Principles of audiovisual integration in 3-D space

Inverse effectiveness and spatial alignement in depth

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Background

Multisensory interactions have mainly been investigated in one plane of depth. Whereas there is a growing amount of evidence that the location of multisensory stimuli in depth influences multisensory interactions, previous studies have mainly focused on the *temporal* aspects of multisensory perception in depth. We investigated two well-known principles in the field of multisensory integration in 3-D space: the principle of inverse effectiveness and the principle of spatial alignment.

Inverse Effectiveness

- Stimulus intensity can decrease as a function of distance. We investigated whether there is a preference of the brain to integrate weak stimuli at larger distances compared to close distances.
- We compared the influence of decreases in stimuli intensity on multisensory integration with and without an increase in the distance between the stimuli and the observer.

Spatial Alignment in Depth

- The principle of spatial alignment has often been investigated in azimuthal space. Support for this principle is often observed in spatial tasks (Spence, 2013). It is unclear, however, whether alignment in depth is important for audiovisual integration.

Methods

- A, V, and AV Targets were presented in near space or far space (Exp 1) and were randomly presented at one of three locations: left, center, or right.
- V targets were presented in near space, A targets were presented in near or far space. AV targets could be aligned/misaligned in azimuth and depth (Exp 2).
- Participants were instructed to respond to lateral targets only.

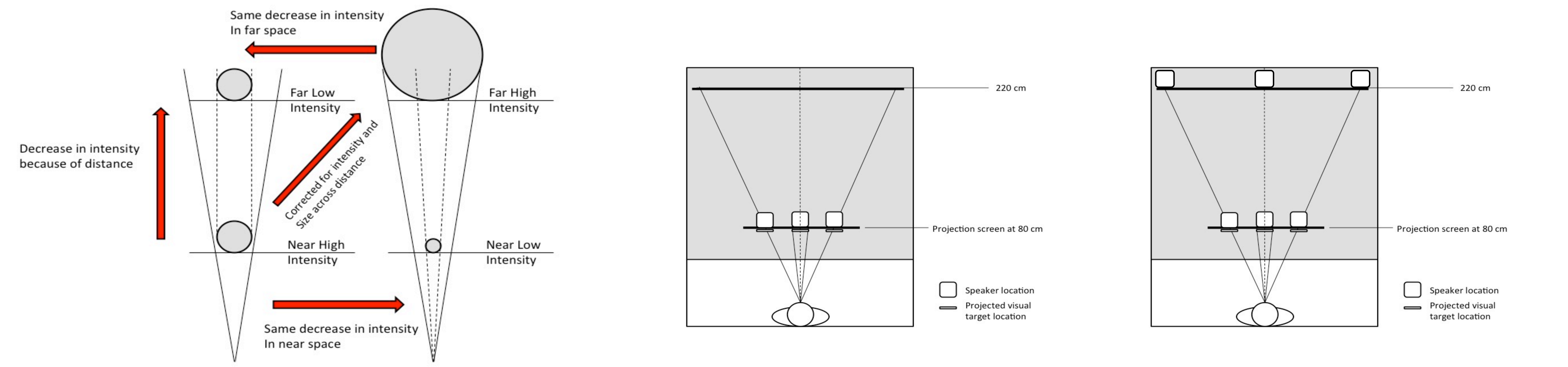

Fig 1. Left: Schematic representation of the intensity conditions in the experiment. Center: A bird's-eye view of the experimental setup of the near space condition of Experiment 1. In the far space condition, stimuli were presented at 220 cm. Right: Bird's-eye view of the experimental setup of Experiment 2.

Table 1.
Retinal image size and Intensity of stimuli in each condition of Experiment 1

	High Intensity	Low Intensity
Near Space	3 x 3˚, 6.6 cd/m², 70 dB(A)	1.2 x 1.2˚, 2 cd/m², 60 dB(A)
Far Space	3 x 3˚, 6.6 cd/m², 70 dB(A)	1.2 x 1.2˚, 2 cd/m², 60 dB(A)
Background	1.3 cd/m²	1.3 cd/m²

Experiment 2

- Visual targets: 2.8 x 2.8˚, 6.4 cd/m2.
- Auditory targets: Near and far 60dB(A) (corrected for intensity changes across distance).
- Participants were instructed to respond to lateral targets only.

Results

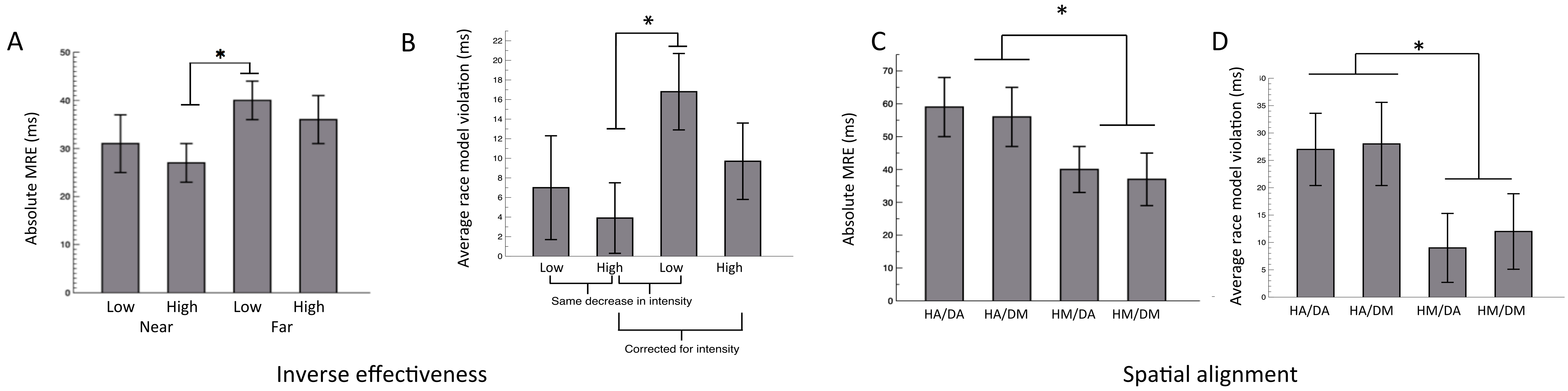

Fig 2. A: Absolute MRE in each condition of Experiment 1. B: Average race model violation in each condition of Experiment 1. C: Absolute MRE in each alignment condition of Experiment 2. D: Average race model violation in each condition of Experiment 2. HA = Horizontally Aligned, DA = Depth Aligned, HM = Horizontally Misaligned, DM = Depth Misaligned. Significant differences are indicated with an asterisk (*p* < .05).

- Absolute MRE was observed in all conditions (Exp. 1 & 2).
- A decrease in intensity only caused more audiovisual integration when this decrease in intensity was accompanied by an increase in distance (Exp. 1).
- Only the particular alignment of stimuli in azimuth influenced the amount of absolute MRE and race model violation, not their alignment in depth (Exp. 2).

Discussion

- Audiovisual integration followed the principle of inverse effectiveness, but only across distances, not at the same distance.
- Audiovisual integration followed the principle of spatial alignment in azimuth, but not in depth, when azimuthal space was task-relevant.
- These findings indicate that the location of multisensory stimuli in depth is an important factor that modulates multisensory integration through changes in spatial, temporal, and stimulus properties that may differ from changes in these properties in one plane of depth.

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