Effects of whole-body vibration on visual information processing

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The present study investigated whether visual information processing deteriorates during exposure to whole-body vibration (WBV). It focused on the frequency effects of the vibration on target color discrimination and target detection performance. Eight participants performed target color discrimination and target detection tasks with, and without, 5 Hz and 16 Hz sinusoidal vertical vibration at a magnitude of 1.0 ms\(^{-2}\) r.m.s. Their reaction times (RTs) as a function of inter-stimulus intervals (ISIs) between a fixation display and a target display were compared for three experimental blocks: baseline without vibration (0 Hz); 5 Hz vibration; and 16 Hz vibration. In the target discrimination tasks the RTs during shorter ISIs in the 5 Hz block were significantly briefer than during the 0 Hz and 16 Hz blocks. For target detection, on the other hand, no significant difference was found between the three experimental blocks. These results suggested that visual information processing (i.e., target color discrimination) could be improved during exposure to 5 Hz sinusoidal vertical WBV.

**Key words:** whole-body vibration, vibration frequency, target color discrimination

Visual information processing is affected by noise, vibration, temperature, and other environmental factors. A few studies have addressed the issue of whole-body vibration (WBV) on visual information processing (e.g., Hopcroft & Skinner, 2005). Although the general finding is that vibration produces decrements in performance, the stages of information processing affected by WBV are controversial. It could be due to differences of vibration frequency or magnitude which have been used in the previous studies. The purpose of this study was to investigate the effects of WBV on target detection and discrimination. To this end, performance during exposure to 5 Hz or 16 Hz vibration was compared to that of a baseline condition without vibration.

**Methods**

**Participants.** Eight experimentally naive, right-handed university students, ranging in age from 21 to 23 years (M=21.9 years) were paid participants. All had vision which was self-reported as normal or corrected-to-normal, and without color vision defects. All participants gave written informed consent before taking part in this study, which was approved by the appropriate research ethics committees.

**Apparatus.** The stimuli were presented on a 22-inch color monitor with a resolution of 512 pixels \(\times\) 512 pixels and a frame rate of 100 Hz. A color A-V-tachistoscope controlled timing of the events, generated the stimuli, and recorded the reaction times (RTs). Each participant was tested in a dimly lit room. The monitor was located at eye level, approximately 120 cm from the participant. A vibrator was used to generate sinusoidal vertical vibration at a magnitude of 1.0 ms\(^{-2}\) r.m.s. (unweighted acceleration).

**Stimuli.** For fixation, a white central dot was displayed on a black background. The target was displayed as a central red or green spot (1.0 deg. in diameter).

**Procedure.** The participants performed two types of task: target color discrimination and target detection.

**Target color discrimination task:** At the beginning of each trial the fixation display was presented for 1,000 ms. The fixation dot was then removed. After an inter-stimulus interval (ISIs=250, 500, 750, or 1,000 ms) a target display was presented for 100 ms. The participants were instructed to respond to the target as quickly and accurately as possible by pressing one of two keys assigned to a color. The RTs and responses were recorded. One experimental block consisted of 112 trials. Each participant performed the task during each of the following three experimental conditions: a baseline block of trials without
vibration (0 Hz); a block with 5 Hz vibration; and a block with 16 Hz vibration.

**Target detection task:** The trial procedures were the same as those for the target color discrimination task, with two exceptions. First, 28 catch trials in which a target was not presented were included. Thus, one experimental block consisted of 140 trials. Second, only one response key was used. Half of the participants started with three blocks of the target color discrimination task, and the other half started with three blocks of the target detection task. In each task, the order of performing the blocks was randomized among the participants. At the end of each block each participant reported a rating of discomfort from the WBV (from 1, not uncomfortable to 5, very uncomfortable) as well as a confidence in the accuracy of their responses (from 0, completely unconfident to 100, completely confident).

**Results and Discussion**

**RTs:** All trials during which participants had made an incorrect response, and all trials in which an RT was less than 100 ms or greater than 2.5 standard deviations from the mean RT, were removed from the analyses. The RTs, as a function of experimental block and ISI, are shown in Figure 1. An analysis of variance (ANOVA) was performed on the RTs with experimental block (0, 5, 16 Hz) and ISI (250, 500, 750, and 1000 ms) as within-subject variables. In the target color discrimination task, a main effect of ISI and an interaction between experimental block and ISI were significant, $F(3, 21) = 6.66, p = .0025$ and $F(6, 42) = 2.40, p = .0439$, respectively. The main effect of experimental block was not significant ($p = .2443$). A post-hoc Tukey's HSD test revealed that, in the 250 ms ISI, the RT in the 5 Hz block was significantly less than during the 0 Hz and the 16 Hz blocks. In the 500 ms ISI, the RT in the 5 Hz block was significantly less than that during the 0 Hz block. There was no significant difference of RTs during the 0 Hz and the 16 Hz blocks. Furthermore, in the 5 Hz block significant ISI effects were not observed. In the target detection task, the RTs were not significantly different for the three experimental blocks.

**Discomfort and confidence:** The mean ratings of discomfort and the confidence ratings are listed in Table 1. The discomfort was worst in the 5 Hz block, and least in the 0 Hz block. The confidence rating for the three blocks was not significantly different.

The present study revealed that performance of visual target color discrimination was improved during the 5 Hz WBV. The rating of worst discomfort during the 5 Hz block might be attributable for this improvement. One possible explanation is that, to maintain an appropriate performance level during the unpleasant 5 Hz WBV, an arousal level or readiness for the appearance of the target might be increased. Further investigation will be required to demonstrate if the 5 Hz WBV itself has a positive effect on the response selection stage of visual information processing. But contrary to earlier findings, the present study has suggested that visual information processing (i.e., target color discrimination) could be improved during 5 Hz sinusoidal vertical vibration.

**References**


![Figure 1. RTs for the target color discrimination task (left) and for the target detection task (right)](image-url)