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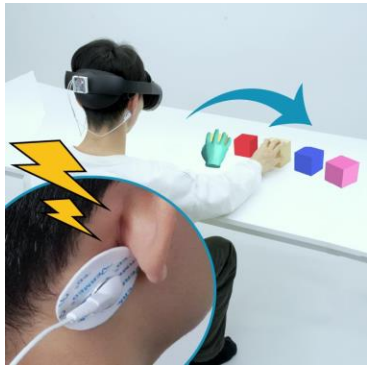
If you need a PPTX/editable version for your class, email us hci@uchicago.edu
More on this paper (or others of our lab) at: https://lab.plopes.org/ - GVSHandRedirection



Vestibular Stimulation Enhances Hand Redirection
Kensuke Katori, Yudai Tanaka, Yoichi Ochiai, Pedro Lopes. In Proc. UIST'25 (paper)

We demonstrate how the vestibular system (i.e., the sense of balance) influences the perception of hand position in VR. By exploiting this via galvanic vestibular stimulation (GVS), we can enhance the degree to which we can redirect the user's hands in VR without them noticing it. The trick is that a GVS-induced subtle body sway aligns with the user's expected body balance during hand redirection. This alignment reduces the sensory conflict between the expected and actual body balance. Our user study validated that our approach raises the detection threshold of VR hand redirection by 45~55%. Our approach broadens the applicability of hand redirection (e.g., compressing a VR space into an even smaller physical area).

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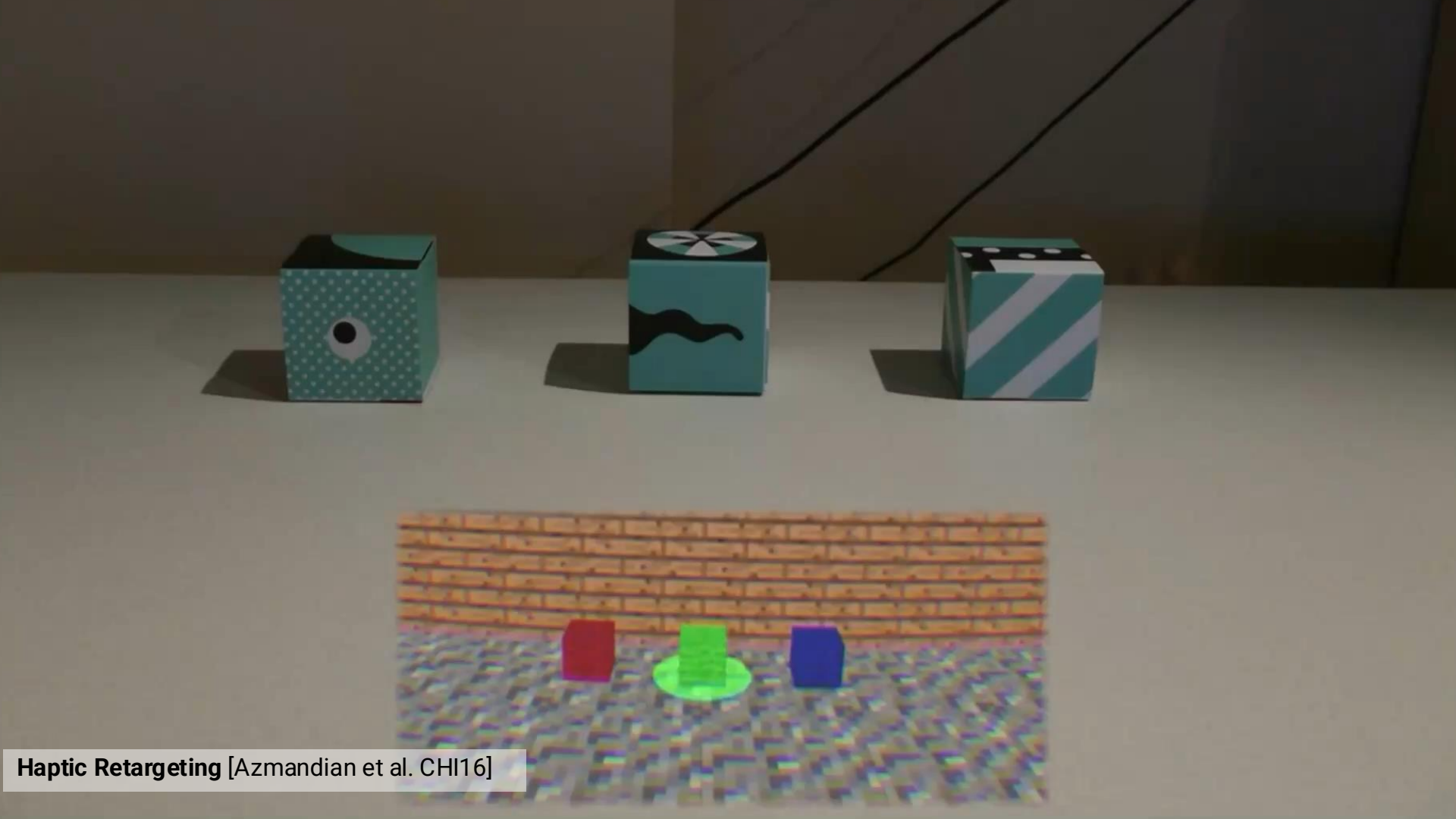
vestibular stimulation enhances hand redirection

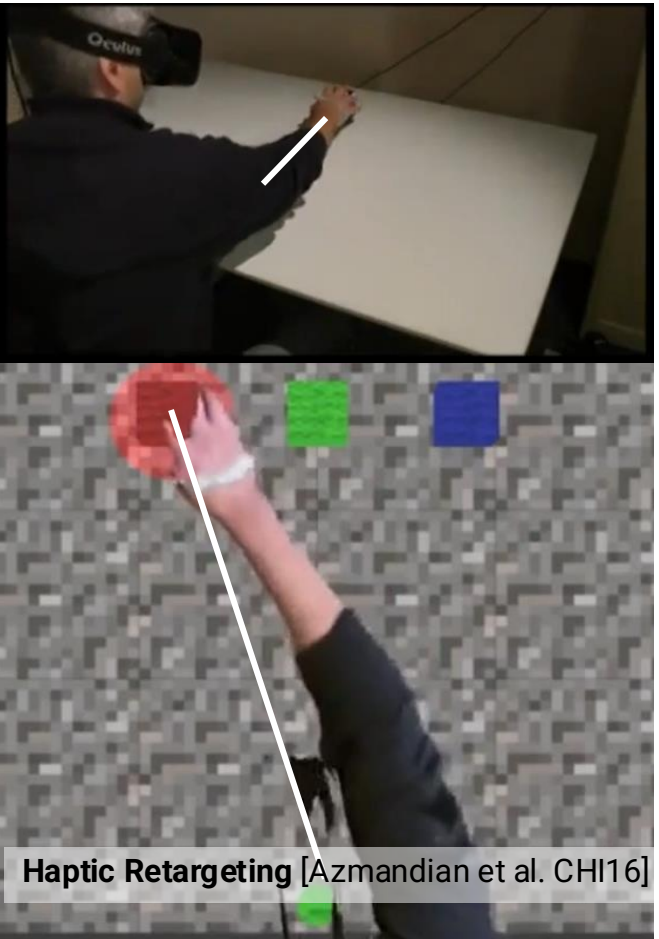
kensuke katori, yudai tanaka, yoichi ochiai, pedro lopes

1. motivation



Haptic Retargeting [Azmandian et al. CHI16]

Haptic Retargeting's key advantage: **altering the perceived interaction volume**



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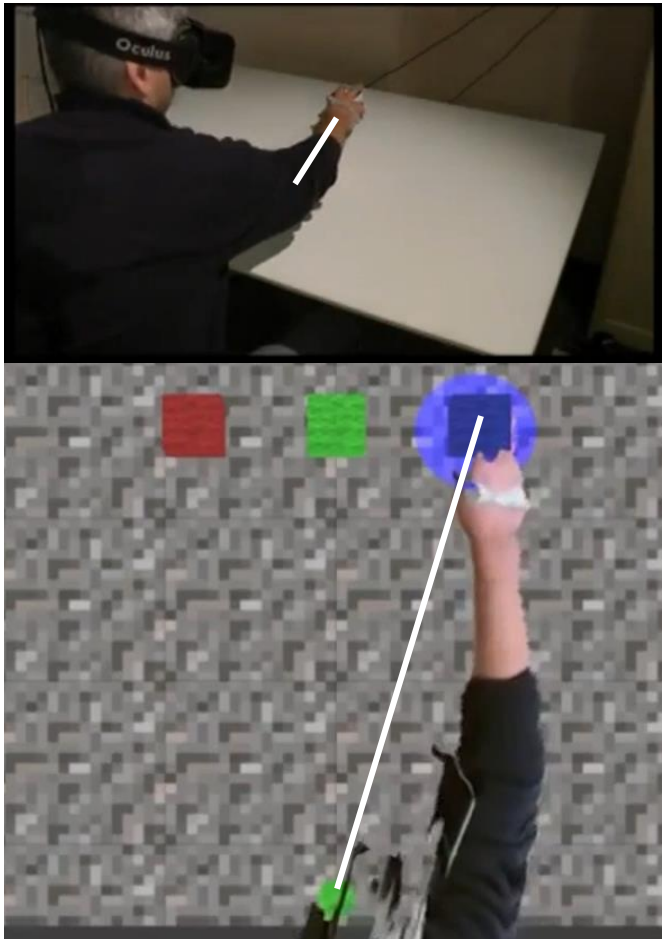
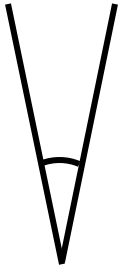
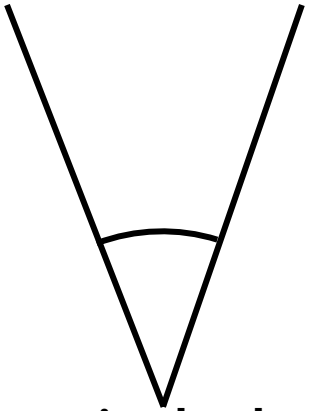
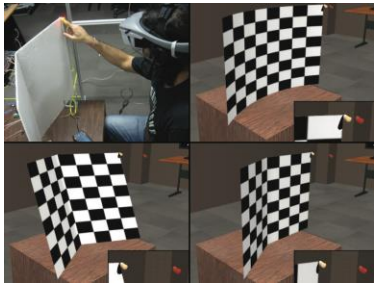




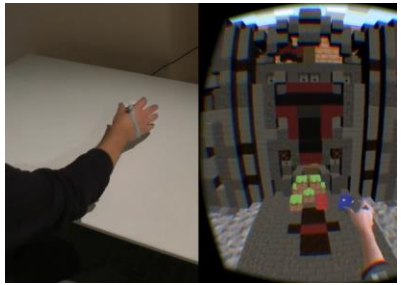
physical volume
smaller angle (real)



perceived volume
larger angle (virtual)

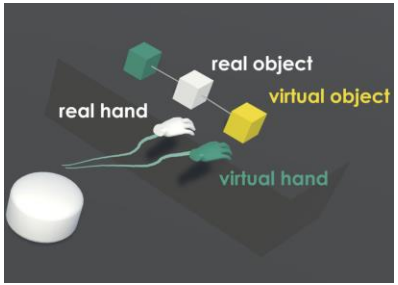


Kohli et al., 3DUI‘10



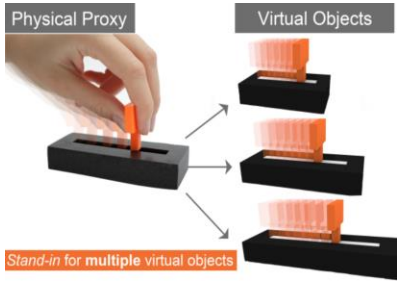
Azmandian et al., CHI‘16

Cheng et al., CHI‘17

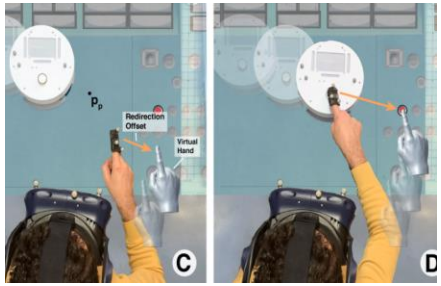


Zenner et al., CHI EA‘21

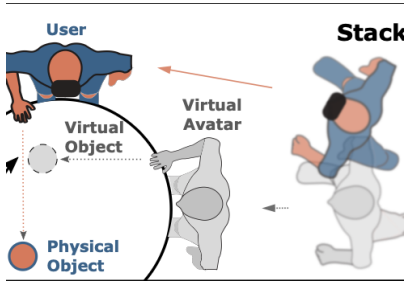
Hartfill et al., VRST’21



Feick et al., CHI’21



Gonzalez et al., UIST’20

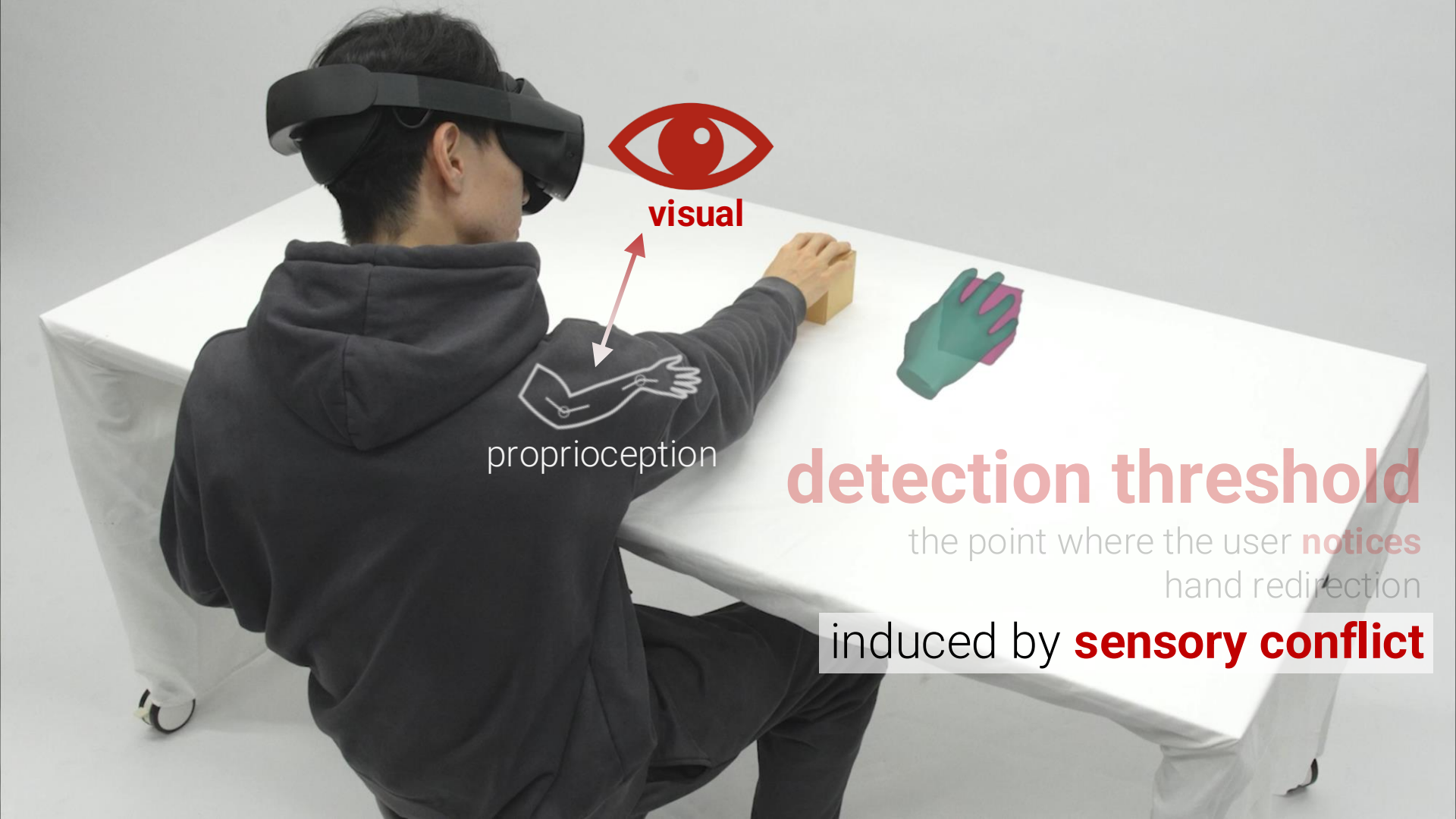


Clarence et al., CHI’24

2. the catch


detection threshold
the point where the user notices
hand redirection


?
detection threshold
the point where the user notices
hand redirection

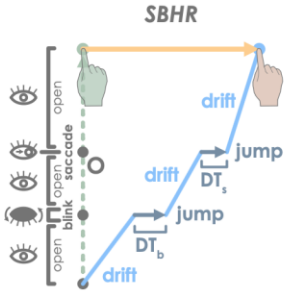


detection threshold

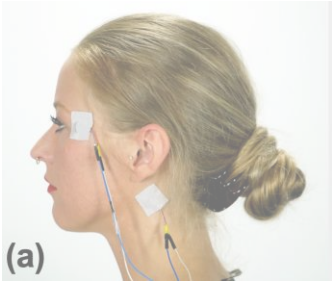
the point where the user **notices**
hand redirection

induced by **sensory conflict**

visual approaches / distraction

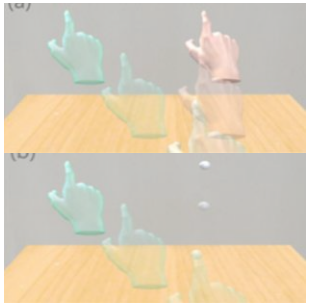


Zenner et al., CHI'24

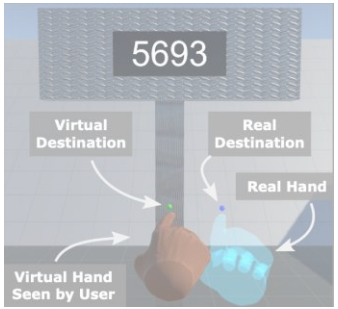


Zenner & Krüger et al., 3DUI'19

improvement of threshold: ~20% increase at best

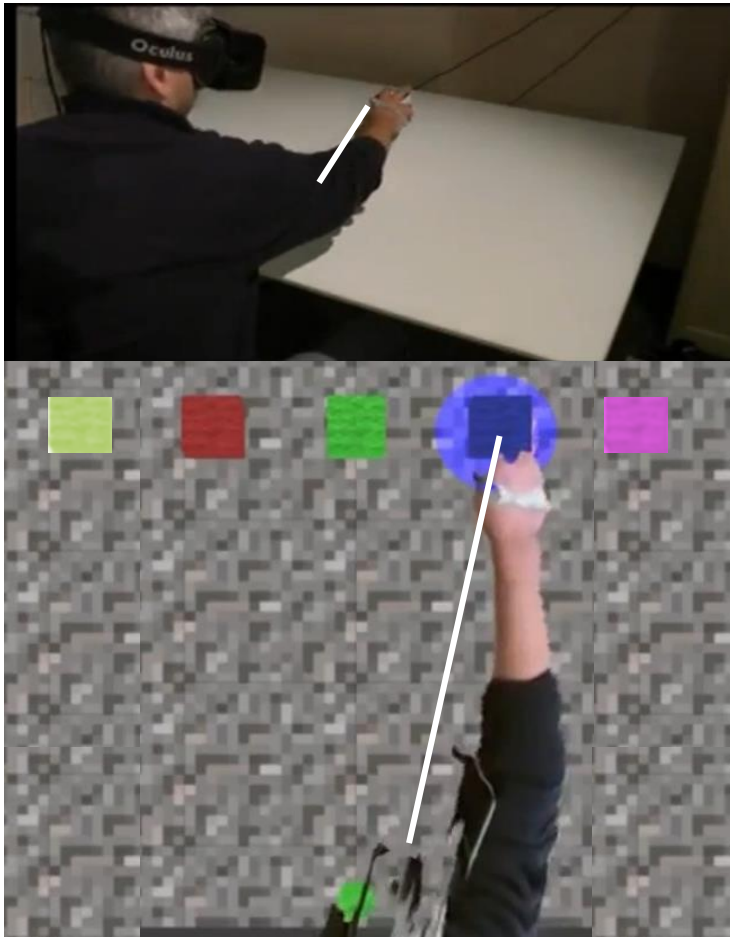


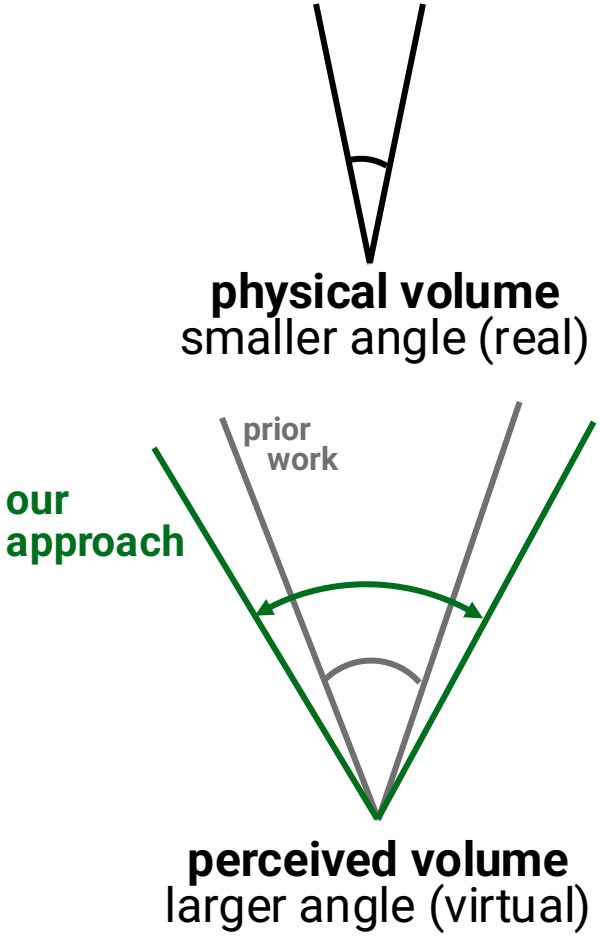
Ogawa et al., TVCG'21



Zenner & Krüger et al., 3DUI'19

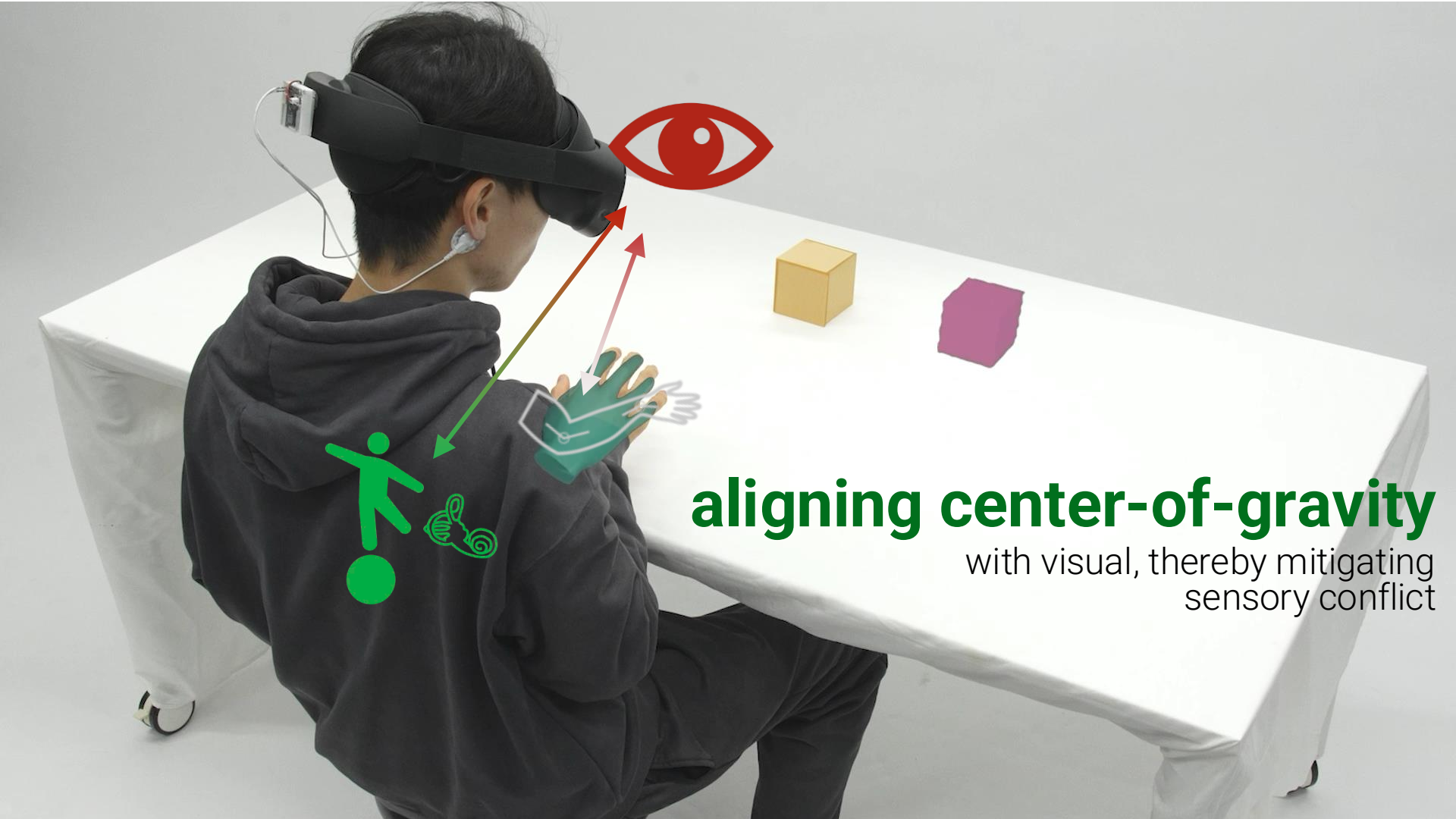
what if I told you: **I think we can extend this below the detection threshold?**





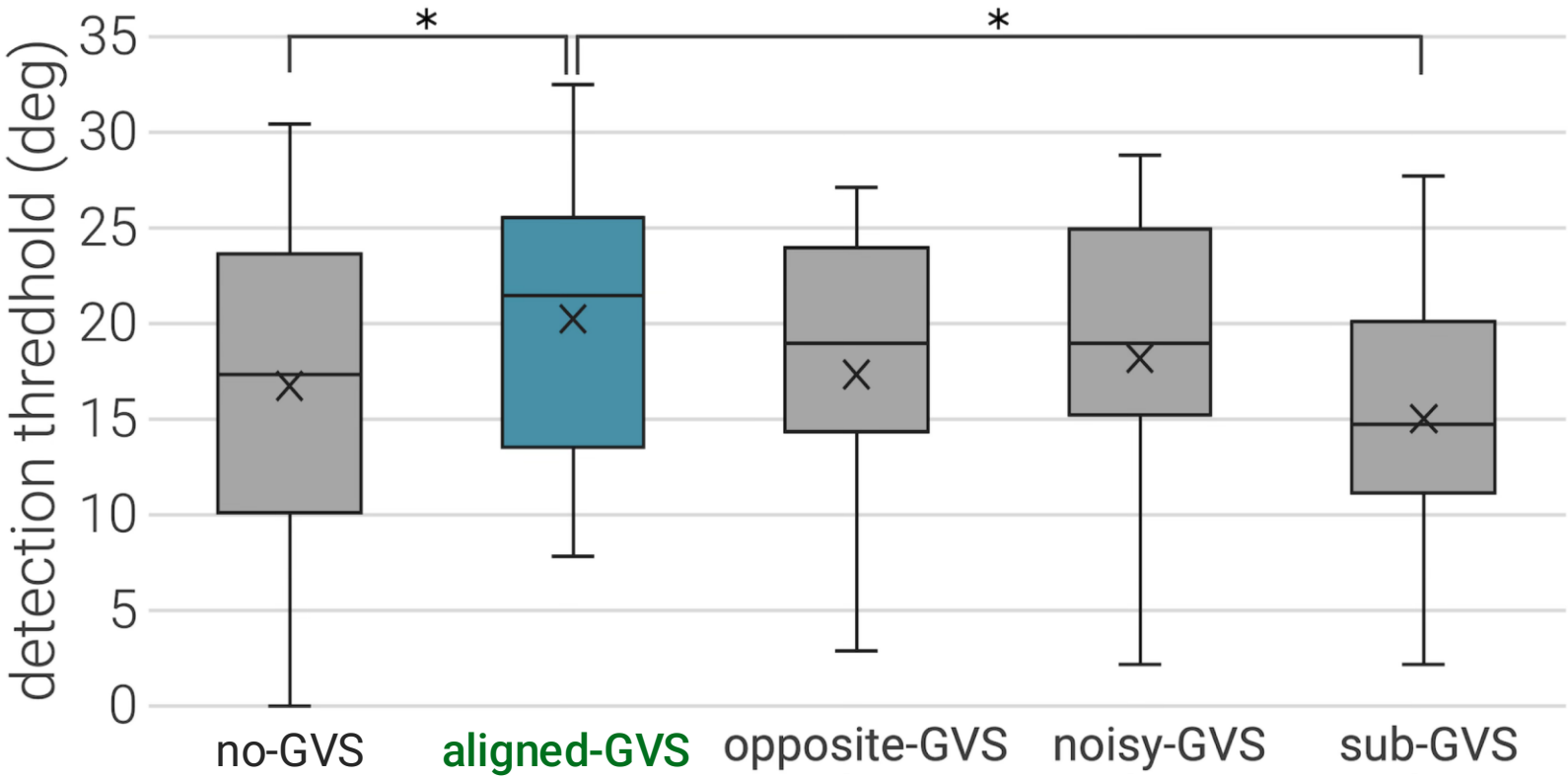
3. our approach

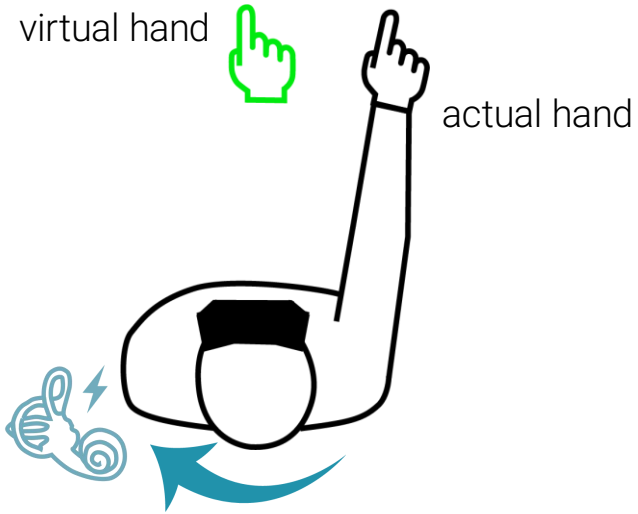
galvanic vestibular stimulation **(GVS)**


aligning center-of-gravity
with visual, thereby mitigating
sensory conflict

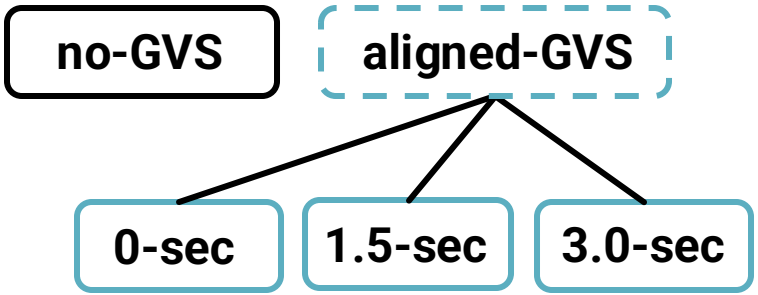

actual
center-of-gravity
conflicts with visually
expected center-of-gravity
aligned by GVS
see video: https://www.youtube.com/watch?v=tpcovBqYYAo

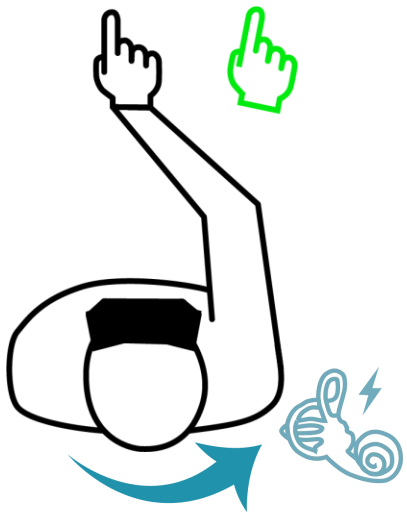
4. user study


*
*
35
30
25
20
15
10
5
0
detection thredhold (deg)
no-GVS
aligned-GVS
opposite-GVS
noisy-GVS
sub-GVS

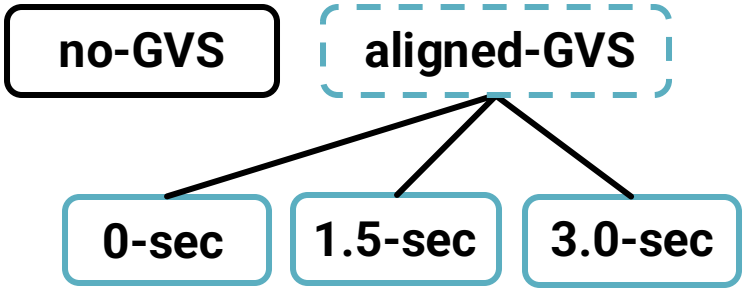


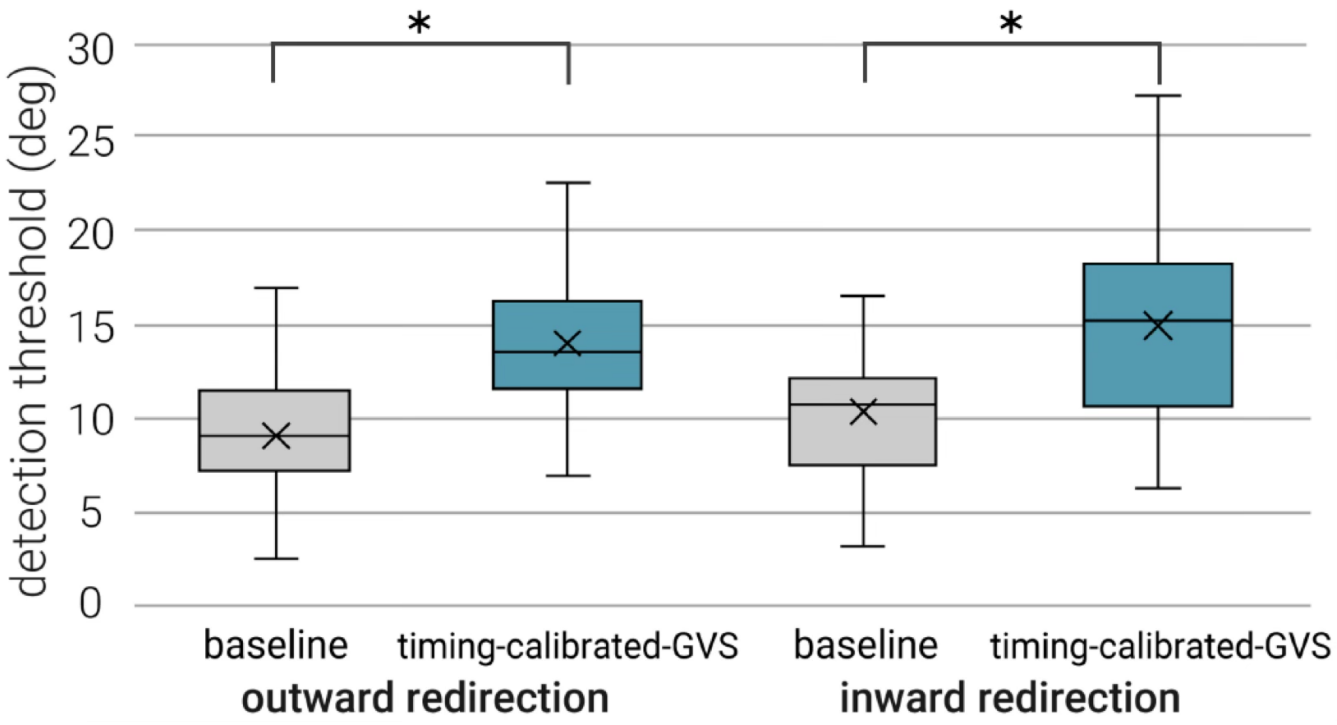
outward redirection



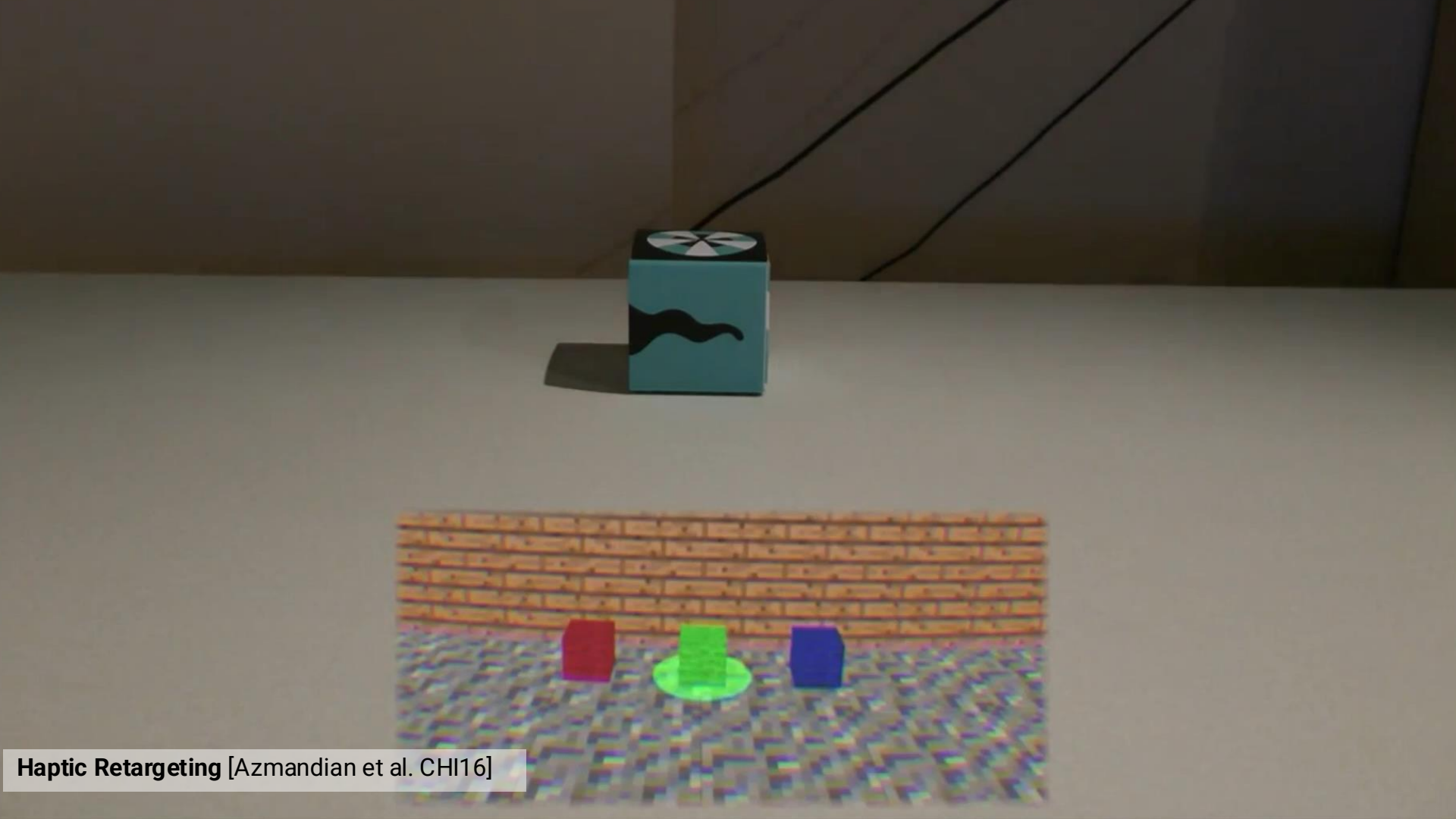


inward redirection





~55% increase **~45%** increase



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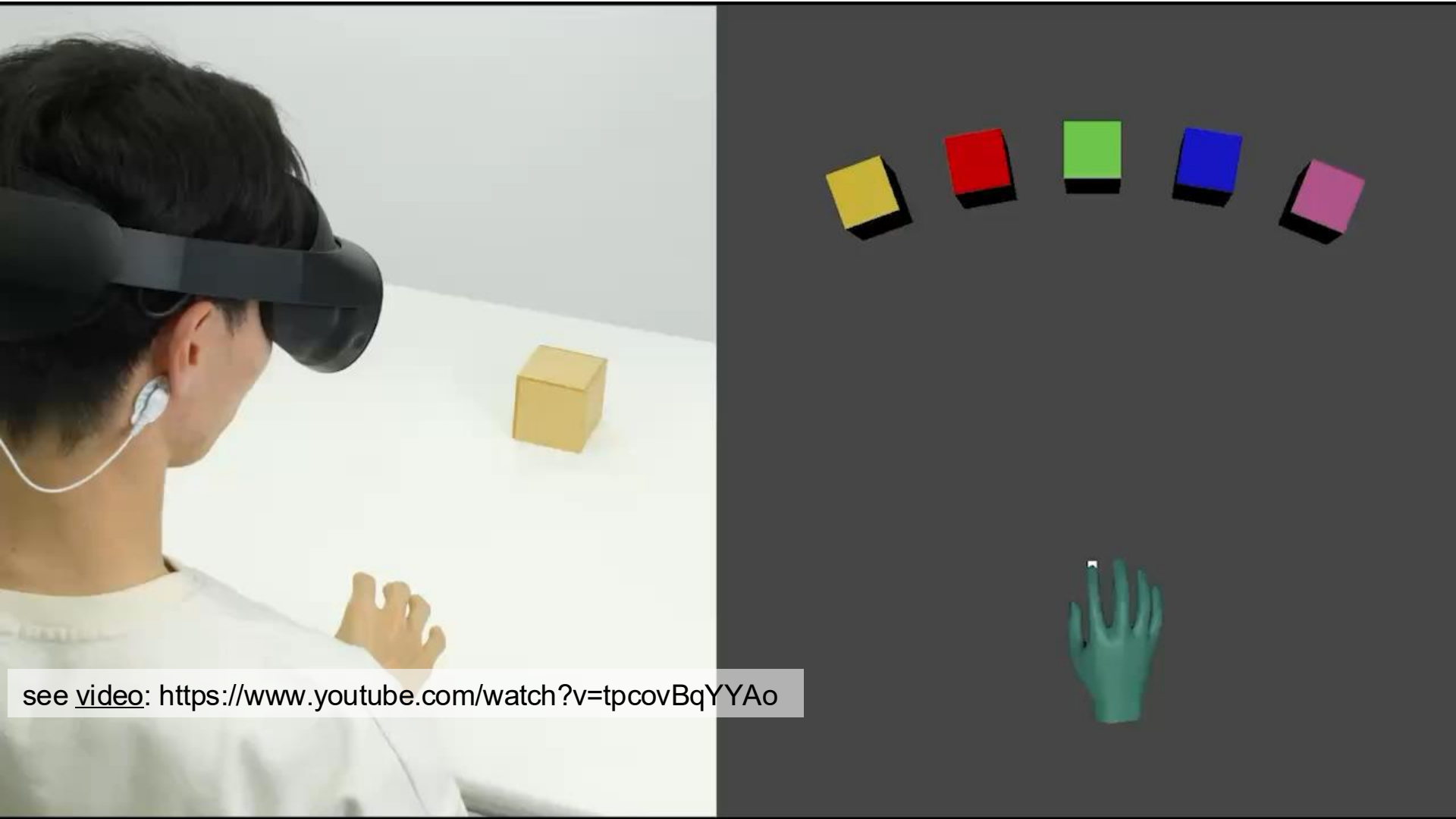
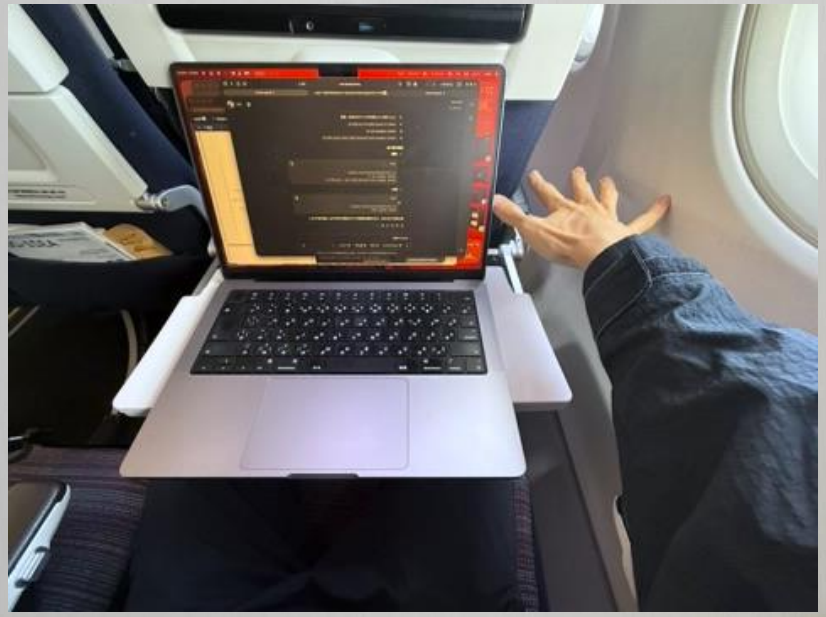

see video: https://www.youtube.com/watch?v=tpcovBqYYAo



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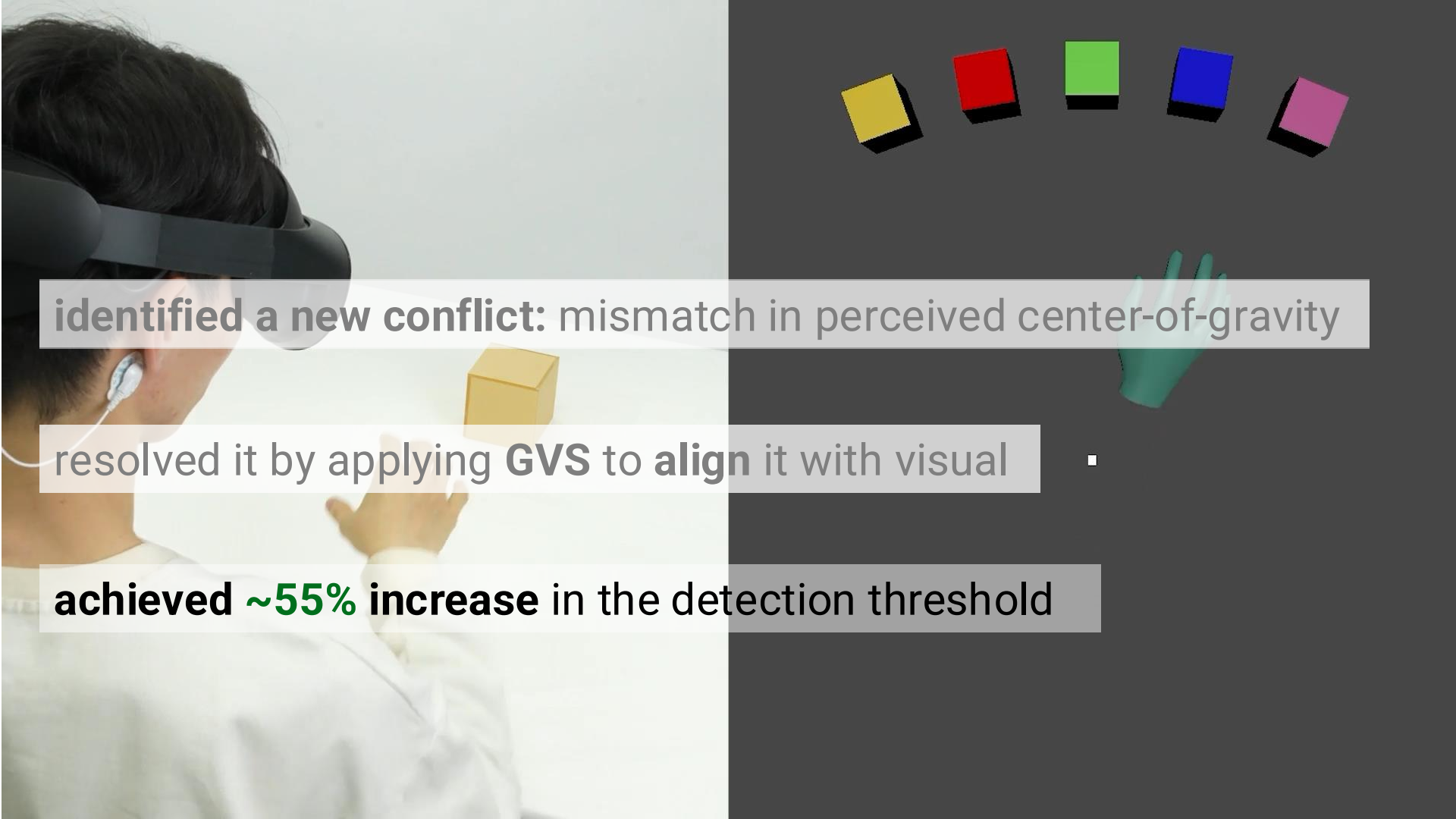
see video: https://www.youtube.com/watch?v=tpcovBqYYAo

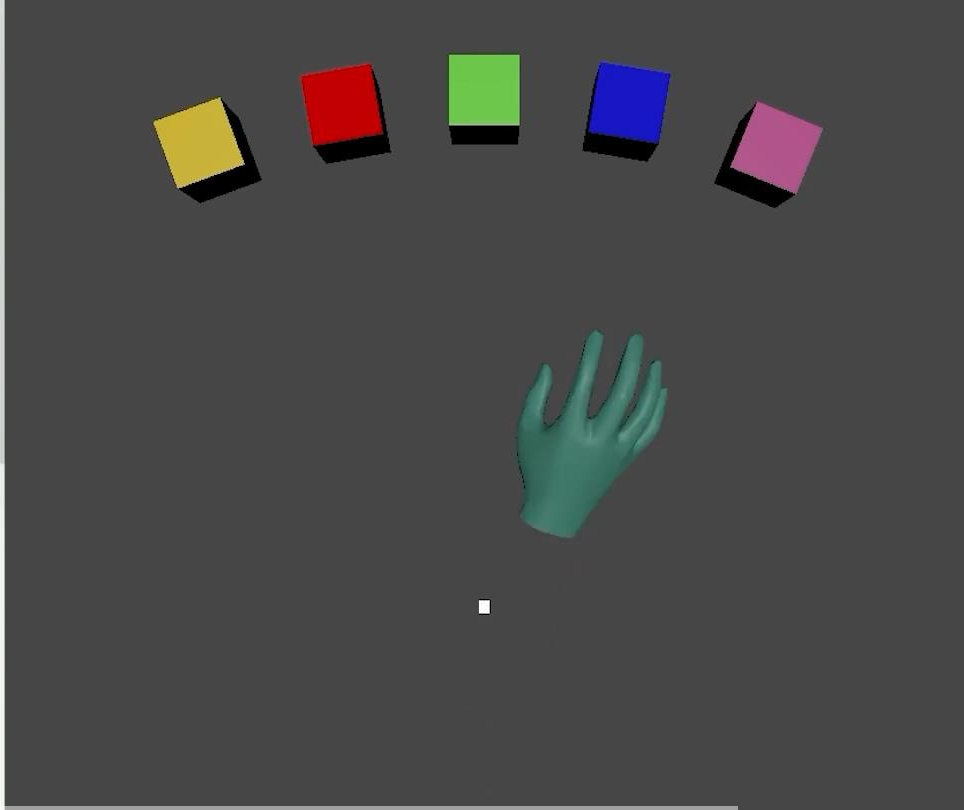
5. conclusions



identified a new conflict: mismatch in perceived center-of-gravity

resolved it by applying **GVS** to **align** it with visual

achieved ~55% increase in the detection threshold



vestibular stimulation enhances hand redirection

kensuke katori, yudai tanaka, yoichi ochiai, pedro lopes

THE UNIVERSITY OF CHICAGO

筑波大学 University of Tsukuba

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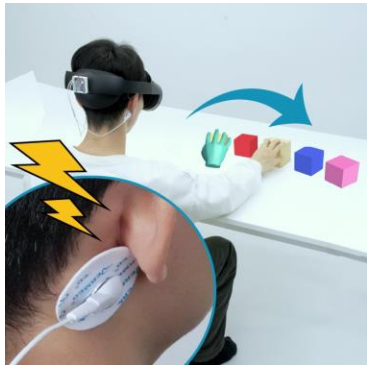

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