Des *gestes* pour enrichir l'information d'entrée sur les surfaces *tactiles*

Glissements vs. Roulements du Doigt (MicroRolls)
Promesses du Mouvement Oscillatoire (CycloStar)

Yves Guiard

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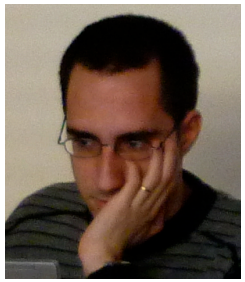
Telecom ParisTech - CNRS

Paris, France

Human-Computer Interaction at TELECOM ParisTech



Eric Lecolinet
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Doctorants
Sylvain Malacria
Mathias Baglioni
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Dong-Bach Vo
Simon Perrault

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   - Fitts' Law
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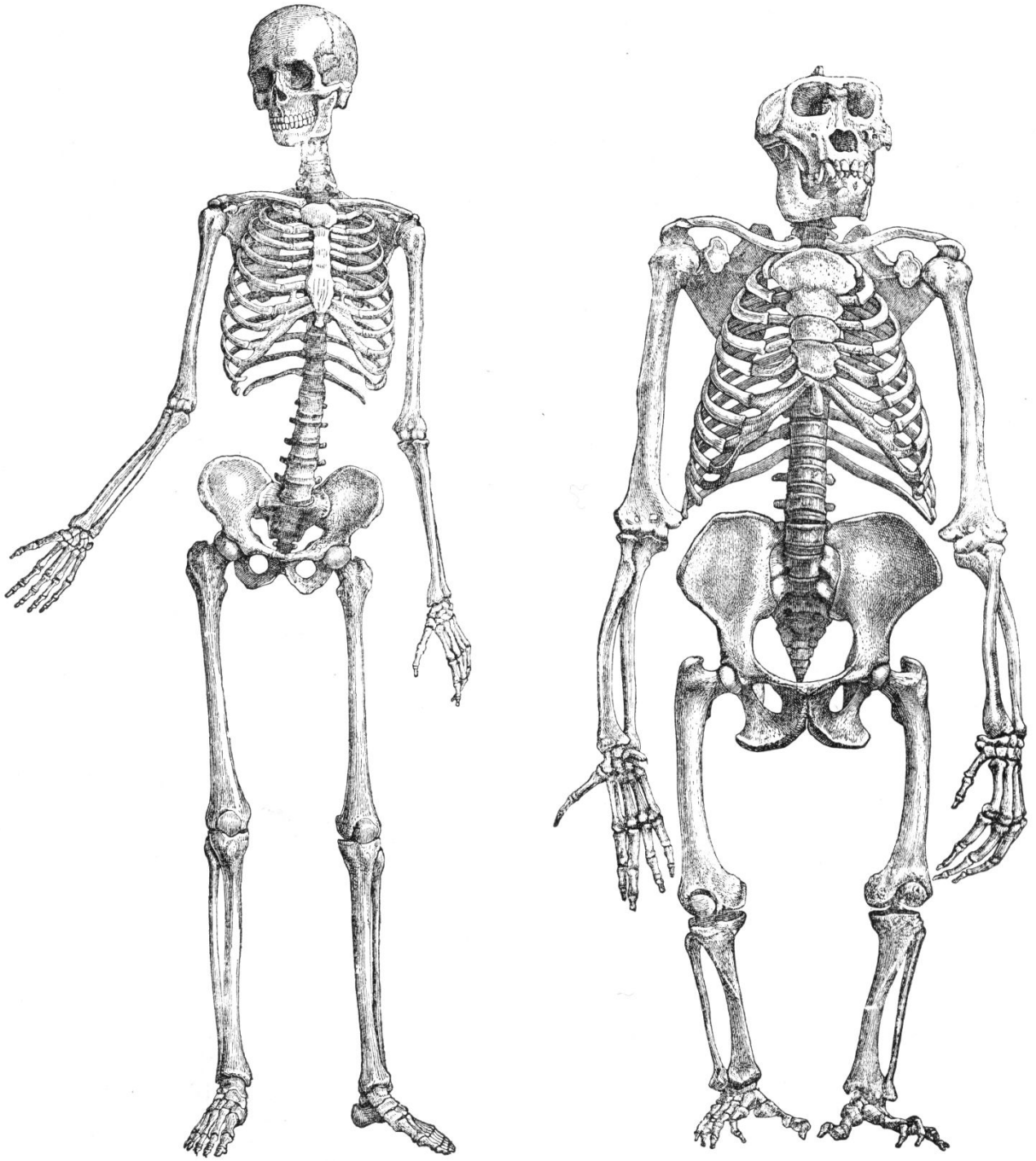
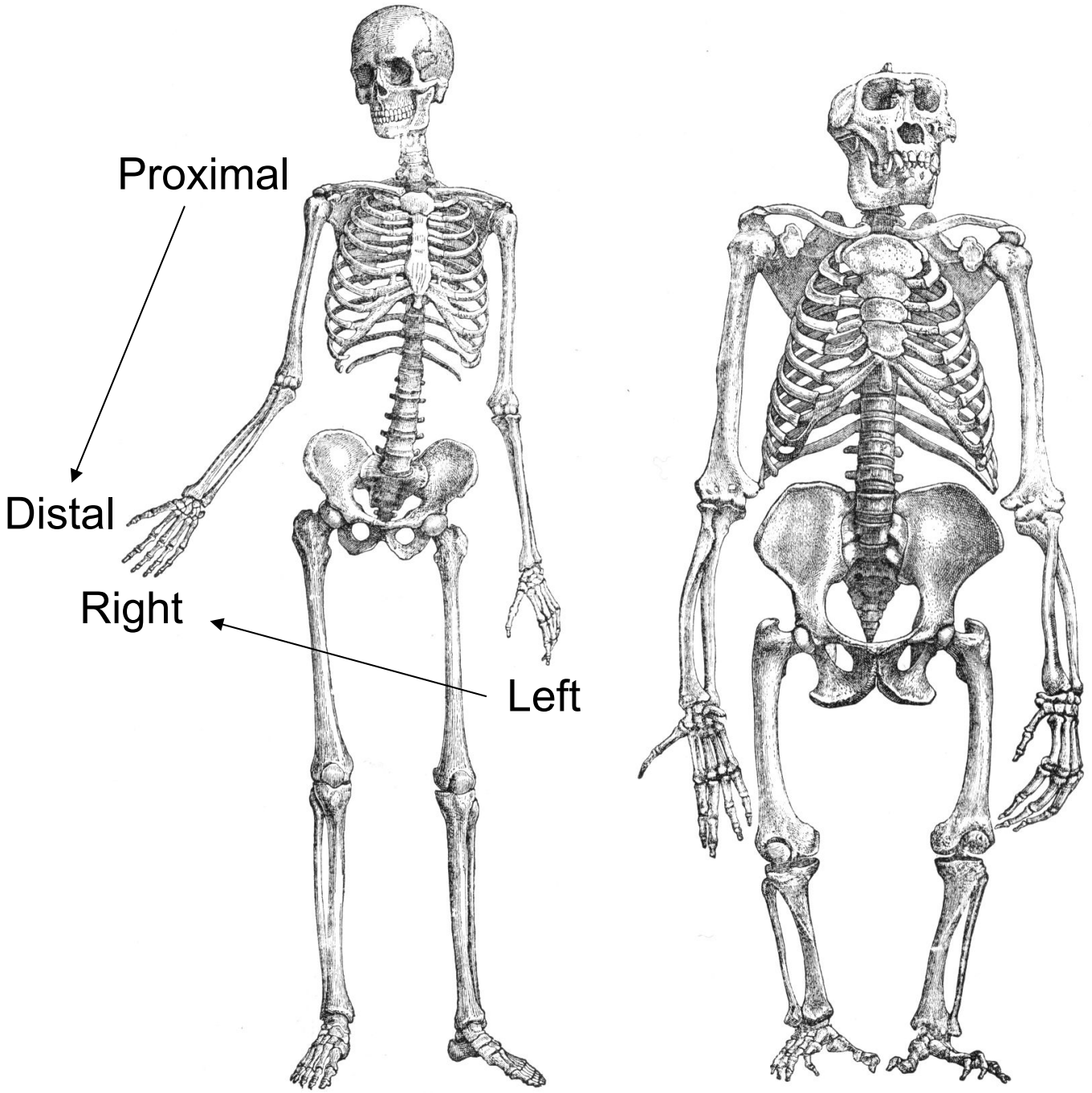
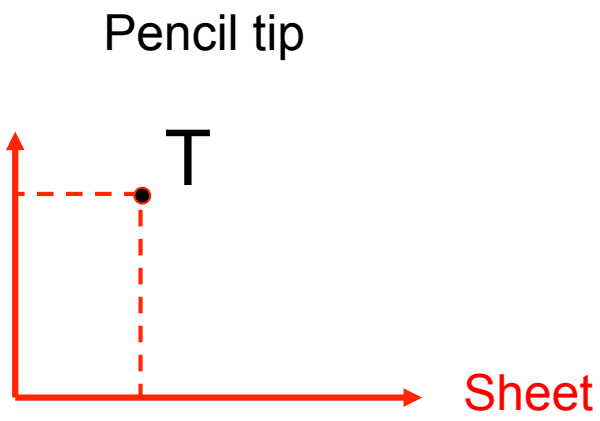
Two-Handed Input
The kinematic chain theory

Guiard, Y. (1987). **Asymmetric division of labor in human skilled bimanual action : The kinematic chain as a model**. *Journal of Motor Behavior, 19*, 486-517.




Proximal
Distal
Right
Left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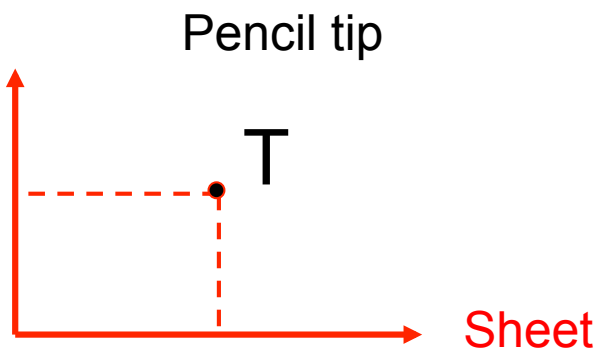
Sheet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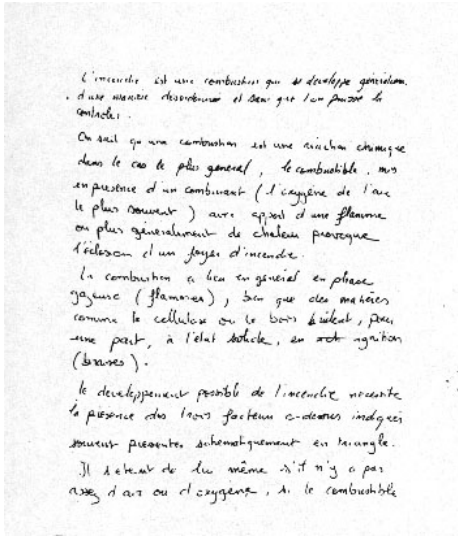

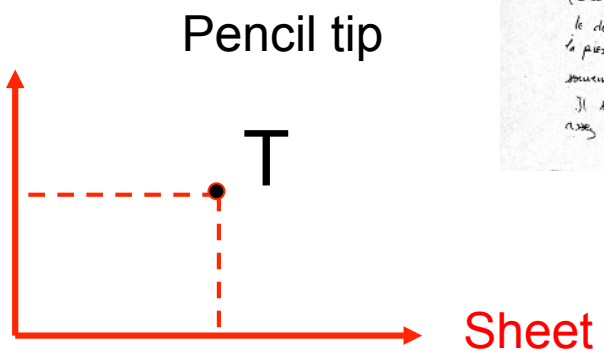
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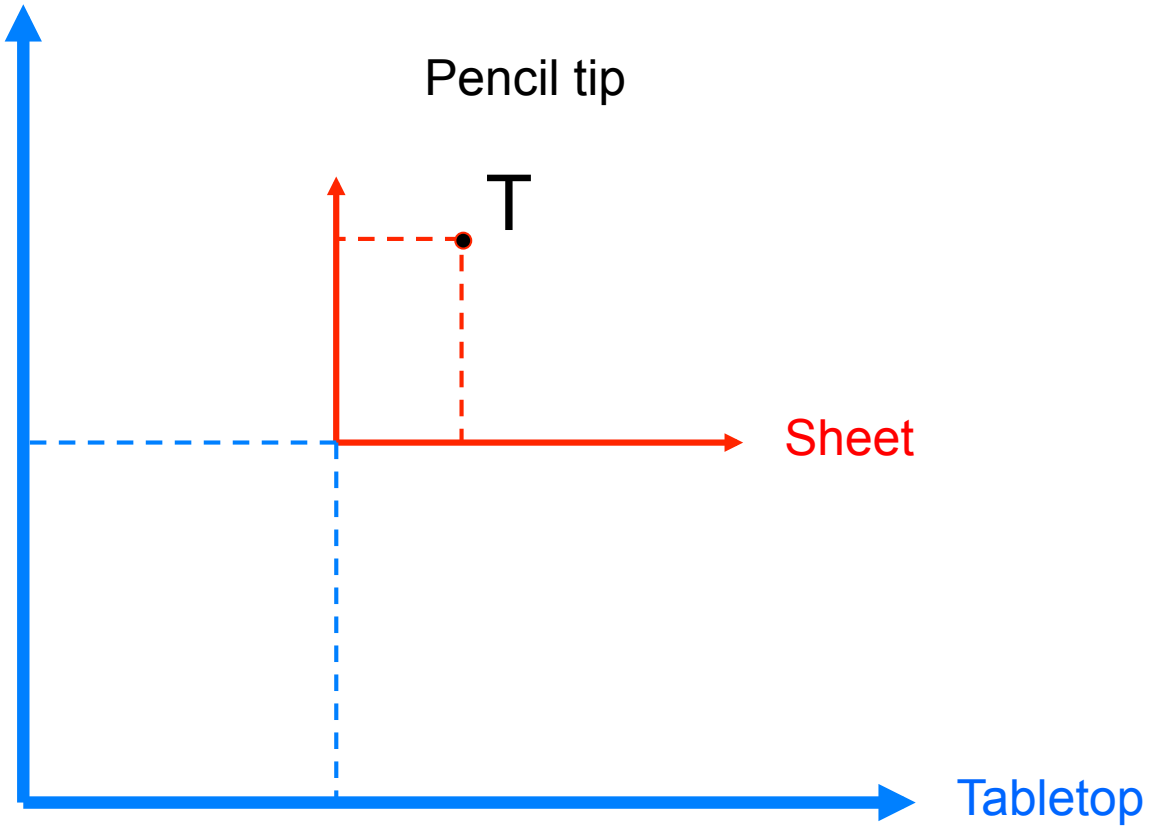
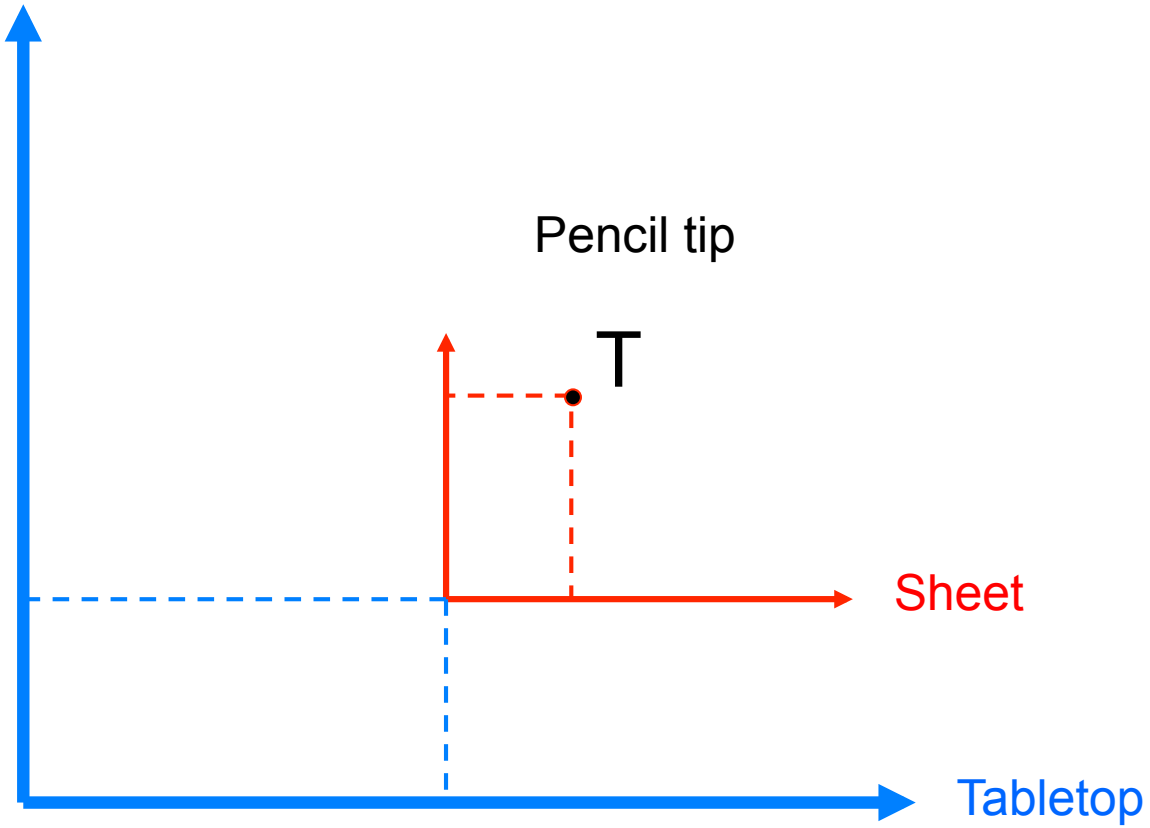

Pencil tip
T
Sheet
Tabletop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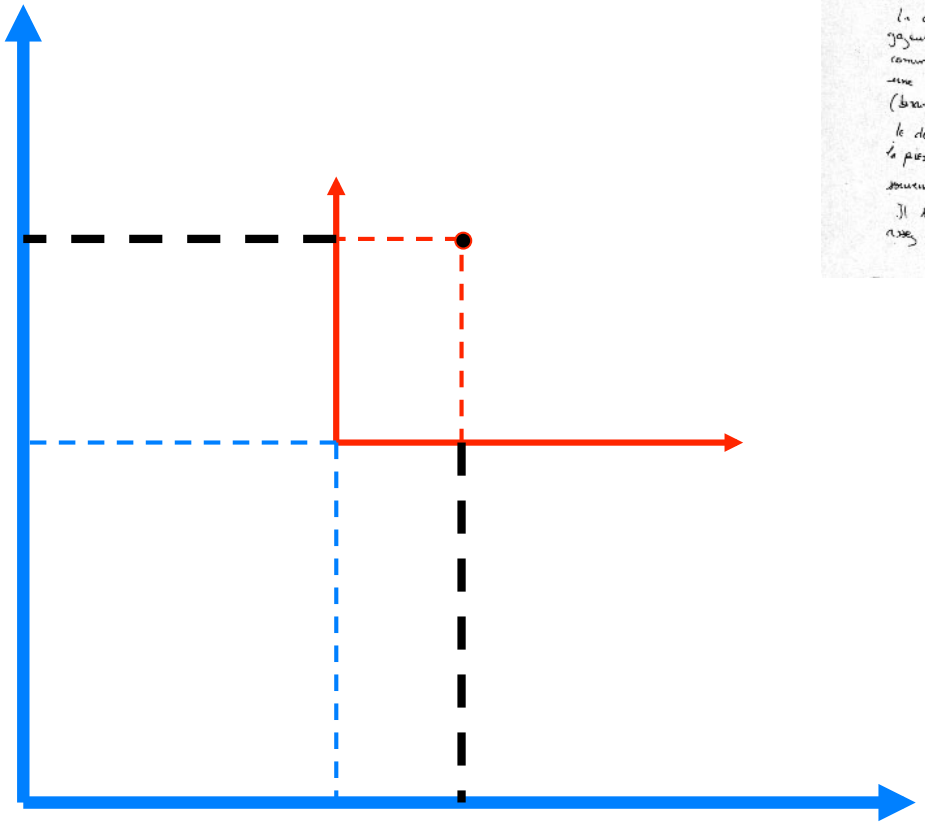
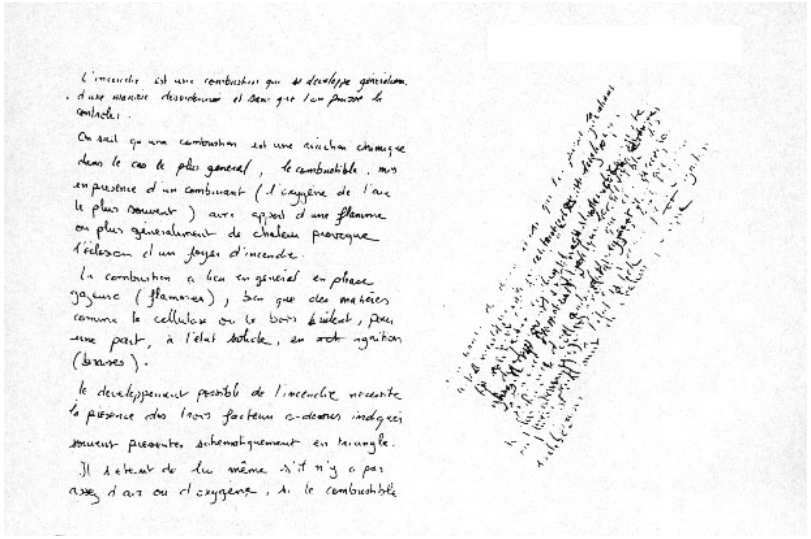




L'incendie est une combustion qui se développe généralement d'une manière désordonnée et dans le but de propager le contact.

On sait que une combustion est une réaction chimique dans le cas le plus général, le combustible, mis en présence d'un comburant (l'oxygène de l'air le plus souvent) avec apport d'une flamme ou plus généralement de chaleur provoque l'éclosion d'un foyer d'incendie.

La combustion a lieu en général en phase gazeuse (flammes), bien que des matières comme le cellulose ou le bois brûlent, pour une part, à l'état solide, en voie oxydation (braises).

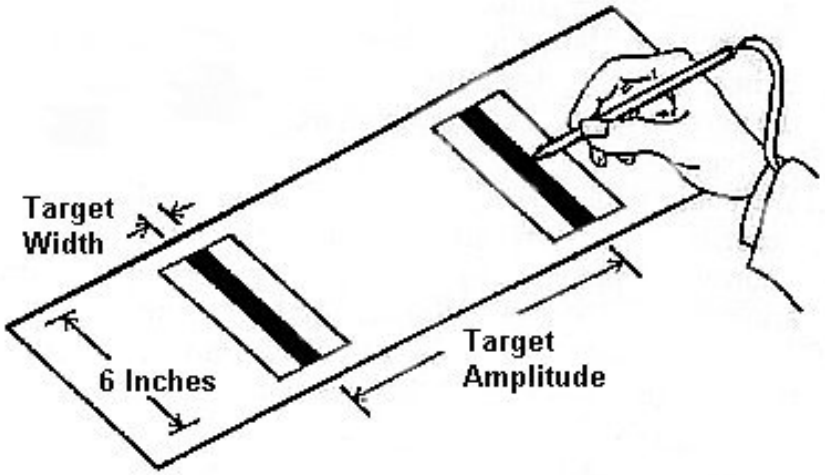
Le développement possible de l'incendie nécessite la présence des trois facteurs ci-dessus indiqués souvent présentés schématiquement en triangle.

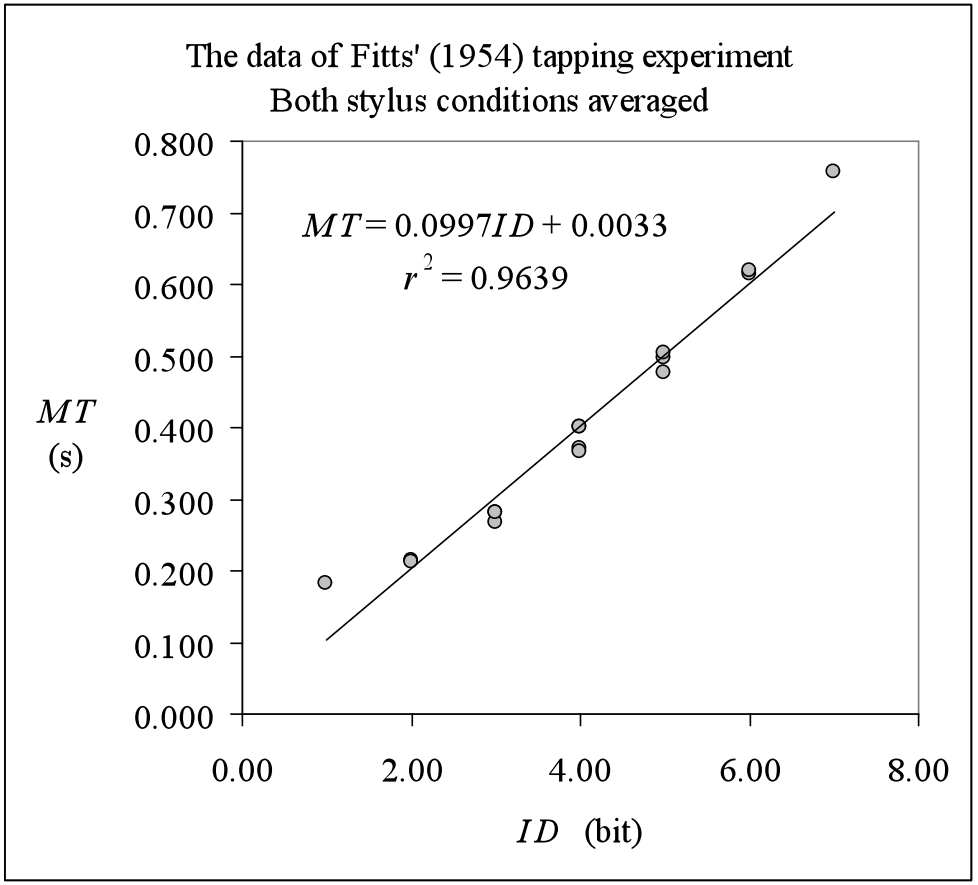
Il s'éteint de lui même s'il n'y a pas assez d'air ou d'oxygène, si le combustible

Stimulus-response compatibility

Paul Fitts (1953, 1954)

Fitts' law





$$TM = a + b \log_2(D/W + 1)$$

Currently in Progress at Telecom Paristech

With Halla Olafsdottir, post-doc,

Simon Perrault, PhD student,

And Eric Lecolinet

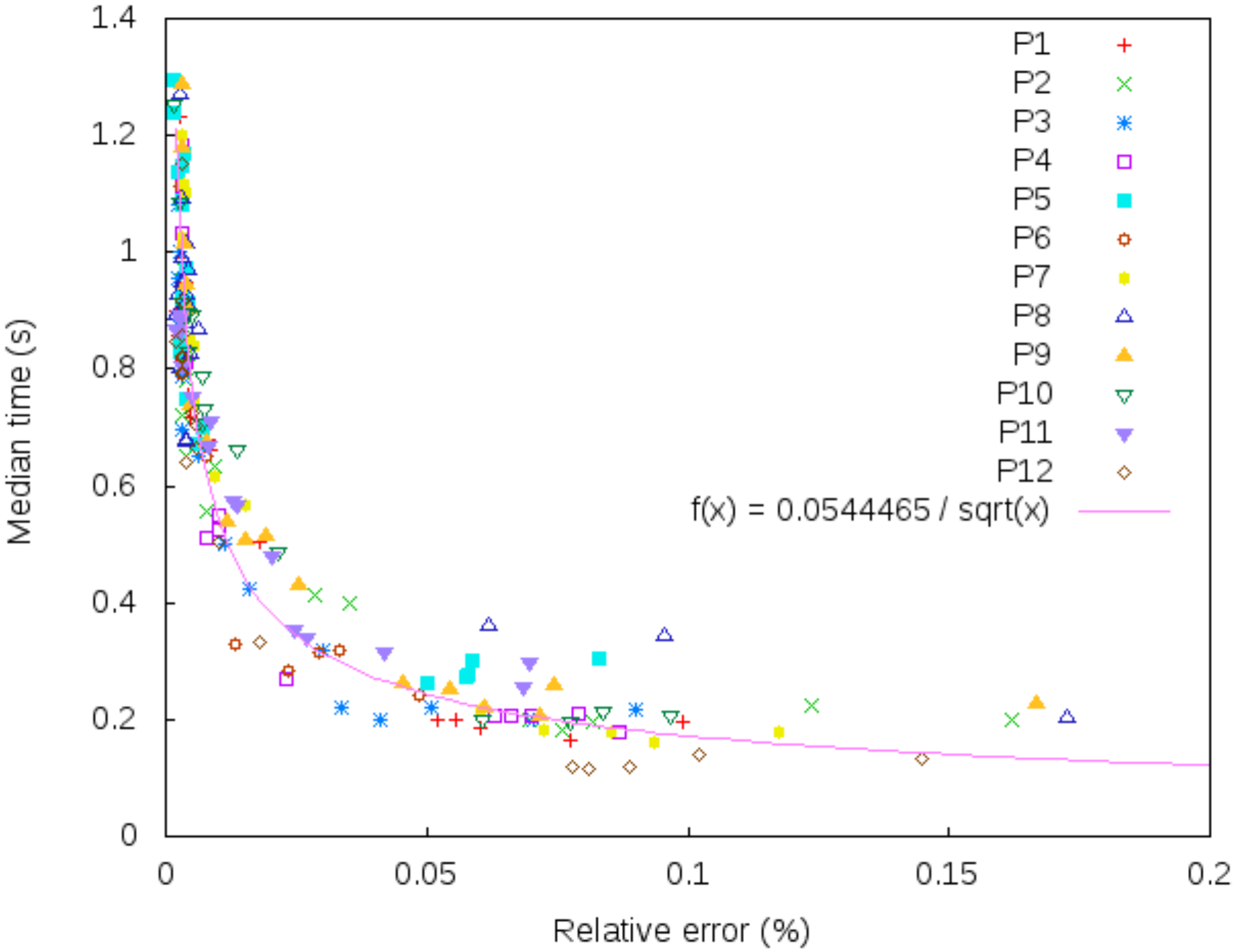
A Fitts' law study with emphasis on theory

- Tradeoff theory: resource, strategy, etc.

… as well as methodology

- Discrete movement
  - Movement time = pure execution time
- Revised definition of variables
  - Relative error (σ_A/μ_A) rather than *D/W*
  - Fitts' law $\mu_T = f(\sigma_A/\mu_A)$
- Revised definition of the task
  - Min-min effort (minimization of MT and error)

Our goal: understanding *miniature* pointing


Median time (s)
Relative error (%)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
0.05
0.1
0.15
0.2
P1
P2
P3
P4
P5
P6
P7
P8
P9
P10
P11
P12
f(x) = 0.0544465 / sqrt(x)

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Years 2000: gradual transition from indirect cursor manipulation to direct-touch manipulation

- Scale issues
  - Tablet PCs or iPad: about optimal size
  - Wall displays: *too large* surfaces
  - Miniature devices: *too small* surfaces for interaction

Very large indeed

The *WILD* Project of in|situ (Orsay)

5.5m x 1.8m, 131 million pixels

Very large indeed

The *WILD* Project of in|situ (Orsay)

5.5m x 1.8m, 131 million pixels

Rather smal

iPhone

Blackberry

Very small indeed

IBM Linux wristwatch (2000)

Rather smal

iPhone

Blackberry

Very small indeed

IBM Linux wristwatch (2000)

Fat-finger problem

“Super Cool Mobile Phone Wrist Watch” of Smarttoget.com

~100€

Wanted

- New hardware technologies
- New interaction techniques

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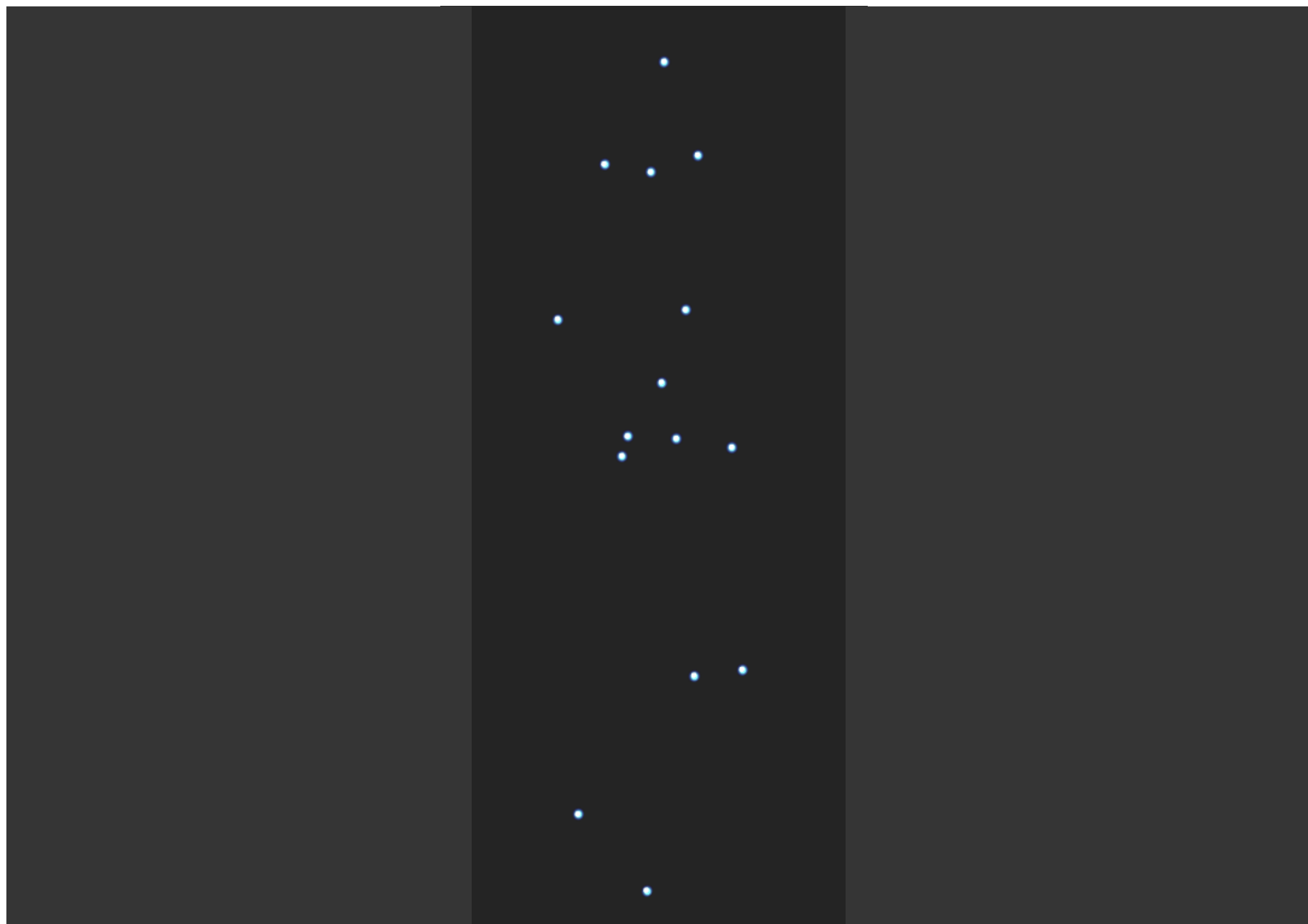

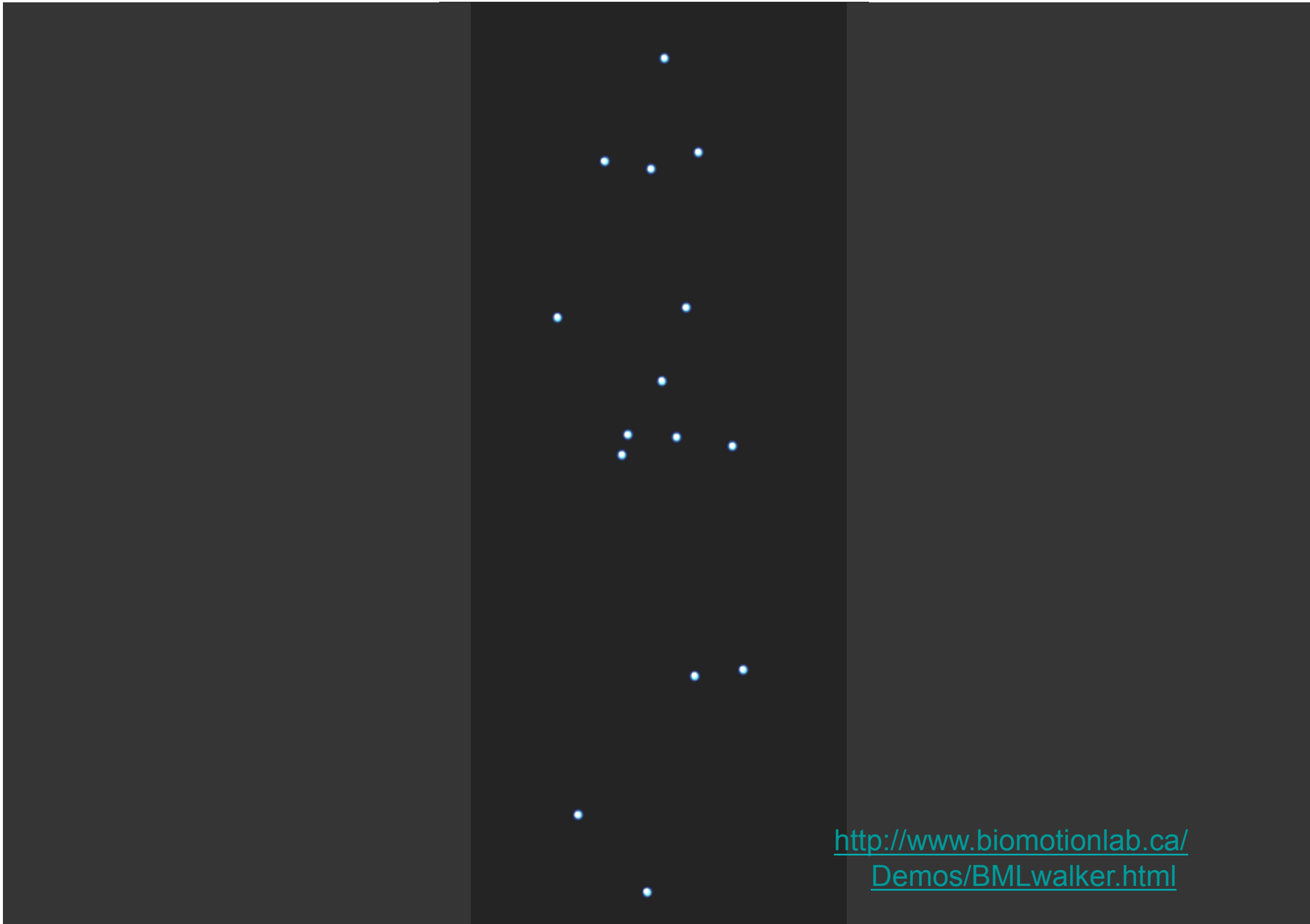

http://www.biomotionlab.ca/Demos/BMLwalker.html

Input information in HCI: Some Classification Dimensions

Type of user action

- Brain waves (brain-computer interaction)
- Speech
- Movement
  - Cephalic (e.g., Jagacinsky)
  - Ocular (e.g., Jacob, Zhai)
  - Lingual (e.g., Zhai)
  - Manual

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  - Ocular (e.g., Jacob, Zhai)
  - Lingual (e.g., Zhai)
  - **Manual**

Nearly 100% of all input

Input information in HCI: Some Classification Dimensions

Action Goal (Cadoz)

- Ergotic
- Epistemic
- Semiotic

NB. Ergotic/epistemic coupling (Gibson)

Dimensional Approach to Movement

Fundamental physical dimensions

Mass **M**, length **L**, time **T**

e.g., force = $\mathbf{MLT^{-2}}$, frequency = $\mathbf{T^{-1}}$

Geometry **L**, $\mathbf{L^2}$, or $\mathbf{L^3}$

Point geometry

A *pointing act* delivers just 1, 2, or 3 spatial coordinates

Differential geometry

A gesture traces a *path* (a large set of *x*, *xy* pairs or *xyz* triplets)

Kinematics **LT**, $\mathbf{L^2T}$ or $\mathbf{L^3T}$

A gesture traces a space-time *trajectory* (same plus time coordinates)

Dynamics **MLT**, $\mathbf{ML^2T}$, or $\mathbf{ML^3T}$

A gesture involves forces and torques (same plus mass measures)

Geometry L^2

Kinematics L^2T

Log of a pointing act

x (mm)	*y (mm)*
52.598	113.072

Log of a path

x (mm)	*y (mm)*
52.598	113.072
63.118	135.686
75.741	162.824
90.889	195.388
109.067	234.466
130.881	281.359
157.057	337.631
188.468	405.157
226.162	486.189
271.394	583.427
325.673	700.112
390.808	840.134
468.969	1008.161

Log of a space-time trajectory

t (s)	*x (mm)*	*y (mm)*
0.000	52.072	111.941
0.010	62.486	134.330
0.020	74.984	161.195
0.030	89.980	193.435
0.040	107.977	232.121
0.050	129.572	278.546
0.060	155.486	334.255
0.070	186.583	401.106
0.080	223.900	481.327
0.090	268.680	577.592
0.040	322.416	693.111
0.050	386.899	831.733
0.060	464.279	998.080

Pointing without a pointer (Williamson & Murray-Smith, CHI'04)

Demo

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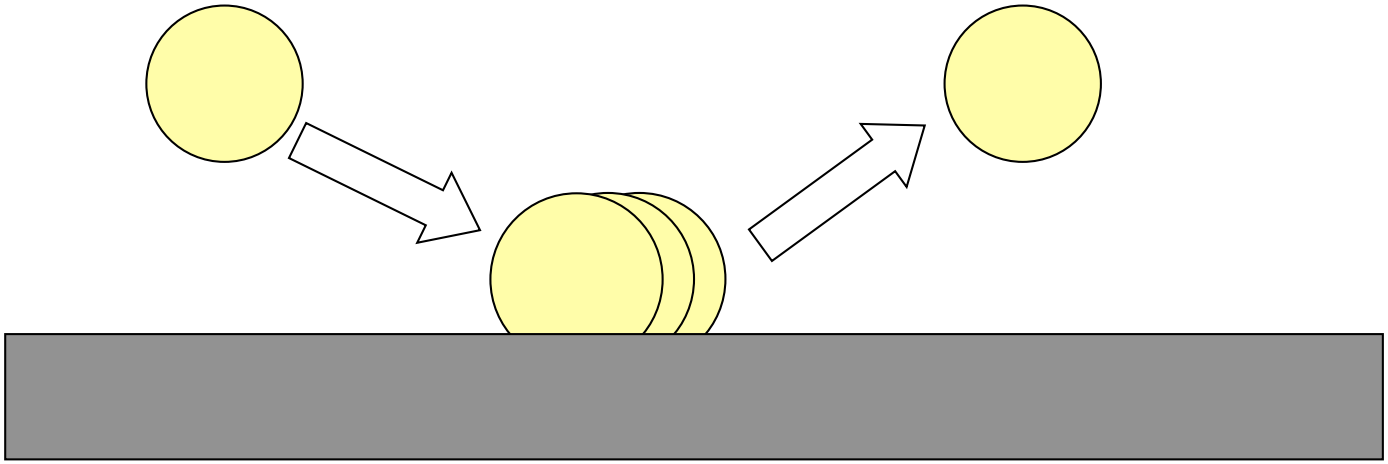
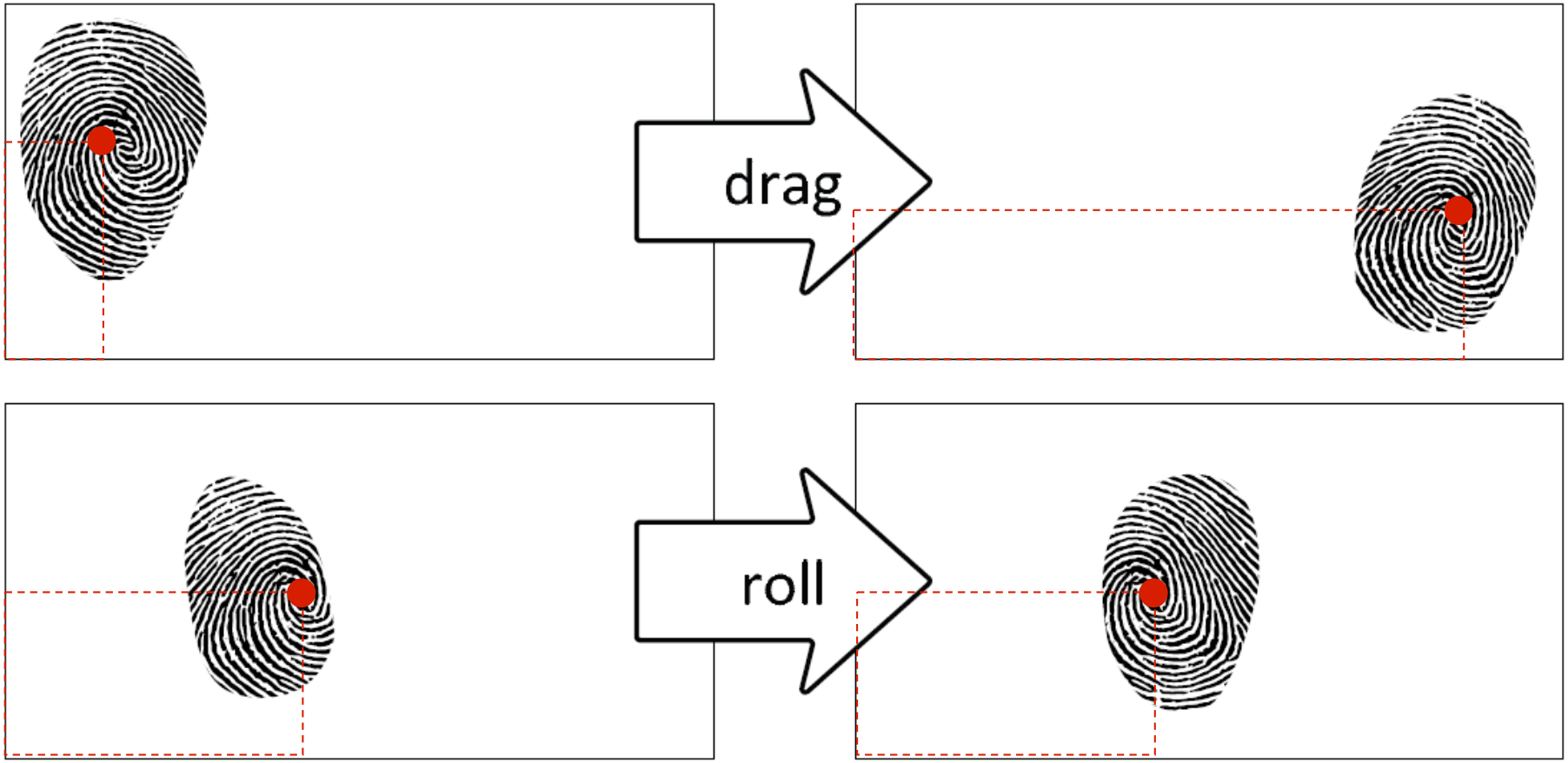


Does the bouncing tennis ball slide or bite-and-roll?

Both

Criterion: the relative velocity between the two surfaces

Sliding: non-zero velocity Rolling: *zero* velocity



Holz, C. and Baudisch, P.

The Generalized Perceived Input Point Model and How to Double Touch Accuracy by Extracting Fingerprints

CHI'10, Atlanta, GA, April 10-15, pp. 581-590.

Two Regimes of Finger Motion on a Touchscreen

Coulomb dry friction
Static friction sets a threshold

Below	fingertip rolls
Above	fingertip slides

MicroRolls

Roudaut, A., Lecolinet, E. & Guiard, Y. (2009). **MicroRolls: Expanding touch−screen input vocabulary by distinguishing rolls vs. slides of the thumb**. CHI'09, ACM Conference on Human Factors in Computing Systems (927−936). New York: Sheridan Press.

MicroRolls

MicroRolls

- Human finger tip *rounded*: it can not only slide but also roll on a limited amplitude (hence the prefix “Micro”)
- MicroRolls used spontaneously for small amplitude moves of contact barycenter
- One-handed one-finger operation on handhelds: thumb
- Compatible with other interaction techniques (e.g., the drag, the swipe, and the rubbing)
- MicroRolls easy to perform, and easy to discriminate for the system
- Finger MicroRolls are *qualitatively different* from slides

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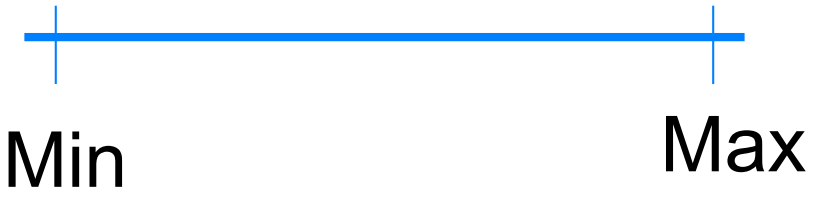
Linear variables bounded

e.g., tracing a path on a touchscreen

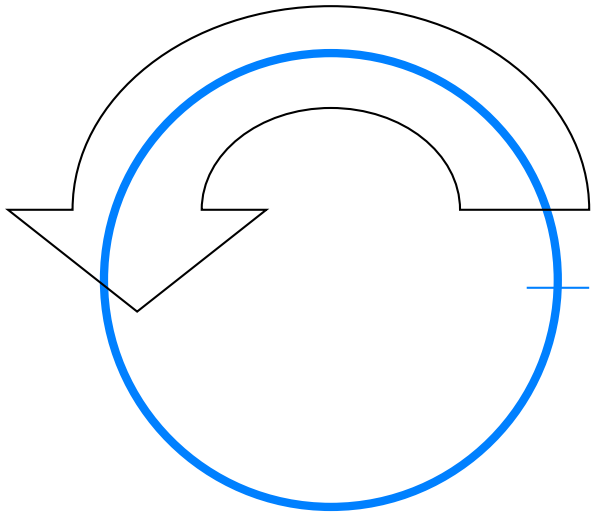
Limited amplitude range



Circular variables unbounded

e.g., tracing a closed curved

Unlimited amplitude range



0° = 360°

Periodic movement is a circular event

Possibility of *permanent* input over long periods of time

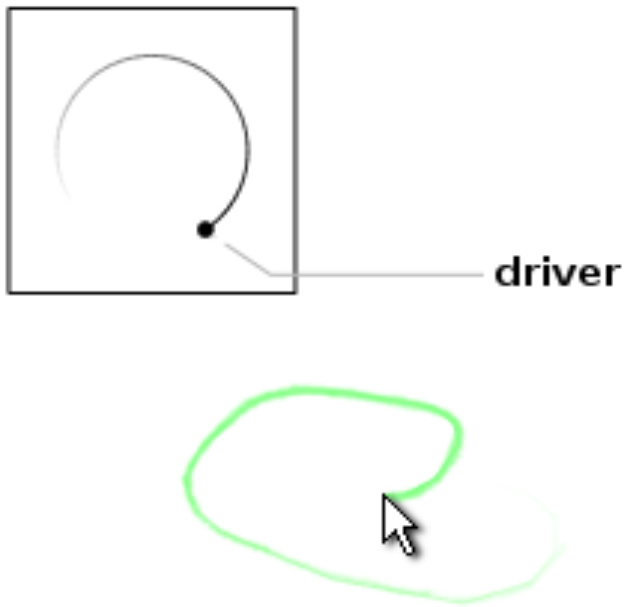
Many parameters under user control

In 2D space	Ellipse size
	Ellipse form (eccentricity)
	Ellipse orientation
	Cycling frequency
	Rotation direction (CW vs. CCW)
	Ellipse horizontal location (*x*)
	Ellipse vertical location (y)

Possibly location independent

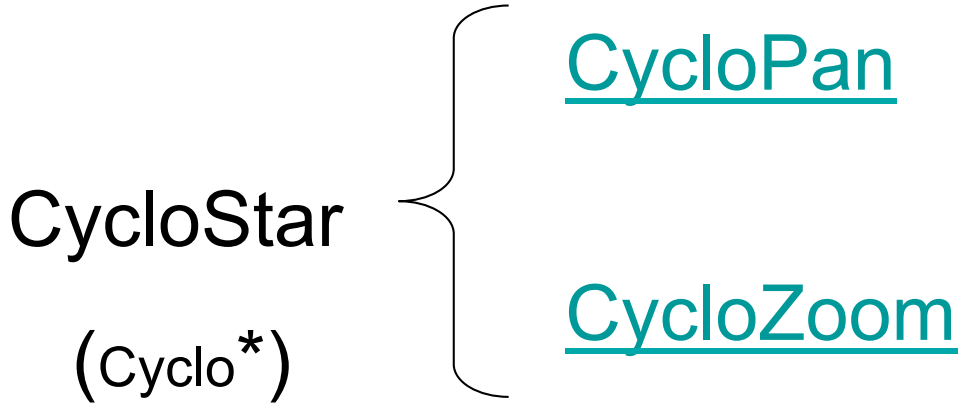
Possibly scale independent

Elliptic gesture for **selection**



Fekete, J.−D., Elmqvist, N. & Guiard, Y. **Motion−Pointing: Target Selection using Elliptical Motions**. CHI'09, ACM Conference on Human Factors in Computing Systems (289−298). New York: Sheridan Press.

Elliptic gesture for **continuous control**



Malacria, S., Guiard, Y., & Lecolinet, E. **Clutch-free panning and integrated pan-zoom control on touch-sensitive surfaces: The CycloStar approach**. CHI'10, ACM Conference on Human Factors in Computing Systems. New York: Sheridan Press.

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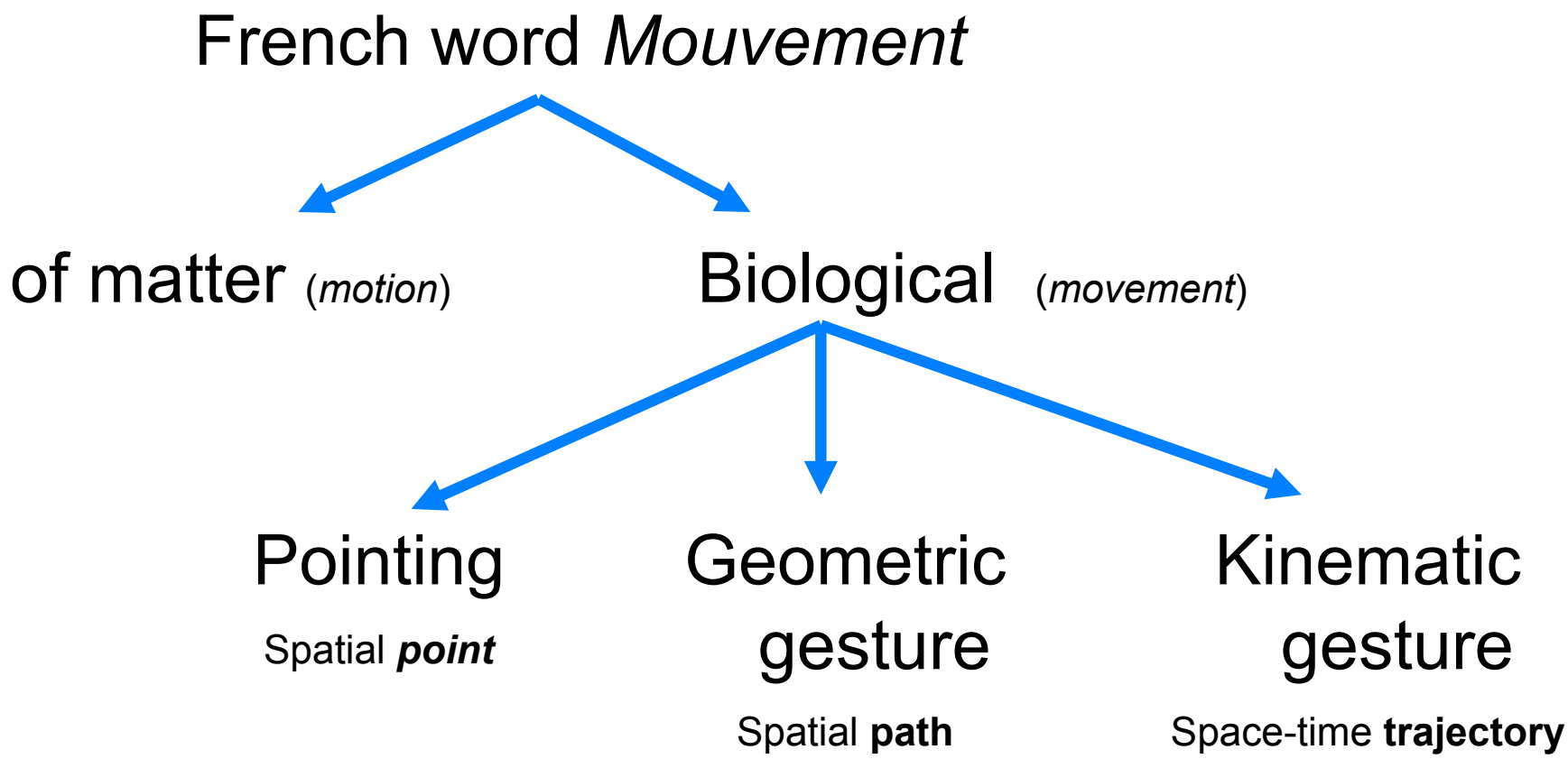

Nb. Particle motion model

(e.g., motion of finger or stylus tip)