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Neural activity during persistent sensations caused by intracortical microstimulation

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Introduction: Intracortical microstimulation (ICMS) in the somatosensory cortex (S1) can be used in closed-loop brain computer interfaces (BCIs) to provide artificial somatosensory feedback and can improve motor BCI performance [1]. When a tactile sensation is elicited using ICMS, it is expected to last exactly as long as the stimulation. However, on very rare occasions (41 cases in over 260,000 trials), some participants in our studies report sensations that outlast the stimulation period, typically by several seconds. The cause and underlying neurophysiological mechanisms of these persistent sensations are unknown.

Material, Methods and Results: Three people were implanted with microelectrode arrays in tactile regions of S1 as part of a clinical trial of an intracortical sensorimotor BCI (NCT01894802). The Neuroport System (Blackrock Neurotech) allowed us to simultaneously stimulate and record from these microelectrode arrays. Two participants reported percepts that outlasted stimulation at least once throughout their participation. In some of these cases, we observed a large amplitude signal resembling self-limiting after discharges [2] observed in electrical cortical mapping studies and that disappear spontaneously (Fig. 1A). Apart from the extended percept duration, the only other effects the participants reported were infrequent and slight changes in the quality of the sensation. The sensations remained localized to the location where stimulation initially evoked a percept. The neural activity during these events occurred across all channels on the array containing the stimulation electrode, with the maximum amplitude (1.58 ± 0.23 mV, Fig. 1B) centered on or near the stimulated electrode (see Fig. 1C). The activity did not occur on any other array in the motor cortex or S1, demonstrating highly localized activity. In all cases, the activity vanished within 20 seconds after stimulation ended (12 ± 4.3s).

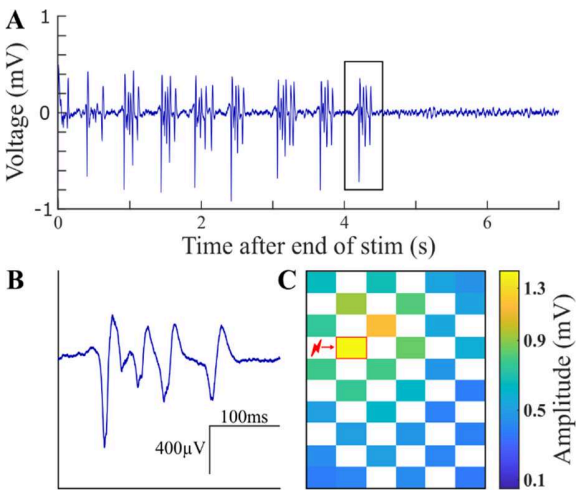

Figure 1: (A) Rhythmic neural activity during a persistent sensation. (B) Zoomed-in view of one burst. (C) Signal strength across the array.

Conclusion: These results indicate that in some study participants large amplitude rhythmic neural activity can occur in S1 after ICMS, and that this activity is sometimes associated with sensory percepts. This activity is spatially and temporally self-limiting. Whether this also occurs spontaneously is unknown. Apart from these infrequent persistent sensations, ICMS has not been associated with any significant clinical findings regardless of whether synchronous neural activity is observed or not. As this rhythmic neural activity is often associated with persistent sensations, which are undesirable, this activity may allow us to more rapidly identify and avoid these stimulus parameters.

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