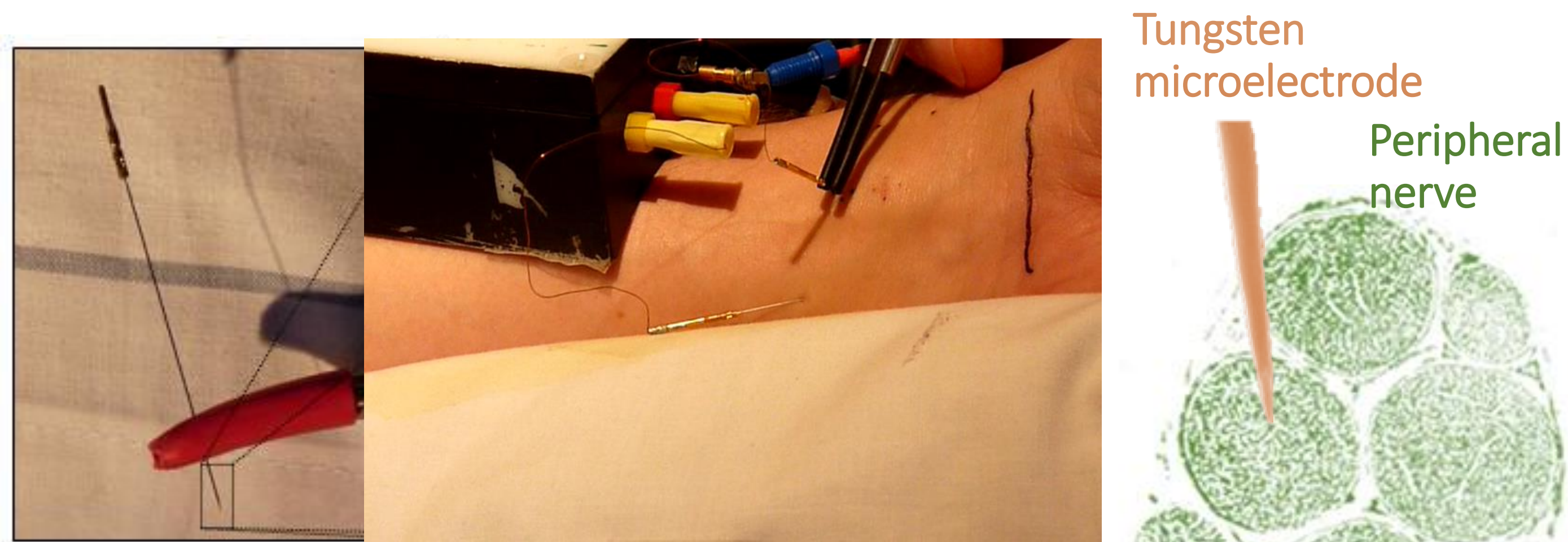


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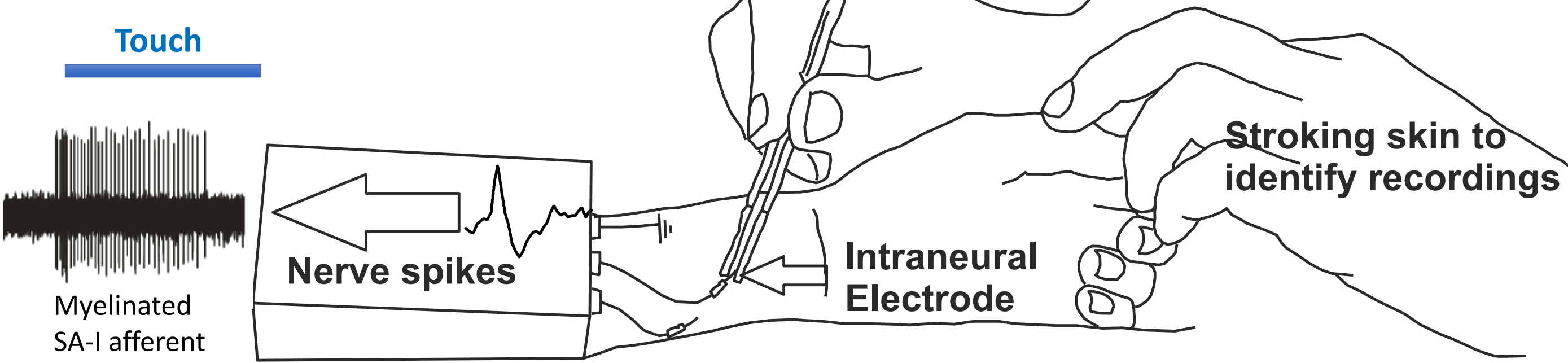
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Microneurography



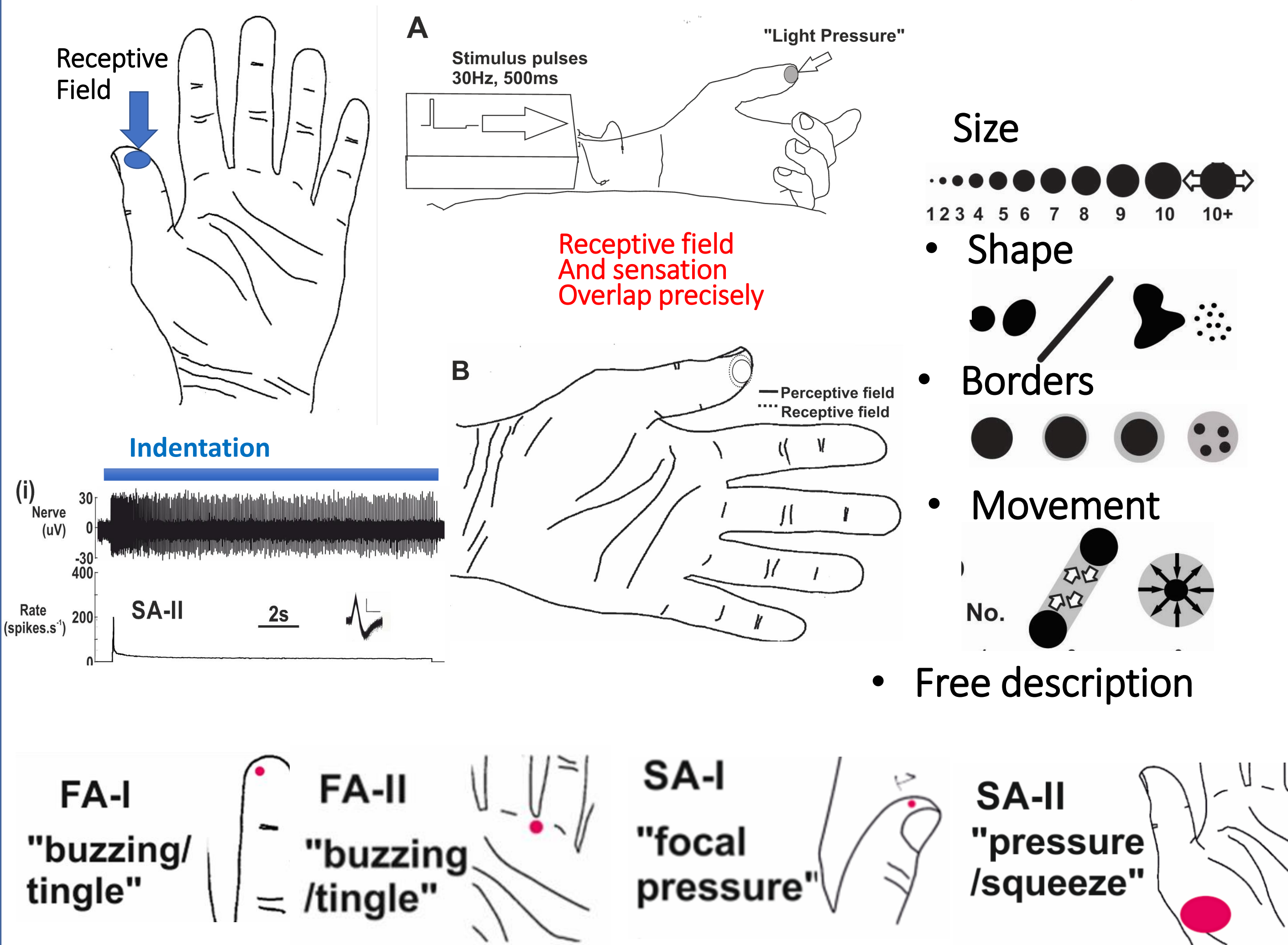
- Afferents identified & classified by responses to stroking/pressure/tapping/ blowing



Intraneural implantation of tungsten microelectrodes allows us to record & characterize individual mechanoreceptive afferents in human subjects

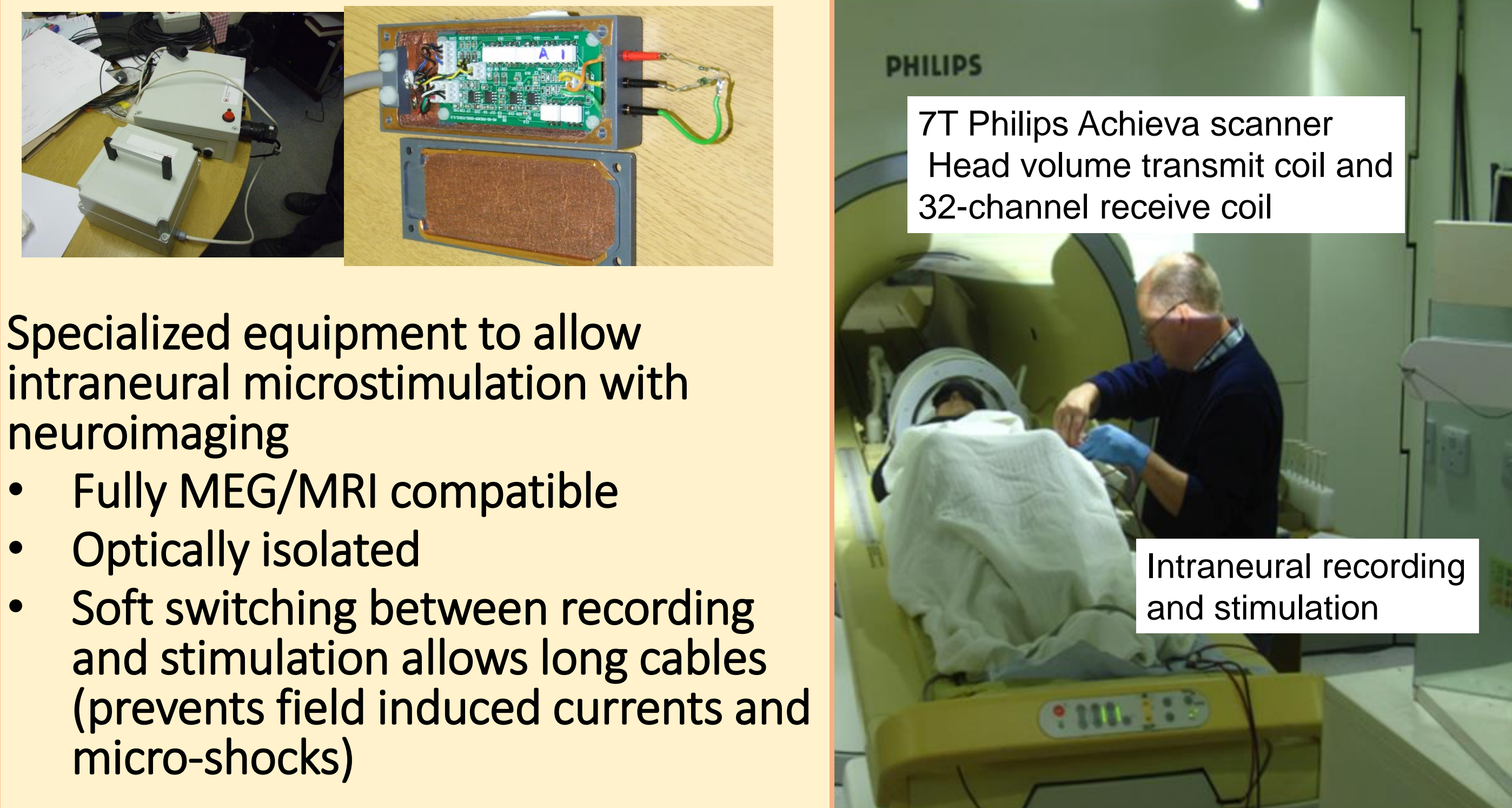
Intraneural microstimulation

Characterize afferent → Intraneural STIM (<10uA) Until subject reports sensations → Sensation descriptors



INMS can be used to stimulate individual afferent neurons, and evokes distinctive sensations for each afferent type

7T fMRI



Specialized equipment to allow intraneural microstimulation with neuroimaging

- Fully MEG/MRI compatible
- Optically isolated
- Soft switching between recording and stimulation allows long cables (prevents field induced currents and micro-shocks)

Imaging sequence

gradient-echo, echo-planar imaging sequence (TE = 25 ms, TR = 2 s,

Protocols

Intraneural stimulation

8 x 60Hz trains (500ms on, 500ms off)
23s inter stimulus intervals

Vibrotactile stimulation

Amplitude and location matched 60Hz piezo actuator stimulation

Analysis

fMRI data were analyzed using a general linear model (GLM) in FSL FEAT.

1.25mm voxels each fitted to canonical hemodynamic response function (HRF)

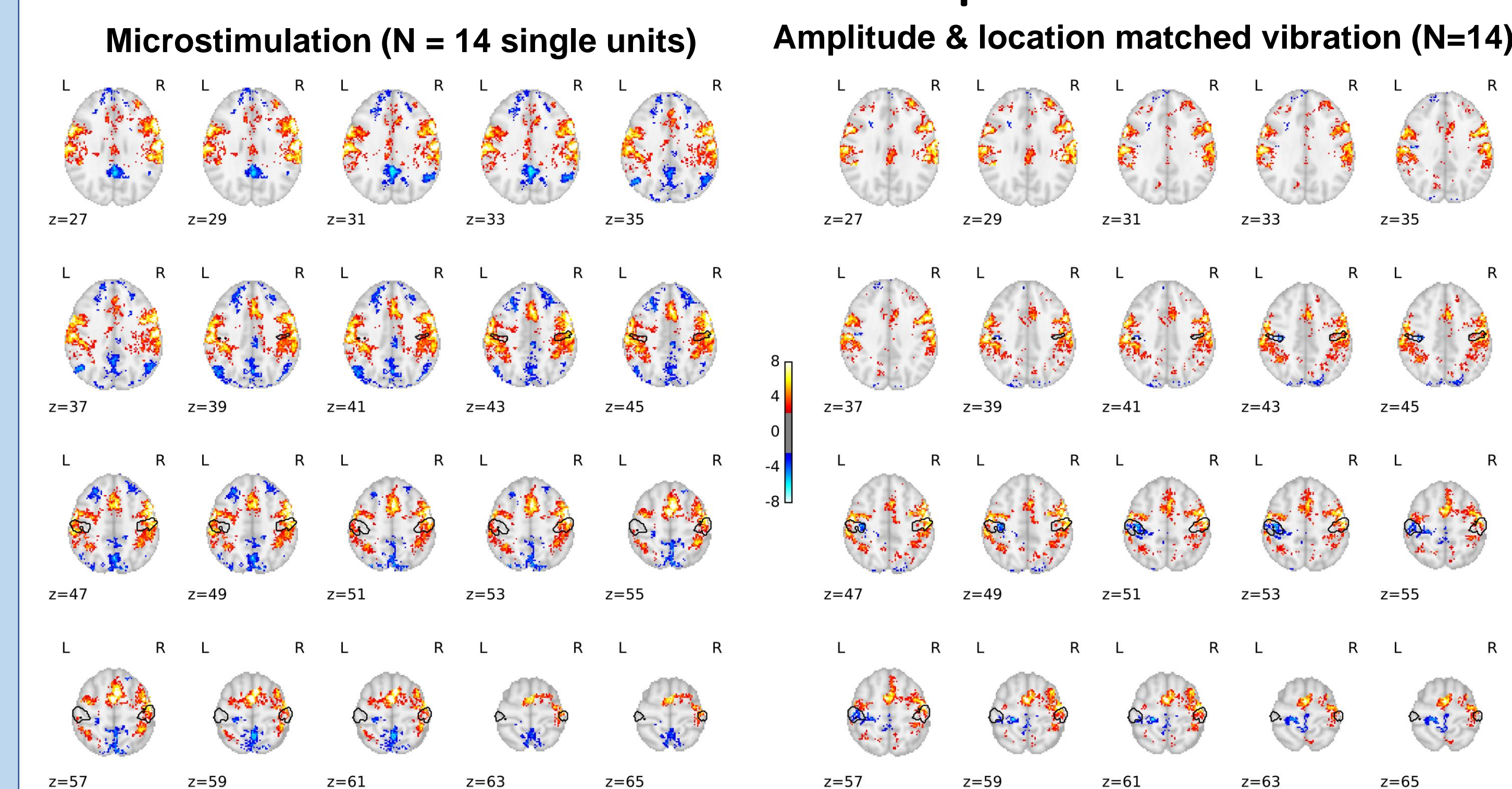
The fronto-parietal network (FPN) and the default mode network (DMN) ROIs were obtained from Smith et al.

Bilateral hand area in S1 area ROI determined from the digit probabilistic atlas and thresholding

contrast masking to reveal group patterns of activations/deactivations between intraneural stimulation and vibration

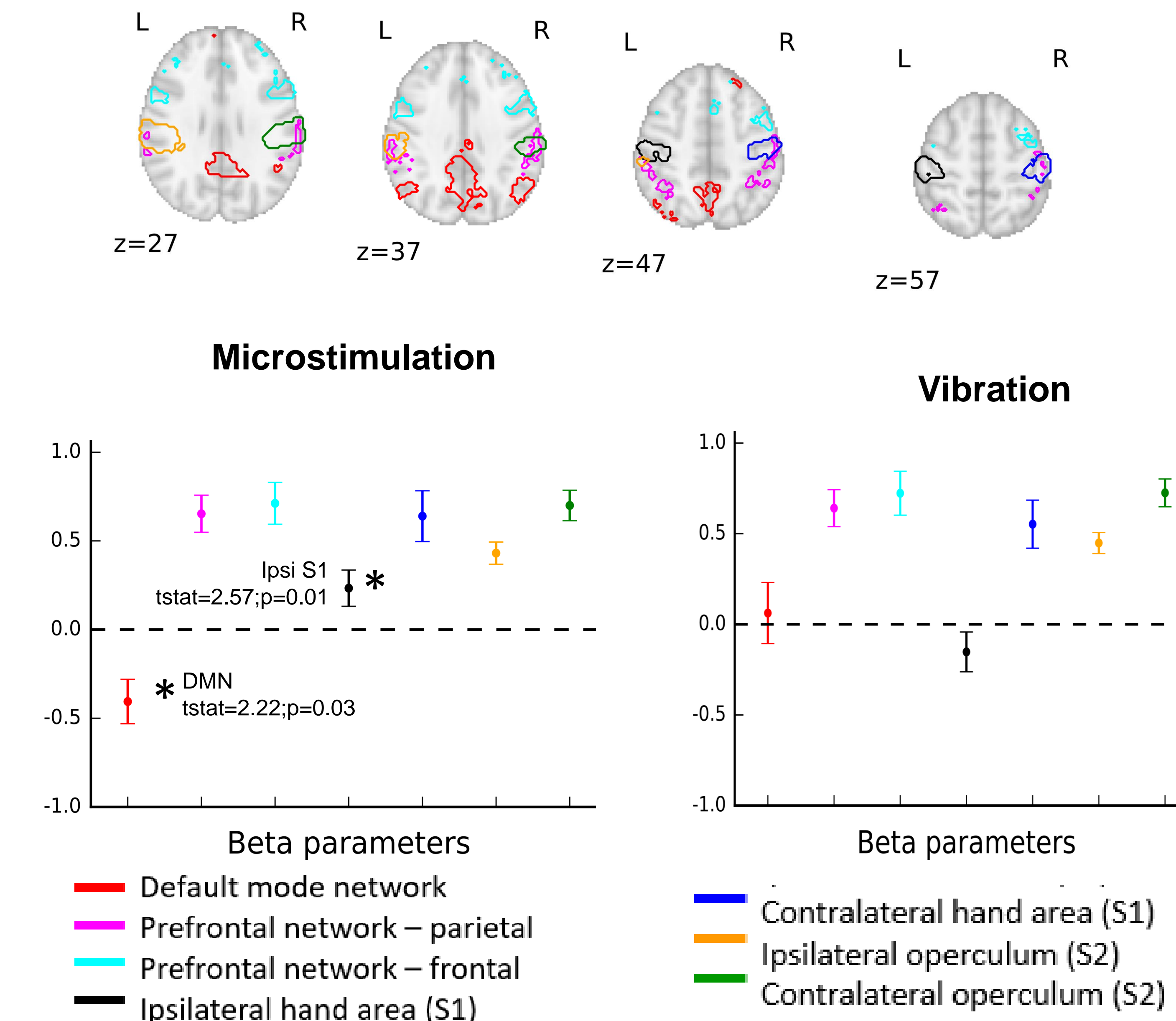
Results

Global bold responses



Widespread Positive & negative BOLD responses induced by vibration and intraneural microstimulation

Cortical network differences



Microstimulation > vibration

Default mode network deactivation

Vibration > Microstimulation

Ipsilateral S1 deactivation

Conclusions

- In addition to our previous studies of S1 activation → strong global brain responses to single neuron activation
- Comparison to matched vibration → down-regulation of default mode network, reflecting salience of single neuron activation
- Lack of ipsilateral S1 inhibition when using INMS
- lack of parallel processing?

Future steps

- Attentional control experiments, implicit task for subjects in microstimulation, not in vibration
- Mechanisms of the ipsilateral inhibition, attention or single neuron related?