Voluntary Movement II.
Cortical representation of movements and parameters.
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1. Primary motor cortex: how are movement parameters coded
   - Distal movements
   - CM neurons.  
   - Population coding.

2. Premotor areas higher order features of movement
   - Supplementary motor area: Sequences
   - Lateral dorsal premotor area: sensorimotor transformations
   - Lateral ventral premotor area: grasping

3. Experience modifies representations

Corticospinal neurons (PTN) code direction and force

Target muscles can be identified by “spike triggered averaging”
CM neurons: divergence

CM neurons to distal muscles have small “muscle fields” (1-4 muscles)
CM neurons to proximal muscles have large (6+) “muscle fields”

Single corticospinal axons diverge to terminate in several motor nuclei

CM neurons code for force exerted
CM neurons are preferentially recruited for tasks requiring topographical precision.

Neurons in proximal motor cortex regions are broadly tuned for direction.

Primary motor cortex receives direct input from 5 premotor areas. These premotor areas also project to the spinal cord.

Section of pyramidal tracts in monkeys produces loss of independent “individuated” digit control.

Movement direction can be coded precisely by the population responses of broadly tuned neurons.

“Self initiated” voluntary movement are preceded by premotor activation: early evidence from evoked potentials.
Mental rehearsal of finger sequence

Motor cortex
Sensory cortex
Repetitive simple finger flexion
Repeating sequence finger-thumb apposition

Primary motor cortex Lateral premotor area Supplementary motor area

First neuroimaging data

Supplementary motor area neurons code movements in specific context of movement sequence.
Cell fires with pull followed by turn but not followed by pull
Cell fires with turn followed by pull and push but not just with pull

Activation of motor areas depend different on behavioral context

Separate pathways convey visual inputs to premotor areas for reaching and grasping

Instruction: Left
Instruction: Right
LED= trigger signal
Panel= instruction signal

Instructed delay task: coding of “preparatory set” for directed reach by dorso-lateral premotor neurons

Neurons in ventral premotor area (PMv) code for hand configuration of grasp
“Mirror neurons” in PMv represent types of movement independent of its actualization: motor vocabulary. Practice and learning of finger sequence can alter motor representations in primary motor cortex.

Damage to local region of motor cortex induces change in representation of nearby areas.

Motor practice can alter functionality and motor mapping in motor cortex.