Improving multi-tasking ability through action videogames

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A B S T R A C T

The present study examined whether action videogames can improve multi-tasking in high workload environments. Two groups with no action videogame experience were pre-tested using the Multi-Attribute Task Battery (MATB). It consists of two primary tasks; tracking and fuel management, and two secondary tasks; systems monitoring and communication. One group served as a control group, while a second played action videogames a minimum of 5 h a week for 10 weeks. Both groups returned for a post-assessment on the MATB. We found the videogame treatment enhanced performance on secondary tasks, without interfering with the primary tasks. Our results demonstrate action videogames can increase people’s ability to take on additional tasks by increasing attentional capacity.

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1. Introduction

1.1. The need to train multi-tasking ability

Information technology has greatly increased system complexity (Dekker, 2012; Karr-Wisniewski and Lu, 2010). Whether the domain is nuclear power plants, unmanned aircraft systems (UAS), military command, or air traffic control, operators need to coordinate the performance of multiple tasks, but have limited attentional resources to do so (Chiappe et al., 2012; Liu et al., 2009). Indeed, cognitive demands on operators are most likely going to increase. In the case of UAS, for example, future designs will incorporate more high-resolution cameras and sensing equipment, increased weapons delivery capabilities, and possibly a single operator controlling many aircraft (Liu et al., 2009). Although automation tools are being developed, their net effect will likely be to reduce physical workload while increasing cognitive workload (McCarley and Wickens, 2005; Dehais et al., 2012). Fortunately, recent studies have found that capacity for attention can be enhanced (Bavelier et al., 2012). The present study examines whether videogames can serve as a cost-effective training tool to increase operators’ proficiency at coordinating multiple tasks in high-stress situations.

Much research has been devoted to how to train performance of complex cognitive tasks; ones requiring people to simultaneously process multiple interacting information elements as they carry out various subtasks (e.g., Healy et al., 2012; Lim et al., 2009; Merrill, 2002; Paas and Van Gog, 2009). In general, training is most effective when it involves practicing all subtasks simultaneously, in environments that are as similar as possible to those the operator will be engaged in (Paas and Van Gog, 2009; Van Merriënboer and Kirschner, 2007). High-fidelity training environments, however, are costly. As such, cost-effective techniques are being investigated, including using off the shelf action videogames (Green and Bavelier, 2008; Wu et al., 2012).

Action videogames have the potential to serve as useful training tools for improving multi-tasking because they can preserve the cognitive authenticity associated with many complex tasks (Herrington et al., 2003). Cognitive authenticity refers to when training and transfer environments possess similar information-processing demands, despite different superficial characteristics. The benefit of cognitive authenticity is illustrated by Cassavaugh and Kramer (2009), who found that computer-based training of attention demanding driving tasks improved driving performance of older adults. The cognitive authenticity of many videogames stems from the fact that they simulate the same mental demands many system operators regularly employ; constantly shifting attention across multiple tasks that include monitoring communications, fuel status, weapons, and the location of team members, all while simultaneously navigating through a virtual system (Spence and Feng, 2010; Wu et al., 2012).

Using action videogames to develop multi-tasking skills is also supported by well-known training principles. This includes deliberate practice, well-timed feedback, and variability of training...
With respect to deliberate practice, action videogames promote learning that is highly motivated, focused, and effortful (Green et al., 2010). They have features motivating players to keep improving their performance, including different levels of difficulty so novices can gradually develop their skills. They also have engaging storylines and cinematic elements like music and sound effects that increase emotional impact. In terms of well-timed feedback, videogames often display scores at the end of each level. This allows players to improve performance without interfering with play. If games feature multiplayer modes, feedback on how performance compares to others can also motivate players to improve their skills (Spence and Feng, 2010). Regarding “variability of training,” with the great number of titles available, videogames offer a large variety of contexts where skills relevant to multi-tasking can be exercised. Varying the practice stimuli strengthens representations of key features that need to be attended to during task performance, increasing the likelihood that individuals will be able to generate action schemata in novel situations (Green et al., 2010).

1.2. Theoretical background

While the preceding suggests that videogames may improve multi-tasking, this is only going to be the case if capacity for attention can be modified through training. Fortunately, many studies have found that videogame play can increase attentional resources (e.g., Bavelier et al., 2012; Boot et al., 2008; Green et al., 2010; Hubert-Wallander et al., 2011; Rosser et al., 2007). The greatest benefits come from action videogames, particularly the First Person Shooter (FPS) variety, as opposed to strategy games, role playing games, or maze/puzzle games (Feng et al., 2007; Green and Bavelier, 2003, 2006; Spence et al., 2009). This is not surprising because as Spence and Feng (2010) point out, action videogames place greater demands on spatial attention than other genres. Playing FPS games requires that individuals have their attention captured by unexpected objects in the periphery. They must quickly recognize those objects, select relevant ones for further processing and ignore those that are irrelevant, all while making split-second decisions. In addition, FPS games require individuals to divide their attention across different objects, as multiple threats often need to be dealt with simultaneously.

Studies also suggest that the increased attentional resources produced by action videogames lead to a broadening of the attentional visual field (Hubert-Wallander et al., 2011; Bavelier et al., 2012). This is the area around fixation an individual is able to attend to, and process information from, without moving their head or eyes. For example, Green and Bavelier (2003) used the Useful Field of View task (UFOV) that required participants to identify small targets presented radially at different eccentricities (10°, 20° and 30°). They found individuals that trained with action videogames improved their ability to identify targets at all eccentricities compared to those trained by playing non-action videogames. Green and Bavelier (2006) added a primary task that required processing information at fixation, in addition to detecting peripheral targets. They found action videogame and non-action videogame groups did not differ in the primary task. However, the former performed better on the peripheral task. This suggests the improved ability to process peripheral information did not come at the expense of primary task performance. Important to our purpose, these results suggest playing action videogames can improve people’s ability to take on additional tasks.

More recently, neuropsychological research has found evidence that action videogames benefit attentional processing. Bavelier et al. (2012), for example, compared action videogame players to non-gamers in a fMRI study that used a version of the UFOV task. They found that non-gamers featured increased activation of fronto-parietal regions (i.e., regions crucial to the control of attention) as attentional demands of the task increased, while gamers did not. Evidently, the latter were able to manage the greater task demands with less attentional effort. Likewise, Wu et al. (2012) recorded ERP at parietal regions while people performed a task similar to the UFOV. Two training groups were compared; those that had played a FPS game for 10 h, and those that played a non-action videogame for 10 h. They found large differences in late-onset parietal activation for those who played the FPS game, but not for the control group. Wu et al. (2012) state this reflects an enhanced allocation of attentional resources among those that played the FPS game. More directly related to multi-tasking, Maclin et al. (2011) examined parietal ERP changes for primary and secondary task performance as a function of playing the Space Fortress action videogame. In a pre-assessment, participants played the game while also performing the “oddball” secondary task. The latter required them to silently count the rare tones presented in a sequence of frequent tones. This was followed by 20 h of playing the videogame. During a post-assessment, participants had to play the game while carrying out the oddball task. They found that after treatment, parietal ERP activity was lower during videogame maneuvers, but higher during the oddball task. Thus, due to practice, participants were able to devote fewer attentional resources to the videogame, and were able to devote more to the secondary task.

1.3. The present study

This study also examined whether action videogames can improve multi-tasking. It differs from previous studies in important respects. First, people administered treatment in their own home. This was done because for videogame training to be cost-effective (e.g., as part of an effort to reduce the high cost of pilot training), it should be implemented at home. It is thus necessary to show benefits even when treatment is administered outside the confines of the laboratory. Second, we assessed multi-tasking using the Multi-Attribute Task Battery (MATB), a task environment much more complex than is typically used in videogame research. It consists of two dwell tasks requiring constant monitoring and action, as well as two secondary tasks performed intermittently, simulating many of the tasks that aircrews regularly perform. It is a validated measure that correlates with real-world performance (Comstock and Arnegard, 1992). By using the MATB, we were able to determine whether effects of videogame play “scale up,” and provide benefits in high-workload tasks more comparable to realistic task environments. This is important because a recent study by Donohue et al. (2012) calls this into question. It failed to find multi-tasking differences between action videogame players and non-players using complex tasks. For example, videogame players did not perform better in a driving task under dual task conditions that required participants to simultaneously answer trivia questions.

In our study, two groups with no experience playing action videogames were pre-tested using the MATB. One group served as a control, while the experimental group was treated with action videogame play for 10 weeks. Both groups were then given a post-assessment on the MATB. We hypothesized that if playing action videogames increases attentional resources, those receiving the treatment should perform better on the MATB post-assessment. Consistent with claims that greater attentional resources leads to a broadening of the attentional field, we expected the biggest improvement to be in the secondary MATB tasks, and that this improvement should not come at the expense of the primary tasks.
2. Method

2.1. Participants

Participants were undergraduates from California State University, Long Beach. They were recruited from Introductory Psychology courses and word-of-mouth. Potential participants filled-out questionnaires to be entered into a raffle for $50. This questionnaire asked students to provide information about whether they are currently playing videogames, or whether they have played them in the past, and if so, which types of games they played. Of the 600 questionnaires received, we selected 53 individuals who indicated they had no prior or current experience playing action videogames. Of these, 26 were randomly assigned to the videogame group and 27 to the control group. Ages ranged from 18 to 36 with a mean of 22 years for both groups. Two videogame participants were dropped for not playing the required amount. Two control participants were dropped because they did not attend all assessment sessions. The remaining included 12 males and 12 females in the videogame group, and 12 males and 13 females in the control. According to their responses to a questionnaire, all participants had normal or corrected to normal vision, and 87% reported being right-handed. All reported being in good general health, with no physical disabilities. Furthermore, 76% reported their occupation as being a full time student. The remainder reported working part-time, with sales and service jobs as the most frequent occupations.

2.2. Materials

The tool used to assess multi-tasking is the MATB (Comstock and Arnegard, 1992). It consists of computerized tasks analogous to activities aircrews perform while engaged in high workload flight operations, yet is accessible to populations with no aviation experience. It requires the performance of four tasks: systems monitoring, fuel management, communications, and tracking tasks. These are described in detail in Table 1.

Videogame participants were given a SONY PS3™ console to use at home during the 10 weeks of treatment. In addition, they were given commercially-available FPS games. This means players have the same point of view as the main character in the game, and the primary task is to shoot at enemy targets. While designing our own game would have afforded greater control over the stimuli that participants were exposed to, we followed much of the research literature in using off the shelf games. Indeed, many of the games we used were ones used in other studies examining the cognitive effects of action videogames. Although some control is relinquished by not designing our own game, the virtue is it allows us to examine whether these products can be used to enhance attentional effects of action videogames. Although some control is relinquished by not designing our own game, the virtue is it allows us to examine whether these products can be used to enhance attentional demands, as targets are often presented in cluttered settings. In terms of attentional demands, all the games feature abrupt onset of events, with the need to discriminate and select important objects among distracters. The games also require task switching and multi-tasking, as players have to monitor factors such as ammunition and weapons systems, as well as other team members, while at the same time carrying out the primary task of shooting targets. In addition, multiple objects have to be attended to, and often at the periphery of the visual field. Working memory is also taxed by these games as people have to make decisions on how to allocate resources, and which weapons to use, often under stressful conditions. Finally, all games place high demands on spatial cognition as they require mental rotation and navigation through complex visual domains. They also require visuo-motor coordination through aiming and shooting and the operation of complex virtual machinery. In short, games were chosen for the high mental, visual, and attentional demands they exert. Our participants were given two games to start: Ghost Recon Advanced War Fighter 2™ and Unreal Tournament 3™. Once they finished these, they were given additional games including Medal of Honor™, Vanquish™, Bioshock 2™, and Resistance 2™.

2.3. Procedure

Selected participants in the control and videogame groups were brought into our lab for a pre-assessment on the MATB. It was administered in four high workload sessions, including one 10-min (familiarization), one 20-min (warm-up), and two 30-min (practice and test) sessions. The last 30-min session was used in the analyses reported below.

Once they completed the pre-assessment, participants in the videogame condition were trained on the PS3™. Experimenters taught participants how to set up the console. They were then assisted on the training modes of the games Ghost Recon 2™ and Unreal Tournament 3™. This ensured they understood how to orient their characters, the goals of the games, and basic maneuvers such as how to use weapons and positioning. The participants were then instructed on how to complete their weekly game-playing diaries.

Participants were asked to play a minimum of 5 h per week for 10 weeks, but were given some flexibility for their weekly game playing. All participants averaged a minimum of 5 h of play across the 10 weeks. To keep track of gameplay, participants were emailed a videogame diary each week. This required them to record pertinent information about their videogame activities, including time of play, achievements made, how enjoyable the games were during each session, and whether they experienced any difficulties. Participants were informed that they could be asked to come to the

Table 1

<table>
<thead>
<tr>
<th>Task</th>
<th>Description of duties</th>
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<tbody>
<tr>
<td>Tracking task</td>
<td>Requires the manual operation of a joystick to keep a target in the center of a tracking window.</td>
</tr>
<tr>
<td>Systems monitoring task</td>
<td>Requires monitoring lights and dials. For the lights, when one goes out, participants are required to press a button to turn it back on. For the other designated light, participants should press a button when it is lit to turn the light back off. For the dials, participants must reset a dial by pressing a button if it is found to be operating outside of a specified range.</td>
</tr>
<tr>
<td>Communications task</td>
<td>Requires individuals to respond to auditory communication instructions to a particular call-sign (ignoring communications to other call-signs). When their call-sign is mentioned, they must change one of two communications settings, or one of two navigational settings.</td>
</tr>
</tbody>
</table>

*The MATB tool was presented to participants on a Dell Desktop computer using a 20" by 20" computer monitor.*
lab to demonstrate their reported level of videogame skills during the course of the study. Because we captured the number of reported hours of videogame playing and levels/games completed in the weekly diaries, we were able to perform correlational analyses to examine the relationship between number of games completed and performance on the MATB.

Participants in the videogame and control conditions were informed after the pre-assessment whether they would be coming back for one more (post-assessment only) or two more (mid-term\(^1\) and post-assessment) sessions. Following each session, the control group was paid in cash, at a rate of $10/hour. In the post-assessment, videogame participants were given the code to unlock their PS3\(^{TM}\) consoles, which they were allowed to keep.

3. Results

3.1. Description of analyses

To analyze performance on the MATB, we conducted a series of 2 \(\times\) 2 \(\times\) 2 \(\times\) 3 mixed-model analysis of variance (ANOVA) tests, with condition (videogame vs. control) and gender (male vs. female) as between-subject factors, and session (pre-assessment vs. post-assessment) and interval (first 10 min, second 10 min, vs. third 10 min) as repeated measures factors. Interval was included because workload is not evenly distributed throughout the MATB. Workload starts light (e.g., no communications, and dials within the normal range) and builds during the session. Including interval therefore enabled us to examine whether there are any changes in performance throughout the session, either because of fatigue, or practice effects. The alpha level was set a priori to a p-value of .05 for statistical significance, and to .10 for marginal effects.

While MATB yields data on 21 variables, separate ANOVAs were carried out only for some of these. We only included variables not suffering from range restriction and that have been reported in other studies using the MATB (e.g., Caldwell and Ramspott, 1998; Singh et al., 2010). We also selected variables in each MATB subtask. For reasons of brevity, below we report only findings pertaining to main effects or interactions with the variable condition. Whenever appropriate we also include correlations for the videogame group between number of games completed and performance.

3.2. Communications

The analysis examining RT for correct responses to communication instructions (COMCRT) revealed a significant interaction between session and condition, \(F(1,45) = 5.02, p < .05\). In the control, RT did not decrease between pre- and post-assessments, \(F < 1\), but for the videogame condition, RT did decrease, \(F(1,22) = 10.18, p = .004\) (See Fig. 1). Although the two groups started off at the same level, the videogame group was faster at responding to communications during the post-assessment. There were no other main effects or interactions. Correlation analyses between number of videogames completed and post-assessment COMCRT revealed that those who completed more games had a faster RT \((r = -41, p < .05)\). There was no significant correlation between number of games completed and pre-assessment COMCRT \((p > .10)\). These results show playing videogames for 10 weeks improved performance on the communications task.

An analysis of the standard deviation of the RT to correctly respond to communication instructions (COMCSD) revealed a marginal interaction between session and condition, \(F(1,45) = 3.32, p = .075\). For the control group, SD did not decrease between the pre- and post-assessments, \(F < 1\). For the videogame condition, however, there was a decrease in SD between the two assessments, \(F(1,22) = 4.47, p < .05\) (See Fig. 2). Not only did the videogame participants become faster; they also became more consistent in how quickly they responded to communications. This is further supported by a negative correlation between number of games completed and their overall COMCSD performance for the post-assessment \((r = -48, p = .017)\). Number of videogames completed was not related to performance during the pre-assessment.

3.3. Systems monitoring

With respect to the time out errors for the dials (DLSTO), there was a main effect of condition, \(F(1,45) = 6.84, p < .05\). Videogame participants had fewer time-out errors \((M = .33, SE = .10)\) than controls \((M = .70, SE = .10)\). There was also a significant interaction between session, gender, and condition, \(F(1,45) = 6.02, p = .018\). Subsequent analyses revealed that for male participants there was a significant interaction between session and condition (See Fig. 3). \(F(1,22) = 5.95, p = .02,\) but not for females \(F(1,23) = 1.06, p = .31\). For the males in the control condition, the time-out errors increased between the pre-assessment \((M = .42, SE = .19)\) and the post-assessment \((M = .83, SE = .21)\), while for the videogame group, the time-out errors decreased between the pre-assessment \((M = .50, SE = .19)\) and the post-assessment \((M = .17, SE = .21)\).

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\(^1\) One-third of the control and videogame participants came back for a midterm evaluation on the MATB. However, due to the small sample size, no significant effects were obtained when comparing the midterm performance to the pre-test performance. Many of the trends evident in the midterm, though, were significant in the post-assessment comparisons.
Furthermore, there was an interaction between interval, session, and condition, $F(2,90) = 1.45$, $p = .23$. Post hoc analyses revealed that for the control group, the interaction between session and interval was not significant, $F(2, 46) = 2.95$, $p = .05$. For the videogame condition, the interaction was marginally significant, $F(2,44) = 3.07$, $p = .06$. In the pre-assessment, videogame participants displayed an inverted U function across the three intervals. They had fewer time-out errors in the first interval ($M = 29.25$, $SE = .14$), but these increased during the higher workload second interval ($M = 92.30$, $SE = .30$), and then decreased again in the final interval ($M = 21.10$, $SE = .10$). However, in the post-assessment, time-out errors did not increase due to increasing workload. Instead, they decreased from the first ($M = .25$, $SE = .09$) and second interval ($M = .25$, $SE = .11$) to the third ($M = .08$, $SE = .06$). Thus, in the post-assessment, the videogame participants displayed a greater ability to manage an increased workload, while the control group did not display a similar improvement. Furthermore, in the post-assessment, the more games participants completed, the fewer their time-out errors in the second 10-min interval ($r = -.39$, $p = .056$). In contrast, none of the correlations between the number of games completed and DLSTO errors for the pre-assessment were significant.

For the RT to respond to the lights (LTSRT), there was a main effect of condition, $F(1,45) = 5.34$, $p < .05$. Overall, videogame participants responded more quickly to the lights ($M = 1.72$ s, $SE = .08$) than controls ($M = 1.97$ s, $SE = .08$). There was also an interaction between interval and condition, $F(2,90) = 5.59$, $p = .005$. For the control group, RT remained constant throughout the three 10-min intervals, $F(2,46) = 1.89$, $p = .163$, while for the videogame group, RT decreased across the three 10-min intervals, $F(2,44) = 7.15$, $p = .002$, showing that the videogame participants improved throughout the 30-min sessions while the control group did not. However, the absence of an interaction between interval, condition and session does not allow us to conclude that the improvement is due to treatment.

With respect to the time-out errors to the lights (LTSST), there were no main effects or interactions with condition ($F < 1$). However, we found a negative correlation between the number of games completed and the number of time-out errors to the lights in the post-assessment ($r = -.40$, $p = .055$), but not for the pre-assessment ($r = -.16$, $p = .46$), showing a benefit of playing videogames for 10 weeks.

### 3.4. Tracking

For the tracking task, we examined the tracking RMS errors (TRKRMS). We found a main effect of condition, with videogame participants ($M = 23.25$, $SE = 1.09$) overall performing better than controls ($M = 27.86$, $SE = 1.07$), $F(1,45) = 9.10$, $p = .004$. However, the lack of an interaction between session and condition ($F < 1$) suggests the intervention is not responsible for this effect. None of the correlations between number of videogames completed and post-assessment TRKRMS approached significance.

### 3.5. Fuel management

Prior to analyzing the mean deviation of fuel tanks from the ideal of 2500 (TNKMAD), three participants’ responses were dropped (two control, and one videogame) because their data was greater than 2 standard deviations from the mean. With the remaining participants, we found a significant effect of condition, $F(1,42) = 4.84$, $p = .033$. Participants in the videogame condition did better ($M = 279.24$, $SE = 30.26$) than the controls ($M = 373.41$, $SE = 30.26$). No other main effects or interactions reached significance, including the interaction between session and condition, $F(1,45) = 1.02$, $p = .32$. The absence of an interaction between session and condition does not allow us to claim the treatment had any effect on this task. Furthermore, none of the correlations between number of videogames completed and TNKMAD for the post-assessment were significant.

### 4. Discussion

We examined whether action videogames can enhance the ability of novices to carry out multiple tasks. We found playing FPS games improved performance on the communications and systems monitoring tasks of the MATB. Specifically, participants who played FPS games became faster and more consistent in their time to respond to communications, with those completing more games showing the most improvement. In the systems monitoring tasks, videogame participants got better at monitoring and responding to the lights and dials compared to control participants. In particular, male videogame players showed a greater overall improvement in reacting to dials. Furthermore, videogame participants but not control participants, improved in their ability to react to dials needing their attention during the high workload second interval. Indeed, the more games they completed, the fewer time out errors they had during this interval. With respect to reacting to the lights, participants that completed more videogames had fewer time out errors. However, our results did not reveal any differences between conditions in the tracking or fuel management tasks that could be attributed to treatment.

Our results show the 10-week action videogame treatment improved performance on the secondary tasks, and this benefit did not come at the expense of the primary tasks. The tracking and fuel management tasks are primary because they appear in the center of the field of view, and are the most dynamic and demanding of attentional resources. The fuel management task also requires complex decision-making because participants have to develop a strategy for efficiently transferring fuel across the various tanks. In contrast, the communications and system monitoring tasks, although important, do not change as frequently, require intermittent responding, and involve processing peripheral information. Of course, because we only used action videogames and no other types of videogames, on their own the results of our study do not allow us to conclude that only action videogames benefit multitasking. However, given the results of previous studies (e.g., Wu et al., 2012; Spence and Feng, 2010), it is likely that the nature of the FPS games produced the performance benefits.

The present findings are noteworthy because, unlike other experiments examining the effects of videogames (e.g., Feng et al., 2007; Green and Bavelier, 2006), we had participants administer...
the treatment in their own home rather than in a lab. Although we required them to carefully document their videogame play, we did not closely monitor their activity during treatment. We took this approach for reasons of ecological validity — it is likely that any training program that makes use of videogame play will require individuals to administer the treatment on their own. Adding close supervision would, after all, eliminate much of the cost effectiveness. The fact that videogame play enhanced performance even though the intervention took place at home demonstrates the robustness of the treatment.

The results of the present study are consistent with those reported by Green and Bavelier (2006). Their study employed the UFOV task, where the primary task required participants to discriminate between shapes presented centrally, while the secondary task required them to identify the location of targets presented peripherally. They found that action videogame training improved performance on the peripheral task, without sacrificing performance on the primary task. A key difference between our study and theirs, however, is that we employed a much more complex task, one that has been shown to predict performance in real life settings — the MATB.

Our finding that action videogame play improved participants’ performance in a complex task differs from that obtained by Donohue et al. (2012). They found that participants classified as action videogame players did not perform complex tasks under dual task conditions better than non-gamers. One possible reason for the discrepancy between the present results and theirs is that in our study, participants played videogames for a longer period of time (minimum of 5 h per week). In Donohue et al. (2012), participants labeled “action videogame players” reported currently playing only an average of 3 h per week. Thus, it is possible they were not playing enough to see multi-tasking benefits in complex task environments. Indeed, we saw that the more games people completed in the 10 weeks of treatment, the more they improved in their ability to multi-task. In addition, Donohue et al. (2012) used a trivia task as a secondary task that is different from the visuo-spatial or communication secondary tasks used in the present study. Although the trivia task was prescreened to include questions that participants would answer with 50—90% accuracy, in actuality it resulted in much lower accuracy rates, as participants under dual task conditions averaged only slightly above 50%. Thus, it is not clear whether the excessive difficulty of their secondary task washed out any differences between the action videogame players and non-players, or whether the participants were even taking the secondary tasks very seriously.

According to Hubert-Wallander et al. (2011), action videogame play enhances multi-tasking by increasing attentional resources. This allows for a broadening of the attentional visual field (see also Feng et al., 2007 and West et al., 2008). Playing such games thus increases the ability to spatially distribute visual attention and to resolve visual details. As a result, when task-relevant information appears on the periphery, it is more likely to capture attention and receive the required processing. Our finding that the videogame participants showed improvements on the systems monitoring tasks supports this theory. Although their attention was primarily focused on the tracking and fuel management tasks, the videogame players were more likely to notice deviations in the lights and dials and to be able to process these stimuli during high-workload intervals.

The fact that we found videogame play also enhanced the ability to process auditory communications suggests that the benefits of videogame play are not limited to the visual modality, but can spill over to other modalities. While many studies have found increases in visual attention (e.g., Spence and Feng, 2010; Green and Bavelier, 2008), ours is the first to show behaviorally that the increased attentional capacity occurs in both the visual and auditory modalities. Maclin et al. (2011) found increased attentional resources for an acoustic secondary task. However, the attentional benefits were only evident in the ERP data, and not in the behavioral data. Finding behavioral benefits that span modalities is important, however, because complex systems often distribute information across modalities, with a strong reliance on auditory communications and alarms. In short, our results support the view that attentional capacity is a domain-general resource that can be increased through training (Liu et al., 2009; Shipstead et al., 2010).

The finding that action videogame play enhances the ability of individuals to process peripheral information also suggests training programs that incorporate this treatment will likely yield improvements in the ability of operators to maintain situation awareness (SA). SA refers to the understanding needed to operate a system in a rapidly changing task environment (Chiappe et al., in press; Durso et al., 2007). Maintaining SA requires perceiving task-relevant information, comprehending this information in light of current processing goals, and projecting the status of the system into the near future (Endsley, 2006). Indeed, operators of complex systems spend much of their time developing SA and ensuring that it is up to date (Stanton et al., 2010).

As Endsley (2006) points out, most cases where human error is identified as the cause of an aviation mishap, the problem lies with an operator’s failure to maintain SA. Most of these failures stem from failing to perceive information in the environment. For example, Jones and Endsley (1996) examined 143 aviation incidents involving pilots and air traffic controllers. They found that 76% of the SA errors involved perceptual failures. In contrast, 20% of the errors involved failures in comprehension, with the remainder being failures to properly project future states of a system. Relevant to our findings, the majority of the perception errors involved a failure to perceive information that was clearly available in the operator’s environment, including requests for communication. Many of these failures arose because the pilots or controllers were already engaged in other tasks, displaying “attentional tunneling.” This is likely to happen under conditions of stress, which increases the likelihood of people ignoring peripheral information, even if it happens to be an otherwise salient alarm (Dehais et al., 2012).

In short, failing to maintain SA by ignoring communication requests or failing to monitor the status of systems can have disastrous consequences. Fortunately, it appears playing action videogames can improve SA by minimizing the likelihood operators will succumb to a narrowing of attention when carrying out primary tasks. Action videogames can therefore serve as training tools for increasing attentional capacity. Furthermore, operators will likely enjoy implementing this tool, yielding real improvements at a relatively low-cost.

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References

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