Texture invariance and its neural basis

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Kinematics of tactile texture exploration
Psychophysics setup
Roughness constancy

Roughness ratings are almost constant across speeds.
Stickiness constancy

Stickiness ratings are almost constant across speeds.
Hardness constancy

Hardness ratings are almost constant across speeds.
Texture constancy

How dissimilar two textures feel is mainly determined by the textures themselves, not the scanning speed.
How is texture represented in the nerve and how does this representation change with speed?
The spatial pattern of SA1 activation reflects coarse but not fine textural features.
Texture coding in the nerve

Fine textures evoked highly patterned and repeatable temporal spiking patterns.
The vibrations of texture
Texture coding in the nerve

PC spikes
vibrations
The big picture

Natural textures

Fingertip deformations

High-frequency skin oscillations

Spatial image in SA1 afferents

Spike patterns in RA and PC afferents

Unified percept
Textures do not simply reflect surface microgeometry
Texture invariance in the nerve

Temporal patterns dilate or contract with decreases and increases in scanning speed
Texture invariance in the periphery

Spiking patterns are invariant texture “signatures” if we know the scanning speed.
Speed perception depends on the texture

\[ R^2 = 0.33 \]
Is texture like timbre?

- Tuning fork
- Flute
- Voice
- Violin
Texture constancy in cortex
Conclusions

- Our perception of texture is constant across a wide range of scanning speeds and textural dimensions.
- The peripheral representation of texture changes with scanning.
- An invariant representation of texture can be achieved when scanning speed is taken into account.
- Our perception of scanning speed, however, is biased and imprecise.
- Texture might be akin to auditory timbre.
- Cortical neurons are invariant with respect to scanning speed.