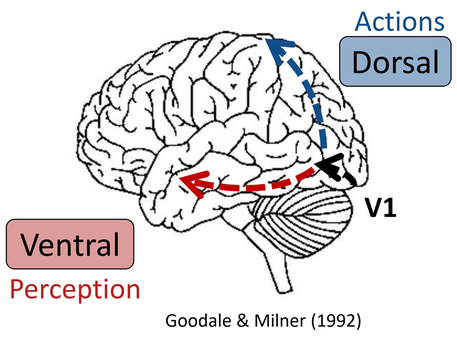
Evaluating Perception-Action Dissociations From Three Behavioural Paradigms

Kriti Bhatia[1], Angela Osenberg[1], Christian Löwenkamp[2], Tanja Huber [1], Frederic Göhringer[3], Thomas Schenk[3], Markus Janczyk[4], Volker H. Franz[1]

[1]*University of Tübingen* [2]*University of Hamburg* [3]*LMU Munich* [4]*University of Bremen*

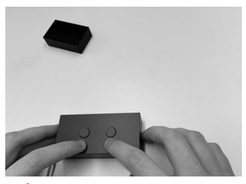
E-mail: kriti.bhatia@uni-tuebingen.de

Perception-Action Model



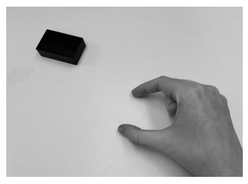
Goodale & Milner (1992)

The Perception-Action Model (PAM) assumes that visual information is processed and represented differently in the ventral and dorsal streams for perception and action respectively. It was proposed based on perception-action double dissociations in brain lesion patients.

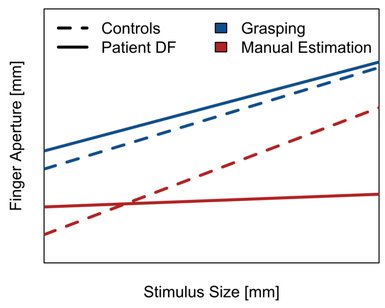


Classic Perception (speeded-classification, adjustment, judgement)

Precision Grasping



Manual Estimation



Validating PAM beyond patients requires demonstrating dissociations in healthy humans. Classic perception tasks are typically compared to precision grasping, but differing task demands prevent meaningful comparisons. Manual estimation seems to rely on perceptual representations but has similar demands as grasping.

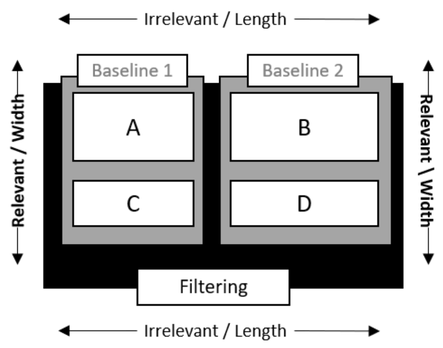
DF (ventral stream lesion) could scale grasps to object size but not estimates; control subjects scale both (Goodale et al., 1991).

Here we evaluate three experimental paradigms where perception-action dissociations were initially reported: **Weber's law**, **Garner interference** and **visual size resolution.**

In contrast, we find no dissociation between grasping and manual estimation (similar to visual illusions, Kopiske et al., 2016).

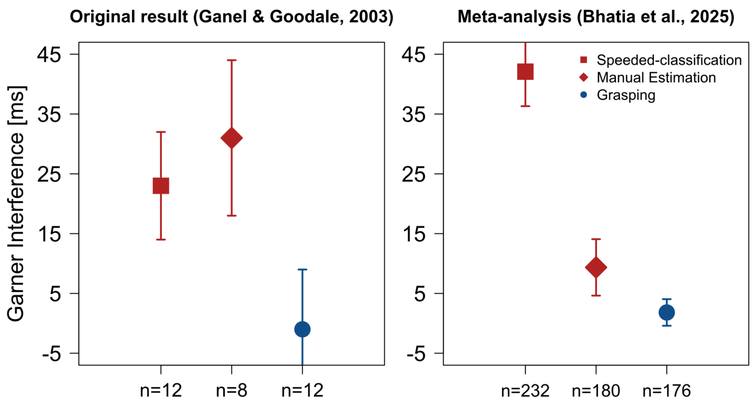
Garner Interference

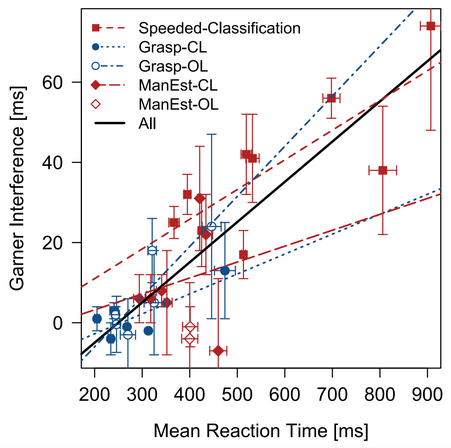
Stimuli & Conditions



Ganel and Goodale (2003) showed an apparent perception-action dissociation in Garner interference. In Garner's task, participants have to classify stimuli like rectangular blocks along one dimension (e.g., width) while ignoring the other dimension (e.g., length). Participants are faster (lower reaction time, RT) when only the width changes (baseline) compared to when both length and width are changing (filtering).

This RT difference Filtering – Baseline is Garner interference. Ganel and Goodale (2003) initially reported larger Garner interference in speeded-classification and manual estimation than in grasping.

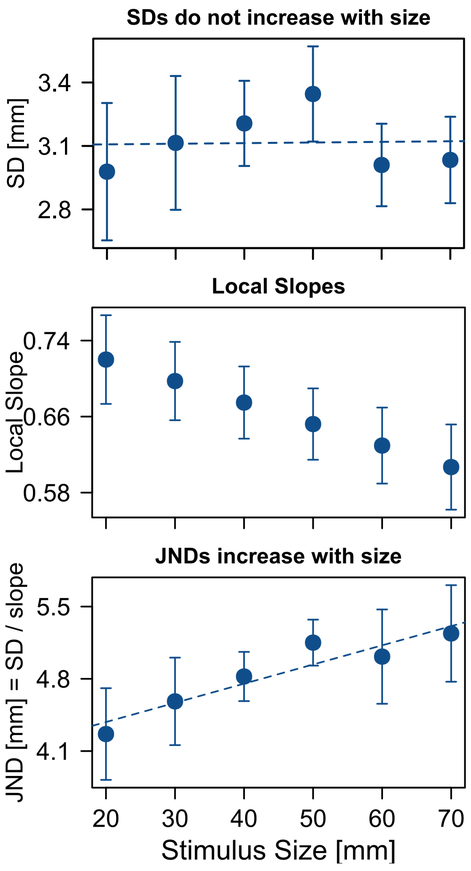




However, a meta-analysis of >15 studies revealed that the effect in manual estimation and grasping was very similar.

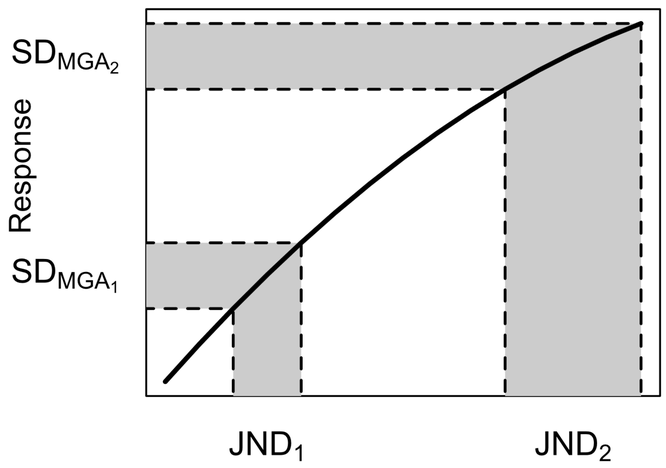
Rather than attributing different magnitudes of Garner interference in those tasks to ventral or dorsal streams, they can be more parsimoniously explained by the differing mean RT in those tasks, overall $r = 0.83$.

Weber's Law



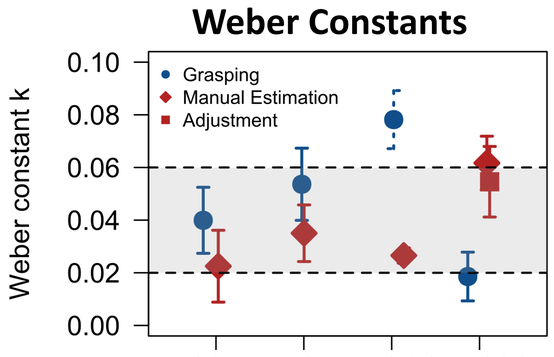
Ganel et al. (2008) reported that Weber's law was violated in grasping. An ubiquitous psychophysical principle (holds for perception), it states that the just-noticeable-difference (JND) increases with stimulus magnitude. Ganel et al. (2008) found that standard deviation of the maximum grip aperture (SD_{MGA}) did not increase with grasped-object size.

Non-linear grasping response function

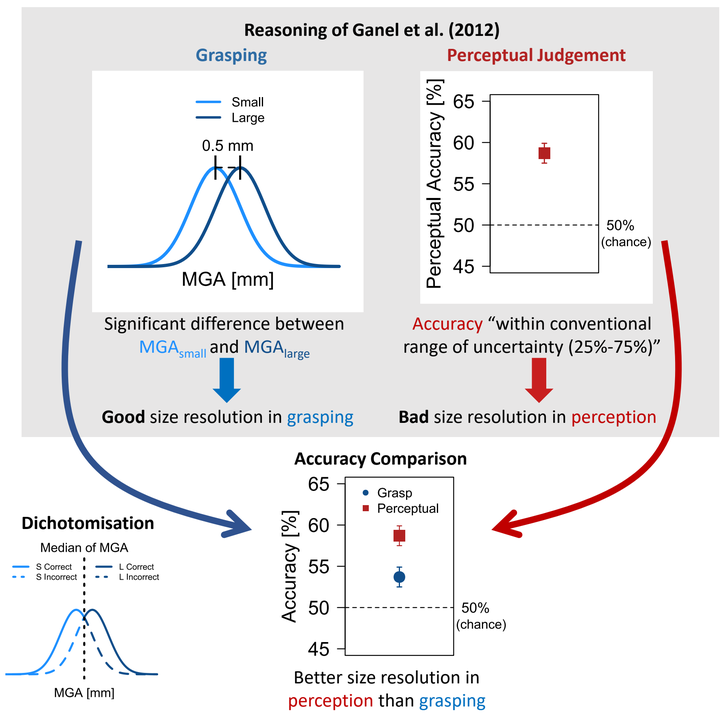


However, the grasping response function is non-linear and we show that the JNDs can increase with size even when SD_{MGA} does not. We also show that JND can be estimated by dividing the SD_{MGA} by the local slope at each size. This analysis applied to four studies results in meaningful Weber constants for grasping, manual estimation and perceptual adjustment within a range expected from studies on size perception.

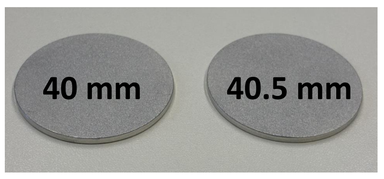
Weber Constants



Visual Size Resolution



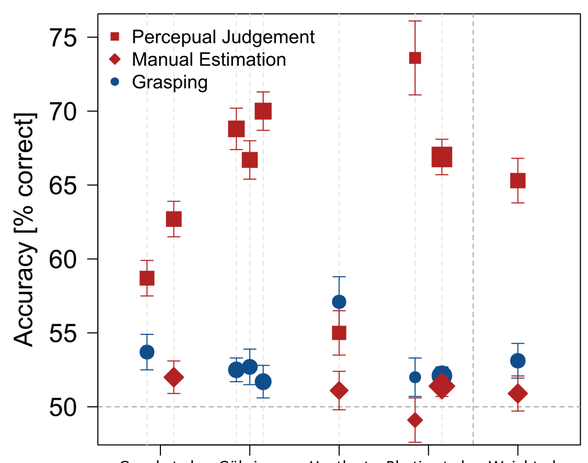
Ganel et al. (2012) claimed that grasping has better size resolution than perceptual judgement. Participants were asked to grasp or judge the size of two discs. The MGAs for small and large discs were significantly different (about 0.5 mm) but the judgement accuracy was poor (59%).



Stimuli: discs of diameters 40 mm and 40.5 mm and 2 mm thick.

Different dependent variables were compared for grasping and judgement, leading to problematic inferences. Meyen et al. (2022) showed that a significant difference in a continuous variable (e.g. MGA or RT) can still result in poor classification accuracy. We dichotomised MGAs (with an optimal classifier, median) to accuracy for a fair comparison. Across four studies with multiple experiments, we found that grasping was less accurate than perceptual judgement, but similar to manual estimation.

Meta-analysis



References

Goodale, M.A., & Milner, A.D. (1992). *Trends in Neurosciences.*
Goodale, M.A., Milner, A.D., Jakobson, L.S., & Carey, D.P. (1991). *Nature.*
Kopiske, K.K., Bruno, N., Hesse, C., Schenk, T., & Franz, V.H. (2016). *Cortex.*
Ganel, T., & Goodale, M.A. (2003). *Nature.*
Bhatia, K., Osenberg, A., Janczyk, M. & Franz, V.H. (2025). *JEP: Human Perception and Performance.*
Ganel, T., Chajut, E., & Algom, D. (2008). *Current Biology.*
Bhatia, K., Löwenkamp, C., & Franz, V.H. (2022). *Journal of Vision.*
Ganel, T., Freud, E., Chajut, E., & Algom, D. (2012). *PLoS ONE.*
Cohen, J. (1983). *Applied Psychological Measurement.*
Franz, V.H. & von Luxburg, U. (2015). *Psychological Science.*
Meyen, S., Zerweck, I.A., Amado, C., von Luxburg, U., & Franz, V.H. (2022). *JEP: General.*
Bhatia, K., Huber, T., Osenberg, A., Göhringer, F., Schenk, T., Janczyk, M., Franz, V.H. (2025). *Manuscript in preparation.*

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