Reflexive attention & audiovisual integration

Exogenous auditory cues decrease audiovisual integration of simple lights and sounds

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Background

Both reflexive attention and multisensory integration are processes that can decrease detection times of simple lights and sounds (Spence, 2010; Stevenson et al., 2012). In previous studies, the interaction between voluntary attention and audiovisual integration has been extensively investigated (for a review see Talsma et al., 2010). These studies indicate that voluntary attention is able to enhance audiovisual integration. Yet, little attention has been given to the interaction between reflexive attention and audiovisual integration. These types of attention appear to be different mechanisms (Berger, Henik, & Rafal, 2005) and may therefore influence audiovisual integration in different ways.

Research Question

Bottom-up attention and audio-visual integration are both stimulus-driven and it is unclear how they interact. If reflexive attention is able to enhance audiovisual integration (like voluntary attention), then its effect should be stronger for attended compared to the unattended locations and when no location is cued.

Methods

A group of 24 healthy volunteers participated in this study. All had normal or corrected-to-normal acuity and reported no hearing problems. There were 9 conditions: 3 target modalities (Audiovisual, Visual, Auditory) x 3 cue conditions (no cue, valid cue, invalid cue). We blocked target modality in order to avoid inter-trial effects on response time (see Otto & Mamassian, 2012). The order of blocks was counterbalanced across conditions. The three cue conditions were randomly presented within each target modality block. Participants had to press a button as soon as they heard or saw a target stimulus. The setup is shown in Figure 2.

Cue: 65dB, 75 ms, 2000 Hz sinusoid, Visual target: 100 ms, 1˚ x 1˚, 0.93 cd/m^2 (background: 0.64 cd/m^2), Auditory target: 60 dB, 100ms, white noise, N trials/condition: 45 (33% Catch trials)

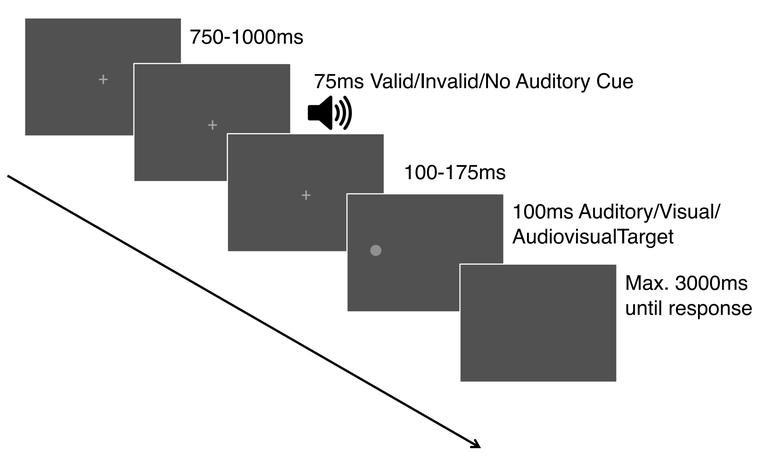

Fig. 1 Schematic representation of the procedure

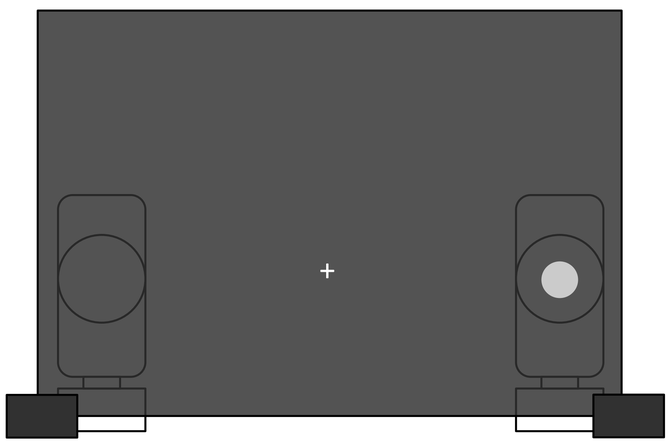

Fig. 2 Schematic representation of the setup. A black projection screen was placed at 80 cm distance from the participant. Targets were projected on the screen with an LCD projector. Auditory cues and targets were presented through loudspeakers placed directly behind the possible target locations.

Results

Analysis

Median response times of correct trials and accuracies in each condition of each participant were analyzed with a repeated-measures ANOVA. We calculated a race-model in each cue condition based on the individual unimodal CDFs and compared it with their respective audiovisual CDFs (Ulrich, Miller, Schröter, 2007) to investigate the amount of audiovisual integration.

Response Times

A repeated-measures ANOVA on RT revealed a significant main effect of Modality and Cue Type, and an interaction between Modality and Cue Type (all $p < .01$). Bonferroni corrected contrasts revealed significant differences between Cue Types in each target modality. Mean RTs in each condition are shown in Figure 2.

CDF Analysis

We compared bimodal CDFs to their respective race-model CDF for each Cue Type and Bonferroni corrected the *p*-values for the number of tests performed in each condition. We observed significant violations of the race-model in the third and fourth bin of the No Cue condition only. The difference between the audiovisual condition and the race-model for each condition is depicted in Figure 3.

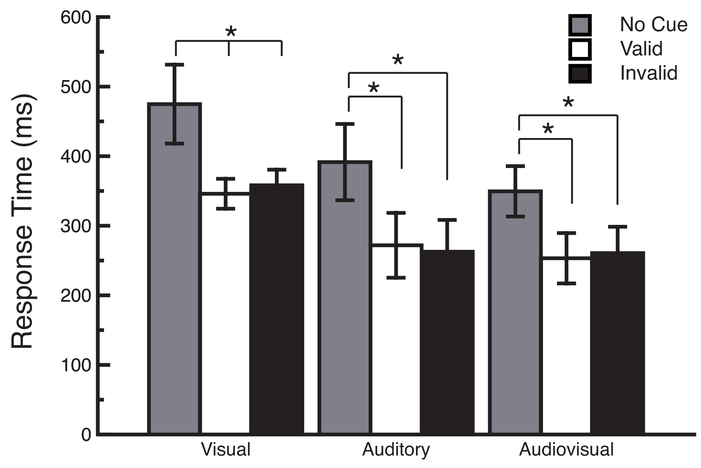

Fig. 3 Response times to unimodal (visual or auditory) and bimodal targets for each cue condition.

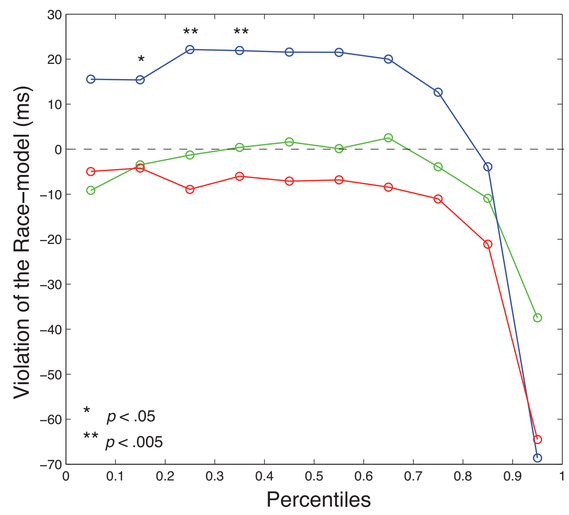

Fig. 4 Violation of the Race-model in milliseconds for each RT bin for the No Cue (blue), Valid Cue (red), and Invalid Cue (green) condition. The dotted line represents the race-model.

Conclusions

- We observed cueing effects for each target modality.
- Audiovisual integration was only found in the No Cue condition.
- Bottom-up attention facilitates audiovisual target detection.
- Bottom-up attention appears to eliminate audiovisual integration.

Discussion

- There was no validity effect: There may be differences in integration between the attended and unattended location when space is made relevant for the response.
- A possible floor effect of RT may have caused the lack of race-model violation in the cued conditions.
- The race-model may be differentially influenced by within/cross-modal cueing effects (see Girard,Pelland, Lepore, & Collignon, 2013).
- Follow-up experiments are planned to address these questions.

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