Enhancing Spatial Input on the Body with a Smart-Ring

Andrea Bianchi, Seungwoo Je, Hyelip Lee, Ian Oakley

MAKinteract

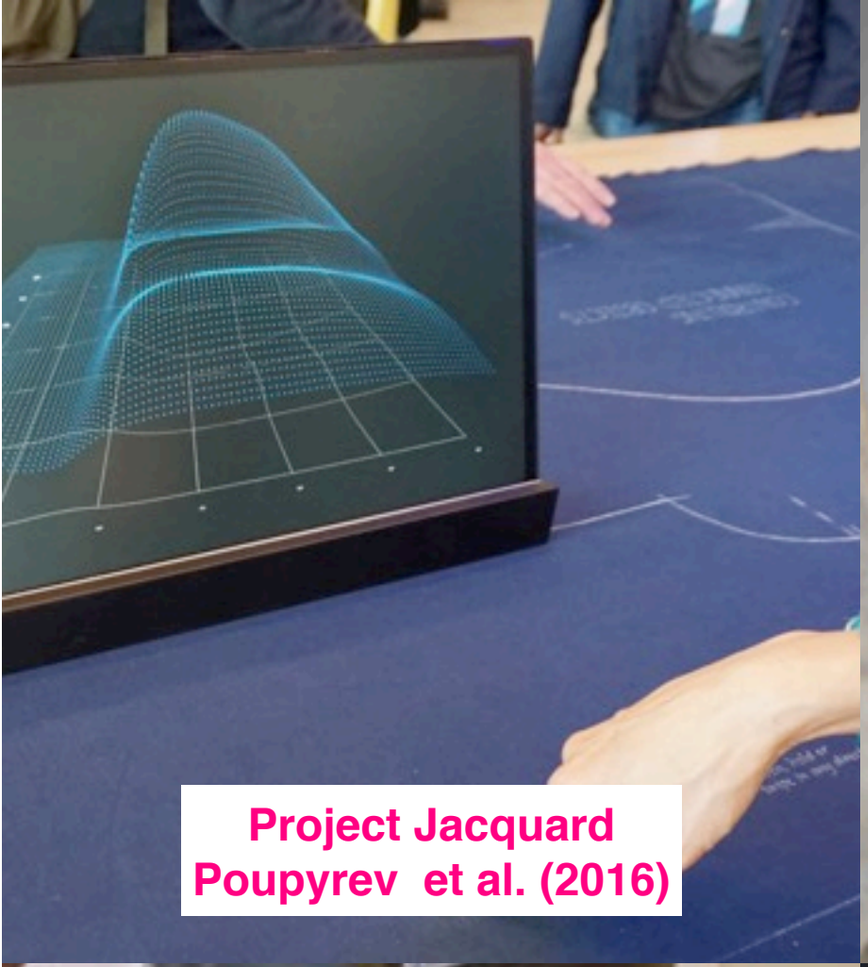
id KAIST UNIST

A common problem

Limited input space:
constrains / precision

Where Does the Mouse Go?
Thomas et al. (2002)

Can we use body as an extension of the input space?



Project Jacquard
Poupyrev et al. (2016)

Pinstripe
Karrer et al. (2011)

FabriTouch
Heller et al. (2014)

Capacitive Touch
Holleis et al. (2008)

PocketTouch
Saponas et al. (2011)

Skinput
Harrison et al. (2010)

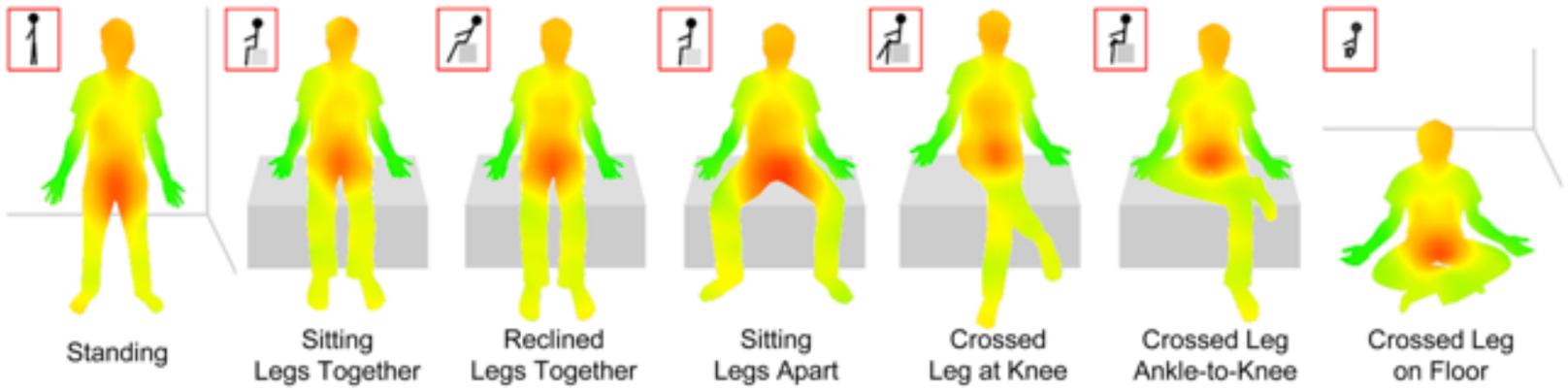
The body has a potentially huge input canvas

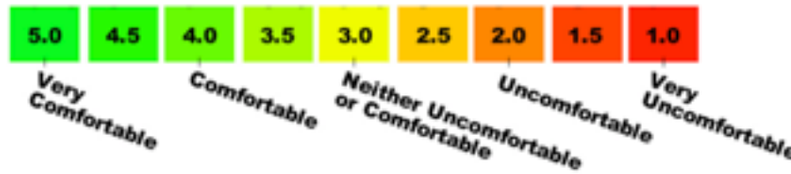
Are all body parts suitable for input?

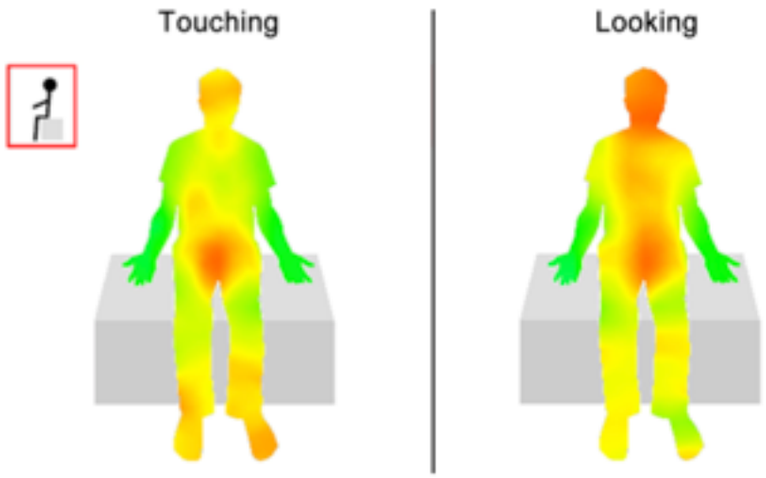
Where is ok to display information?
Where is ok to touch?

On-Body Projection

Harrison and Faste (2014)







On-Body Touches

Wagner et al. (2013)

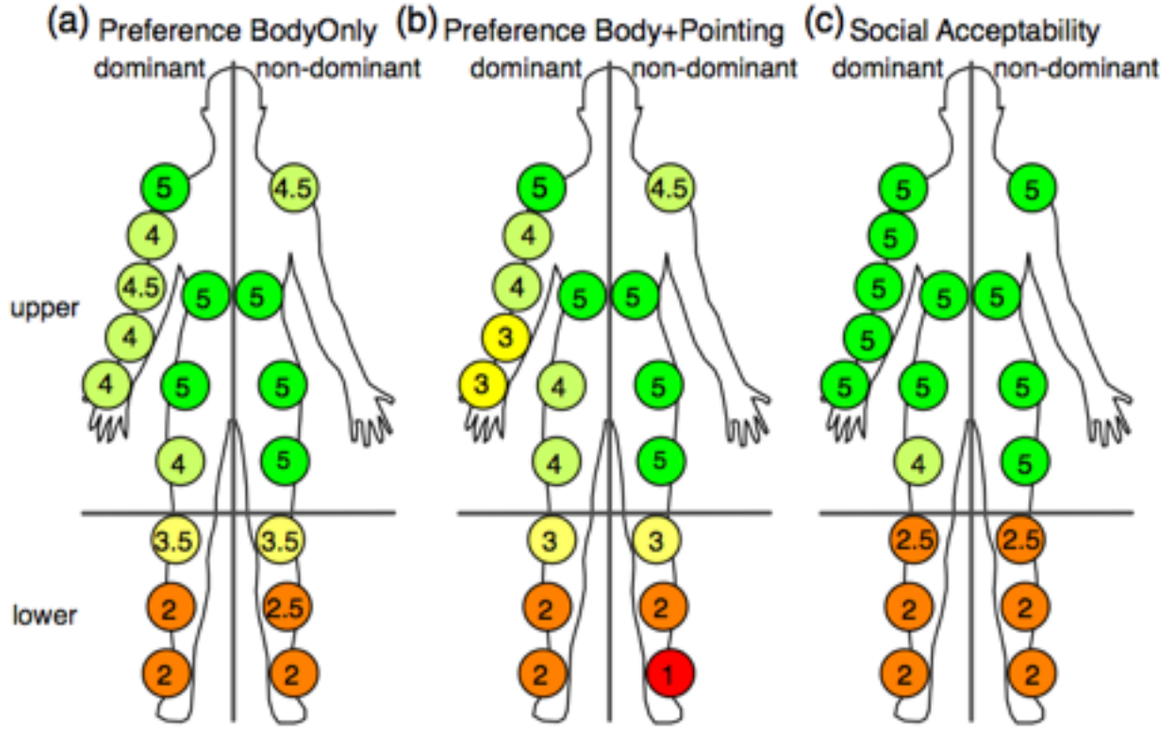


Figure 7. Median preference and acceptability rankings of on-body targets (from green = acceptable to red = unacceptable).

The body has a potentially huge input canvas

*but **practical** eyes-free input space is small*

22

Limited input space:

constrains / precision

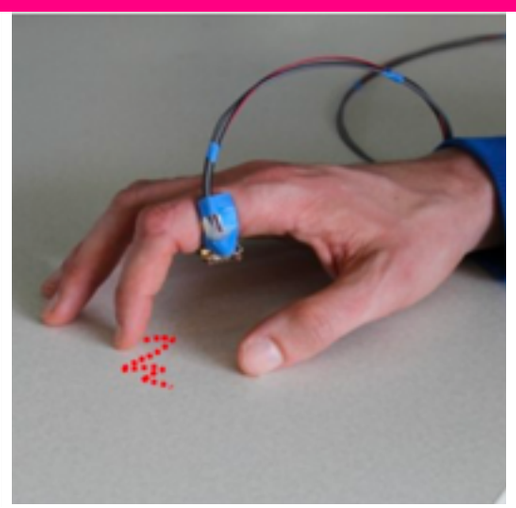
Touch + Ring

Can we combine touch selections on the body with complementary input on a ring wearable to increase the input space at almost no cost?

Three Rings for the Elven Lords under the Sky…

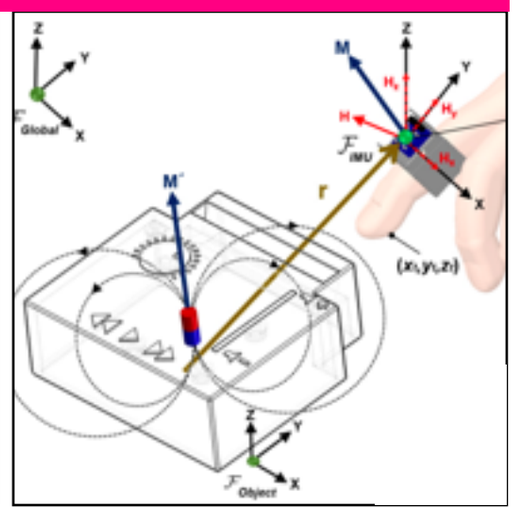
Tracking

uTrack (Chen)



LightRing (Kienzle)

Magic finger (Yang)



TRing (Yoon)

Input

Nenya (Ashbrook)

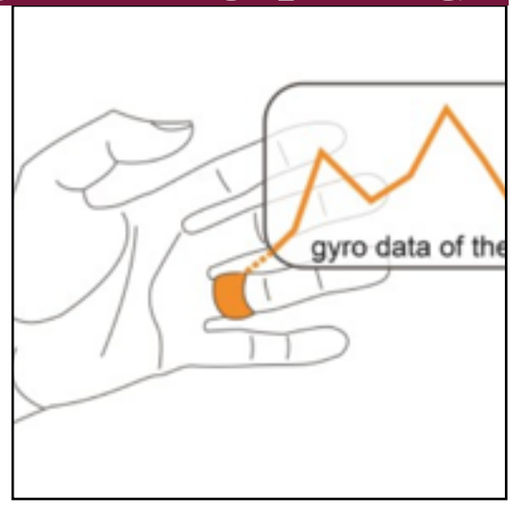
iRing (Ogata)

Notification

NotiRing (Roumen)

Miscellaneous (e.g., reading, pairing)

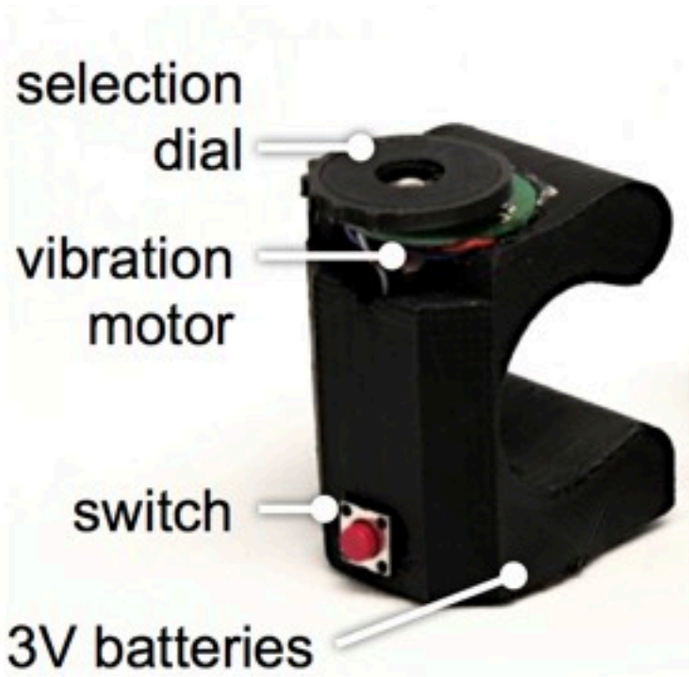
FingerReader (Shilkrot)



PickRing (Wolf)

MAKinteract

Input and output rings

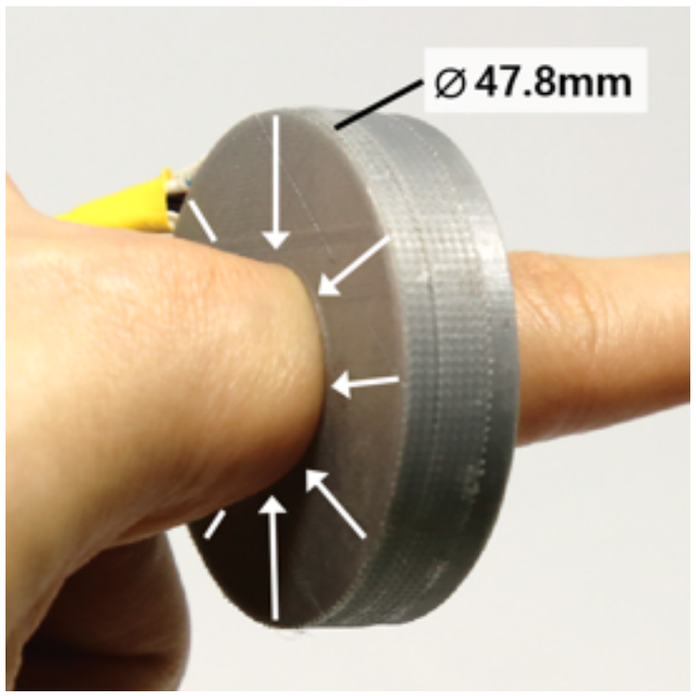


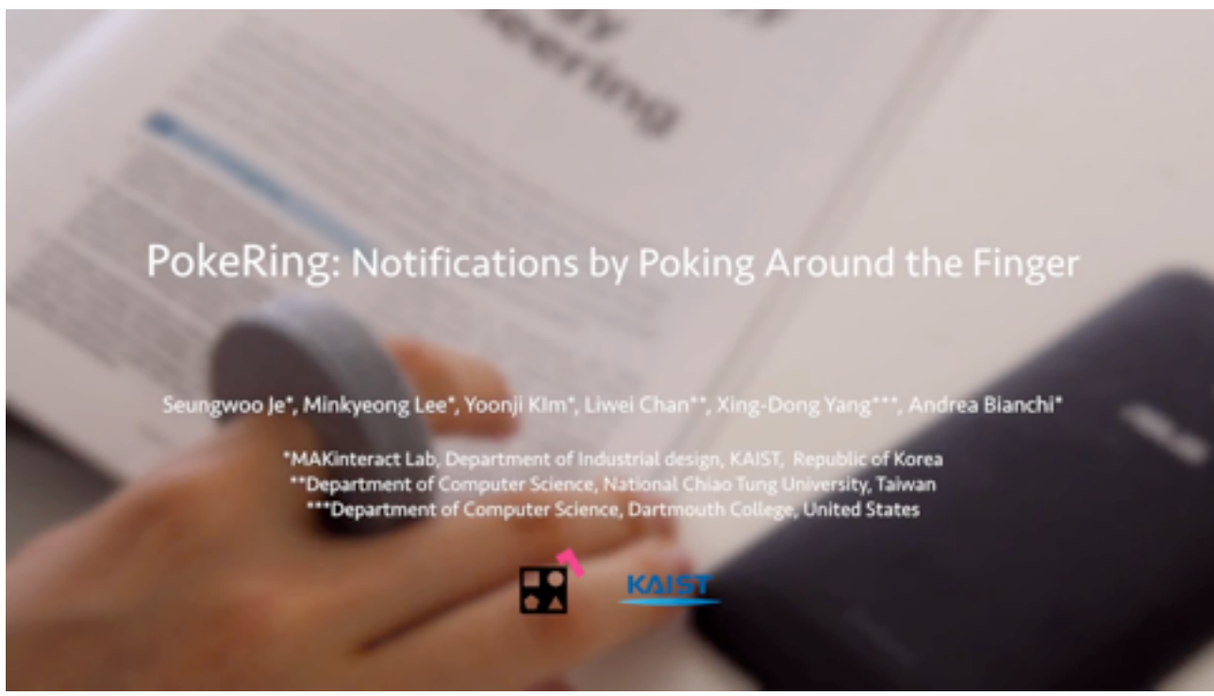
Disambiguating input through touch + ring

VibRing
Bianchi and Je
(Augmented Human 2017)

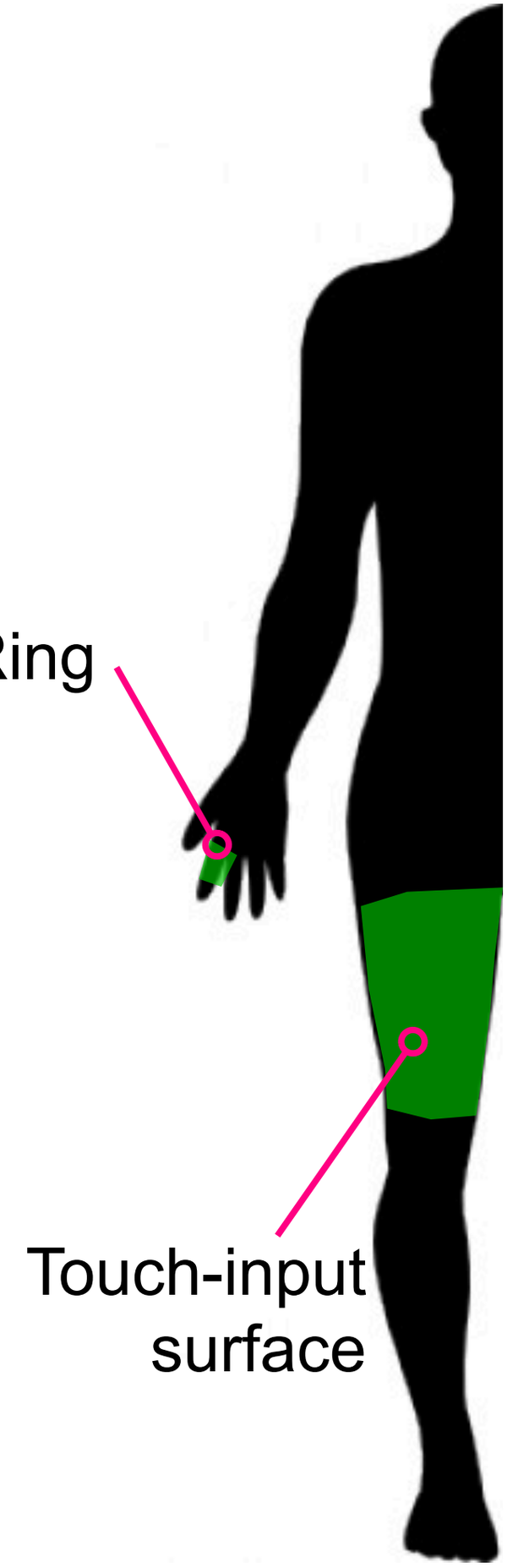
Rich output notifications with a ring

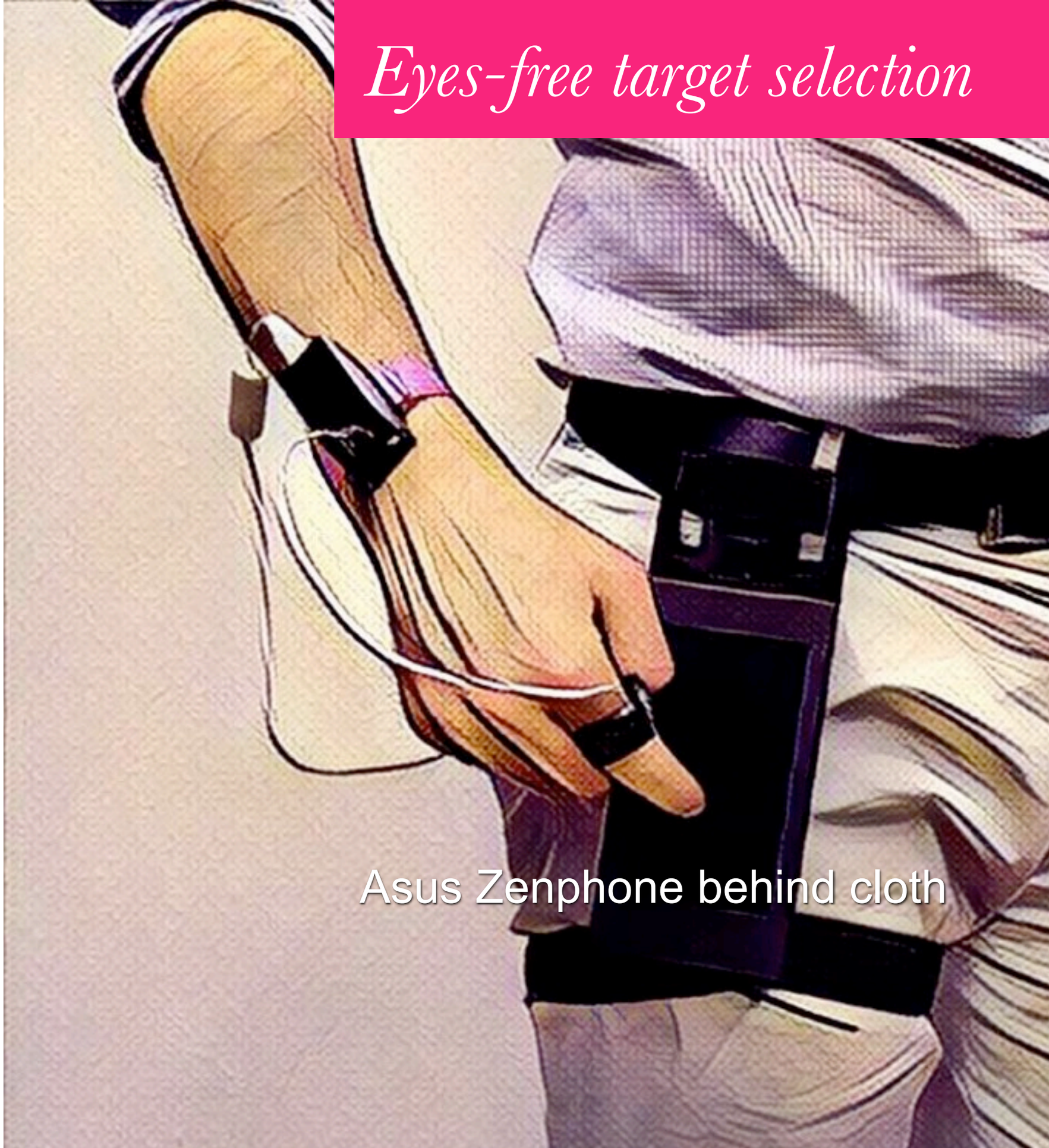
PokeRing
Je et al. (CHI 2018)



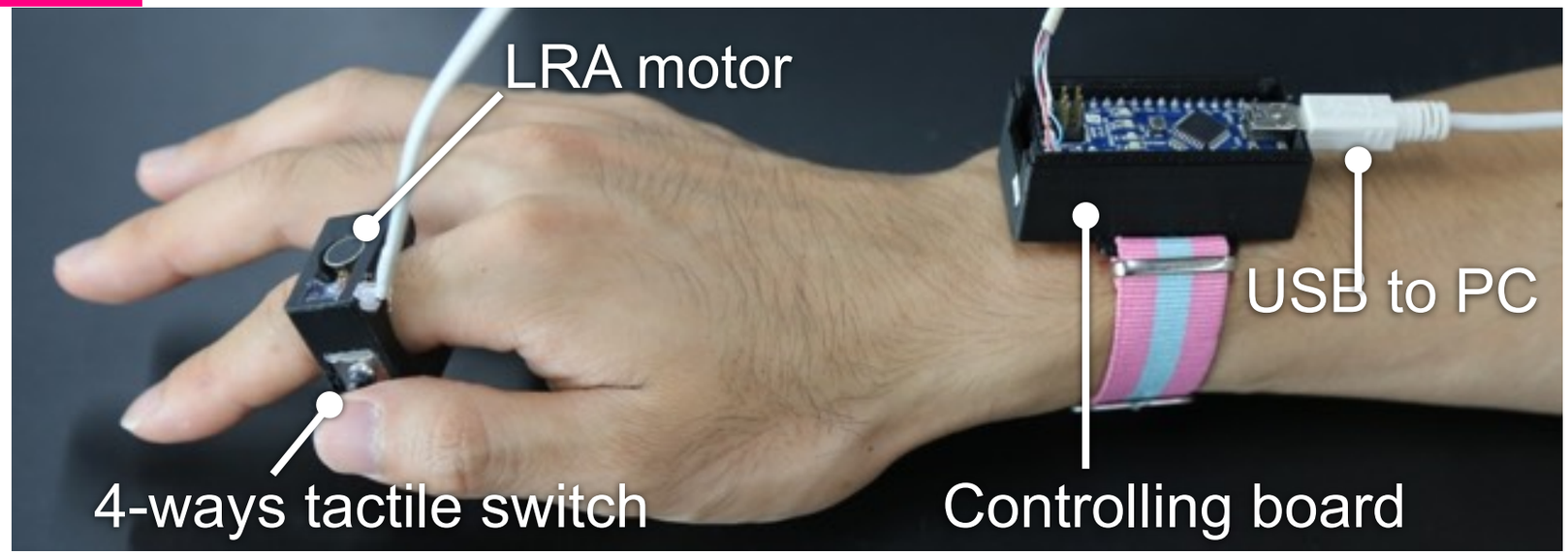


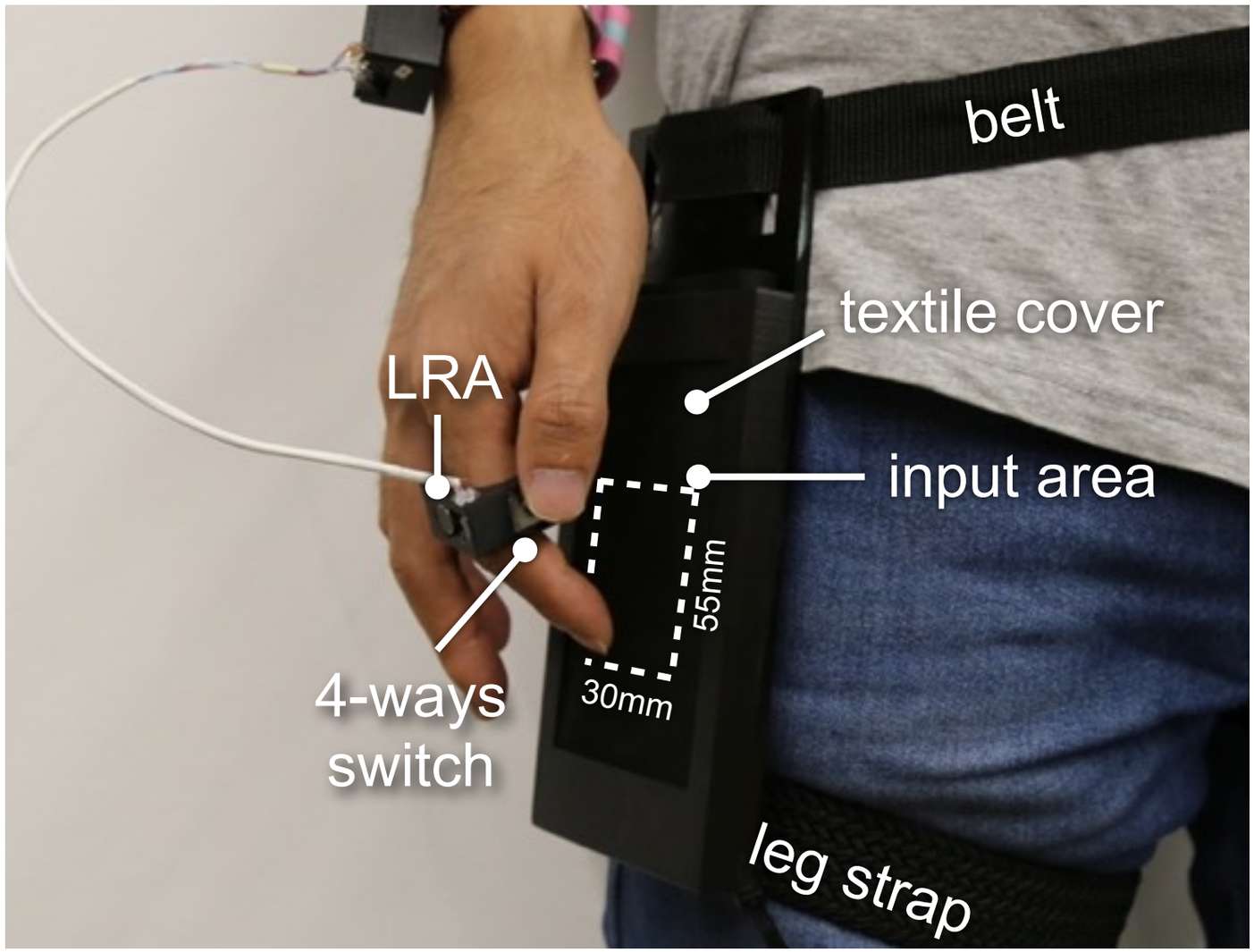
Eyes-free target selection

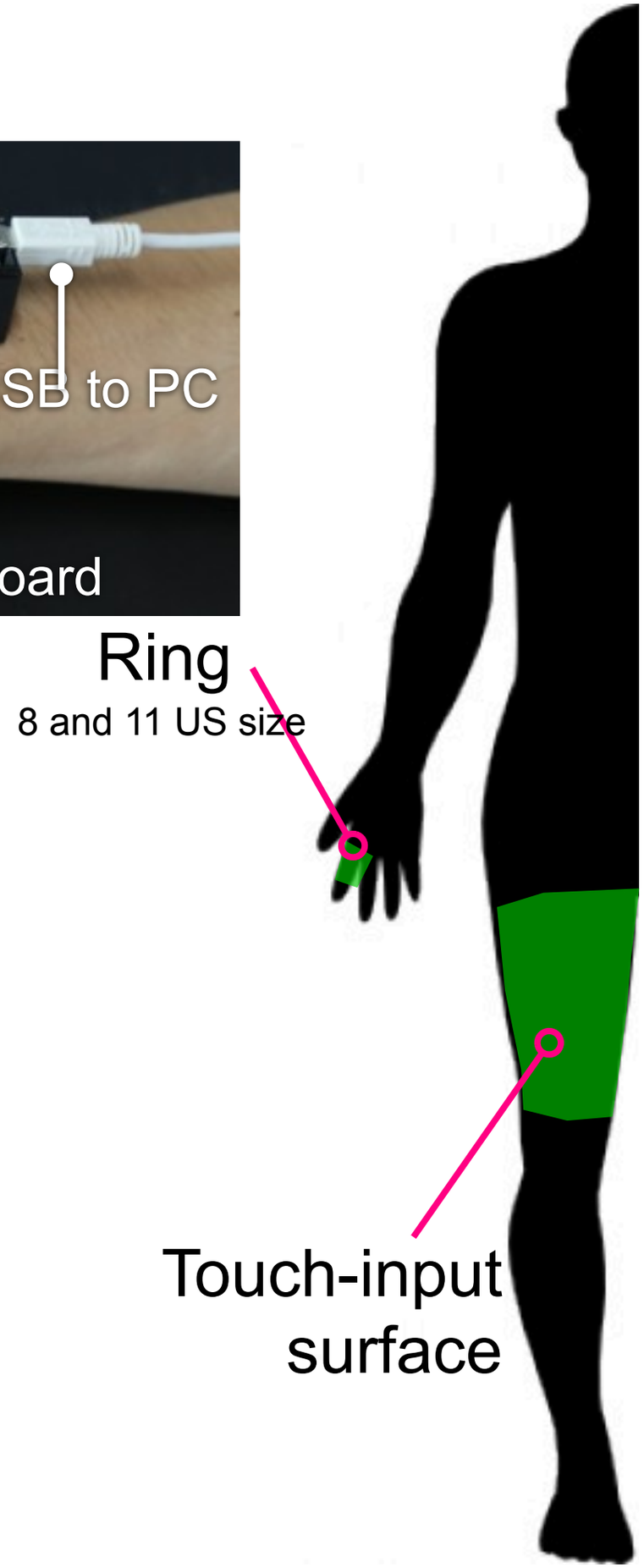




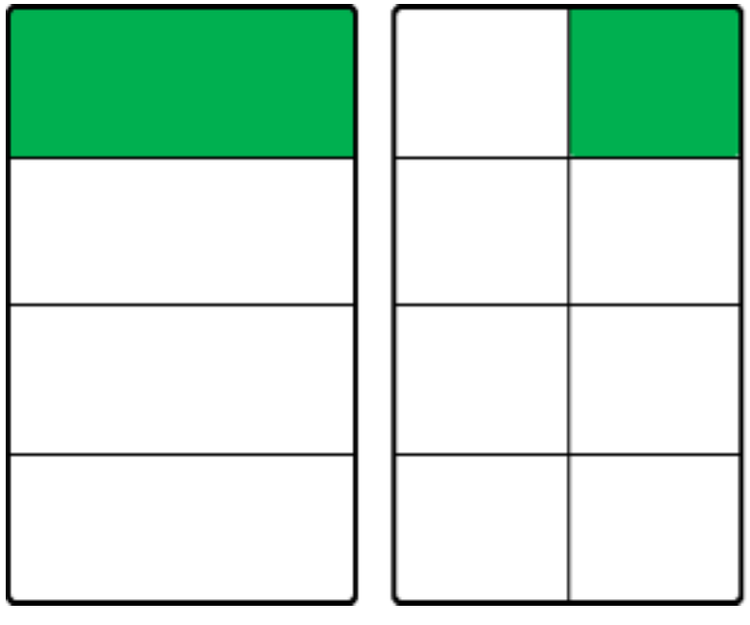
Setup


LRA motor
USB to PC
4-ways tactile switch
Controlling board


belt
textile cover
LRA
input area
55mm
30mm
4-ways switch
leg strap

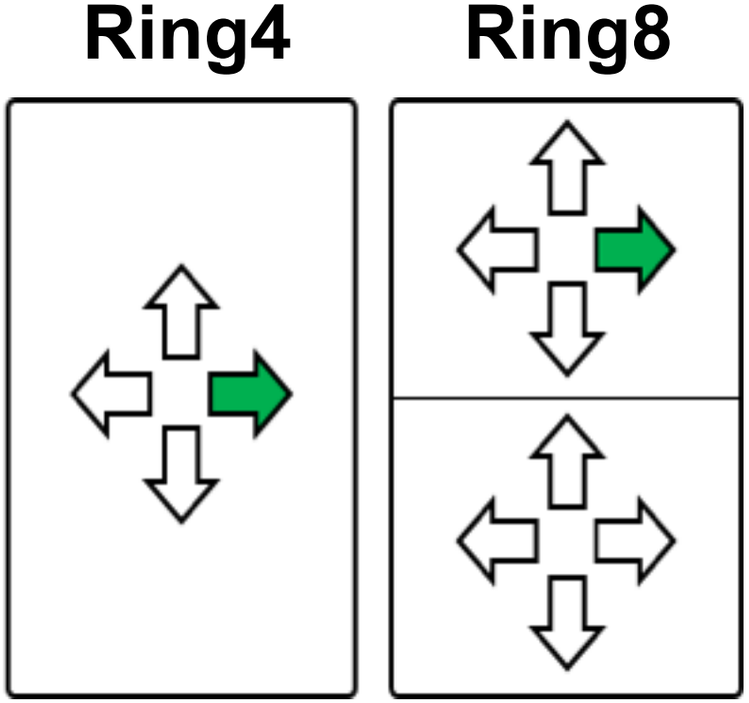

Dominant side
Ring
8 and 11 US size
Touch-input surface

2x2 design



Number of locations on body

4 or 8

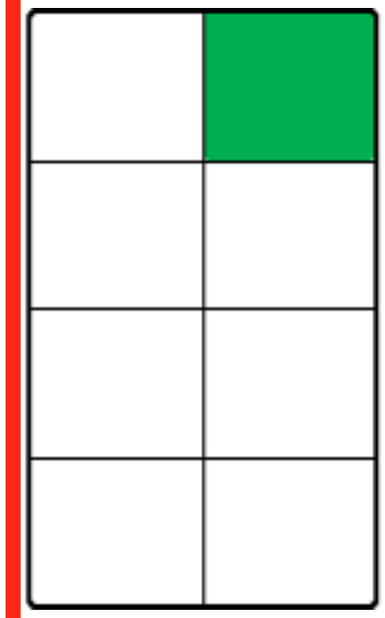


Interface

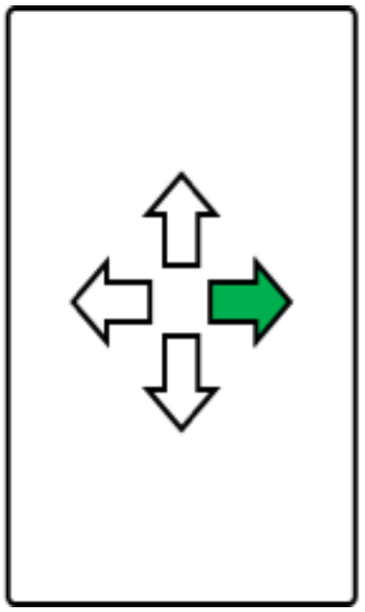
Touch vs. Ring+Touch

Touch4

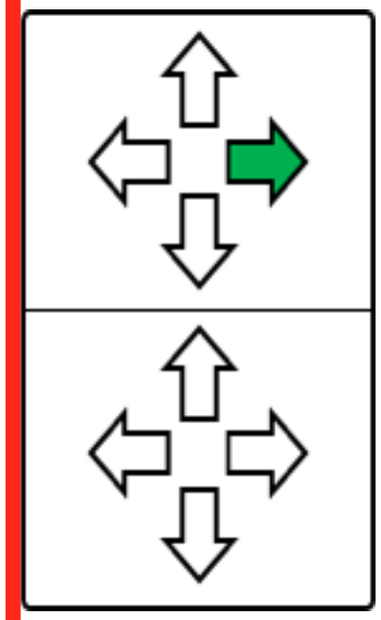
Touch8



Ring4

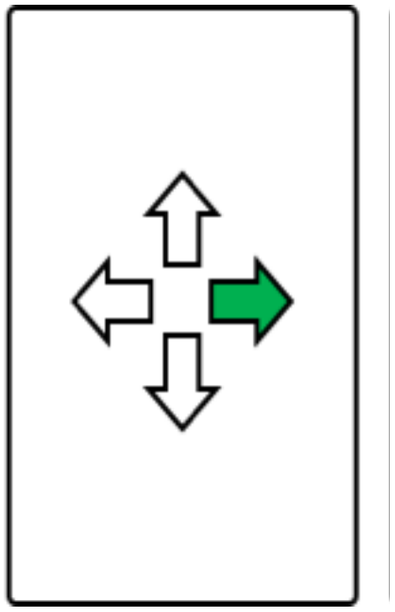


Ring8



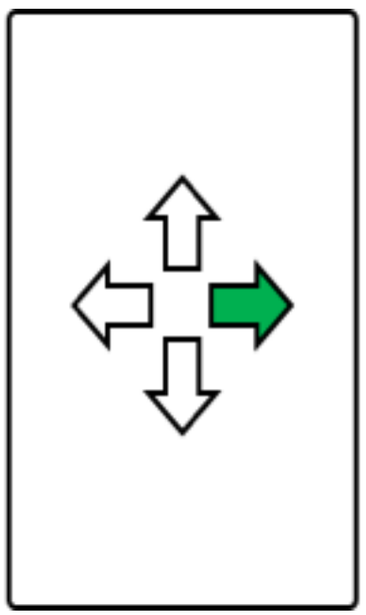
Touch4

Ring4



Touch4

Ring4



Screen

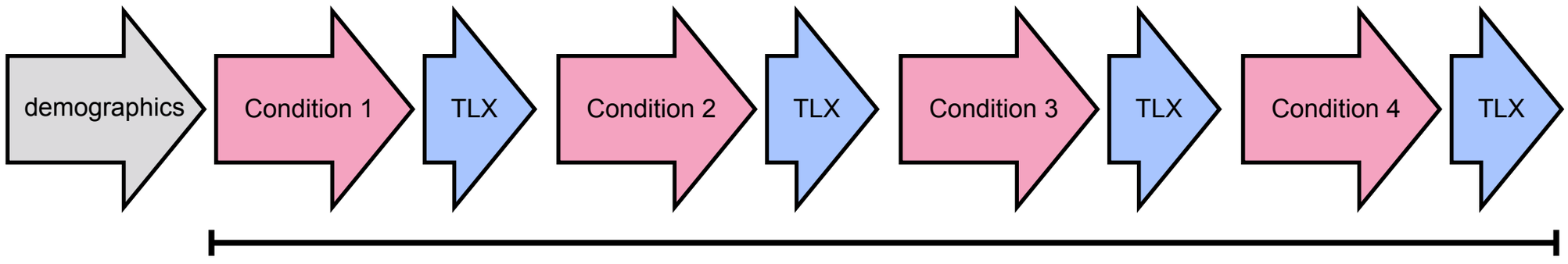
Keyboard

Tactile feedback on selection

Experiment details

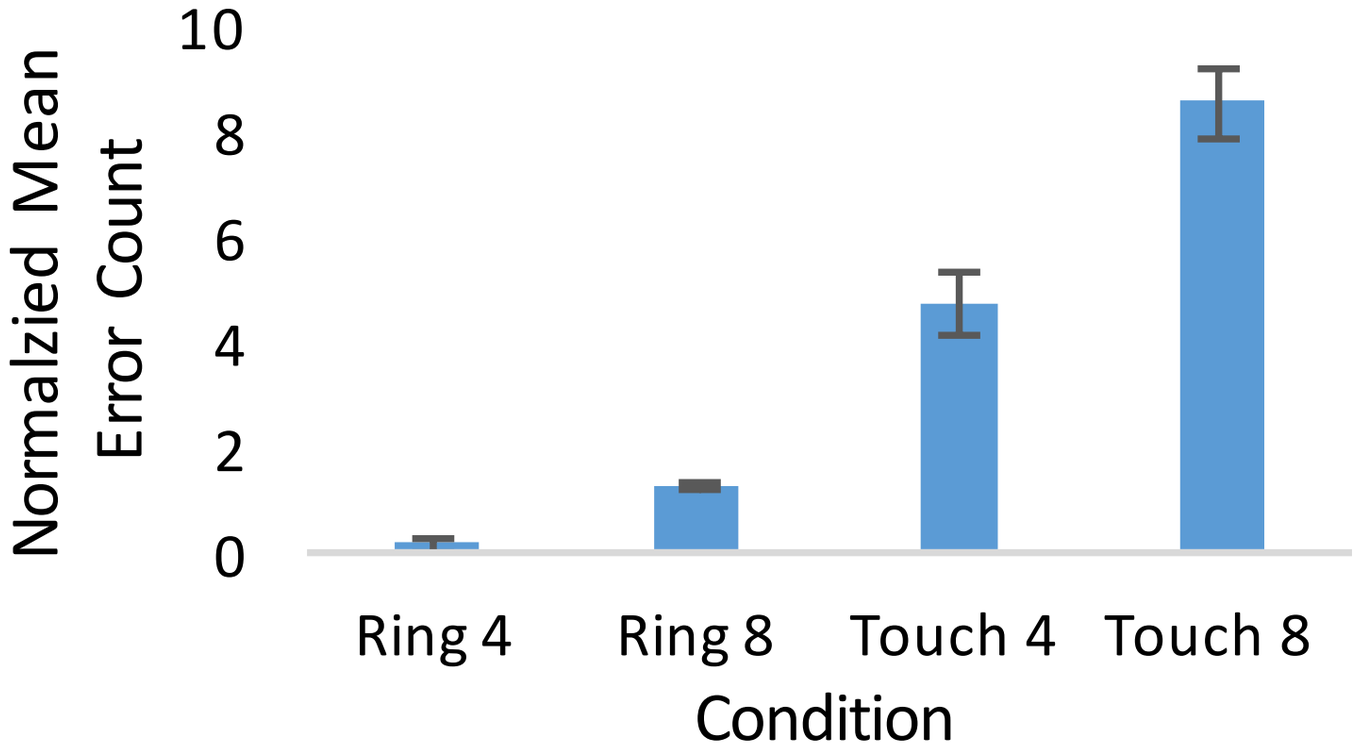
- 2x2 repeated measure design (Interface x number of targets)
- Interface fully balanced; targets with Latin square design
- 13 blocks per target location (3 training trials + 10 testing trials)
- Errors were repeated in random order

- 12 participants (age: 20-35, M: 25.8, SD: 4.9), 4 female
- ~10 SUD compensation



240 correct trials per user (total **2880**)

Results: errors

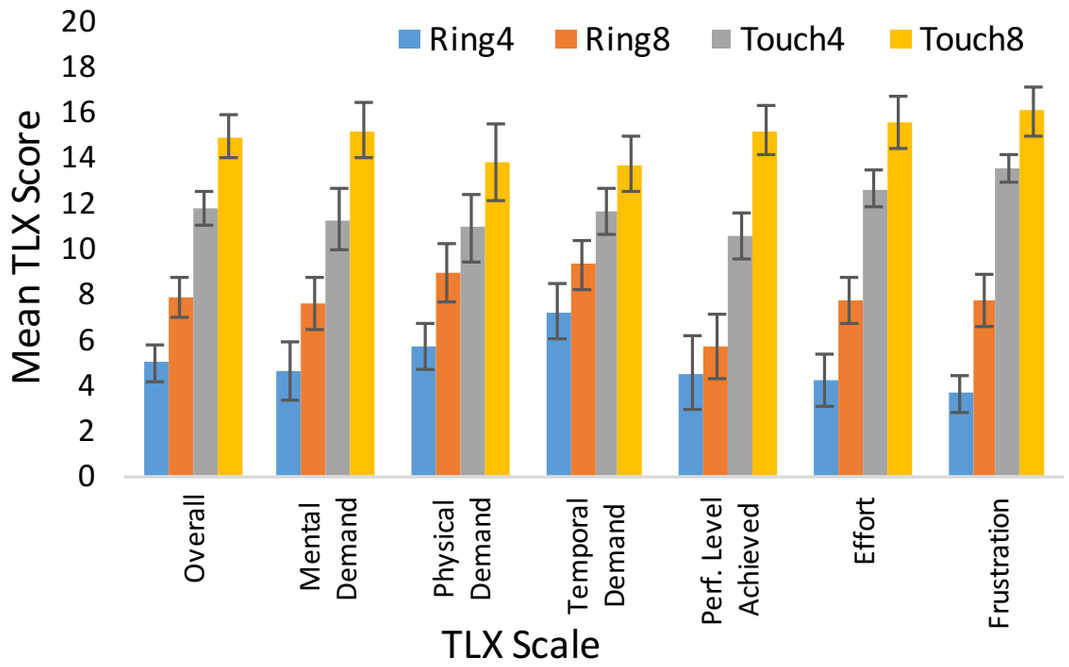


ANOVA: significant interactions and main effects ($p<0.001$)

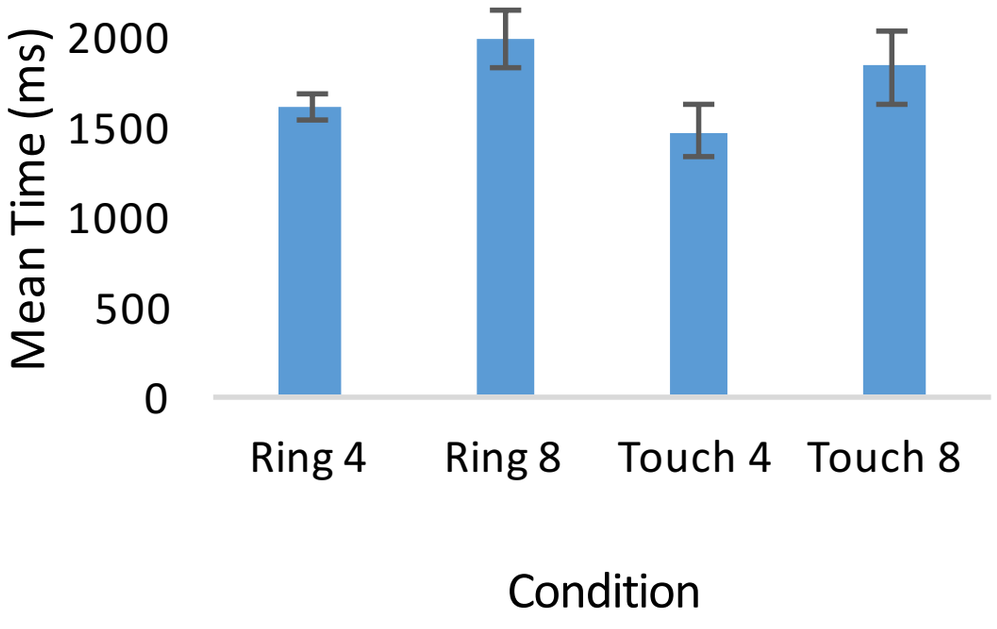
Ring 4	Ring 8
99.7%	*99.6%*
	99.5%

Touch 4	Touch 8	
97.9%	*94.8%*	*95.2%*
82.7%	*86.3%*	*84.0%*
74.0%	*81.1%*	*81.1%*
98.1%	*95.4%*	*96.1%*

Results: time and cognitive load



ANOVA: significant main effects ($p<0.001$) for workload



ANOVA: **not** significant

Summary of findings

number of **targets**

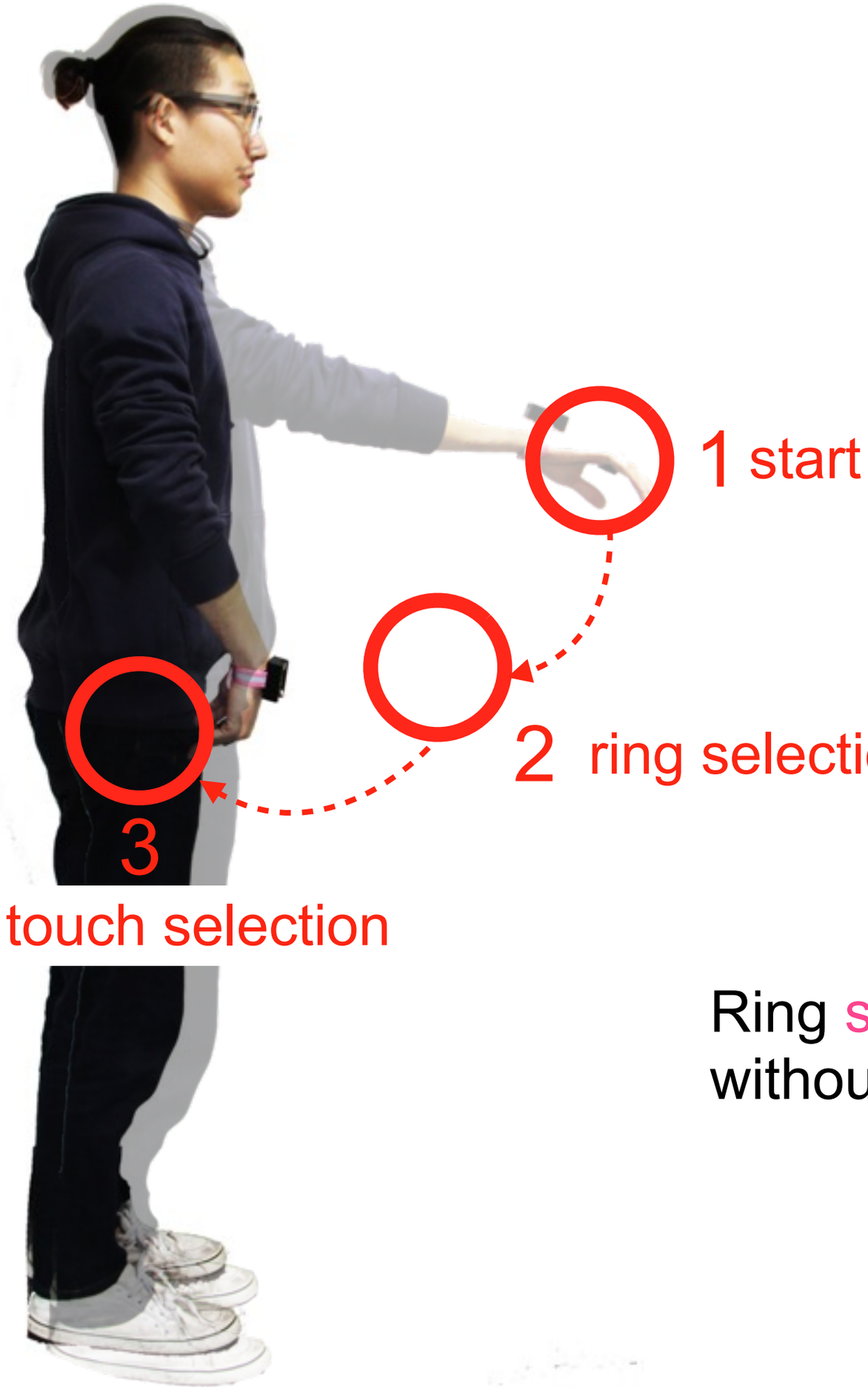
accuracy

No **time** differences

Drastic differences for **errors** and **cognitive load** between

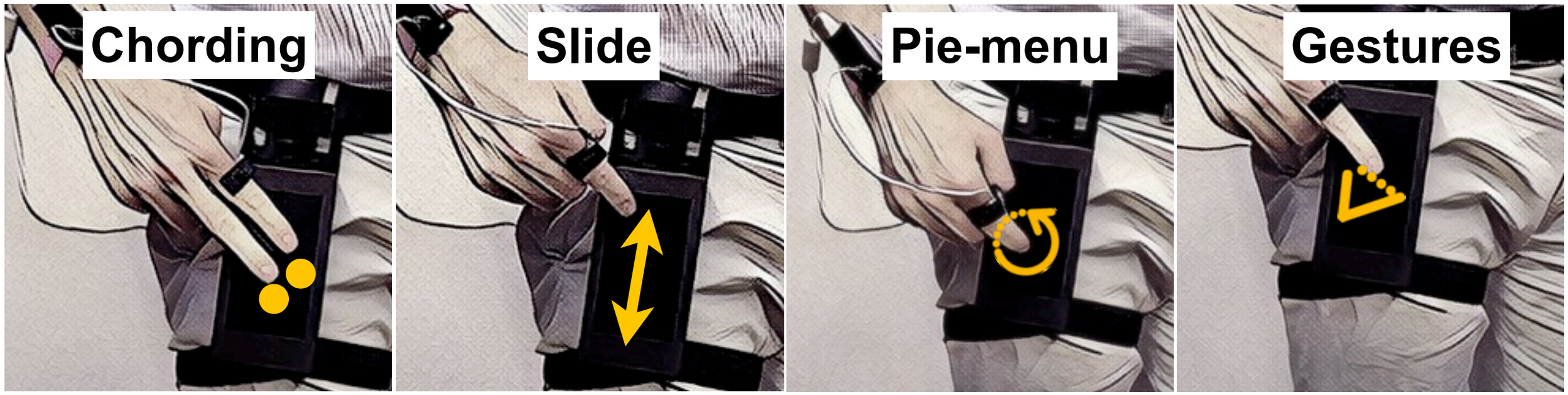
touch and Ring+Touch

So, what happened?

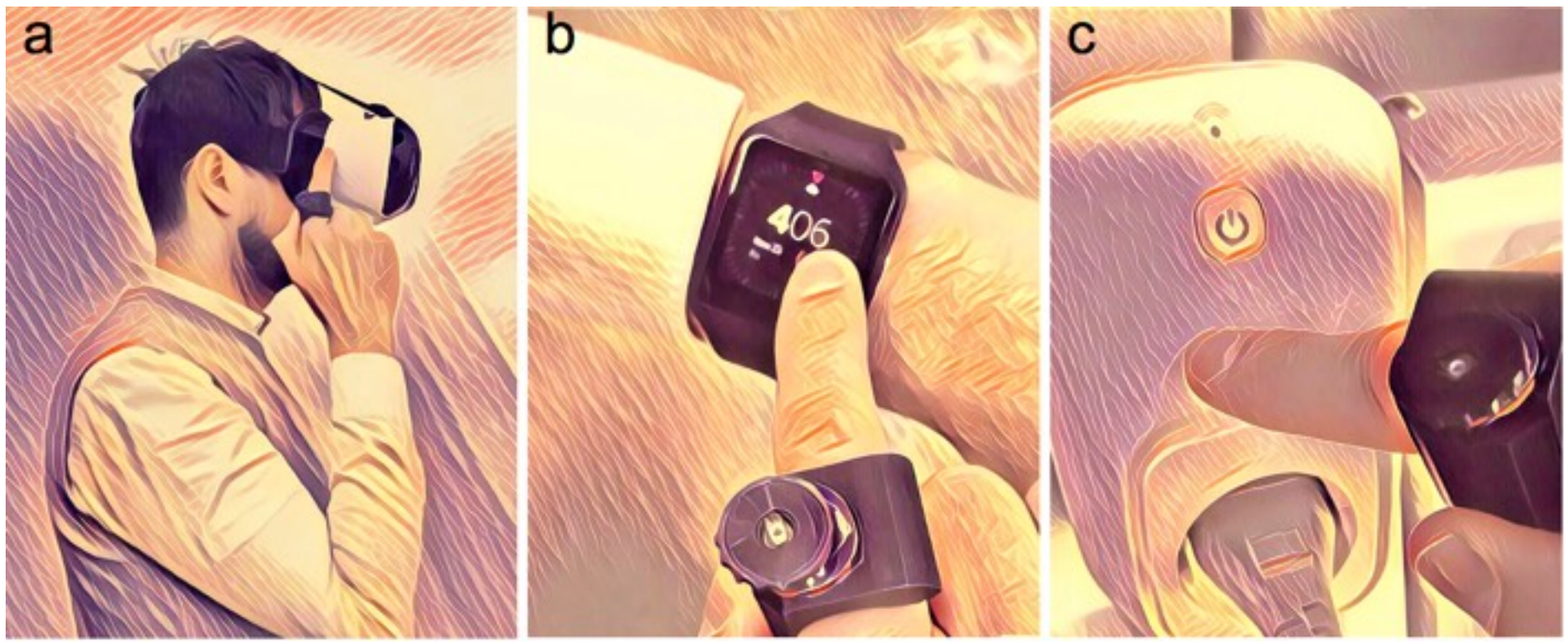


Ring selections were made in-air
without reducing the interaction speed.

Applications and future work



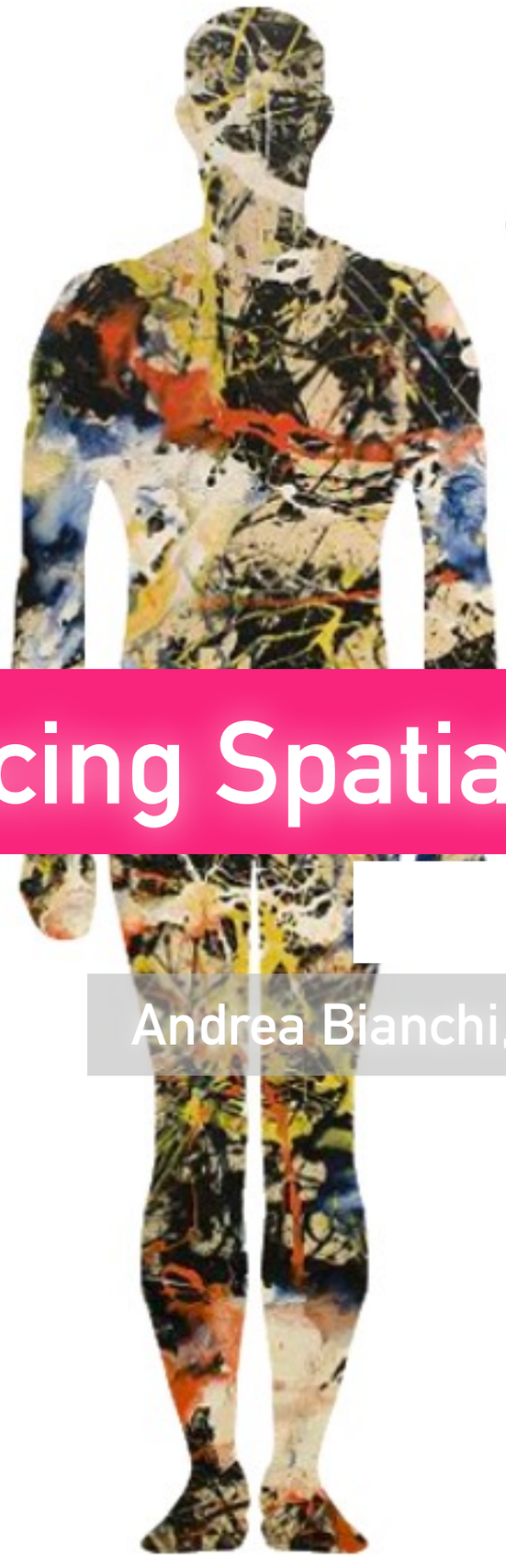
Interaction space suitable for input on devices with small screens



a. Head-mounted interfaces
b. Smart-watches/wearables
c. IOT devices with no screens

Summary

- Using Ring+Touch to increase input space
- No significant cost in terms of time, errors or cognitive load
- Applicability of results beyond on-body touches



Questions?

Enhancing Spatial Input on the Body with a Smart-Ring

Andrea Bianchi, Seungwoo Je, Hyelip Lee, Ian Oakley

andrea@kaist.ac.kr

paper download:
alsoplantsfly.com

MAKinteract

id KAIST UNIST