tactile sensation (a.k.a., touch sense or mechanoreception)

the weekly principle: ‘topographic representation’
Topographic representation:

In many cases, neurons in the brain are anatomically (i.e., spatially) arranged in a systematic fashion such that those responding to (or ‘representing’) similar features of a single sensory modality (e.g., vision or audition) are grouped into the same space in the brain. An important feature of such groupings is the interconnectivity of its members. Multiple such groups are, in turn, organized in a systematic fashion.

Sensory inputs that are topographically represented in the space of the brain may reflect actual space, as in the space of the retina or skin surface, or may reflect stimulus space as, for example, type of odor or sound frequency.

Related concepts: surround inhibition, the cortical column, the homunculus
1 barrel = 1 whisker

topographic representation
proprioception and touch sense: the ‘all-axon’ ganglion cell

**Ganglion cell types: breakdown by conduction speed**

Aα – proprioception – myelinated, very fast (70-120 m/s)

Aβ – mechanoreception – myelinated, pretty fast (40-70 m/s)

Aδ – thermoreception, nociception, hair cell – myelinated, fast (12-36 m/s)

C – nociception – unmyelinated, slow (0.5-2 m/s)
Touch receptors in skin

- Hair receptor
- Pacinian corpuscle
- Meissner's corpuscle
- Merkel disk receptor
- Bare nerve ending
- Epidermal-dermal junction
- Ruffini ending
- Peripheral nerve bundle
- Hairy skin
- Glabrous skin
- Epidermis
- Dermis
Meissner’s corpuscle

Pacinian corpuscle
excitatory response = more AP’s
inhibitory response = fewer AP’s
excitatory response = no change in AP rate

small versus large response fields
inhibitory surround complete vs. incomplete
whole versus patchy
Sustained versus transient responses

slowly-adapting
(= sustained)

rapidly-adapting
(= transient)

stimulus

Merkel disks,

Meissner corpuscles,
Pacinian corpuscles
<table>
<thead>
<tr>
<th>type</th>
<th>RA / SA</th>
<th>depth</th>
<th>response field</th>
<th>sensitivity</th>
<th>info. processed/best stimulus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pacinian</td>
<td>RA</td>
<td>deep</td>
<td>very large (hand)</td>
<td>very high (10 nm)</td>
<td>high-freq. vibration</td>
</tr>
<tr>
<td>Meissner</td>
<td>RA</td>
<td>shallow</td>
<td>3-5 mm</td>
<td></td>
<td>slip / low-freq. vibration</td>
</tr>
<tr>
<td>Merkl</td>
<td>SA</td>
<td>shallow</td>
<td>spotty 2-3 mm (0.5 mm)</td>
<td>broad depth range</td>
<td>form, texture / points, edges</td>
</tr>
<tr>
<td>SA2</td>
<td>SA</td>
<td>deep</td>
<td>12-25 mm</td>
<td></td>
<td>hand shape / stretch</td>
</tr>
<tr>
<td>hair</td>
<td>RA</td>
<td>deep</td>
<td>10 mm</td>
<td>1 micron</td>
<td>hair displacement</td>
</tr>
</tbody>
</table>
two-point discrimination = Merkl disk density
small Merkl disk receptive field = fine texture discrimination (e.g., Braille)
Pacinian corpuscles = frequency-dependent sensitivity to vibration
Meissner’s corpuscles = low-frequency vibration sensitivity
sensitivity to slip = grip control
dorsal root ganglion pathways to the brain
Somatosensory cortex

- primary somatosensory cortex (SI): postcentral gyrus + posterior bank of central sulcus
- contains 4 sub-regions: 3a, 3b, 1, 2
primary somatosensory cortex: within-region (column) processing

the cortical column

layer-specific inputs

slowly-adapting (= sustained)
rapidly-adapting (= transient)
stimulus

merging RA info. into SA info.?
dynamical into static?
Pacinian’s/Meissner’s into Merkl’s?
low-resolution into high-resolution?
S1: direction-selective surround inhibition
S2 – response fields expand across digits, but maintain directional selectivity