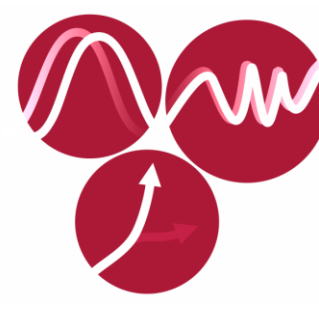



Can our Hands Discriminate Object Sizes Better Than our Eyes?

Kriti Bhatia¹, Tanja Huber¹, Angela Osenberg¹, Frederic Göhringer³, Markus Janczyk², Thomas Schenk³, Volker Franz¹

 **Experimental Cognitive Science**

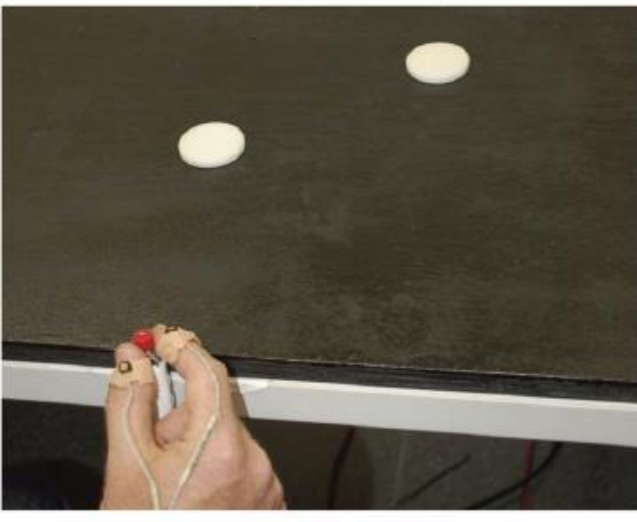
¹Universität Tübingen; ²Universität Bremen; ³Ludwig-Maximilians-Universität München

kriti.bhatia@uni-tuebingen.de

 **EBERHARD KARLS UNIVERSITÄT TÜBINGEN**

BACKGROUND

Size Resolution in Perception & Action

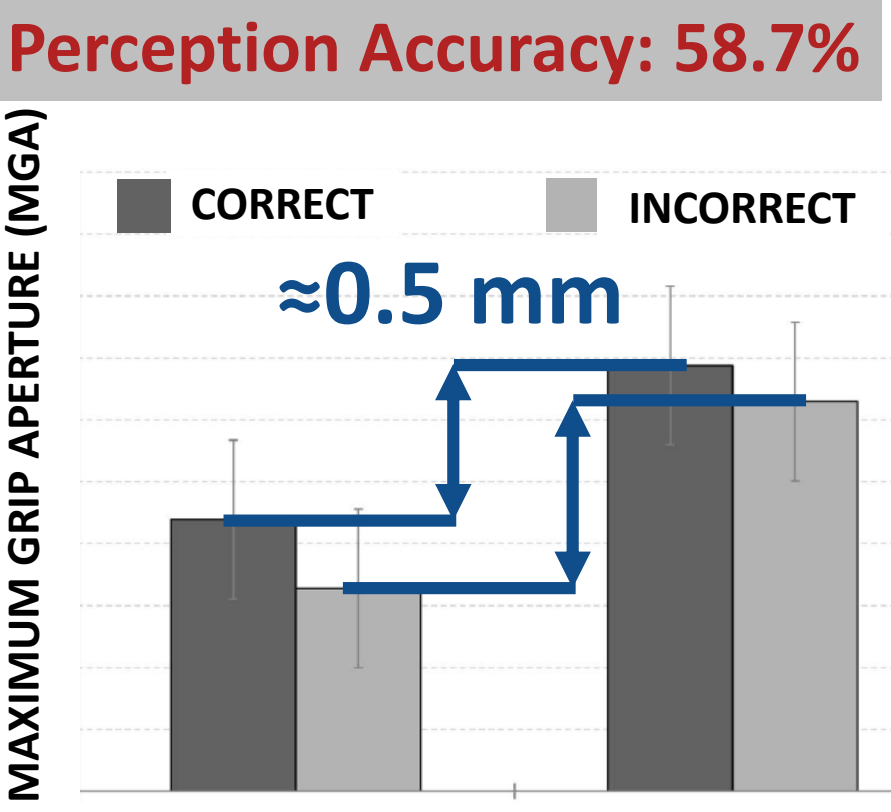


Two tasks on same trial: judge the size of the disc and grasp the disc. Discs differ by only 0.5 mm resulting in low accuracy of perceptual judgement.

40 mm 40.5 mm

Differing grip apertures (MGA) in grasping small vs. large disc.

Grasping has better size resolution than visual perception!



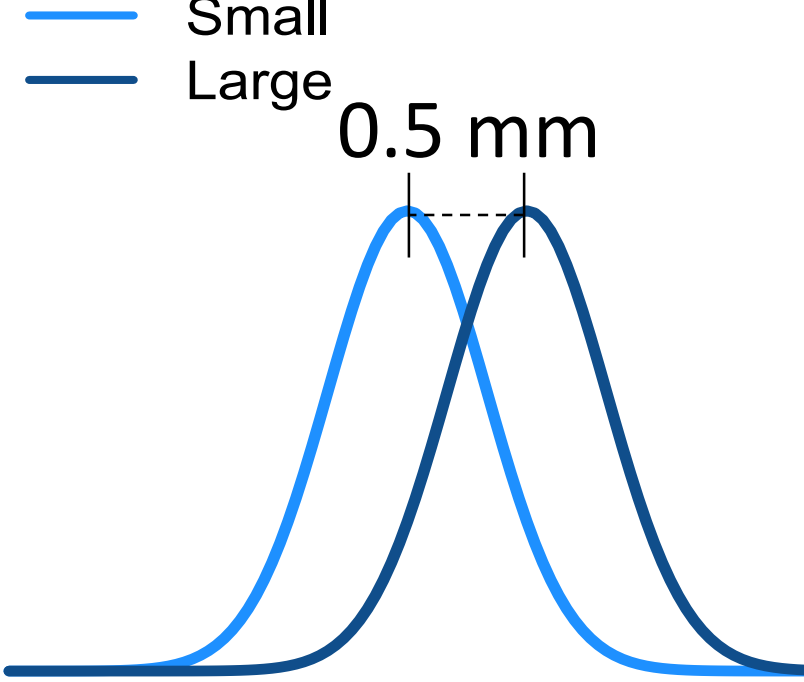
Perception Accuracy: 58.7%

MAXIMUM GRIP APERTURE (MGA)

SMALL LARGE

Ganel et al. (2012)

Continuous vs. Dichotomous Measures



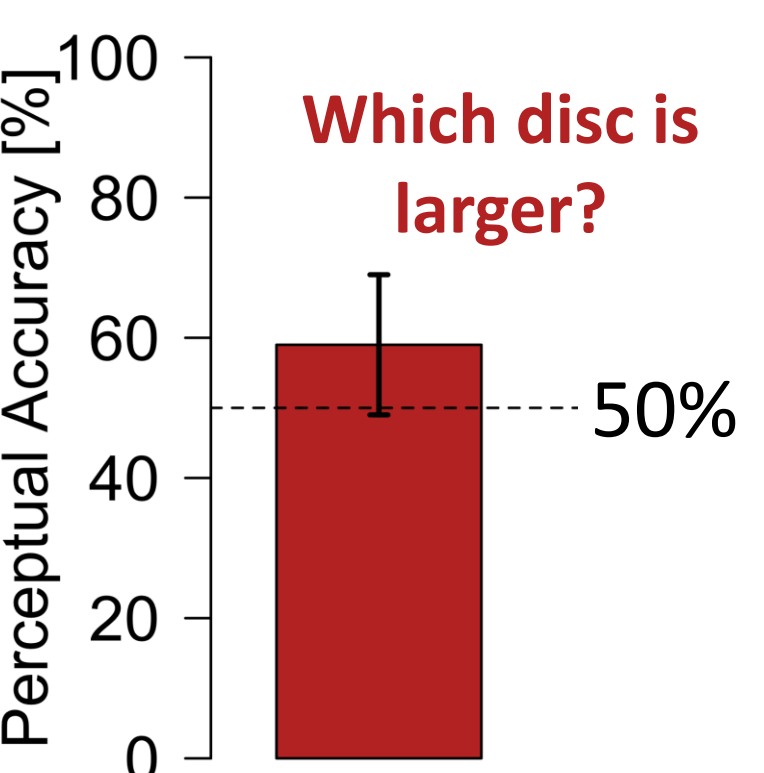
Small Large

0.5 mm

MGA

Good size resolution in grasping

Continuous Measure has many possible values and more information in response



Which disc is larger?

Perceptual Accuracy [%]

Bad size resolution in perception

Dichotomous Measure has only two possible answers and less information

Ganel et al. (2012), Cohen (1983)

Reanalysis & Review

Results (MGAs) of three studies were reanalysed to estimate accuracies in grasping using median split. Accuracies from two studies were calculated from reported summary statistics (t/F values) using the following formula (Meyen et al., 2022). Full data of Göhringer et al. (2019) were used to estimate accuracies and q^2 ($= 0.021$) for the reanalysis.

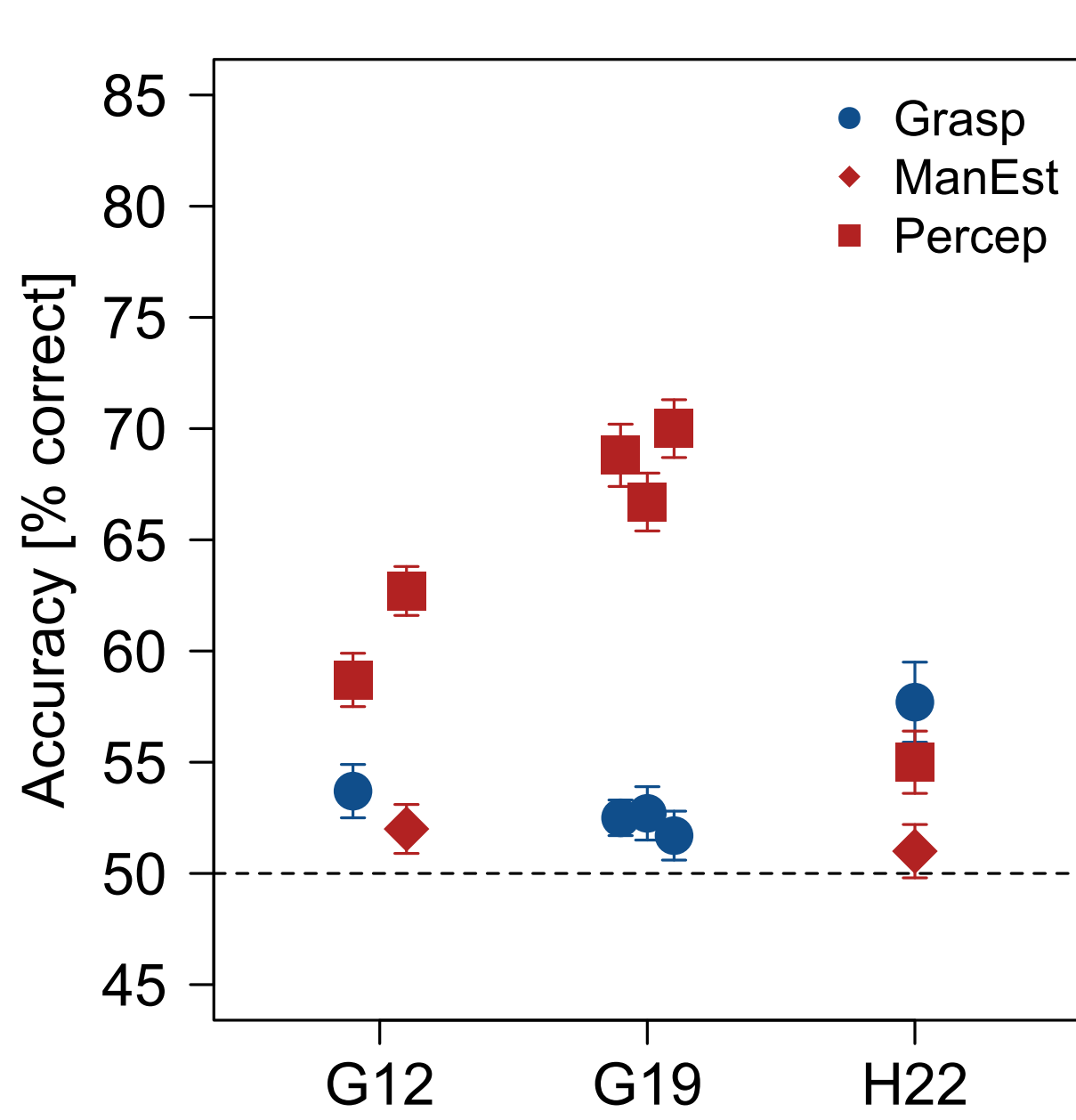
$$d' = t \cdot \sqrt{\frac{q^2 + \frac{4}{K}}{N}} \cdot \sqrt{\frac{2}{N-1}} \cdot \frac{\Gamma(\frac{N-1}{2})}{\Gamma(\frac{N-2}{2})}$$
$$Accuracy = \Phi\left(\frac{d'}{2}\right)$$

where:

t = t -value ($= \sqrt{F}$ = F -value) N = number of participants

$q^2 = \frac{\sigma_{Effect}^2}{\sigma_{\epsilon}^2}$ = variance ratio K = number of trials

Γ = Gamma function Φ = Cumulative normal distribution



Accuracy [% correct]

Grasp ManEst Percep

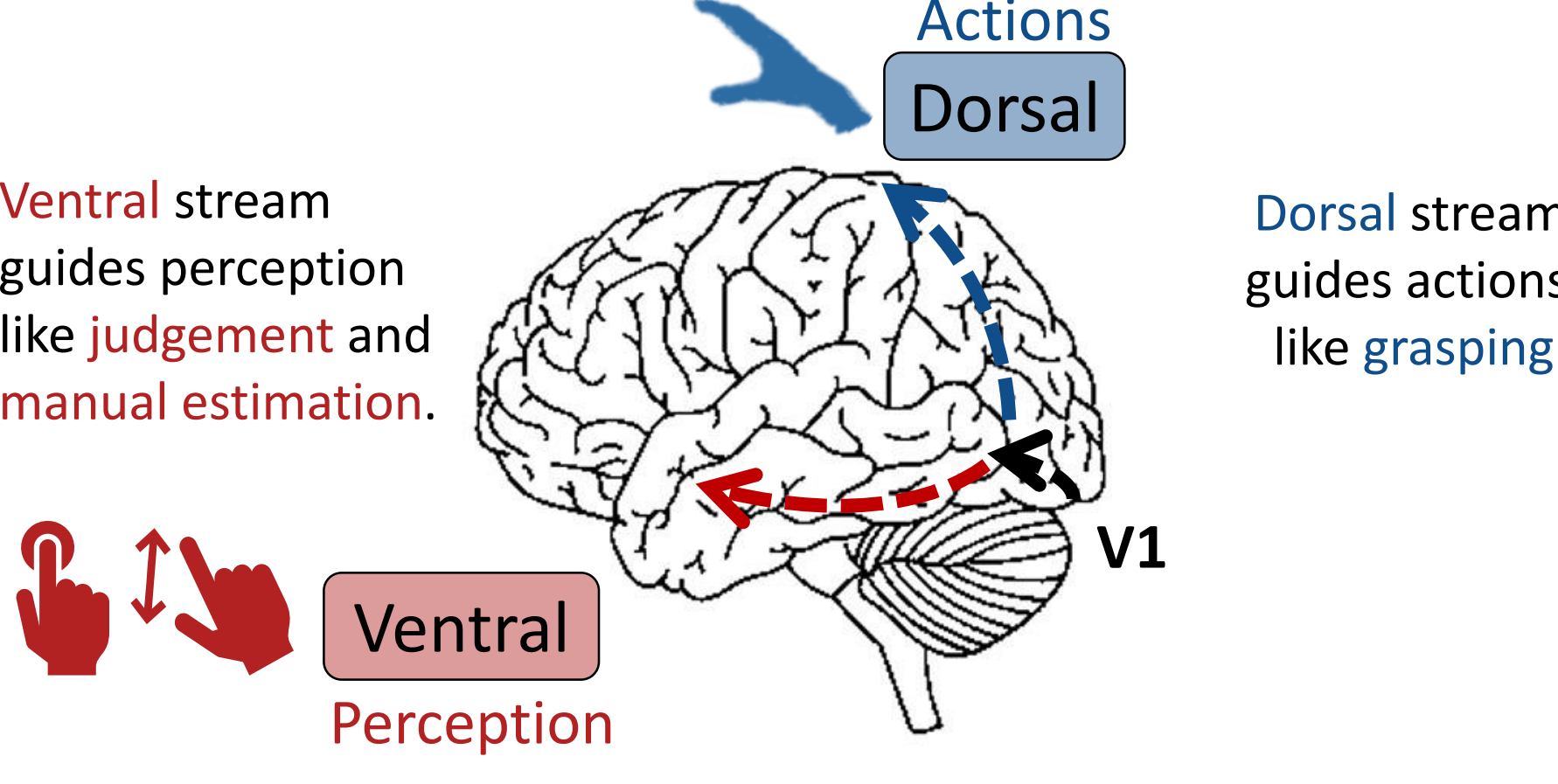
G12 G19 H22

Accuracies in perceptual judgement higher than grasping.

No evidence for better resolution in grasping than perception.

Ganel et al. (2012), Meyen et al. (2022), Göhringer et al. (2019), Heath et al. (2022)

Perception-Action Model (PAM)



Ventral stream guides perception like judgement and manual estimation.

Dorsal stream guides actions like grasping.

V1

Visual input is assumed to be processed differently in dorsal and ventral streams.

Goodale & Milner (1992)

Dichotomising Continuous Measures

Set criterion c for categorisation

MGA $< c$ \Rightarrow Small

MGA $> c$ \Rightarrow Large

WHICH CRITERION?

Statistically optimal = median

Successfully used for reaction times

Compare with true sizes

prediction == true size \Rightarrow correct

prediction != true size \Rightarrow incorrect

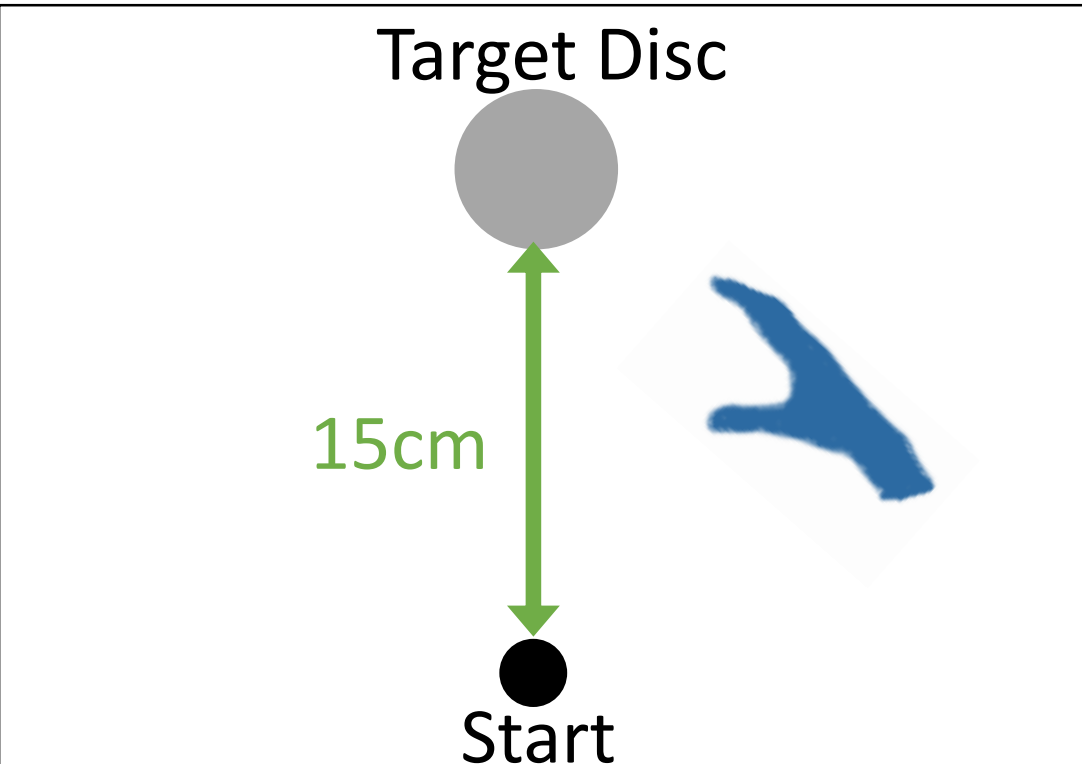
CLASSIFICATION ACCURACY

Comparable to perception task

Meyen et al. (2022)

SET-UP & DESIGN

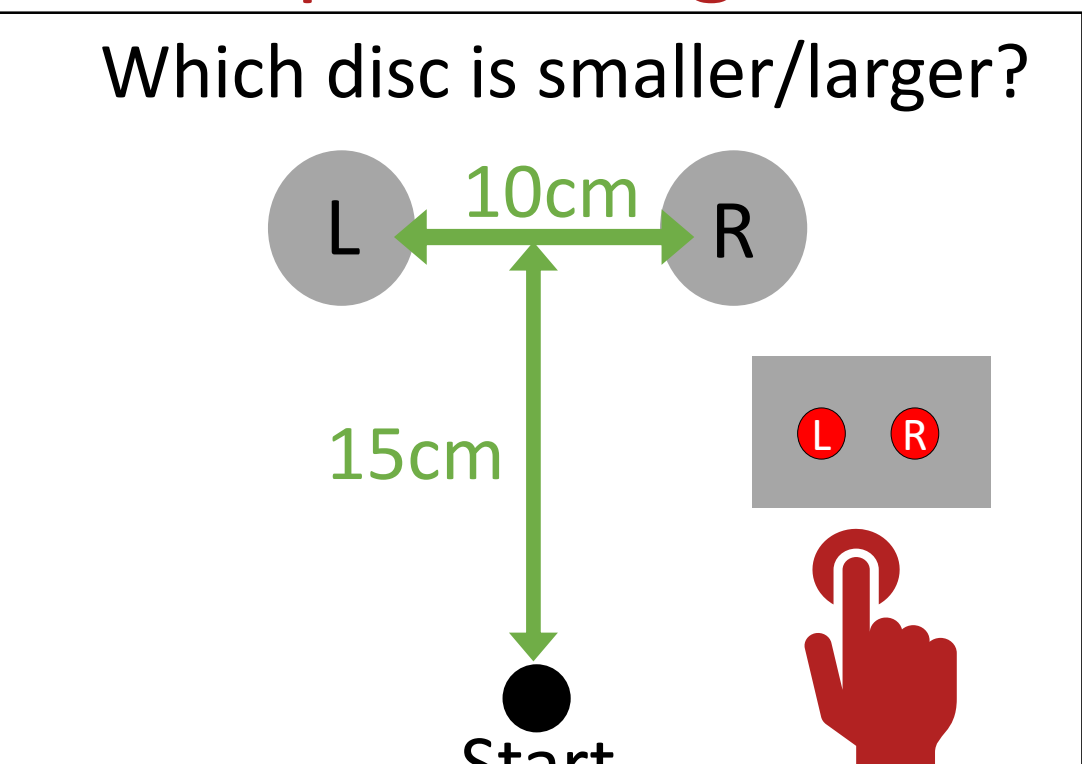
Grasping



Grasp disc using index finger and thumb as accurately as possible. MGAs are measured.

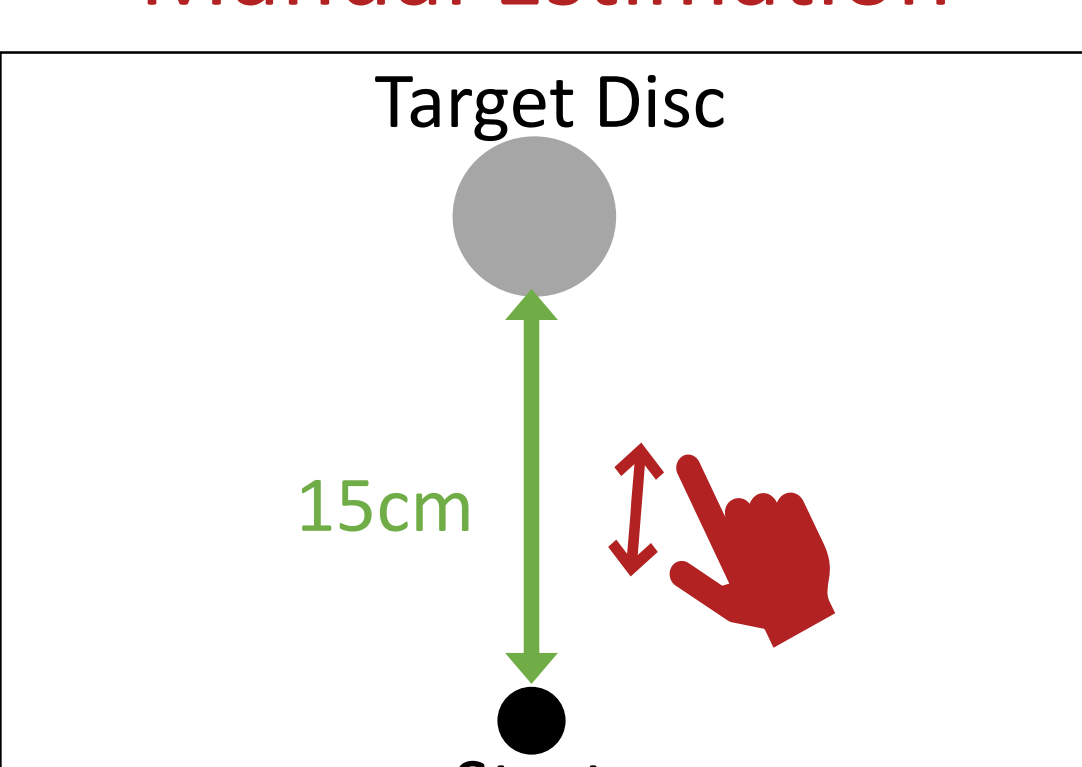
Perceptual Judgement

Which disc is smaller/larger?



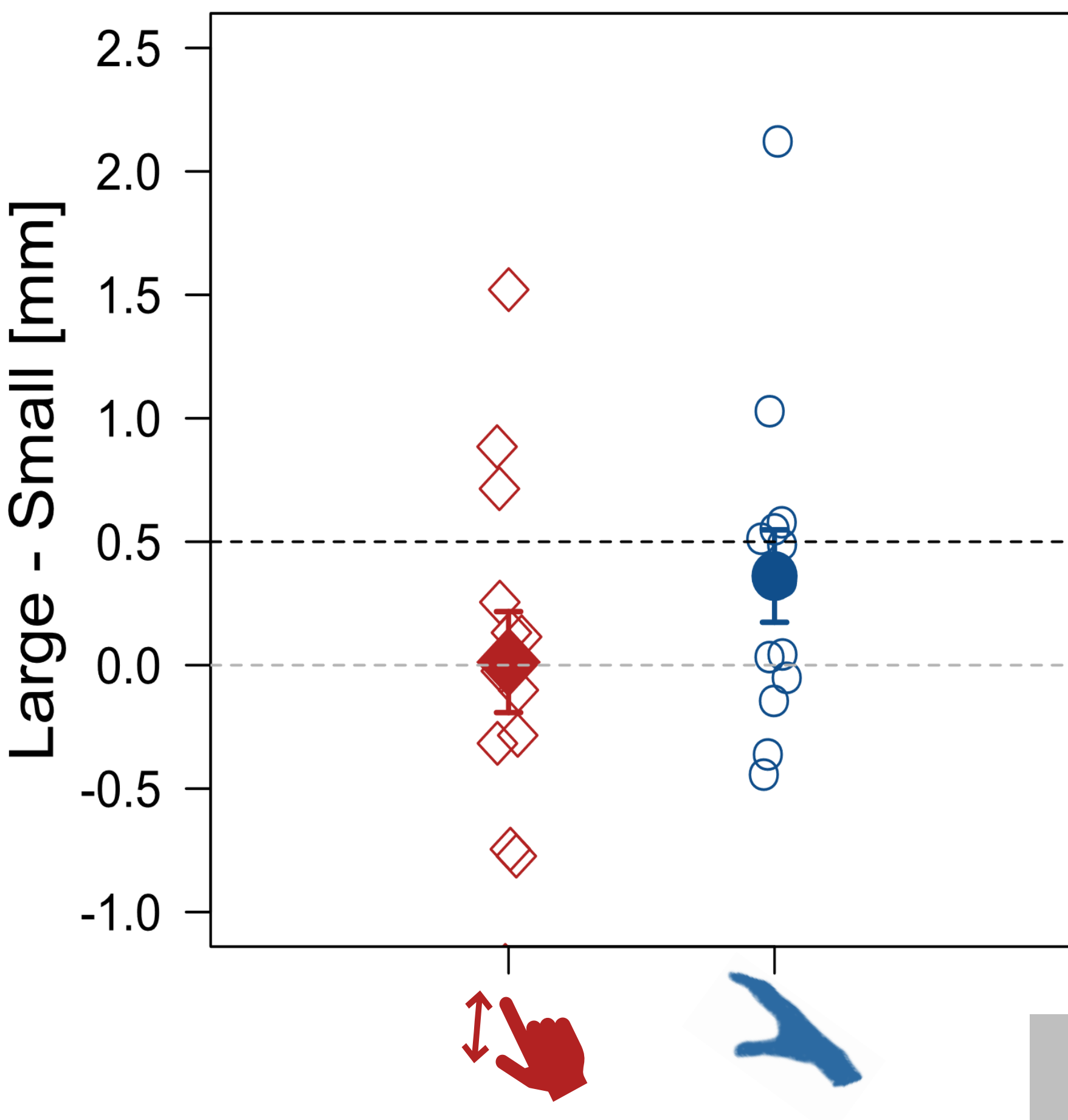
Judge which disc is smaller (or larger, counterbalanced) using button press. Accuracy of judgements is measured.

Manual Estimation



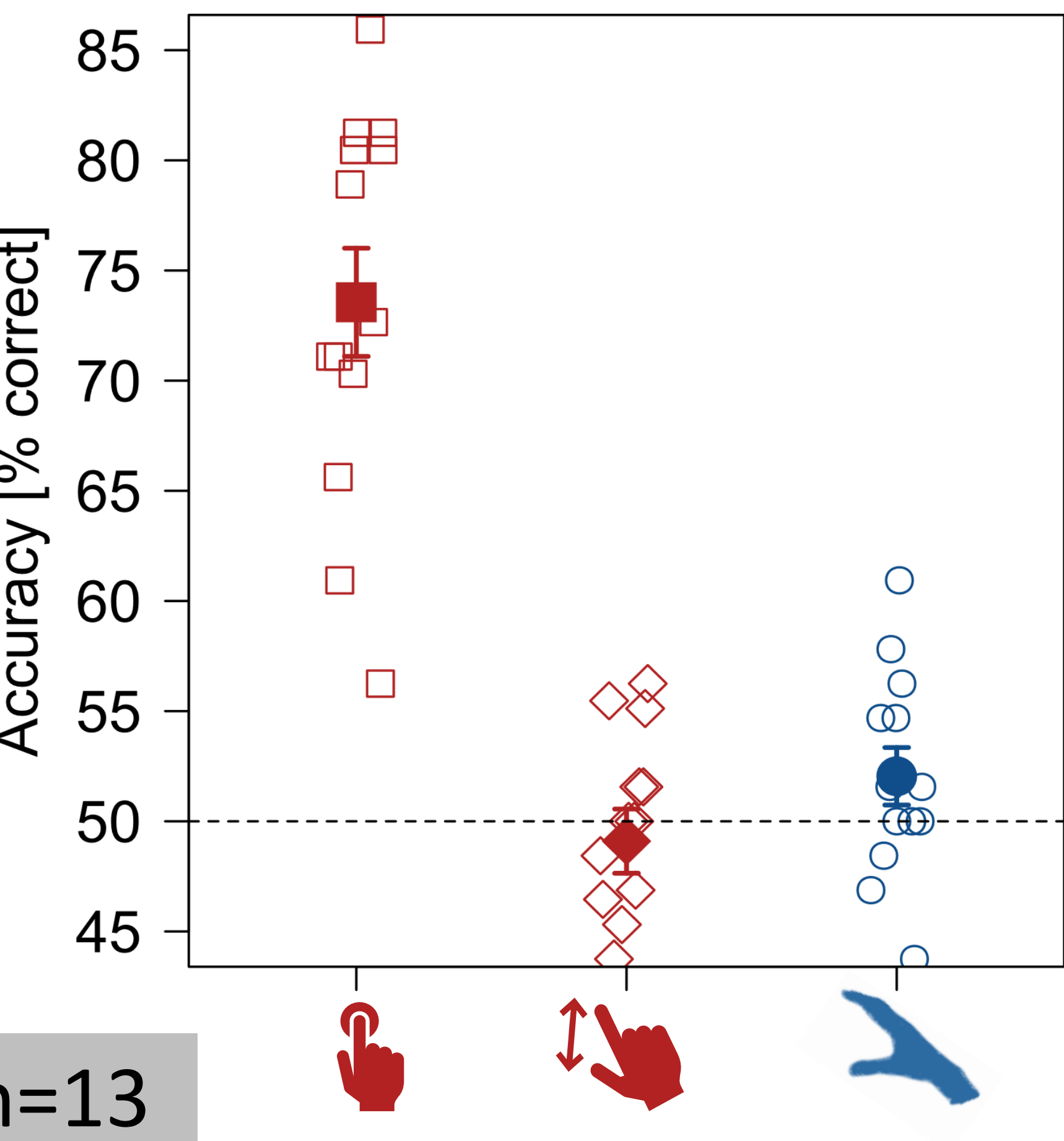
Estimate size of disc using index finger and thumb as accurately as possible. Estimates are measured.

PILOT STUDY & OUTLOOK



Large - Small [mm]

n=13



Accuracy [% correct]

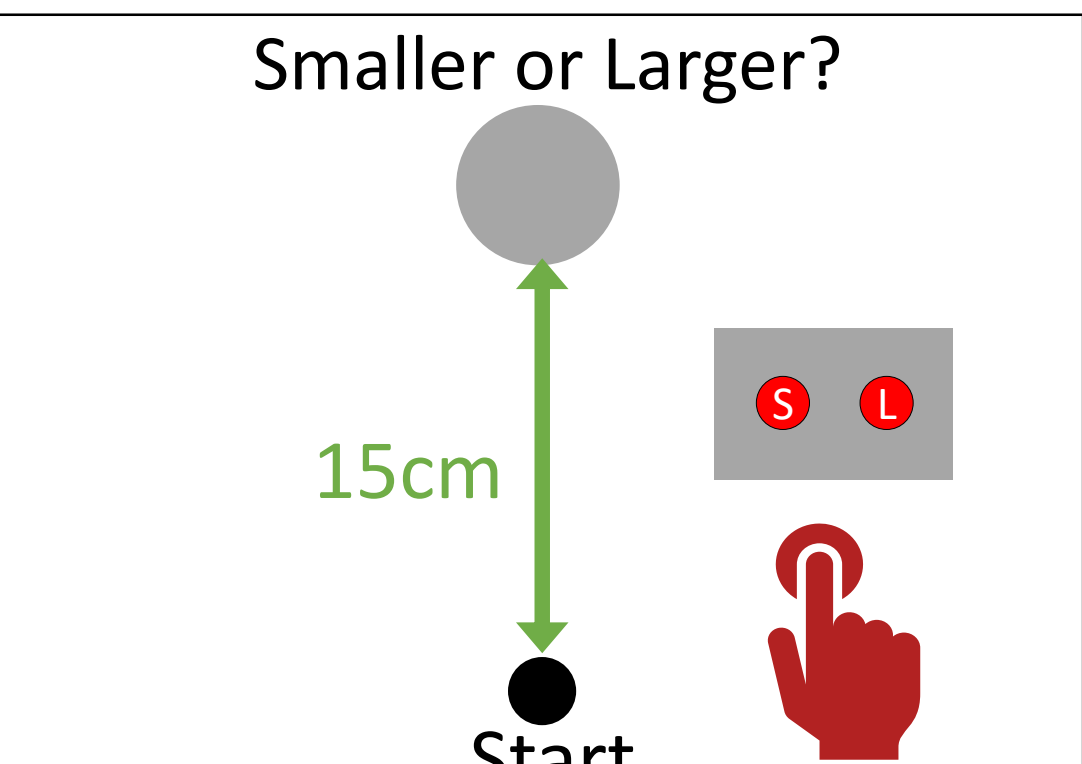
n=13

High accuracy in perceptual judgement may be due to two discs presented simultaneously.

New control perception task with only one disc comparable to grasping / manual estimation in main experiment ($n = 48$).

Control Task

Smaller or Larger?



Estimate size of disc using index finger and thumb as accurately as possible. Estimates are measured.

REFERENCES

Ganel, T., Freud, E., Chajut, E., & Algom, D. (2012). Accurate visuomotor control below the perceptual threshold of size discrimination. *PLoS ONE*, 7(4).

Goodale, M. A., & Milner, A. D. (1992). Separate visual pathways for perception and action. *Trends in Neurosciences*, 15(1), 20-25.

Cohen, J. (1983). The Cost of Dichotomization. *Applied Psychological Measurement*, 7(3), 249-253.

Meyen, S., Zerweck, I. A., Amado, C., von Luxburg, U., & Franz, V. H. (2022). Advancing research on unconscious priming: When can scientists claim an indirect task advantage? *JEP:General*, 151(1), 65-81.

Göhringer, F., Löhr-Limpens, M., Hesse, C., & Schenk, T. (2019). Grasping Discriminates between Object Sizes Less Not More Accurately than the Perceptual System. *Vision*, 3(3), 36.

Heath, M., Ayala, N., Hamidi, M., & Tari, B. (2022). Distinct visual resolution supports aperture shaping in natural and pantomime-grasping. *Canadian Journal of Experimental Psychology*, 76(1), 22-28.

Meyen, S., Vadillo, M. A., von Luxburg, U., & Franz, V. H. (2024). No evidence for contextual cueing beyond explicit recognition. *Psychonomic Bulletin and Review*, 31(3), 907-930.

FUNDING

Funded by the Deutsche Forschungsgemeinschaft – Project 381713393 (Research Unit 2718: Modal and Amodal Cognition) and Machine Learning Cluster of Excellence, EXC 2064/1 – Project 390727645 (VF).



POSTER PDF

