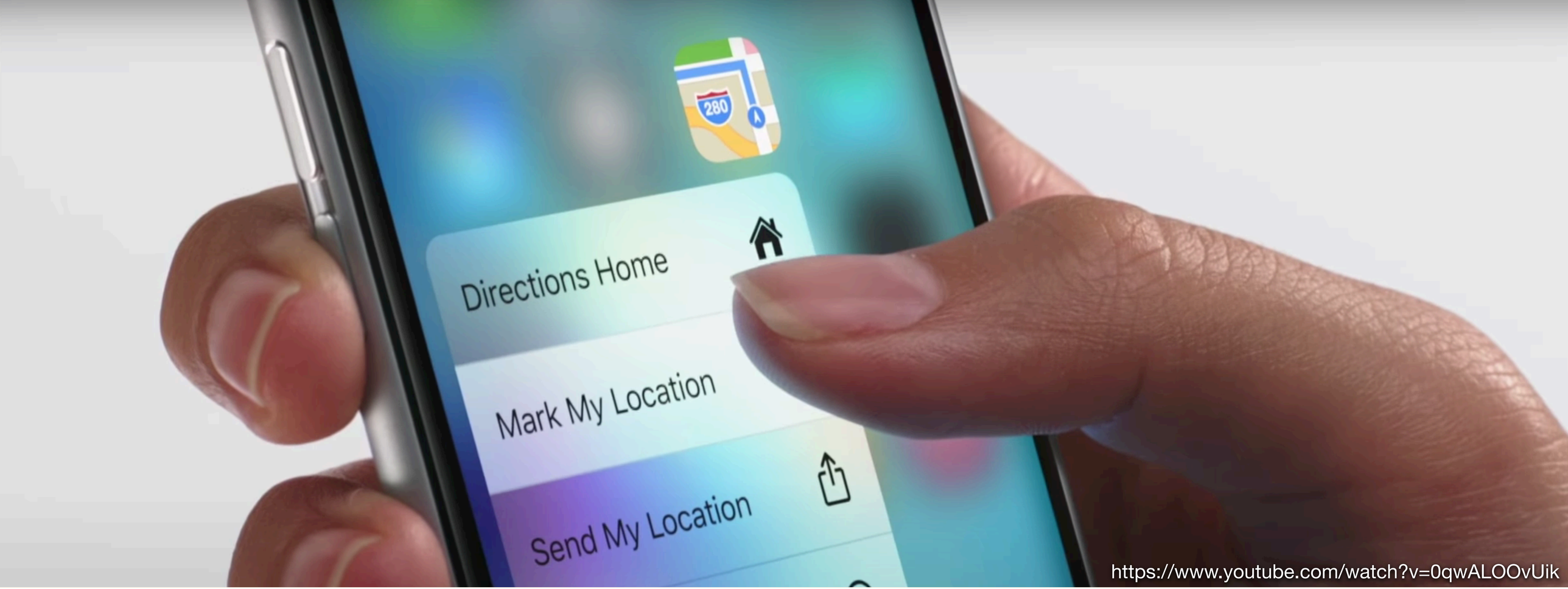

CTHCI: Force Touch Input

Oliver Nowak
Slides originally by Christian Corsten
Summer 2020

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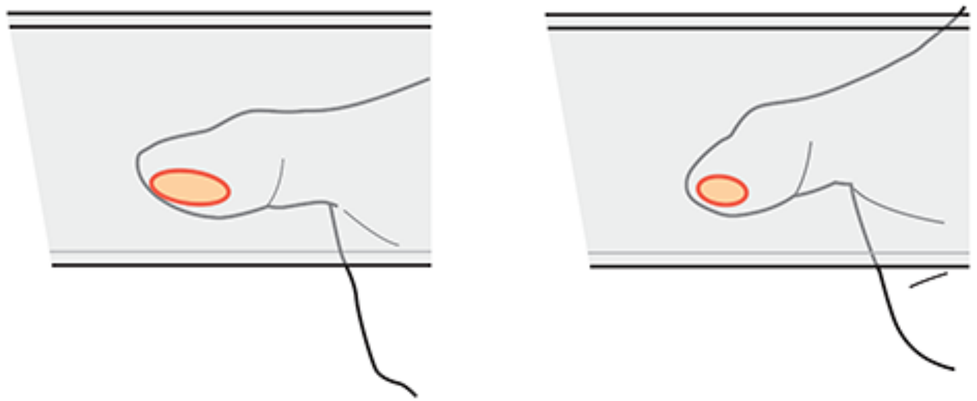
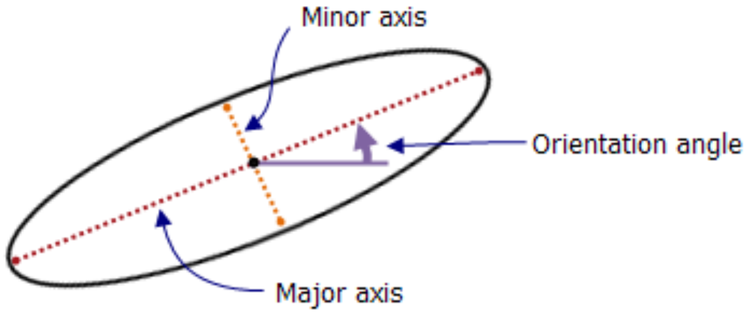
Touch Input: Properties

- Usually binary (finger on the surface vs. off the surface)
- Location (x, y)
- Contact size (radius)
- Orientation (angle)
- What else?
  - Distance to the touchscreen?
  - Force?





https://www.apple.com/de/apple-pencil/

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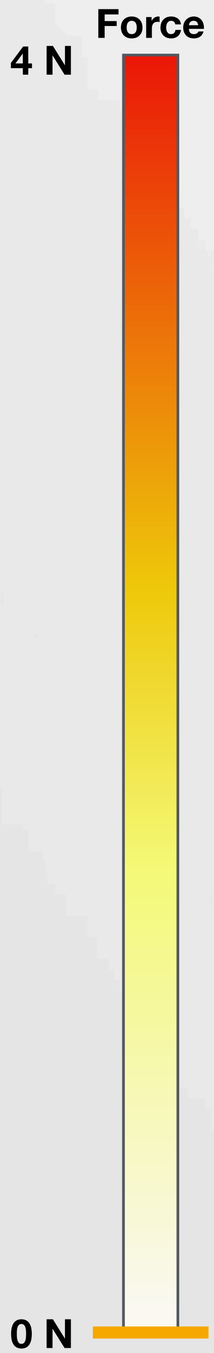
https://www.pexels.com/de-de/foto/arbeiten-arm-bildschirm-buro-2047910/

 https://www.pexels.com/de-de/foto/apfel-apple-apple-watch-bildschirm-1682821/

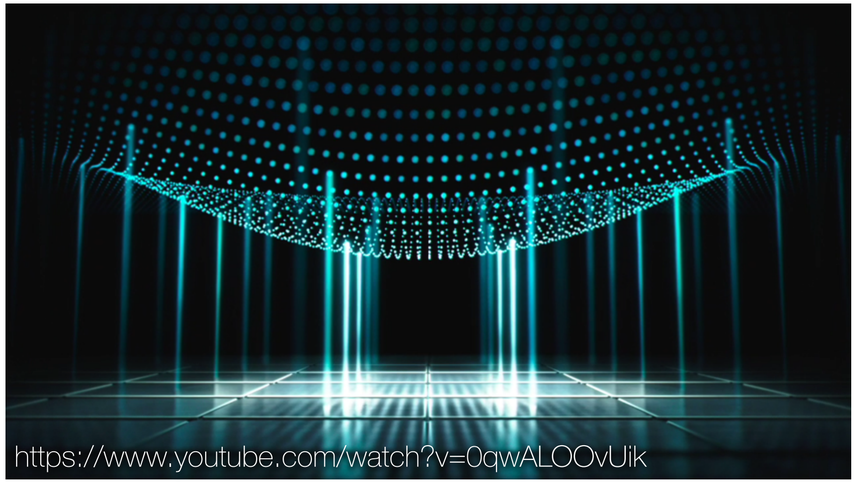
Force Input on iPhone



https://www.youtube.com/watch?v=0qwALOOvUik

Force Sensing

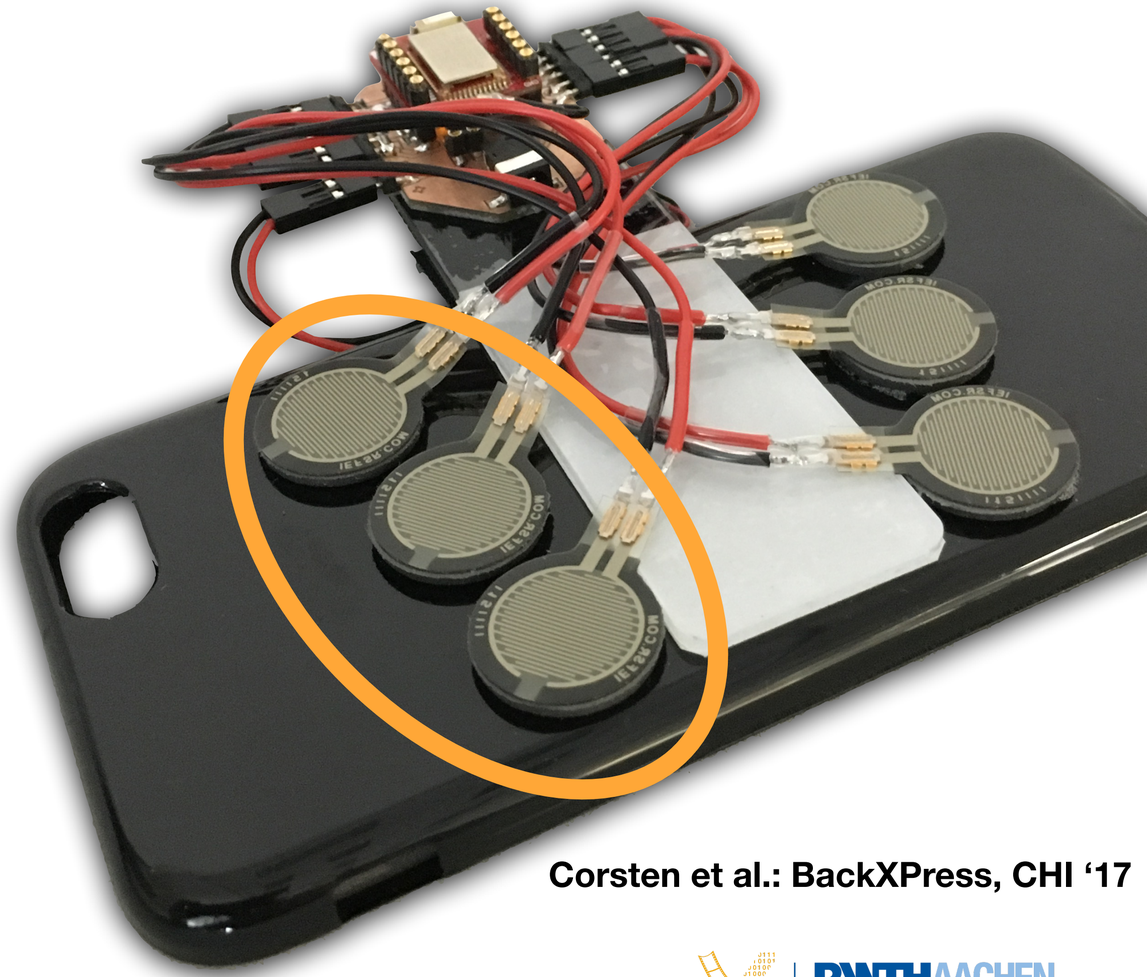
On an iPhone:



Full article:

"[…] with each press, these sensors measure microscopic changes in the distance between the cover glass and the backlight." – Apple Inc.

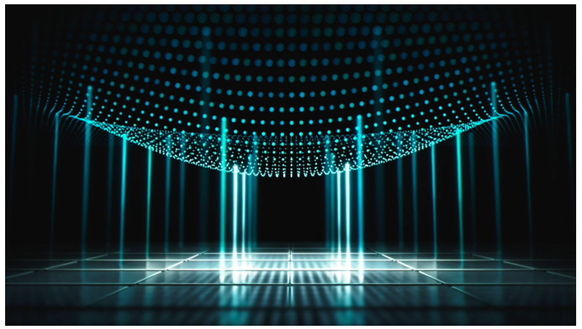
Using Force Sensing Resistors:

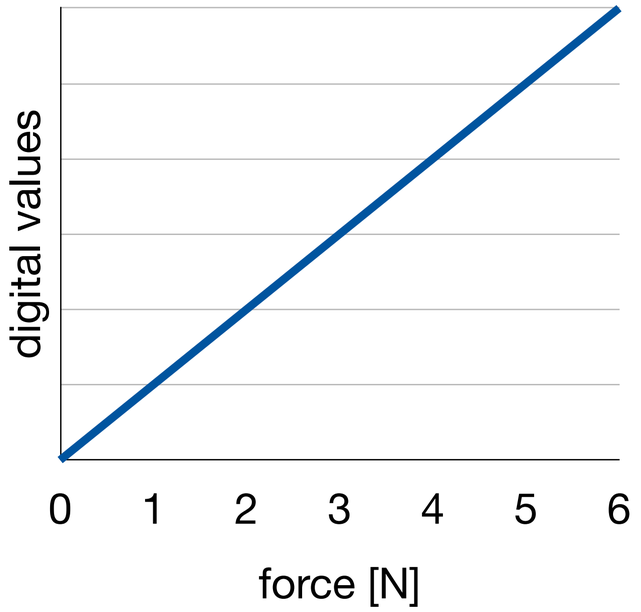


Corsten et al.: BackXPress, CHI '17

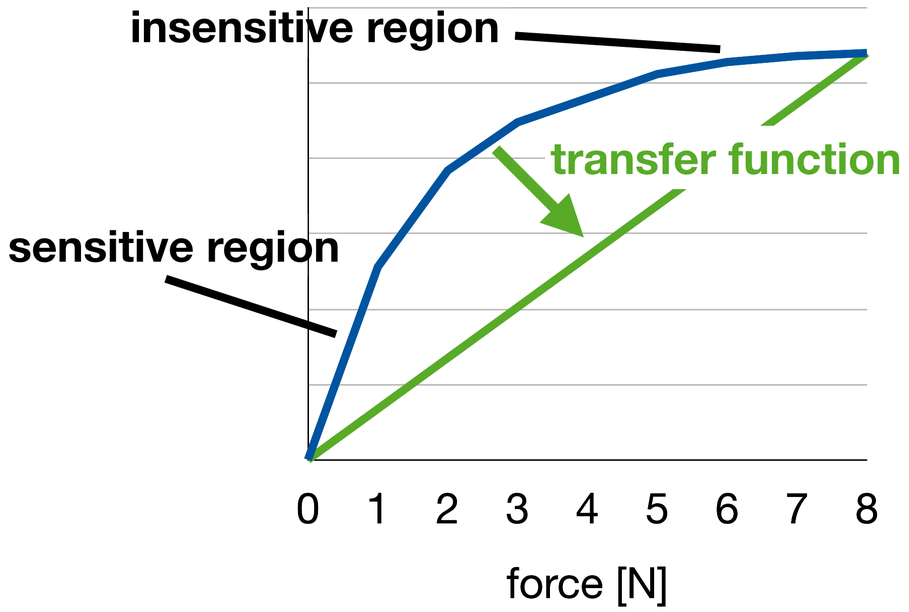
Force Sensing: Transfer Function

On an iPhone:



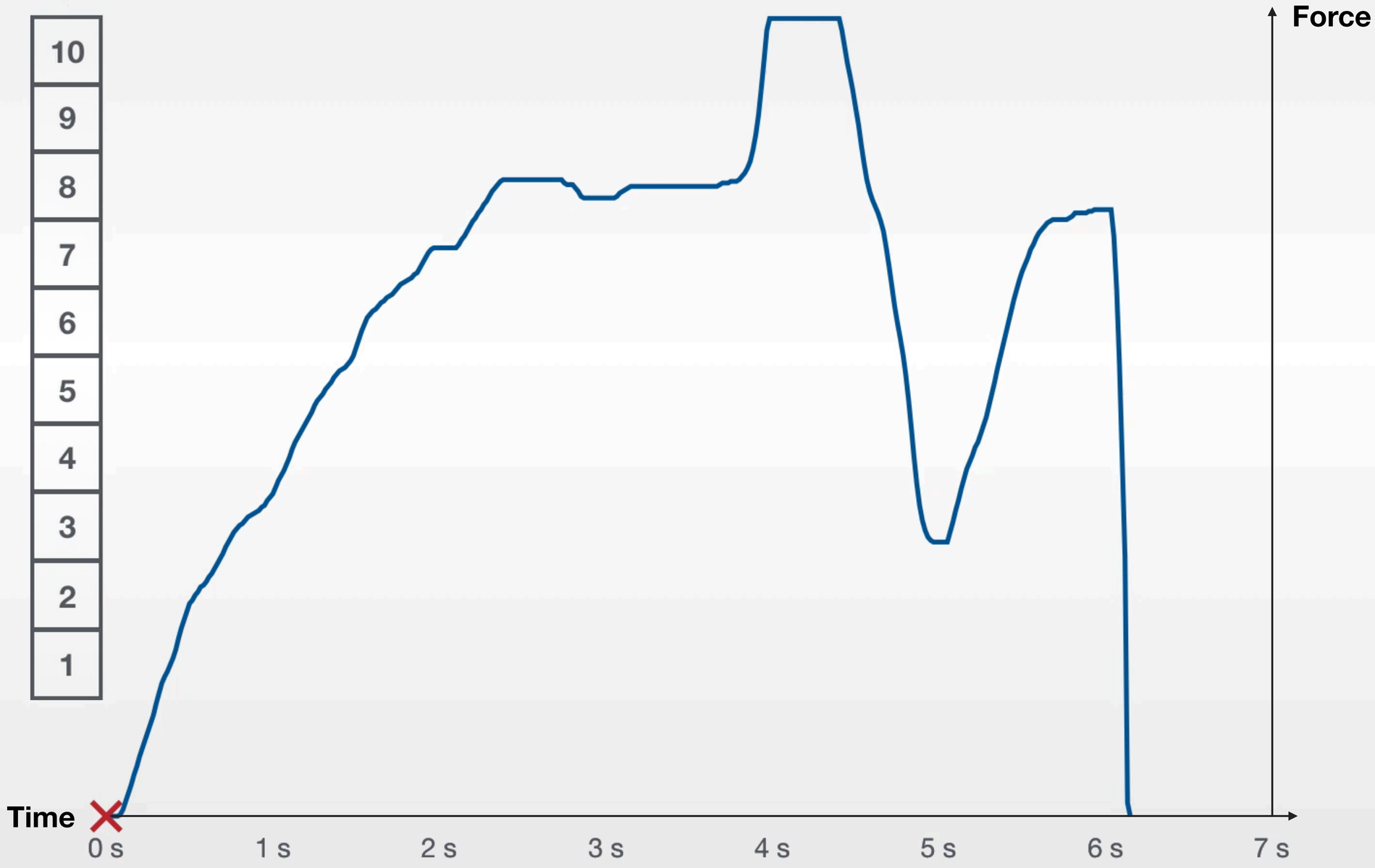


Using Force Sensing Resistors:

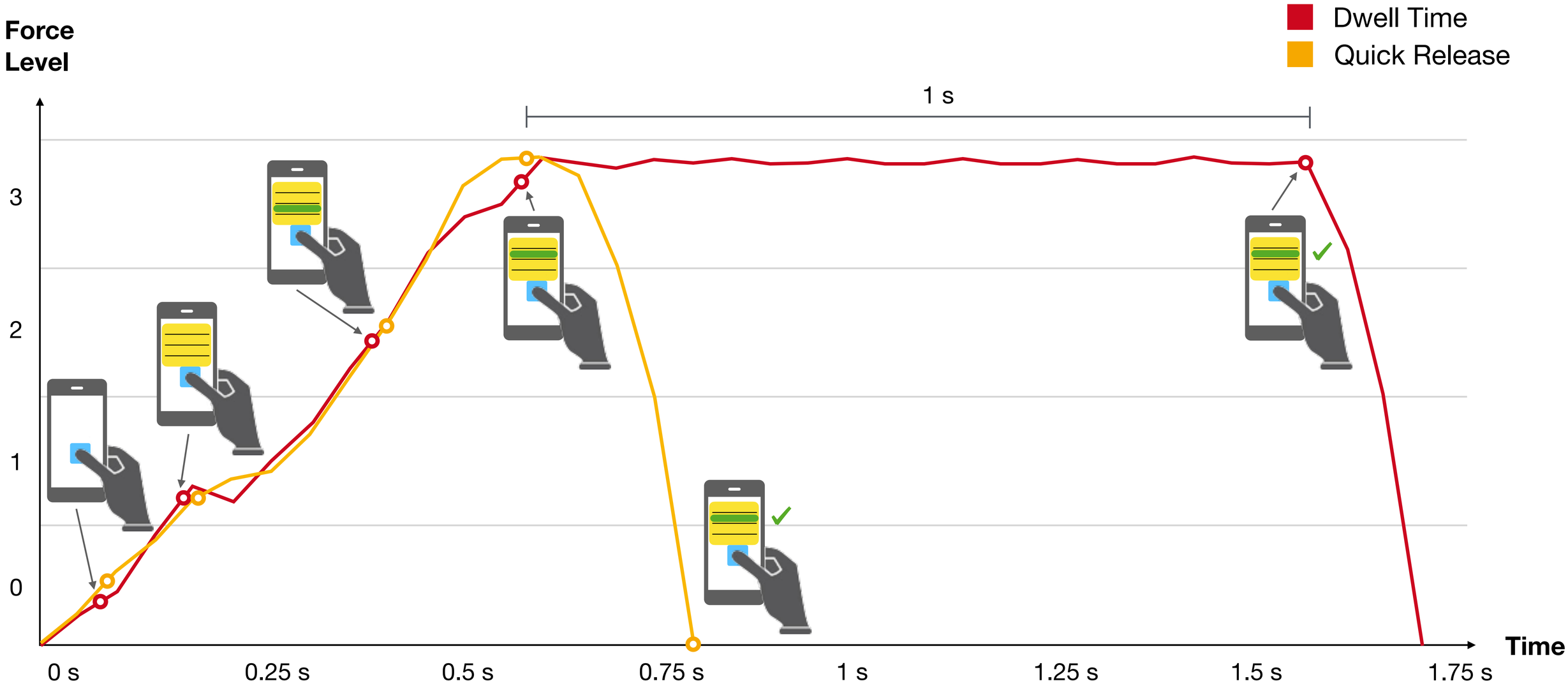


- Raw sensor value change can vary a lot for different force regions
- Transfer functions shall improve input control

Pressure-Based Linear Targeting (PBLT)



Confirming Value Selection



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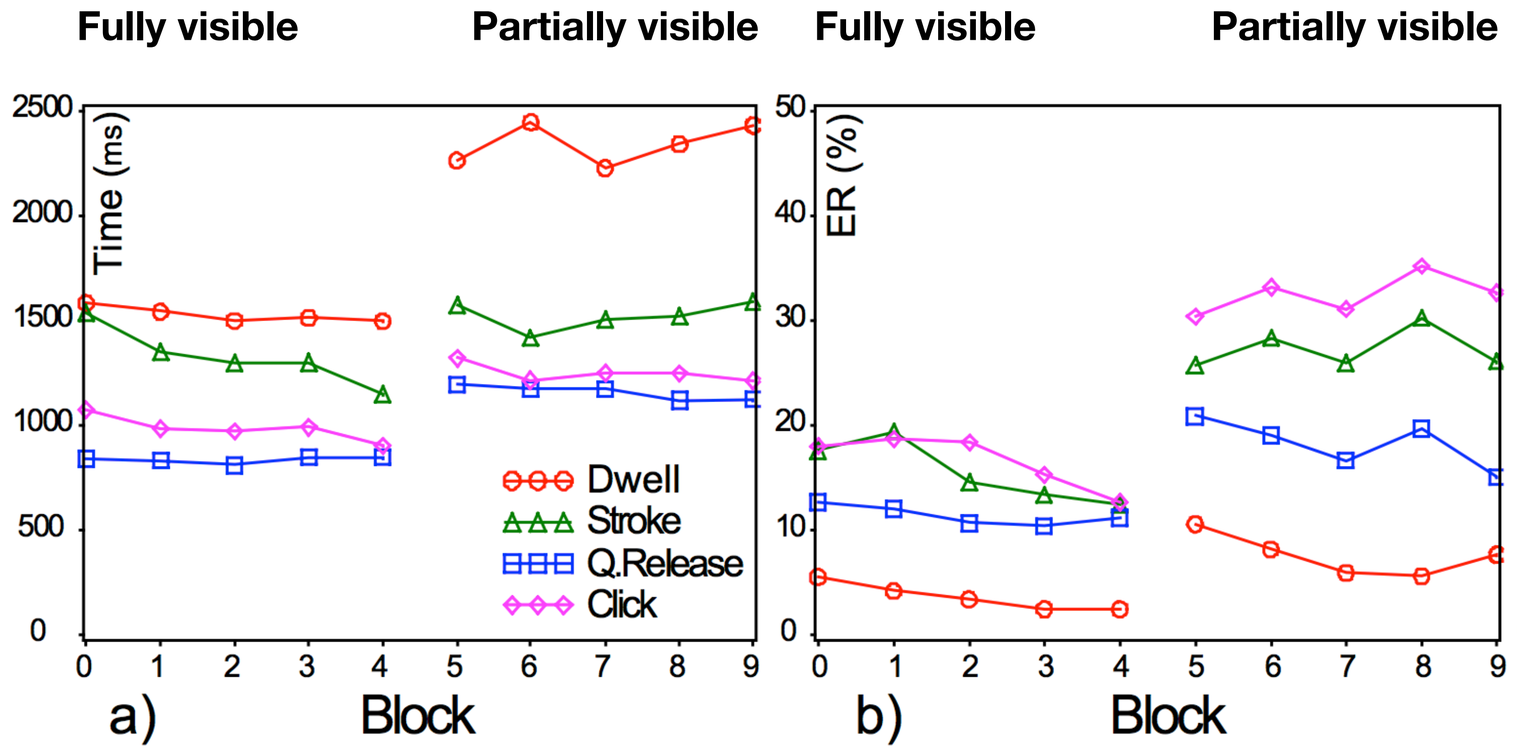
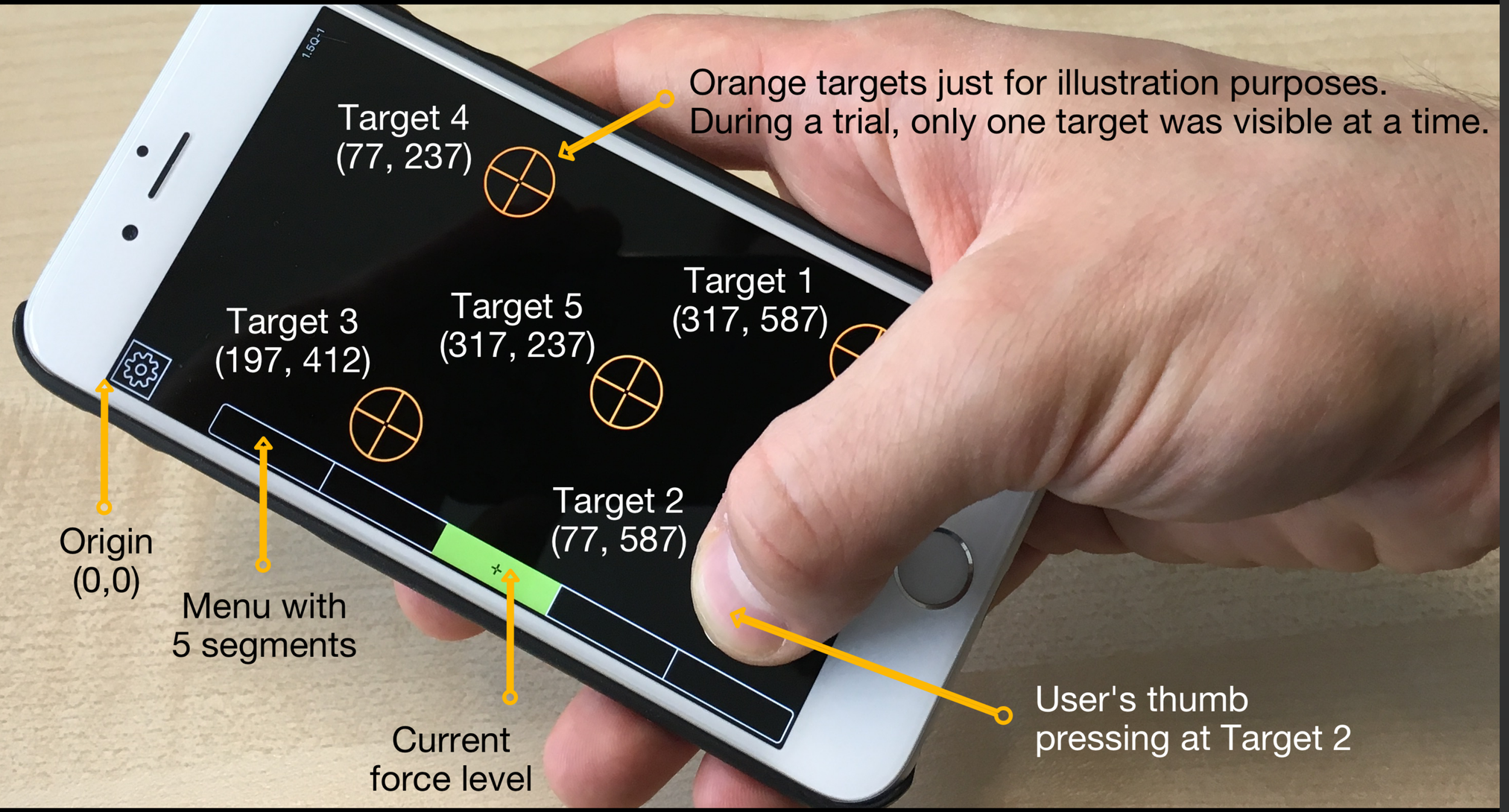
Quick Release vs. Dwell Time



Ramos et al., Pressure Widgets, CHI ‘04

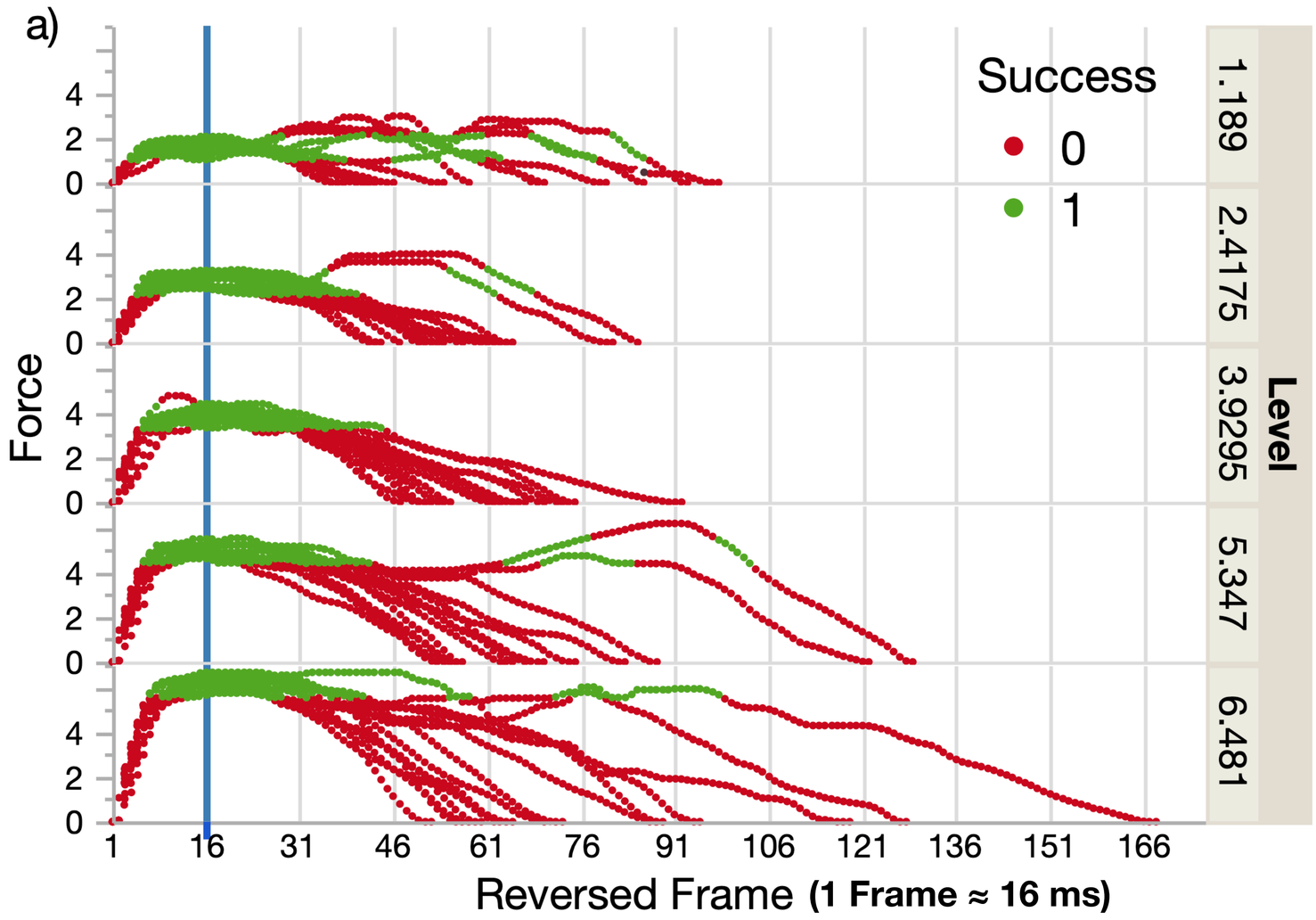
Quick Release vs. Dwell Time

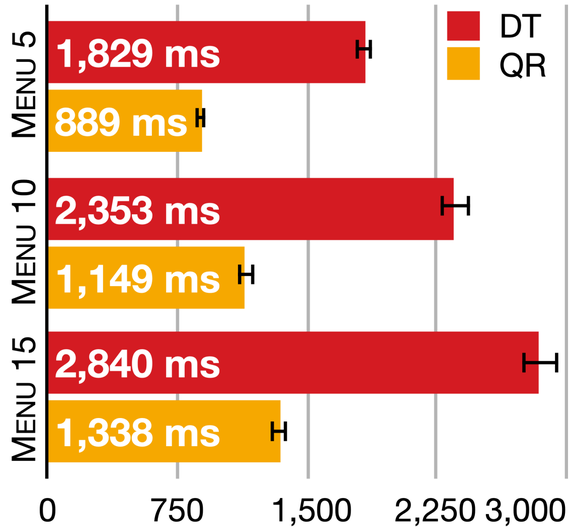


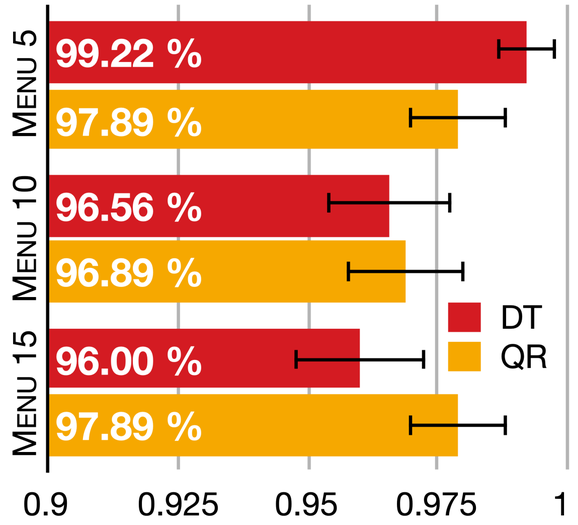
Release, Don't Wait!

Corsten et al.,
ISS '17

Quick Release vs. Dwell Time







Corsten et al., Release, Don't Wait!, ISS '17

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https://www.youtube.com/watch?v=_sPGvRXhDHE

ForceBoard:
Subtle Text Entry Leveraging Pressure

Mingyuan Zhong, Chun Yu, Qian Wang, Xuhai Xu, Yuanchun Shi

Department of Computer Science and Technology

Key Laboratory of Pervasive Computing, Ministry of Education

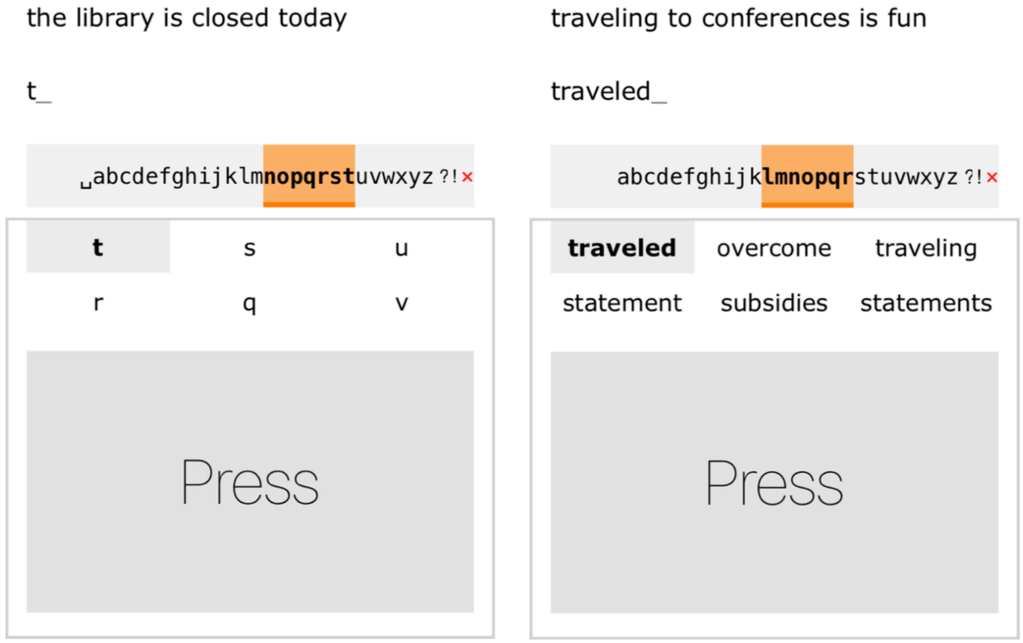
Global Innovation eXchange Institute

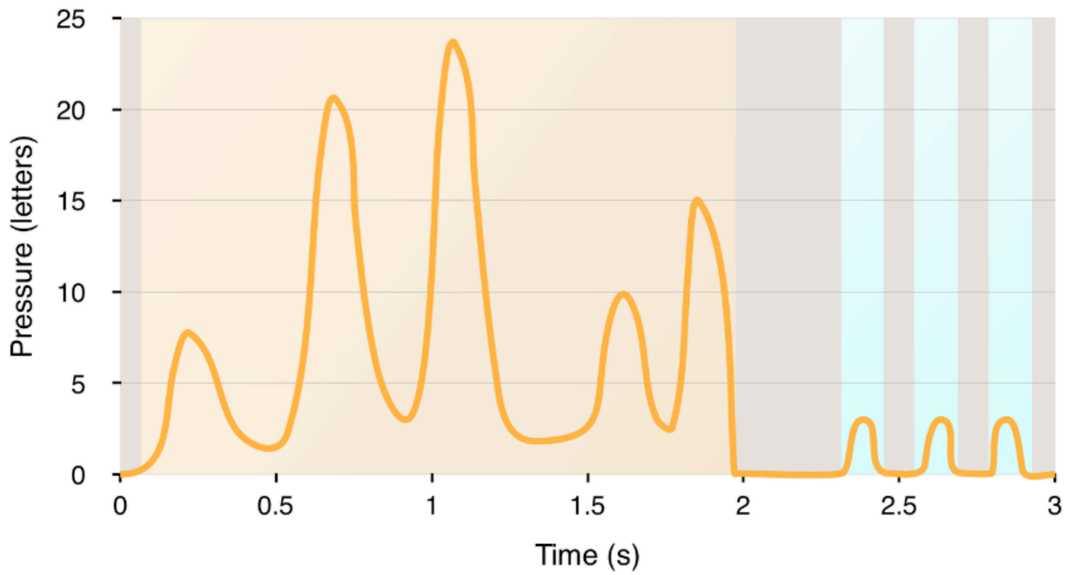
Tsinghua University, Beijing, China

ForceBoard

Zhong et al., CHI ‘18

- 1D keyboard with sliding cursor controlled by force + tap
- Cursor width: 7 characters
- Quick Release to select,
  tap to select from available choices
- 11 WPM after 10 minutes of training





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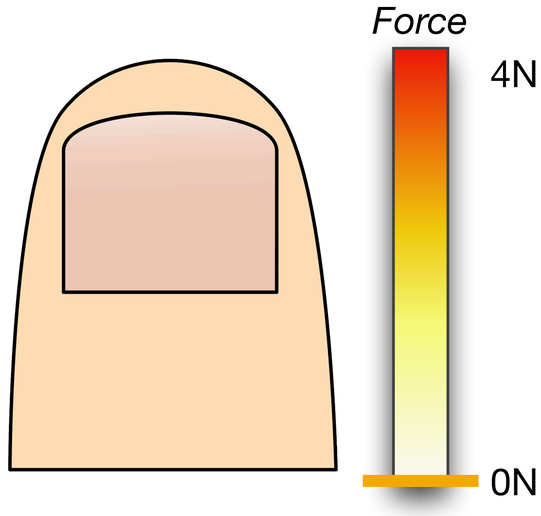
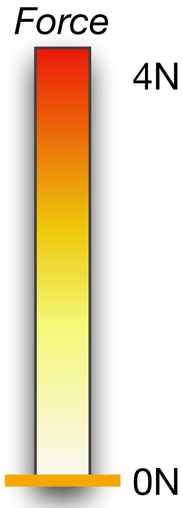
Control Mechanisms

Positional Control



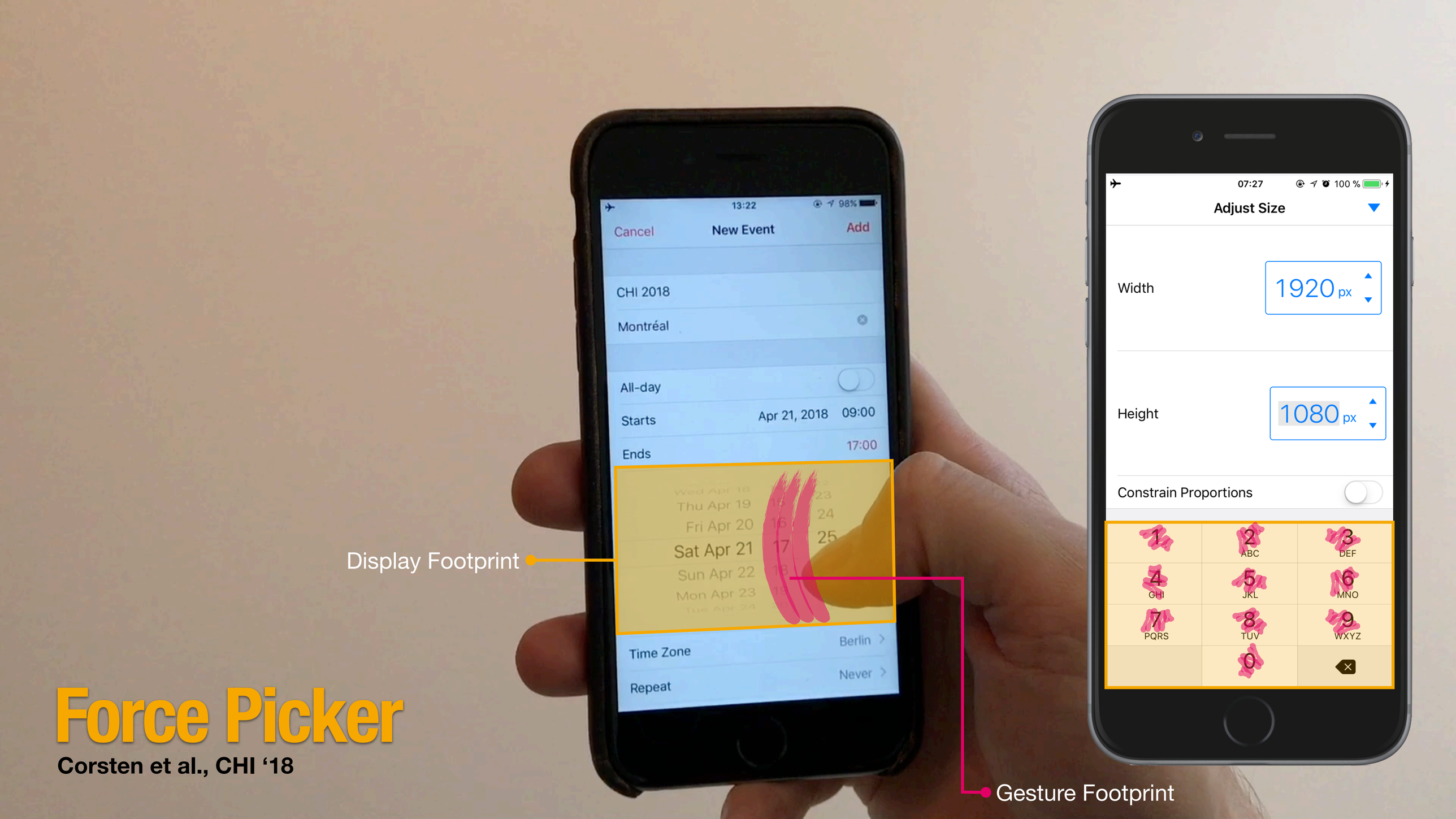
Rate-based Control



How to *decrease* the value?

Force Picker

Corsten et al., CHI ‘18

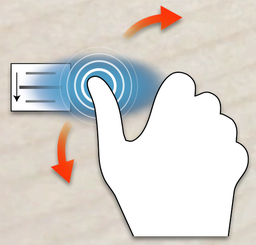


Force Picker

Corsten et al., CHI '18

Force Picker

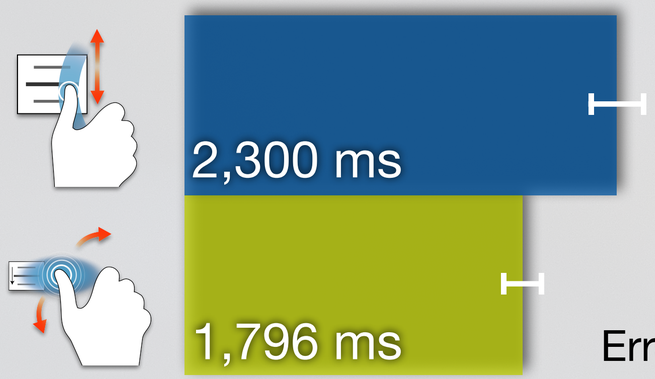
Corsten et al., CHI ‘18



Force Picker

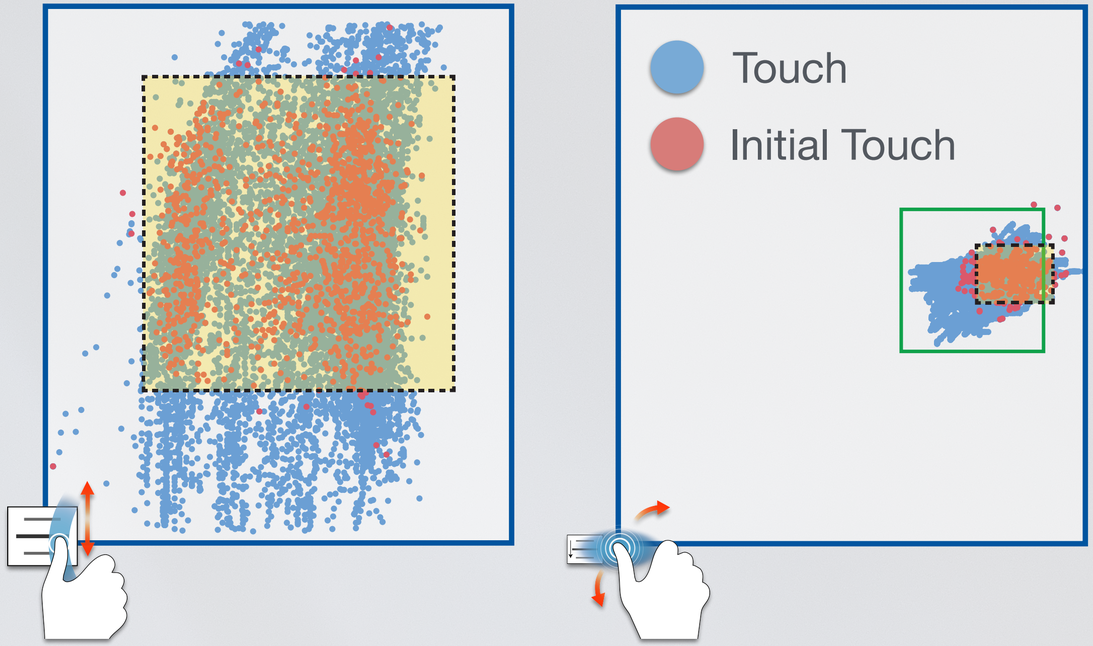
Corsten et al., CHI ‘18

Time after Training



Error bars: 95% CI

Gesture Footprint after Training



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Force Control Performance: How To Quantify?

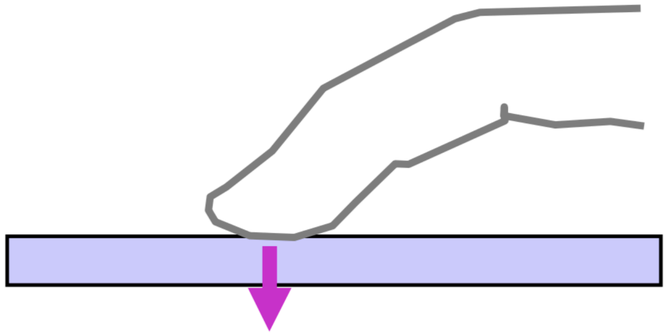
- Task completion time (measured in ms)
- Error rate
  - How often did the user *not* select the correct item?
- Number of crossings
  - Just accidental over- & undershoots or hard to use the technique?
- Pressure variance/jitter
  - Can indicate difficulties controlling the force in your technique

Reverse Direction: GraspZoom & PreSense II

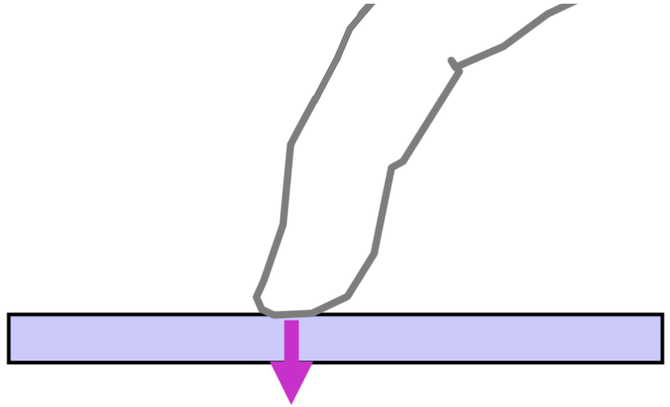
Miyaki et al.:
***GraspZoom*, MobileHCI '09**

- Zoom-in: force
- Zoom-out: swipe & force

Large Contact Area: Increase Value

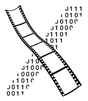


Small Contact Area: Decrease Value



Rekimoto et al.: PreSenseII, CHI '06

Application Examples



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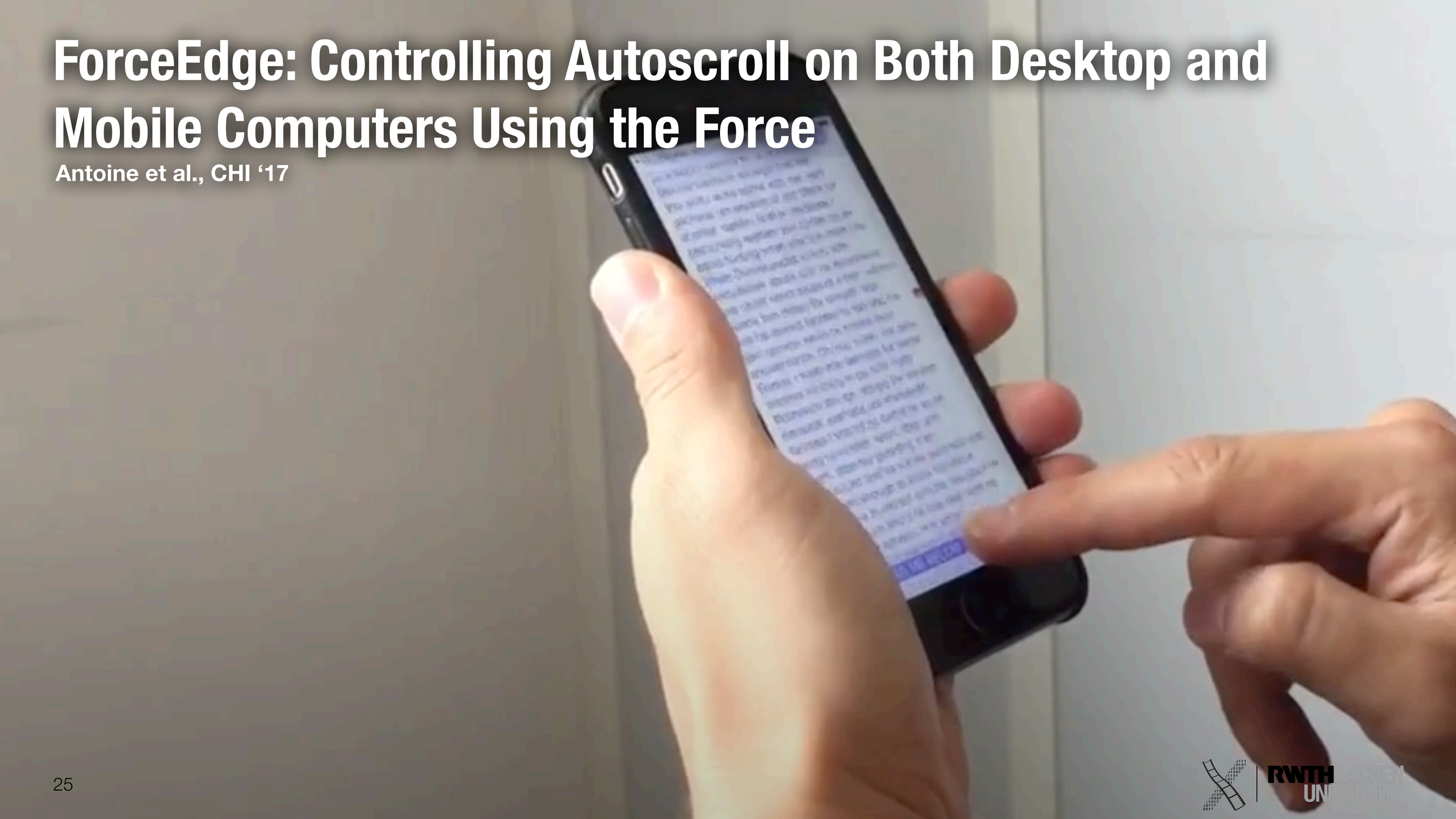
ForceEdge: Controlling Autoscroll on Both Desktop and Mobile Computers Using the Force

Antoine et al., CHI ‘17



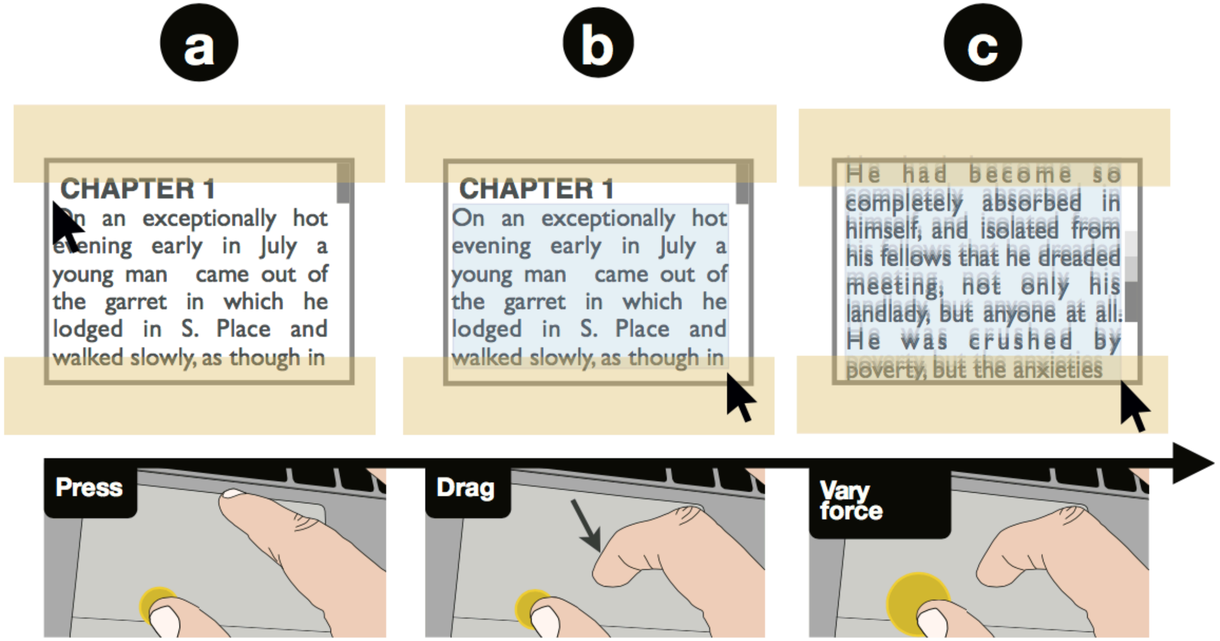
ForceEdge: Controlling Autoscroll on both Desktop and Mobile Computers using the Force

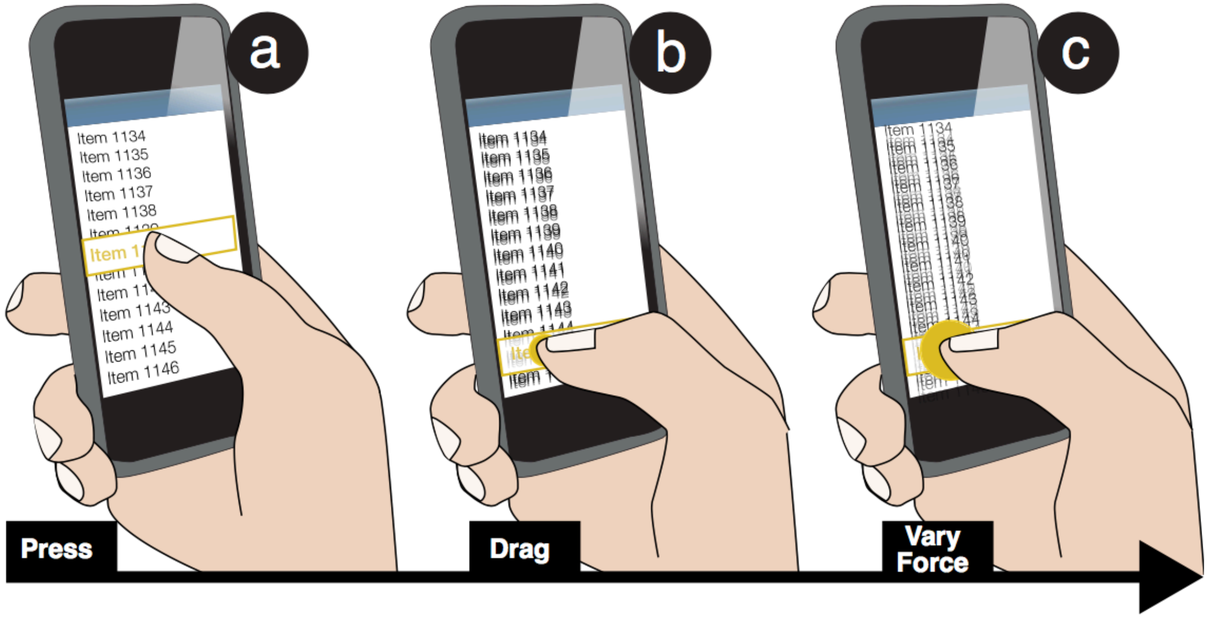
Axel Antoine, Sylvain Malacria, Géry Casiez

CHI 2017 Video Preview

ForceEdge

Antoine et al., CHI ‘17





- Trackpad: 45% shorter moving time
- Smartphone:
  - 58% faster
  - 16% less errors

BackXPress: Using Back-of-Device Finger Pressure to Augment Touchscreen Input on Smartphones

Christian Corsten – Bjoern Daehlmann – Simon Voelker – Jan Borchers

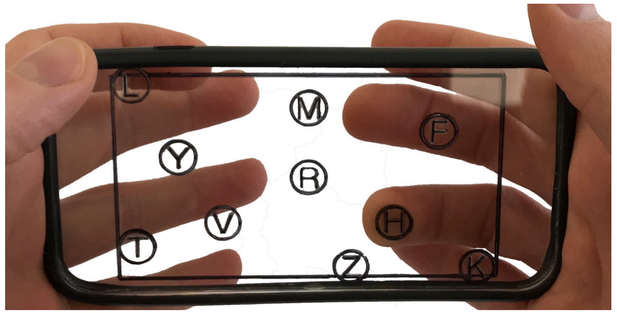
Chair for Computer Science 10 (Media Computing and Human-Computer Interaction)

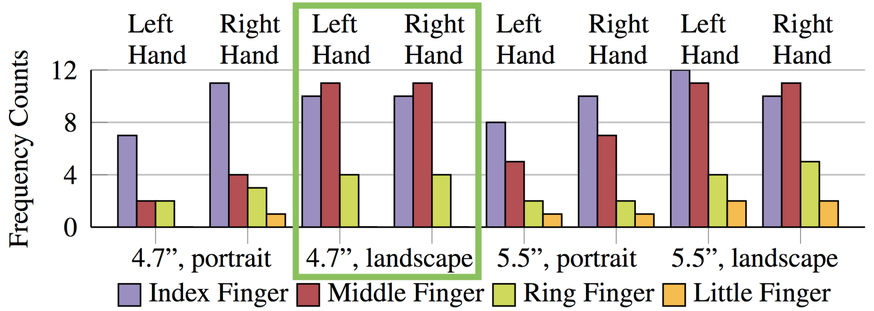
RWTH AACHEN UNIVERSITY

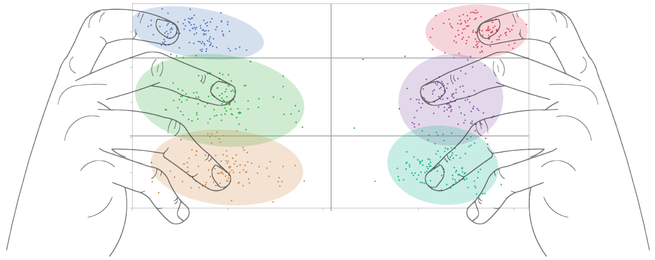
www.hci.rwth-aachen.de

BackXPress

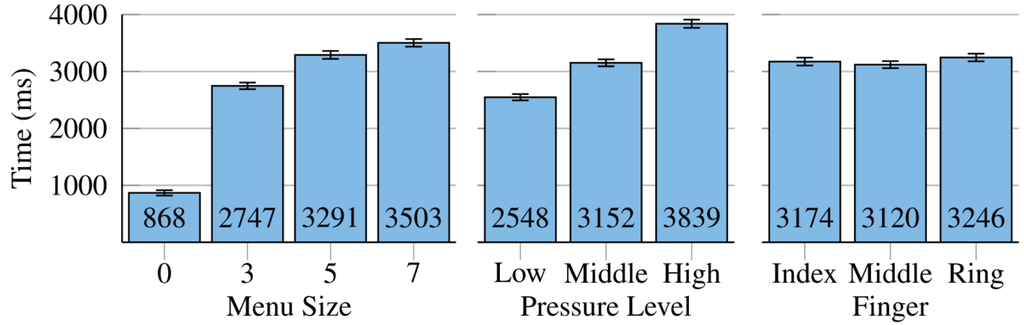
Corsten et al., CHI ‘17

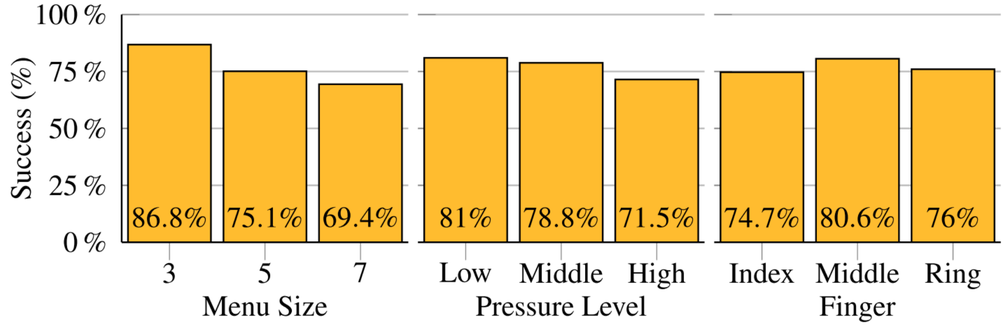






1-Tap:





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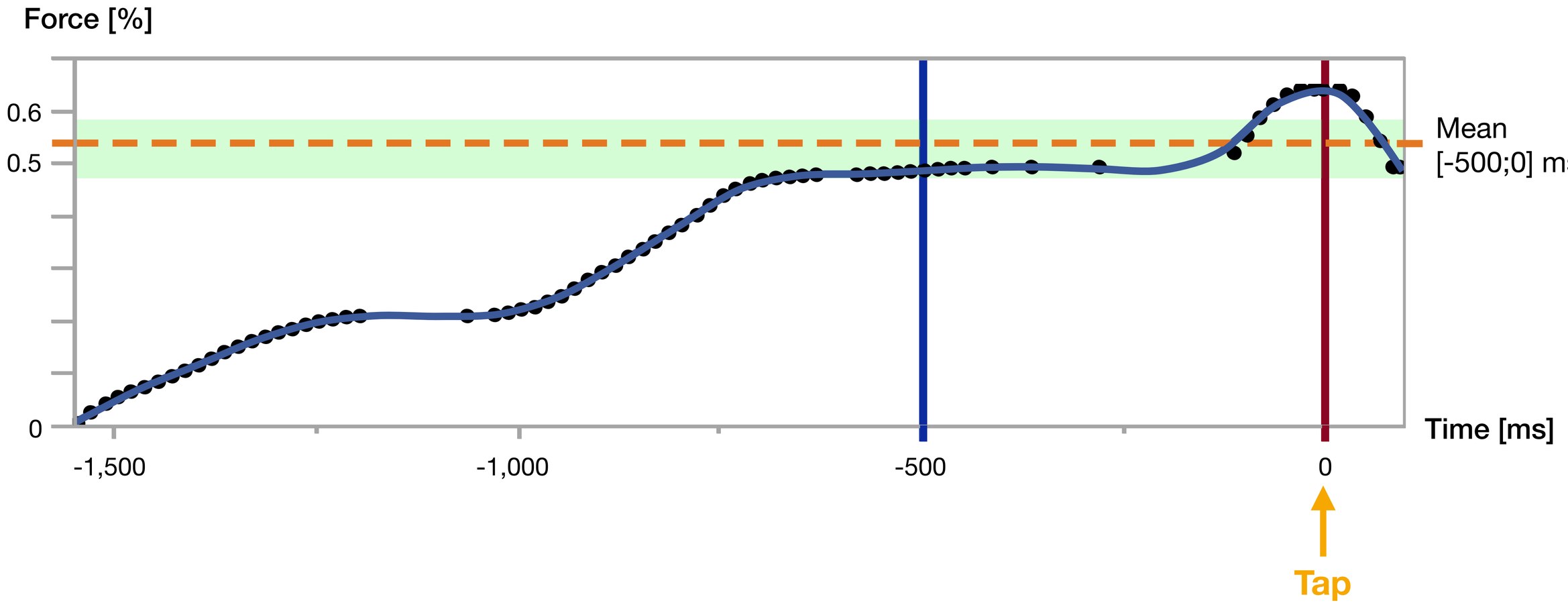
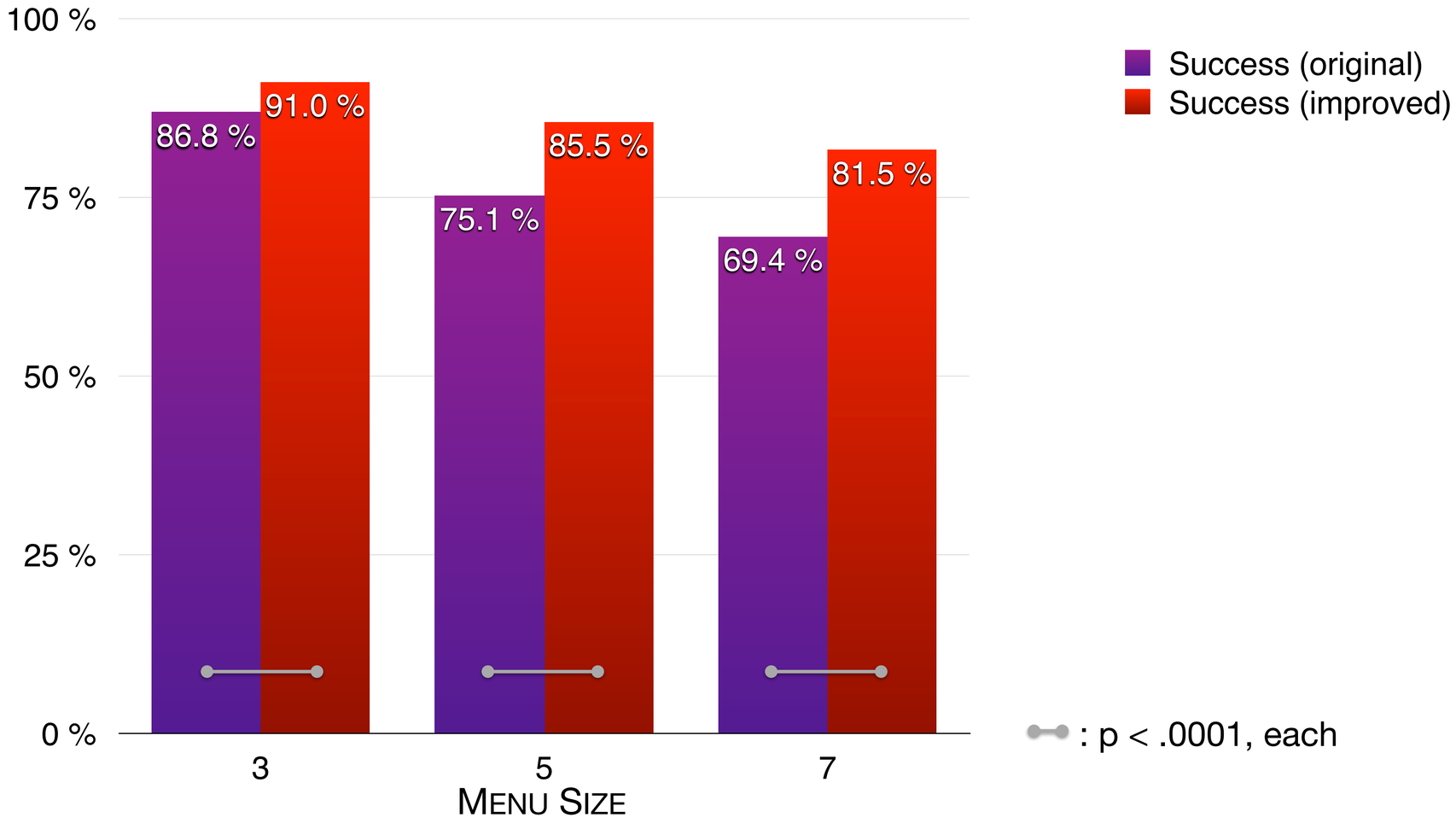
BackXPress

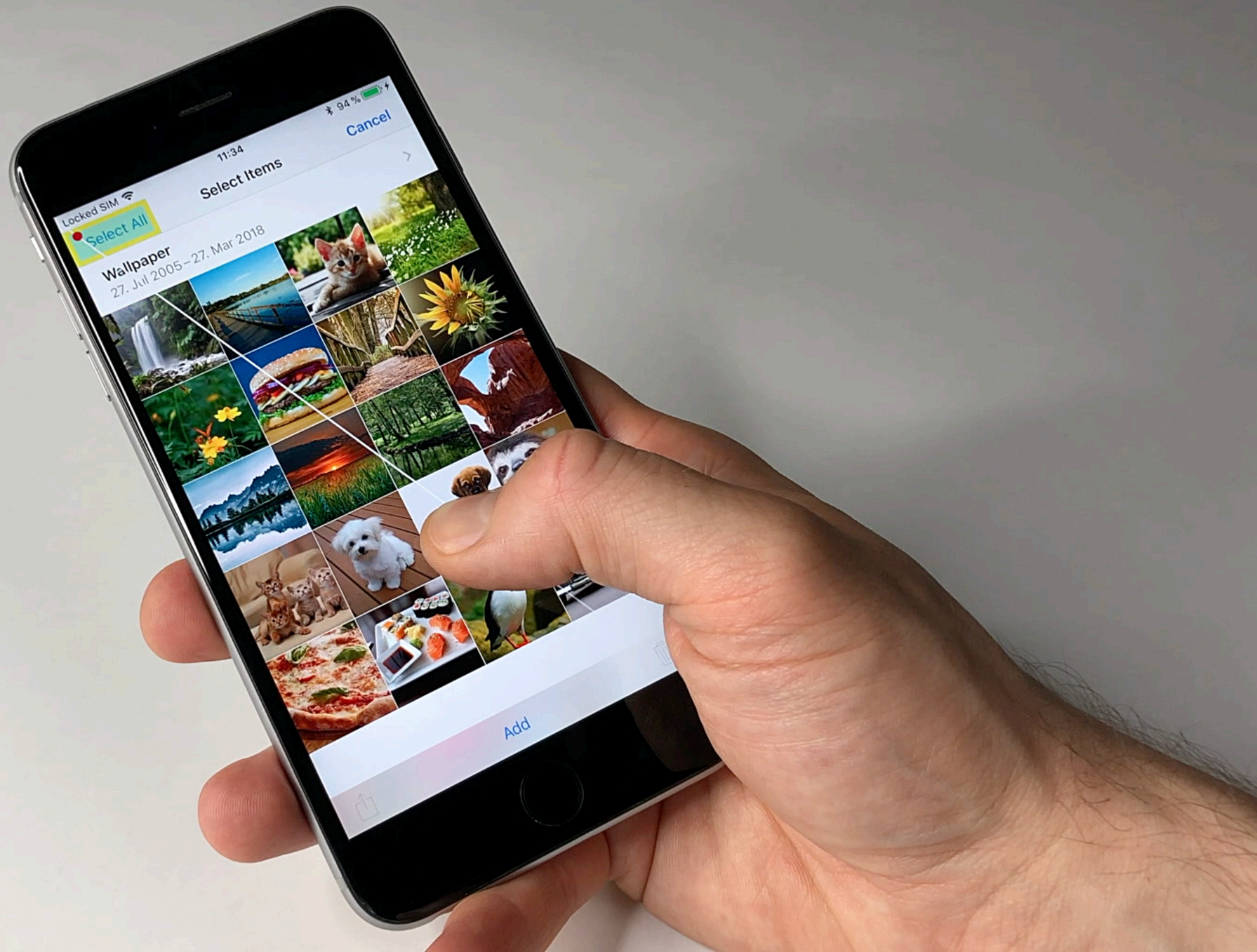


BackXPress



ForceRay

Corsten et al., CHI ‘19



ForceRay:

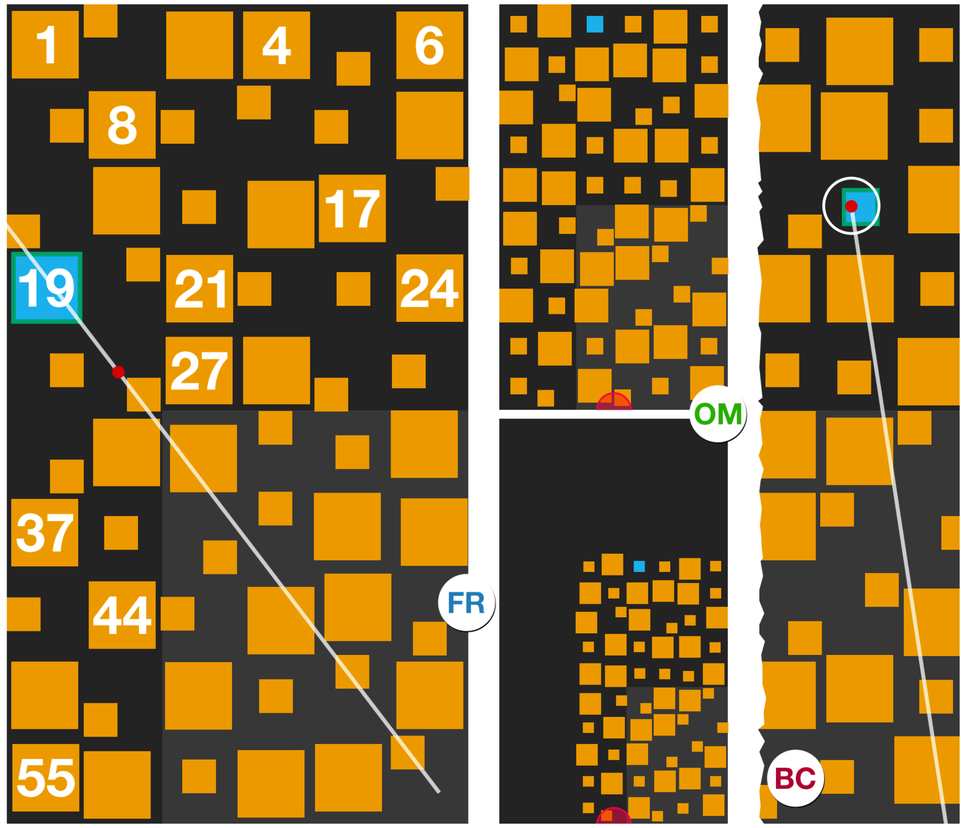
Extending Thumb Reach via Force Input Stabilizes Device Grip for Mobile Touch Input

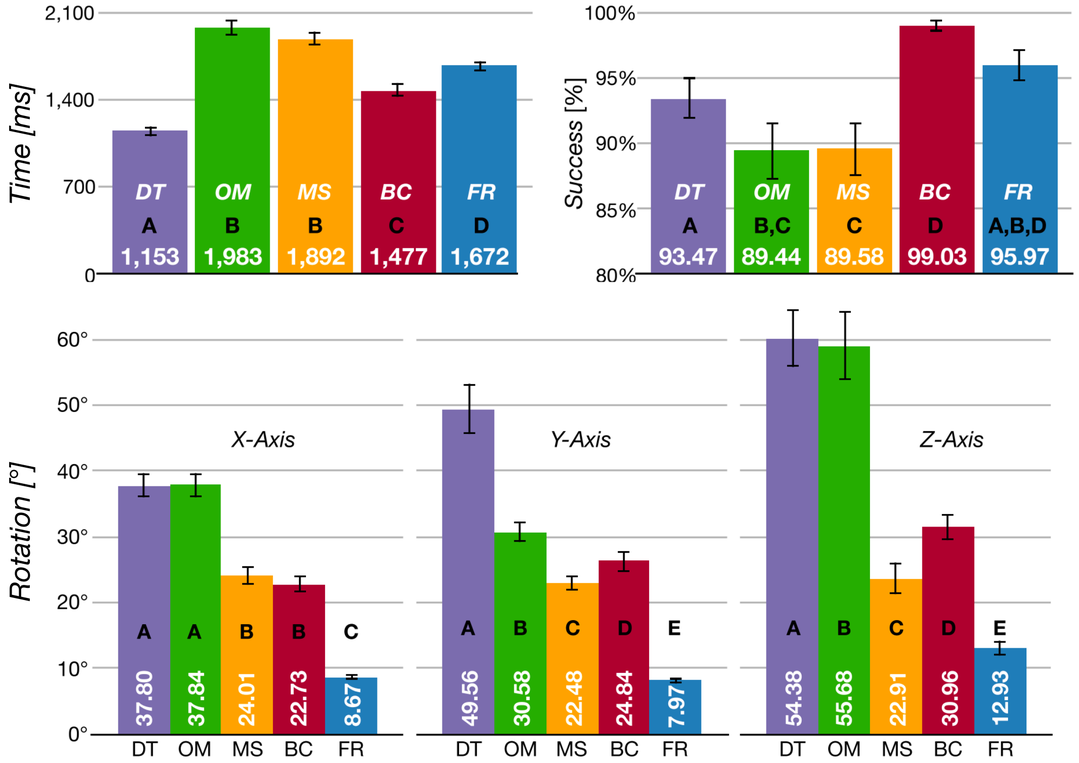
Christian Corsten, Marcel Lahaye, Jan Borchers, and Simon Voelker

hci.rwth-aachen.de/ForceRay

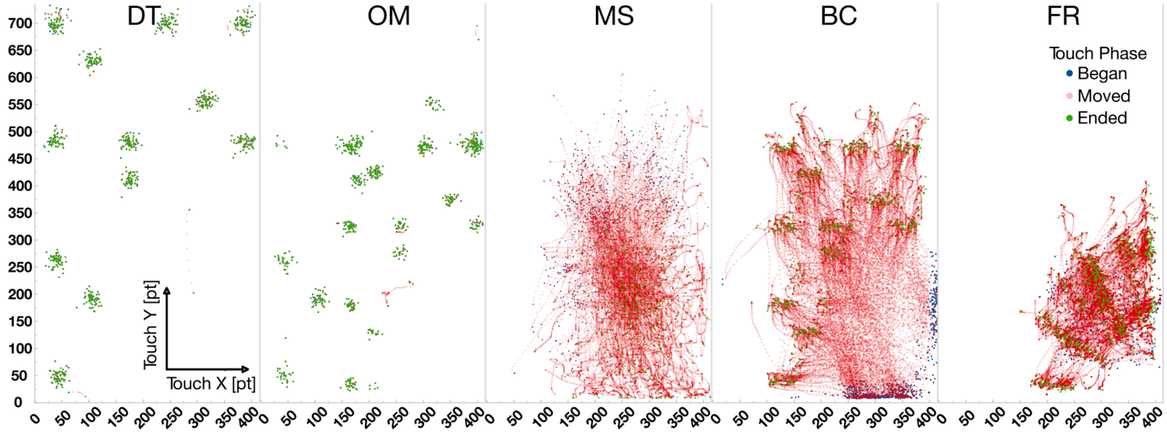
RWTH AACHEN UNIVERSITY

ForceRay



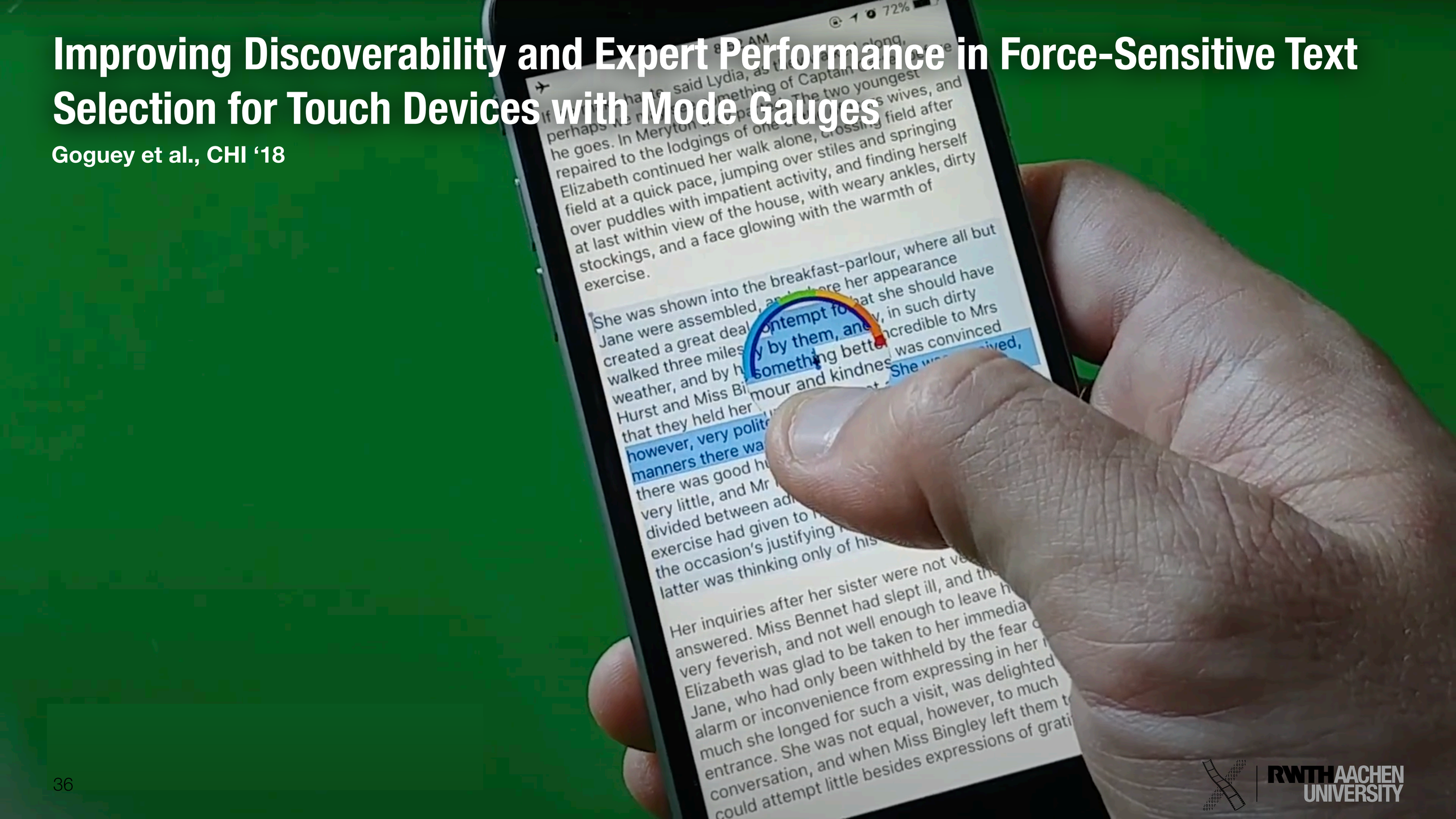


*Techniques not charing the same letter are significantly different.



Improving Discoverability and Expert Performance in Force-Sensitive Text Selection for Touch Devices with Mode Gauges

Goguey et al., CHI ‘18



Improving Discoverability and Expert Performance in Force-Sensitive Text Selection for Touch Devices with Mode Gauges

Alix Goguey[1], Sylvain Malacria[2], Carl Gutwin[1]

CHI 2018

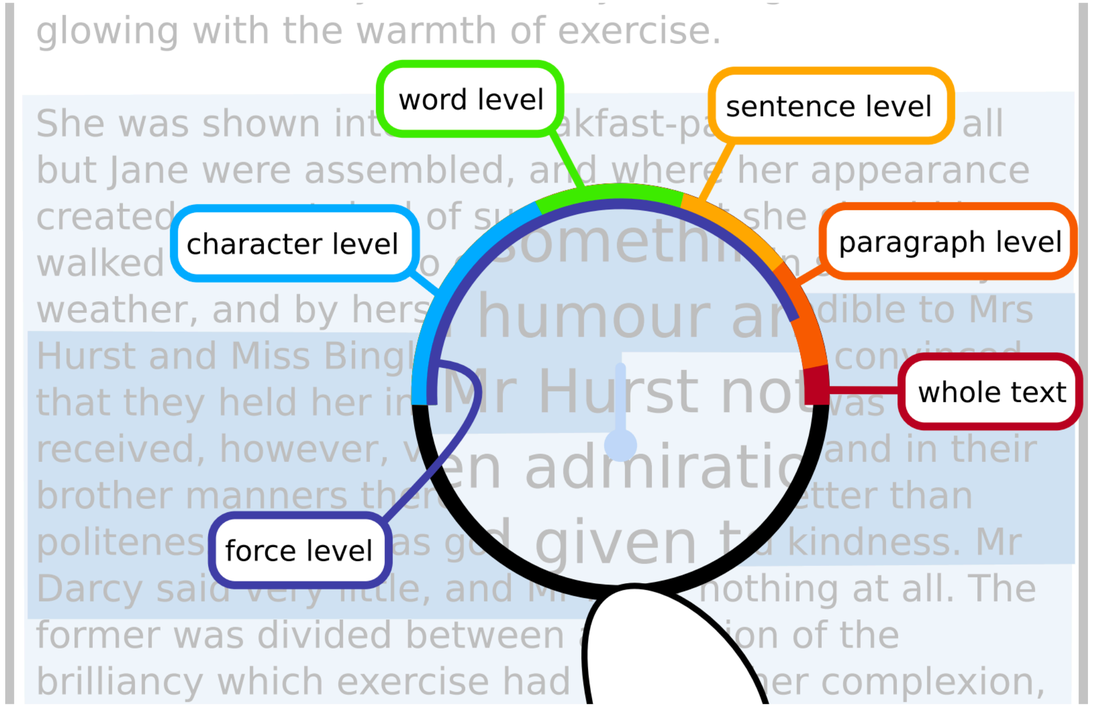
[1]University of Saskatchewan, Canada, [2]Inria, France

https://www.youtube.com/watch?v=DY9F8ULxpS0

Discoverability of Force

- Force interaction often misses signifiers

- Showing continuous feedback helped the users to discovering the technique



Summary

- Pressure input extends touch input by adding a z-dimension
- Embedded in desktop and handheld devices
- Benefits: Input from idle fingers, could address occlusion and reachability issues on handheld devices
- Force input needs feedback for better control and discoverability
- A lot of factors influence human performance: Levels, transfer function, control mechanism, feedback, selection mechanism, …
- Usual DV’s: Task completion time, error rate, number of crossings