Flash Localization in the Vicinity of a Moving Object

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Introduction

The perceived location of a stationary object is affected by the presence of a nearby motion [1, 2, 3].

When two visual probes are flashed at the same location inside a moving frame, they appear widely separated [4, 5]. In this "frame effect", their separation is not judged relative to the world, but relative to their positions in the frame when they flashed.

Here, we examine three components of the frame effect:
1) Number of frame's back-and-forth motion repetitions
2) Number of probes
3) Spatial extent of the frame's influence

Method

In the experiments below, we asked the participants to note the location of one or both dots that flashed while a frame (outline square) moved. After the frame's motion ended, participants had to report the perceived location of the one or both dots by mouse click.

Conclusion

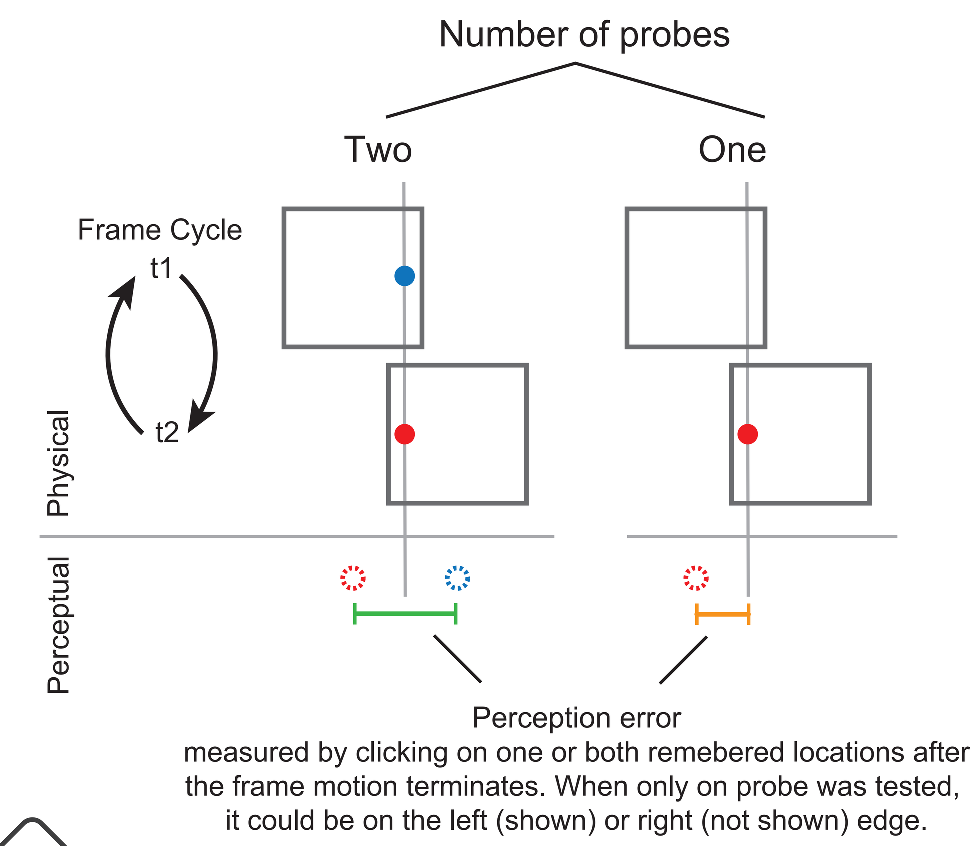
The separation seen between two flashes is approximately the sum of the shifts induced on each dot when presented alone.

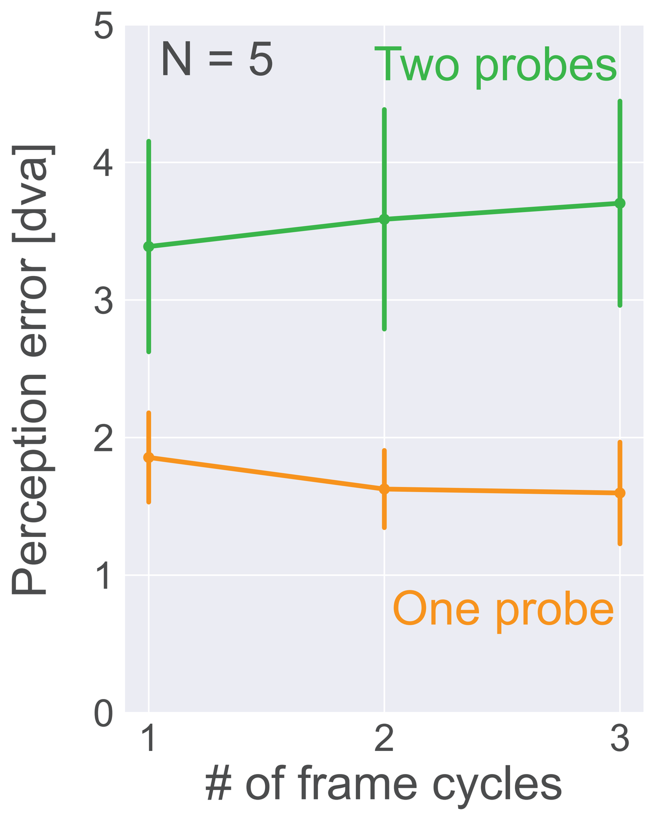
For the unidirectional frame motion, the shift at motion onset is in the direction of motion and larger than the shift, and the shift at motion offset is in the direction opposite to the motion.

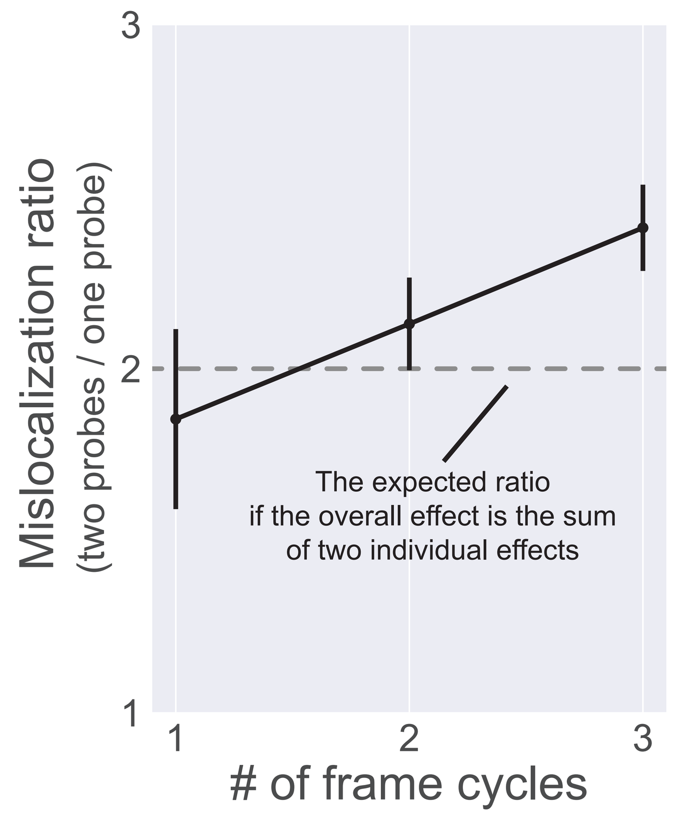
A continuously moving frame shifts probes presented ahead of it but not those presented behind it.

Exp. 1

Number of Repetitions and Probes







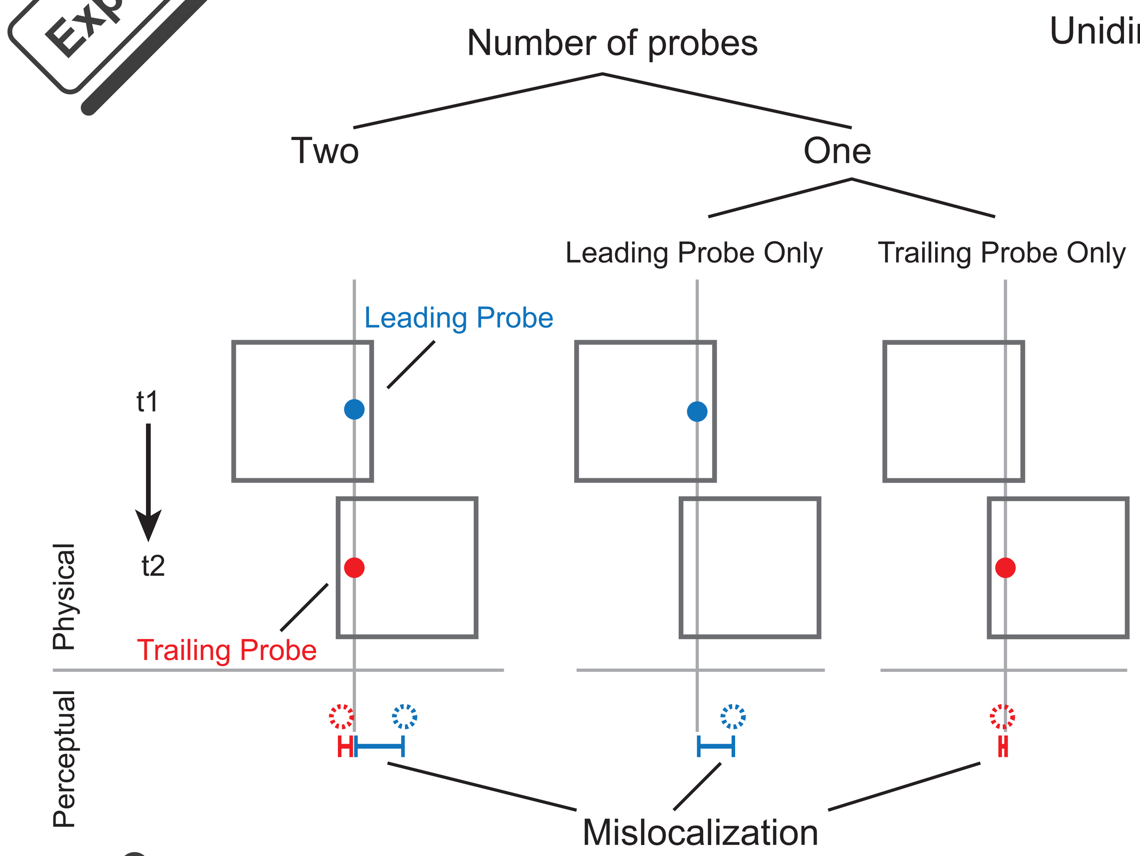
Does the number of repetitions and number of probes affect the mislocalization size?

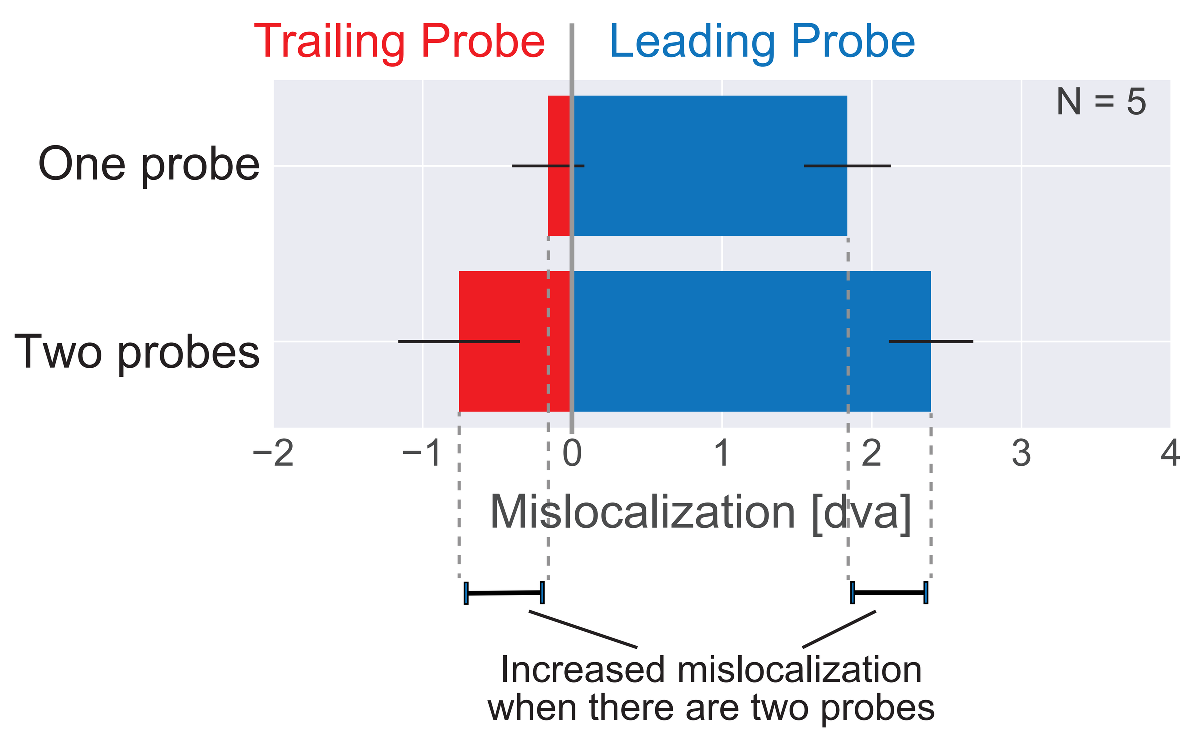
The relative spacing between two probes, measured independently, is approximately the sum of the shifts seen for each probe tested alone.

However, there is an effect of the number of back-and-forth cycles: the ratio between the one and two probe shifts increases with the number of frame cycles.

Exp. 2

Unidirectional Motion





Unidirectional motion: Does the appearance of the second probe affect the mislocalization of the first probe?

Here, the frame moves once along its path with probes presented at the start of the motion, at the end, or both.

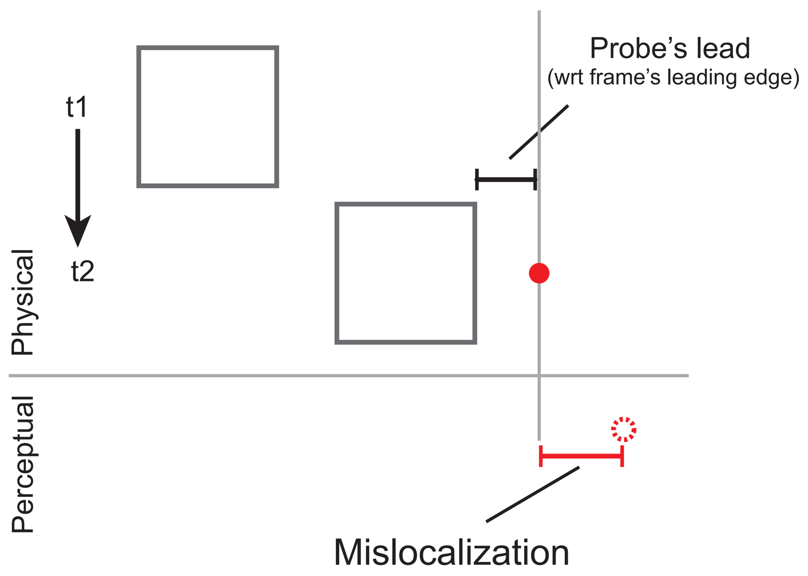
The mislocalization of the flashed probes is larger for the leading probe (flashed at motion onset) than for the trailing probe (flashed at motion offset).

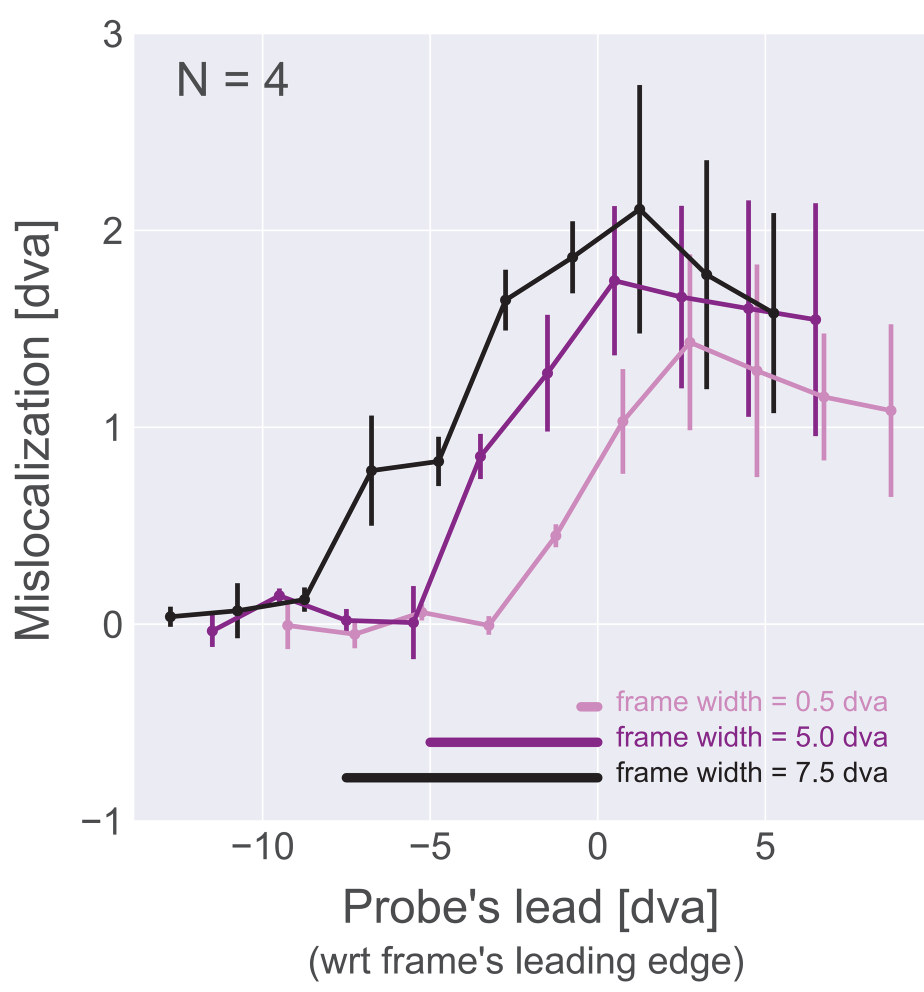
Probes flashed close to the leading edge are shifted in the direction of motion; probes flashed close to the trailing edge shift in the opposite direction by a smaller amount.

The size of mislocalization for the two-probe condition is larger than for the one-probe condition. This may be a perceptual effect or a memory effect when two responses are required.

Exp. 3

Continuous Motion (Single Flash)





What is the spatial profile of the mislocalization for a single flash in the vicinity of a continuously moving frame?

Here, the frame moves continuously in one direction and a single probe is presented at different locations relative to the frame.

Probes that flash ahead of the moving frame shift in the direction of the moving object and it gradually becomes zero as the probe flashes close to the trailing edge of the moving object.

This suggests that the small mislocalization seen for the probe near the trailing edge in Exp. 2 above cannot be caused by the motion offset as in this continuous motion case, the frame kept moving after the flash near its trailing edge.

The mislocalization increases as the frame size increases.

For the two larger frames, the highest mislocalization takes place when the probe flashed at the leading edge of the moving object and it is zero when it appears at the trailing edge. For the smallest frame though, the largest and smalles mislocalization take place beyond the physical extent of the object.

Further Reading

1. Motion distorts visual space: shifting the perceived position of remote stationary objects
Whitney, Cavanagh (2000, Nature)

2. The flash grab effect
Cavanagh, Anstis (2013, Vision Research)

3. Motion extrapolation in catching
Nijhawan (1994, Nature)

4. Paradoxical stabilizatoin of relative position in mvoing frames
Özkan, Anstis, 't Hart, Wexler, Cavanagh (2021, PNAS)

5. Exploring the frame effect
Cavanagh, Anstis, Lisi, Wexler, Maechler, 't Hart, Shams-Ahmar, Saleki (2022, Journal of Vision)

Additional Information

General:
Monitor: iMac24 (2240 x 1260)
Stimulus control: Python 3.8; Psychopy 2022.1.4
Background color: normalized gray level = - 0.8
Frame edge color: white
Probe radius: 0.5 dva

Exp. 1:
Frame width: 7.5 dva
Path length: 6 dva
Cycle duration: 866 ms

Exp. 2:
Frame width: 7.5 dva
Path length: 6 dva
Path duration: 433 ms

Exp. 3:
Path length: 20 dva
Path duration: 1433 ms

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