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WORKING MEMORY FOR VISUAL AND HAPTIC TARGETS: A STUDY USING THE INTERFERENCE PARADIGM

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INTRODUCTION

Working Memory is an outstanding mental resource with limited capacity that temporarily maintains and stores information [1]. Although psychophysical studies demonstrated analogous neural mechanisms for WM across tactile and visual modalities [2], haptic WM is generally more limited and shows more variability than visual WM [3]. In a previous study, we found larger spans for visual than for haptic spatial WM using a dual-task paradigm [4]. In the present study, we tested the hypothesis that haptically encoded information would be more sensitive to interference than visually encoded information. Because spatial and verbal interference tasks produce negative effects on WM [5], we introduced two new non-spatial interference tasks. We predict that spatial interference will impair performance in both modalities, but more in touch than in vision. Moreover, the impairment would be greater when the primary and the interference tasks would be performed using the same perceptual modality. To test these hypotheses, we used a dual-task paradigm with two primary task (visual, haptic) combined with four secondary tasks (auditory, visual-static, spatial-visual, and spatial-haptic).

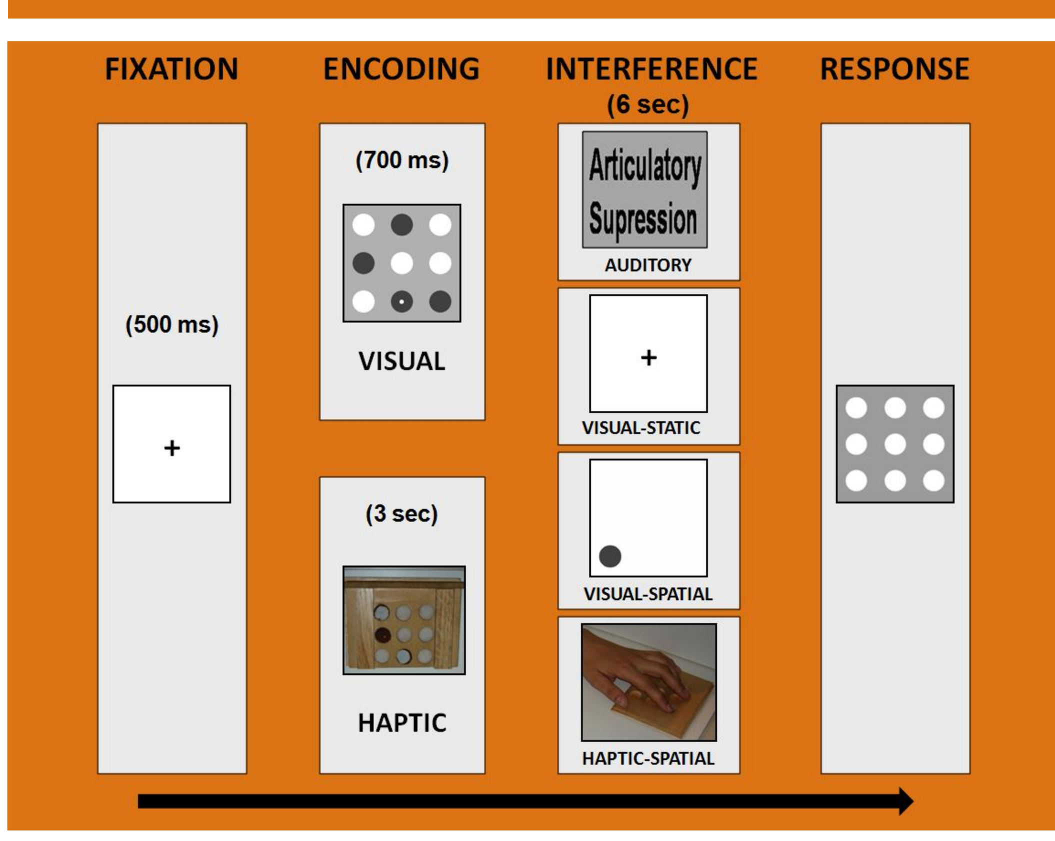
METHODS

Participants. 16 undergraduate students (8 men, 8 women; mean age=28.25; SD=4.57). All had normal or corrected-to-normal vision.

Apparatus and tasks. Two haptic matrices with 9 positions were used to perform the primary and the interference haptic tasks. They were presented behind a haptic device to occlude them from vision. Each trial consisted of two tactile items and a distracter that were created from 1,5cm diameter round cushions. Tactile items were covered with Velcro texture, whereas the distracter had a plastic dot. The visual task was presented on a computer screen. Each trial consisted of three black dots and a black distracter with a white central dot.

Procedure. Each trial began with a fixation cross that appeared at the center of the screen for 500ms, followed by one of the primary tasks. Haptic primary task: participants explored for 3 seconds with the dominant hand the spatial locations of the two targets while ignoring the distracter. Visual primary task: the visual matrix was presented for 700ms. Participants had to remember the position of the black dots while ignoring the distracter. Once the locations were haptically or visually encoded, one of the secondary tasks was performed during a 6 seconds retention interval. Auditory task: consisted of repeating aloud the syllable "la, la, la…" (articulatory suppression). Visual-static task: participants just looked at a fixation cross that appears at the center of the computer screen. Visual-spatial task: participants followed a continuously moving dot on the computer screen. Haptic-spatial task: participants explored continuously an empty matrix with the non-dominant hand. After the retention interval elapsed, participants marked the locations to be remembered on a blank matrix. They performed 4 practice trials and 12 experimental trials in each condition. The order of the primary and secondary tasks was counterbalanced across participants.

PROCEDURE

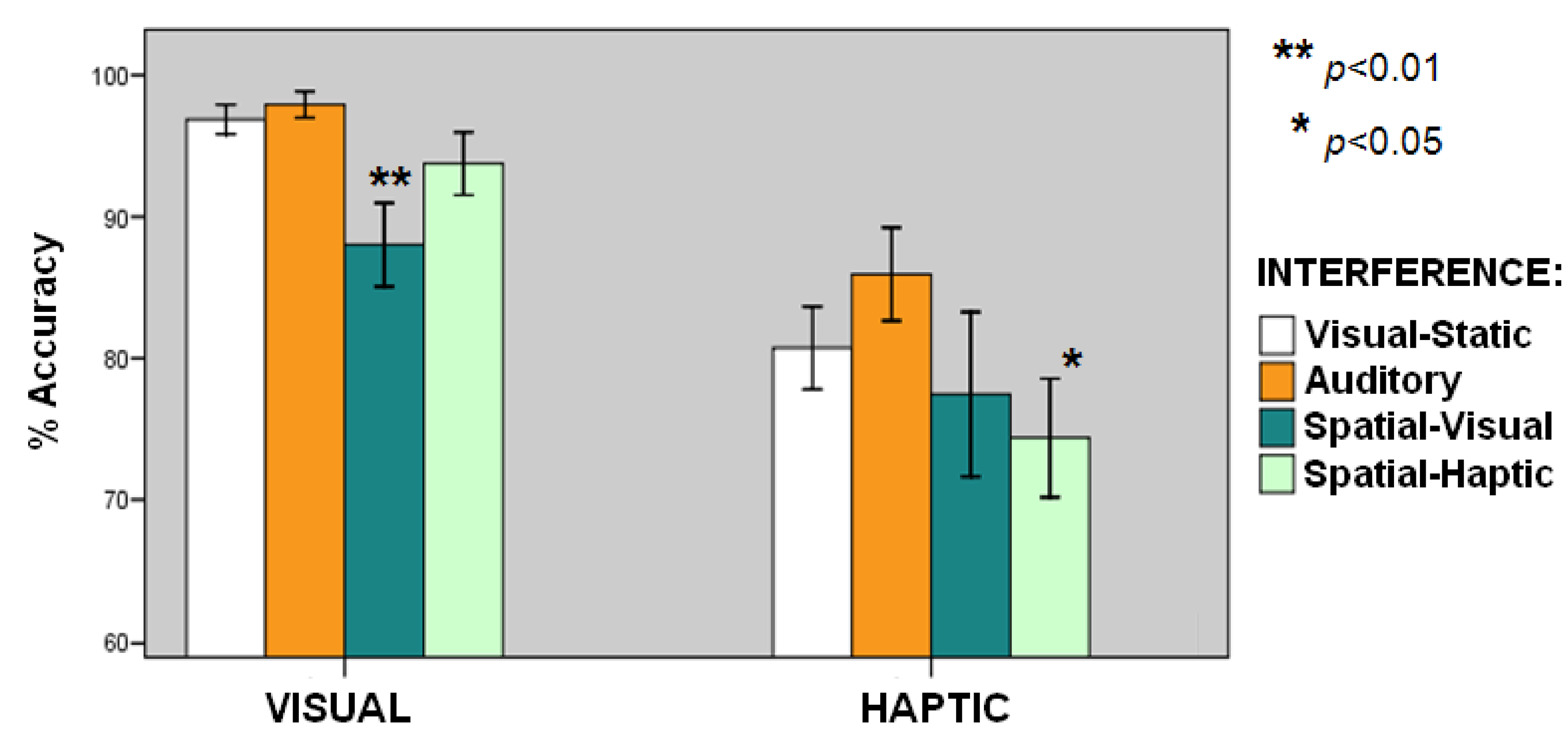


Haptic encoding with haptic interference

DESIGN AND RESULTS

Accuracy was the main variable and was submited to a 2 x 4 ANOVA, with Modality (tactile, visual) and Type of Interference (auditory, visual-static, spatial-visual, spatial-haptic) as within-subjects factors.

The main effects of Modality and Type of Interference were significant. Accuracy was higher for visual than for haptic WM (94,14% *vs* 79,61%). Pairwise comparisons of Type of Interference showed better performance for both auditory and visual-static tasks than for both spatial interference tasks. Two one-way ANOVA were conducted for each modality with the four interference tasks. Results showed larger spatial interference when both the primary and the secondary tasks were performed using the same modality (p<0.05).



DISCUSSION

In agreement with previous findings [4, 5] participants showed better performance when the primary task was visual than when it was tactual in all interference conditions. Note that the encoding time allowed to explore the displays was larger in the haptic modality, and the number of items was also lower in the tactual than in the visual task.

Concerning interference effects, the spatial tasks deteriorated the visuospatial component of WM, although this effect only reached significance when the primary and secondary tasks were performed using the same sensorial modality. This result suggests that regardless of the spatial component shared on these tasks, there was a specific modality component that affected performance. In contrast, visual-static and auditory interference tasks did not deteriorated performance on visuospatial WM. Further research is needed to clarify the effects of different interference tasks when participants show similar level of performance in both modalities, vision and touch. Another important topic for future research is whether the haptic spatial WM deteriorates more than the visuospatial WM with age.

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