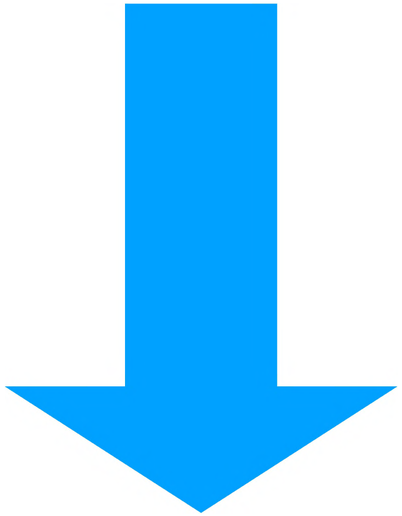
New materials



New factors

Technological explorations

User perception study

New device design

Interaction beyond shapes

Challenges and future work

User perception study

New device design

Interaction beyond shapes

Challenges and future work

User perception study

Psychophysical experiment studying

the **impact** of **softness**

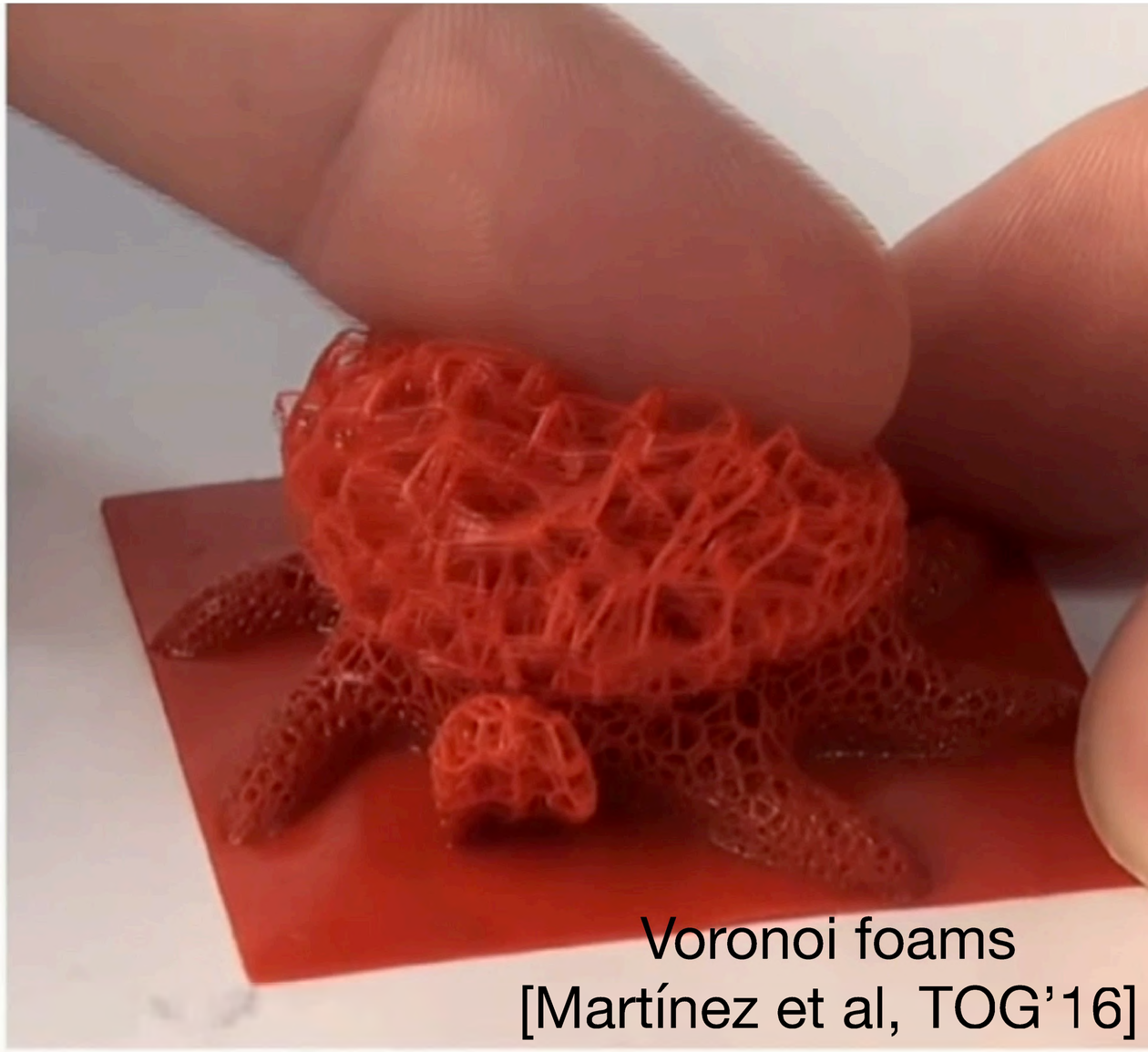
on users' **shape perception** ability

Soft curved UIs

Daily objects

Annexing Reality
[Hettiarachchi et al, CHI’16]

Customised UIs

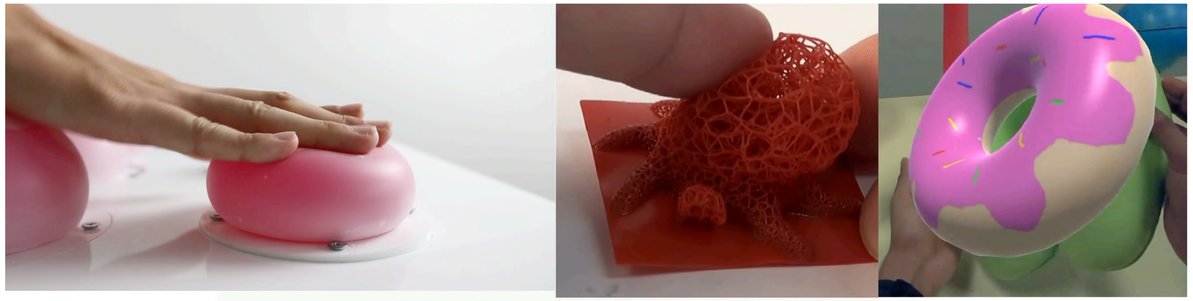


Voronoi foams
[Martínez et al, TOG'16]

Curvature changing UIs

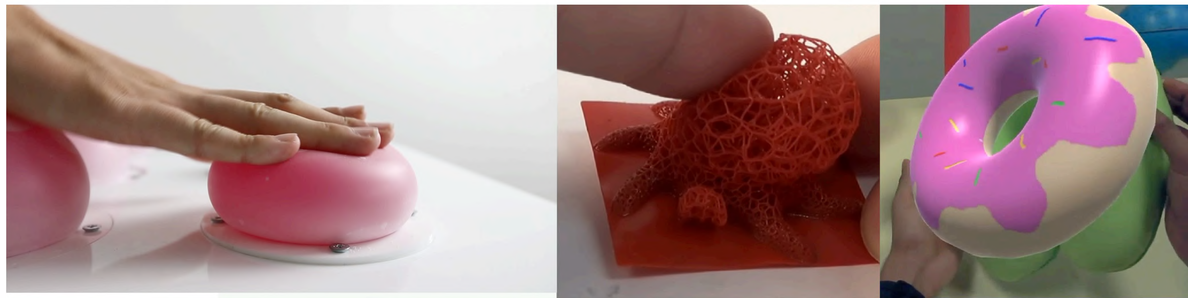
COLORISE
[Fujii, et al. TEI’18]

Efficiency of soft curved UIs



Curvature perception of a soft UI

Efficiency of soft curved UIs



Experiment

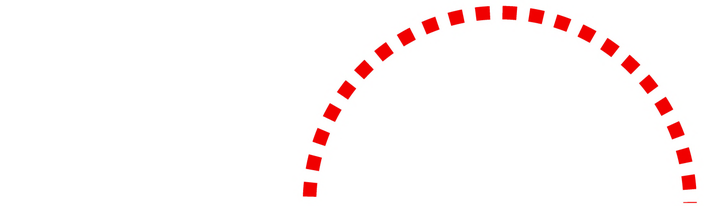
Curvature perception
precision and accuracy
in **different softness conditions**

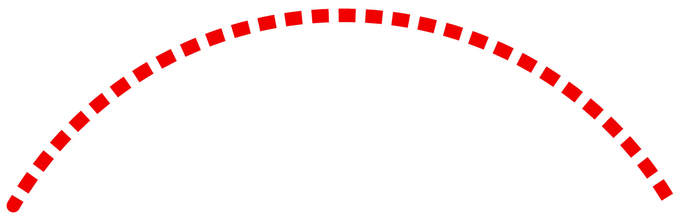
12 Participants (6 women, 6 men, M=26.1 years old, SD=4.1 years)

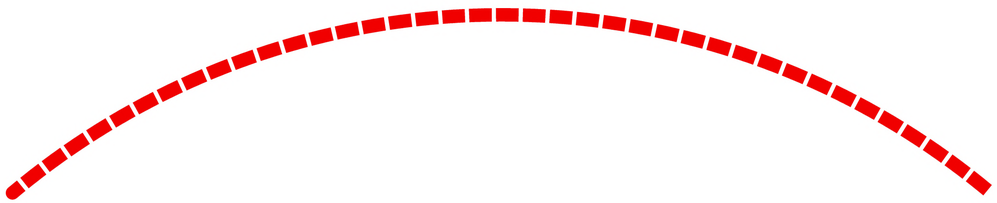
Registration on osf.io/scnj9

Independent variables

Four softnesses × Three curvatures







Softness levels

Softness

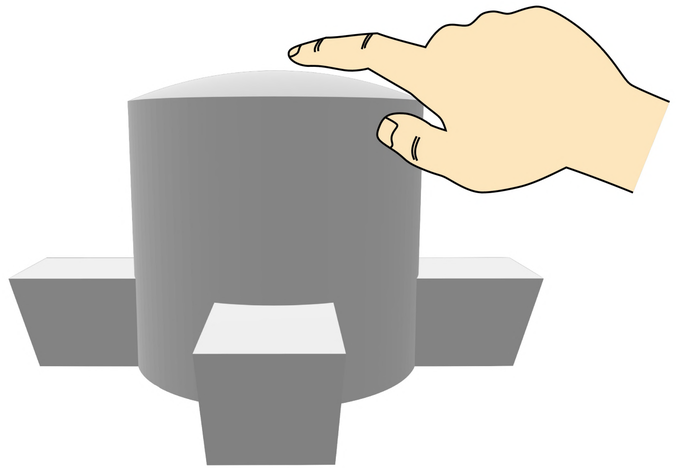
Shore 00-10

Shore 00-50

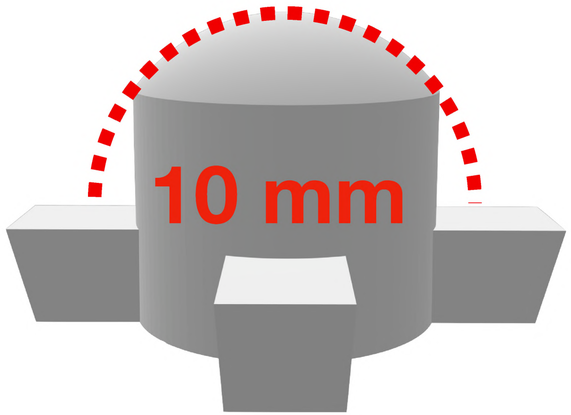
Shore A-30

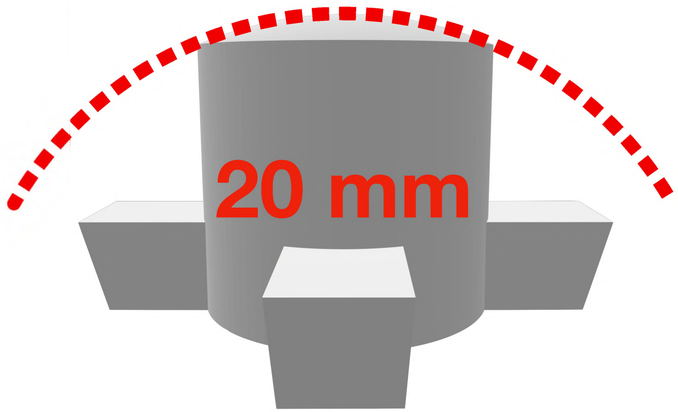
Rigid

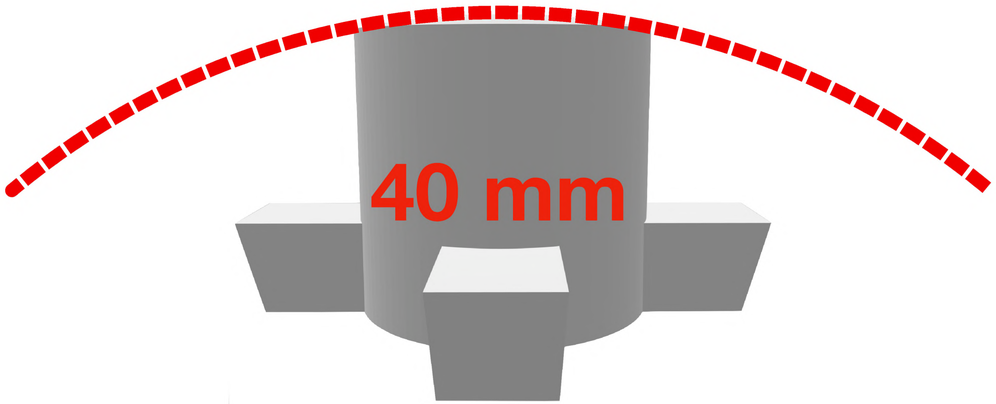
Curvature levels

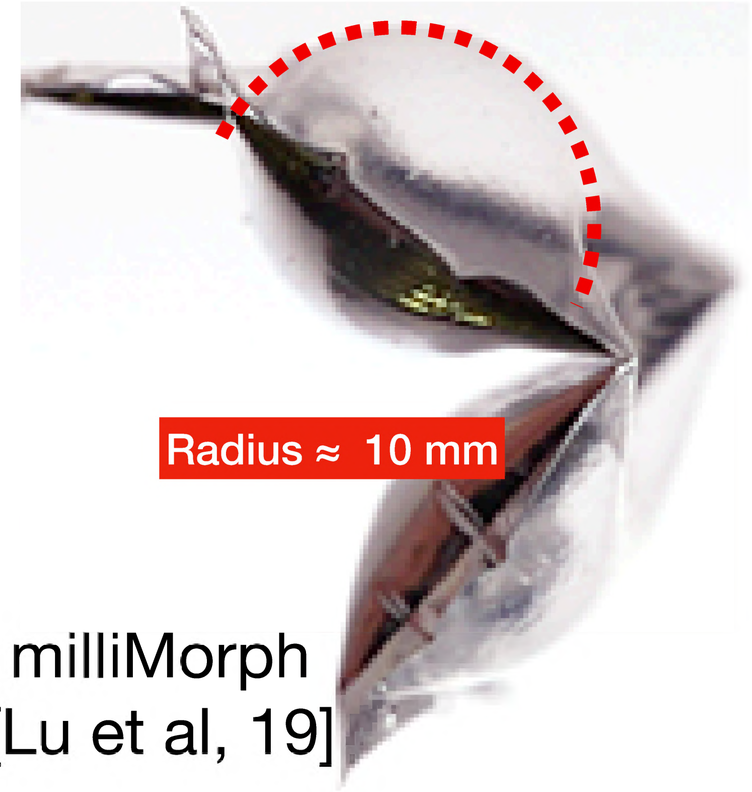


Curvature levels

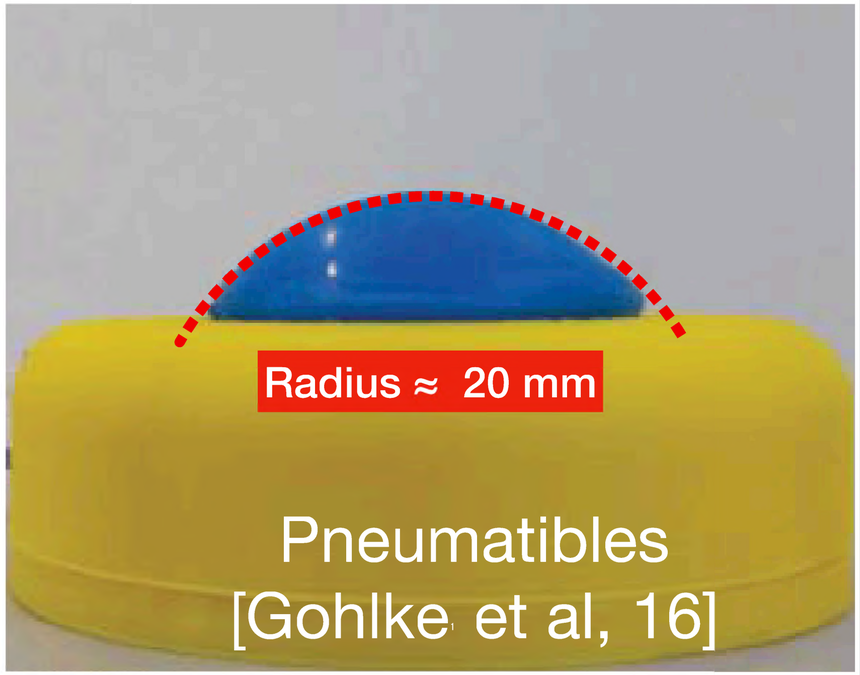




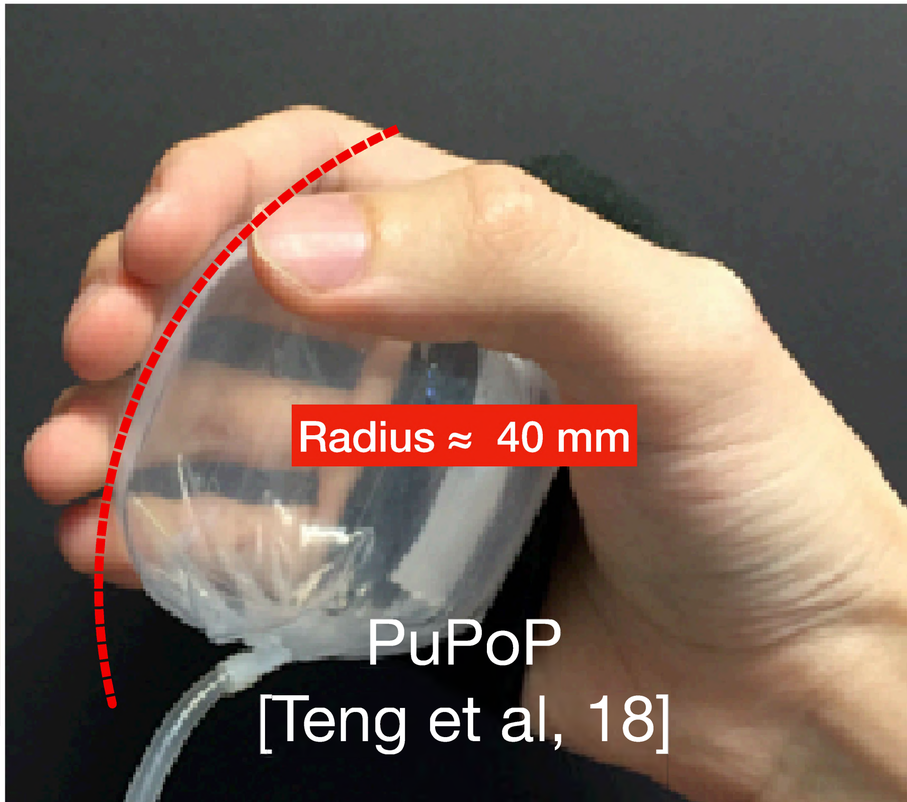




milliMorph
[Lu et al, 19]

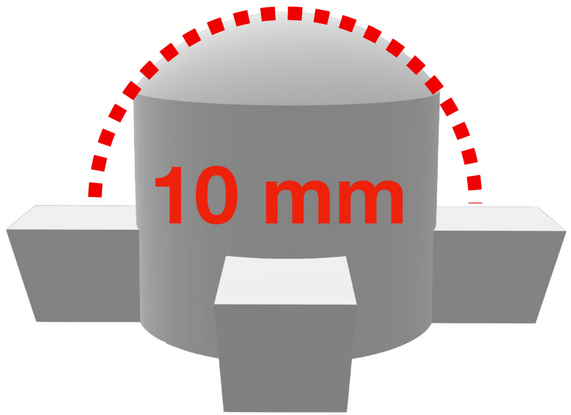


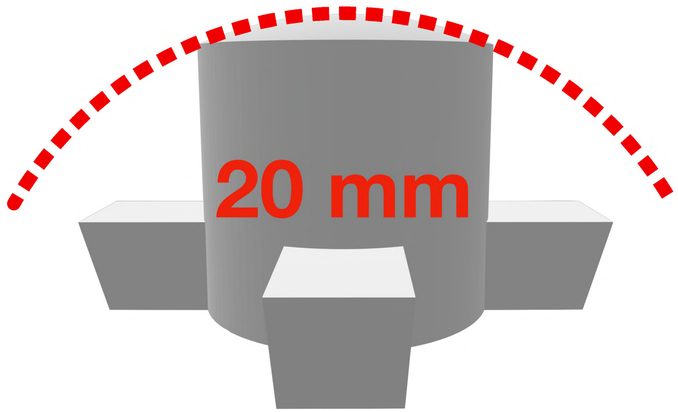
Pneumatibles
[Gohlke et al, 16]

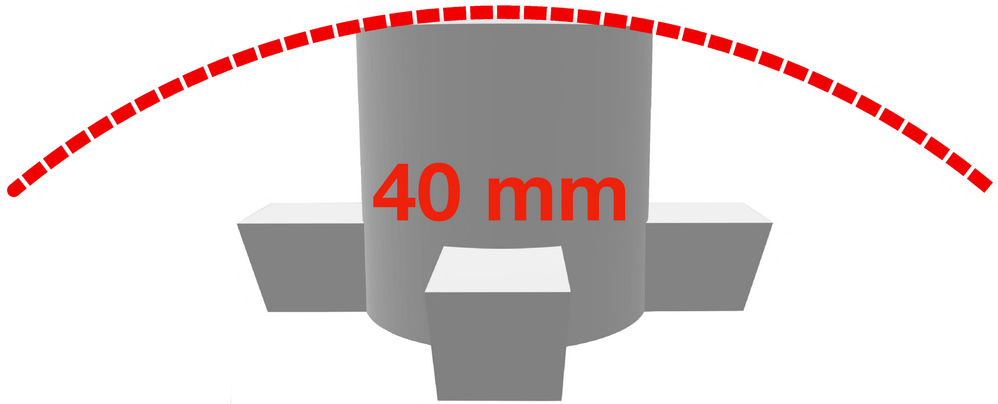


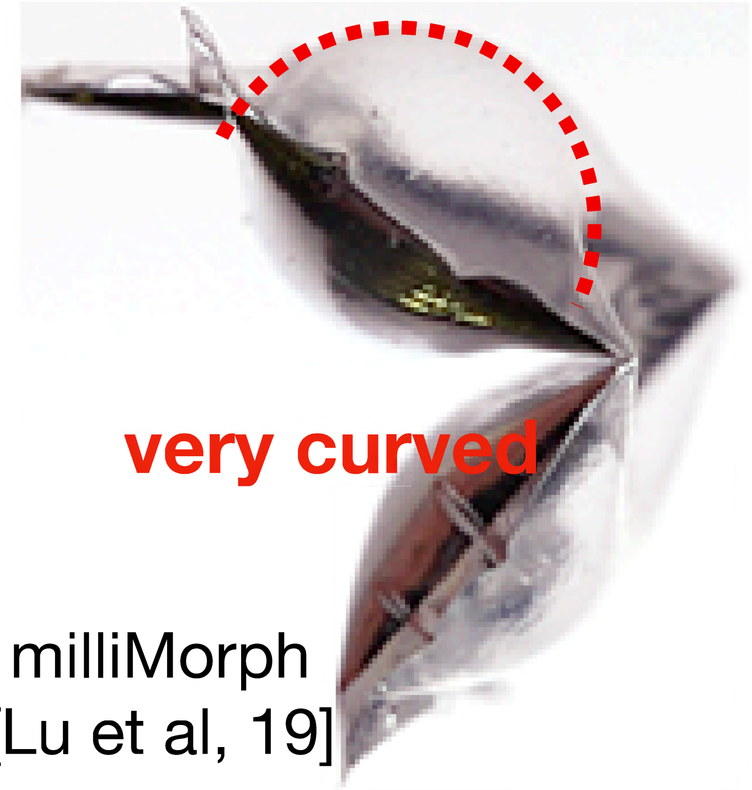
PuPoP
[Teng et al, 18]

Curvature levels

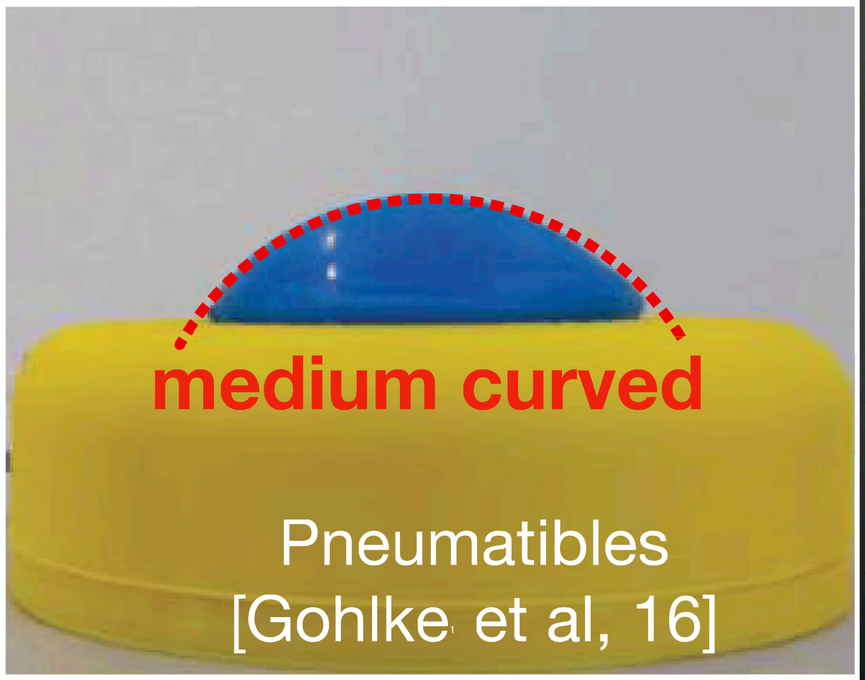




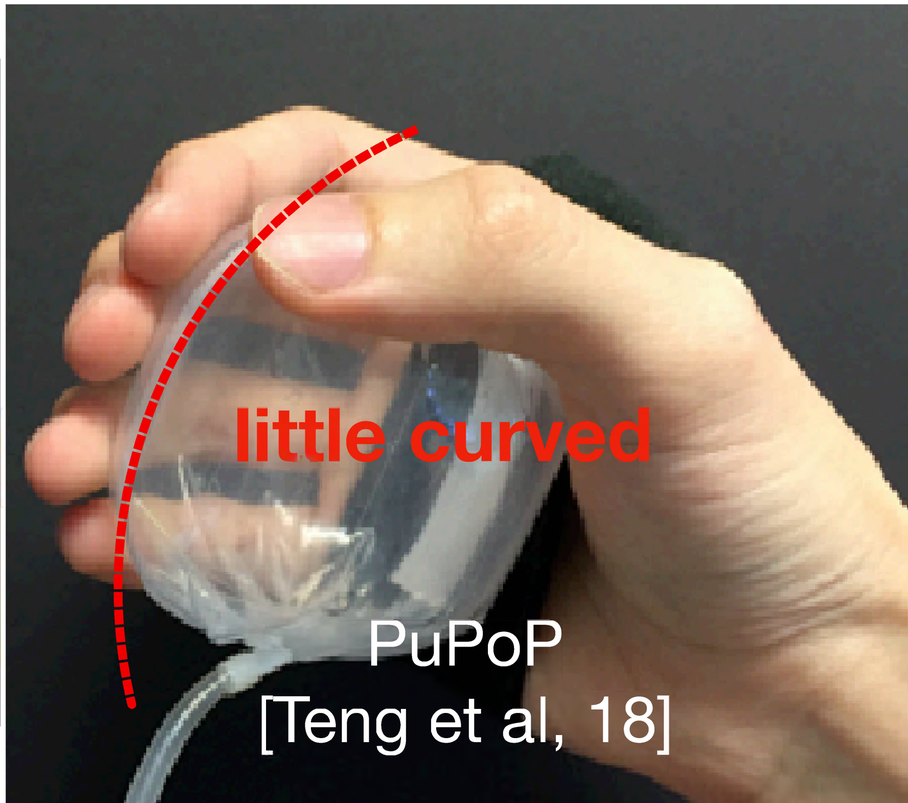




milliMorph
[Lu et al, 19]



Pneumatibles
[Gohlke et al, 16]



PuPoP
[Teng et al, 18]

Dependent Variables

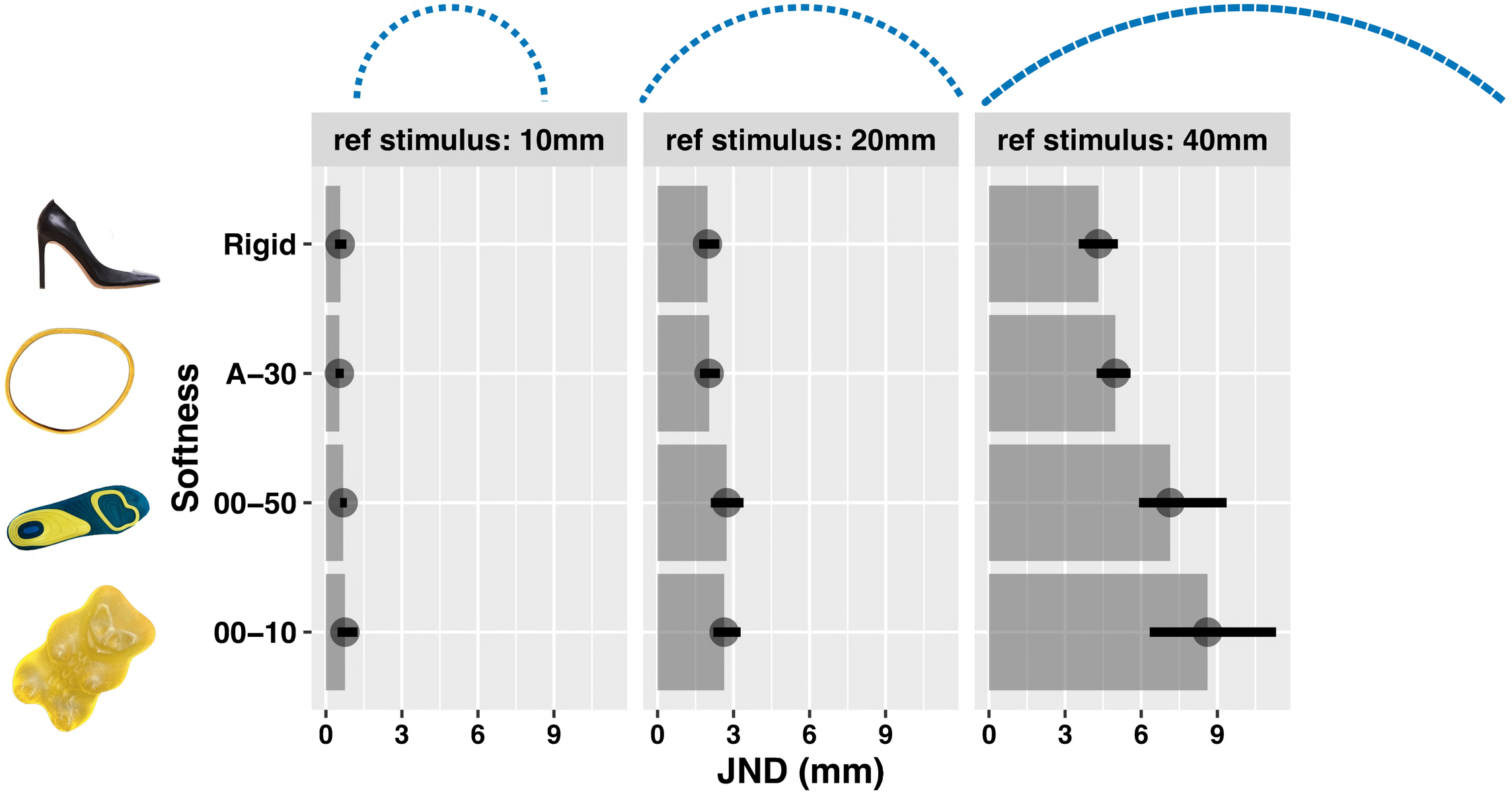
precision → Just Noticeable Difference (JND)

accuracy → Point of Subjective Equality (PSE)

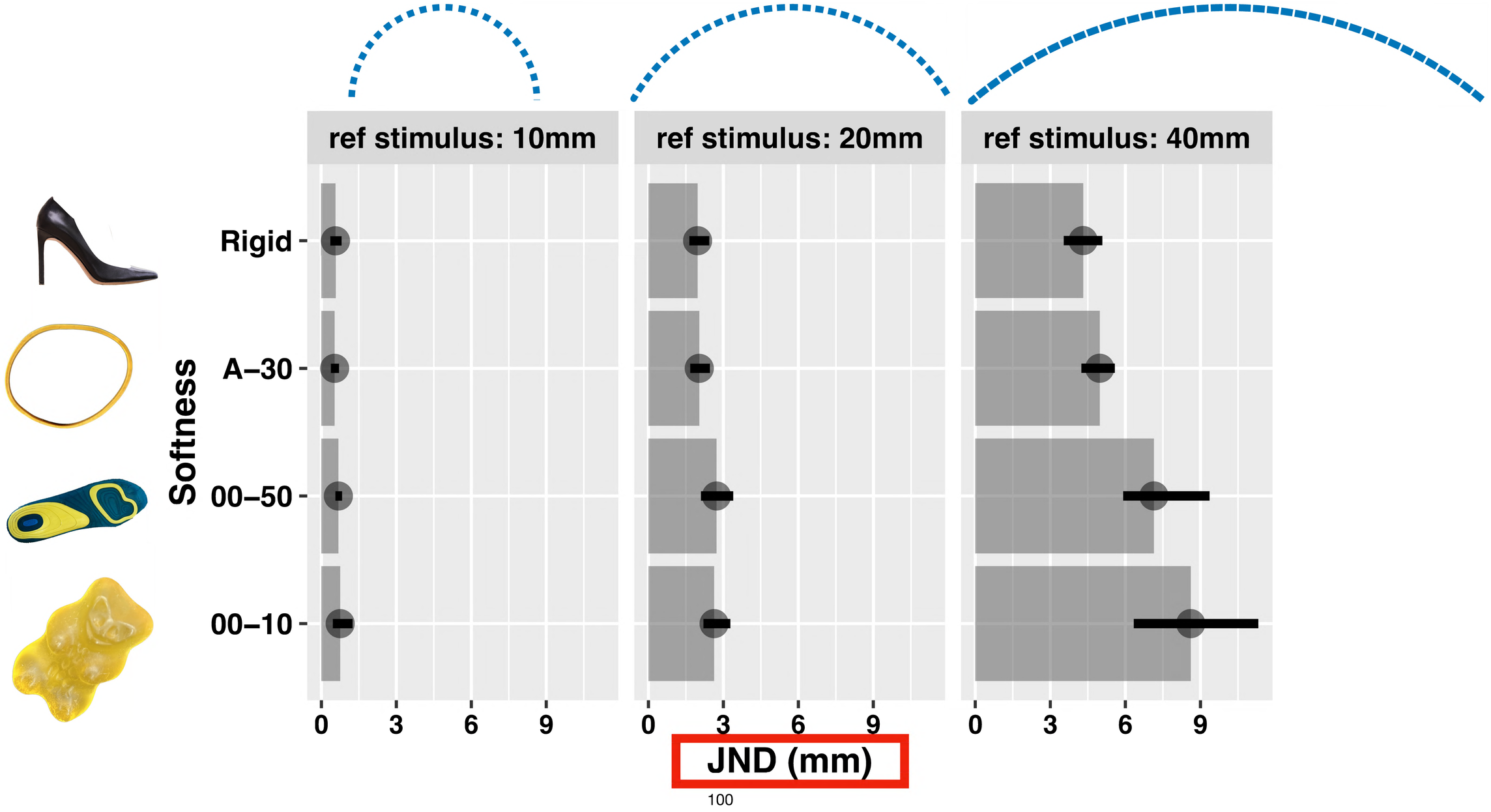
Curvature perception

precision

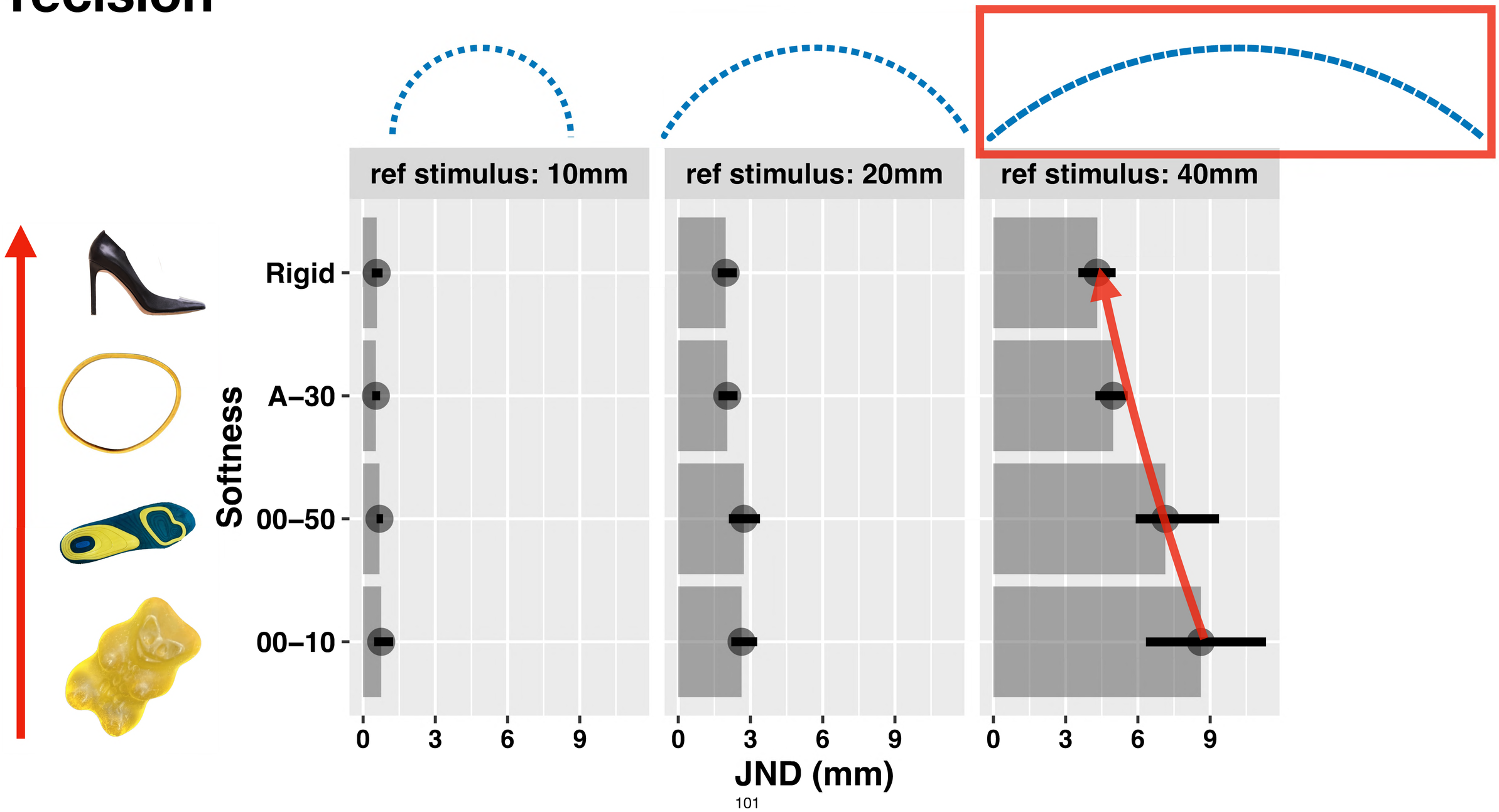
Precision


ref stimulus: 10mm
ref stimulus: 20mm
ref stimulus: 40mm
Softness
Rigid
A–30
00–50
00–10
0
3
6
9
JND (mm)

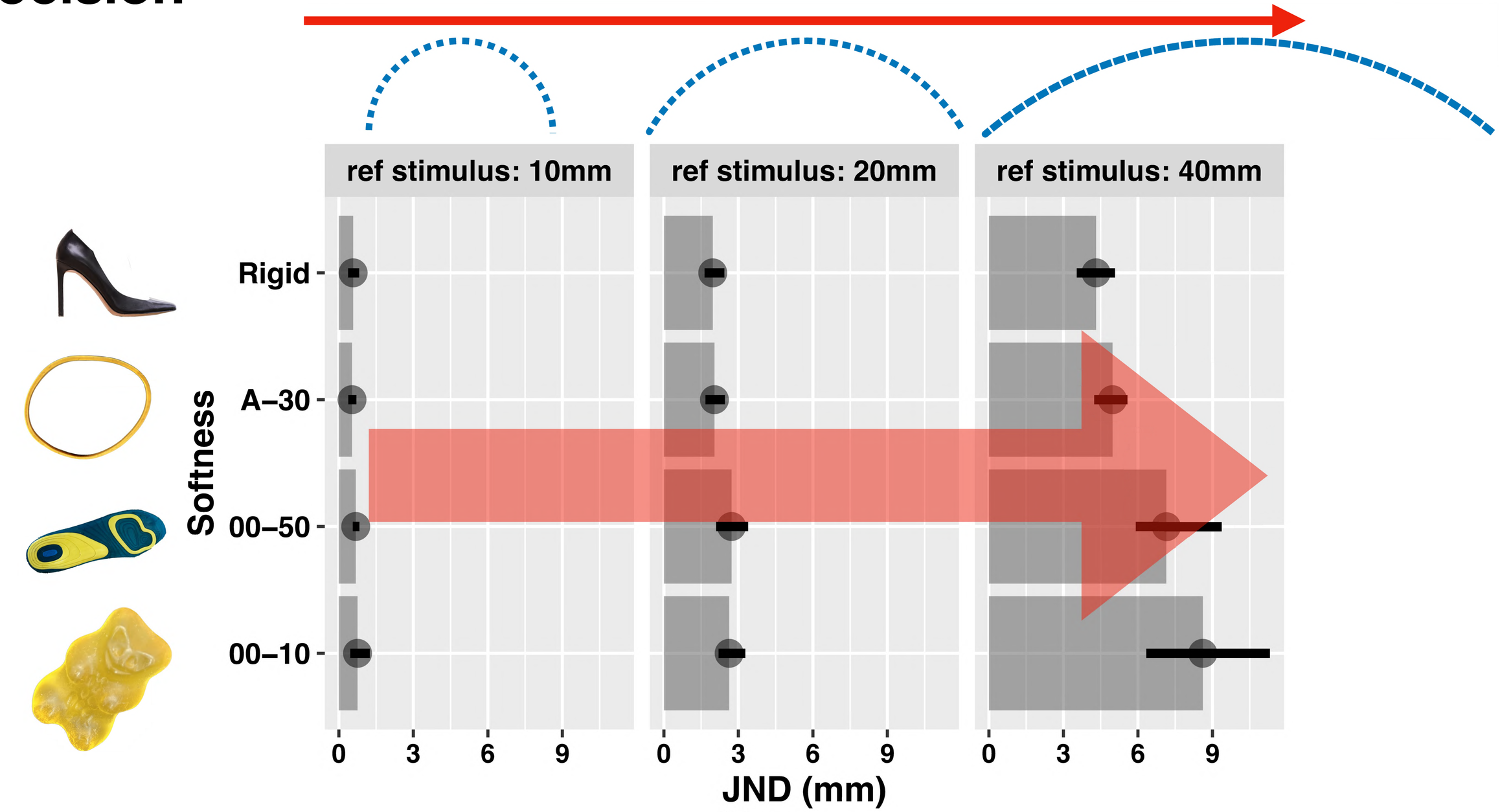
Precision


ref stimulus: 10mm
ref stimulus: 20mm
ref stimulus: 40mm
Softness
Rigid
A–30
00–50
00–10
0
3
6
9
JND (mm)
100

Precision

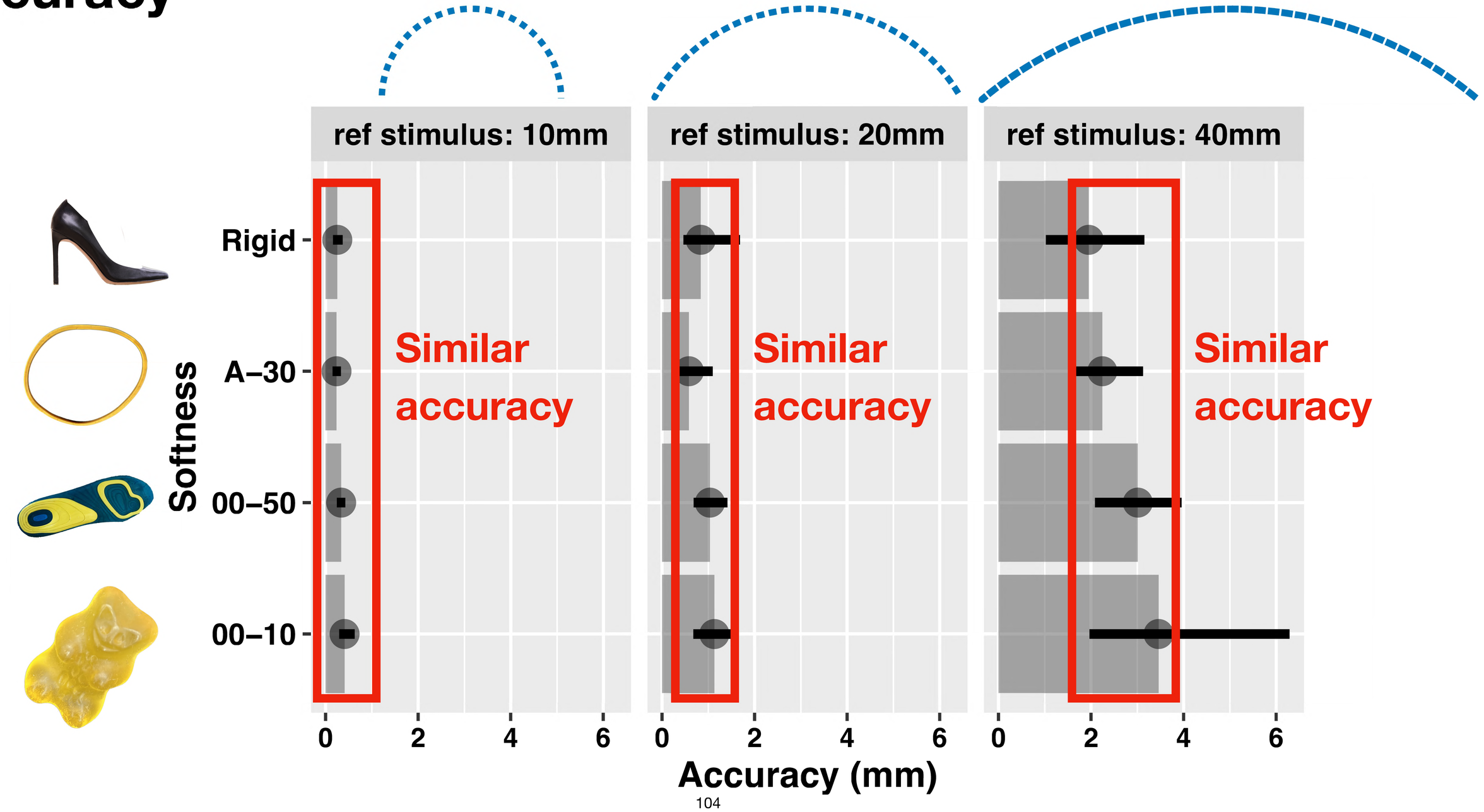

ref stimulus: 10mm
ref stimulus: 20mm
ref stimulus: 40mm
Softness
Rigid
A–30
00–50
00–10
0
3
6
9
JND (mm)

Precision

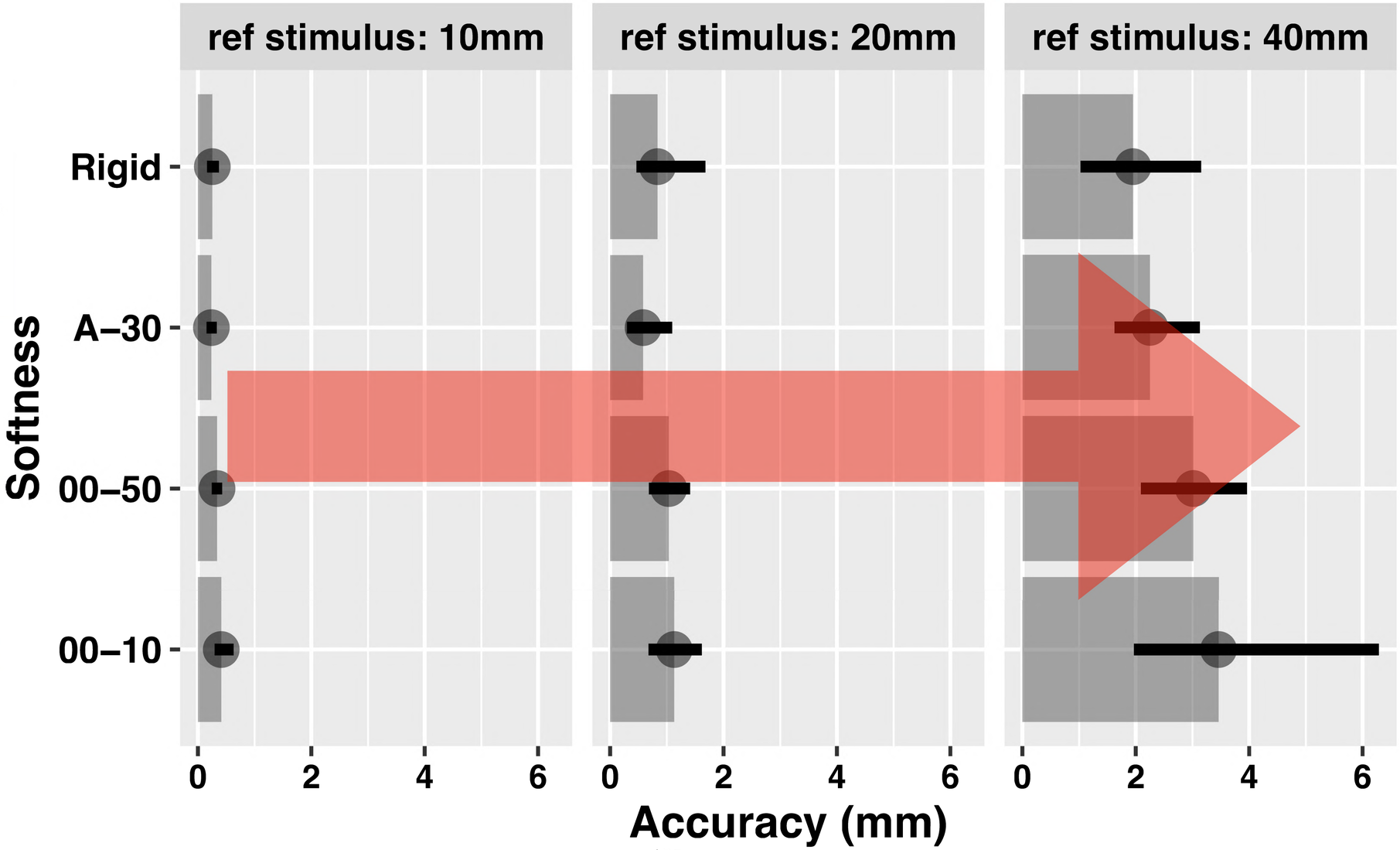

ref stimulus: 10mm
ref stimulus: 20mm
ref stimulus: 40mm
Softness
Rigid
A–30
00–50
00–10
0
3
6
9
JND (mm)

Curvature perception
accuracy

Accuracy

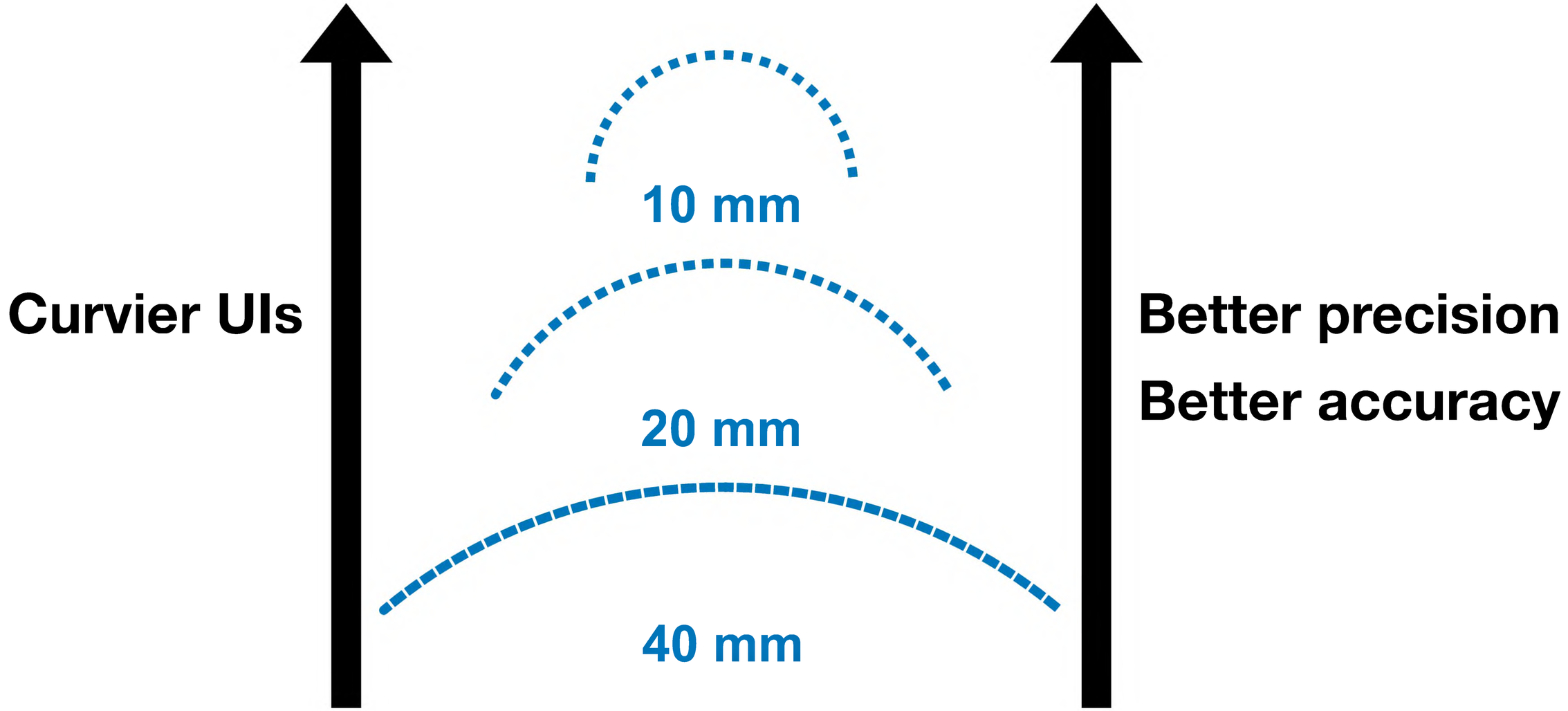

ref stimulus: 10mm
ref stimulus: 20mm
ref stimulus: 40mm
Softness
Rigid
A–30
00–50
00–10
Similar accuracy
Similar accuracy
Similar accuracy
0
2
4
6
Accuracy (mm)

Accuracy

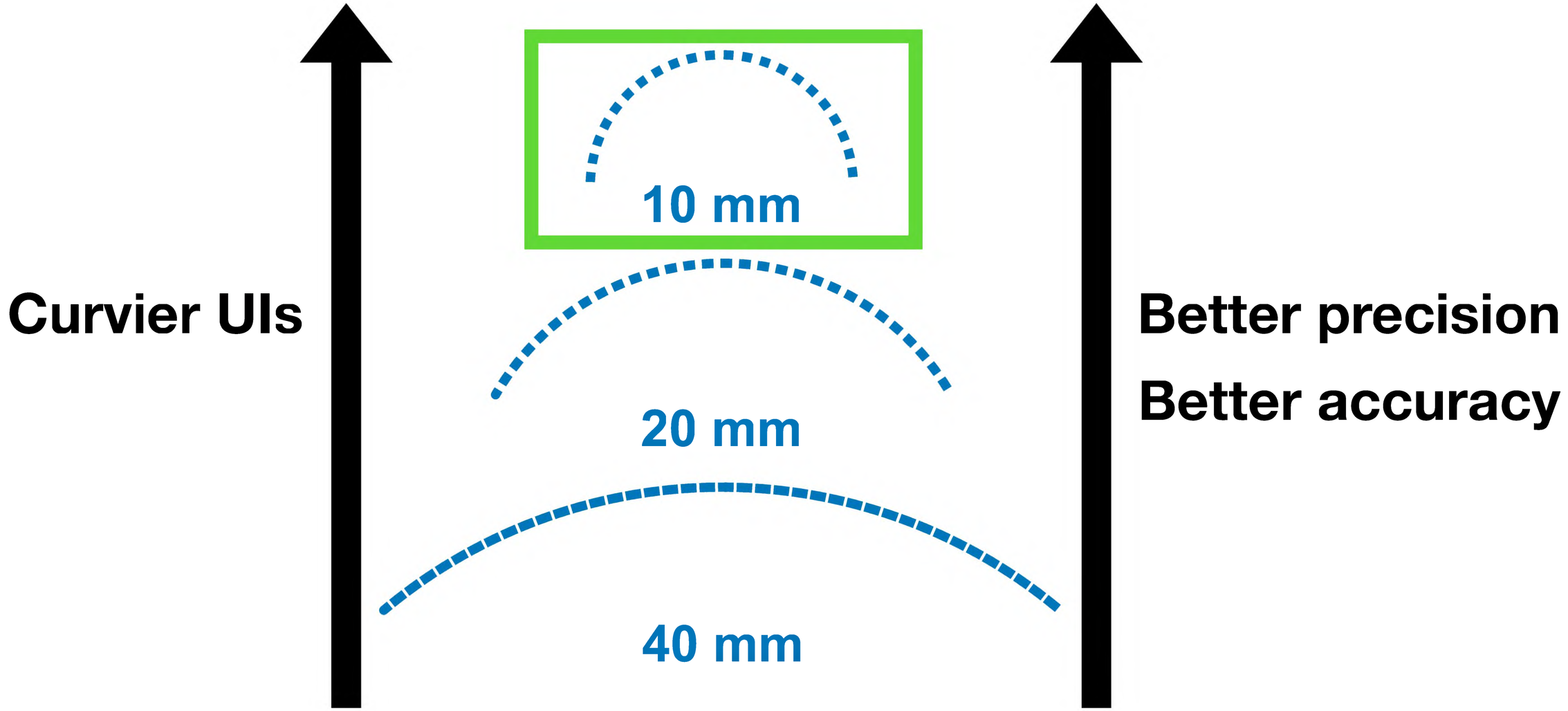

ref stimulus: 10mm
ref stimulus: 20mm
ref stimulus: 40mm
Softness
Rigid
A–30
00–50
00–10
0
2
4
6
Accuracy (mm)

Design guidelines

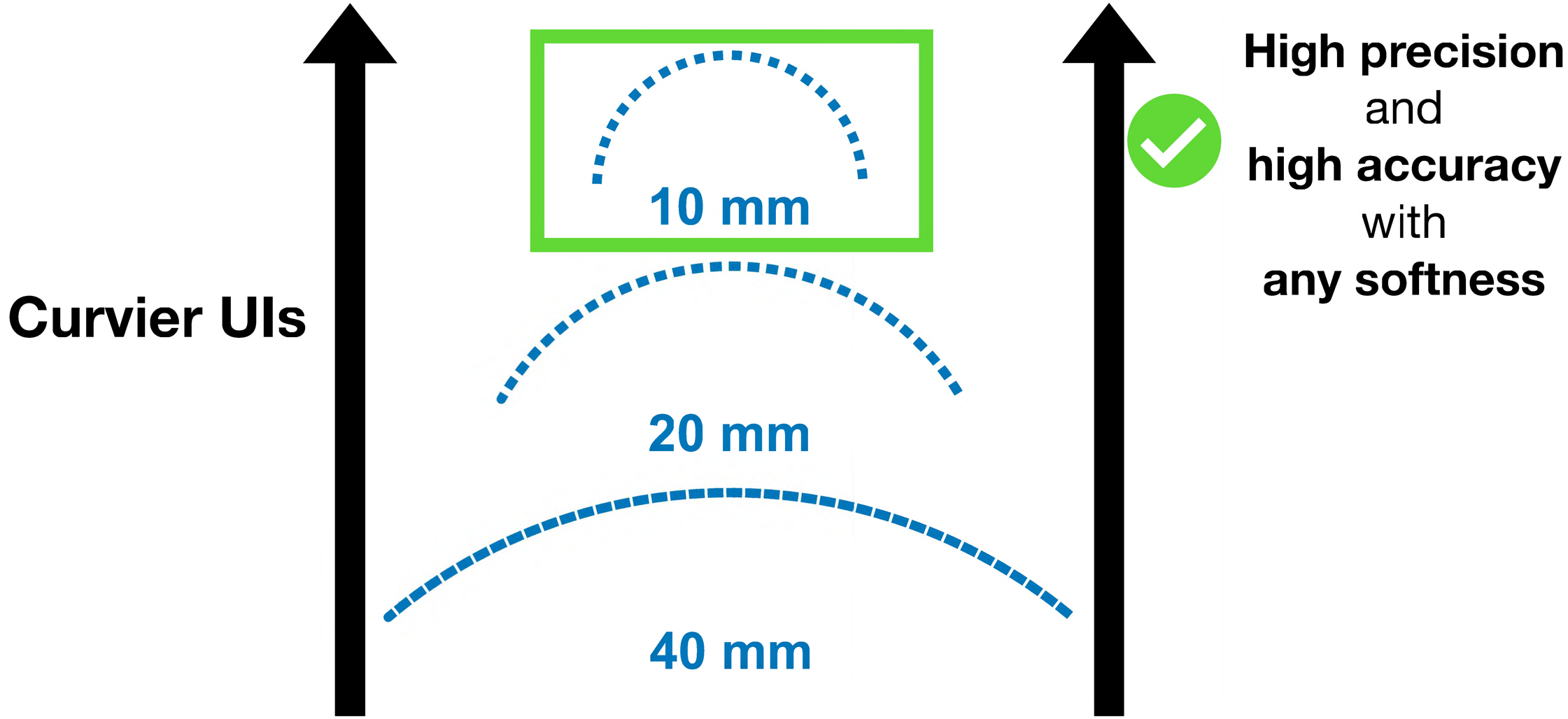
Building precise and accurate soft curved UIs



Building precise and accurate soft curved UIs



Building precise and accurate soft curved UIs



Very curved UIs for better precision

Very curved UIs for better precision


Technological explorations
User perception study
New device design

New device design

Interaction beyond shapes

Challenges and future work

New device design

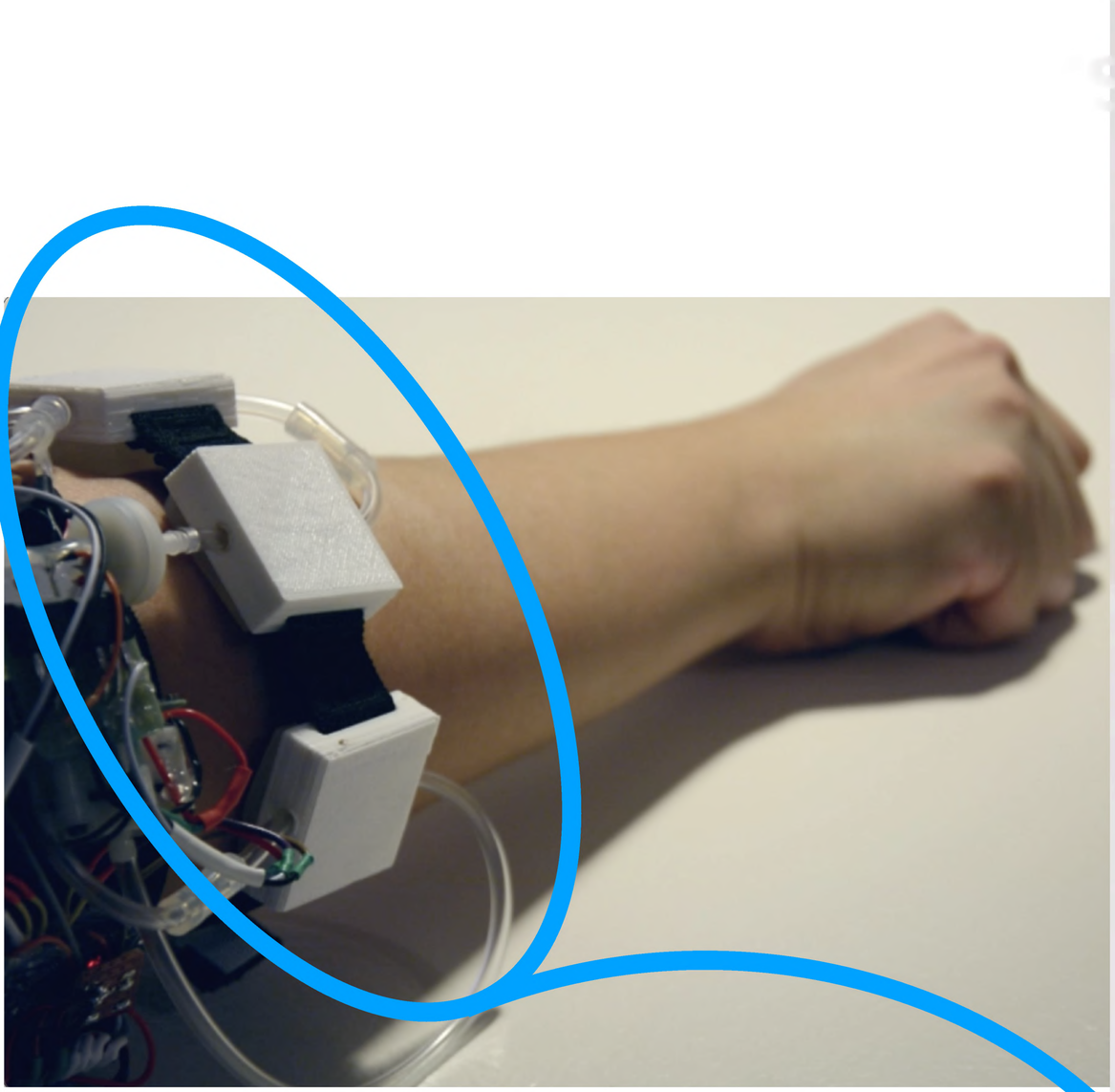
Design of

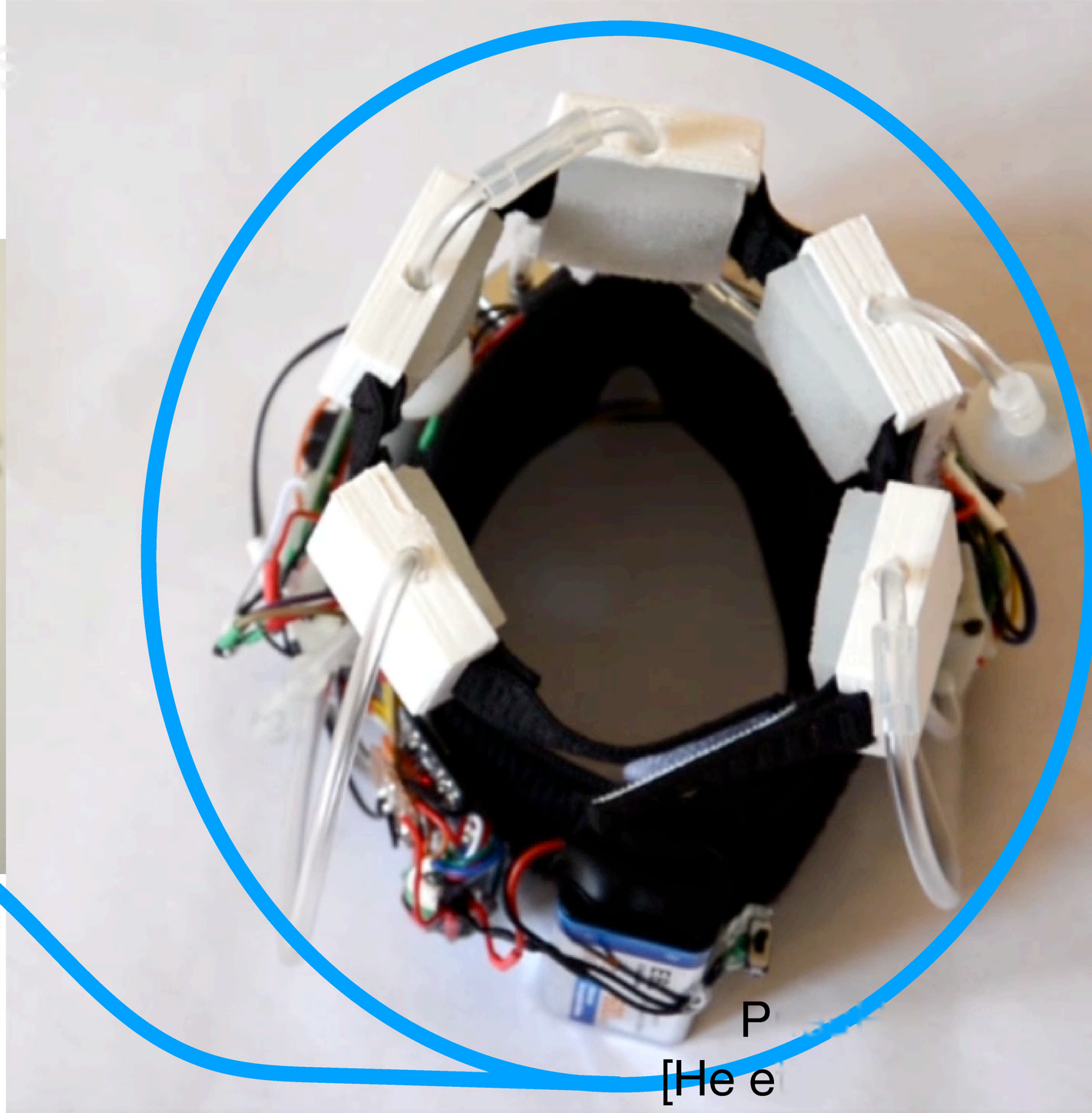
a **novel** shape-changing **wearable device**

providing users with **novel haptic feedback**

Commonly-used notifications

Feedback
by
shape change

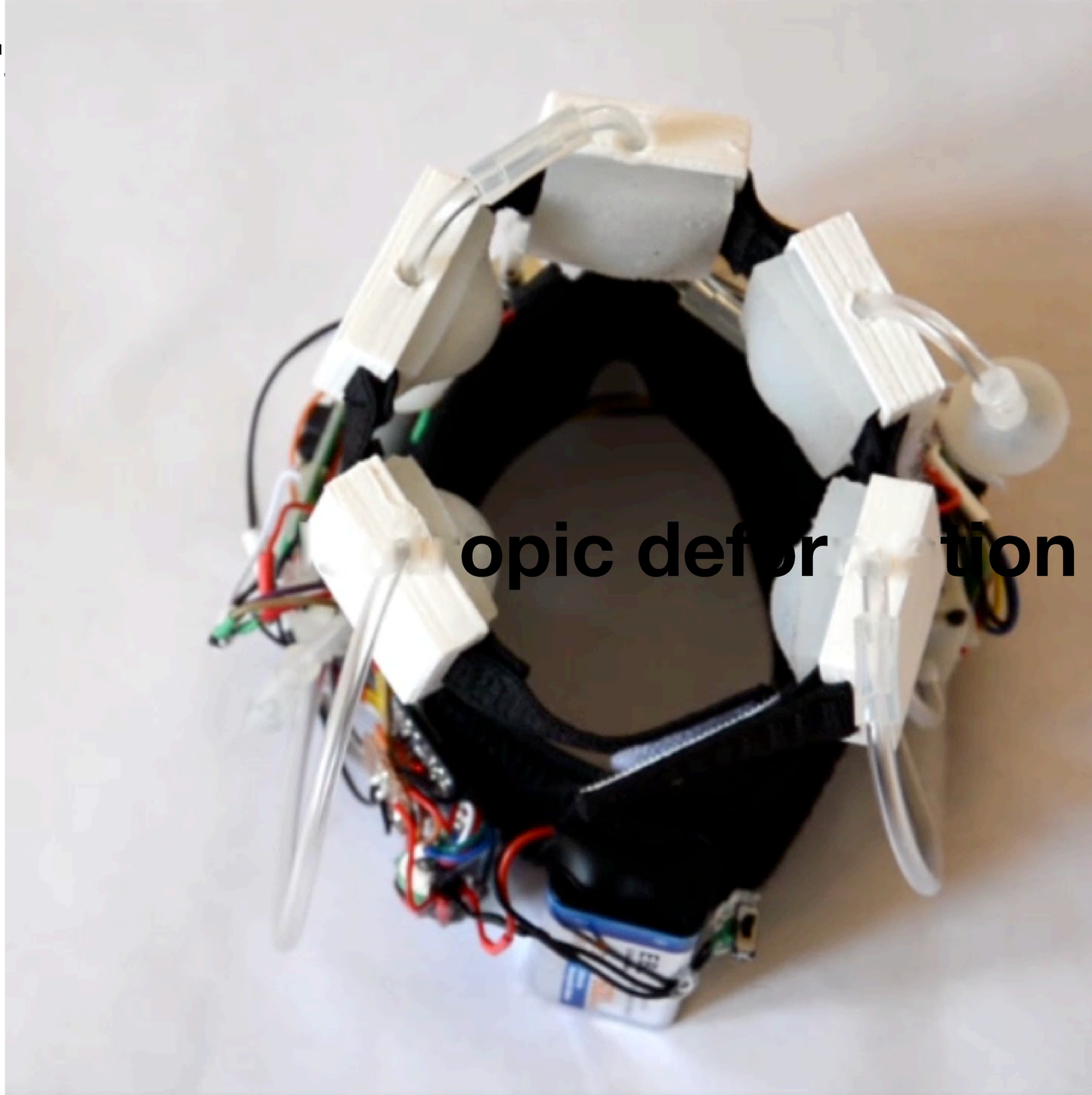




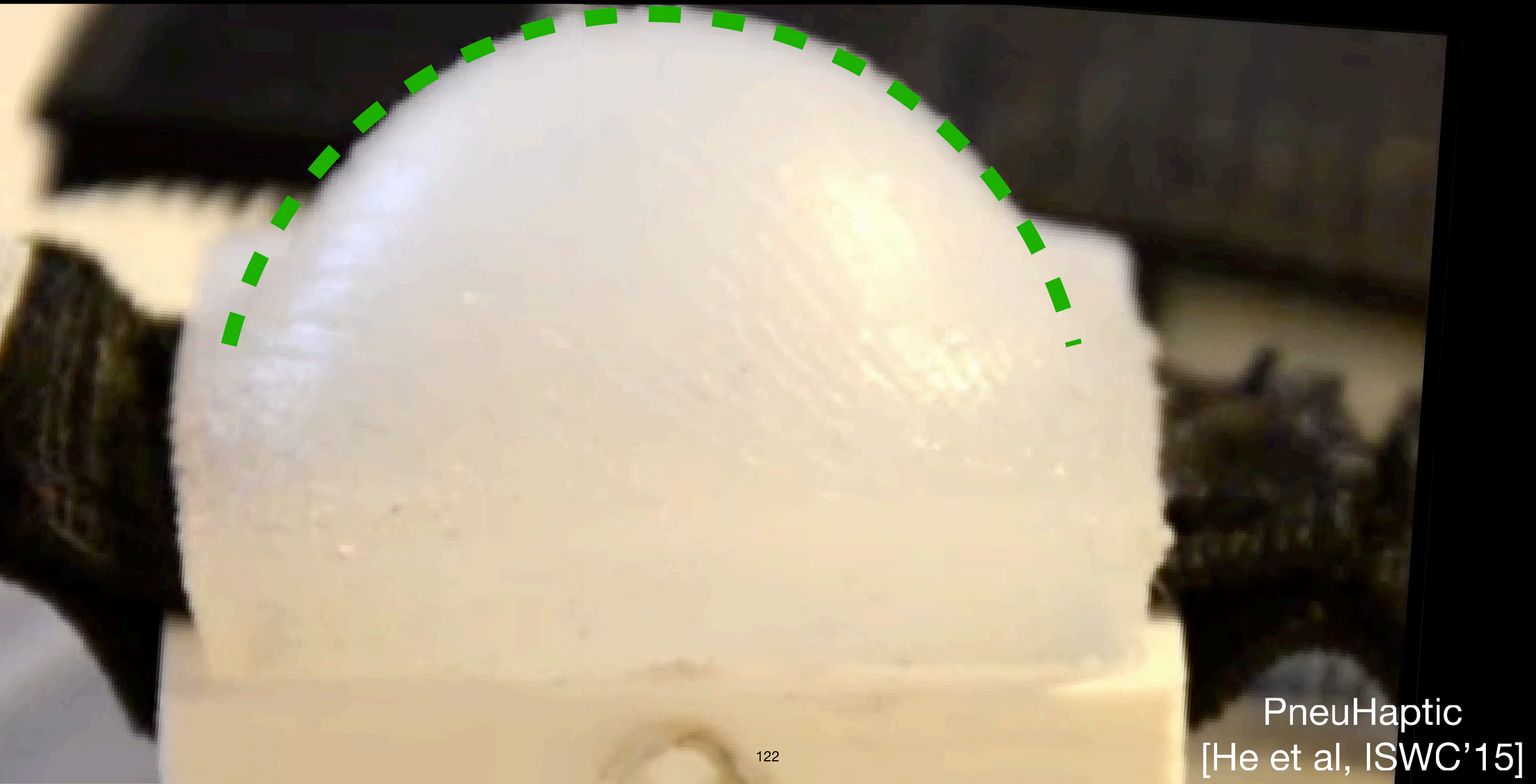
P

[He e

Inflatable air chamber



Creates only a spherical shape



PneuHaptic
[He et al, ISWC'15]

Curvature is **important**
for the perception of the shape of soft surfaces

SoftMorphees

Size

Curvature

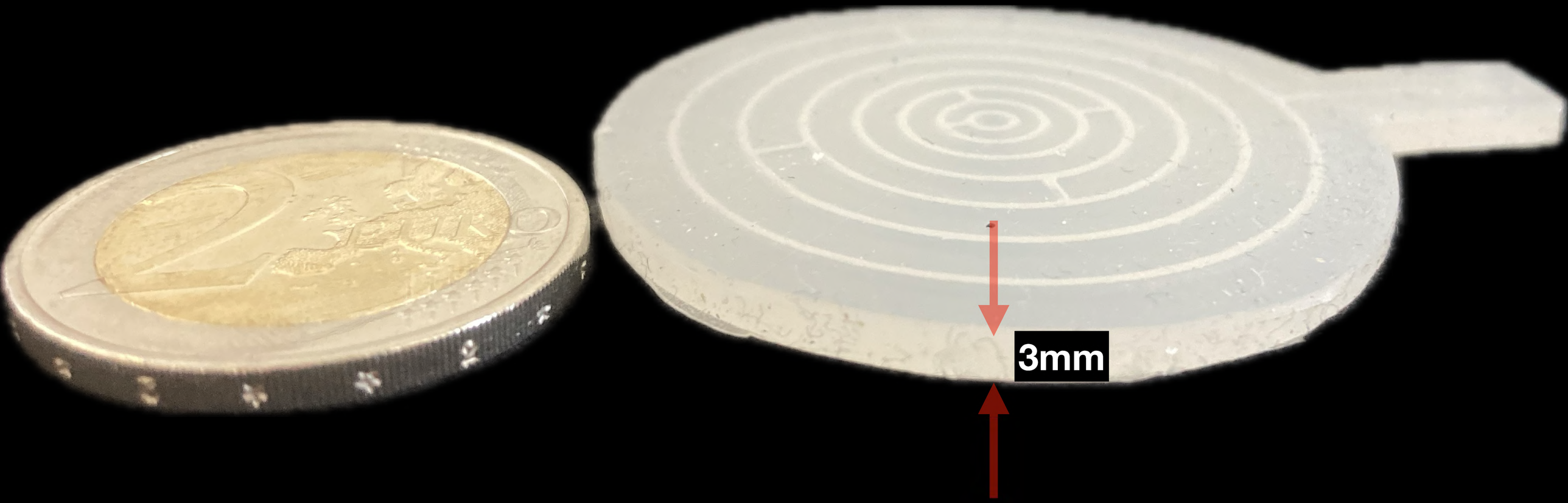
Amplitude

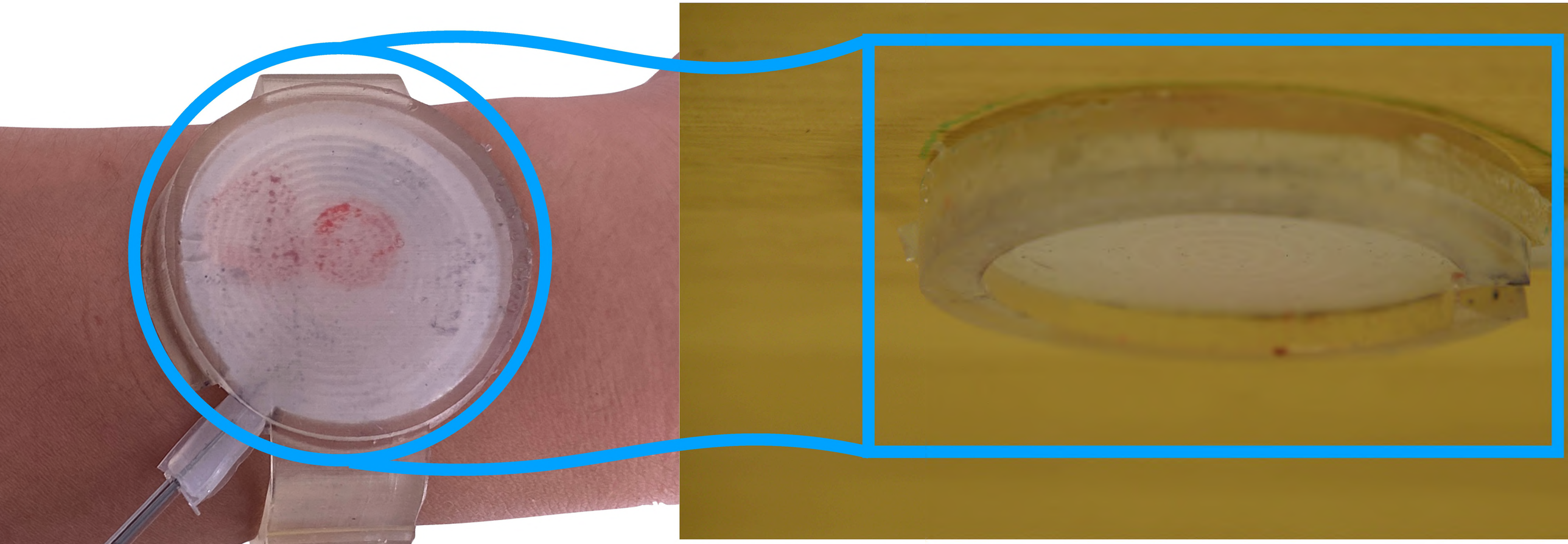
Porosity

Closure

Zero-crossing

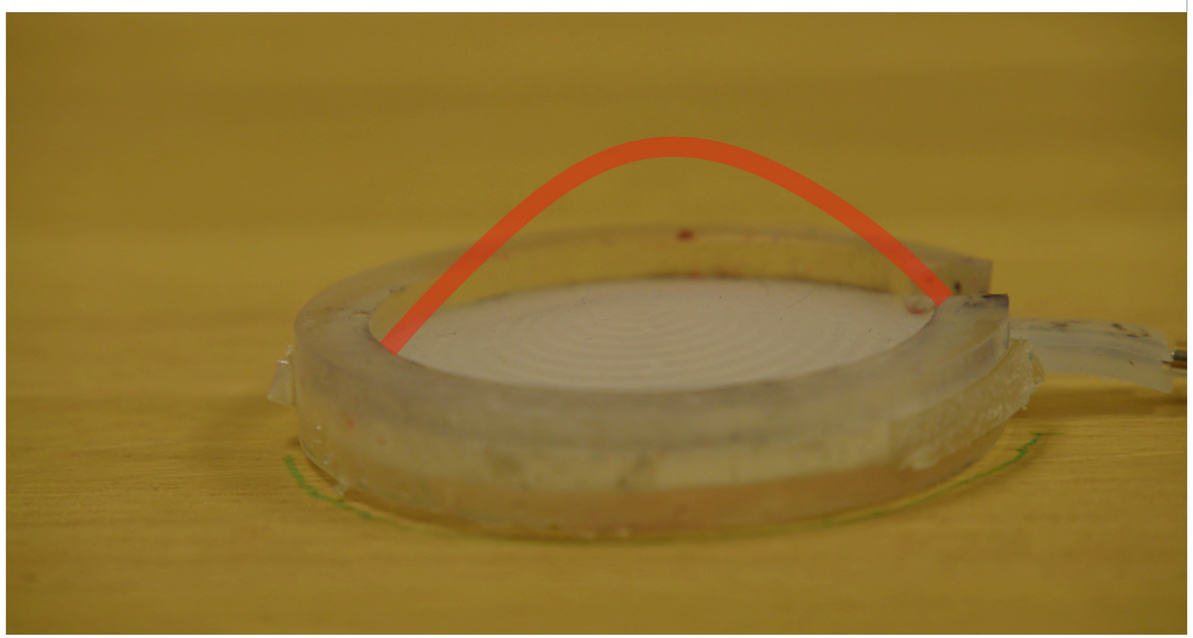
Thin surface



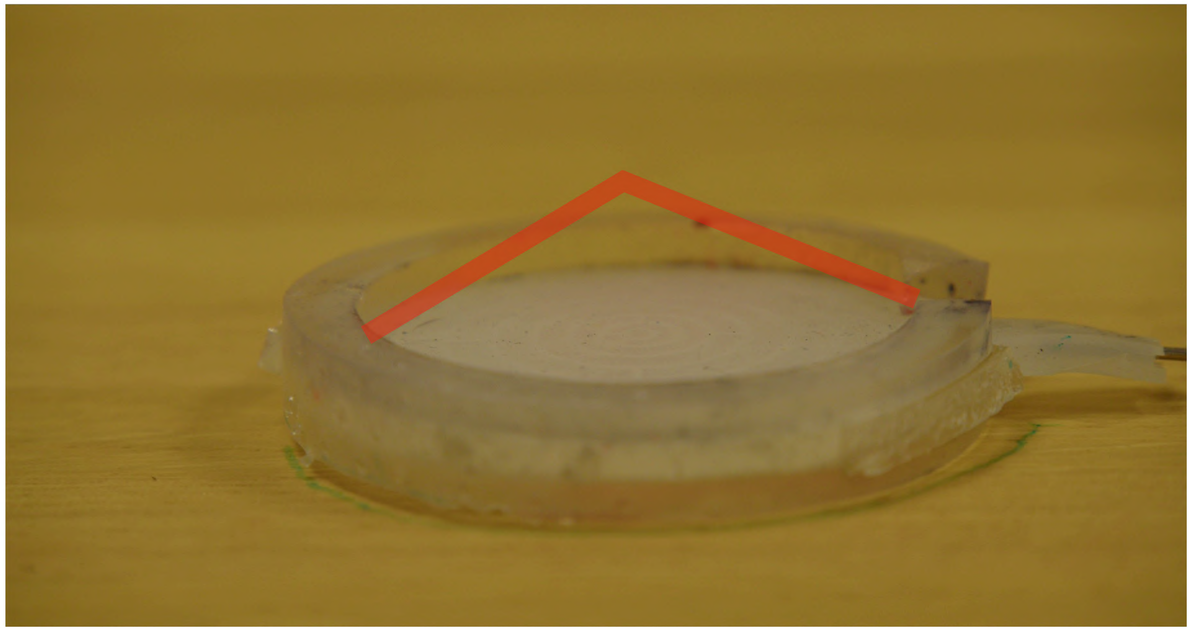


Which **shape change** makes the deformation **more noticeable**?

Surfaces with different shape changes



Round



Pointy

Psychophysical experiment
to measure the **absolute detection threshold**

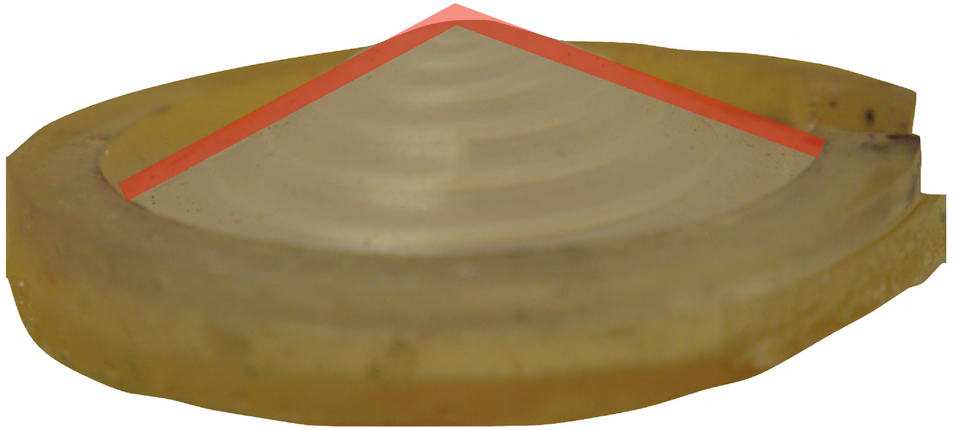
12 Participants (6 women, 6 men, median = 27 years)

Registration on osf.io/cqv7f

Independent variable

Round

Pointy

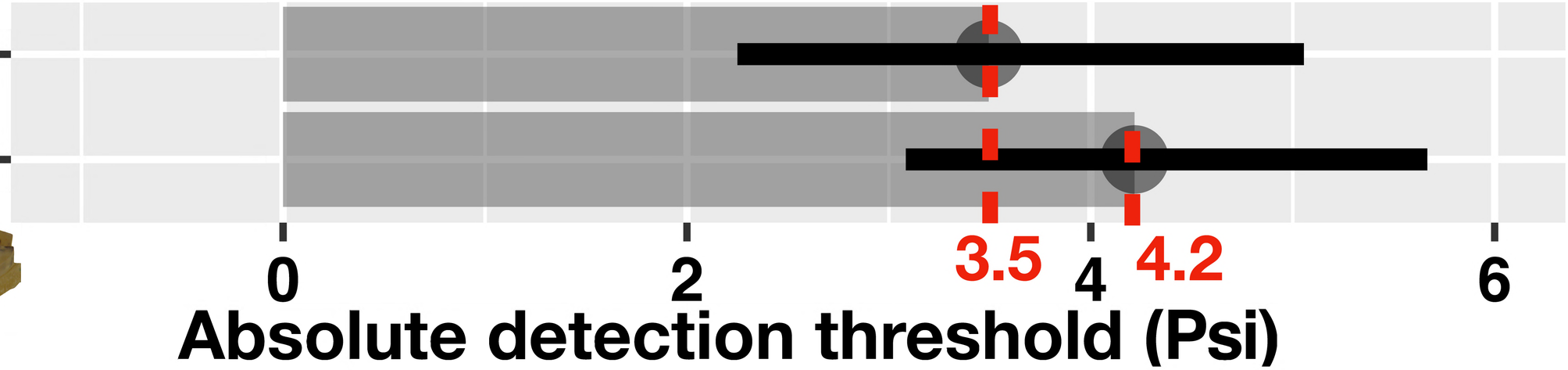


Absolute detection threshold

Low detection threshold

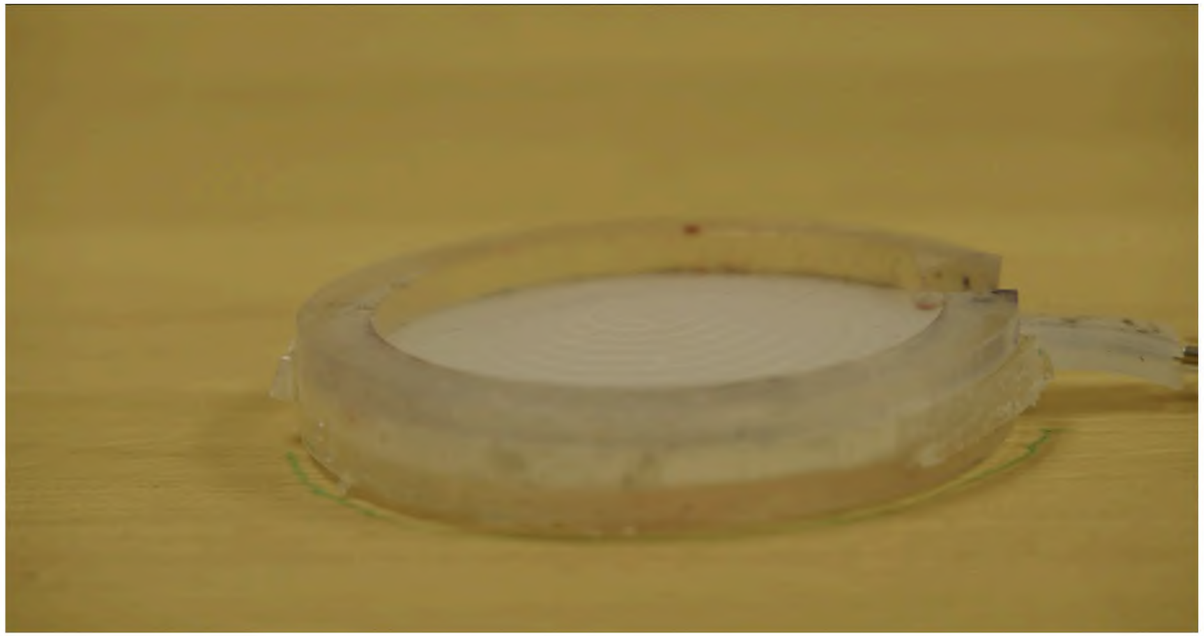
Round

Pointy

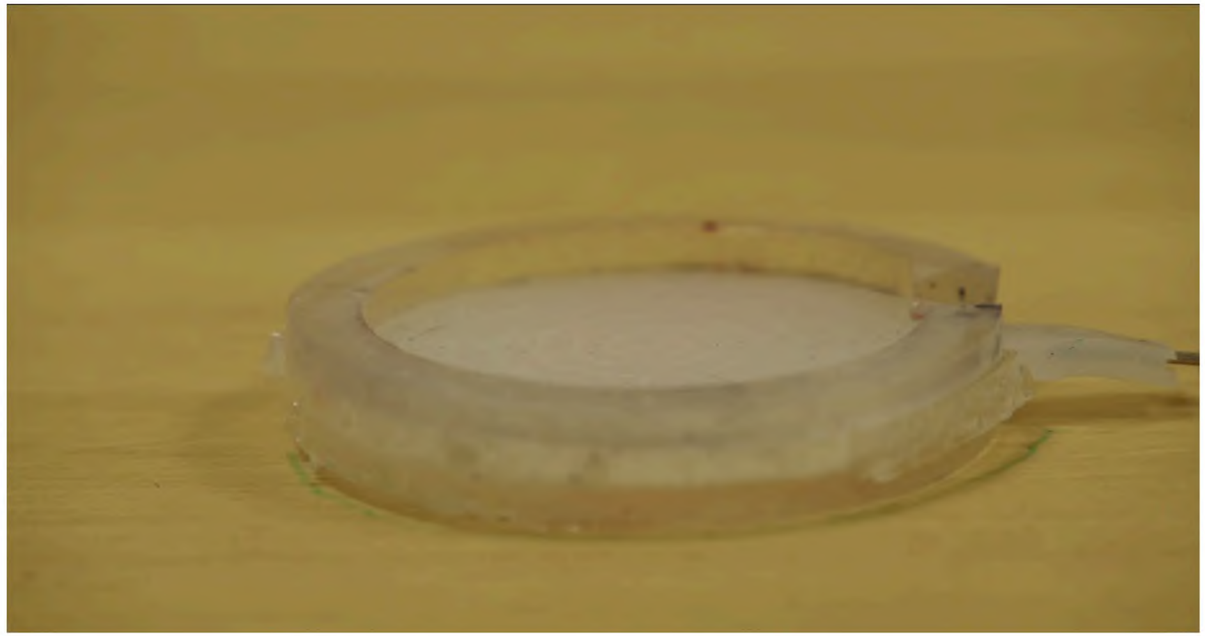


Efficient haptic feedback

Efficient haptic feedback

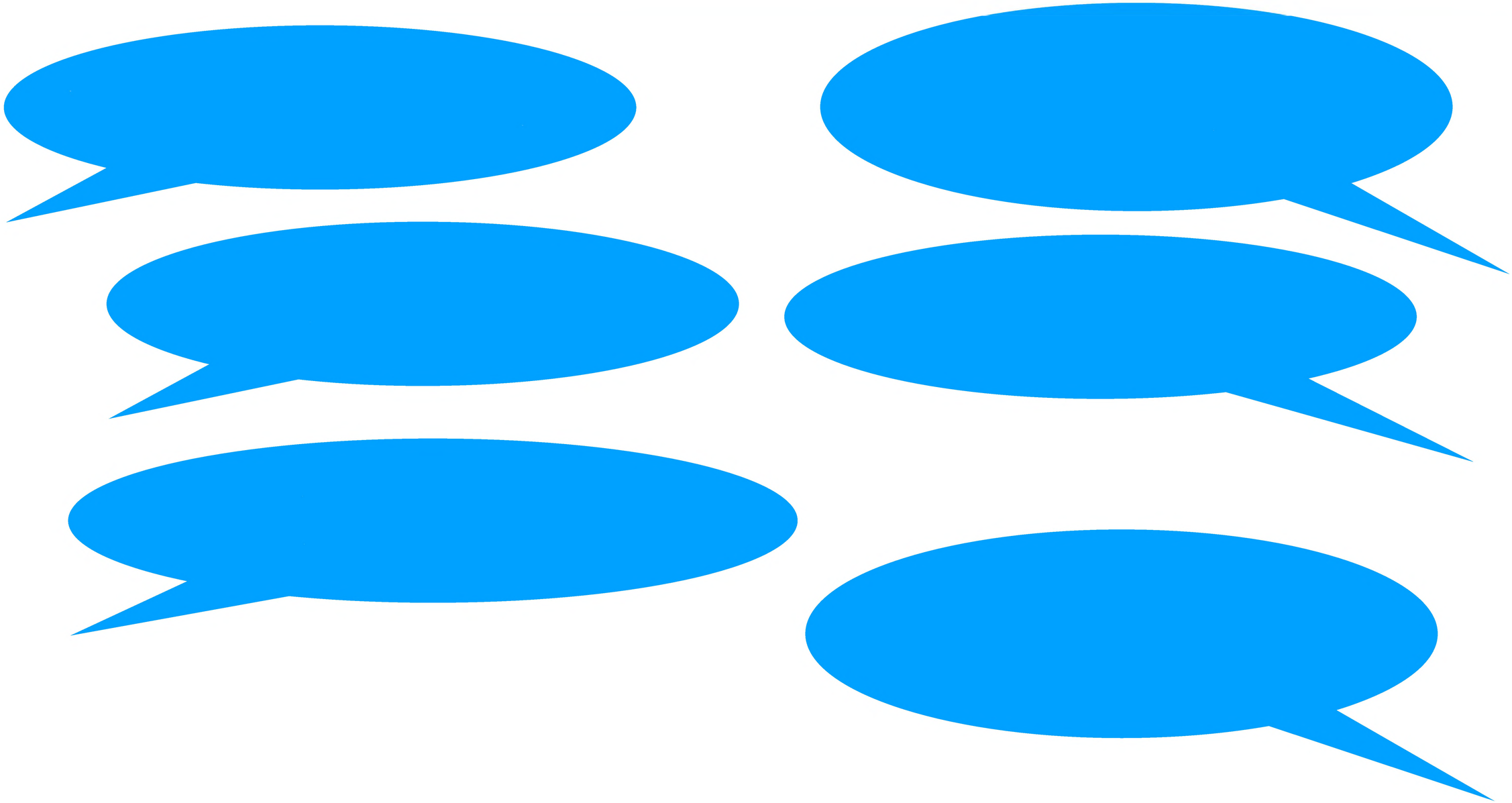


Round



Pointy

Qualitative feedback



New device design

Interaction beyond shapes

Challenges and future work

Interaction beyond shapes

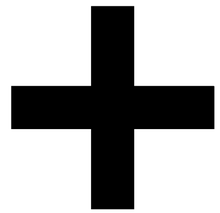
Challenges and future work

Developping shape-changing surfaces

+

Other interaction information beyond shapes?

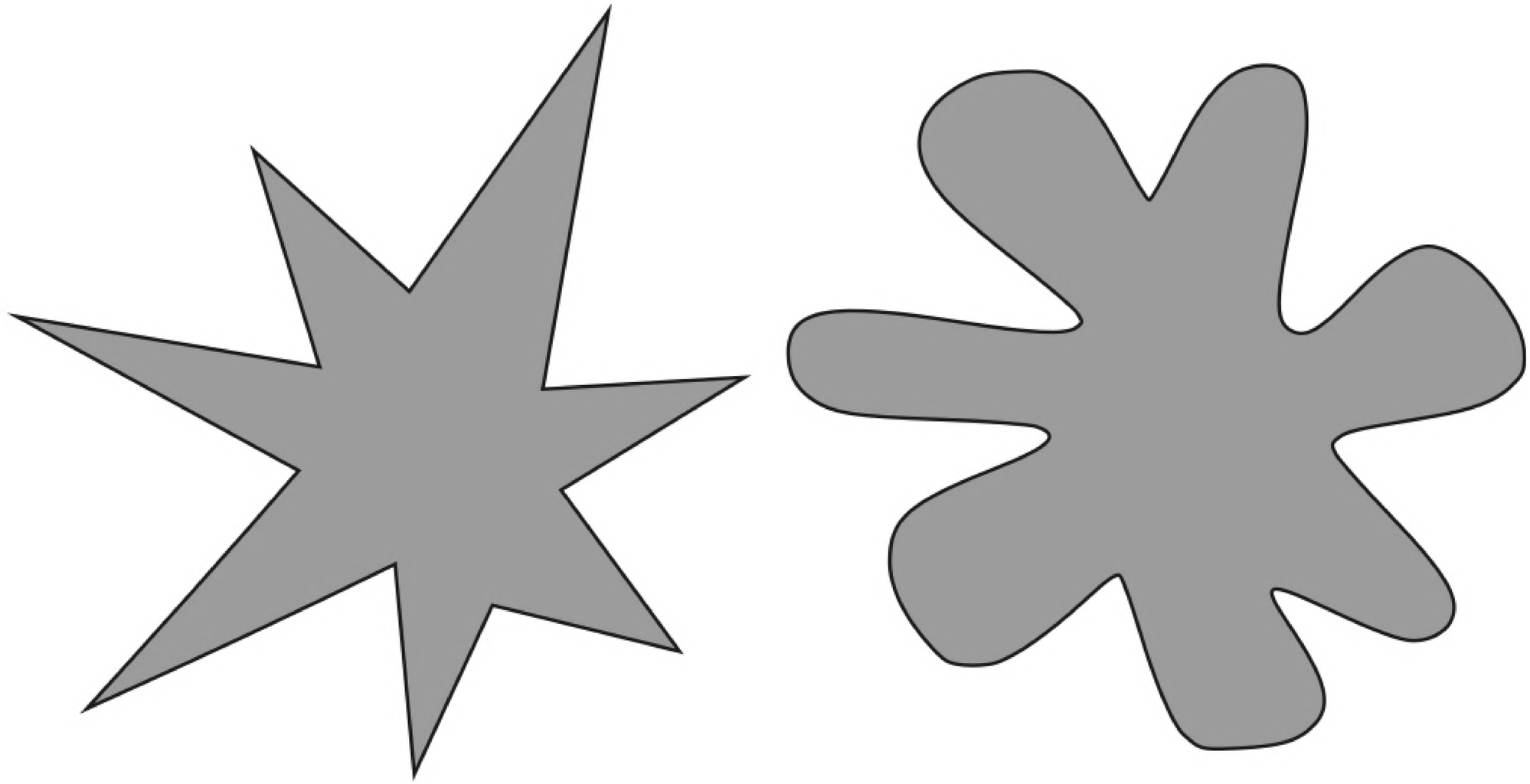
Which shapes



Which other interaction information

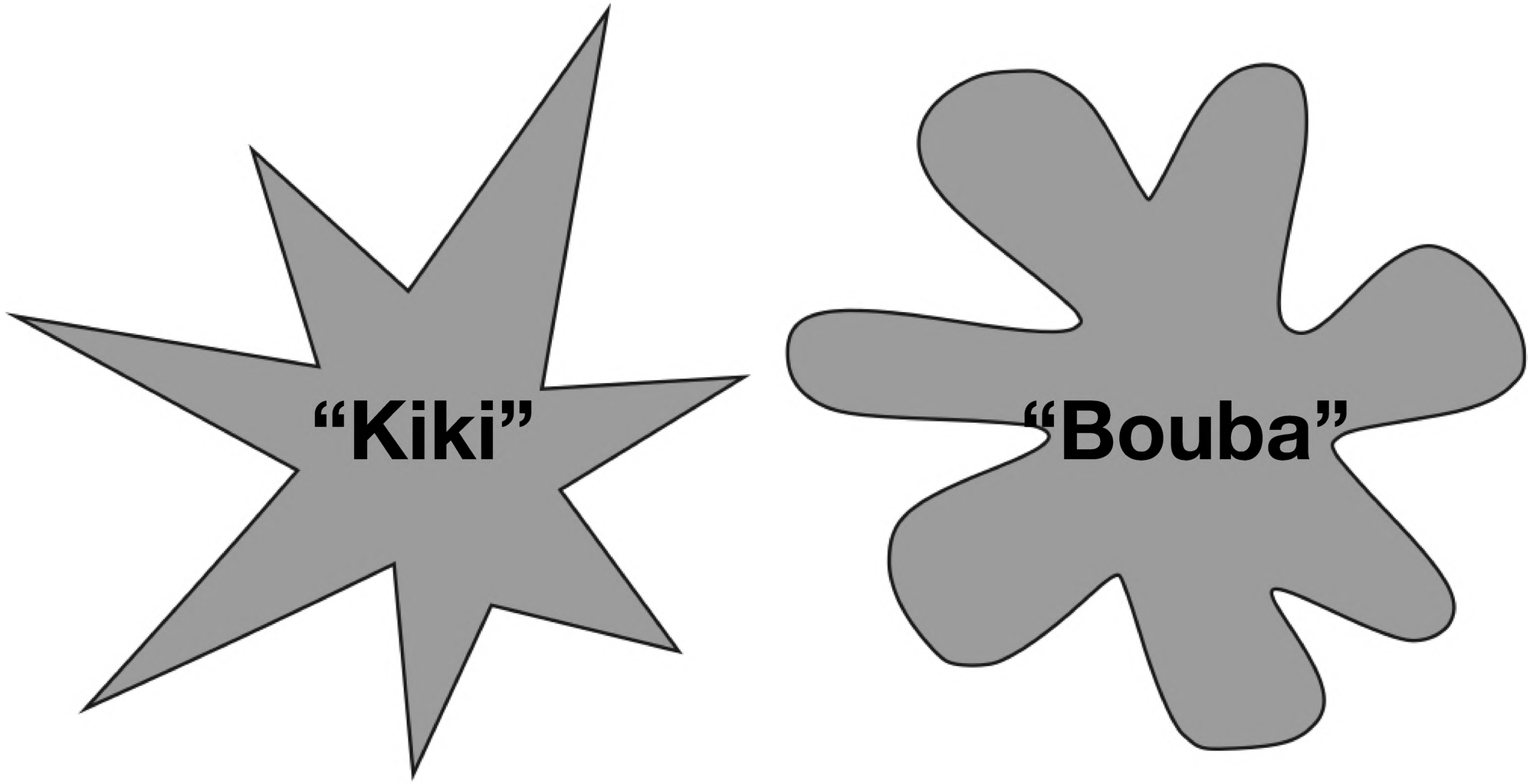
Cross-sensory correspondences

Auditory-visual association



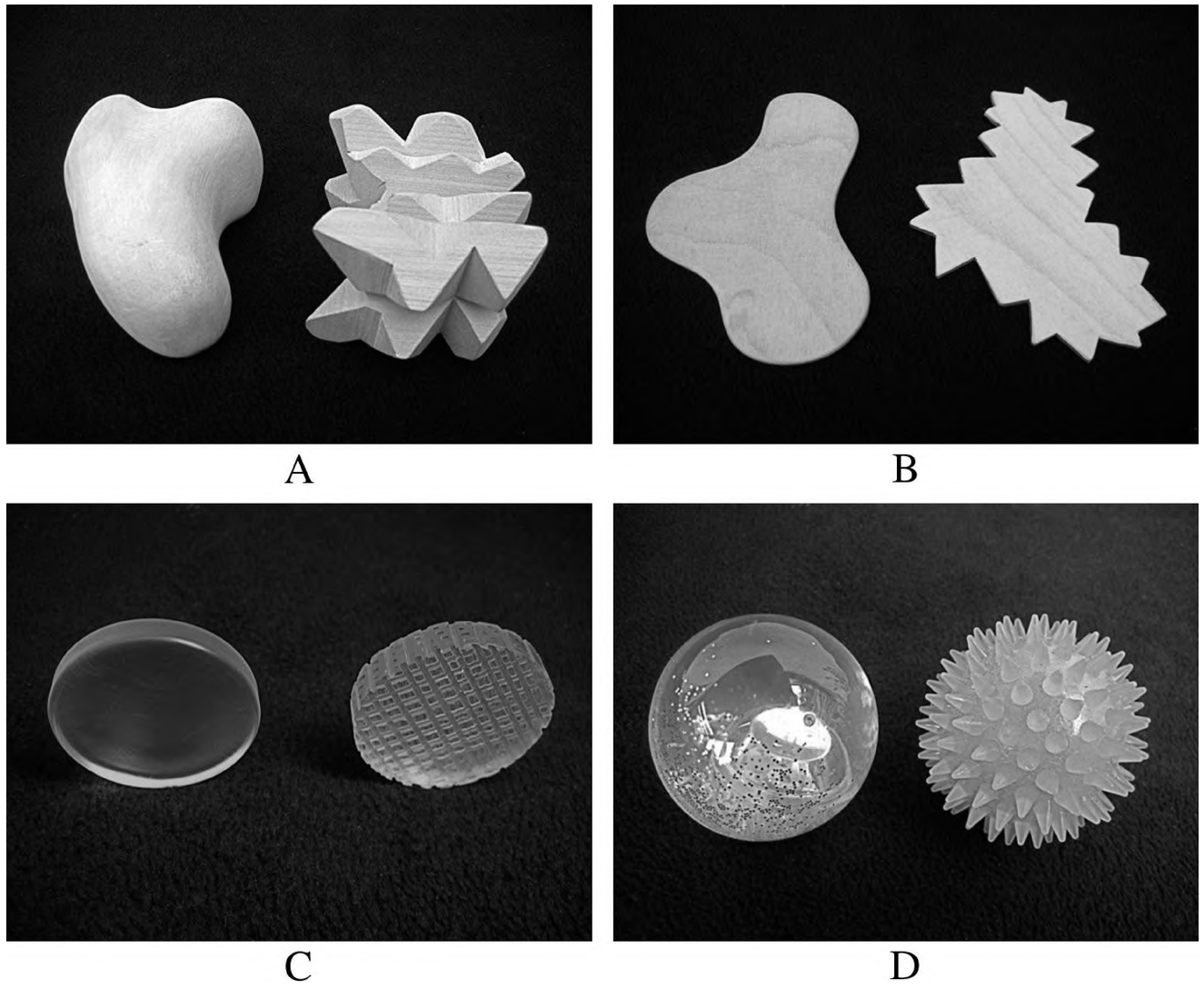
(Köhler, 1929)
(Ramachandran & Hubbard, 2001)

Auditory-visual association



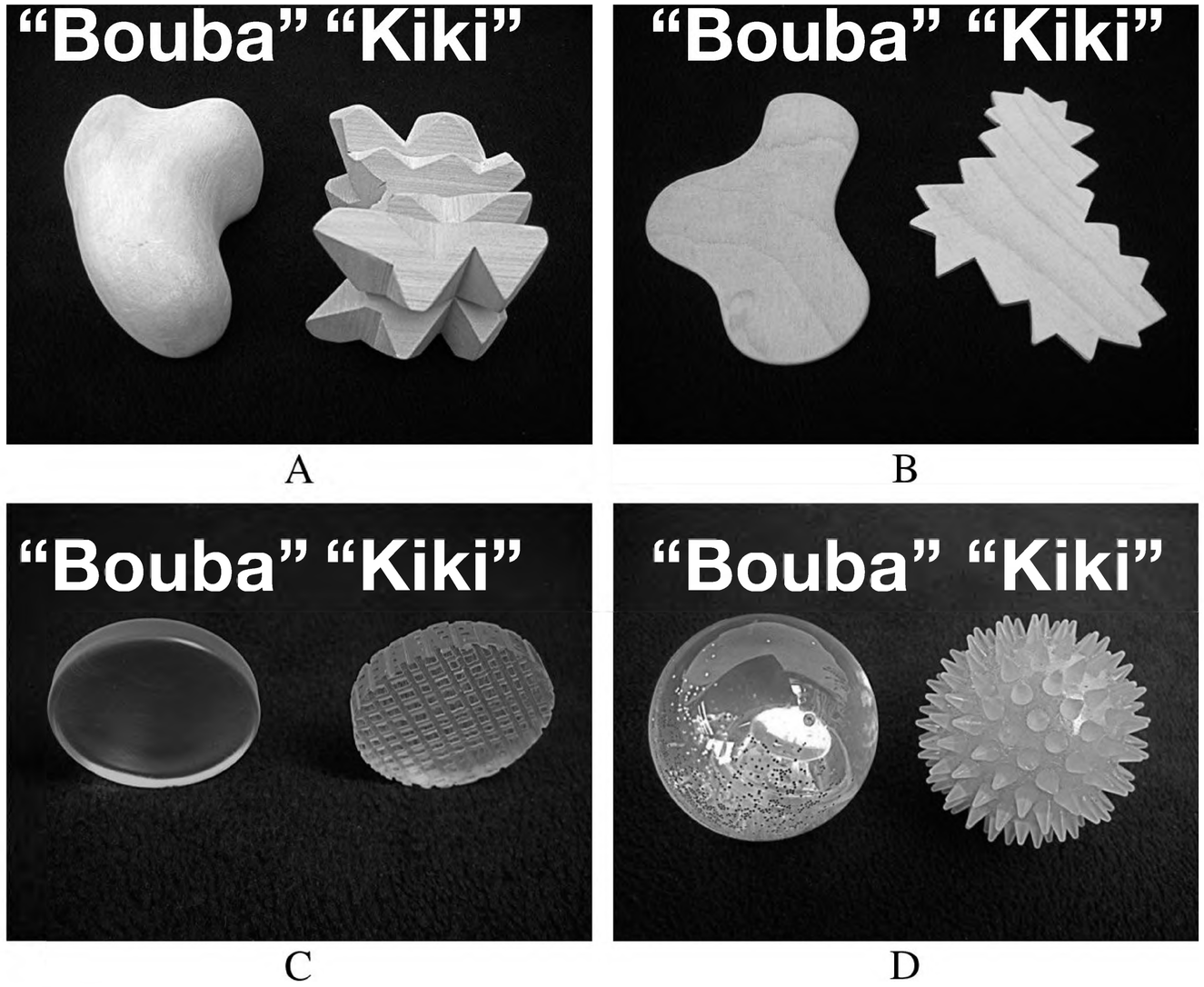
(Köhler, 1929)
(Ramachandran & Hubbard, 2001)

Auditory-haptic association



(Fryer et al., 2014)

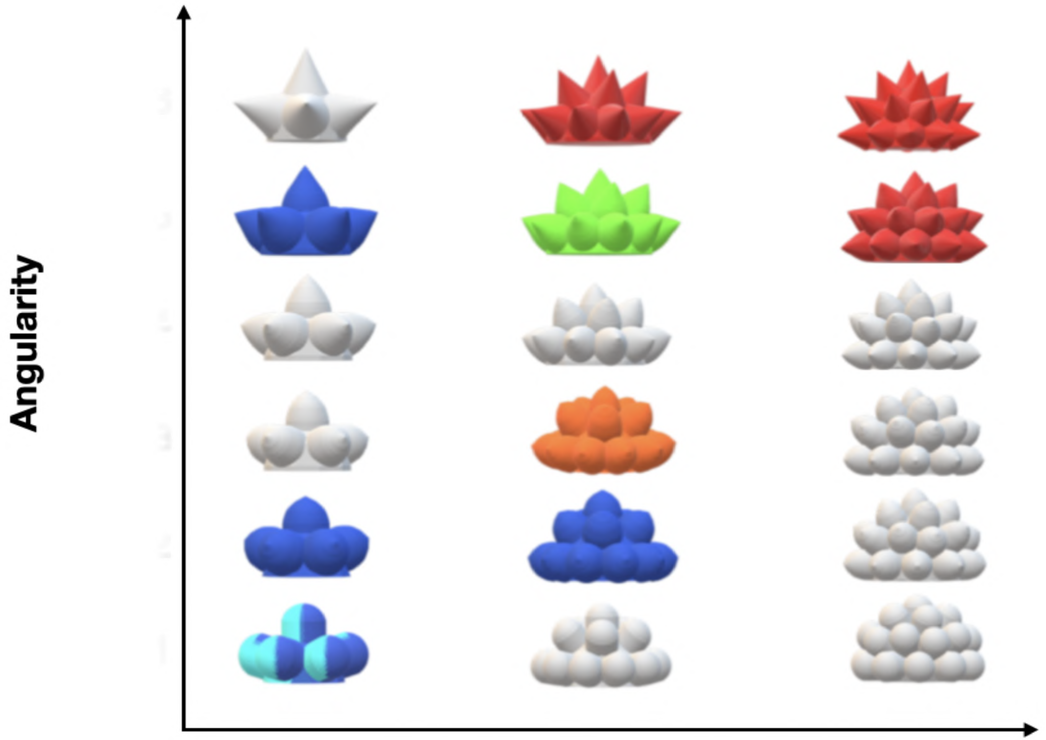
Auditory-haptic association



(Fryer et al., 2014)

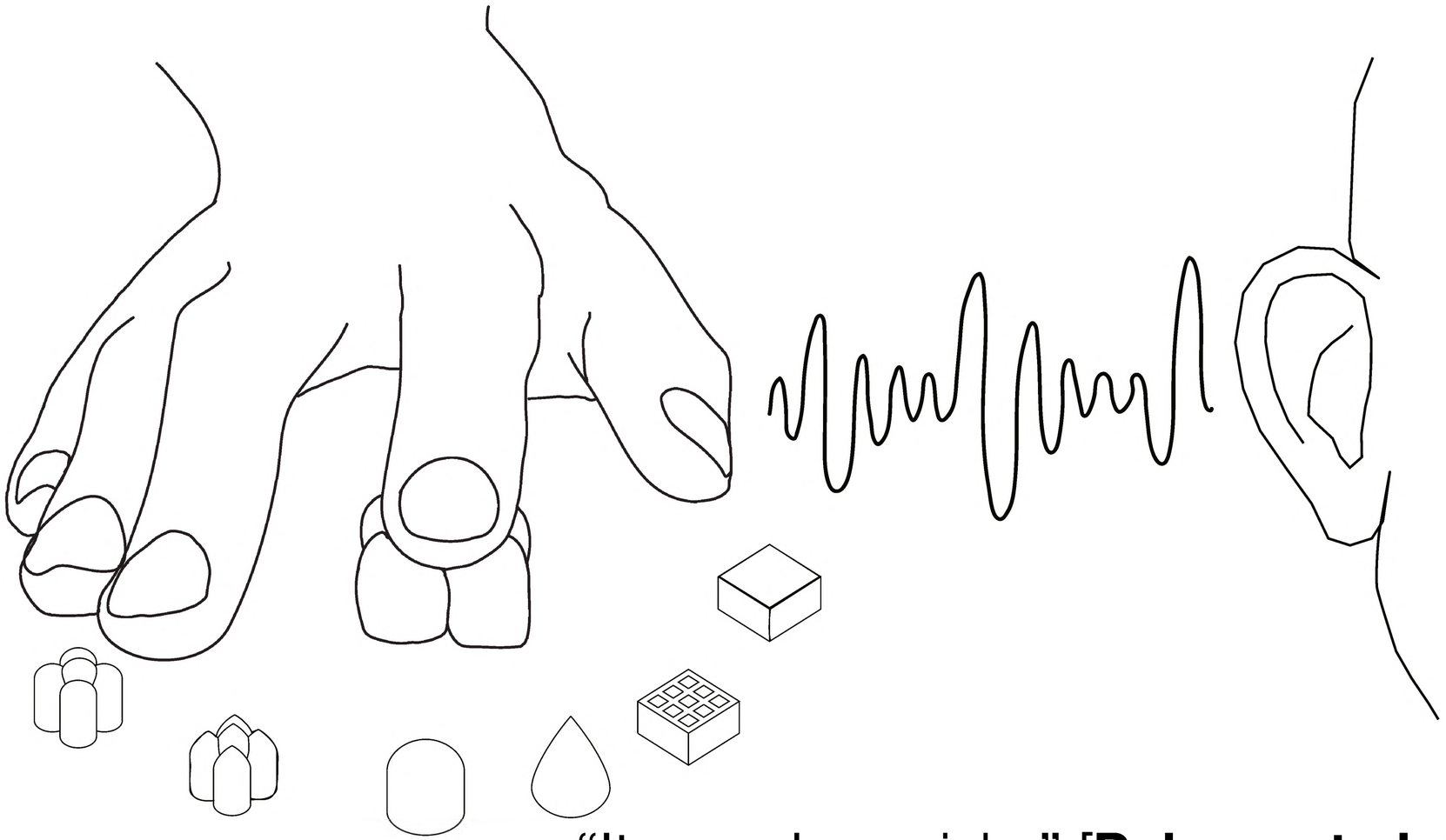
Haptic-olfactory association

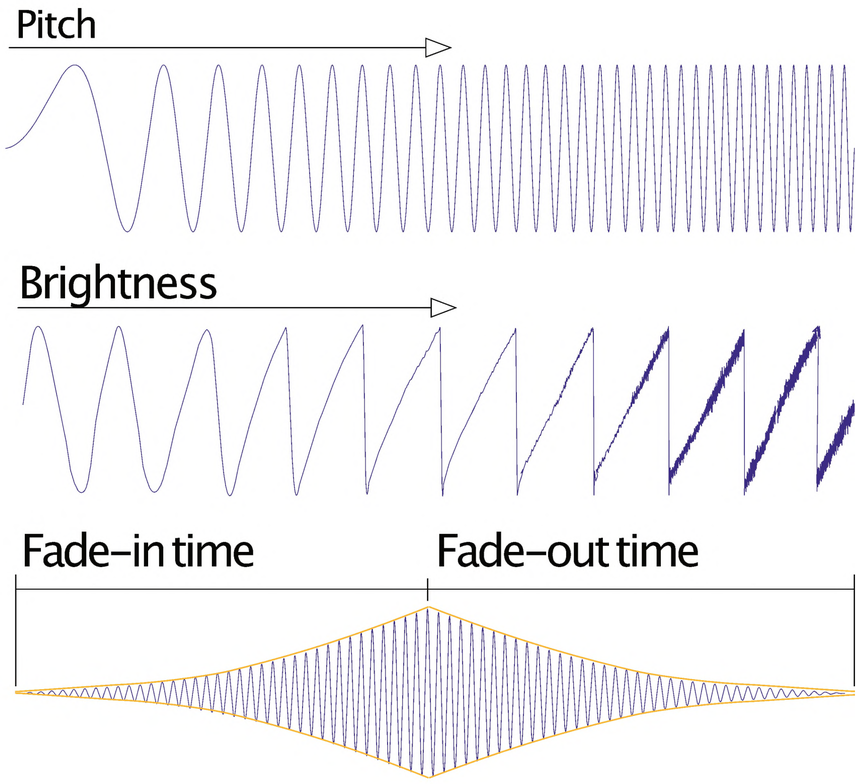
Haptic-visual association



“Feeling Colours” [**Lin et al.** CHI’21]

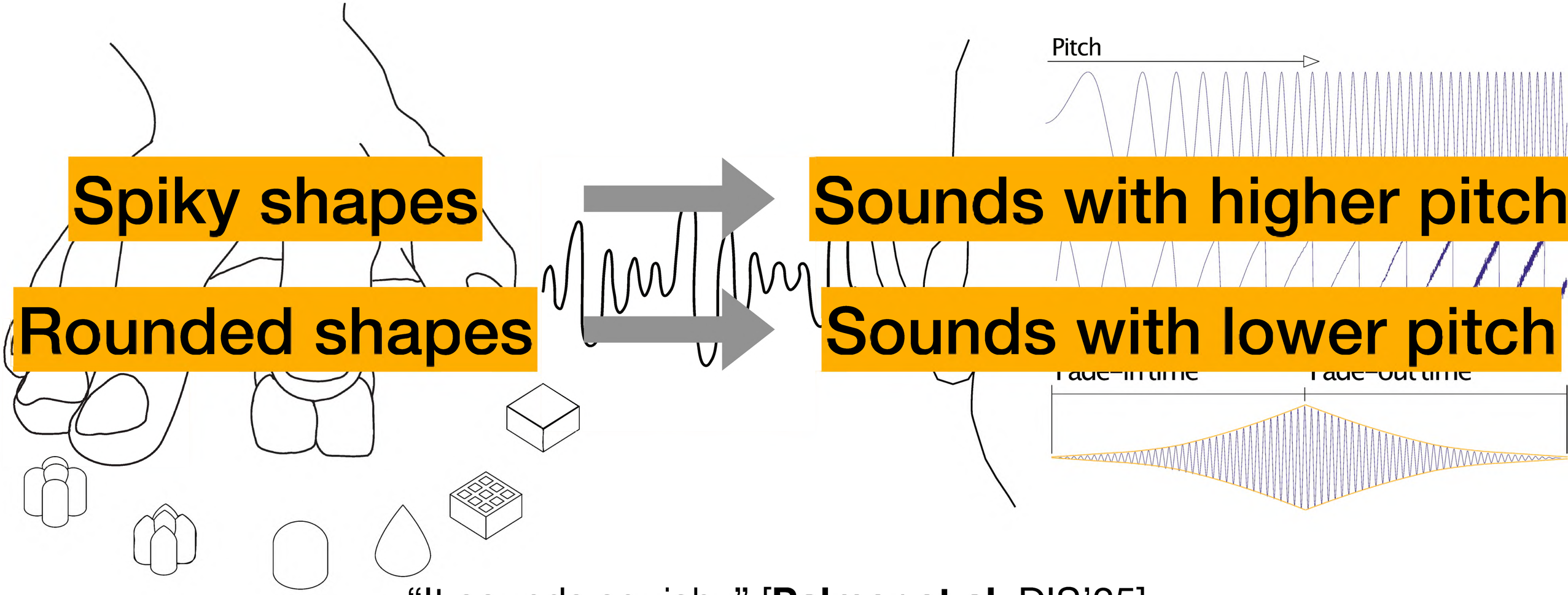
Haptic-auditory association





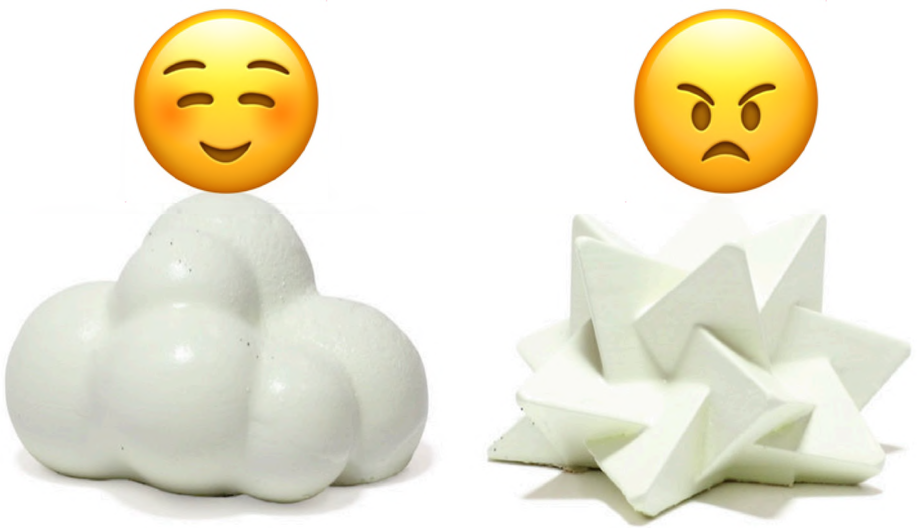
"It sounds squishy" [**Palmer et al.** DIS'25]

Haptic-auditory association

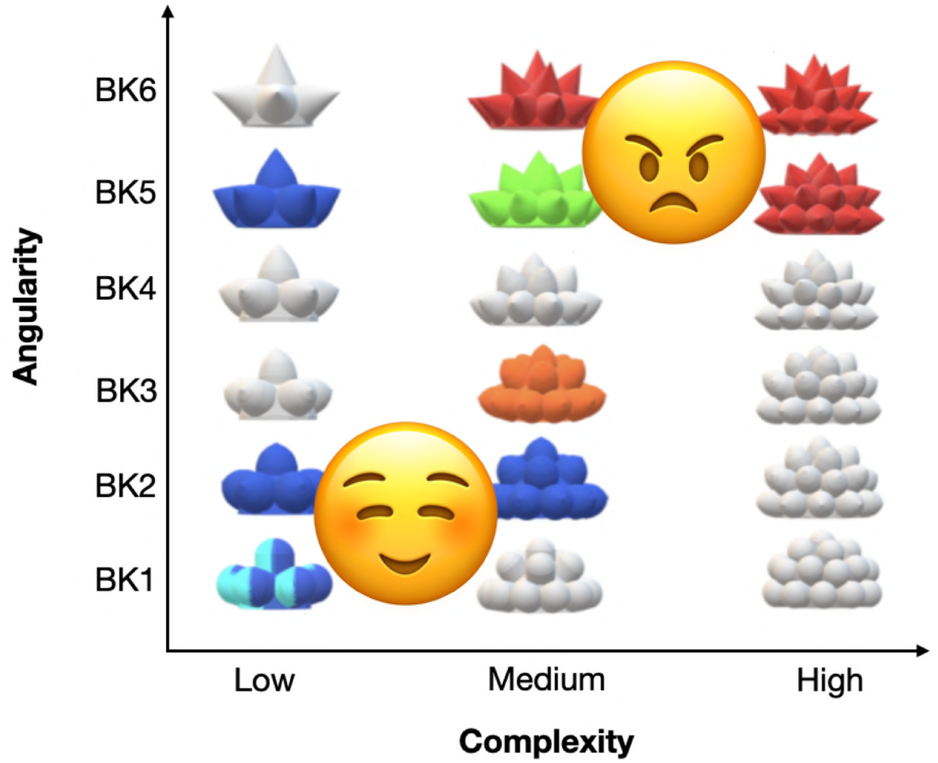


"It sounds squishy" [**Palmer et al.** DIS'25]

Haptic-emotion association



“Like Popcorn” [**Metatla et al.** CHI’19]



“Feeling Colours” [**Lin et al.** CHI’21]

Developping shape-changing surfaces

+

Other interaction information beyond shapes?

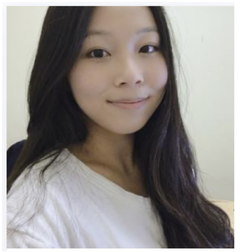
Interaction beyond shapes

Challenges and future work

Interaction through shape-changing surfaces

Main contributors:

Zhuzhi Fan



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CNRS 80 Prime MeMorI

ANR SecondSkin

ERC inclusive cross-sensory social play

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DIVERSE-Ability Interaction Lab

inclusive Cross Play

cnrs

UGA Université Grenoble Alpes

LIG