



Les bases physiques du toucher et leurs effets sur la perception

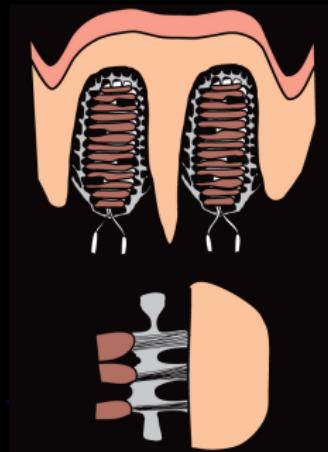
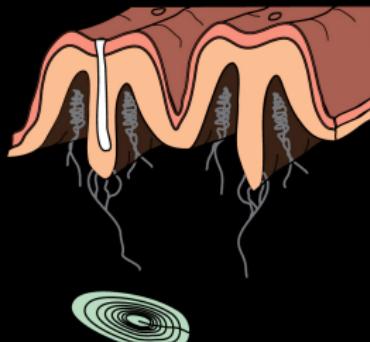
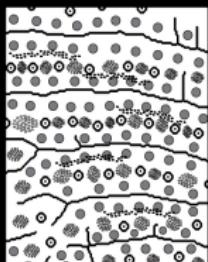
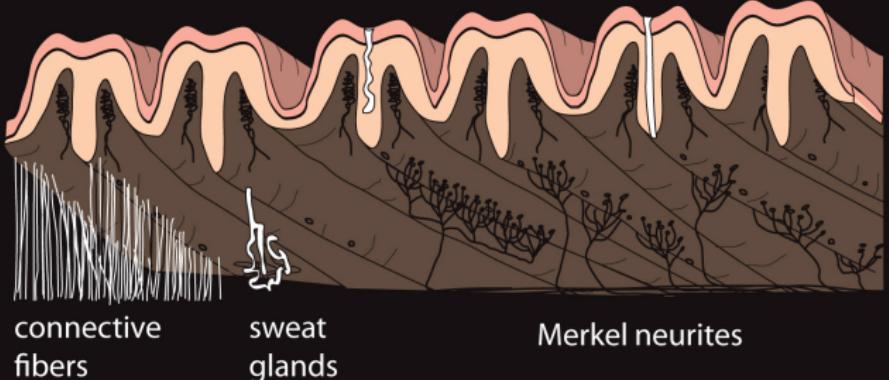
Vincent Hayward



Toucher pour apprendre,
toucher pour communiquer



Meissner's corpuscles

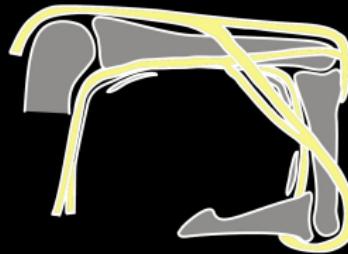




extension

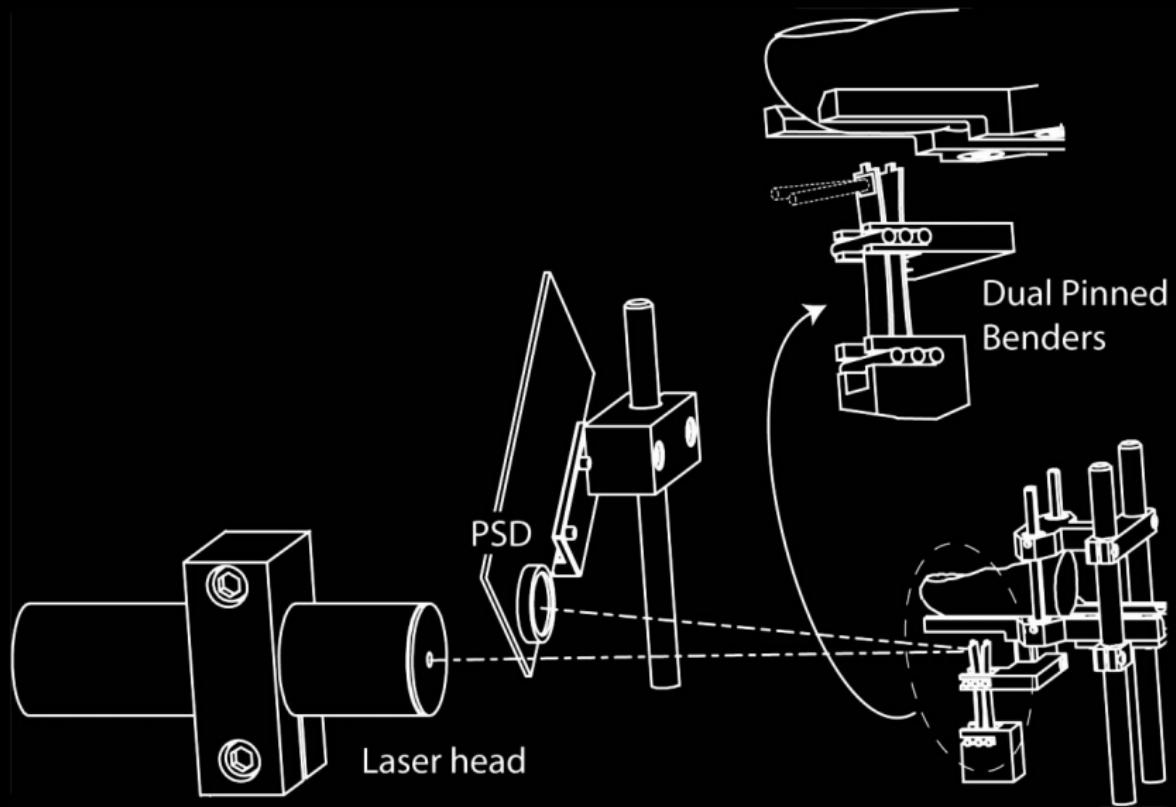


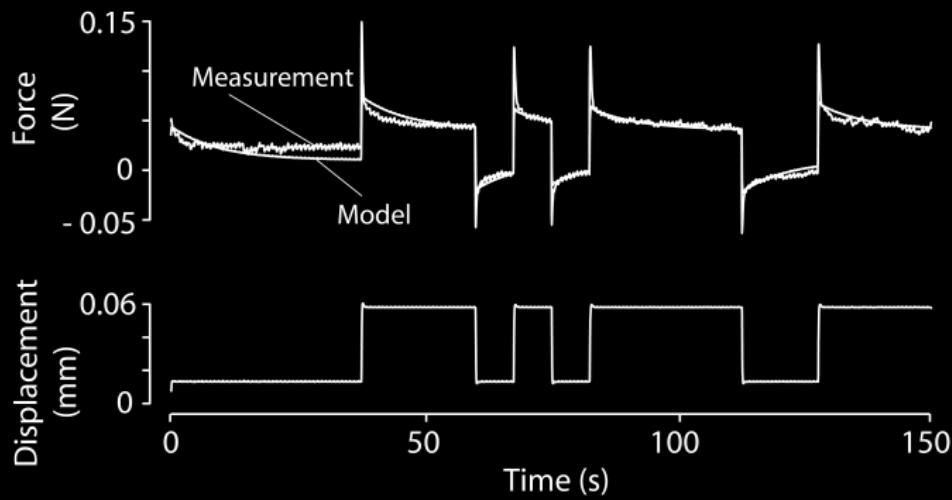
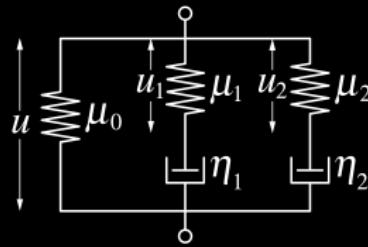
flexion

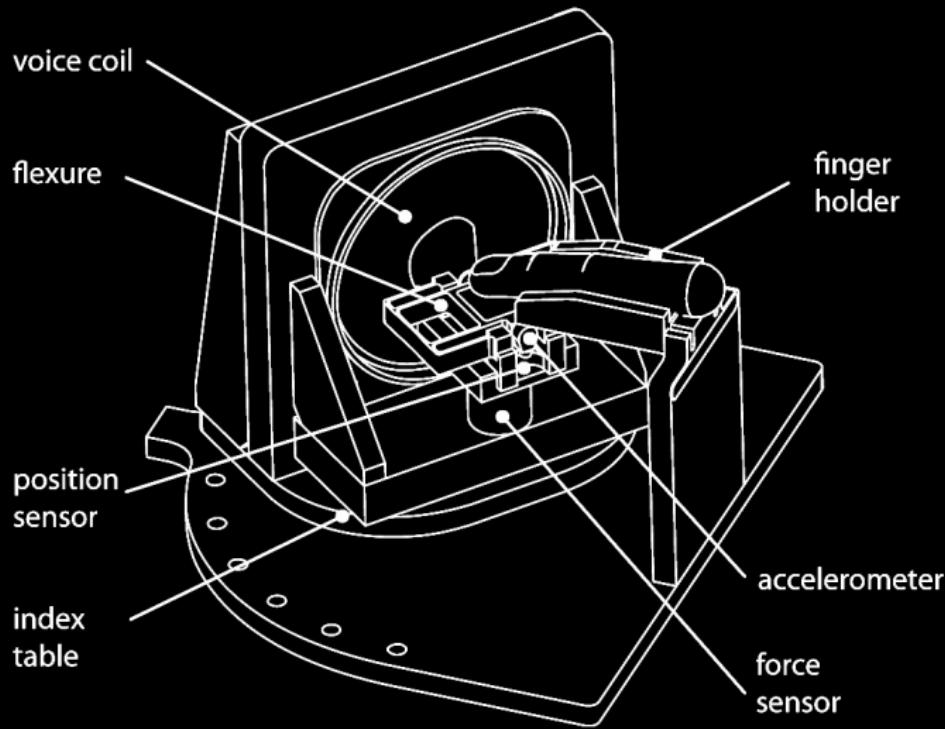




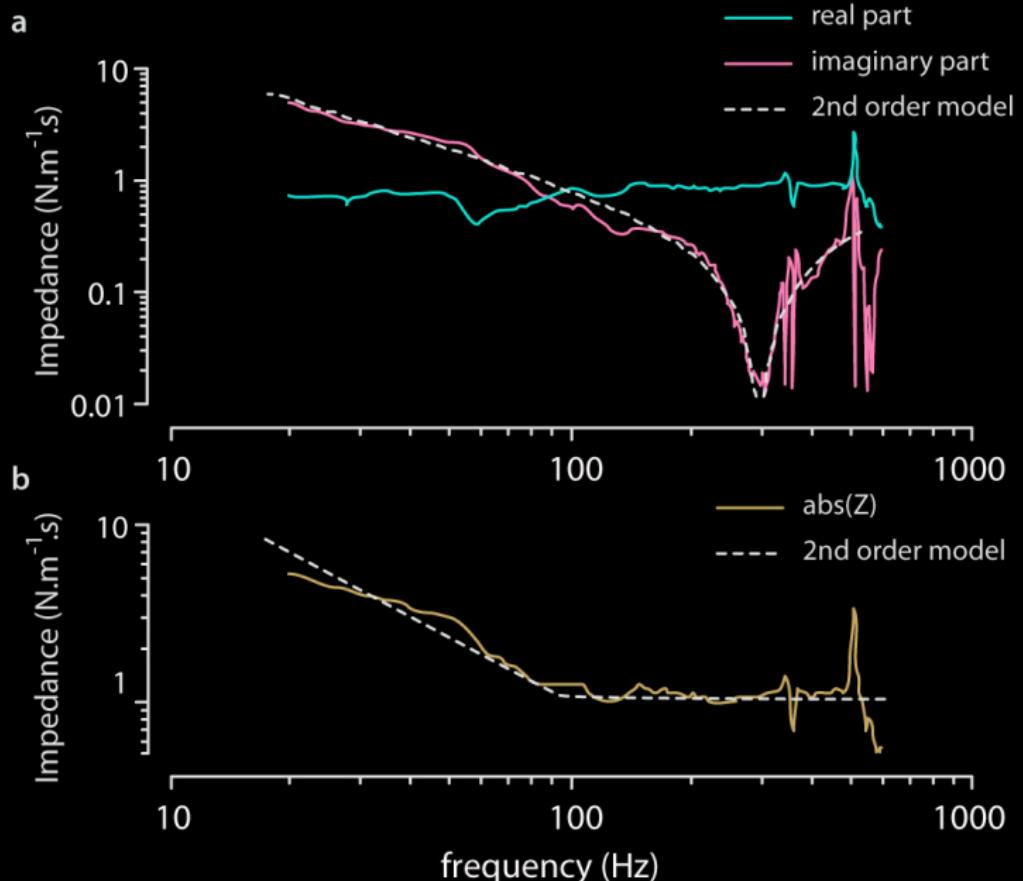
© Cyril Ruoso/Minden/Solent



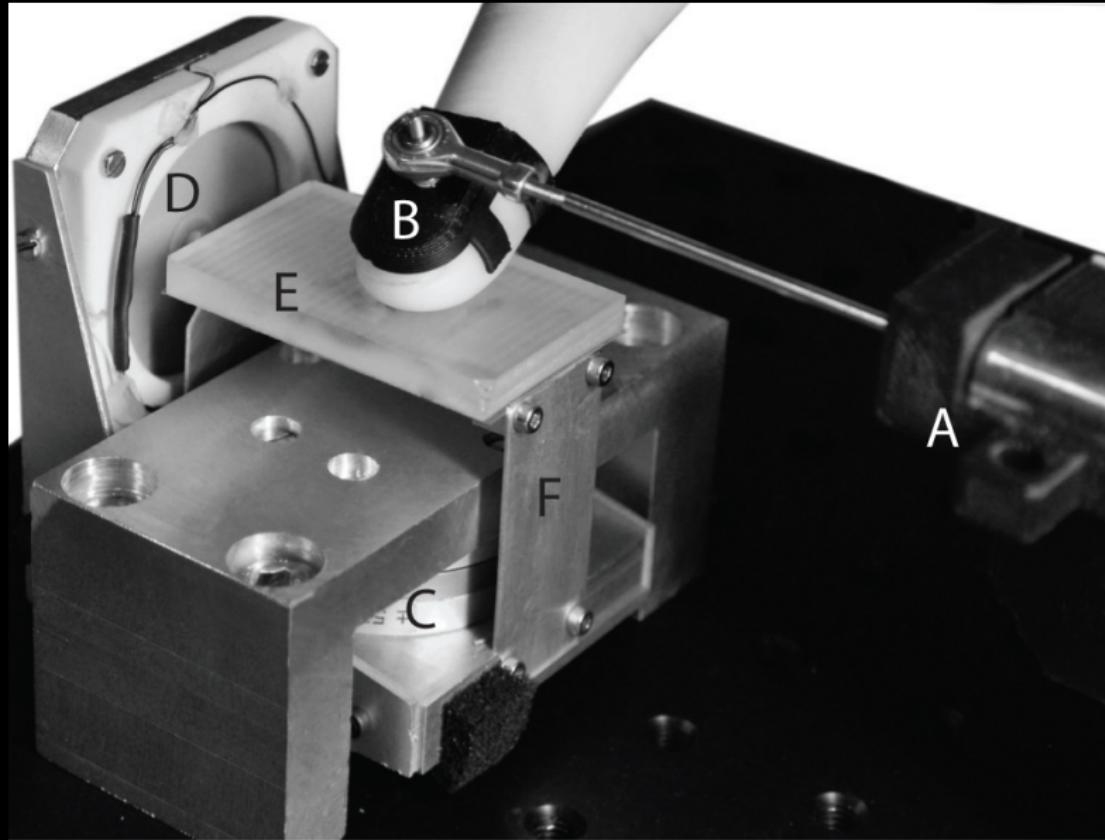




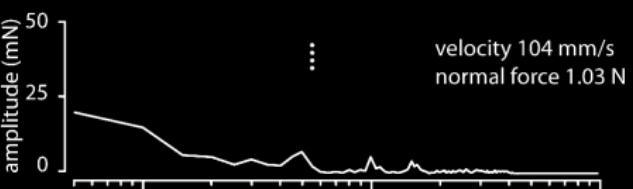
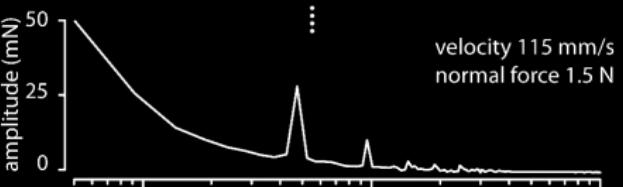
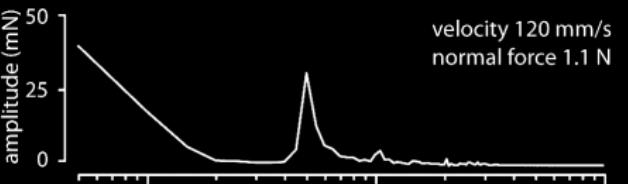
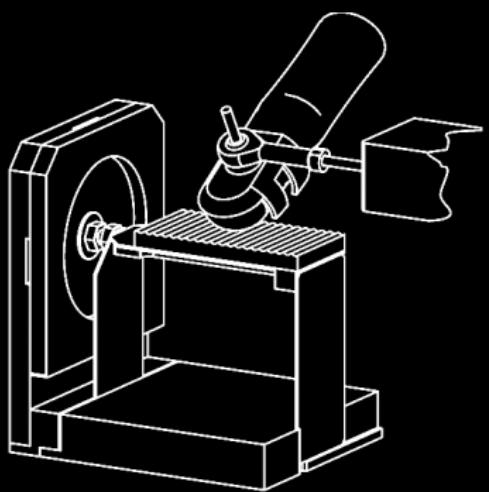
Wiertlewski, M., Hayward, V. 2012. Transducer For Mechanical Impedance Testing over a Wide Frequency Range Through Active Feedback. *Review of Scientific Instruments*. 83(2):025001



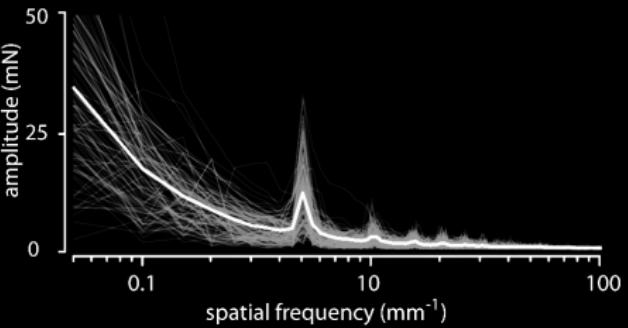
Wiertlewski, M., Hayward, V. 2012. Mechanical Behavior of the Fingertip In The Range of Frequencies and Displacements Relevant to Touch. *Journal of Biomechanics*, 45(11):1869-1874



Wiertlewski, M. , Hudin, C., Hayward, V. 2011. On The 1/F Noise And Non-Integer Harmonic Decay Of The Interaction Of A Finger Sliding On Flat And Sinusoidal Surfaces. *Proc. of World Haptics Conference 2011*, pp. 25–30.



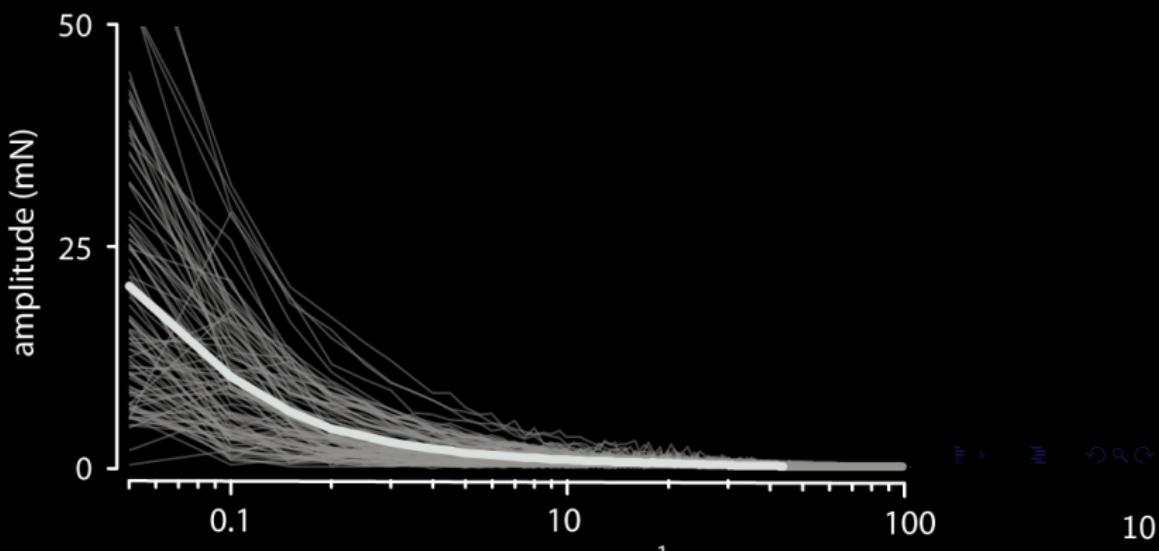
Σ

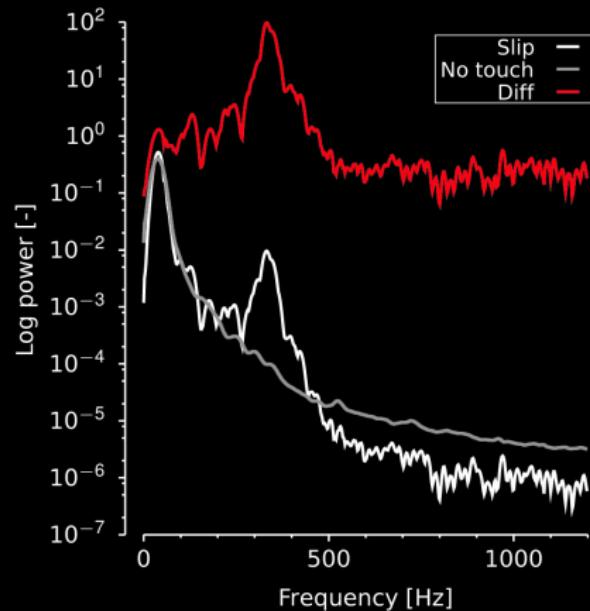
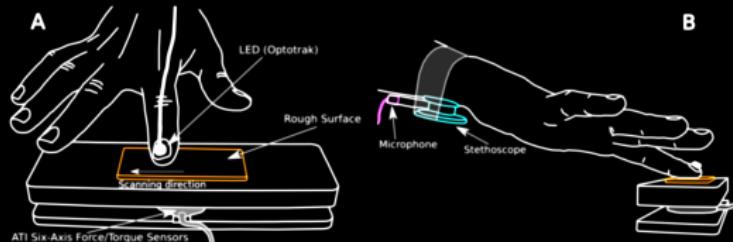


Modèle d'un doigt glissant sur une surface ondulée

$$\langle S_{\text{noise}}(k) \rangle \propto 1/k^{0.9} \quad \langle S_h(k) \rangle = \beta_h/k^{\alpha_h}$$

$\lambda = 1/k$	1.76	1.96	2.5
α_h	1.5	1.3	1.3
β_h	$e^{-2.2}$	$e^{-2.5}$	$e^{-2.3}$



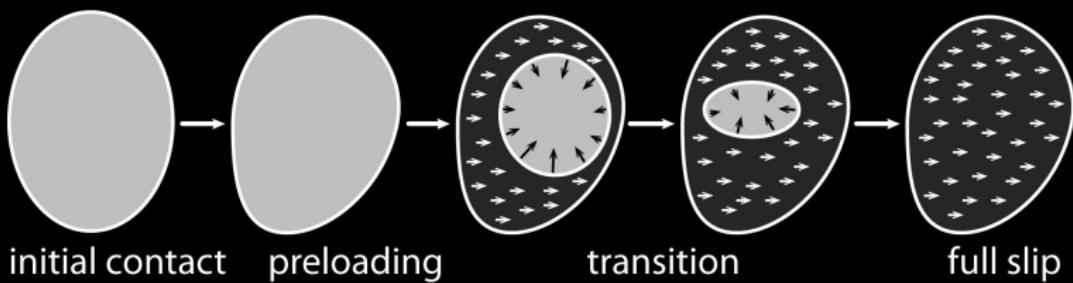


B. Delhaye, V. Hayward, Ph. Lefèvre, J.-L. Thonnard. 2012. Texture-induced vibrations in the forearm during tactile exploration. *Frontiers in Behavioral Neuroscience*. 6(7):1-10.

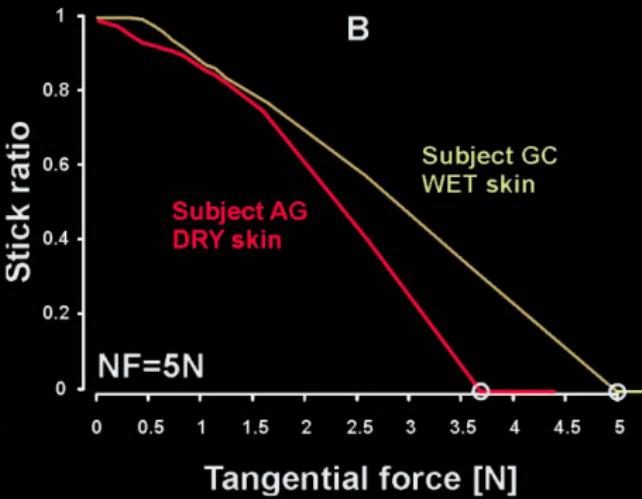
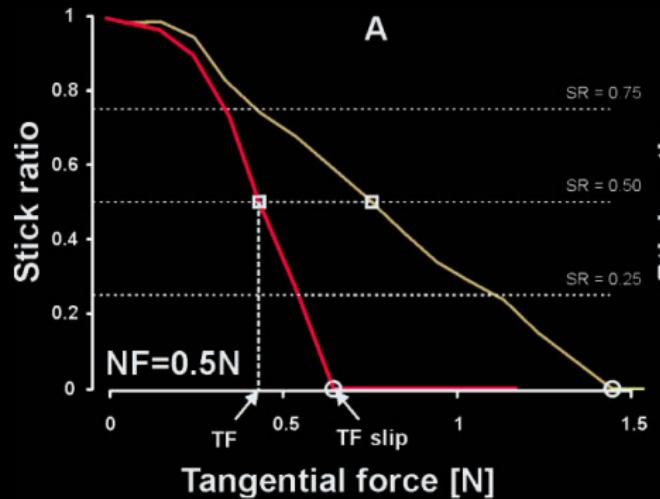




loading direction



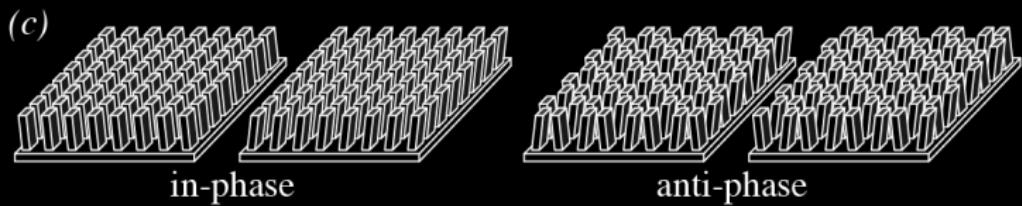
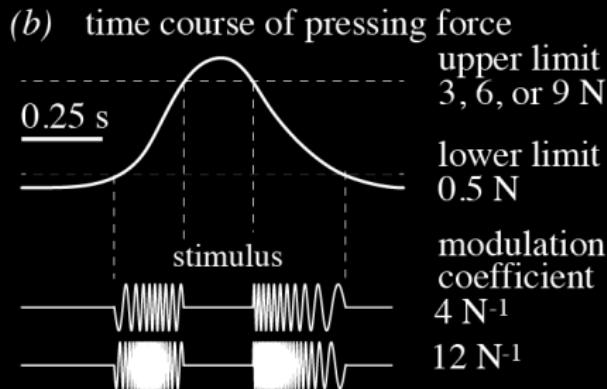
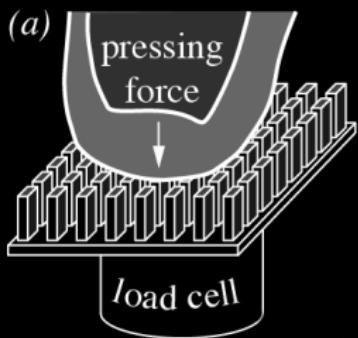
André, T., Lévesque, V., Hayward, V., Lefèvre, P. and Thonnard, J-L. Effect of skin hydration on the dynamics of fingertip gripping contact, 2011. *Journal of the Royal Society Interface*, 8(64):1574–1583



La morale de cette histoire,

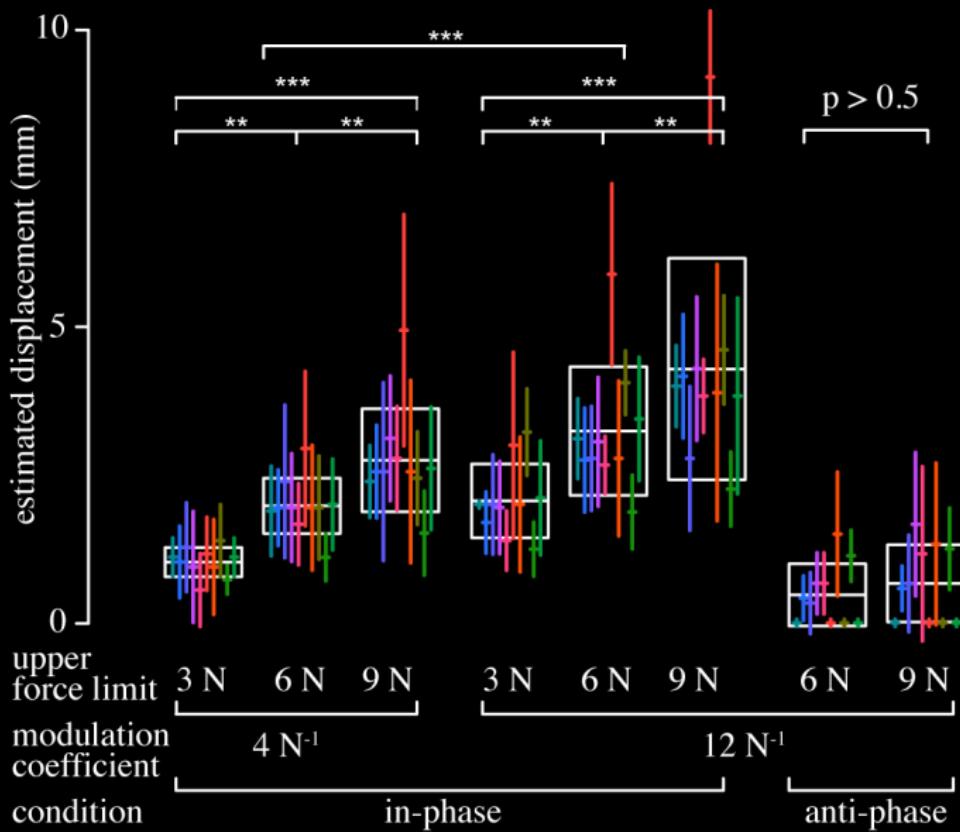
Adams, M., Johnson, S., Lefèvre, Ph., Levesque, V., Hayward, V., André, T., Thonnard, J.-L. 2013. *Finger pad friction and its role in grip and touch*. Journal of the Royal Society Interface, 10(80):20120467

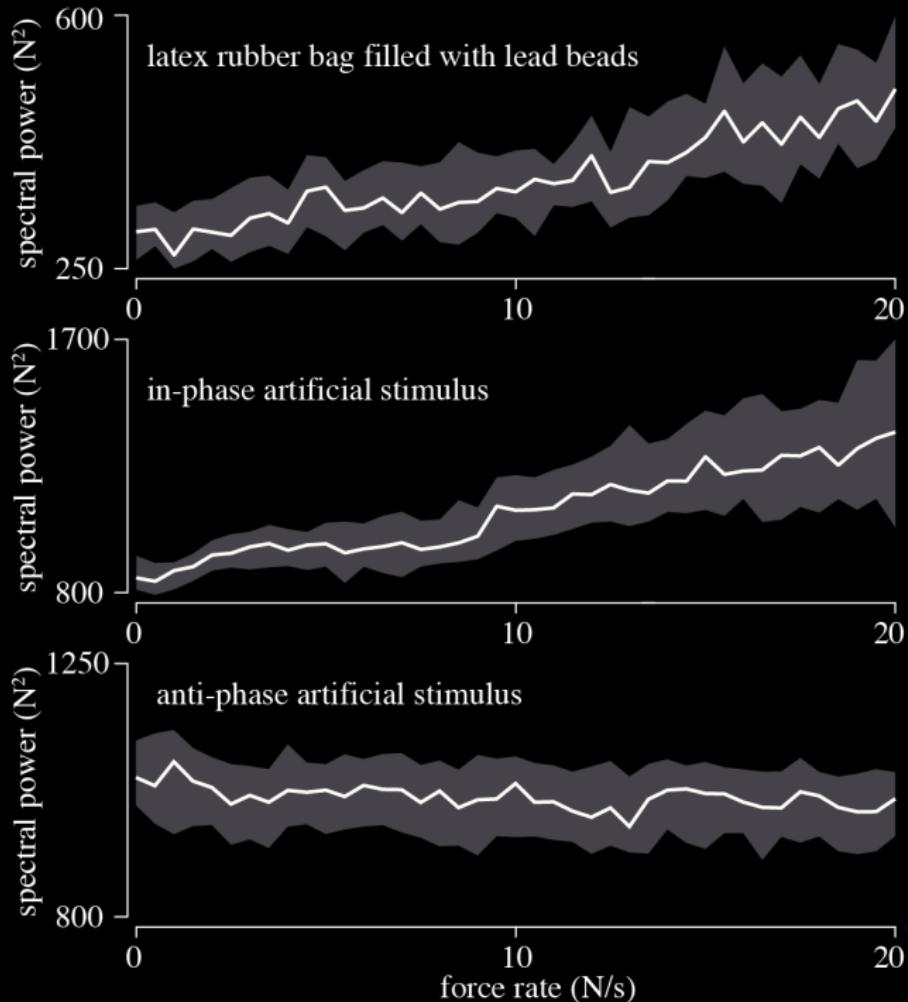
- ▶ glissement / non glissement
- ▶ La loi d'Amontons ne marche que pour les doigts secs
- ▶ Le frottement dépend de manière cruciale de la sueur sécrétée par les doigts
- ▶ Les forces capillaires jouent un rôle mineur
- ▶ Enorme influence du phénomène de plastification
- ▶ Le frottement dépend du temps
- ▶ Les surfaces imperméables ou poreuses divisent le monde en deux



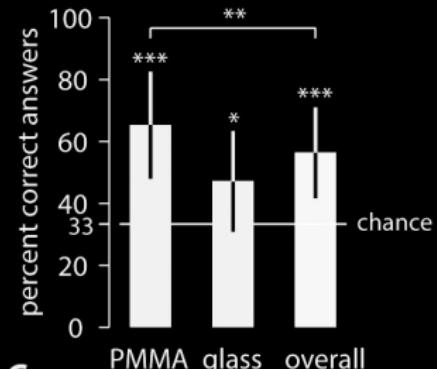
$$p_{ij}(t) = \begin{cases} A \sin(2\pi M F_N(t)), & \text{in-phase}, \\ (-1)^{i+j} A \sin(2\pi M F_N(t)), & \text{anti-phase}, \end{cases} \quad i, j \in \{0, \dots, 7\}.$$



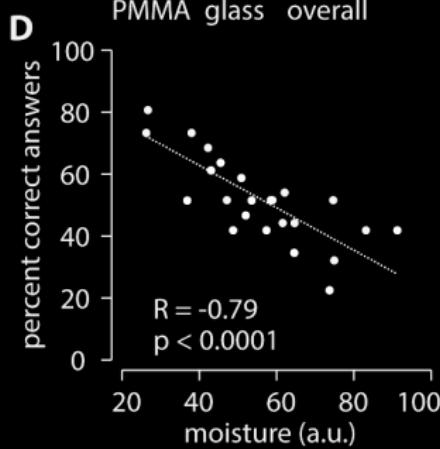
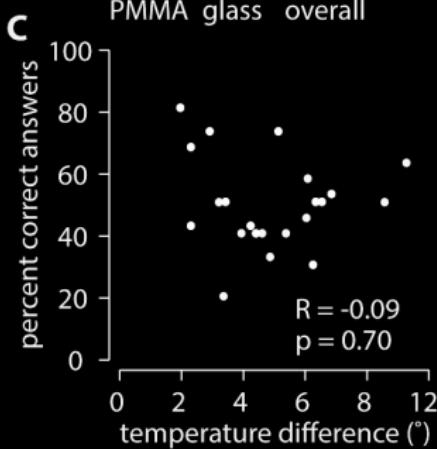
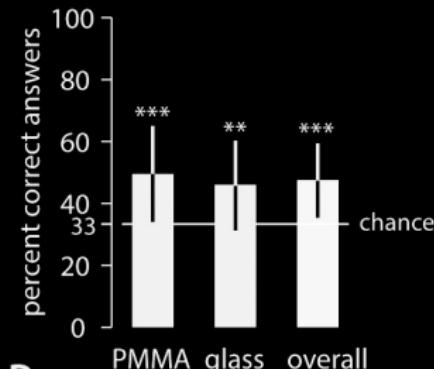




A free exploration
(33.4 °C — experiment 1)



B constrained exploration
(23.5 °C — experiment 2)



Gueorguiev, D., Bochereau, S., Mouraux, A., Hayward, V. and Thonnard, J-L. 2016. Touch uses frictional cues to discriminate optically flat materials. *Scientific Reports*, sous-presse