Neural mechanism of activity spread in the cat motor cortex and its relation to the intrinsic connectivity - DTU Orbit (24/12/2018)

**Neural mechanism of activity spread in the cat motor cortex and its relation to the intrinsic connectivity**

**NON TECHNICAL SUMMARY**: The motor cortex (MCx) is an important brain region that initiates and controls voluntary movements. Neurons in MCx are anatomically connected by recurrent (feedback) networks. This connectivity pattern allows neurons to communicate reciprocally with each other potentially over distances of 6–7 mm. However, how far such neural activity is actually communicated was not known. We found that the activity of a small cortical point, about 0.4 mm in radius, activates a surrounding territory of approximately 7.22 mm² in area. This is smaller than the area covered by the anatomical connections, indicating the existence of mechanisms that limit the spread of activity. Nonetheless, such an area contains the representations of a variety of muscles spanning several joints, from digits to shoulder. These results support the hypothesis that the MCx controls the forelimb musculature in small synergistic groups, rather than singly and separately. Understanding motor cortical physiology is important for the design of neuro-prosthesis to interface the brain to paralyzed muscles. **ABSTRACT**: Motor cortical points are linked by intrinsic horizontal connections having a recurrent network topology. However, it is not known whether neural activity can propagate over the area covered by these intrinsic connections and whether there are spatial anisotropies of synaptic strength, as opposed to synaptic density. Moreover, the mechanisms by which activity spreads have yet to be determined. To address these issues, an 8 x 8 microelectrode array was inserted in the forelimb area of the cat motor cortex (MCx). The centre of the array had a laser etched hole ~500 (μm) in diameter. A microiontophoretic pipette, with a tip diameter of 2–3 (μm), containing bicuculline methiodide (BIC) was inserted in the hole and driven to a depth of 1200–1400 (μm) from the cortical surface. BIC was ejected for ~2 min from the tip of the micropipette with positive direct current ranging between 20 and 40 nA in different experiments. This produced spontaneous nearly periodic bursts (0.2–1.0 Hz) of multi-unit activity in a radius of about 400 (μm) from the tip of the micropipette. The bursts of neural activity spread at a velocity of 0.11–0.24 m s⁻¹ (mean = 0.14 mm ms⁻¹, SD = 0.05) with decreasing amplitude. The area activated was on average 7.22 mm² (SD = 0.91 mm²), or ~92% of the area covered by the recording array. The mode of propagation was determined to occur by progressive recruitment of cortical territory, driven by a central locus of activity of some 400 (μm) in radius. Thus, activity did not propagate as a wave. Transection of the connections between the thalamus and MCx did not significantly alter the propagation velocity or the size of the recruited area, demonstrating that the bursts spread along the routes of intrinsic cortical connectivity. These experiments demonstrate that neural activity initiated within a small motor cortical locus (∼400 (μm) in radius) can recruit a relatively large neighbourhood in which a variety of muscles acting at several forelimb joints are represented. These results support the hypothesis that the MCx controls the forelimb musculature in an integrated and anticipatory manner based on a recurrent network topology.

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