VISUOMOTOR PROCESSING, INDUCED STRESS AND PERCEPTUAL LEARNING

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ABSTRACT

The current study utilizes an immersive, large-format tactical environment to examine human multielement tracking under conditions of stress. Previous research (Morelli & Burton, in press) has shown that individuals who passively viewed standardized photographic stimuli rated as negative in emotive valence revealed a decrement in target identification accuracy compared to those shown neutral valence photographs. The current study builds upon these findings by employing an *interactive* stressor, a first-person perspective combat simulation that varies in intensity, and asking participants to track and identify human figure simulations within a multielement tracking paradigm. Implications for the efficacy of immersive simulator combat training and future field research to gauge infantry skill under conditions of induced stress are discussed.

1. INTRODUCTION

The selective processing necessary to filter pertinent data from input of lesser relevance is critical to Soldier performance, especially within high-density settings (i.e., MOUT). The current study expands upon findings from an earlier multielement tracking study (Morelli & Burton, in press), improving stressor realism by using an immersive, large-format tactical simulator and increasing the visual complexity of target stimuli by using life-like human figure simulations.

Comparing the performance of expert video game players with non-experienced video game players on multiple assessments of attention, Green & Bavelier (2003) concluded that experience and proficiency playing video games alters human visual attention beneficially in terms of numerical capacity, and both spatial and temporal scope. They also found that inexperienced players improved performance on various cognitive tasks after brief training in first-person perspective video game play. We propose that psychological stress, though not addressed as a main factor in their study, may be an intrinsic component to the impact of gaming experience on cognitive performance. To determine the impact of stress on attention within the context of multielement tracking, our current study examines the influence of a visually dynamic, interactive stressor on visual attention as it relates to human-figure tracking.

1.1 Research Objective

Utilizing the available technology provided by the U.S. Army Research Laboratory (ARL) Tactical Environment Simulation Facility (TESF), the simple shapes that represented target and distractor items in our original multielement tracking paradigm were replaced by lifelike physics based human simulations ("DI Guy" System, Boston Dynamics). The TESF is equipped with an Immersive Environment Simulator (IES), a reconfigurable stereoscopic display system consisting of three self-contained 10-ft x 12.5-ft rear-projected modules, allowing for significant enlargement of the visual stimulus display. The expansive display, coupled with the added visual realism of the simulation environment, provide the opportunity to compare performance data between the traditional, high-contrast geometric target multielement tracking task and an adaptation that more closely resembles the environmental cues (e.g., for depth, size), biological motion characteristics, and spatial panorama of scenes in the 3-D world.

In a study not specifically concerned with the effects of stress on cognitive processing, yet germane to the issues presented herein, Green & Bavelier (2003) compared the performance of video game players (VGPs) with non-videogame players (NVGPs) on multiple assessments of attention. They tested the numerical bounds, spatial distribution, and temporal resolution of attention in VGPs and NVGPs, and concluded that experience and proficiency playing video games alters human visual attention beneficially in terms of numerical capacity, and both spatial and temporal scope. Furthermore, they found that even NVGPs achieved significant performance improvements on various attention tasks after only brief training in first-person perspective action video game play. First-person

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perspective action games of the type they used to train NVGPs require the distribution of attention over a wide spatial field of view in order to monitor potential enemy threats and complete game objectives. In an experiment to control for a possible visuomotor or attentional proficiency advantage for NVGPs over VGPs, they compared performance on a battery of attention tasks between NVGP groups briefly trained to play either a first-person perspective action video game simulating WWII-era combat (Medal of Honor), or a strategy video game featuring a comparatively limited spatial focus and smaller attentional distribution requirements for achieving game success (Tetris). Results showed that relative to those trained to play strategic video games, individuals who trained to play action video games improved their attentional processing capacity after only brief exposure, indicative of a perceptual learning effect that generalizes to multiple facets of visual processing including speed and spatial distribution.

Though stress was not addressed as a main factor in the superior performance shown by VGPs in Green & Bavelier (2003), it is likely an intrinsic component to the impact of action video game experience on attentional performance, as evidenced by Skosnik et al. (2000). To determine the impact of stress on such attentional improvements, our second experiment will examine the influence of a visually dynamic, interactive induced stressor upon visual attention and perception in a simulated tactical environment. Specifically, we are interested in the impact of stress, induced through interactive video game play, on the ability to track and maintain attentional focus on multiple moving visual targets over time. Video game play has been utilized as an effective psychological stressor in a number of studies designed to evaluate the influence of stress upon physiological state measures such as heart rate variability, blood pressure, and UNaV (sodium excretion), generally producing elevated cardiovascular and hemodynamic responses (Goodie & Larkin, 2001; Harshfield et al., 2002; Mounier-Vehier et al., 1995; MacDougal et al., 1983; Murphy et al., 1986).

To corroborate the influence of induced stress in the current study that is derived from the First-person Shooter (FPS) combat simulation video game, all participants will be administered the Today form of the Multiple Affect Adjective Checklist – Revised (MAACL-R; Lubin & Zuckerman, 1999). Our results will have implications for the efficacy of immersive simulator combat training, and will provide a foundation for field research to gauge infantry skill under conditions of induced stress.

2. METHODOLOGY

2.1 Participants

Thirty-seven participants volunteered to participate in the study. One participant expressed symptoms simulator sickness-related discomfort and decided not to complete the experiment. Of the thirty-six remaining participants, eighteen were assigned randomly to participate in the moderate first-person perspective non-combat video game condition and eighteen assigned randomly to the intense combat simulation video game condition. Participants included both military and civilian personnel. Demographic information on all participants was collected to record computing, gaming and combat experience for future analysis regarding potential influence on experimental performance. Participants performed the experimental tasks individually, with no more than one individual participating in a session at a given time. All participants were verified for normal or corrected-to-normal visual acuity via examination with a Snellen eye chart, and a health screening questionnaire was used to determine possible risk to participants.

2.2 Stimuli and Apparatus

Psychological State Measure:

Multiple Affect Adjective Checklist – Revised. The Today form of the Multiple Affect Adjective Checklist – Revised (Lubin & Zuckerman, 1999) was administered. Because of its improved discriminant validity and control of checking the response set, the MAACL-R Today form has been found to be particularly suitable for investigations which postulate changes in specific affects in response to stressful situations. This form consists of a list of adjectives in which participants are instructed to check all words describing how they "feel right now", or "have felt since they last completed this form".

First-Person Shooter (FPS) Combat Simulation:

Individuals randomly assigned to participate in this condition were trained to play a realistic first-person perspective tactical combat simulation video game module that included simulated military weaponry, mission settings and objectives (Medal of Honor – Allied Assault [EA Games]). The game was modified from its original format, a World War II themed game featuring weapons and scenarios dating from that era, to increase the prevalence of content marked by intense battlefield violence. Weaponry and enemy tactics were also modified to more closely simulate the characteristics of a modern close-quarters firefight. Mission goals in this condition included search and identification of target objects while combating an overwhelming number of enemy entities.

First-Person Perspective Non-combat Simulation:

Participants in this condition were trained to play modules of the same modified combat simulation video game, but that were devoid of the intense violence prevalent in the FPS combat simulation described above. All violent content was removed, with the goal of the simulation changed to one where participants were asked to search for and identify target objects in an environment devoid of threat or enemy presence.

Tactical Environment Simulation Facility (TESF)

The 6,000 square-foot TESF at ARL's Human Research & Engineering Directorate includes two adjoining simulation environments. The current study utilized the TESF Immersive Environment Simulator (IES). The IES includes Fakespace Systems' RAVE II®, a reconfigurable stereoscopic display system consisting of three self-contained 10-ft x 12.5-ft rear-projected modules that can be arranged to form a flat wall display, an immersive theater, or and enclosed CAVE®-like environment. Both the multielement tracking task and the first-person perspective gaming scenarios were displayed on one of these large format 10-ft x 12.5-ft screens.

2.3 Design and Procedure

Participants were seated at a table in front of the IES display screen described above, asked to read the Volunteer Agreement Affidavit, and briefed regarding confidentiality. Participants were also reminded that they could refuse or later withdraw from the study without penalty. Individuals were given an opportunity to communicate their concerns to the investigators "off the record" and were provided with several options for refusing or withdrawing in a private manner.

Upon completing the Volunteer Agreement Affidavit, participants were asked to complete a demographics and health screening questionnaire. The demographics questionnaire included questions about past incidence of motion sickness or simulator sickness, military experience (if applicable), computer use, and video gaming experience. The health screening questionnaire included questions about history of nervous, circulatory or respiratory issues, and was mandated by the ARL-HRED Human Use Committee as a precaution to mitigate risk given the study's stress component.

Baseline Trials

Baseline MAACL-R data were collected prior to informing the participant of the nature of the video game they would be playing. When the checklist was administered, participants were asked to check all words on the list that described how they "feel right now." A demonstration of the multielement tracking task was then presented, and participants were asked to complete a set of practice trials at each of the three difficulty levels (i.e., tracking four, five, or six targets). Upon completion of the practice trials, a baseline session of multielement tracking task trials was presented that consisted of 24 four-, five-, and six-target trials (i.e., 8 trials of each type) randomly presented within each of three trial blocks, making seventy-two trials total. Each trial block was followed by a 1-minute break. This three-block baseline session of multielement tracking task trials was identical for participants in both the combat and non-combat simulation conditions. Tracking accuracy served as the sole dependent measure for this task.

Post-gaming Trials

Upon completion of the baseline trial session and following a five-minute break, participants were asked to play either the FPS combat simulation video game, or the first-person perspective immersive non-combat video game, depending upon experimental condition assignment. Since our research focus was not to instill a level of gaming expertise in non-video game players, but rather to compare skill transfer to the multielement tracking task after interaction with the different game types, participants in each condition were trained to achieve familiarity with the respective game's operational environment and rules of gameplay, but were not expected to perform with great proficiency. Participants practiced the basic operational gaming functions (e.g., walking, jumping, firing, etc…) until they were minimally able to navigate the game and perform basic actions. Following training, gameplay commenced, the MAACL-R was administered, and a multielement tracking task trial block (24 trials) was presented. As in the baseline trial session, this sequence (i.e., gameplay, MAACL-R, and the multielement tracking task) was presented three times, resulting in a total of 72 multielement tracking trials over the three trial blocks. The twenty-four multielement tracking trials in each block also included four-, five-, and six-target trials (i.e., 8 trials of each type) randomly presented within each of the three trial blocks. As in the baseline trials, tracking accuracy served as the sole dependent measure for this task.

Due to the mild risk of motion sickness when playing first-person perspective video games, participants were asked after each gameplay session to note any discomfort they may feel during the experiment. It was stressed that they should volunteer any discomfort felt at any time during the experiment, and that they were free to end the experiment at any time. Any comments provided were recorded and factored into the tracking performance analysis to prevent a possible confound. Though participant reported discomfort did not materialize for the vast majority of experimental volunteers, this step was taken so that fluctuations in tracking performance would not mistakenly be ascribed to a stressor whose root influence (i.e., the induced sickness or the characteristics of the game) would be unknown.

2.4 Preliminary Results

To verify that the first-person shooter combat simulation increased perceived stress relative to the non-combat simulation on the four MAACL-R subscales of anxiety, depression, hostility, and dysphoria, the data were subjected to a 2 (non-combat vs. combat interactive simulation) x 4 (initial MAACL-R data sampled prior to gaming exposure, and three post-exposure MACCL-R samples) multivariate analysis of variance (MANOVA). The MAACL-R positive affect and sensation seeking subscales were not used in the analysis.

There was a significant two-way interaction between sampling time and group (combat vs. non-combat gameplay) $F(3,34)=3.37, p<0.05$. A significant two-way interaction between MAACL-R scale and group was also noted $F(3,34)=5.67, p<0.05$. Figure 1 illustrates the MAACL-R score differences reported between combat and non-combat gaming participants on the subscales of depression and hostility.

Tracking performance results revealed a pattern typical of multielement tracking paradigms, such that accuracy suffered as the number of targets to be tracked (i.e., difficulty) increased $F(2,34)=16.31, p<0.05$. Although there was a significant effect of trial block $F(5,34)=113.82, p<0.05$ and a difficulty by trial block interaction $F(10,34)=2.54, p<0.05$, no significant differences between participant groups (combat vs. non-combat simulation) were noted.

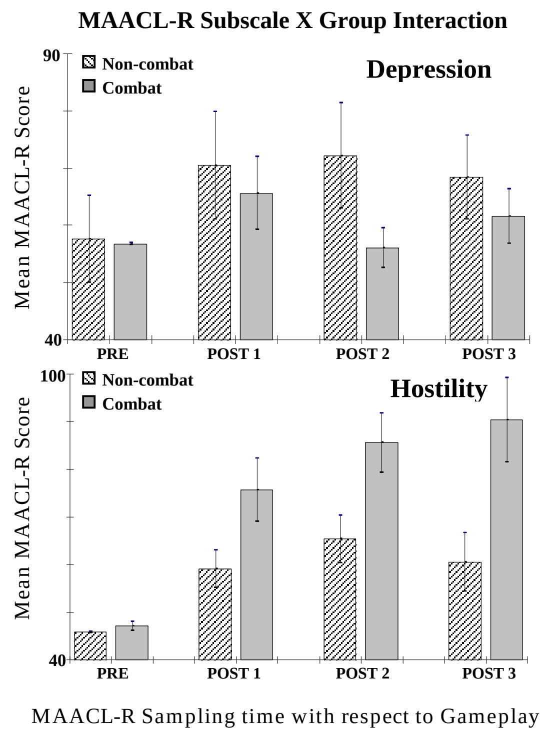

Figure 1. Non-combat simulation participants revealed a tendency toward higher post-gameplay depression levels relative to those who engaged in the combat simulation. Conversely, MAACL-R hostility scores were higher after engaging in combat simulation gameplay relative to non-combat simulation experience. No reported differences were shown between groups on either subscale prior to gameplay.

CONCLUSIONS

The current pattern of performance differs from that obtained in our previous study (Morelli & Burton, in press), where a between subjects main effect of experimental condition on tracking accuracy was revealed. In our previous study, participants viewed either disturbing or neutral valence photographs. On trials completed post-photograph exposure, an improvement in tracking accuracy was noted for participants in the non-stressed (i.e., neutral photograph) condition relative to baseline, with no change in performance shown for those who viewed negative valence photographs. Unlike our previous tracking task, no significant differences in tracking accuracy were revealed in the current study between participants who played the first-person perspective gaming simulations, despite simulation variability in emotive intensity as corroborated by results obtained from the MAACL-R instrument.

A number of factors distinguish the methodology and environmental context of the current study from our previous work. The stressors employed in the current study were interactive in nature, while the previous study simply called upon volunteers to passively look at pictures that were presented for brief intervals. Also, our current study employed a large format display in an attempt to augment the intuitive feeling of immersion within both the gaming environment and the tracking task, while prior stimulus presentation and tracking were presented on a standard computer monitor. Finally, the target stimuli and background environment employed in our current study consisted of human figures moving through a simulated built-up urban environment, a stark contrast from the 2-dimensional geometric shapes moving against a solid black background in our previous tracking task.

While the first-person shooter simulations used in the current study were modified in an attempt to elicit an increased stress response from participants engaged in the combat version of the game compared to those who played the non-combat game, a number of confounding factors may have contributed to the similarities in tracking performance revealed between the participant groups post-gameplay. Both scenarios called upon players to search for a target item of interest, such as an enemy weapons cache or computer hardware, with the main distinction between scenarios being the overwhelming number and extreme tenacity of enemy presence in the combat simulation. However, despite the lack of enemy presence in the non-combat scenario, successful completion of mission objectives was not trivial. Target objects were hidden within large virtual environments and, given trial time restrictions, were quite difficult to find. This may account for the elevated levels of depression reported by non-combat gaming participants on the MAACL-R checklist. Coupled with the change in display and stimulus formats, the results warrant future research to gain a better understanding of the dynamics at play when investigating the impact of gameplay upon multielement tracking.

Future research should include experimental conditions where a) 2-dimensional geometric target stimuli are presented on a large-format display, with participants asked to either passively view disturbing/neutral valence photographs or engage in interactive gameplay, and b) human figure targets are tracked on a small-format display, after passive exposure to either photographs or interactive gameplay. By including these experimental manipulations, an improved representation of the impact of stress upon visual multielement tracking may begin to emerge. Further work into the specific impact that different gaming scenarios may have upon psychological state may also be beneficial in refining the specific impact that simulation systems have upon perceptual learning and Soldier performance.

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