CNB Annual Meeting 2022

UNIVERSITÄT BERN

# Motor imagery facilitates spatial memory – Insights from a novel kinesthetic VR-based task

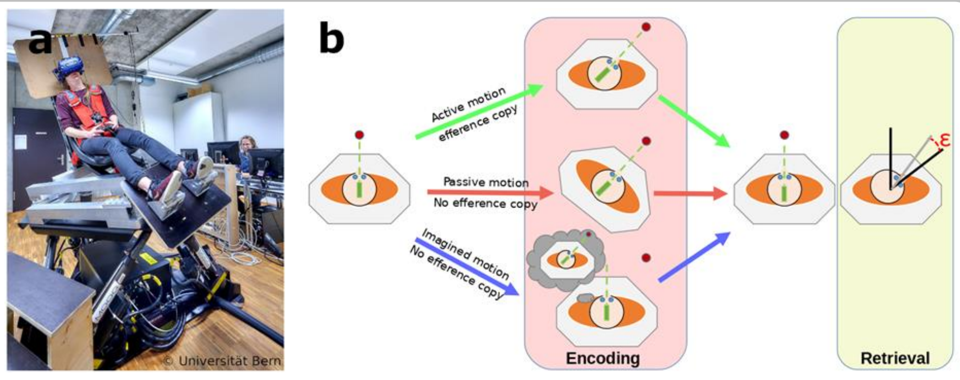
**Gerda Wyssen[1], Fred W. Mast[1], Matthias Ertl[1]**

[1]Department of Psychology, University of Bern, Bern

## Background

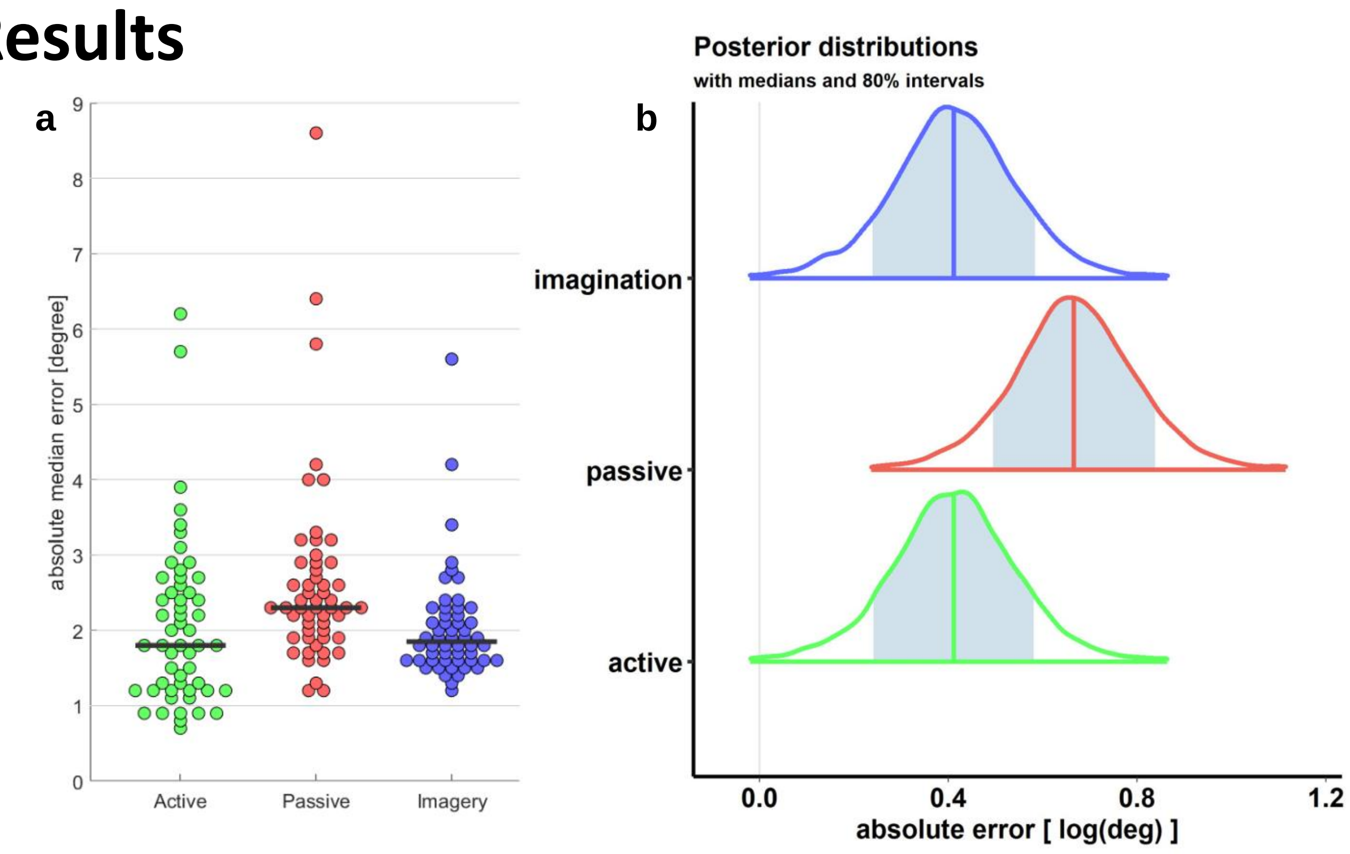
The term spatial memory refers to stored information regarding the location of objects or the self in three-dimensional space. The importance of vestibular input for spatial memory is widely disregarded despite compelling evidence [1,2]. It is known that efference copies, elicited by a self-caused action, can increase performance in spatial memory tasks. A recent study on motor imagery and touch suggested a functional equivalence between imagined and executed movements [3] and proposed that efference copies are also created during motor imagery.

## Methods



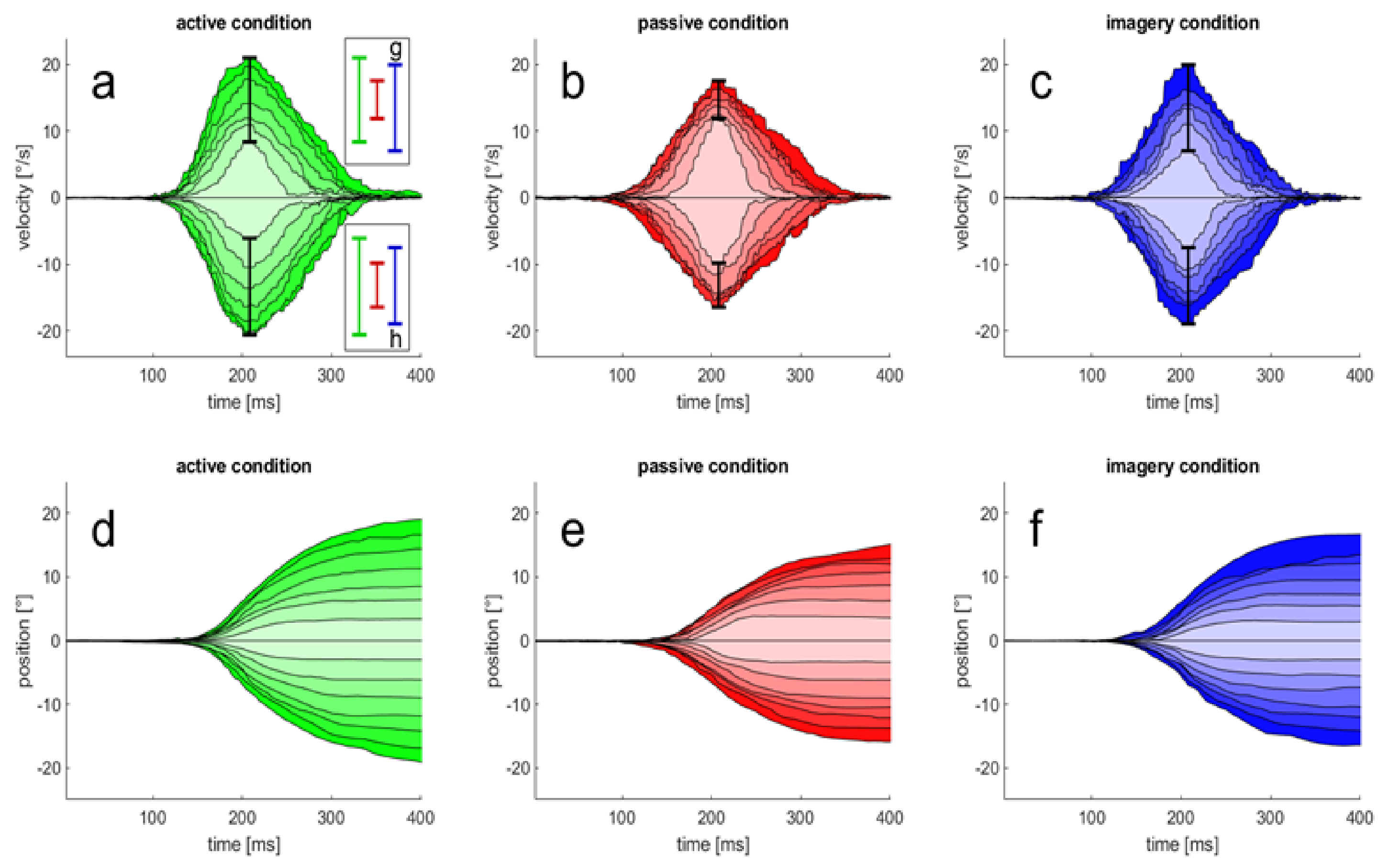

55 participants (39 females, 16 males, mean age: 22.4 years, SD: 3.4 years) were included in the study. Visual stimuli were presented via a VR-headset, equipped with accelerometers. Passive motions were performed by a motion platform **(a)**. Participants were asked to encode a target position in three different encoding conditions (*active*, *passive*, and *imagery*). The retrieval was always performed by an active head rotation and the positioning error was measured **(b)**. The experiment was implemented using PlatformCommander [4] and data were analyzed using Bayesian regression models.

## Results




Visualization of the absolute errors per condition **(a)**. Each dot represents the median error of one participant. **(b)** Result of the Bayesian regression model. The credible interval of the *passive* condition does not contain the zero, indicating a meaningful difference compared to the *imagery* and *active* conditions.

Visualization of the head velocity **(a-c)** and the head position **(d-f)** over time. Peak velocities showed a reduced range **(g,h)** with larger peak velocities for small target angles but smaller peak velocities for large target angles in the *passive* compared to the *active* and *imagery* condition.




## Discussion

We have found that imagining a head rotation, without performing it during encoding, leads to similar performance as an actively performed head rotation and to better performance compared to the *passive* condition. In the *passive* condition, no motor commands are prepared and conveyed to the muscles, hence no efference copy is generated, and vestibular information is the only information related to self-motion. It has been theorized that during imagery sensory information is simulated internally by means of corollary discharge [4]. Our study provides first empirical evidence of a specific influence of corollary discharge on spatial memory. The most plausible explanation for the smaller variance in peak accelerations in *passive* condition is that the participants incorporated the velocity properties into their head rotations. Due to the technical limitations of the motion platform, it is impossible to match the peak velocities occurring during *active* head rotations for large target angles.

**References**

**[1]** F. W. Mast, N. Preuss, M. Hartmann, und L. Grabherr, „Spatial cognition, body representation and affective processes: the role of vestibular information beyond ocular reflexes and control of posture", Frontiers in Integrative Neuroscience, Bd. 8, Nr. May, S. 1–14, 2014, doi: 10.3389/fnint.2014.00044 **[2]** T. Brandt, M. Strupp, und M. Dieterich, „Towards a concept of disorders of "higher vestibular function"", Frontiers in integrative neuroscience, Bd. 8, Nr. June, S. 1–8, 2014, doi: 10.3389/fnint.2014.00047. **[3]** K. Kilteni, B. J. Andersson, C. Houborg, und H. H. Ehrsson, „Motor imagery involves predicting the sensory consequences of the imagined movement", Nat Commun, Bd. 9, Nr. 1, S. 1617, 24 2018, doi: 10.1038/s41467-018-03989-0. **[4]** M. Ertl, C. Prelz, D. C. Fitze, G. Wyssen, und F. W. Mast, „Manual PlatformCommander Version 0.9". Zenodo, 30. November 2021. doi: 10.5281/zenodo.5743201. **[5]** D. Subramanian, A. Alers, und M. A. Sommer, „Corollary Discharge for Action and Cognition", Biological Psychiatry: Cognitive Neuroscience and Neuroimaging, S. 1–9, 2019, doi: 10.1016/j.bpsc.2019.05.010.

Contact Preprint

Videos gitlab