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Aim, Shoot, Deplete: Playing Video Games Depletes Self-Regulatory Resources

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Two experiments investigated whether playing video games impaired subsequent self regulation. In Experiment 1 (*n* = 43), participants either played a video game (i.e., Quake III) for 10 min or just browsed the Internet for the same time interval. Participants in the video game condition had slower response time than participants in the no-game condition. In Experiment 2 (*n* = 94), either participants played Quake III, or watched Quake III game scenes, or they were asked to suppress their thought for 10 min. Participants in the game-playing condition and thought suppression condition showed less persistence on a given unsolvable anagram task than participants in the game-watching condition. Overall, the findings confirm the idea that playing video game consumes self-regulatory sources due to active instead of passive responses in a highly demanding game environment.

1. INTRODUCTION

Stamina is one of the important parameters in the video game mechanics, and it is frequently used as a health or energy level of the avatar. In action video games (e.g., Quake, Doom, etc.), stamina or other similar parameters enable players to sprint, jump, or run for a limited period. To continue the game, the player should occasionally refill the decreased stamina level to prevent being shot down or eliminated. Just as the avatar in the game, individuals should also conserve or refill their own energy level, in a more specific term, self-regulatory resources, which are required to perform subsequent daily tasks in the real world. Such video games entail deliberate actions, focused attention, and response inhibition (Gentile, Swing, Lim, & Khoo, 2012), which eventually drain players' self-regulatory resources. Employing a self-regulation strength model perspective (Baumeister & Vohs, 2003), the present research aimed to investigate whether playing such video games impaired one's self-regulatory capacity.

Research on video games (e.g., violent or action) provided extant evidence that playing such games is associated with heightened aggressive behavior (Willoughby, Adachi, & Good, 2012), physiological arousal (Anderson & Bushman, 2001), and increased aggression related thoughts (Giumetti & Markey, 2007).[1] Recent studies also showed adverse impacts of playing video games at the physiological (Wang, Hummer, Kronenberger, Mosier, & Mathews, 2011), physical (Straker et al., 2009), and cognitive levels (Gentile et al., 2012). More specifically, playing video games was found to be associated with greater subsequent attention problems and impulsiveness, even when earlier attention problems were statistically controlled (Gentile et al., 2012).

Such findings about the adverse impacts of playing video games (e.g., aggression, impulsive behaviors) are in parallel with the findings related to the reflection of poor self-regulation. Previous works on self-regulation suggest that poor self-regulatory resource leaves individuals more likely to behave impulsively when they were triggered by an external stimulus (DeWall, Baumeister, Stillman, & Gailliot, 2007). To our knowledge, however, no systematic empirical evidence exists addressing subsequent adverse impact of playing video games on cognitive processes. Rather, theoretical models and related studies focus mainly on the concurrent impacts of game experiences on cognitive functioning. For instance, Lang's the Limited Capacity Model of Motivated Mediated Message Processing explains how limited cognitive or attentional resources are allocated to basic subprocess (i.e., encoding storage and retrieval) during a mediated communication (Schneider, Lang, Shin, & Bradley, 2004). In this framework, these authors showed that playing first-person shooter games, such as Quake-II and Half-Life, increased participants' arousal level, indicating that available cognitive resources were reserved for game experience (especially when participants were in a fight episode).

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[1]Relatively little research has investigated the positive consequences of playing violent video games on perceptual and motor skills. These studies revealed significant associations with playing violent video games and enhanced hand–eye coordination and increased multitask ability (Green & Bavelier, 2003).

That is, highly demanding game experience can deplete ego resources, which are necessary to fulfill a following task. In this respect, this study investigated the possible underlying mechanisms of the link between playing video games and subsequent cognitive resources from the self-regulatory strength model perspective.

The self-regulatory strength model posits that a deliberate and conscious alteration of the self-responses, such as making choices, inhibiting a tempting response, or making and carrying out plans, requires some form of energy or strength that is limited in capacity (Baumeister & Vohs, 2003). Each act of ego-control consumes some of this limited resource and leaves less available energy for the subsequent acts. When this limited resource is depleted, self-regulatory failures become more likely. Thus, people with a depleted ego state would experience more difficulty in switching from one task to another (Baumeister & Vohs, 2003), directing attention to the new task (Baddeley, 1996), and concentrating on difficult tasks (Baumeister & Vohs, 2003). Given that self does not have different resources for affect regulation, performance enhancement, thought suppression, impulse control, active initiative, and responsible choosing, the same resource is used for all these operations (Baumeister & Vohs, 2003). In this sense, self-regulatory strength model shares the core tenet of limited capacity models. This model, however, differs in terms of its emphasis on the subsequent task performance, which suffers from insufficient cognitive resources consumed by the previous task (Tyler, 2008). That is, self-regulatory strength model disclaims the basic principle of limited capacity models, which simply assumes that cognitive resources return to the previous level after completion of the task.

Playing a video game presents a challenging environment in which players are required to control their impulse, enhance their performance, and allocate a great amount of the cognitive resources to the playing experience (e.g., Moser & Fang, 2015). Thus, it is plausible that playing a video game would consume subsequent resources for controlling one's own behaviors, or for self-regulatory functioning. Among video game genres, violent video games potentially entail most available self-regulatory resources (Schneider et al., 2004).

To sum up, this study aimed to fill the gap between studies on momentary adverse impacts and negative behavioral outcomes by uncovering the possible cognitive processes lying behind these outcomes. We sought to answer the question of whether playing a video game depletes self-regulatory resources and impairs subsequent task performance. Specifically, we predicted that playing a video game (i.e., a first-person shooter game in this study) would consume self-regulatory resources and, as a result of this depletion state, participants would show poorer performances on specific tasks entailing attention and persistence. To address this question, we conducted two experiments differing in terms of the task aimed to measure self-regulatory functioning.

2. STUDY 1

Study 1 investigated whether playing violent video games consumes self-regulatory resources, as measured by performance in a lexical decision task (LDT), a task that measures executive function of self with available self-regulatory resources and is shown to be affected by prior resource depletion (Kroese, Evers, & De Ridder, 2011). Because first-person shooter games are designed to keep players alert throughout the game experience, we decided to use only this genre of video games in our studies (Schneider et al., 2004).

2.1. Methods

Participants. Forty-five male undergraduate students from the Middle East Technical University, Turkey, participated in the study. We recruited only male participants varying in levels of previous video game experience rather than nonexperienced female participants. Future studies should recruit female participants to increase generalizability of results. One participant withdrew from the study and another participant's LDT session was disrupted due to a technical problem, leaving 43 participants ($M_{age} = 20.88$, $SD = 1.40$).

Materials and procedure. Upon arrival, each participant was told that the session consisted of two separate studies, a leisure time activity study and a visual performance study. The participants were randomly assigned to one of two conditions. In the game-playing condition, participants were instructed to play Quake-III for 10 min. In Quake-III, the player progresses through a map, combating different virtual characters with highly paced game play experience. Players are expected to avoid getting shot by other characters, to protect their weapon stock, and to kill other virtual characters as much as possible. In the control condition, participants were asked to freely browse the Internet (e.g., checking mail, reading a newspaper, or searching Facebook/YouTube) as they do in their daily routine for 10 min. At the end of 10 min, all participants were asked to proceed to the next, ostensibly unrelated study. Specifically, participants completed an LDT with randomly presented 60 words and 60 pronounceable nonwords in the Turkish language. All words were identical in terms of their frequency in written Turkish based on the Turkish Word Frequency Dictionary (Tekcan & Goz, 2005) and pronounceable nonwords were generated by changing one or two letters in a corresponding target word. Participants were asked to indicate as quickly as possible whether a letter string displayed on the screen was a word or a nonword. Letter strings were displayed for 500 ms, and the participant had responded by pressing the "yes" button or the "no" button marked on the keyboard. Participants first completed 10 practice trials to familiarize themselves with the task.

Following the LTD, all participants completed the Turkish version of the Positive and Negative Affectivity Schedule (Watson, Clark, & Tellegen, 1988; adapted by Gencoz, 2000) using a 5-point scale from *not at all* to *extremely* ($\alpha = .86$).

We computed a composite negative affect score by averaging negative affect and reverse-scored positive affect items.[2] To prevent positive mood impact of game liking on ego-depletion, we asked the participants how they like violent such games using a 6-point scale from *not at all* to *extremely* (M *liking* = 3.82, SD = 0.82). Participants also rated their previous game experiences, from 1 (*never played these kinds of games before*) to 10 (*I am the grand master of these kinds of games;* M = 6.21, SD = 1.98). At the end of the session, written informed consent was obtained and participants received extra course credit for completing the study.

Data reduction procedures. Following past work (Greenwald, McGhee, & Schwartz, 1998), we excluded trials that were incorrectly categorized and trials with RTs outside the expected range (< 150 ms or > 4,999 ms). On average, 9% of all trials were excluded in LDT. All analyses were conducted on log-transformed RTs, and only the raw scores were reported to simplify interpretation.

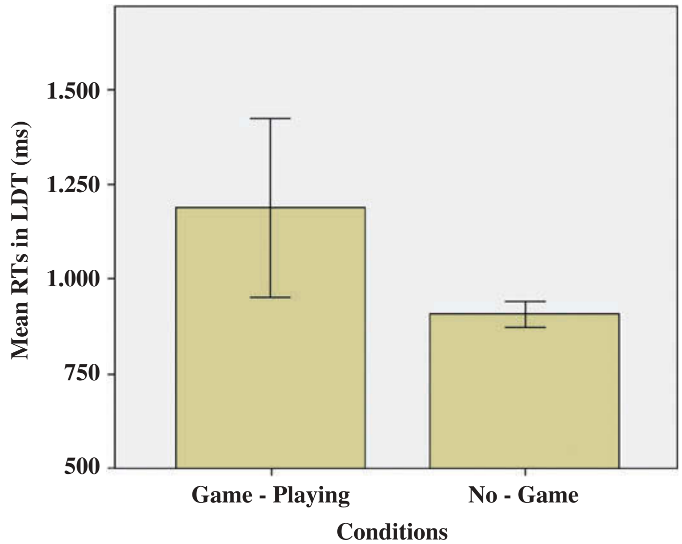

FIG. 1. Bars represent reaction times (RTs) in lexical decision task (LDT; in milliseconds) for participants in game-play and no-game conditions. *Note.* Error bars represent 1 standard error above and below the mean.

2.2. Results

Participants in the game-playing condition showed worse performance in LDT (M = 1,187.65 ms, SD = 516.01) than those who did not play (M = 907.63 ms, SD = 78.61), $t(41) = 2.52$, $p < .05$, $d = .76$; see Figure 1. Considering that positive mood has a replenishment role on ego-depletion rather than on depletion (Tice, Baumeister, Shmueli, & Muraven, 2007), a one-way analysis of covariance (ANCOVA) was run. Results revealed that this difference was still significant, after controlling participants' negative mood, liking of the game, and previous experience with violent video games, $F(1, 38) = 5.50$, $p < .05$, $\eta^2 = .13$.[3] Results suggest that playing violent video games depletes self-regulatory resources and leads to difficulty in directing attention to the new task. Specifically, exerting control over a violent video game depletes an individual's capacity to exercise control in LDT, measuring executive function of self.

[2]Both positive and negative mood were tested separately and results were same with the composite score of mood. We also compared mood differences in experiment conditions for both Study 1 and Study 2. There were no significant mood differences between game-playing and no-game condition, $t(41) = 1.32$, *ns*, for Study 1 ($M_{game\text{-}playing} = 2.85$, $SD = .63$; $M_{no\ game} = 2.65$, $SD = .55$). Similarly, mood differences between game-playing, thought-suppression, and game-watching conditions were not statistically significant, $F(2, 91) = 0.99$, *ns*, for Study 2 ($M_{game\text{-}playing} = 2.63$, $SD = .55$; $M_{thought\ suppression} = 2.72$, $SD = .49$; $M_{game\text{-}watching} = 2.68$, $SD = .57$).

[3]We conducted post hoc power analyses using G*Power (Faul, Erdfelder, Lang, & Buchner, 2007) to indicate whether the desired power of .80 (Cohen, 1988) was achieved in Study 1. Results revealed that the observed power was .68 for both independent samples t test and ANCOVA, suggesting that our sample size was not good enough to reject false Null Hypotheses. The main effect of game on LDT performance, however, was quite large according to Cohen's (1988) effect size conventions ($d = .76$ for t test and $f = .38$ for ANCOVA).

3. STUDY 2

Study 2 was designed to conceptually replicate Study 1 while addressing a limitation of Study 1. The depletory impacts of playing a first-person shooter game may instead be due to just exposed to aggressive scenes rather than actively engaged in those activities. To address this question, we used two control conditions (i.e., thought suppression and game watching) and operationalized self-regulatory strength as persistence on an unsolvable anagram task. The task used in this study was adapted from previous self-regulation research, and it was based on requiring participants to override responses and exert self-control (Baumeister & Vohs, 2003).

Another limitation of Study 1 was that the observed effect of playing video games was not compared to the impact of standard ego depletion tasks. For that reason, a third experimental group was composed, in which participants were required to complete an initial thought-suppression task (i.e., white bear task; Baumesiter & Vohs, 2003). Furthermore, Baumeister and Vohs (1998) showed that white bear task reduced participants' persistence on subsequent unsolvable anagrams by depleting their ego sources. Thus, it was expected that white bear and game-play groups would not significantly differ in terms of their persistence on the second task, and they would show lesser persistence than the game-watching group.

3.1. Methods

Participants. Ninety-four undergraduate male students (M_{age} = 21.49, SD = 1.70) from Middle East Technical University participated in the study.

Materials and procedure. Upon their arrival, the participants were told that they would complete two separate studies, one on entertainment preferences and the other on vocabulary knowledge. Participants were randomly assigned to one of three experimental conditions. In the thought-suppression condition, the participants were instructed to avoid thinking about a white bear for 10 min while writing their momentary thoughts and to mark their recording sheet at any time that the thought of a white bear occurred in their minds (see Tice et al., 2007, for a similar technique to manipulate self-regulatory strength). In the game-playing condition, the participants were asked to play Quake-III for 10 min. Finally, in the game-watching condition, participants were asked to watch a 10-min video clip of a third person's performance on Quake-III.

At the end of 10 min, the experimenter returned to the room and asked participants to work on an 11-letter anagram. Unbeknownst to the participants, the anagram was unsolvable, reflecting individuals' heightened persistence in the face of a difficulty (e.g., Baumeister & Vohs, 2003). They were first presented with solved anagrams as examples then with the test anagram. They were asked to work on the task as long as they needed and stop whenever they wanted. The time participants worked on the task was recorded as a measure of persistence. After they quit the task, the participants completed the same control measures (i.e., negative mood, liking of the video game, previous experience with video games) used in Study 1. At the end of the session, written informed consent was obtained and participants received extra course credit for completing the study.

3.2. Results

A one-way ANCOVA controlling for game liking, negative mood, and previous game experience was run on participants' persistence. Planned contrasts showed that participants in the game-playing (M = 270.69 s, SD = 86.63) and thought-suppression conditions (M = 252.77 s, SD = 99.18) left the anagram task significantly sooner than the participants in the game-watch group (M = 334.91 s, SD = 122.91), $F(2, 88) = 5.46$, $p < .01$, $\eta^2 = .11$; see Figure 2.[4] Furthermore, participants' persistence on the anagram did not significantly differ from each other. Thus, findings of the Study 2 indicated that playing violent video games has a depletory role on self-regulation resources as much as on the classical thought-suppression task.

Employing a new ego-depletion condition on the persistence task, Study 2 replicated the findings of Study 1, showing that not passively being exposed but actively engaging in playing such video games may consume self-regulatory resources and result in poorer persistence on subsequent tasks.[5]

[4]A post hoc power analysis revealed that the observed power of the ANCOVA was .86, indicating that a desired level of power was obtained in Study 2. Furthermore, the effect size of the experimental manipulation was quite large according to Cohen's (1988) effect size conventions (f = .35).

[5]Following Tice et al.'s (2007) work, we also examined the question whether depleted ego-resources would be replenished using 5-min video clips, inducing positive mood video clips on self-regulatory resources. We could not find any replenishment effects of video-clip sessions on persistence duration.

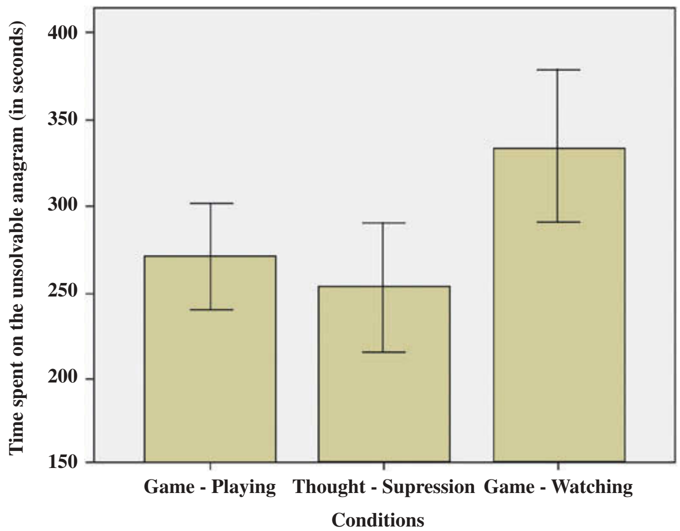

FIG. 2. Bars represent the amount of time participants spent on the unsolvable anagram (in seconds) for participants in game-playing, game-watching, and white bear conditions. *Note.* Error bars represent 1 standard error above and below the mean.

4. GENERAL DISCUSSION

In the two experiments, we tested whether playing a video game consumes self-regulatory resources. Overall, findings highlight a negative effect of playing video game on self-regulation. Specifically, our findings indicated that playing video games results in poorer performances on specific tasks entailing effortful monitoring for a given task (i.e., LDT in Study 1), or persistence on difficult tasks (i.e., unsolvable anagram in Study 2). Findings also showed that the negative consequences of game play were independent from both negative mood and liking of the game. Furthermore, our findings related to the game-watching condition supported the notion that active engagement in the game experience, which eventually requires deliberate and conscious responses and focused attention, is a significant source of ego-depletion. Therefore, such experiences in the virtual world should not be regarded as just a recreational activity, as these activities would consume self-regulatory resources for subsequent daily tasks (Baumeister & Vohs, 2003). Furthermore, it is known that when people are unable to regulate their behaviors due to ego depletion, they may be faced with a series of problems including unconstrained impulsive actions to suppress immediate urges, desires, and emotions (Baumeister & Vohs, 2003).

The present research investigated the effect of acute video game experience on self-regulation. Additional research is necessary to replicate and extend these findings to examine whether the differences in attention and persistence tasks are the result of playing a first-person shooter game per se as opposed to playing any type of video game. Other video game genres (e.g., action-oriented games, high-paced strategy games, etc.) could also entail actively participating challenging game environment, and players should allocate a great amount of the cognitive resources to the playing (see Nagygyörgy et al., 2013, for typology and sociodemographic characteristics of massively multiplayer online game players). Thus, one may plausibly expect depletory effects of game playing, including high-demand attention allocation and cognitive resources. Second, because the depletion literature has failed to provide a clear index for resource depletion, further studies should test reciprocal effect of ego-depletion on people's performance on video games. Establishing this bidirectional effect may show that the limited nature of self-control resources is indeed at play (see Vohs, Baumeister, & Ciarocco, 2005). Finally, all participants, in both studies, were male. Further studies should replicate the current results to generalize to women and nonstudents.

The present research is distinct from past work in notable ways. Although previous studies focused on two important consequences of playing video games on aggression (e.g., Anderson & Bushman, 2001) and perceptual-motor skills (e.g., Green & Bavelier, 2003), the question of whether these activities have negative consequences on self-regulatory resources, which are important indicators of cognitive performance, individual functioning, or/and aggressive behaviors, remained unanswered. The present research provided empirical support for a possible underlying process for the link between playing video games and later functioning in daily life.

Second, previous work investigated concurrent cognitive impacts (Schneider, et al., 2004) or long-term behavioral outcomes of playing a video game (Willoughby, et al., 2012) rather than subsequent performances following actual game experience. In daily life, however, many children and teenagers play such games to take a rest without knowing its adverse impacts on their performance on following work. It seems that these kinds of games should not be played just before important tasks entailing cognitive performance (e.g., preparing for an exam) in order to avoid failure or poor performance on subsequent tasks (e.g., difficulty in persistence on solving a challenging question while studying). Given that depleted ego-resources could be replenished by inducing positive mood (Tice et al., 2007), game designers may consider adding bonus stages inducing positive mood and reducing resource demanding tasks in their games to refill depleted self-regulatory resources.

To sum up, our findings highlight the process of how playing video games has deteriorating impacts for the subsequent tasks entailing self-regulatory resources. In this sense, actively participating challenging game environment does not seem a good alternative for leisure activities, especially when this activity is followed by a work that requires a full capacity of cognitive resources.

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