

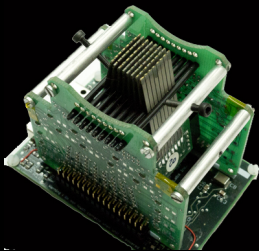
Tactile Illusions

Vincent Hayward



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05/09/2016

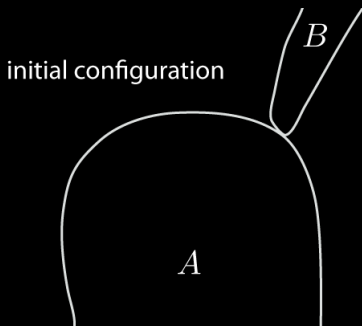




the 'plenhaptic' function

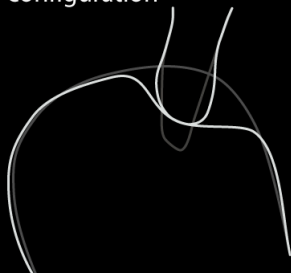
with vision, $p(l, v, \lambda, t)$ is in \mathbb{R}^7

Adelson E. H., Bergen J. R. '81. The 'plenoptic' function and the elements of early vision
with touch,



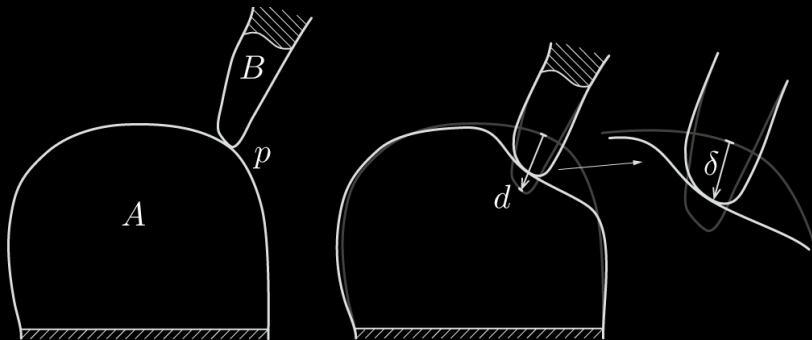
$$a = h_{A,B}(b)$$

new configuration



$$b = h_{B,A}(a)$$

simplifications



$$\delta = \bar{h}_{A,B}(p, d)$$

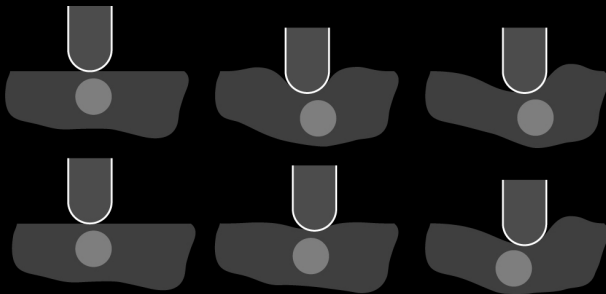
where $d(t) : \mathbb{R}^+ \mapsto \mathbb{R}^3 \times SO(3)$

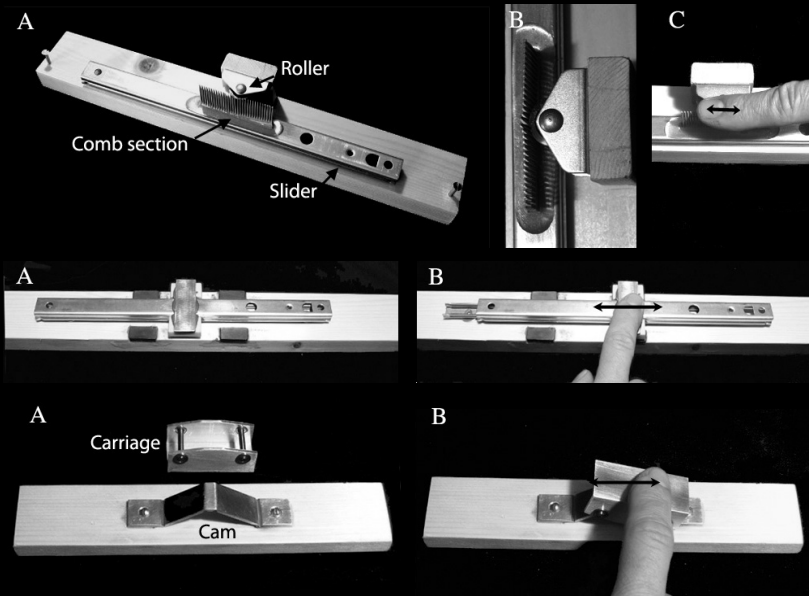
local deformation assumption

simplifications

- ▶ rigid objects and rigid probe: satisfy $0 \approx \bar{h}(p, d)$
- ▶ rigid objects et soft probe: find object, B , such that $0 = h(b)$
- ▶ soft objects et rigid probe: $\delta = h(p, d)$ or $h(p, d) = d - p$

- ▶ complexities:

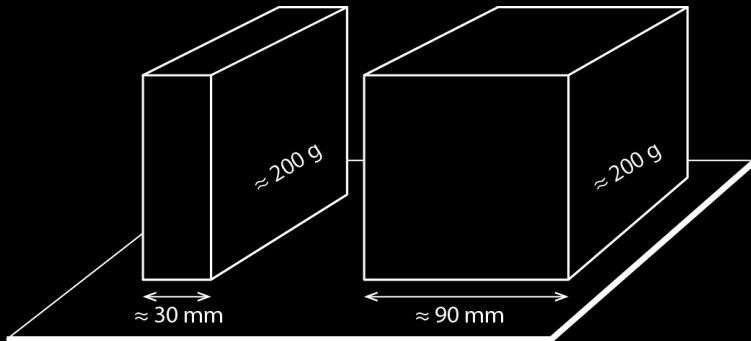




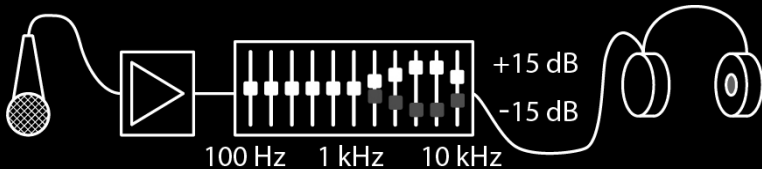
Charpentier A (1891)

Analyse expérimentale de quelques éléments de la sensation de poids.

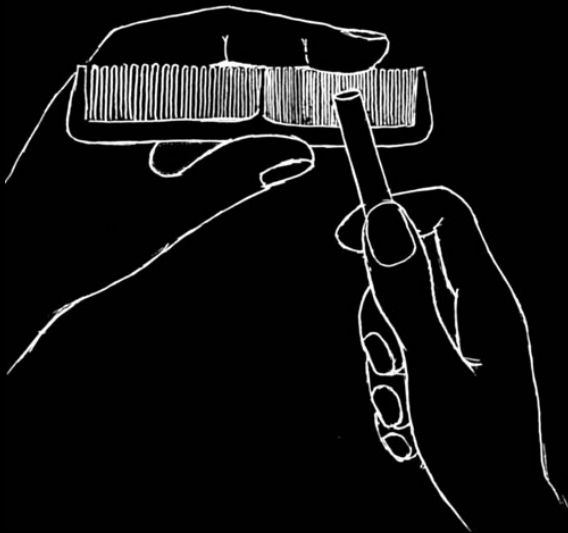
Arch Physiol Norm Pathol 3: 122–135



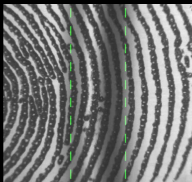
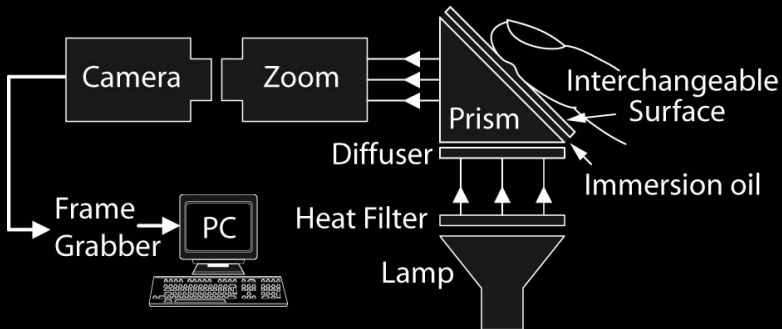
Jousmäki, V. and Hari, R. (1998).
Parchement-skin illusion: sound-biased touch.
Current Biology, 8(6):190-191.

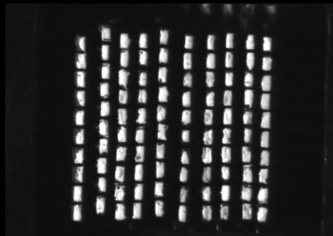
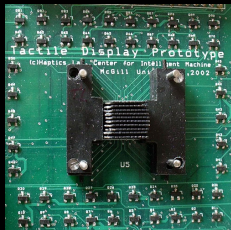


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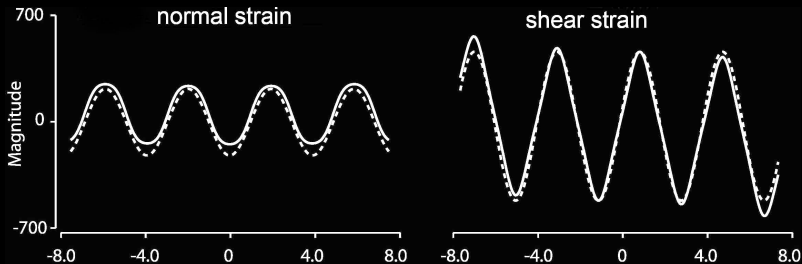
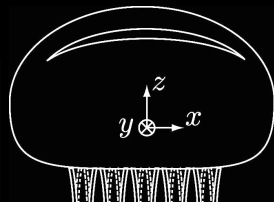
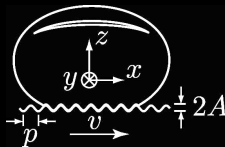
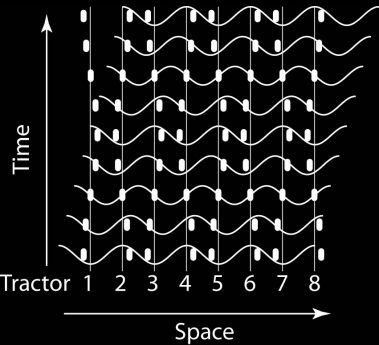


Hayward, V., Cruz-Hernandez, M. 2000. Tactile Display Device Using Distributed Lateral Skin Stretch. Proc. *Haptic Interfaces for Virtual Environments and Teleoperator Systems Symposium*, ASME Vol. DSC-69-2, pp. 1309-1314



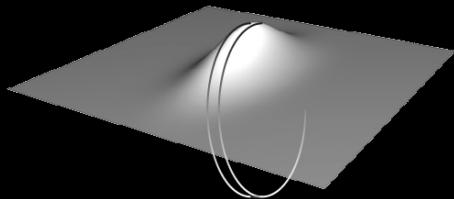


Pasquero, J., Hayward, V. 2003. STReSS: A Practical Tactile Display System with One Millimeter Spatial Resolution and 700 Hz Refresh Rate. Proc. *Eurohaptics* 2003. pp. 94-110

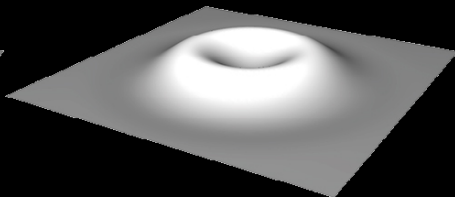
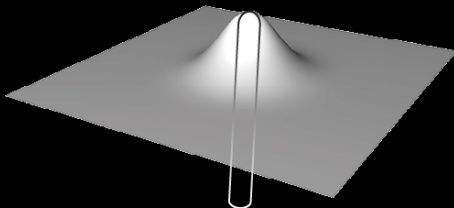
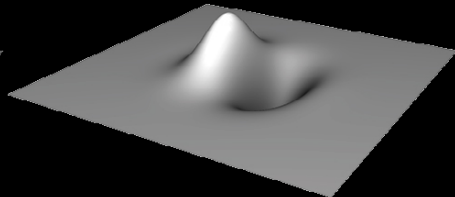


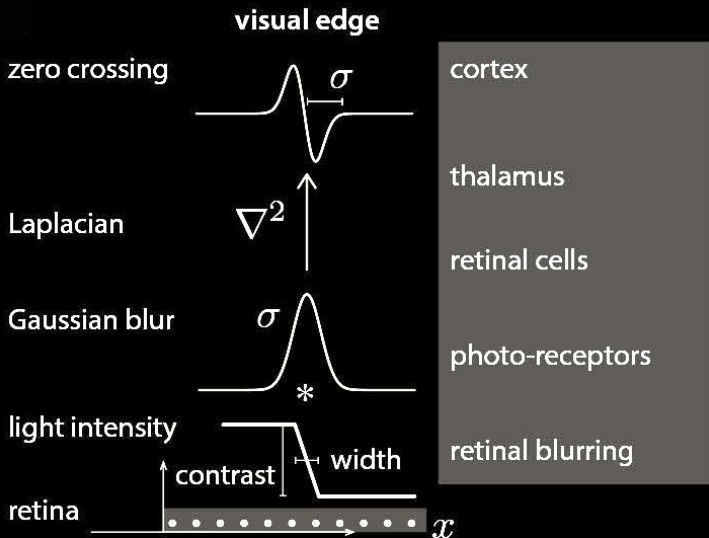
Wang, Q. and Hayward, V. 2008. Tactile Synthesis and Perceptual Inverse Problems Seen from the View Point of Contact Mechanics. *ACM Transactions on Applied Perception*, 5(2):1-19

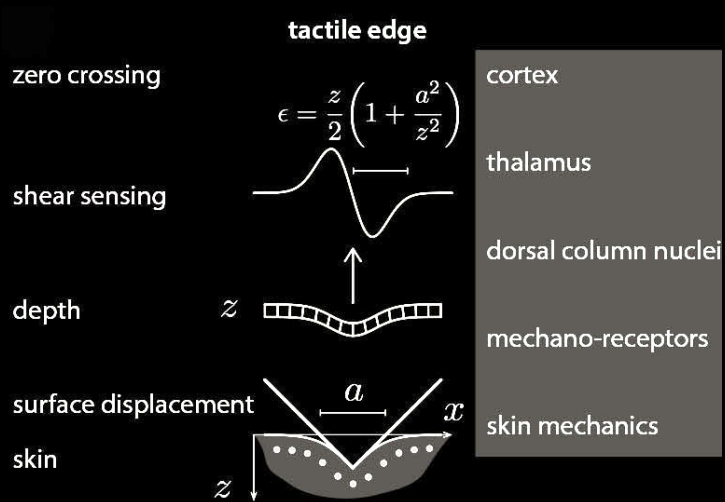
surface displacement



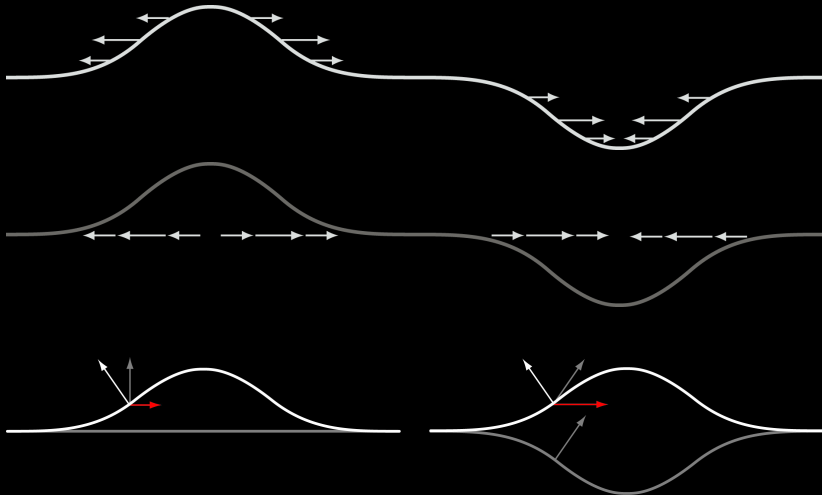
shear beneath the surface

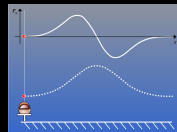
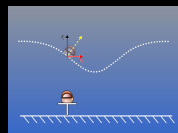
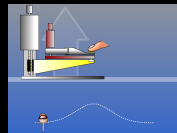
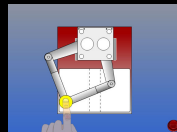
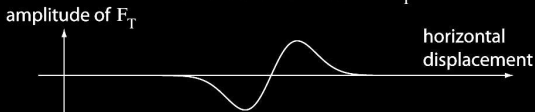
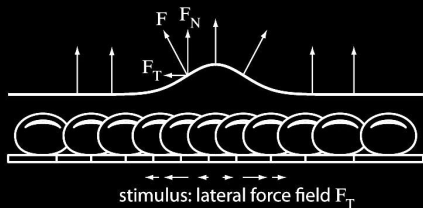
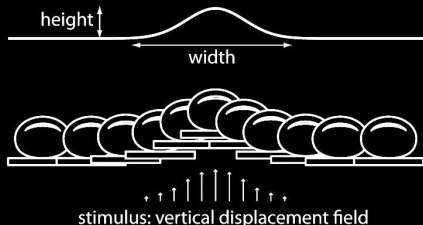




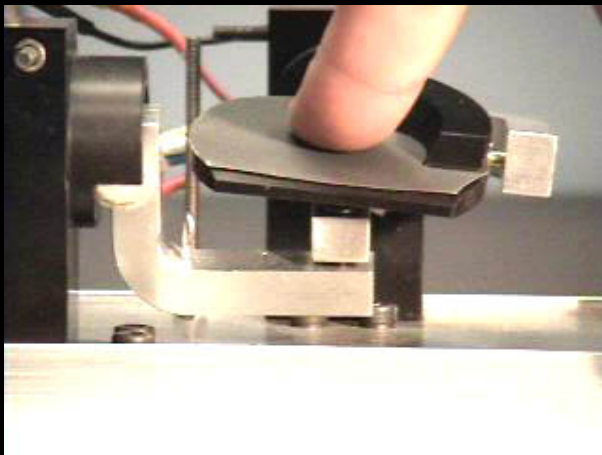


shear:
$$\gamma(x, z) \approx -\frac{3}{E} M_1(z) \partial_x [p(x) * \phi_\epsilon(x)]$$

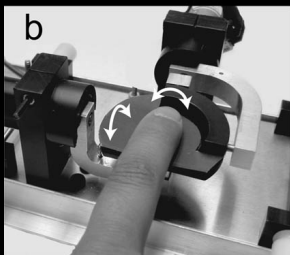
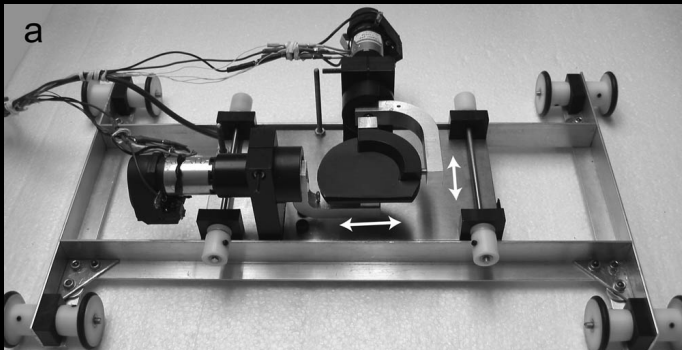


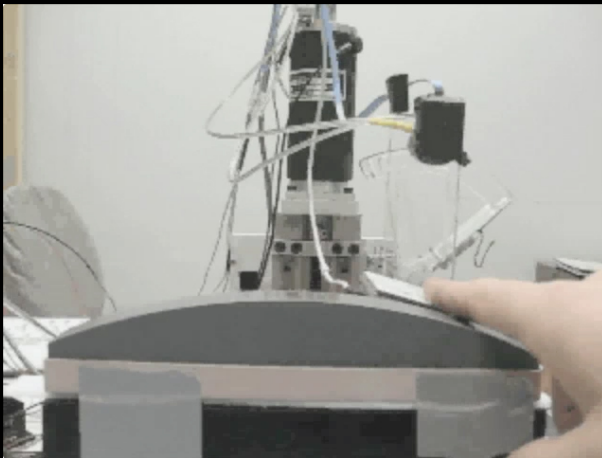


Smith, A. M., Chapman, C. E., Donati, F., Fortier-Poisson, P. and Hayward, V. 2009. Perception of simulated local shapes using active and passive touch. *Journal of Neurophysiology*, 102:3519–3529

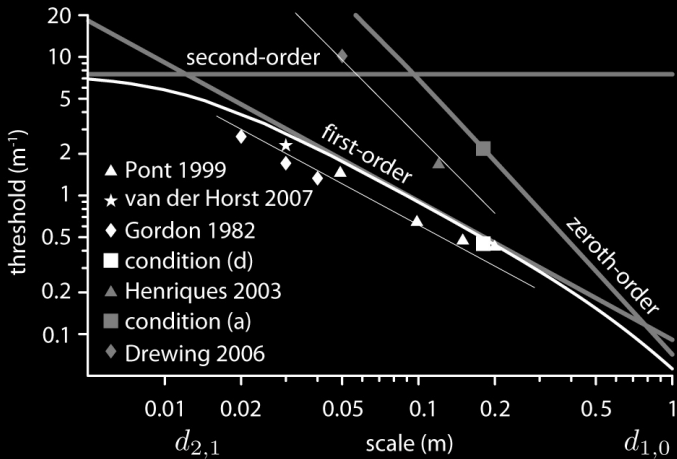


Dostmohamed, H., Hayward. V., 2005. Trajectory of Contact Region On the Fingerpad Gives the Illusion of Haptic Shape. *Experimental Brain Research*. 164:387-394.

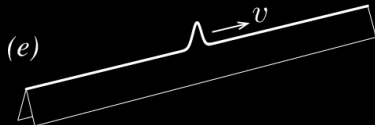
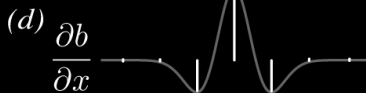
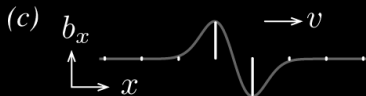
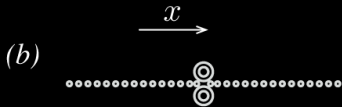
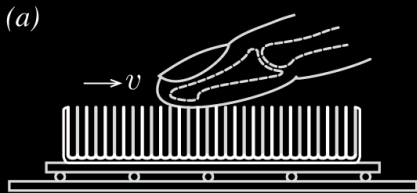




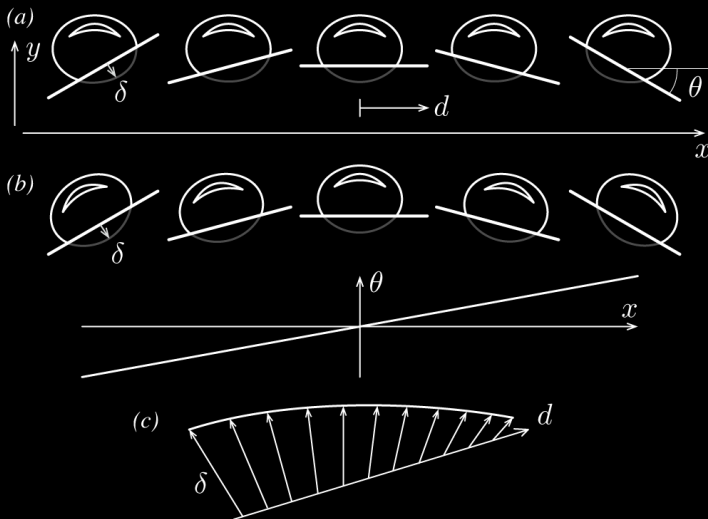
M. W. A. Wijntjes, A. Sato, V. Hayward, A. M. L. Kappers. 2008. Local Surface Orientation Dominates Haptic Curvature Discrimination, *IEEE Transactions on Haptics*, 2(2):94-102



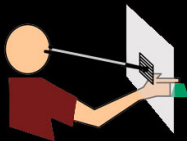
tactile illusions (gradients everywhere)



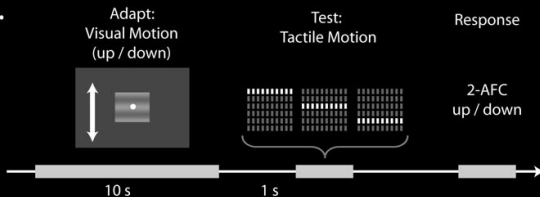
haptic illusions (gradients everywhere)



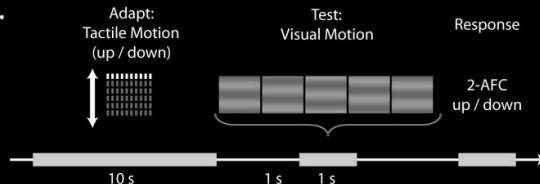
A.



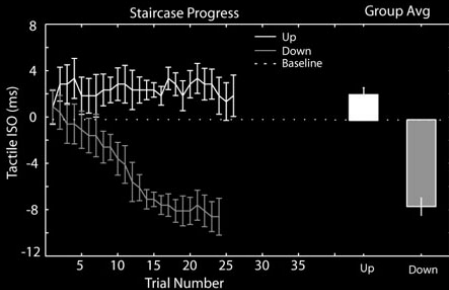
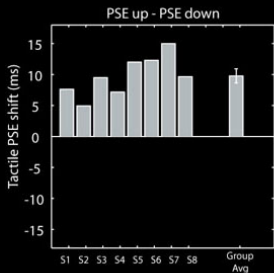
B.



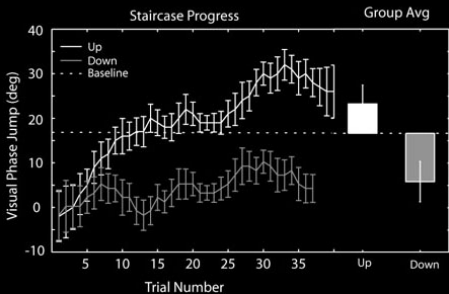
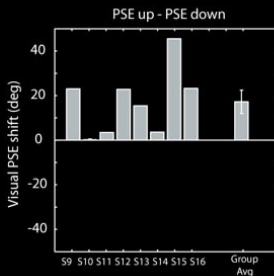
C.

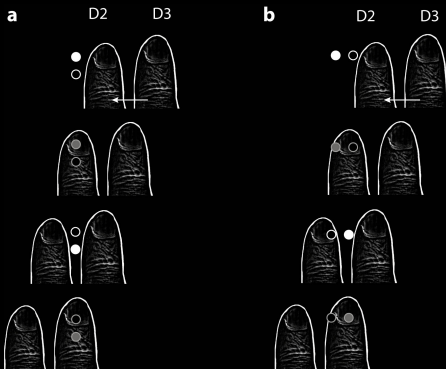
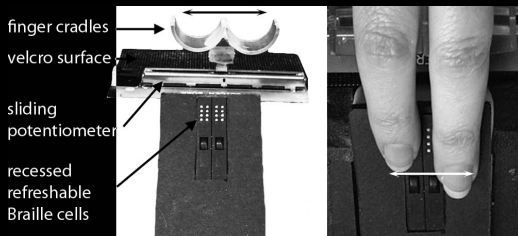


A. Vision to Touch

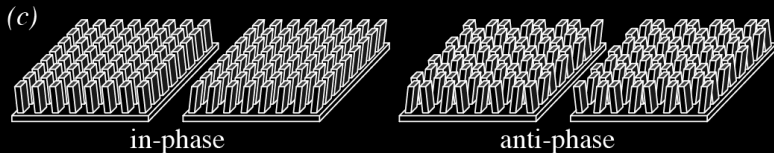
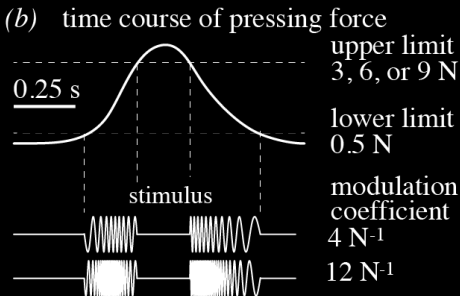
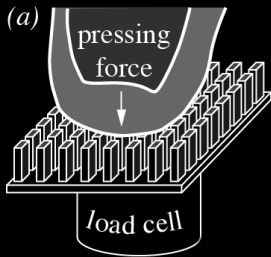


B. Touch to Vision



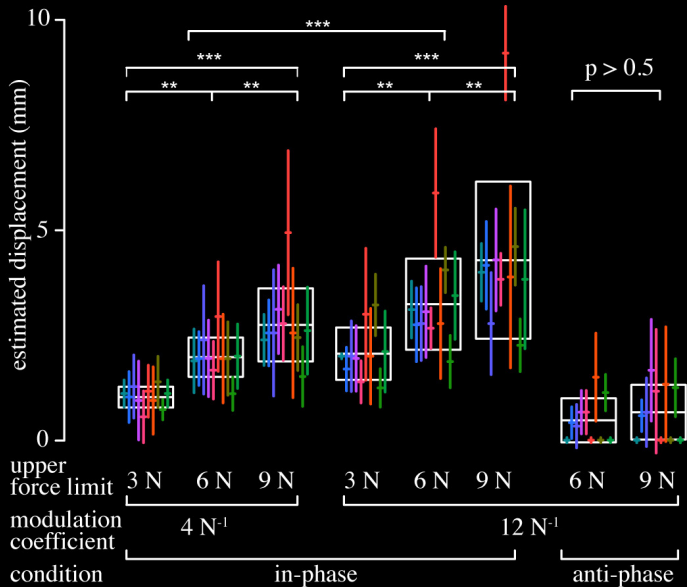


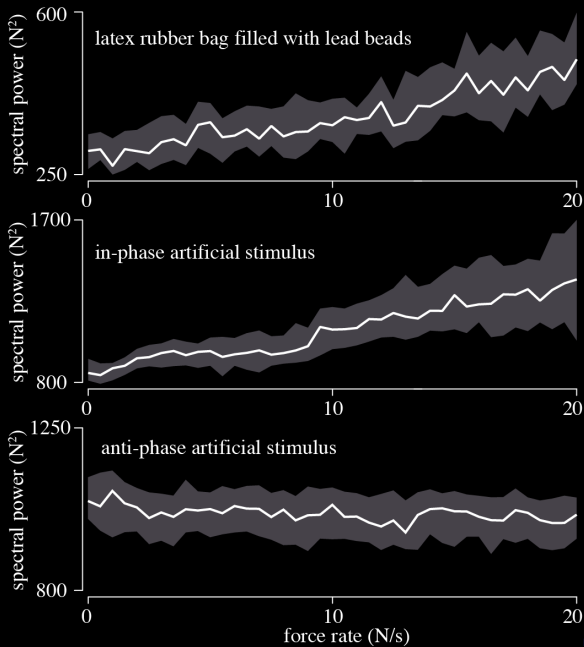
Ziat, M., Hayward, V., Chapman, C. E., Ernst, M. O. and Lenay, C. 2010.
Tactile Suppression of Displacement, *Experimental Brain Research*, 206(3):299–310.

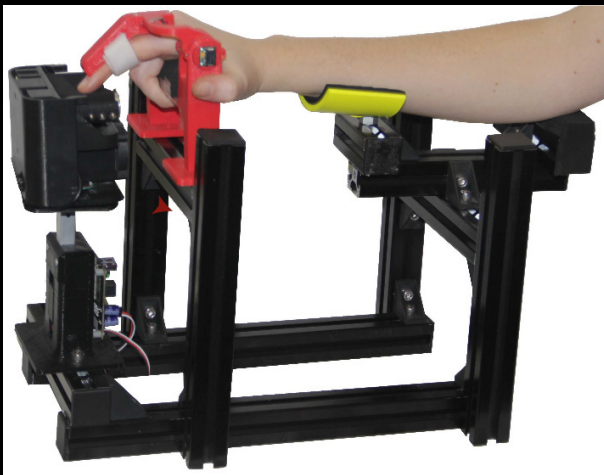


$$p_{ij}(t) = \begin{cases} A \sin(2\pi M F_N(t)), & \text{in-phase,} \\ (-1)^{i+j} A \sin(2\pi M F_N(t)), & \text{anti-phase,} \end{cases} \quad i, j \in \{0, \dots, 7\}.$$



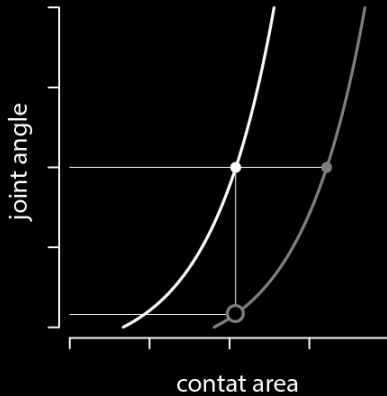
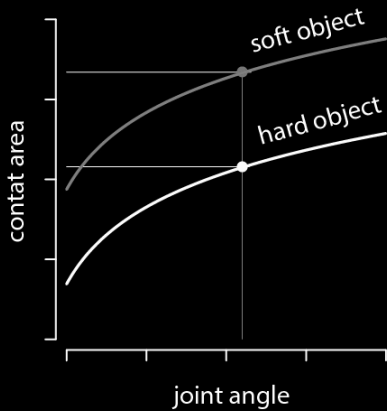


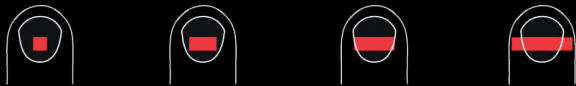




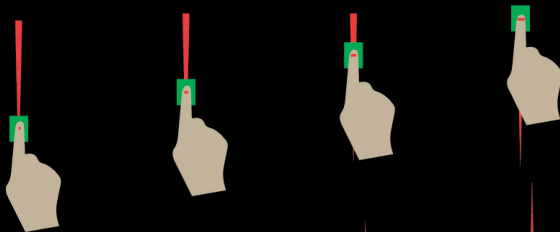
$$A = \varphi(\gamma, \alpha) \quad \hat{\gamma}_A = f(\hat{A}, \bar{\alpha}),$$

Moscatelli, A., Bianchi, M., Serio, A., Terekhov, A., Hayward, V., Ernst, M. O., Bicchi, A. 2016. The Change in Fingertip Contact Area as a Novel Proprioceptive Cue, *Current Biology*, 26(9):1159–1163.





SAME



DIFF

