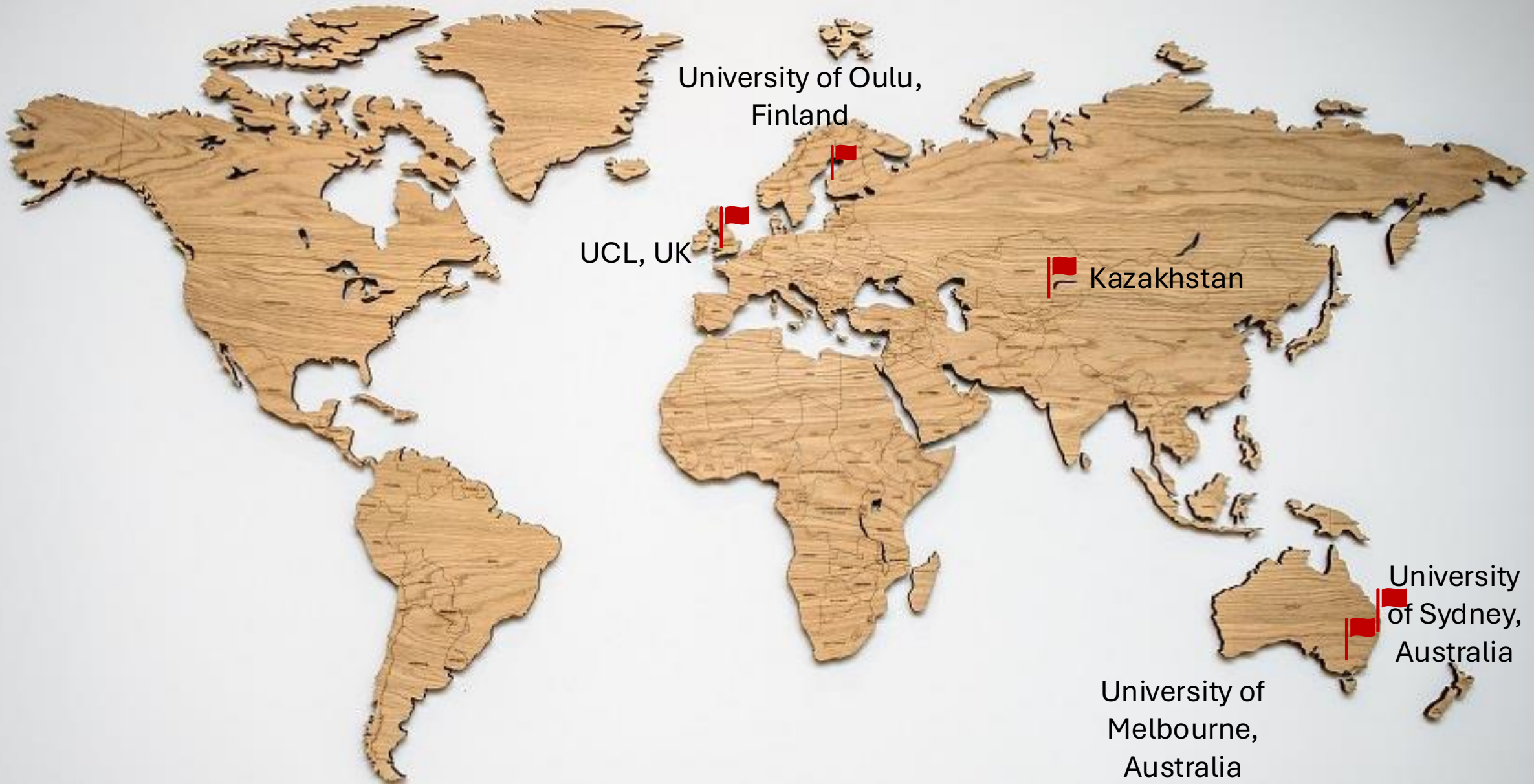


Towards Accessible, Context-Aware and Emotionally Intelligent Devices

Zhanna Sarsenbayeva

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University of Oulu, Finland
UCL, UK
Kazakhstan
University of Sydney, Australia
University of Melbourne, Australia


Create accessible smart solutions that understand and respond to us


MR
amazon
Accessibility
Instrumentation


Accessibility





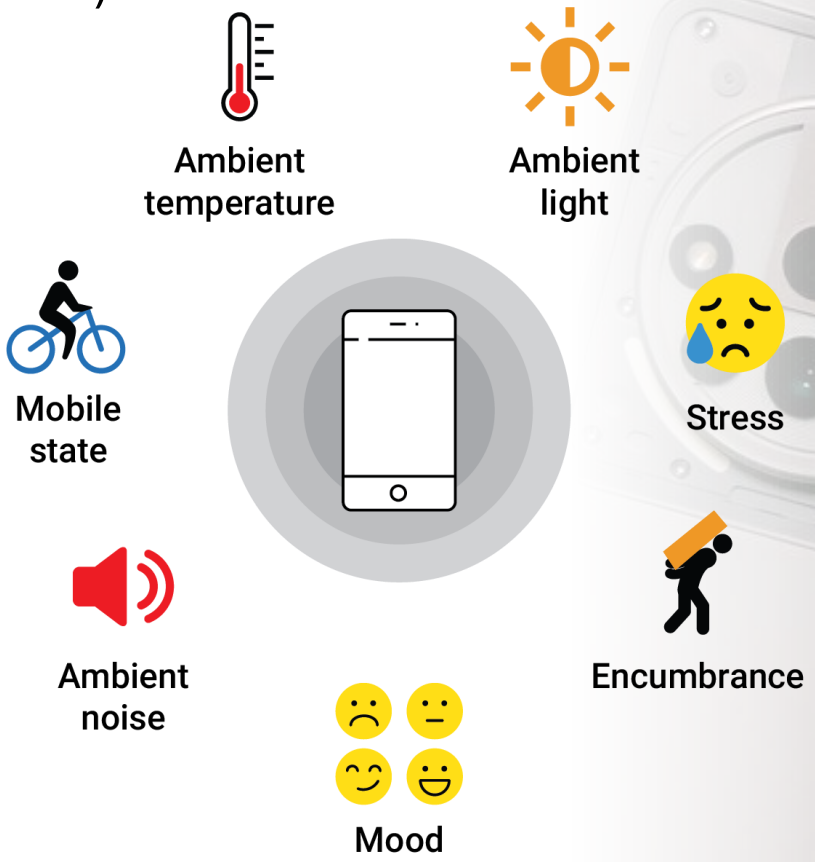



PAY ATTENTION WHILE WALKING
YOUR FACEBOOK STATUS UPDATE CAN WAIT.
MEA
Metropolitan Etiquette Authority



Situationally-Induced Impairments and Disabilities

- Andrew Sears and Mark Young (2003)



- The effects of:
  - Cold ambient temperature
    - Situational Impairments to Mobile Interaction in Cold Environments, UbiComp'16
  - Ambient noise
    - Effect of Distinct Ambient Noise Types on Mobile Interaction, PACM IMWUT/UbiComp'18
  - Stress
    - Measuring the Effects of Stress on Mobile Interaction, PACM IMWUT/UbiComp'19
  - Ambient light
    - Effect of Ambient Light on Mobile Interaction, INTERACT'19



Ubiquitous nature of MR might change the way we perform daily activities




RELENTLESS
USA

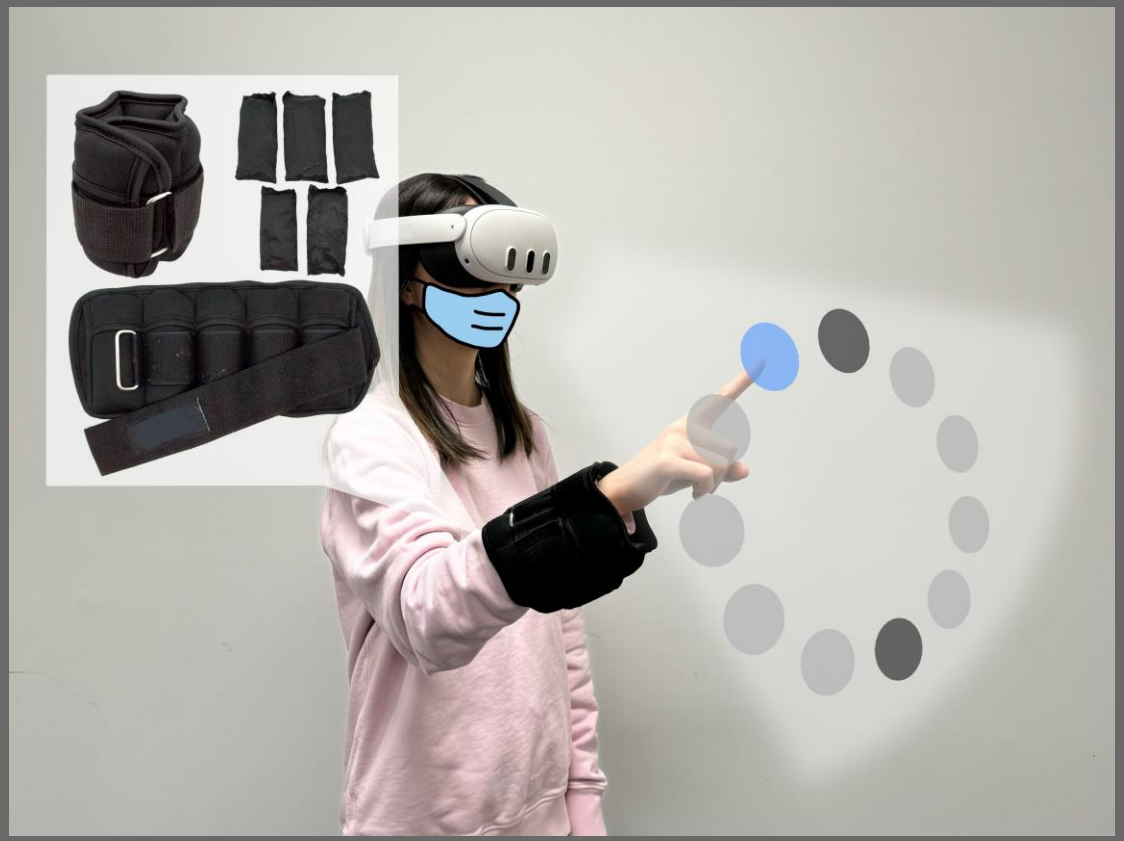



x1
620
0
Swipe down to slide
https://youtu.be/Qqw00uCaGgM?si=9jpDZ-dvzqlgszyS



Estimating the Effects of Encumbrance and Walking on Mixed Reality Interaction, CHI 2025 (Honourable mention award)
T. Li, E. Velloso, A. Withana, Z. Sarsenbayeva

Conditions

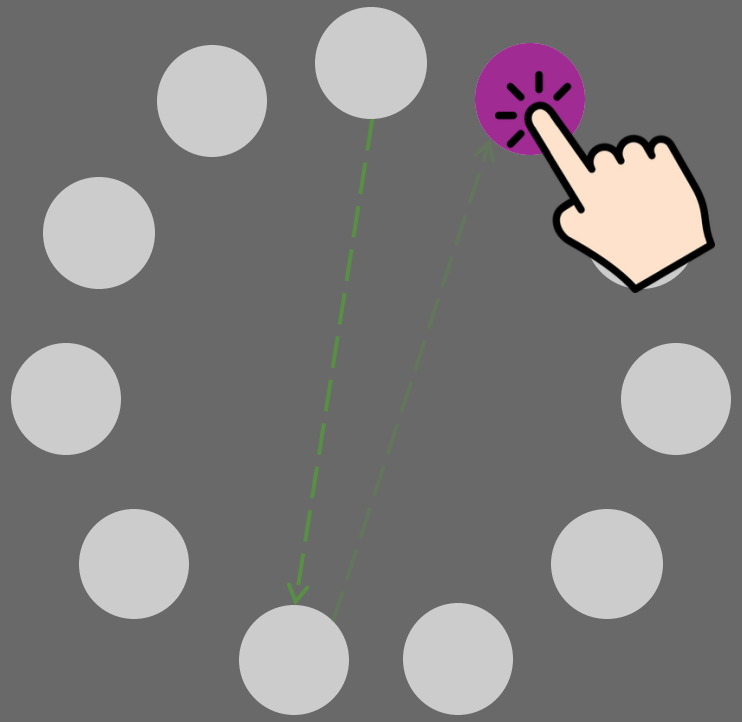


Encumbrance
(0kg, 0.5kg, 1.0kg)

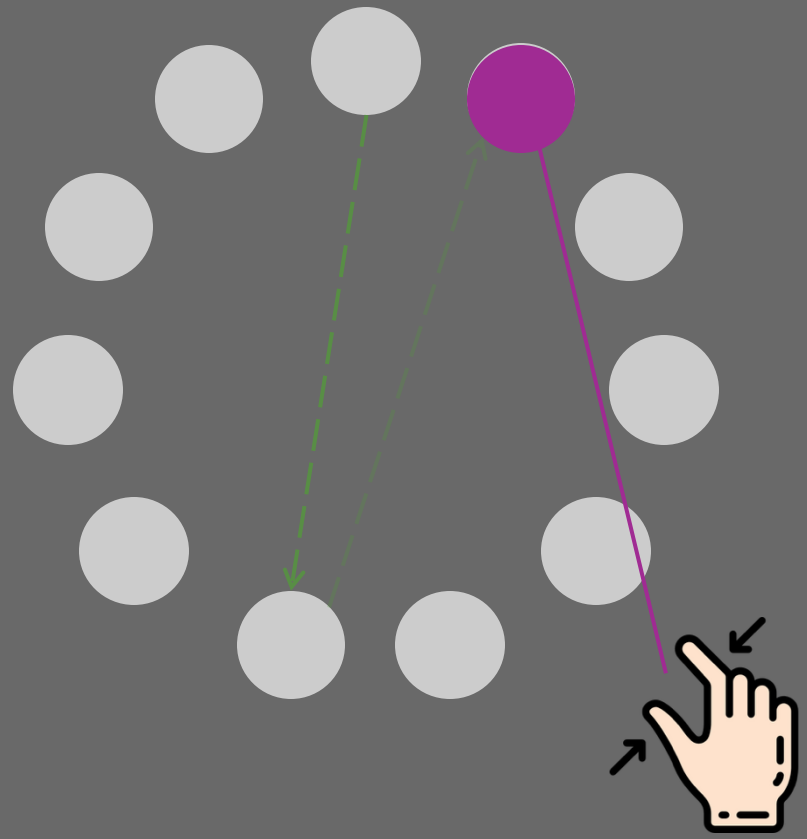


Motion
(Standing, Walking)

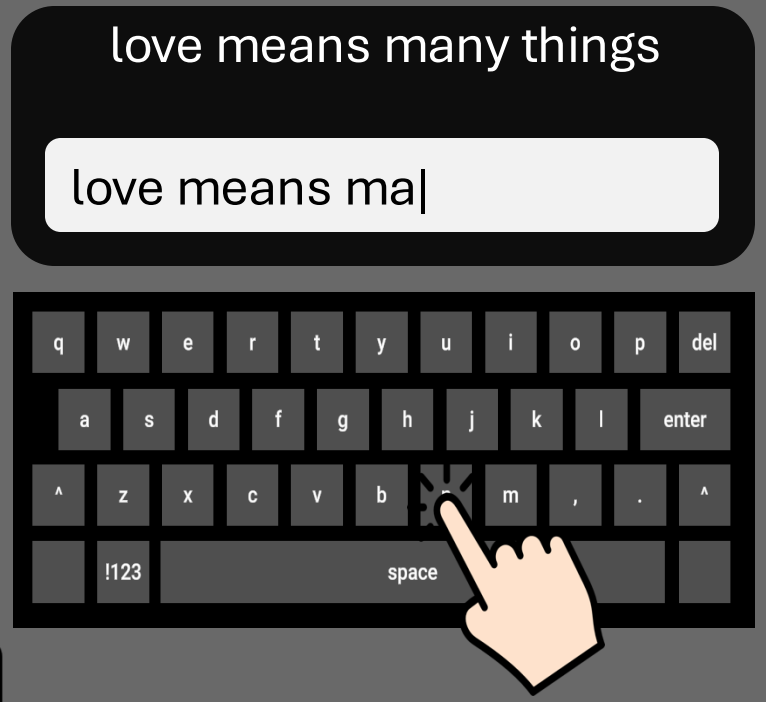
Tasks



Target Acquisition
(Direct Selection)



Target Acquisition
(Ray-Casting)



Text Entry

Findings

	Encumbrance (1.0 kg)	Walking	1.0 kg × Walking
MT	↑ 28% in direct selection	↑ 21% in direct selection	—
	↑ 27% in ray-casting	↑ 63% in ray-casting	↑ 112% in ray-casting
Offset	—	↑ 16% in direct selection	—
	—	↑ 17% in ray-casting	—
Error Rate	—	↑ 8.4% in ray-casting	—
Target TP	↓ 22% in direct selection	↓ 16% in direct selection	—
	↓ 20% in ray-casting	↓ 32% in ray-casting	—
Typing TP	↓ 17%	↓ 51%	↓ 58%
UER	↑ 50%	↑ 28%	—
CER	—	↑ 68%	—

Implications:

- Everyday life
  - environmental constraints
- Research
  - out of confined lab spaces









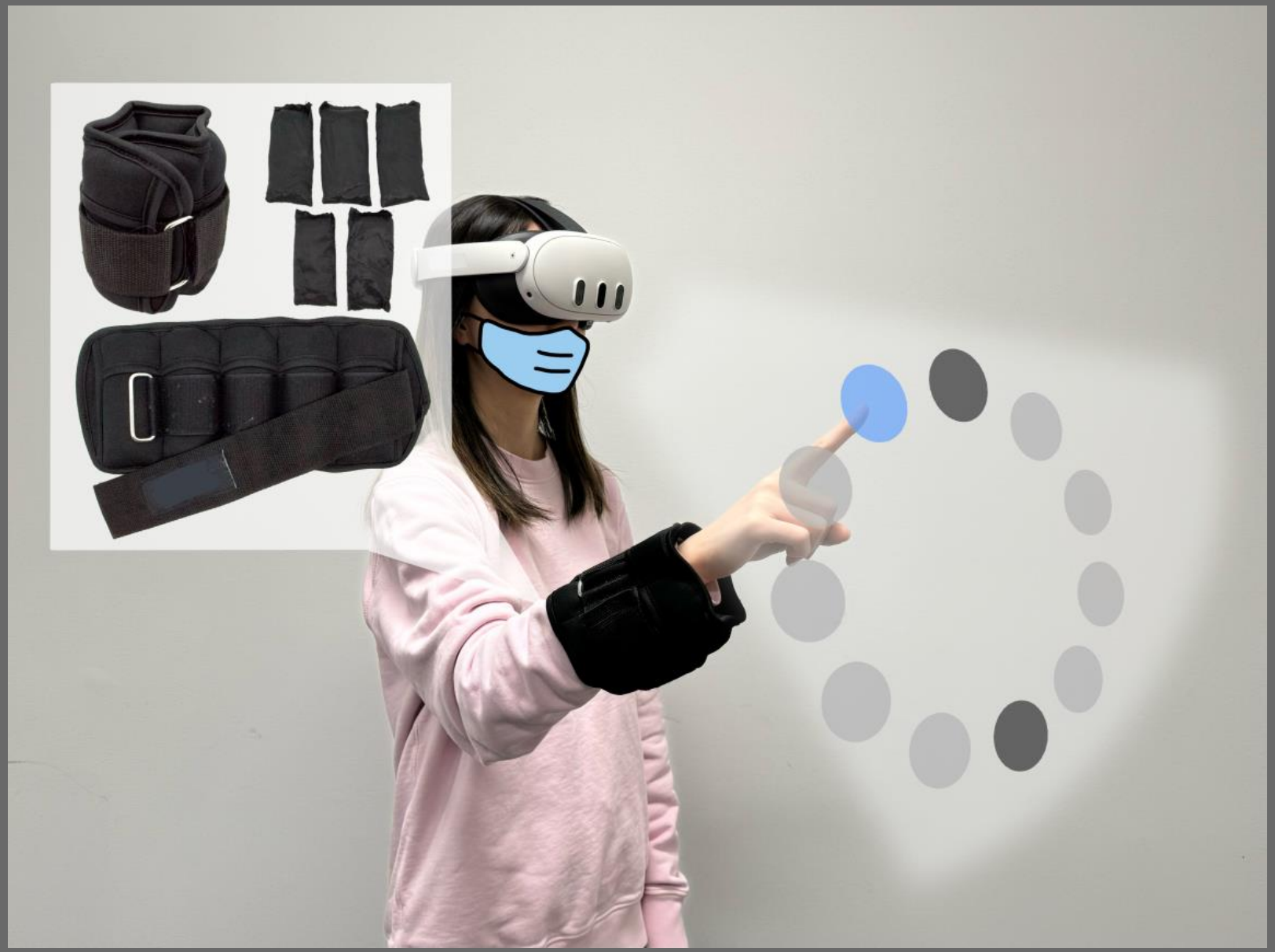



MR
amazon
Accessibility
Instrumentation


Instrumentation
Sensing

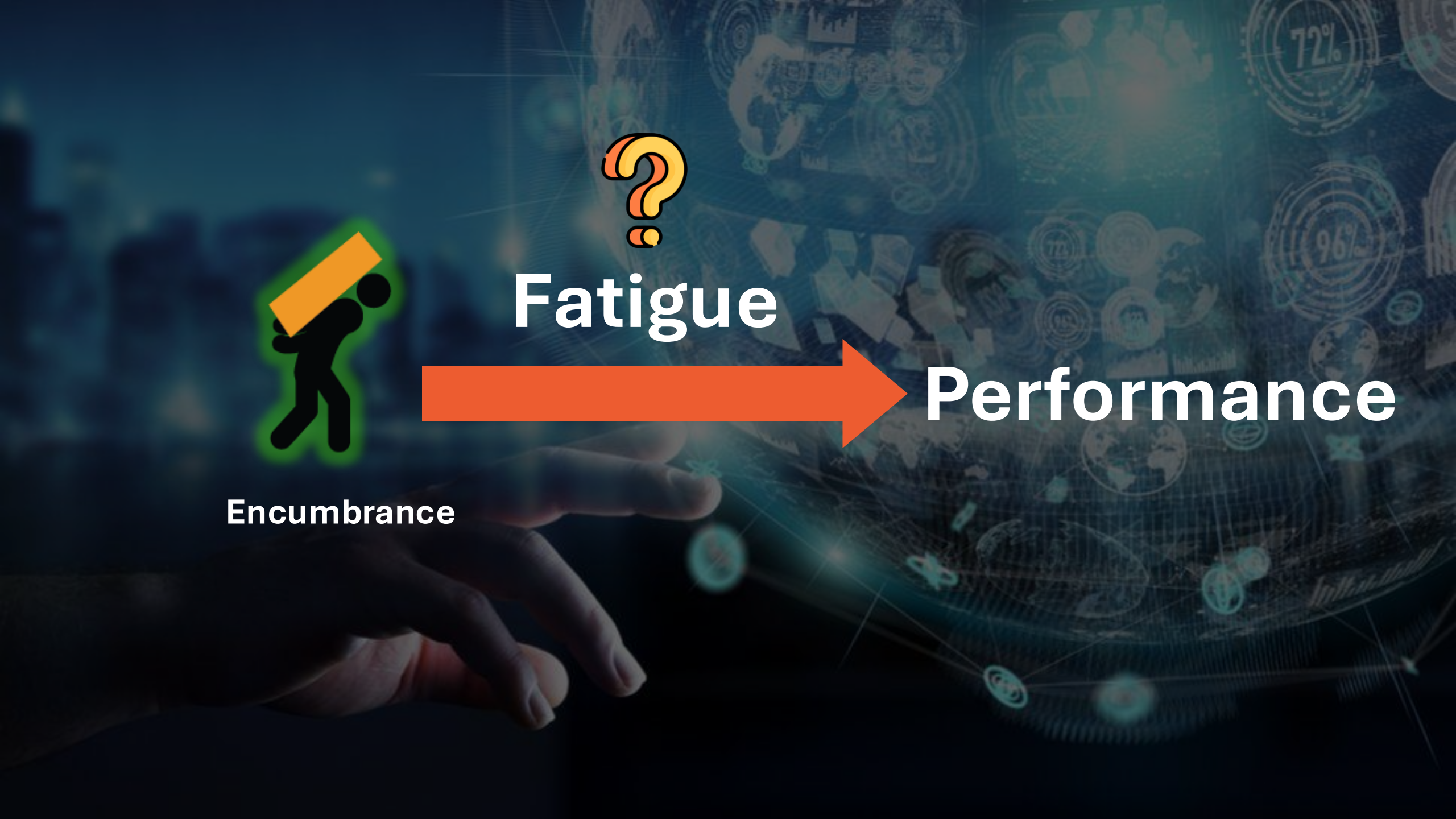
- Cold ambient temperature
  - Sensing cold-induced situational impairments using smartphone's battery temperature, **UbiComp'17**
- Emotions
  - Does Smartphone Use Drive our Emotions or vice versa? A Causal Analysis, **CHI'20**





Encumbrance

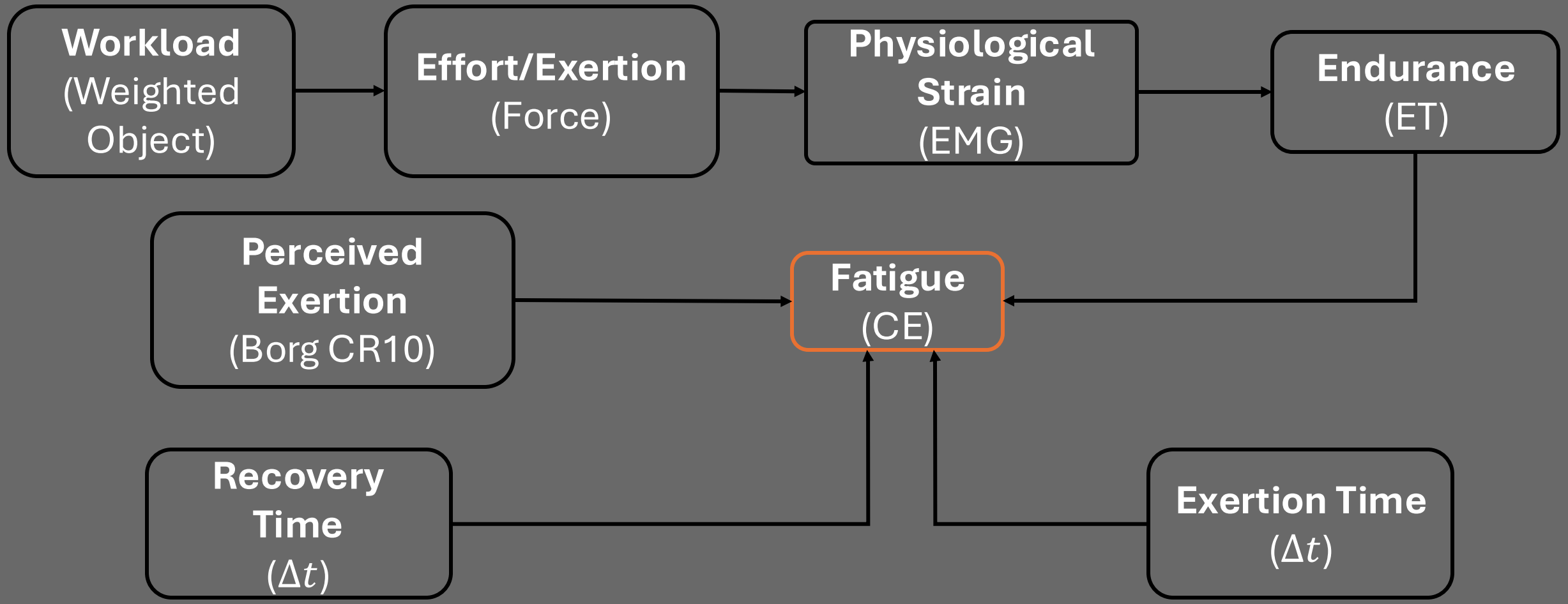

Performance
Encumbrance


Fatigue
Performance
Encumbrance



Weight-Induced Consumed Endurance (WICE): A Model to Quantify Shoulder Fatigue with Weighted Objects, UIST 2025

T. Li, E. Velloso, A. Withana, Z. Sarsenbayeva

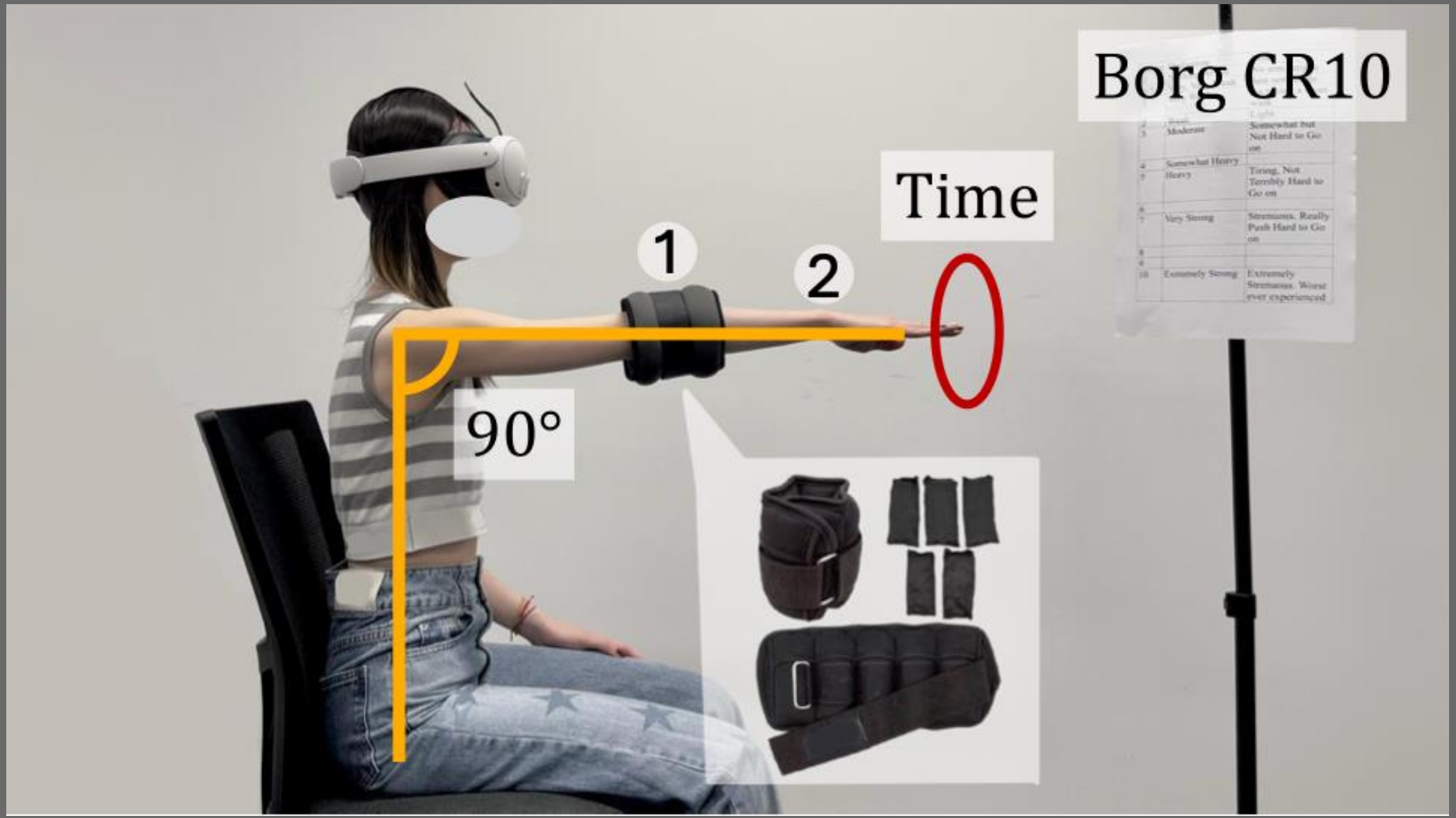

Workload
(Weighted Object)
Effort/Exertion
(Force)
Physiological Strain
(EMG)
Endurance
(ET)
Perceived Exertion
(Borg CR10)
Fatigue
(CE)
Recovery Time
(Δt)
Exertion Time
(Δt)

Related work

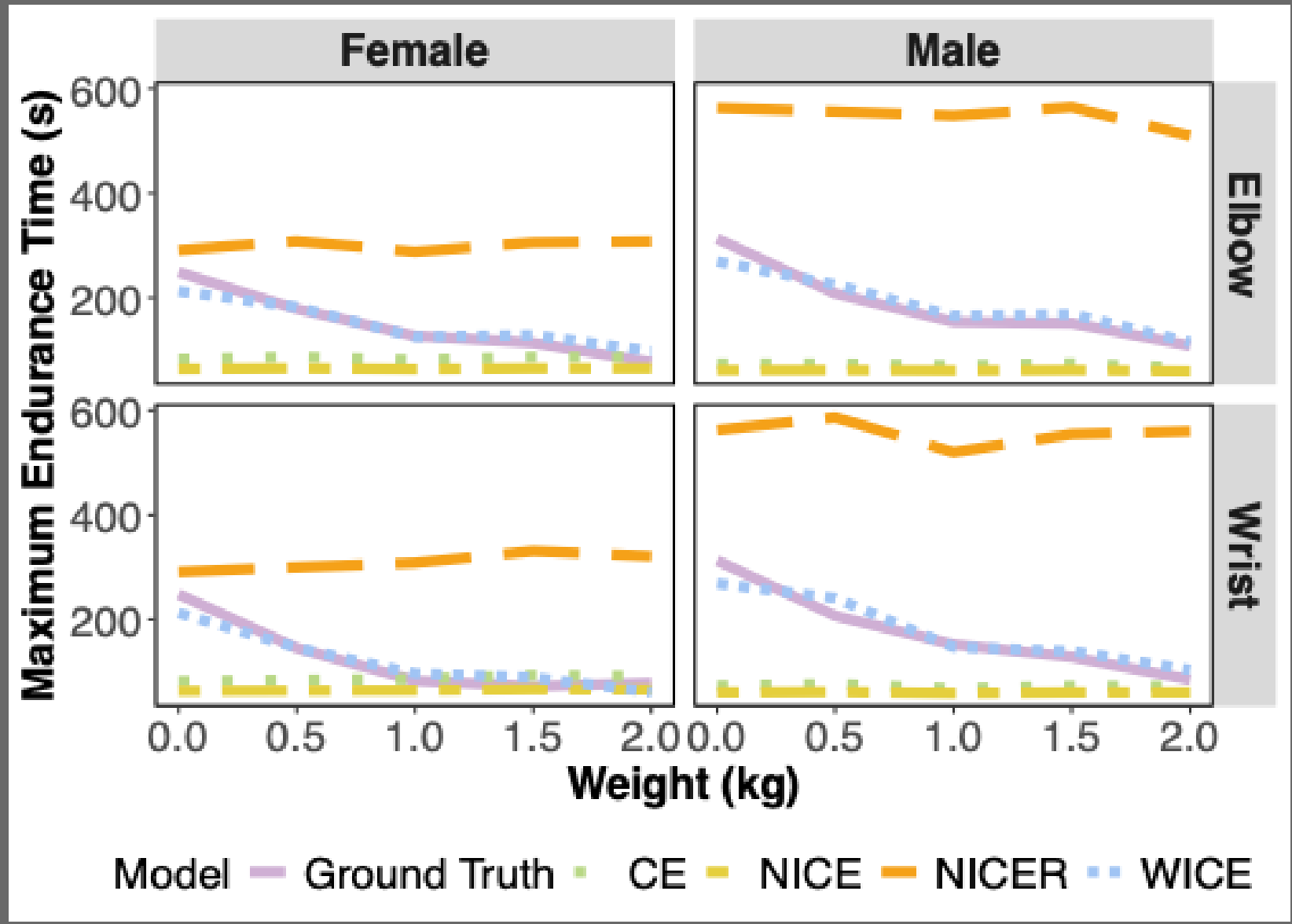
Models	Estimates endurance time	Does not rely on physiological sensors	Calculates recovery period	Models carried objects	Personalised arm mass calculation
CE Hincapié-Ramos et al.	✓	✓	✗	✗	✗
CF Jang et al.	✗	✗	✓	✗	✗
NICE Li et al.	✓	✓	✗	✗	✗
NICER Li et al.	✓	✓	✓	✗	✗

$$ET \sim \frac{a}{\left(\frac{\tau_{shoulder} + C(\alpha_{shoulder})}{\tau_{max}} \cdot 100\right)^{b} \cdot c} + (1|Participant)$$

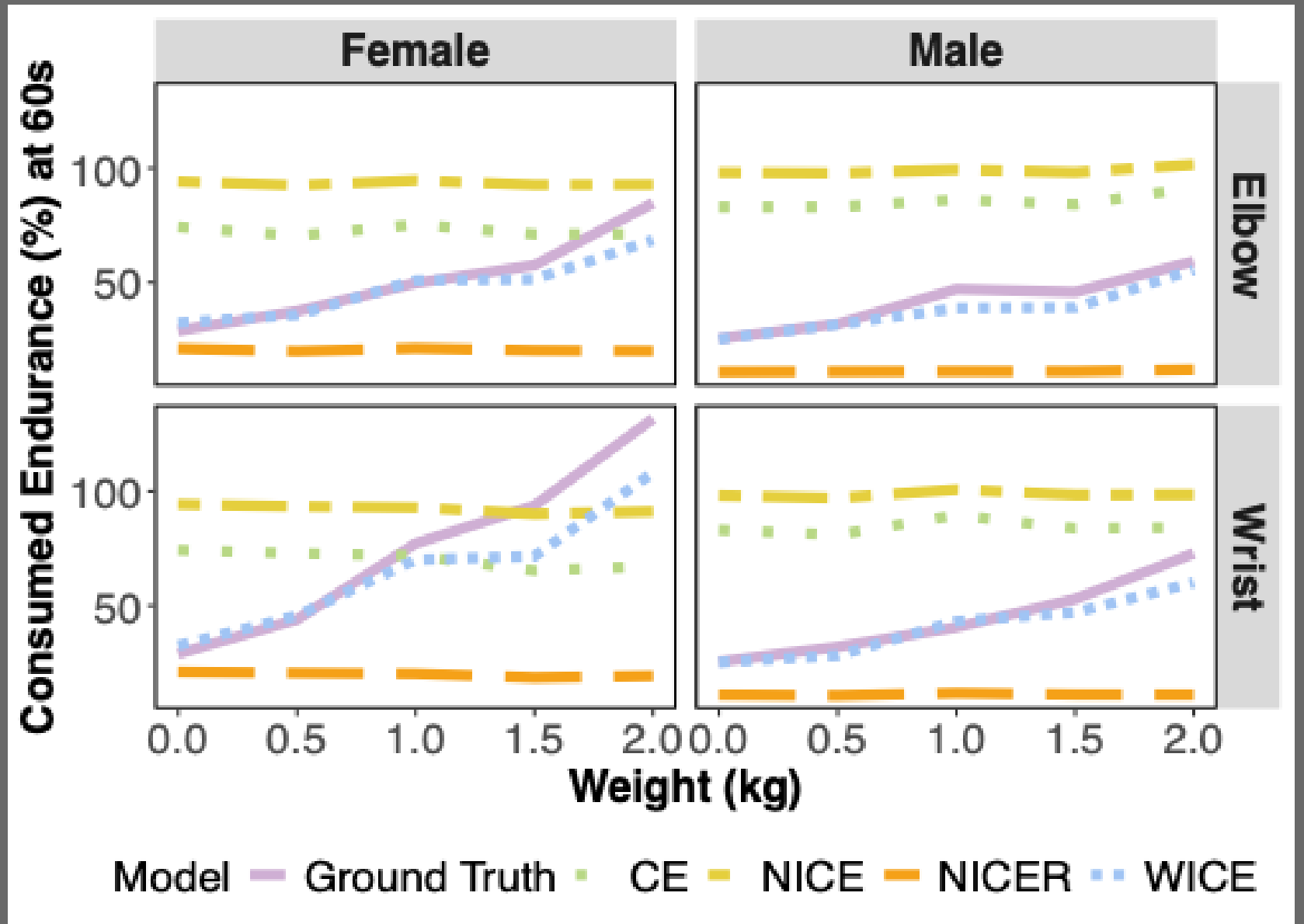
Task and apparatus



$$ET \sim \frac{a}{\left(\frac{\tau_{shoulder} + C(\alpha_{shoulder})}{\tau_{max}} \cdot 100\right)^{b} \cdot c} + (1|Participant)$$



$$ET \sim \frac{a}{\left(\frac{\tau_{shoulder} + C(\alpha_{shoulder})}{\tau_{max}} \cdot 100\right)^{b} \cdot c} + (1|Participant)$$

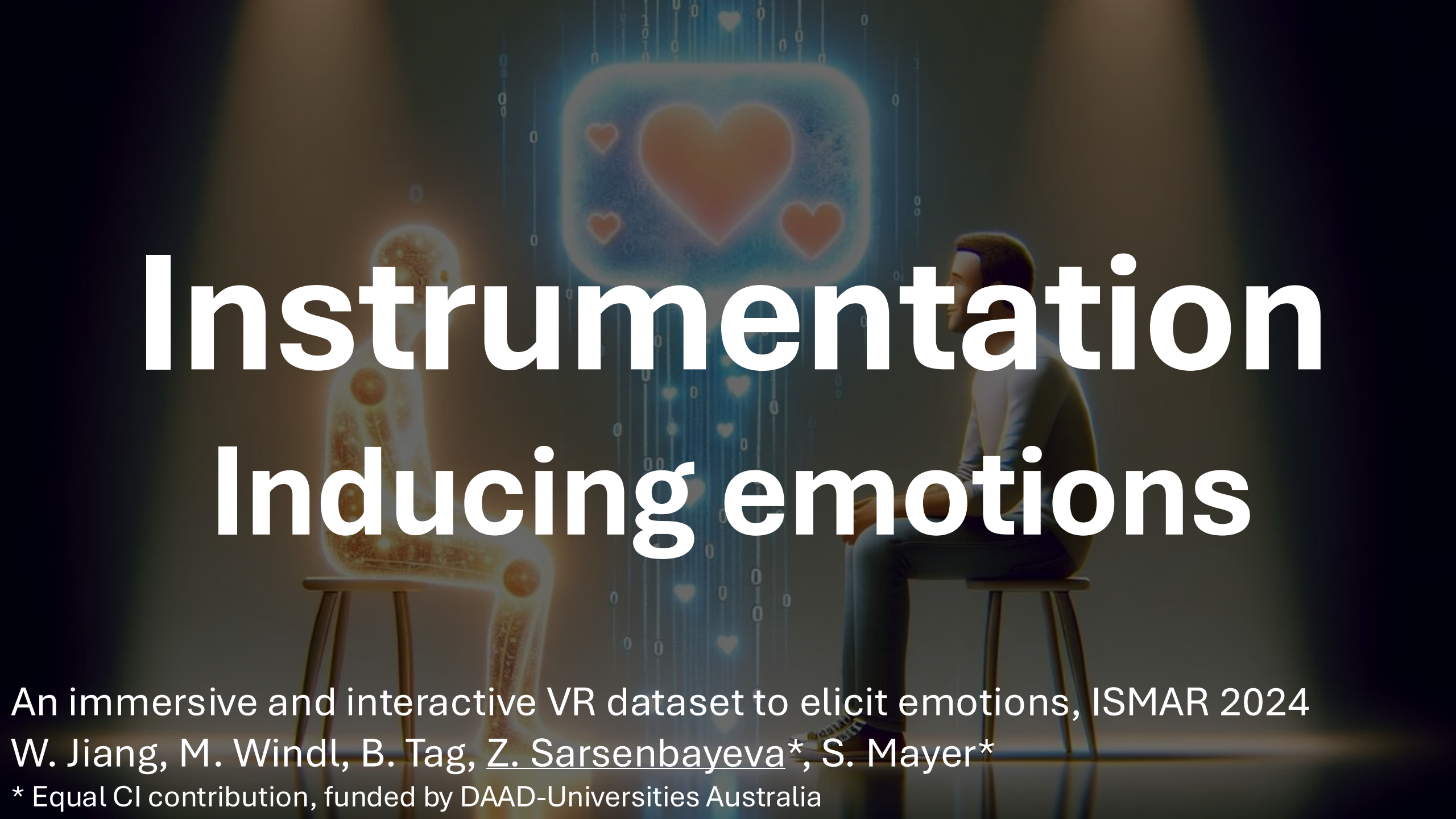


Implications

Product	W	Sex	Est. (Err.)	95% CI	Diff.
Apple Vision Pro	0	F	227 (80)	[111, 419]	-
		M	281 (99)	[136, 519]	-
Meta Quest 3S	0.103	F	218 (76)	[106, 400]	+9 (4%)
		M	272 (95)	[132, 501]	+9 (3%)
Meta Quest 3	0.126	F	215 (76)	[105, 397]	+12 (5%)
		M	269 (95)	[131, 497]	+11 (4%)
Meta Quest Pro	0.164	F	212 (74)	[103, 390]	+15 (7%)
		M	266 (94)	[130, 491]	+15 (5%)
HTC Vive Focus 3	0.142	F	214 (75)	[104, 394]	+13 (7%)
		M	268 (94)	[131, 494]	+13 (5%)
PlayStation VR	0.162	F	212 (74)	[103, 390]	+15 (7%)
		M	266 (94)	[130, 491]	+15 (5%)
Pico 4	0.184	F	210 (74)	[103, 387]	+17 (7%)
		M	265 (93)	[129, 487]	+16 (6%)
HapThimble [42]	0.100	F	218 (76)	[106, 401]	+9 (4%)
		M	272 (95)	[132, 501]	+9 (3%)
HandMorph [52]	0.171	F	211 (74)	[103, 389]	+16 (7%)
		M	265 (93)	[129, 489]	+16 (6%)
Dexmo [30]	0.300	F	200 (70)	[98, 368]	+27 (12%)
		M	255 (89)	[125, 470]	+26 (9%)
Cybergrasp[6]	0.450	F	189 (66)	[93, 347]	+38 (17%)
		M	244 (85)	[119, 448]	+37 (13%)
ELAXO [80]	0.540	F	183 (64)	[90, 335]	+44 (19%)
		M	237 (83)	[116, 437]	+44 (16%)
Haptic Glove [10]	0.640	F	176 (61)	[87, 323]	+51 (22%)
		M	230 (80)	[113, 423]	+51 (18%)

Sensing and adapting

- WICE provides **a foundation for building sensing and adapting mechanisms** to detect and mitigate the effects of encumbrance.
- Future development involves designing a system that leverages built-in cameras to **automatically detect the object** a user is holding and estimate its weight from the captured image.

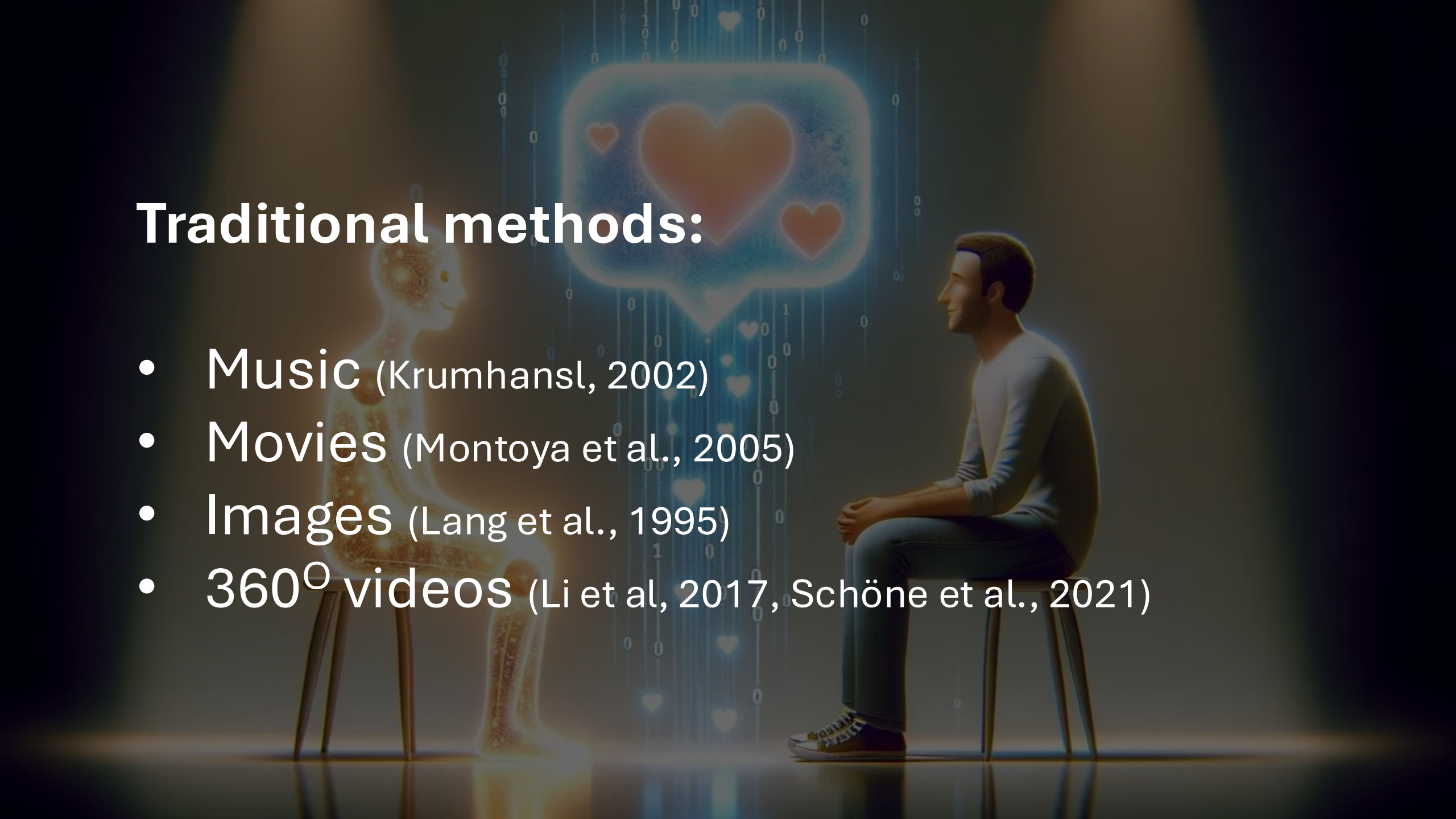


Instrumentation Inducing emotions

An immersive and interactive VR dataset to elicit emotions, ISMAR 2024

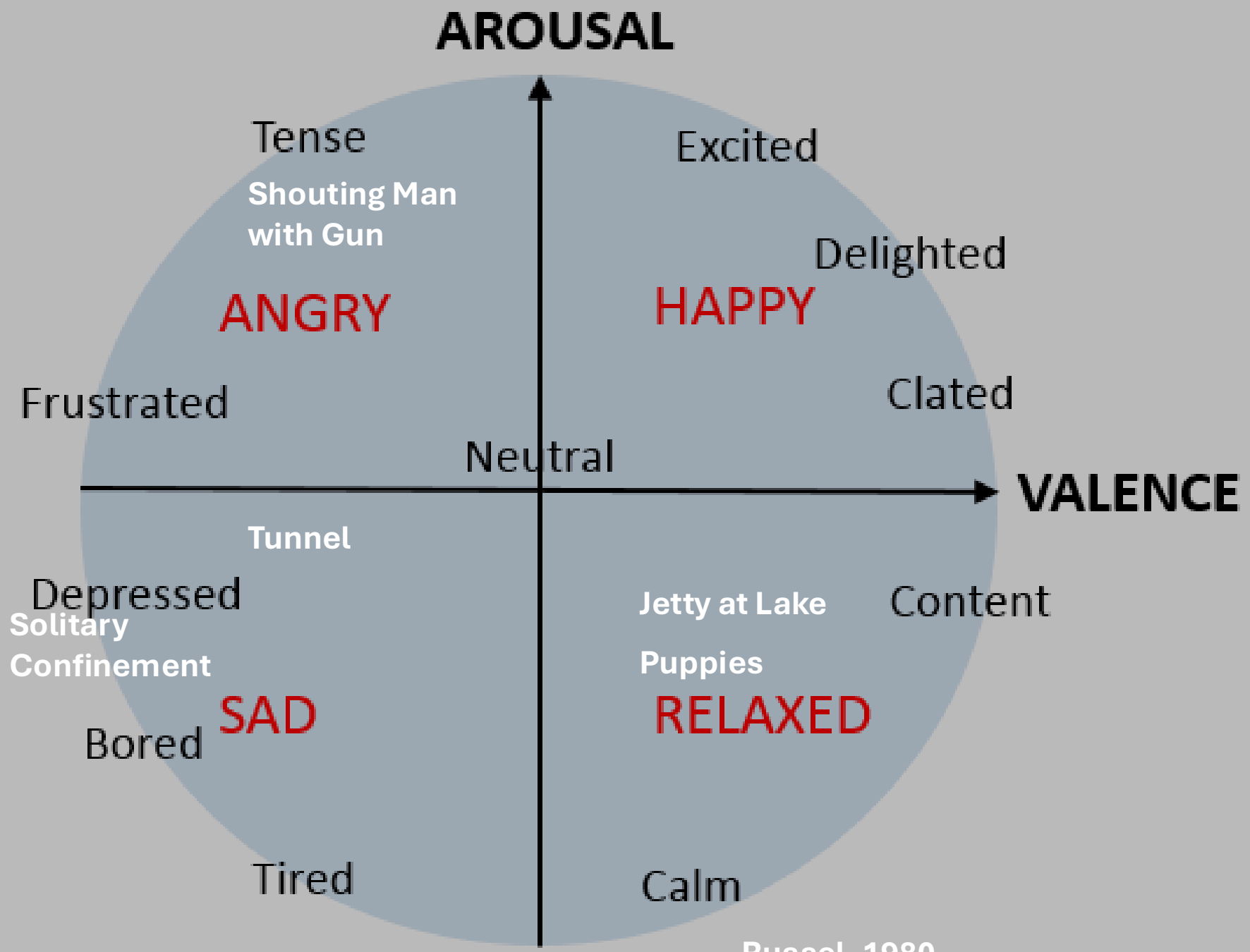
W. Jiang, M. Windl, B. Tag, Z. Sarsenbayeva*, S. Mayer*

* Equal CI contribution, funded by DAAD-Universities Australia



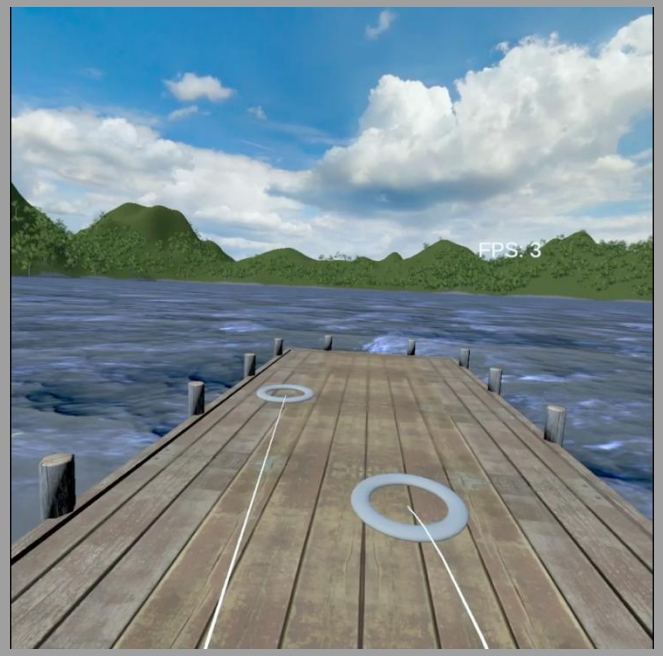
Traditional methods:

- Music (Krumhansl, 2002)
- Movies (Montoya et al., 2005)
- Images (Lang et al., 1995)
- 360^{O} videos (Li et al, 2017, Schöne et al., 2021)


AROUSAL
Tense
Excited
Shouting Man with Gun
Delighted
ANGRY
HAPPY
Frustrated
Clated
Neutral
VALENCE
Tunnel
Depressed
Content
Jetty at Lake
Solitary Confinement
Puppies
SAD
RELAXED
Bored
Tired
Calm

Russel, 1980

Jetty at Lake



Puppies

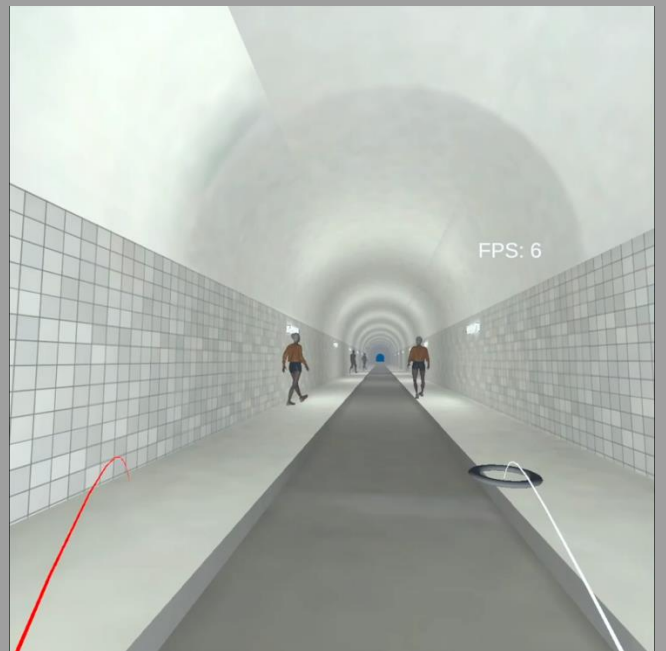


Shouting man with gun



Solitary confinement



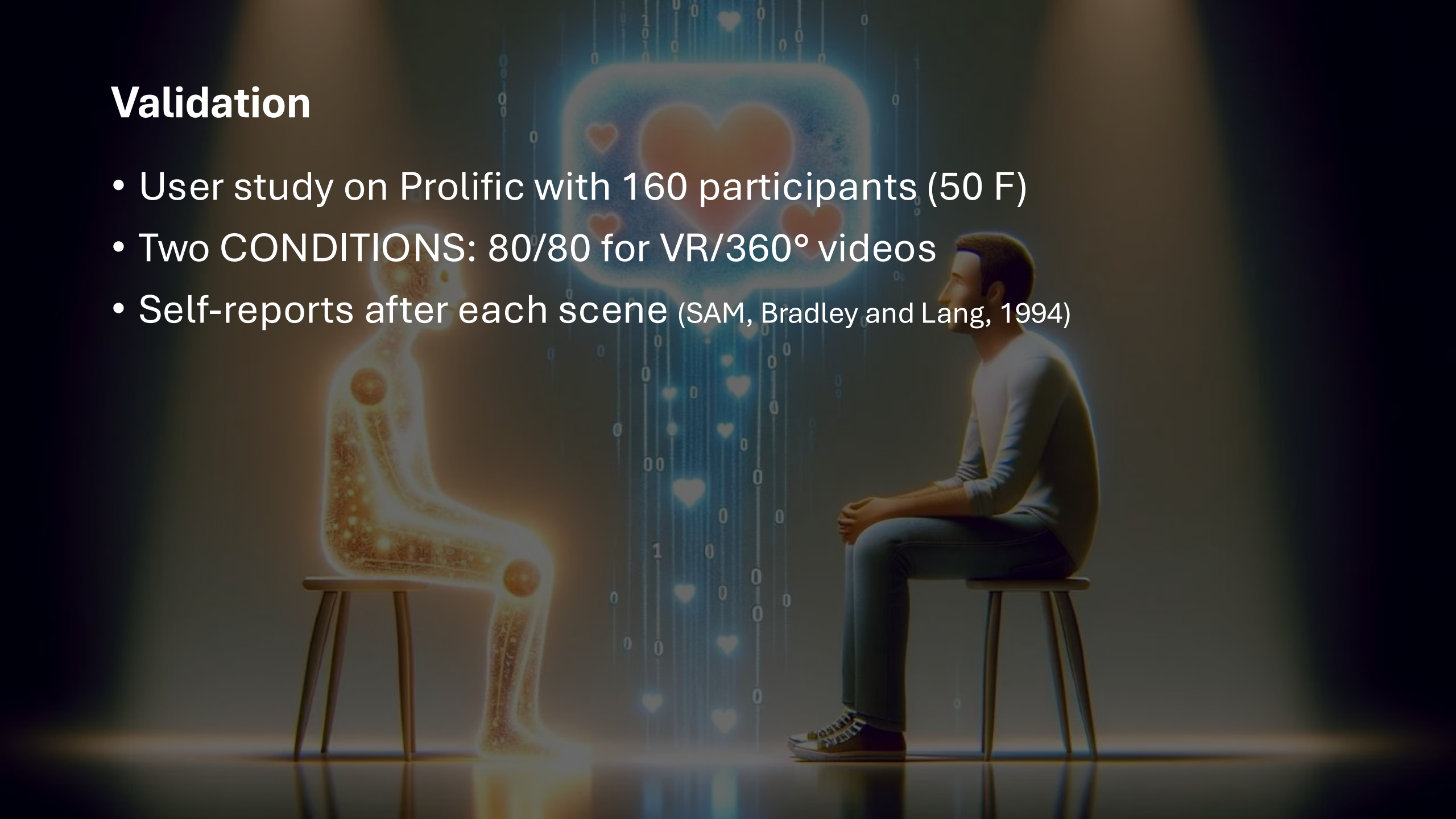


Tunnel

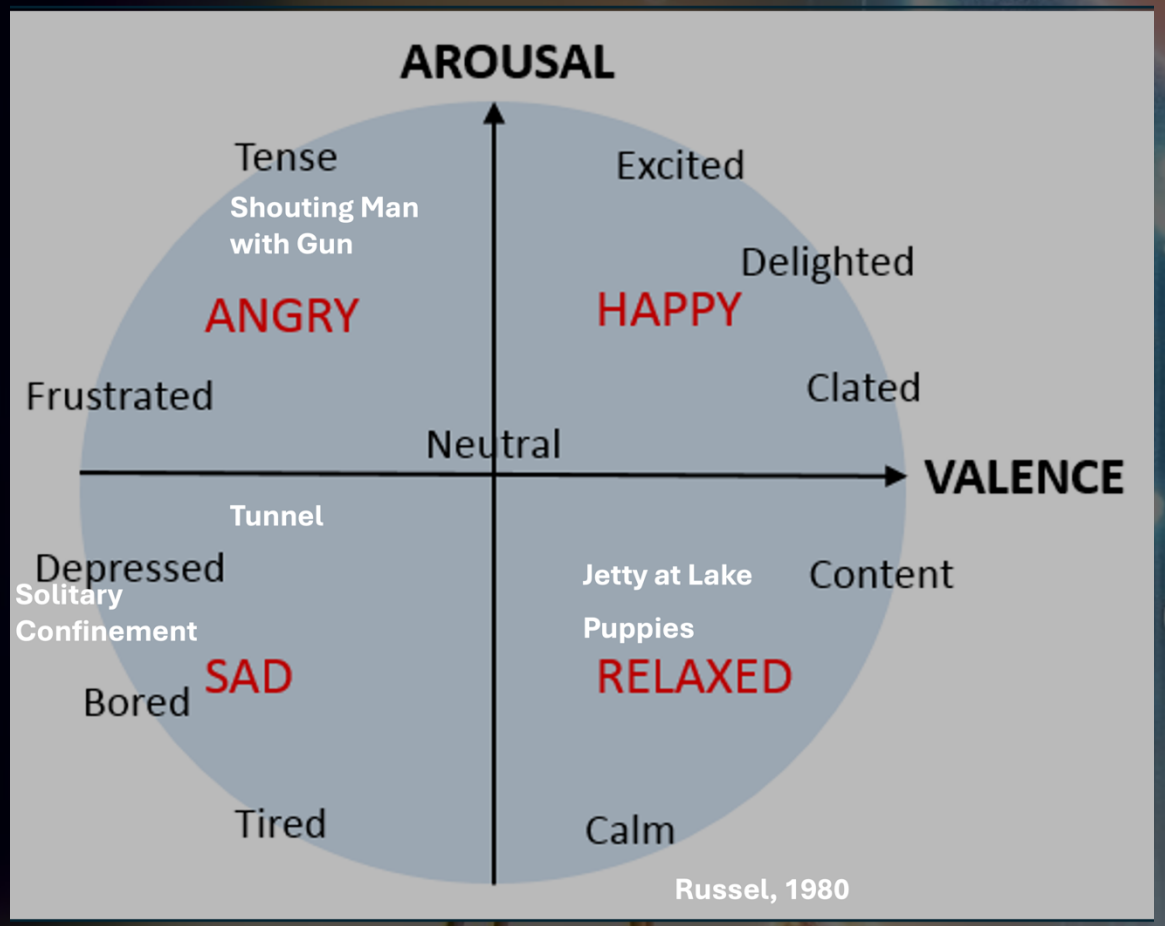
Reference: 360^{O} videos dataset (Li et al, 2017, Schöne et al., 2021)

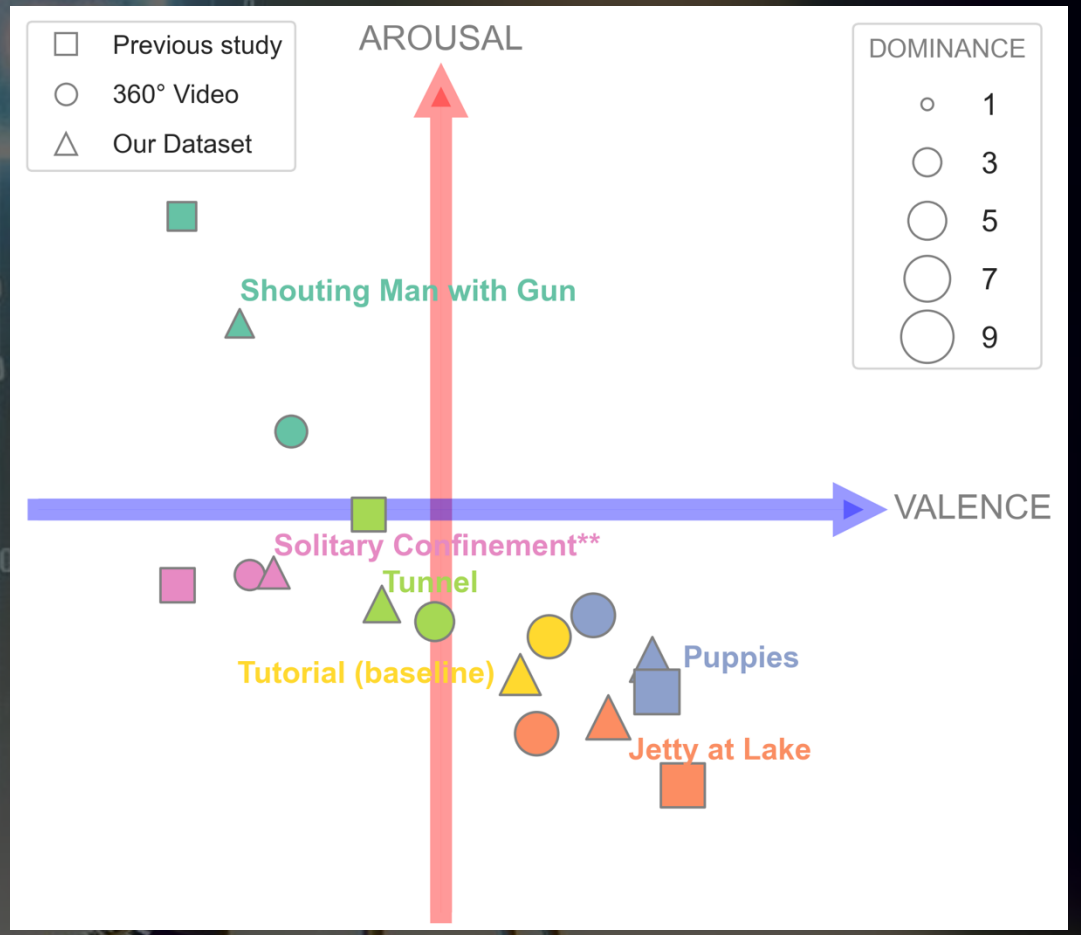
Validation

- User study on Prolific with 160 participants (50 F)
- Two CONDITIONS: 80/80 for VR/360° videos
- Self-reports after each scene (SAM, Bradley and Lang, 1994)



Findings


AROUSAL
Tense
Shouting Man with Gun
Excited
Delighted
ANGRY
HAPPY
Frustrated
Clated
Neutral
VALENCE
Tunnel
Depressed
Solitary Confinement
Jetty at Lake
Puppies
Content
SAD
RELAXED
Bored
Tired
Calm
Russel, 1980


Previous study
360° Video
Our Dataset
AROUSAL
DOMINANCE
1
3
5
7
9
Shouting Man with Gun
VALENCE
Solitary Confinement**
Tunnel
Tutorial (baseline)
Puppies
Jetty at Lake

Findings

- Topic modeling based on post-study survey
- Subjectively, targeted emotions were successfully elicited
- The Shouting Man with Gun scene was outstanding with emotional bleeding/residue

Jetty at Lake



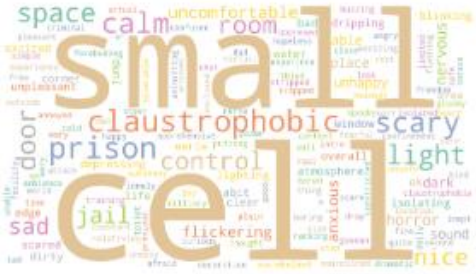
Puppies



Shouting Man with Gun



Solitary Confinement



Tunnel



Contribution

- Tested and validated inducing emotions in VR
- Contributed first ever dataset to induce emotions to the research community





Instrumentation
Inducing empathy

More Than Words: The Impact of Voice Assistant Personality Traits on Failure Mitigation, IMWUT/UbiComp 2025

S. Jayasiriwardene, B. Tag, A. Withana, Z. Sarsenbayeva





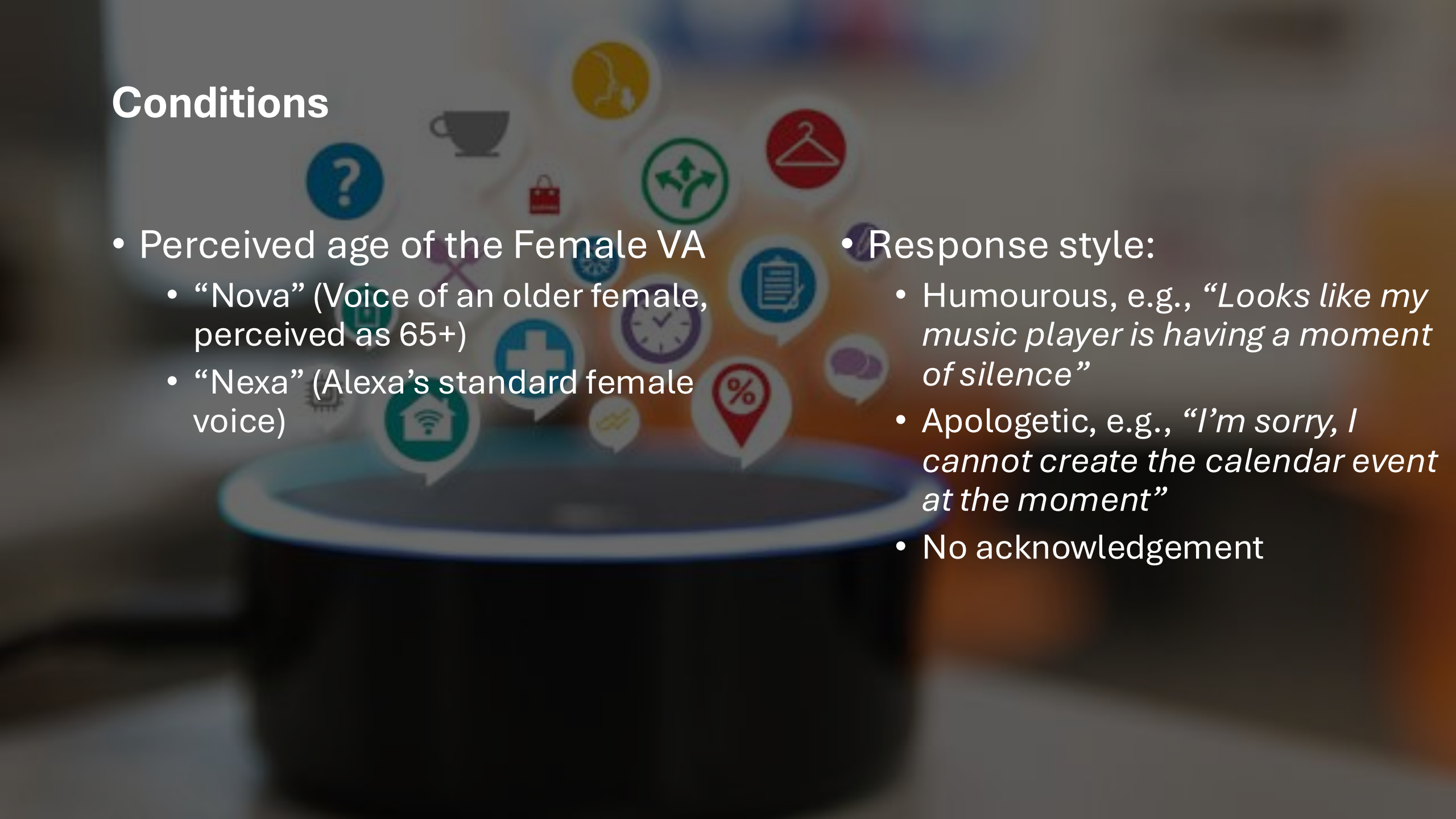
Hey Alexa, can you *just* tell me the weather?!

$&*@#!!!!

Did you know I can make playlists?



Conditions



- Perceived age of the Female VA
  - “Nova” (Voice of an older female, perceived as 65+)
  - “Nexa” (Alexa’s standard female voice)
- Response style:
  - Humourous, e.g., *“Looks like my music player is having a moment of silence”*
  - Apologetic, e.g., *“I’m sorry, I cannot create the calendar event at the moment”*
  - No acknowledgement

Tasks and variables

- Four tasks presented from:
  - Shopping cart
  - Entertainment
  - Timers & reminders
  - Q&A
  - News & weather
  - Home environment
- Variables:
  - Empathy (State empathy scale, Overall empathy)
  - Trust (Baughan et al., 2023)
  - Service Recovery Satisfaction (Clausen et al., 2023)

Findings

Empathy:

- ↑ "Older" voice*
- ↑ Apologetic and humorous responses with "older" voice
- ↓ No-acknowledgment

Trust:

- ↑ "Older" voice*
- ↓ No-acknowledgment

Service Recovery Satisfaction:

- ↑ "Older" voice*
- ↓ No-acknowledgment

** The effect in male participants was stronger than in female participants*

Contribution

- Perceived old age positively contributed to inducing user empathy, trust, and service recovery satisfaction
- Humorous and apologetic responses positively impacted empathy, promoting better failure recovery
- By fostering empathy through voice assistant personality traits we can effectively mitigate failures

Going forward

- Accessibility:
  - Build sensing and adapting solutions to detect situational impairments in MR
  - Co-design of technology for people with Epilepsy and CP
- Affective computing:
  - Understand the effect of interaction on emotions
  - Sensing emotions
- Anthropomorphism in HCI:
  - Personality traits of AI agents

Understand
Sense
Adapt



Walking



Encumbrance



Mood





Multitasking



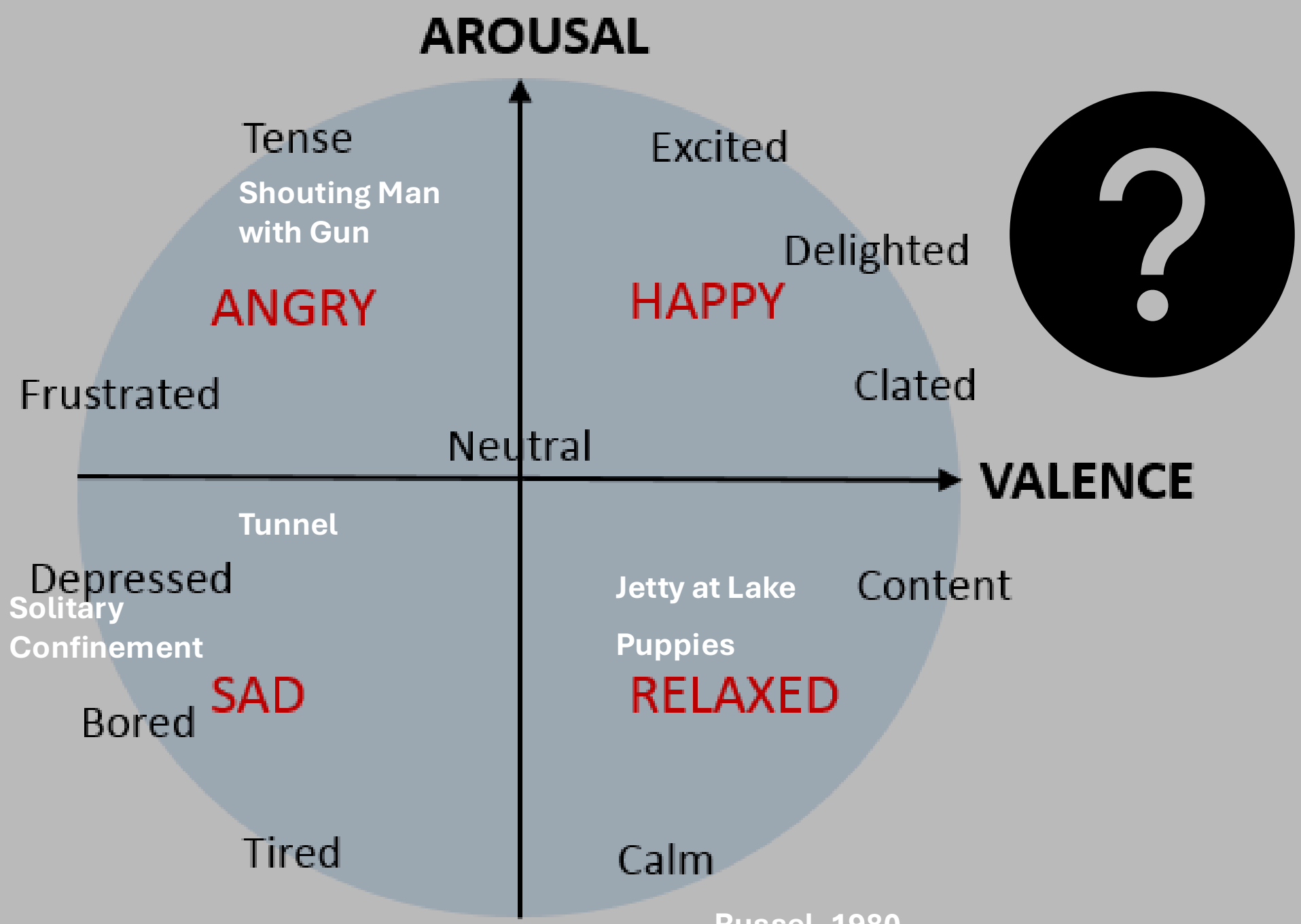
Ambient Light



Ambient Temperature



Ambient Noise


AROUSAL
Tense
Excited
Shouting Man with Gun
Delighted
ANGRY
HAPPY
Frustrated
Clated
Neutral
VALENCE
Tunnel
Depressed
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Jetty at Lake
Solitary Confinement
Puppies
SAD
RELAXED
Bored
Tired
Calm
Russel, 1980





Add interactions





Sense induced emotions



Physiological data: BVP, EDA, ST



Avatar-based facial expressions



Human behaviour: Eye blinking, Body gesture, Speech, Task performance



Use AI in emotion detection

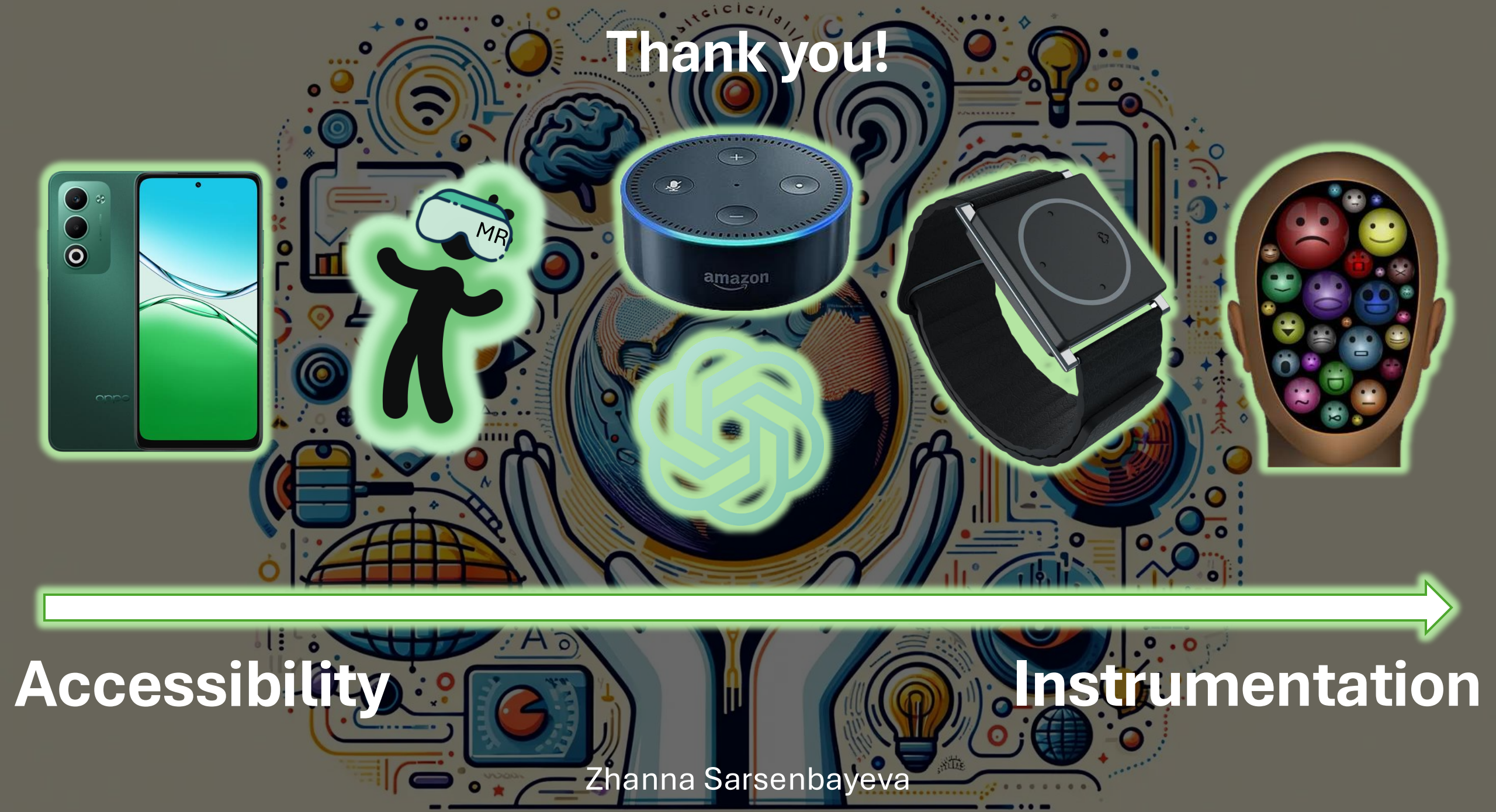
Personality traits of ChatGPT

Decency
Profoundness
Engagement
Instability
Neuroticism
Vibrancy
Serviceability
Subservience

(Kovačević et al., 2024)



Thank you!



Accessibility **Instrumentation**

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