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These are the slides for the talk presented at UIST 2025 by Antonin Cheymol.
All the links in this PDF are clickable and lead you to YouTube videos, paper, etc.
You can watch the live talk here: https://youtu.be/U5T7pk_ccnw
You can watch the video here: https://www.youtube.com/watch?v=uoJtpx78RmU
If you need a PPTX/editable version for your class, email us hci@uchicago.edu
More on this paper (or others of our lab) at: https://lab.plopes.org/#VR-side-effects

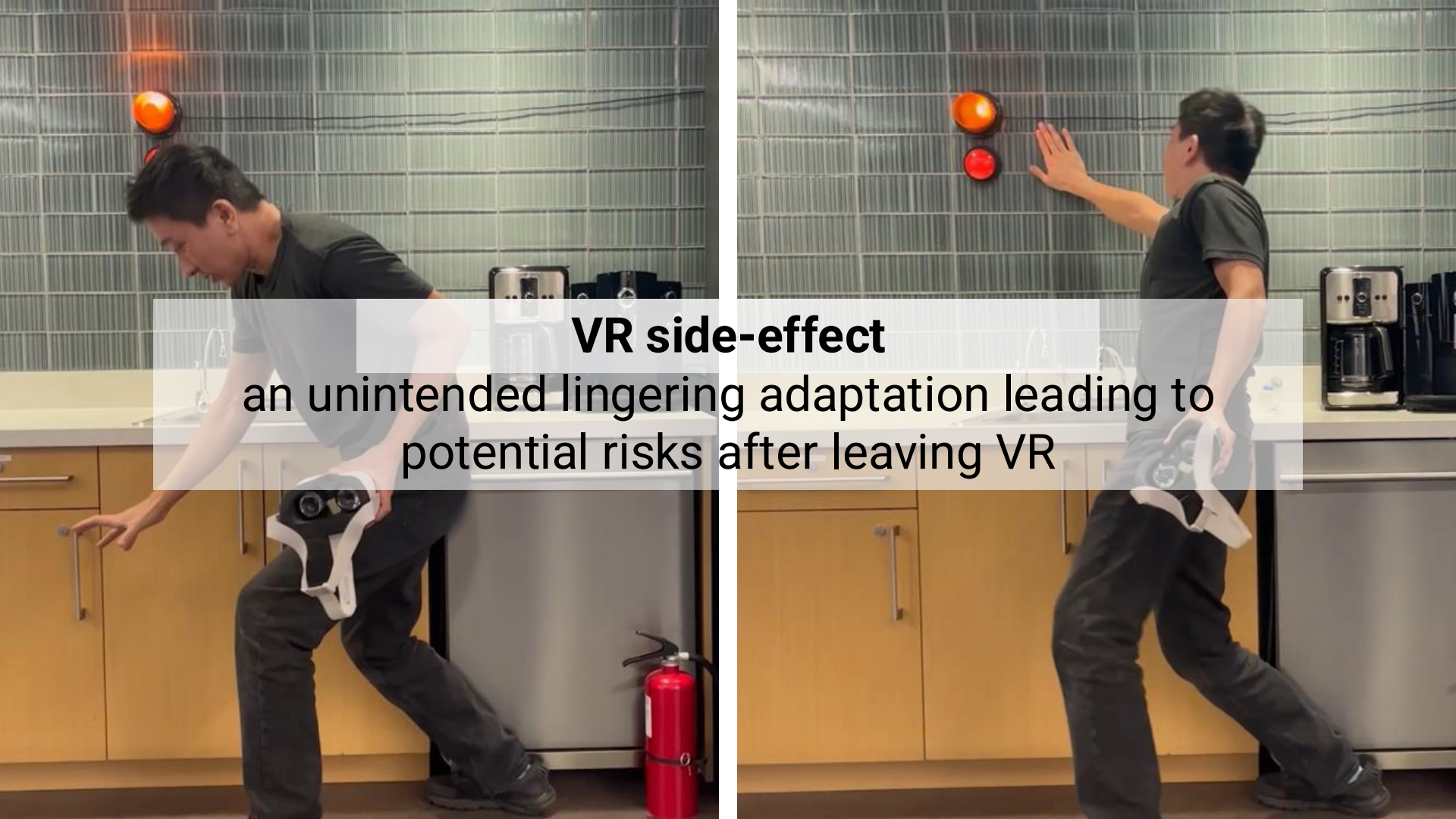
VR Side-Effects: Memory & Proprioceptive Discrepancies After Leaving Virtual Reality
Antonin Cheymol, Pedro Lopes. In Proc. UIST'25 (paper)

Our brain's plasticity rapidly adapts our senses in VR, a phenomenon leveraged by techniques such a redirected walking, hand redirection, etc. However, while most of HCI is interested in how users adapt to VR, we turn our attention to how users need to adapt their senses when returning to the real-world. We found that, after leaving VR, (1) participants' hands remained redirected by up to 7cm, indicating residual proprioceptive distortion; and (2) participants incorrectly recalled the virtual location of objects rather than their actual real-world locations (e.g., remembering the location of a VR-extinguisher, even when trying to recall the real one). We discuss the lingering VR side-effects may pose safety or usability risks.

click for paper PDF click for Paper Video click for UIST Talk (live)


antonin cheymol, pedro lopes
THE UNIVERSITY OF
CHICAGO
IRISA


see video: https://www.youtube.com/watch?v=uoJtpx78RmU



VR side-effect

an unintended lingering adaptation leading to potential risks after leaving VR

motivation


Katori et al. UIST’25
adapting going **into** VR = **immersion**


Katori et al. UIST’25
adapting going **into** VR = **immersion**

Katori et al. UIST'25

adapting going **into** VR = **immersion**

adapting going **out** of VR = **instantaneous?**

Katori et al. UIST'25

adapting going **into** VR = **immersion**

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related work

well-intended effects

Li et al. Front. VR‘21

Peck et al. C&C‘13

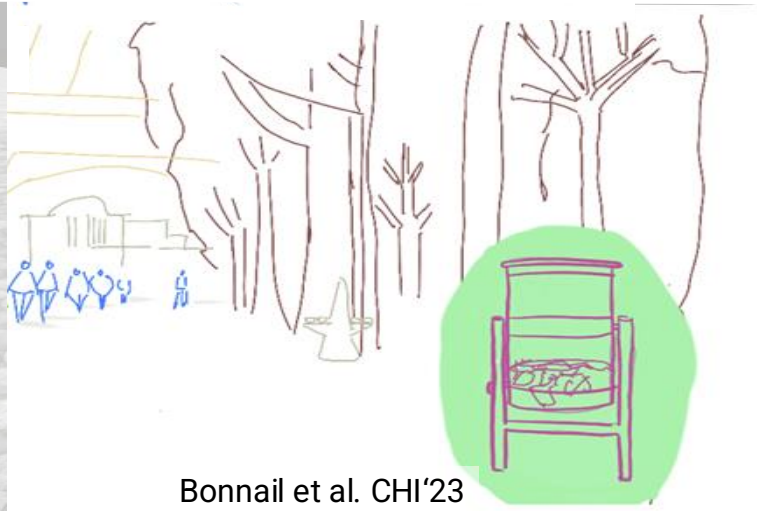
well-intended effects

Li et al. Front. VR‘21

speculating on risks

Tseng et al. CHI‘22

Peck et al. C&C‘13



Bonnail et al. CHI‘23

well-intended effects

Li et al. Front. VR‘21

speculating on risks

Tseng et al. CHI‘22

non-naturalistic interactions

Wähnert et al. VR’24

Peck et al. C&C‘13

Bonnail et al. CHI‘23

Rubo et al. CHBR’21

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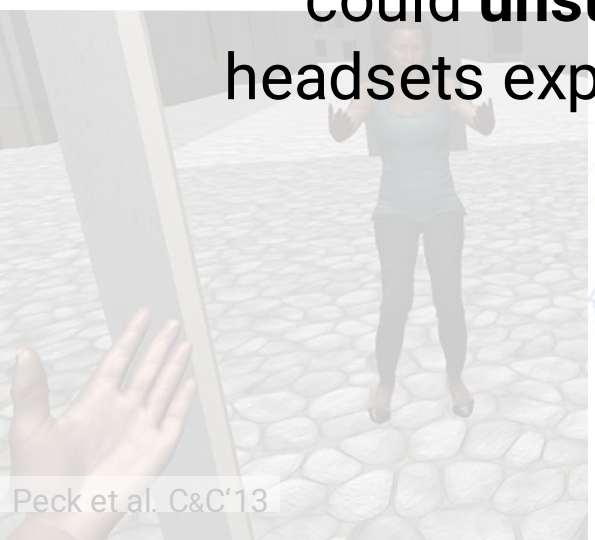

Peck et al. C&C'13

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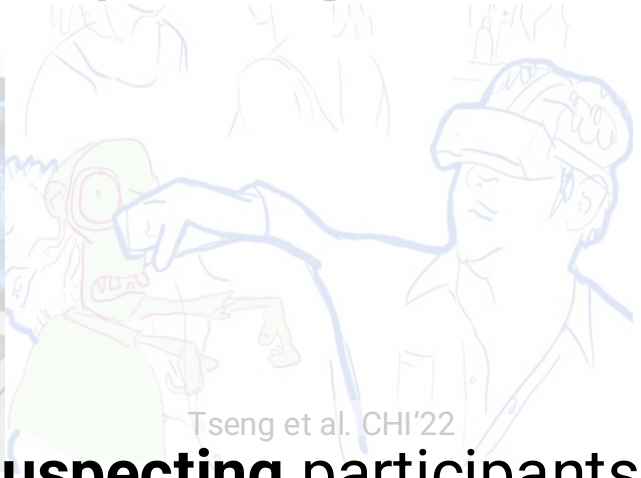
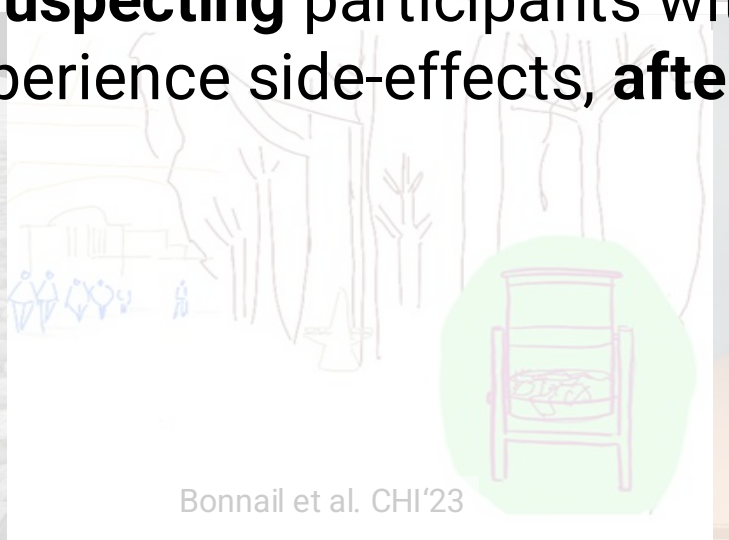
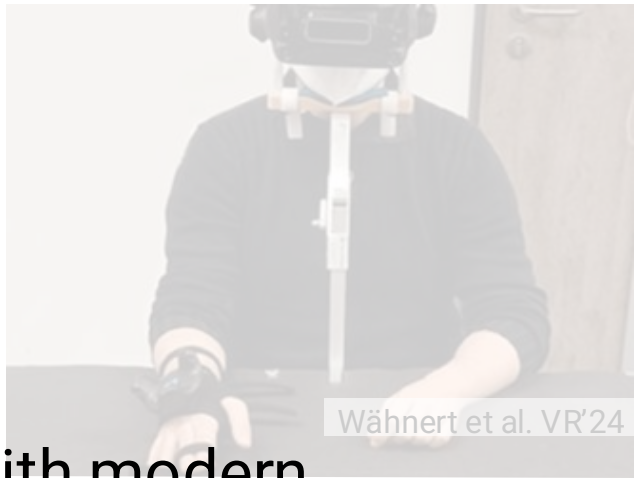


Tseng et al. CHI'22



Bonnail et al. CHI'23

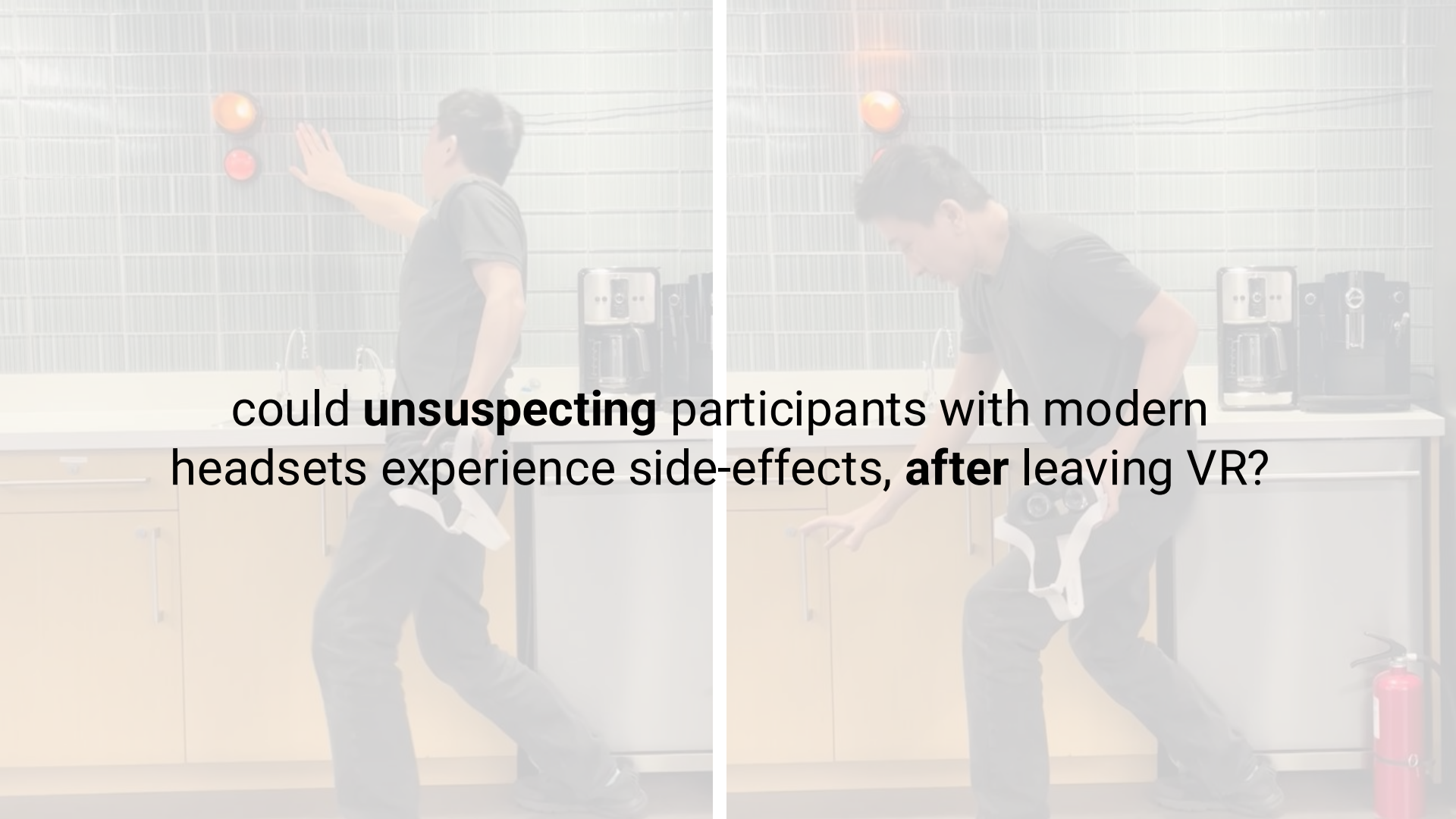
non-naturalistic interactions



Wähnert et al. VR'24

Rubo et al. CHBR'21

could **unsuspecting** participants with modern headsets experience side-effects, **after** leaving VR?



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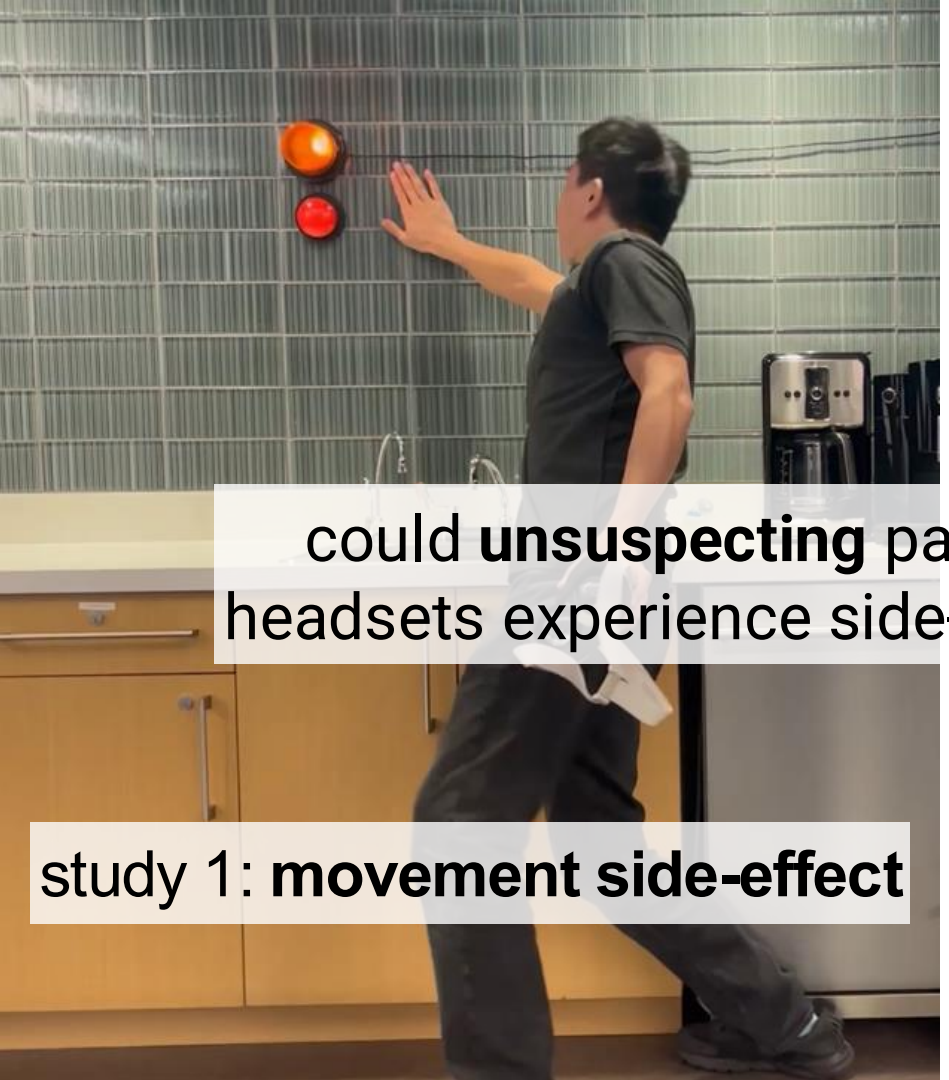
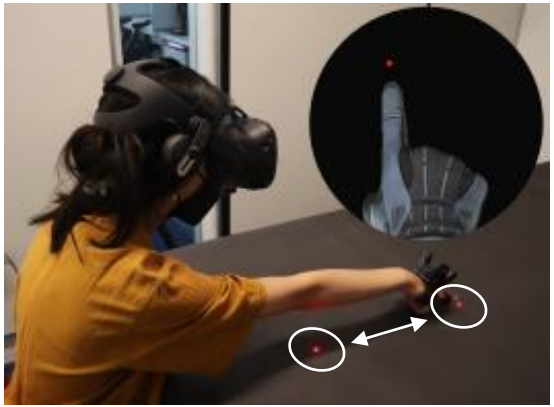


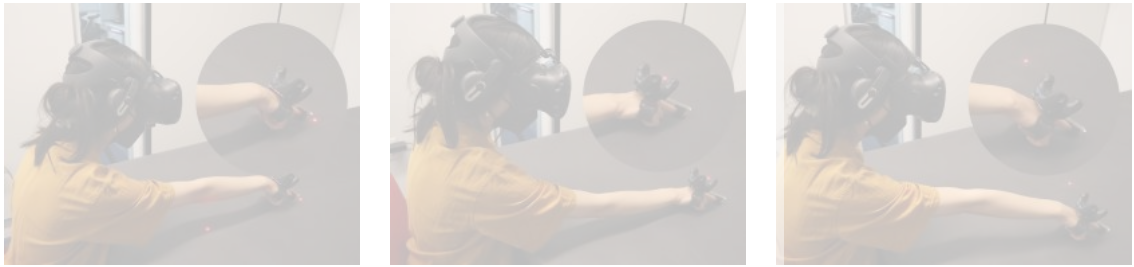
could **unsuspecting** participants with modern headsets experience side-effects, **after** leaving VR?

study 1: **movement side-effect**

in VR: experiencing redirection



in VR: experiencing redirection



no gain

low gain

(unnoticeable)

high gain

in VR: experiencing redirection

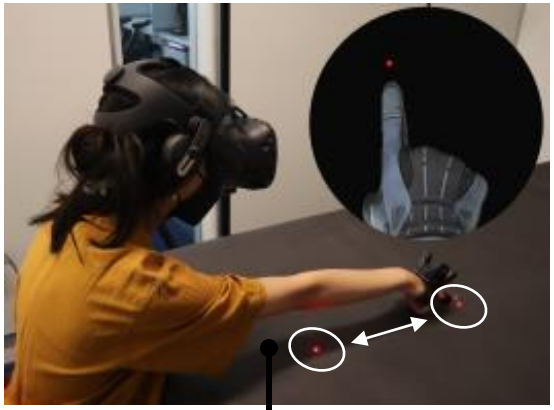
no gain

low gain

high gain

outside VR: reaching

in VR: experiencing redirection



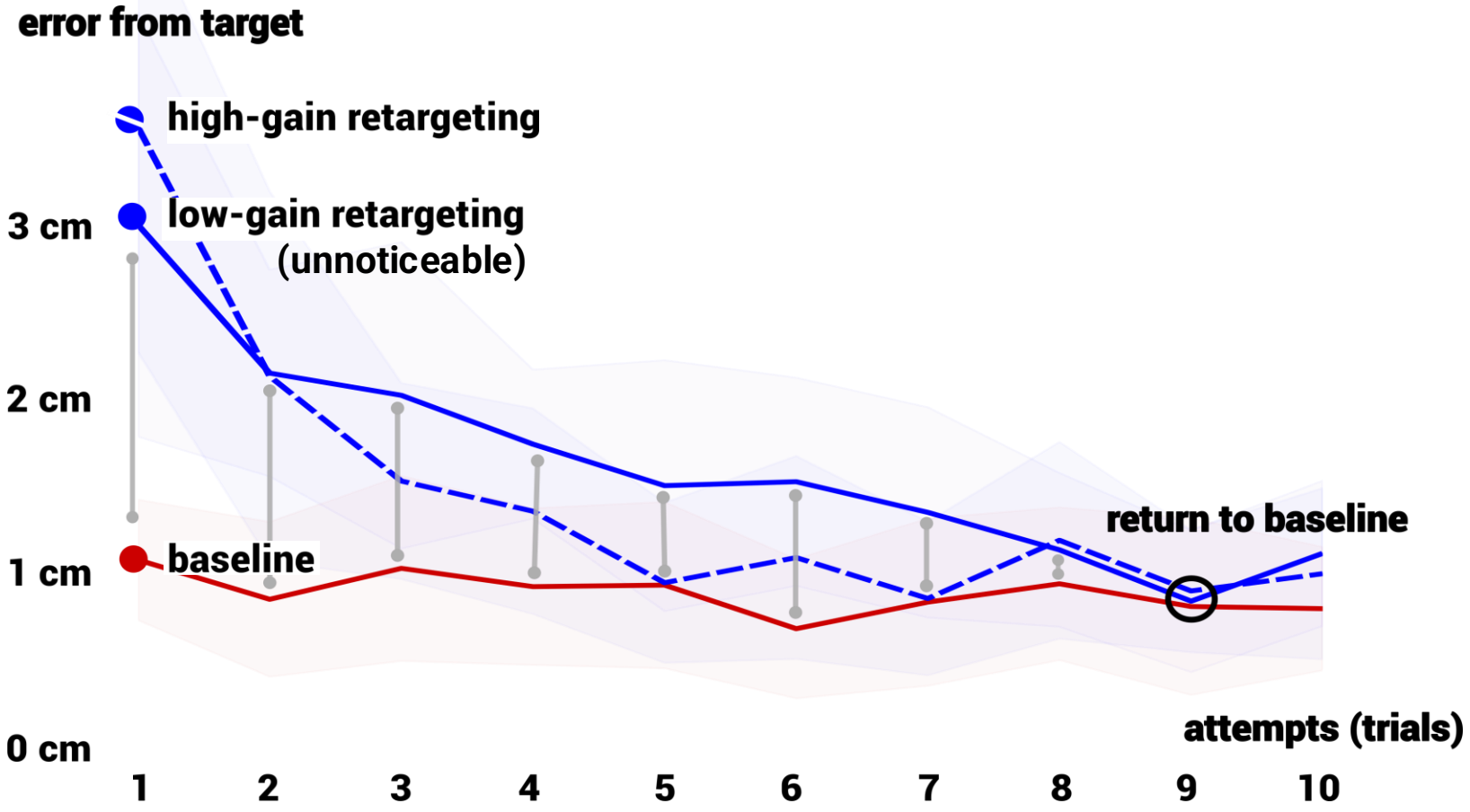
outside VR: reaching

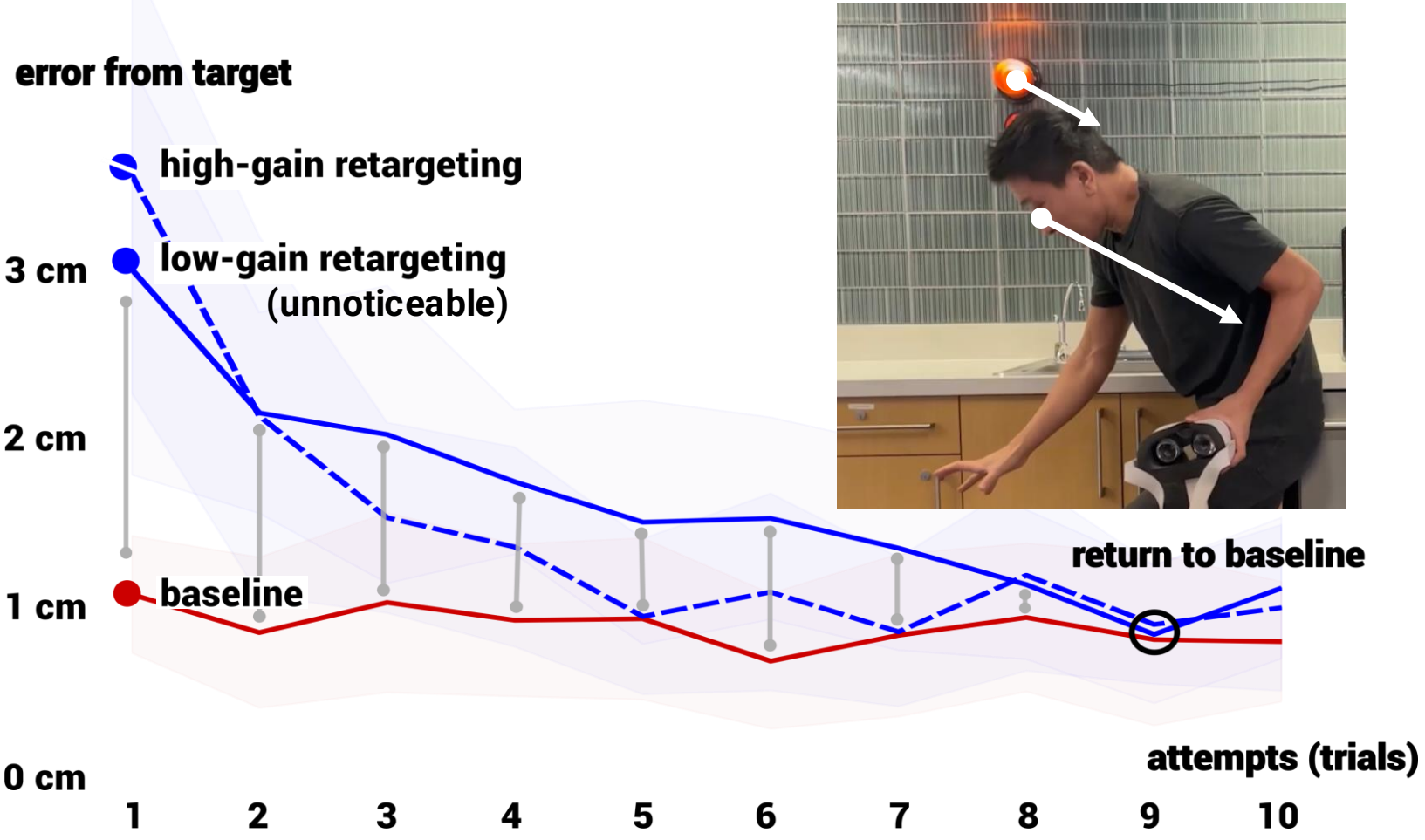
no gain

low gain

high ga

this difference is what **we measure**


error from target
high-gain retargeting
low-gain retargeting
(unnoticeable)
3 cm
2 cm
1 cm
0 cm
baseline
return to baseline
attempts (trials)
1
2
3
4
5
6
7
8
9
10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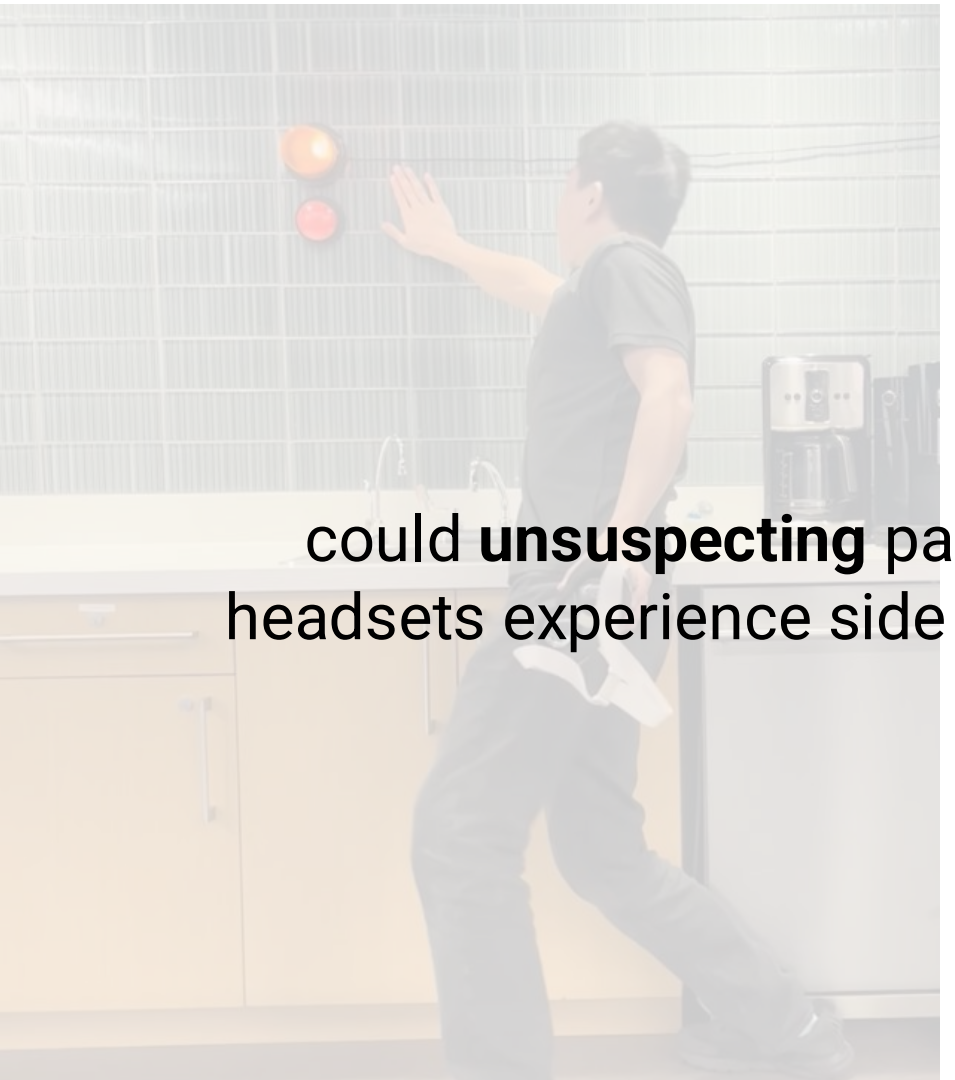
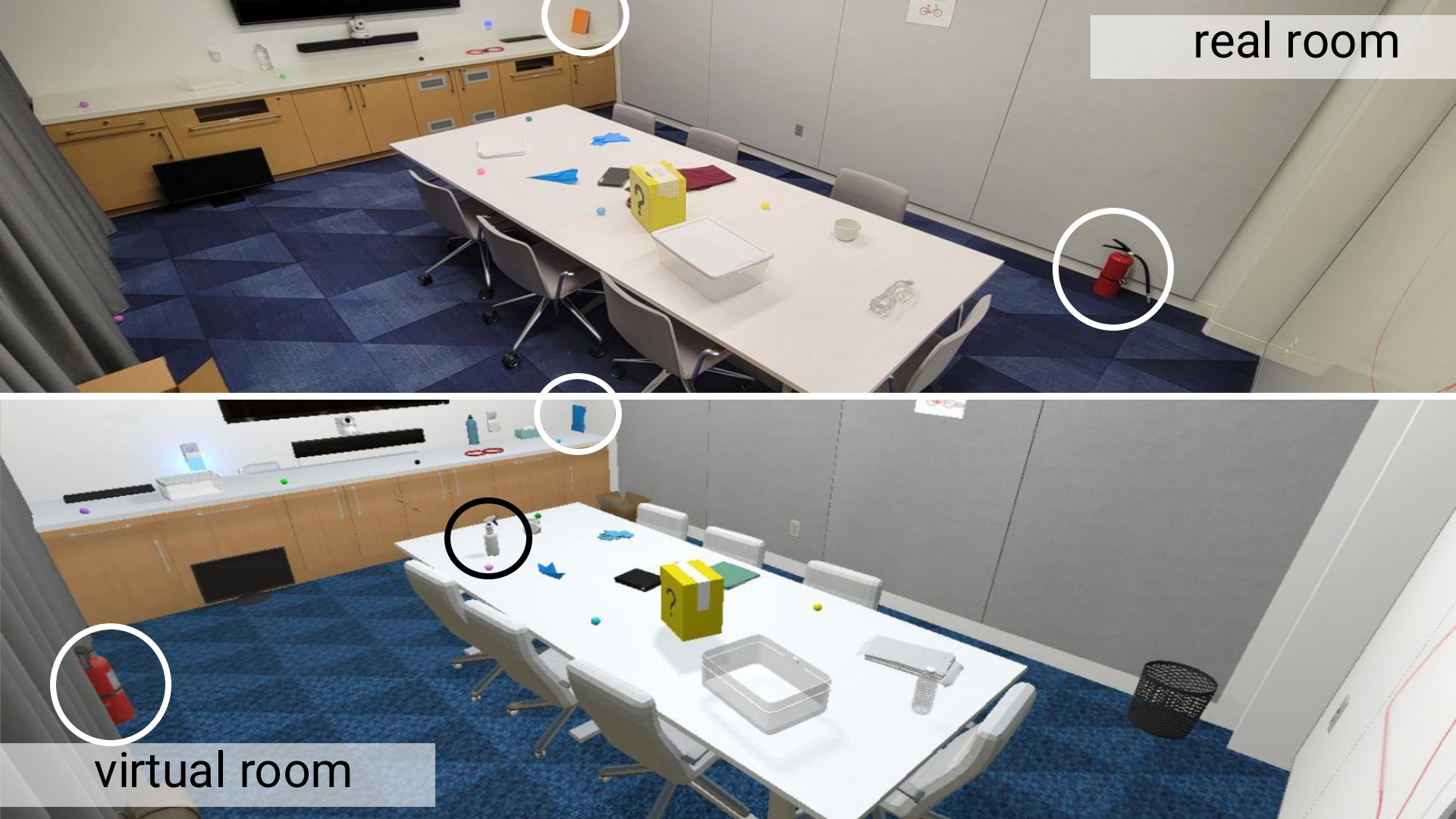
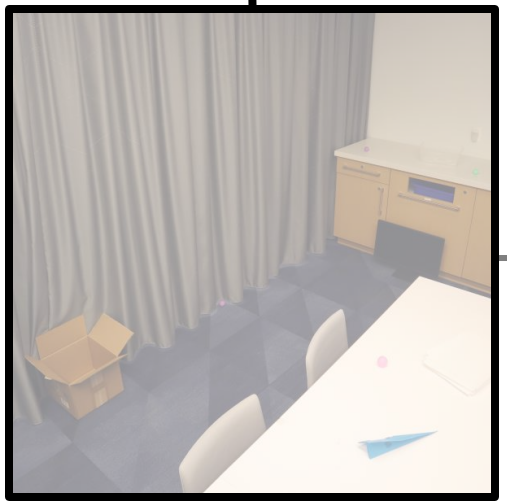


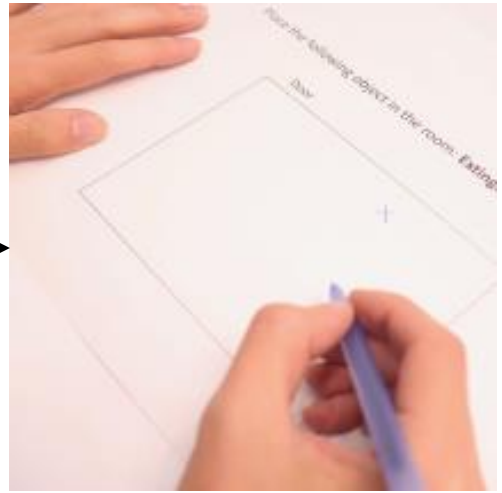
study 2: **memory side-effect**

could **unsuspecting** participants with modern headsets experience side effects, **after** leaving VR?


real room
virtual room

can you remember?





real-room task

4 minutes

VR task

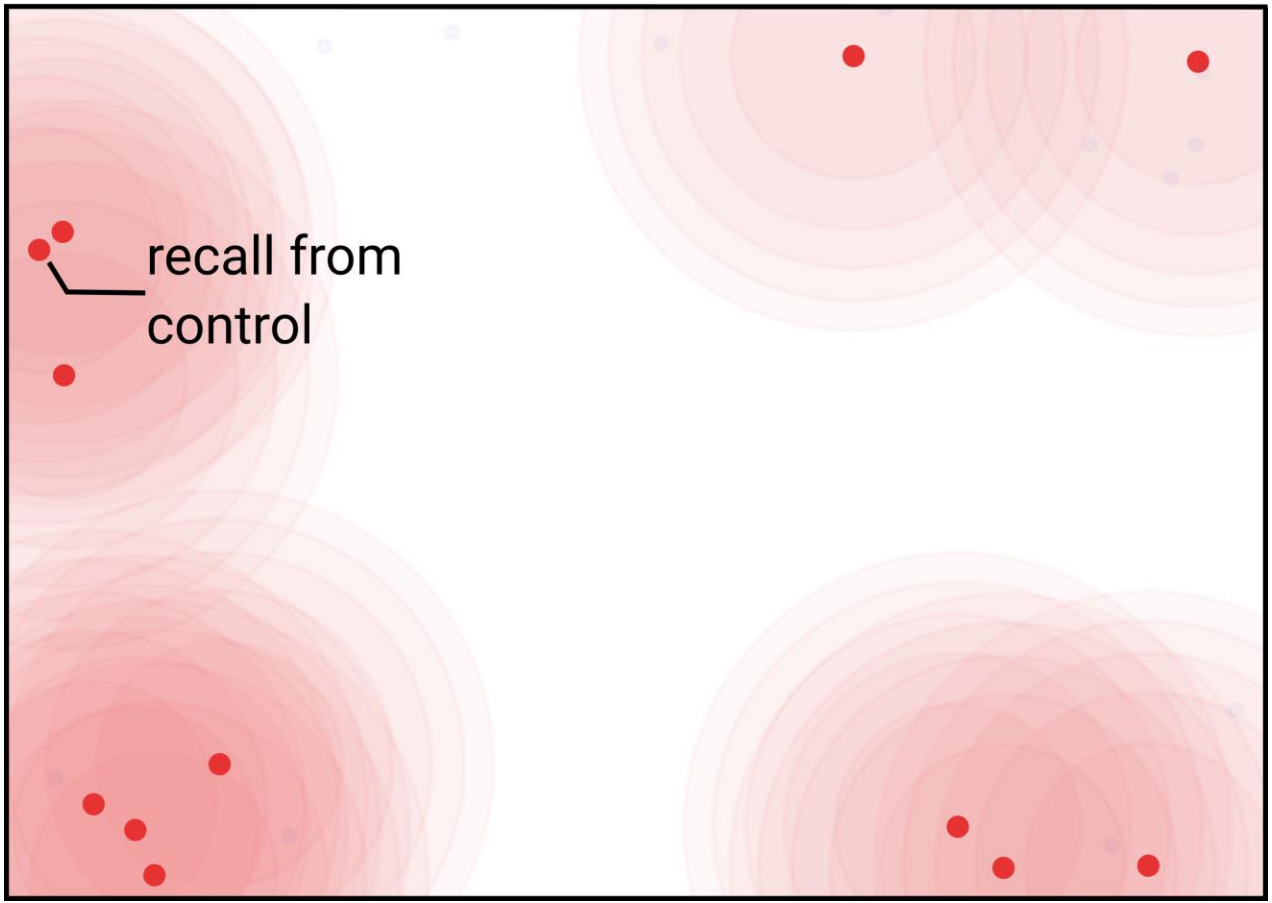
4 minutes

recall task

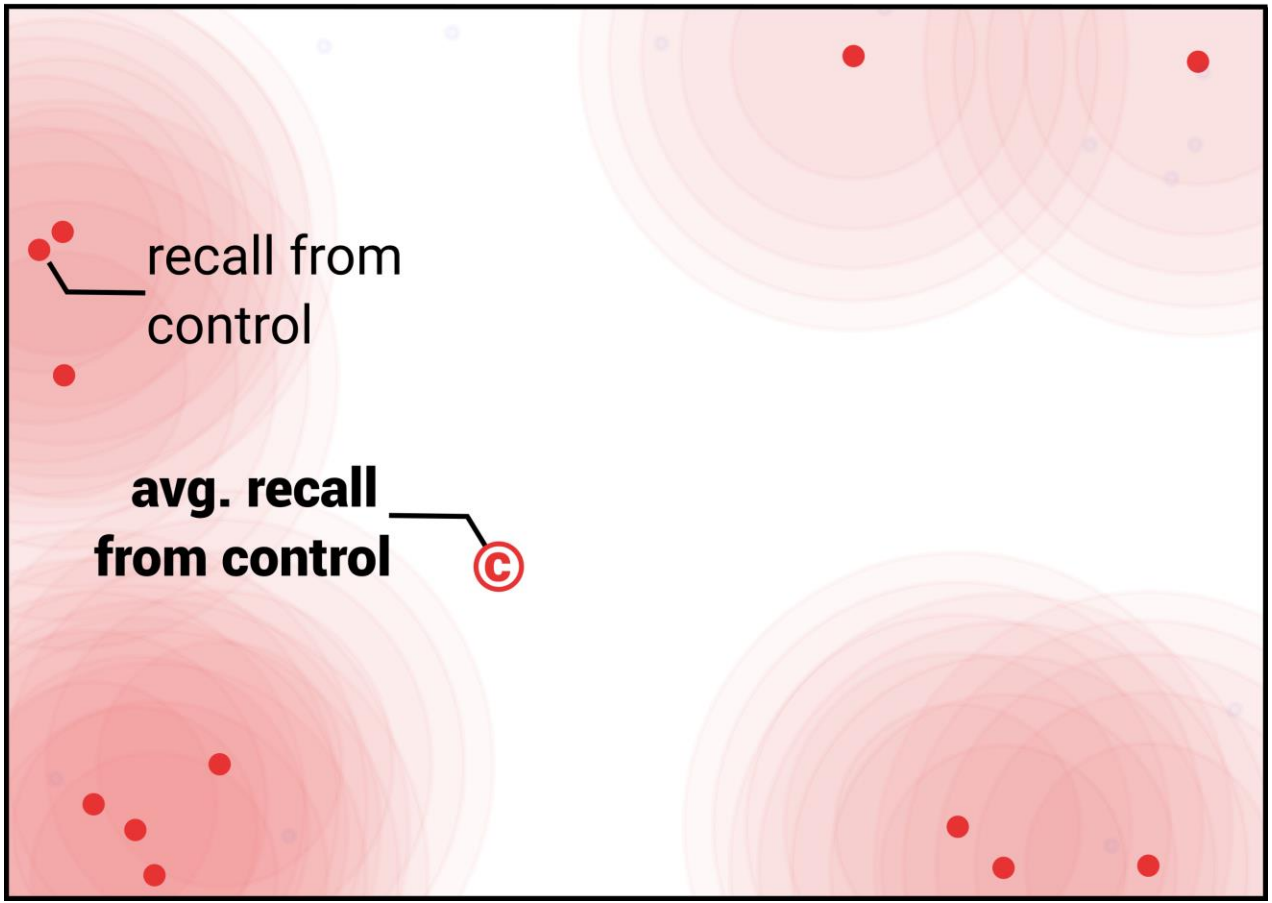
~5 minutes

extinguisher

extinguisher



extinguisher



extinguisher

recall from control

avg. recall from control (c)

real extinguisher (r)

extinguisher

recall from control

avg. recall from control c

recall from side-effect

real extinguisher

r

extinguisher

recall from control

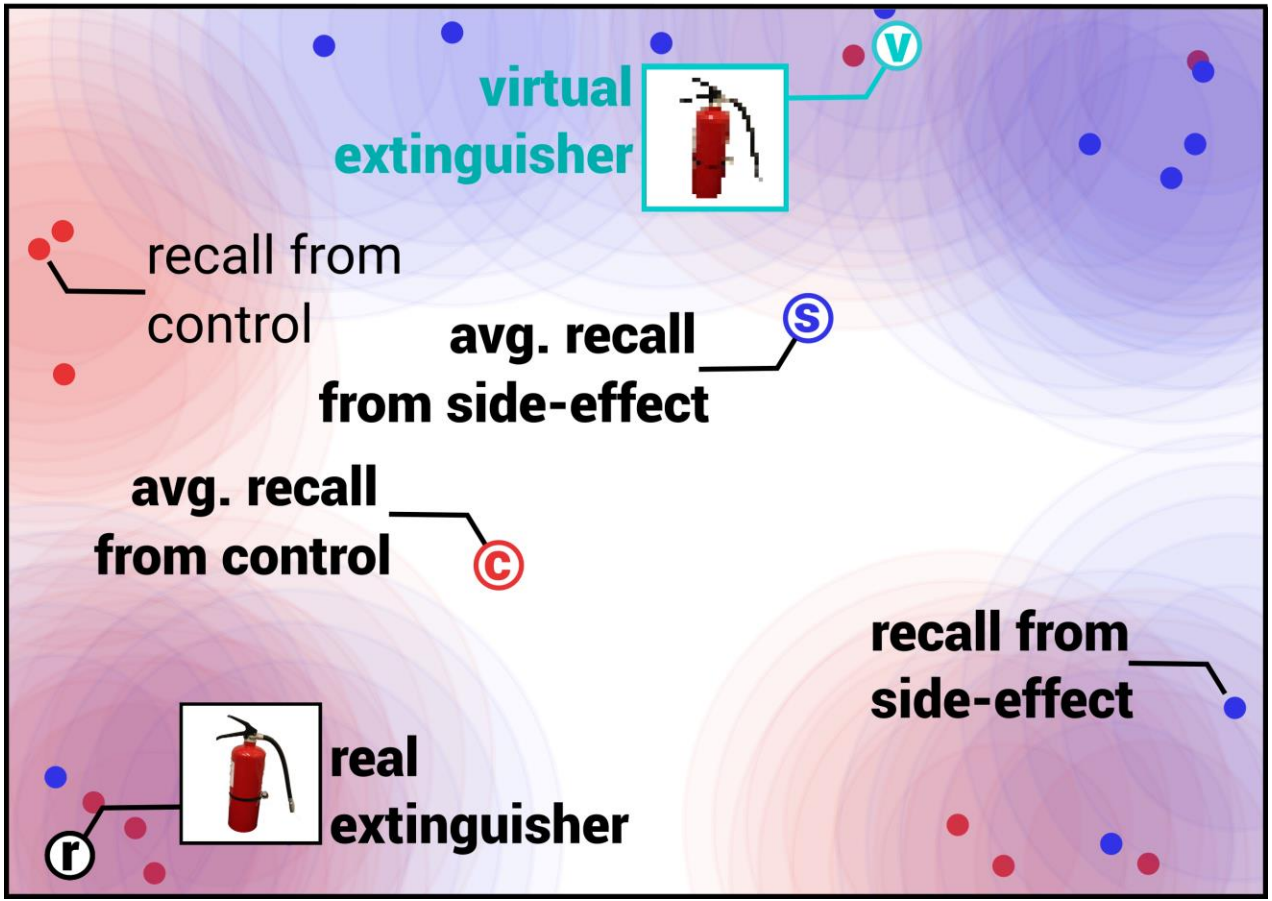
avg. recall from side-effect (s)

avg. recall from control (c)

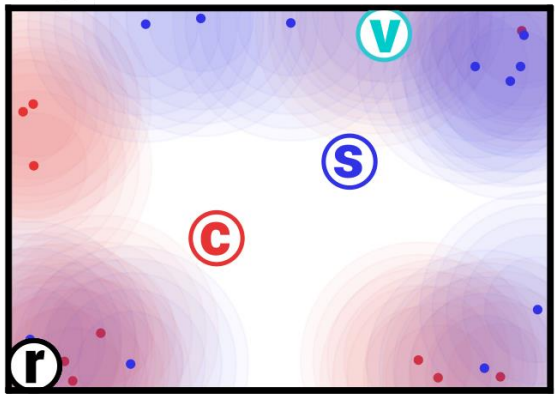
recall from side-effect

(r) **real extinguisher**

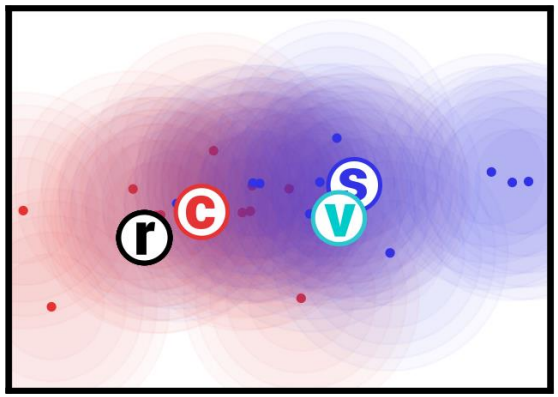
extinguisher



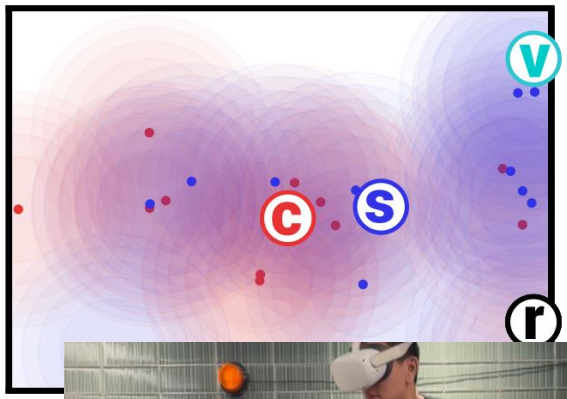
extinguisher



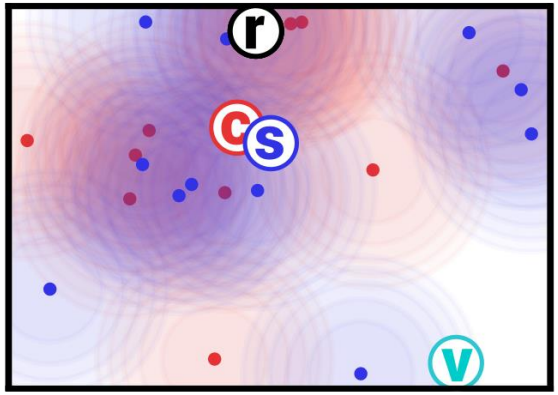
cup



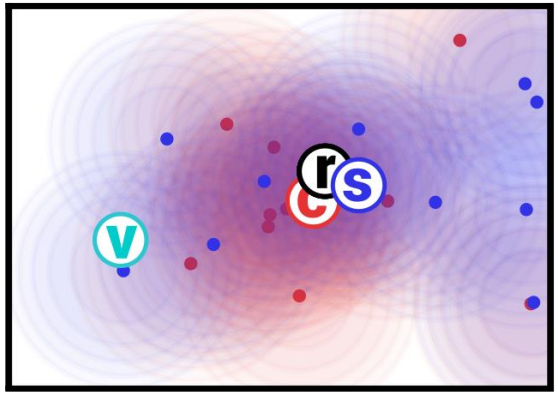
keyboard

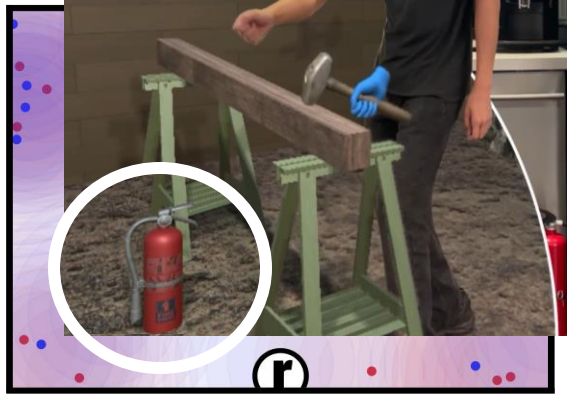


paper box



paper stack





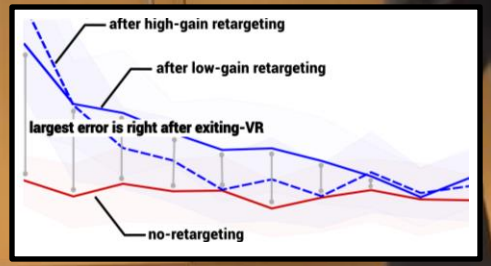
conclusion

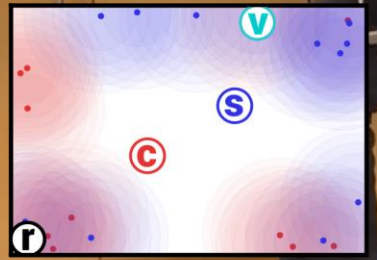
study 1: **movement side-effect**

study 2: **memory side-effect**

VR side-effect

an unintended lingering adaptation leading to potential risks after leaving VR





footage from user study

this is an additional study we conducted that you won't find in the paper, **we invite you to watch it on our video!**

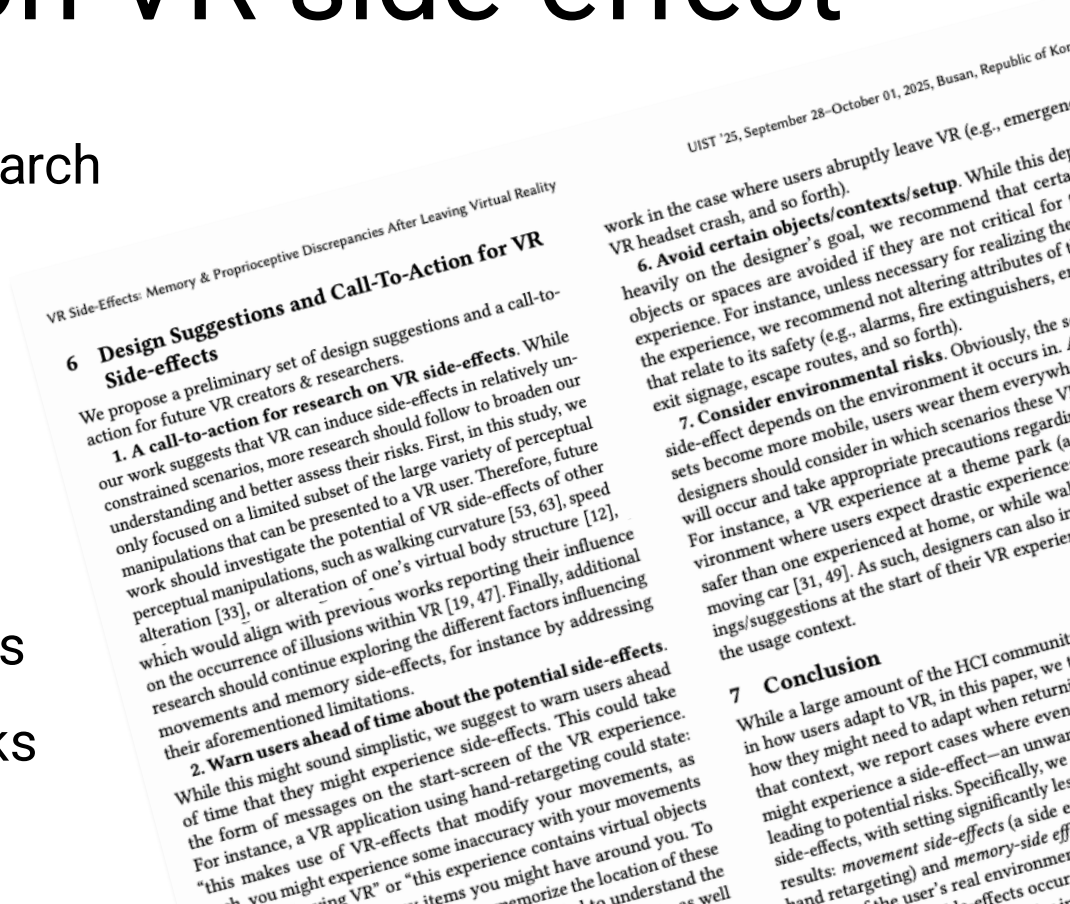
see video: https://www.youtube.com/watch?v=uoJtpx78RmU

real extinguisher

virtual extinguisher

call to action on VR side-effect

1. toward more empirical research
2. warn users ahead of time
3. label effect size
4. warn on exit
5. fading out the side-effect
6. avoid certain context/setups
7. Consider environmental risks



VR Side-Effects: Memory & Proprioceptive Discrepancies After Leaving Virtual Reality

UIST '25, September 28–October 01, 2025, Busan, Republic of Kor

6 Design Suggestions and Call-To-Action for VR Side-effects

We propose a preliminary set of design suggestions and a call-to-action for future VR creators & researchers.

1. A call-to-action for research on VR side-effects. While our work suggests that VR can induce side-effects in relatively unconstrained scenarios, more research should follow to broaden our understanding and better assess their risks. First, in this study, we only focused on a limited subset of the large variety of perceptual manipulations that can be presented to a VR user. Therefore, future work should investigate the potential of VR side-effects of other perceptual manipulations, such as walking curvature [53, 63], speed alteration [33], or alteration of one's virtual body structure [12], which would align with previous works reporting their influence on the occurrence of illusions within VR [19, 47]. Finally, additional research should continue exploring the different factors influencing movements and memory side-effects, for instance by addressing their aforementioned limitations.

2. Warn users ahead of time about the potential side-effects. While this might sound simplistic, we suggest to warn users ahead of time that they might experience side-effects. This could take the form of messages on the start-screen of the VR experience. For instance, a VR application using hand-retargeting could state: "this makes use of VR-effects that modify your movements, as you might experience some inaccuracy with your movements ing VR" or "this experience contains virtual objects items you might have around you. To morize the location of these understand the

work in the case where users abruptly leave VR (e.g., emergen VR headset crash, and so forth).

6. Avoid certain objects/contexts/setup. While this dep heavily on the designer's goal, we recommend that certa objects or spaces are avoided if they are not critical for experience. For instance, unless necessary for realizing the the experience, we recommend not altering attributes of t that relate to its safety (e.g., alarms, fire extinguishers, e exit signage, escape routes, and so forth).

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While a large amount of the HCI communit in how users adapt to VR, in this paper, we how they might need to adapt when returni that context, we report cases where even might experience a side-effect—an unwa leading to potential risks. Specifically, we side-effects, with setting significantly les results: *movement side-effects* (a side e hand retargeting) and *memory-side eff* the user's real environmen side-effects occur

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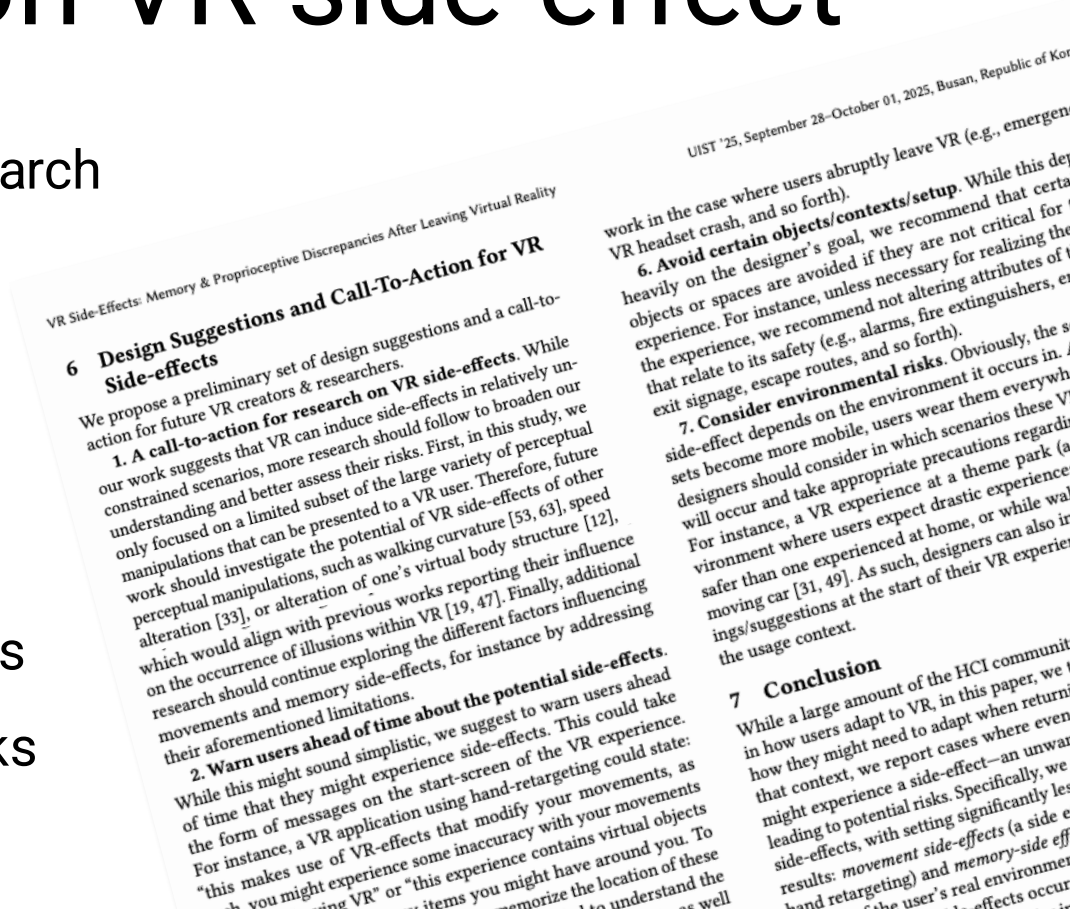

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You can watch the video here: https://www.youtube.com/watch?v=uoJtpx78RmU
If you need a PPTX/editable version for your class, email us hci@uchicago.edu
More on this paper (or others of our lab) at: https://lab.plopes.org/#VR-side-effects

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