MOTION PERCEPTION BY A MOVING OBSERVER

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INTRODUCTION

Most motion-sensitivity studies are performed with observers sitting in darkened rooms, often constrained by forehead support or/and a chinrest. This results in a typical motion sensitivity curves as displayed here. This is fine if one is interested in the front-end sensitivity of motion system. However, it has become increasingly clear that vestibular input plays a role in motion perception (e.g. Davidson, Verstraten & Alais, Nature Communications, 2024).

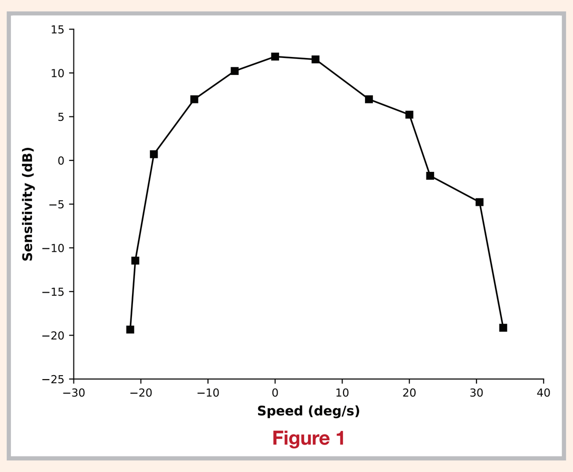


Figure 1

GOAL

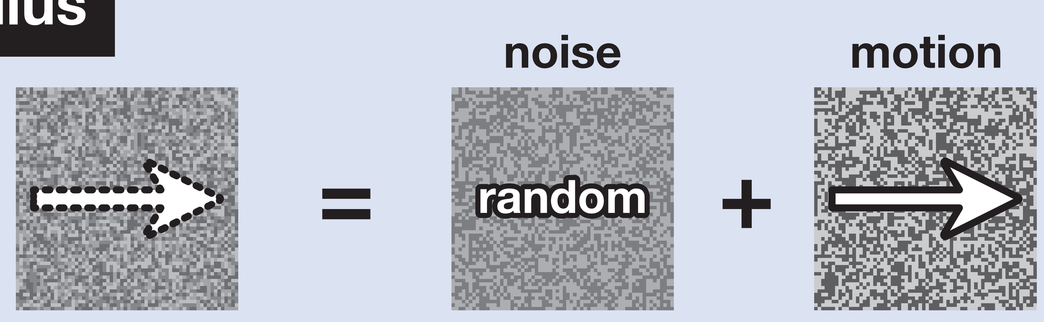
TO INVESTIGATE HOW VESTIBULAR SIGNALS IMPACT VISUAL MOTION SENSITIVITY.

METHOD

Here, we have observers perform a directional motion discrimination task (2AFC) while the participants are being moved on a motion platform. To make sure the vestibular system is active, the motion platform is accelerating when the task is performed.

The stimulus is a moving Random Pixel Array (RPA). We use a Signal-to-Noise paradigm (see Fredericksen et al. VisRes, 1993), where random pixel noise is added when the observer indicates the correct motion direction 3 times in a row. A single mistake decreases the noise level, resulting in a threshold of 79% correct.

Stimulus



Experiment Setup

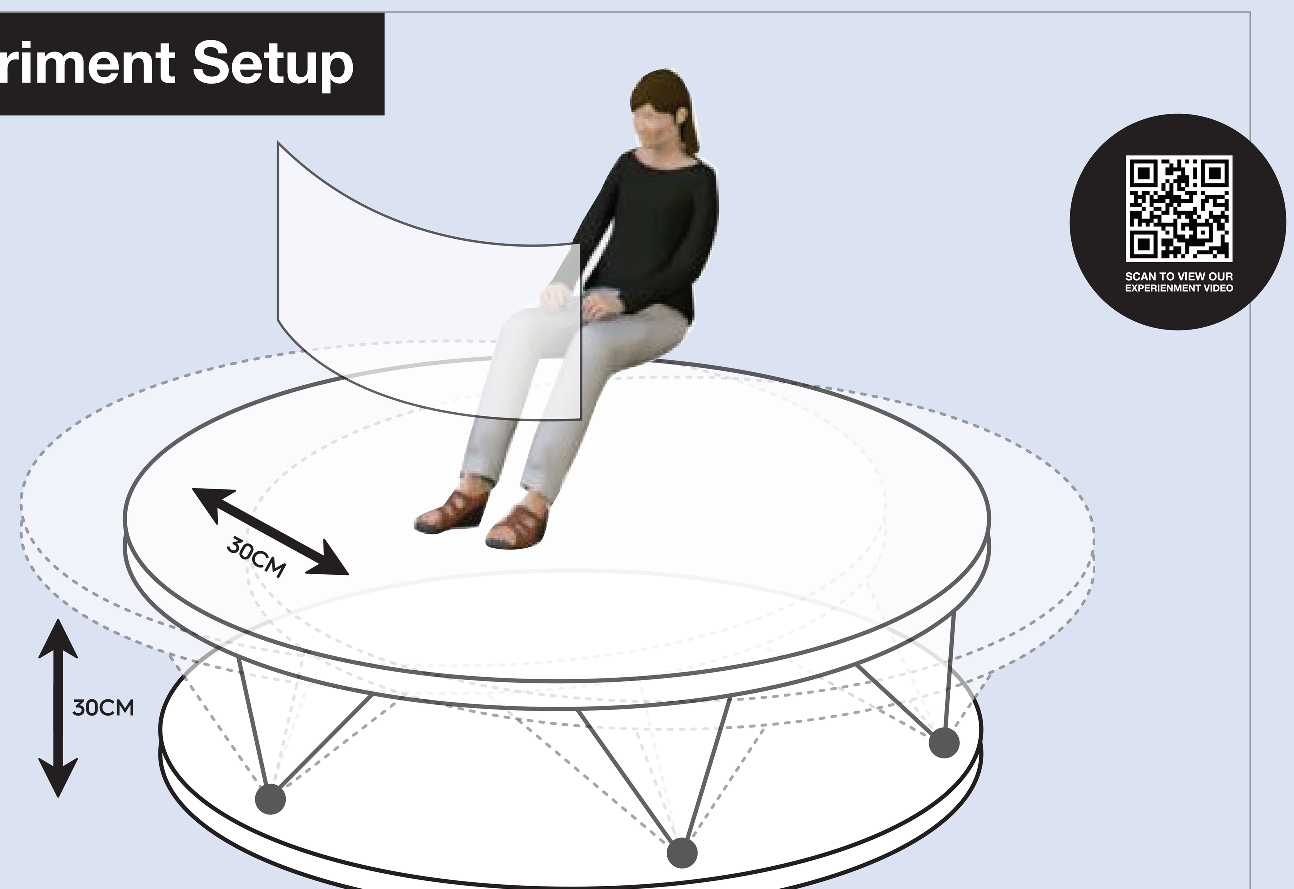


Figure 2

There are 3 conditions, where the motion platform is stationary, moving in the same direction as the motion on the display, or in the opposite direction. A staircase procedure is applied (6 turning points where the average of the last 5 is calculated as the threshold value (for an example see Figure 3). See Figure 4 for one observer, where we highlight the 1 deg/s performance for the three conditions.

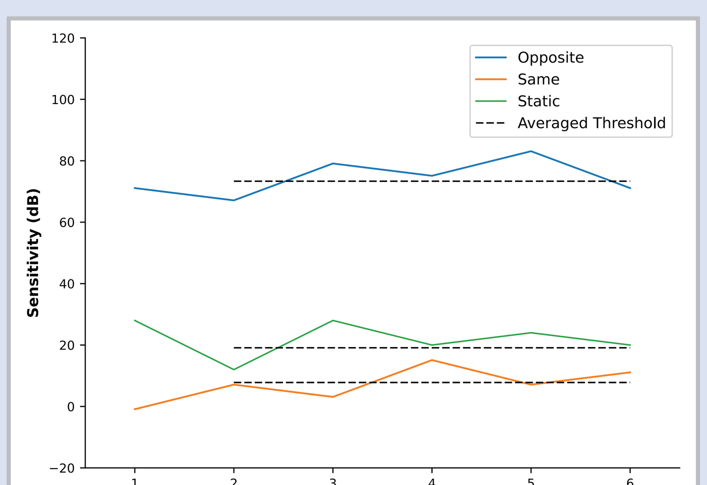


Figure 3

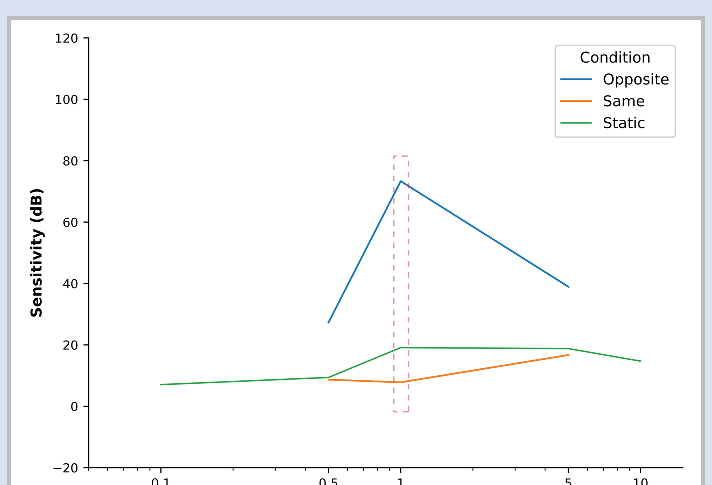


Figure 4

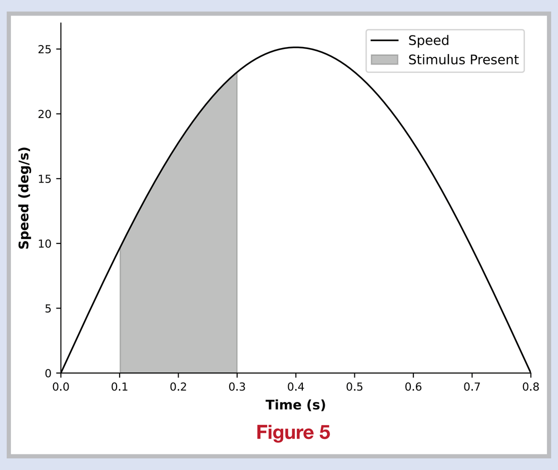


Figure 5

Based on the individual motion sensitivity curve under static conditions (see intro) for which we used 5 speeds, 3 stimulus speeds were selected for the moving conditions. For the moving conditions the motion platform was accelerating between 10 and 23 deg/s (see Figure 5).

RESULTS & DISCUSSION

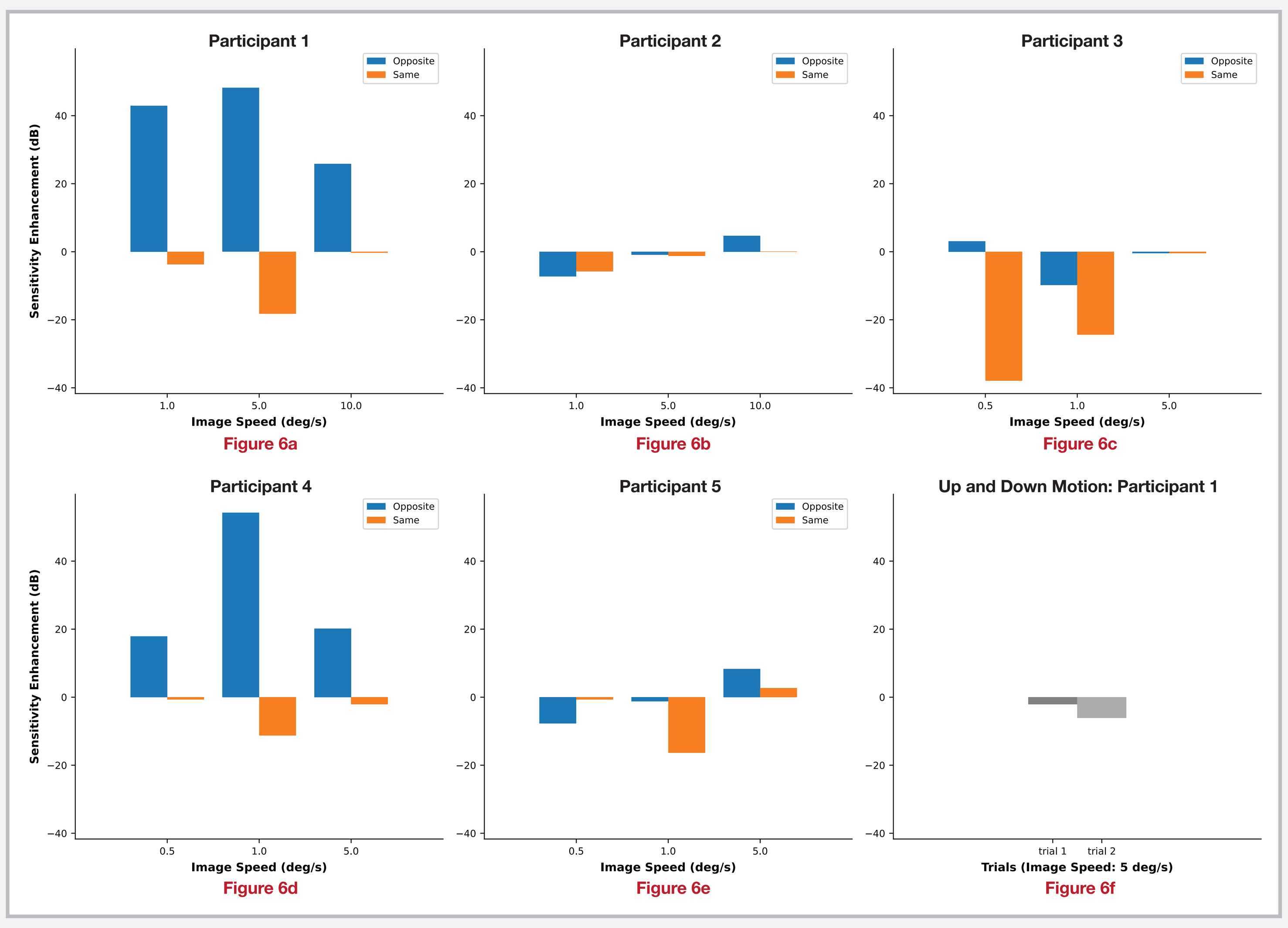


Figure 6a Figure 6b Figure 6c Figure 6d Figure 6e Figure 6f

In the graphs we represent the normalised data for 5 individual observers. We plot the difference between the stationary thresholds and the moving thresholds for the same and opposite direction. The results overall show that the motion sensitivity in the conditions the observer is being moved is higher when the movement on the display is opposite of that of the platform. When they move in the same direction the performance is worse as compared to the stationary condition.

As a control, we repeated the experiments for one observer while the observer was moving up and down and the results are shown in Figure 6f. In short, there is no effect of being moved up/down for motion sensitivity in the left/right direction.

CONCLUSIONS

- Vestibular input has a clear effect on motion sensitivity and is redirectionally relevant.
- It is therefore tempting to suggest that motion sensitivity is not determined by front-end motion sensors as such, but is the result of the integration of several sensory entities.

References: Davidson, M., Verstraten, F.A.J. & Alais, D. (2024). Walking entrains unique oscillations in performance on a visual detection task. Nature Communications, 15, 2027. https://doi.org/10.1038/s41467-024-45780-4 Fredericksen, R.E., Verstraten, F.A.J., & van de Grind, W.A. (1993). Spatio-temporal characteristics of human motion perception. Vision Research, 33, 1193-1205.

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