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Article

Harder, Better, Faster, Stronger? The Relationship between Cognitive Task Demands in Video Games and Recovery Experiences

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Abstract
Research has repeatedly demonstrated that the use of interactive media is associated with recovery experiences, suggesting that engaging with media can help people to alleviate stress and restore mental and physical resources. Video games, in particular, have been shown to fulfil various aspects of recovery, not least due to their ability to elicit feelings of mastery and control. However, little is known about the role of cognitive task demand (i.e., the amount of cognitive effort a task requires) in that process. Toward this end, our study aimed to investigate how cognitive task demand during gameplay affects users' recovery experiences. Results of a laboratory experiment suggest that different dimensions of the recovery experiences seem to respond to different levels of cognitive task demand. While control experiences were highest under low cognitive task demand, there was no difference between groups regarding experiences of mastery and psychological detachment. Nevertheless, both gaming conditions outperformed the control condition regarding experiences of mastery and psychological detachment. Controlling for personal gaming experiences, relaxation was higher in the low cognitive task demand condition compared to the control condition. Findings are discussed in terms of their implications for research on the multilayered recovery effects of interactive media.

Keywords
cognitive task demand; gaming; interactive media; recovery experiences; video games

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1. Introduction

People adopt various strategies to recover from stress; some engage in sports, others enjoy a special meal, or just relax while watching their favorite series. Indeed, previous research has identified the use of entertainment media as an effective strategy to alleviate negative affective states (e.g., Zillmann, 1988) and to recover from stressful situations (e.g., Rieger, Reinecke, Frischlich, & Bente, 2014). Video games in particular have been in the focus of media research given their interactive nature that challenges players to master quests, win out over other players or the game itself and, in doing so, fulfill psychological needs for recovery and well-being (e.g., Reinecke, 2009a; Reinecke, Klatt, & Krämer, 2011). While such research suggests that video games may be a significant recovery resource, the gaming environment also places continual demands on the player: Players engage in continuous "input–output loops" (Klimmt & Hartmann, 2006, p. 137) with the gaming environment and need to react to new challenges. The cognitive task demand of video games can be conceptualized as a function of the cognitive skills required to play as well as the cognitive resources needed to direct attention towards the actions in the game (Bowman, 2018). The role of the fit between a game's cognitive task demand and players' abilities to recover through gaming has been largely neglected by media psychological research thus far. However, as suggested by previous gaming research, experiences that fit media users' (cognitive) capacities may be particularly enjoyable, motivating users to push further, thus helping them to address their recovery needs (Schmierbach, Chung, Wu, & Kim, 2014).

Given that video games—not least due to their interactive nature—demand that players allocate a certain amount of their cognitive ability toward the game, the current article aims to close the gap in current research by testing the assumption that video games that demand just the right level of cognitive capacity are best suited to provide recovery experiences for their players. To this end, we instructed participants to play a high demand, low demand, or no video game and measured their cognitive task demand as well as recovery experiences in an experimental setting.

2. Media Use and Recovery Experiences

A plethora of daily activities—both in and out of work—drain people's mental and physical resources, which can result in negative affect or physiological and psychological fatigue (Fuller et al., 2003; Sluiter, de Croon, Meijman, & Frings-Dresen, 2003). To restore these resources and to avoid long-term stress or health ramifications, people need to recover. In general, recovery refers to the "process of replenishing depleted resources or rebalancing suboptimal systems" (Sonnentag & Zijlstra, 2006, p. 331), which is a vital factor for people's performance and psychological well-being. While the everyday use of the word recover(ing) usually refers to relatively passive activities and a state of low activation (e.g., relaxing or resting), recovery experiences go beyond winding down. In an attempt to integrate the different facets of recovery, Sonnentag and Fritz (2007) discuss four distinct recovery experiences that address different ways to replenish depleted resources: psychological detachment (i.e., mentally/physically distancing oneself from stress-inducing tasks); relaxation (i.e., reducing activation/increasing positive affect); mastery (i.e., experiencing competence and proficiency); and control (i.e., being able to choose activities at one's discretion). While the first two recovery experiences—psychological detachment and relaxation—imply that no new demands are imposed on the person, the latter two—mastery and control—suggest that recovery can also result from engaging in (new) activities that help to build up internal resources such as knowledge or self-efficacy (see also Reinecke & Eden, 2017).

Considering that recovery is a crucial self-regulatory process and essential for health and well-being, it comes as no surprise that determinants and antecedents of successful recovery have attracted considerable scholarly attention, particularly in industrial and organizational psychology (for an overview see Sonnentag, Venz, & Casper, 2017). While this line of recovery research has often marginalized the role of media use, research in media psychology and communication studies has demonstrated that (entertainment) media use is a frequently used and highly successful strategy to recover from stress and strain (e.g., Janicke, Rieger, Reinecke, & Connor, 2018; Reinecke et al., 2011; Rieger & Bente, 2018; Rieger, Reinecke, et al., 2014). Some studies explain these findings by the cognitive challenges posed by the content (e.g., Bartsch & Hartmann, 2017). These studies provide evidence that both interactive (e.g., video games) and non-interactive (e.g., movies) entertainment media can promote the four recovery experiences proposed by Sonnentag and Fritz (2007), although to different extents. Specifically, it was shown that non-interactive and interactive media elicit comparable levels of psychological detachment and relaxation but differ in their effect on experiencing mastery and control (Reinecke et al., 2011). Being interactive in nature, video games demand active participation from users and allow them to be in control of their actions, thus making games particularly suitable for fulfilling recovery needs (see also Reinecke, 2009a, 2009b).

3. Video Games, Cognitive Task Demand, and Recovery Experiences

Video games are interactive entertainment media which require players to use cognitive abilities to solve problems and tasks. Notably, such cognitive task demands are referred to differently in the literature. While some authors speak of "task load" (e.g., Moroney, Reising, Biers, & Eggemeier, 1993; Rieger, Frischlich, Wulf, Bente, & Kneer, 2015), some call it "task demand" (e.g., Bowman & Tamborini, 2012) or "cognitive load" (Read, Lynch, & Matthews, 2018). Considering that there are various demands necessary when playing video games (see Bowman, 2018), we have decided to stick to the term cognitive task demand(s) in the current article to refer broadly to the concept of "cognitive skills required to play games as well as the cognitive resources that the game pulls from the player in order to arrest attention toward the myriad messages in a game's environment" (Bowman, 2018, p. 7).

Solving tasks while playing an interactive video game may result in experiences of self-efficacy (Bandura, 1977), as players will directly experience how their actions affect the game. Early on, it was shown that such experiences are related to game enjoyment (Klimmt, Hartmann, & Frey, 2007; Trepte & Reinecke, 2011). In terms of mood management theory (Zillmann, 1988), being forced to act comes with intervention potential that helps players to be distracted from aversive states (Bowman & Tamborini, 2012; Bryant & Davies, 2006). Rieger and colleagues (2015) instructed participants to either play a game of the arcade classic game Pac-Man or let them watch a video of someone else playing it. They found that playing participants regulated their negative mood more efficiently than the other groups and that cognitive task demand fostered mood regulation. Recently, similar results were found for quiz games' ability to foster competence repair (Koban et al., 2018). Yet, this picture appears simplistic. Bowman and Tamborini (2012) confronted bored and stressed participants with more nuanced cognitive task demand conditions. They found that with increasing cognitive task demand participants' mood regulation increased as long as players were able to control the interactive environment. However, once the game became too demanding, their mood repair decreased. Altogether, the right match between cognitive task demand and players' cognitive capabilities thus appears relevant for the impact of interactive media on mood repair.

Previous research on the recovery potential of video games suggests that the benefit of playing cognitively demanding video games goes beyond mere mood repair. Data from a survey study by Reinecke (2009b) demonstrate that video games can contribute to all four recovery dimensions within Sonnentag and Fritz's (2007) conceptualization. We suggest that cognitive task demand resonates with Reinecke's (2009a) reasoning. First, Reinecke (2009a) argues that video games contribute to psychological detachment by forcing users "to focus their full attention on the game" as they "do not leave much room for thoughts that are not directed toward the gaming environment" (Reinecke, 2009a, p. 128). This argument is supported by authors describing video games as coming with varying task difficulties which players have to adapt to (e.g., Klimmt & Hartmann, 2006) as well as research showing that players immerse into the game and forget about the reality outside of the gaming narrative (e.g., Sherry, Lucas, Greenberg, & Lachlan, 2006). Accordingly, we expect that with increasing cognitive task demand players will experience higher levels of psychological detachment, as they are better able to distract themselves from the sources of their stress:

> H1a: Players in a high cognitive task demand condition will experience more psychological detachment compared to players in a low cognitive task demand condition and participants in a control group not playing a game;

> H1b: Players in a low cognitive task demand condition will experience more psychological detachment compared to participants in a control group not playing a game.

Reinecke (2009a) further argues that video games can help people to relax—although studies often attest that playing games comes with a rise in physiological arousal (e.g., Rieger et al., 2015). The relaxing effects of gaming may function based on similar mechanisms as physical activities, which are followed up by a decrease in anxiety and tension after the actual experience (e.g., Taylor, Sallis, & Needle, 1985). As high cognitive task demand may come with high levels of arousal, it appears counter-intuitive that it could be experienced as particularly relaxing. Thus, we pose the following research question with regard to relaxation:

> RQ1: Does the experience of relaxation differ between players in high, low, and no cognitive task demand conditions?

More intuitively, players experience control when solving in-game tasks. First, the experience of self-efficacy (Bandura, 1977; Klimmt et al., 2007; Trepte & Reinecke, 2011) may help people to experience control over certain gaming tasks. Second, video games provide players with a plethora of decisions, ranging from customization of avatars (Trepte & Reinecke, 2010) to freely exploring the in-game world. For the experience of control, cognitive task demand should play a crucial role. Under low cognitive task demand, players may easily keep all problems in check and experience high levels of control, whereas a game with high cognitive task demand may overstrain players and inhibit control experiences. However, even under conditions of high cognitive task demand, games are likely to provide more opportunities to experience control than the complete absence of current tasks. Thus, we pose the following set of hypotheses:

> H2a: Players in a low cognitive task demand condition will experience more control compared to players in a high cognitive task demand condition and participants in a control group not playing a game;

> H2b: Players in a high cognitive task demand condition will experience more control compared to participants in a control group not playing a game.

Finally, video games help players to experience mastery by allowing them to solve challenges, achieve success, and feel generally competent when playing the game (Klimmt et al., 2007; Rieger, Wulf, Kneer, Frischlich, & Bente, 2014; Ryan, Rigby, & Przybylski, 2006; Sherry et al., 2006). For the experience of mastery, cognitive task demand may play an important part. The more challenging the game, the more triumphant is the experience of having solved it. Hence, we expect:

> H3a: Players in a high cognitive task demand condition will experience more mastery compared to players in a low cognitive task demand condition and participants in a control group not playing a game;

> H3b: Players in a low cognitive task demand condition will experience more mastery compared to participants in a control group not playing a game.

Furthermore, researchers have argued that individual experiences playing video games differ between players as a function of their skills. A game which overexerts the player may lead to frustration (Bowman & Tamborini, 2012) and a game high in cognitive task demand may be too challenging for some players, thus impeding mastery or control experiences. If players are too inexperienced, such games might induce stress rather than helping them to recover from it. On the other hand, if the task is too easy, the experience of recovery may also be impeded, given that the task could have been solved by anyone without special effort. Thus, we pose as our final research question:

> RQ2: Does controlling for previous experience with video games impact recovery experiences between conditions of different cognitive task demand?

4. Method

4.1. Participants and Procedure

Participants were 148 German adults (77% female; age: $M = 24.82$, $SD = 5.49$; 95% students) recruited via student mailing lists and ad hoc on-campus recruitment at a large German University. All students received course credit for participation. After obtaining informed consent and introducing participants to the procedure of the experiment, participants worked on the KLT-R (Düker, Lienert, Lukesch, & Mayrhofer, 2001), a fatiguing concentration test, for about 5 to 10 minutes. The KLT-R consists of a large number of relatively easy arithmetic problems that need to be solved under time pressure. Similar tasks have been successfully used in previous media psychological studies to induce fatigue (e.g., Reinecke et al., 2011; Rieger, Hefner, & Vorderer, 2017).

Following this task, we randomly assigned participants to one of three conditions. Participants in the two gaming conditions played either a low (easy mode) or high (hard mode) cognitive task demand version of Tetris on a computer. During gameplay, participants had to react to a secondary reaction time task as an implicit measure for cognitive task demand (see Section 4.2). The control group did not play a video game, but its members were instructed to relax and react to the audio signals. After finishing the game, participants in the two treatment conditions reported their subjective cognitive effort and recovery experiences. Finally, we assessed demographic variables and debriefed participants. Originally, we also employed a second manipulation. Participants in both gaming conditions were given false feedback on their performance (i.e., they were told that they performed either better or worse than most other players). However, this manipulation failed, as 68.2% rated the authenticity of the feedback poorly. We tested whether feedback manipulation had an impact on any of the target variables when also accounting for task demand. These analyses yielded additional information that this second manipulation failed. Thus, we decided to exclude this variation from our final analyses. This second manipulation is included in the data set provided in our Open Science Framework (OSF) repository and may be used for further analyses (the respective variable is labelled as “feedback”).

4.2. Measures

4.2.1. Cognitive Task Demand

We used a secondary reaction time task programmed with OpenSesame (Mathôt, Schreij, & Theeuwes, 2012) as an implicit measure for cognitive task demand. We instructed participants in all three conditions to press a button with their free hand (as Tetris kept only one of their hands busy) whenever they heard an audio signal (altogether, 20 trials). This procedure is an established measure for cognitive task demand and has been used, for example, within research on message processing (Hefner, Rothmund, Klimmt, & Gollwitzer, 2011; Lang & Basil, 1998; Lang, Bradley, Park, Shin, & Chung, 2006). For the evaluation of reaction times, we identified missing values and outliers. From all trials ($N = 2{,}960$ possible data points), 542 data points were missing values. These missing values are either due to: a) technical issues; or b) participants not reacting at all during a trial. Among the remaining 2418 data points, we identified 79 trials within two standard deviations of the respective trial mean as outliers (Baayen & Milin, 2010), which corresponds to roughly 3.3% of the measured and non-missing data points. Notably, all of these outliers were located two standard deviations above (not below) the respective trial mean. This can be problematic if the right tail is responsible for the effects found in the data (Baayen & Milin, 2010; Luce, 1986). However, given that we excluded less than 5% of cases, this should not pose a problem (Baayen & Milin, 2010; Ratcliff, 1993). From the valid 2,339 trials, we calculated the mean reaction time (in seconds) for each participant ($M = .76$, $SD = .33$).

Additionally, we measured subjective cognitive task demand (cognitive effort) with four items of the NASA Task Load Index (NASA-TLX), assessed by default on a 20-point Likert scale ranging from “Low” to “High” (Moroney et al., 1993). Reliability analyses suggested excluding one item (asking participants how satisfied they were with the overall performance) to reach adequate reliability of the remaining three items ($M = 9.93$, $SD = 5.01$, $\alpha = .83$). This scale has been used in previous gaming studies focusing on cognitive task demand (e.g., Bowman & Tamborini, 2015). Both indices for cognitive task demand (reaction times and cognitive effort) correlated significantly ($r = .27$, $p = .01$).

4.2.2. Recovery Experiences

We measured recovery experiences with the scale developed by Sonnentag and Fritz (2007). This scale measures recovery experiences on four subscales, psychological detachment, relaxation, mastery, and control (each on a 5-point scale). Both the scale overall (recovery) and the previously mentioned subscales showed good internal consistency (recovery, $M = 2.87$, $SD = .78$, $\alpha = .89$; psychological detachment, $M = 3.22$, $SD = 1.03$, $\alpha = .81$; relaxation, $M = 2.89$, $SD = 1.11$, $\alpha = .88$; mastery, $M = 2.49$, $SD = .99$, $\alpha = .83$; control, $M = 2.88$, $SD = 1.02$, $\alpha = .79$).

4.2.3. Previous Gaming Experiences

As a covariate of interest, we asked participants to indicate how often they play video games in their everyday life. This scale ranged from 1 (never) to 5 (often; $M = 2.00$, $SD = 1.23$).

5. Results

Data, as well as analysis scripts of the current project, can be accessed in an OSF repository at https://osf.io/jgp58. Zero-order correlations between all variables of interest are presented in Table S1 in the supplementary material. All items used in the questionnaire can be accessed in Table S2 within the same file.

5.1. Manipulation Check(s)

To check whether the gaming conditions successfully induced different levels of cognitive task demand, we conducted a MANOVA with condition (low demand game vs. high demand game vs. control condition) as the independent variable and both measures of cognitive task demand (NASA-TLX for subjective cognitive task demand and reaction times as an implicit measure of cognitive task demand) as dependent variables. There was a significant effect of condition on subjective and implicit cognitive task demand, Wilk's $\Lambda = .46$, $F(4, 256) = 30.07$, $p < .001$, $\eta_p^2 = .32$. Separate follow-up univariate ANOVAs revealed that condition had a significant impact on both the NASA-TLX, $F(2, 129) = 54.58$, $p < .001$, $\eta_p^2 = .46$, and on reaction times, $F(2, 129) = 14.95$, $p < .001$, $\eta_p^2 = .19$. Sidak post hoc tests for both cognitive task demand measures showed that while subjective cognitive task demand (NASA-TLX) differed between all conditions following a linear trend in the expected direction (high, $M = 13.36$, $SD = 3.37$; low, $M = 9.65$, $SD = 3.97$; no game, $M = 4.32$, $SD = 3.45$), the high-demand ($M = .80$, $SD = .29$) and low-demand ($M = .86$, $SD = .32$) condition did not significantly differ in reaction times. However, participants in both gaming conditions showed slower reaction times compared to the control condition ($M = .47$, $SD = .28$). Altogether, the manipulation can be regarded as successful.

5.2. Cognitive Task Demand and Recovery Experiences

To test the impact of cognitive task demand on recovery experiences (H1–H3 and RQ1), we conducted a second MANOVA with condition as the independent variable and the four recovery dimensions (Sonnentag & Fritz, 2007) as dependent variables. There was a significant effect of condition on recovery experiences, Wilk's $\Lambda = .74$, $F(8, 284) = 5.67$, $p < .001$, $\eta_p^2 = .14$. Separate follow-up univariate ANOVAs revealed that condition had a significant impact on each dimension of recovery. For ease of interpretation, details and Sidak post hoc tests are presented in Table 1. Post hoc tests revealed that for psychological detachment and mastery experiences, both gaming conditions achieved higher recovery scores than the control condition, but there was no difference between the low cognitive demand and high cognitive demand gaming condition. Thus, H1a and H3a had to be rejected, whereas the findings supported H1b and H3b. There was no significant difference between the three conditions for relaxation (RQ1). For control experiences, all groups differed significantly from each other, with the low cogni-

Table 1. Univariate analyses and simple comparisons between conditions for all recovery experiences.

	Conditions					
	No Game Control *M* (*SE*)	**Low Cognitive Demand Game** *M* (*SE*)	**High Cognitive Demand Game** *M* (*SE*)	***F*-Test** *F* (*df*)	***p***	η_p^2
Psychological Detachment	2.60^{a} (.18)	3.49^{b} (.13)	3.30^{b} (.13)	**8.51** (2,145)	< .001	.11
Relaxation	2.65^{a} (.20)	3.15^{a} (.15)	2.78^{a} (.14)	**2.57** (2,145)	.080	.03
Mastery Experiences	1.95^{a} (.17)	2.63^{b} (.13)	2.64^{b} (.12)	**6.25** (2,145)	.002	.08
Control Experiences	2.15^{a} (.17)	3.30^{c} (.13)	2.88^{b} (.12)	**15.26** (2,145)	< .001	.17

Note: Within rows, means (*M*) with no superscript in common differ significantly.

tive demand gaming condition scoring highest, the control condition lowest, and the high cognitive demand gaming condition in between, supporting H2a and H2b.

5.3. The Influence of Previous Gaming Experiences

To account for individual differences in the use of video games (RQ2), we repeated the MANOVA above and introduced the measure for previous gaming experiences as a covariate to the model. When accounting for participants' gaming frequency, the MANCOVA yielded both condition (Λ = .68, $F(8, 282) = 7.50$, $p < .001$, $\eta_p^2 = .18$) and gaming frequency (Λ = .84, $F(4, 141) = 6.82$, $p < .001$, $\eta_p^2 = .16$) as significant predictors of recovery. Follow-up univariate ANOVAs for all recovery dimensions by both condition and gaming frequency were significant. For condition: psychological detachment, $F(2,144) = 12.79$, $p < .001$; relaxation, $F(2,144) = 3.73$, $p = .026$; mastery, $F(2,144) = 7.59$, $p = .001$; control, $F(2,144) = 20.26$, $p < .001$. For casual game play: psychological detachment, $F(1,144) = 19.62$, $p < .001$; relaxation, $F(1,144) = 3.73$, $p = .006$; mastery, $F(1,144) = 5.43$, $p = .021$; control, $F(1,144) = 15.15$, $p < .001$. Keeping gaming frequency constant, the observed effects of cognitive task demand remained. In addition, there now was a significant effect of condition on relaxation. That is, the low cognitive demand gaming condition was more relaxing than the no-game control condition (see Table 2).

6. Discussion

The current study was guided by one overarching question: How does cognitive task demand in a gaming situation impact users' recovery experiences? First, we expected that with increasing cognitive task demand, psychological detachment would increase, as more cognitive capacities would be required. As anticipated, the results indicate that playing a game (low and high cognitive demand gaming conditions) leads to significantly higher psychological detachment than not playing a game. However, there was no difference between both gaming conditions, even when controlling for previous gaming experiences. The simplest explanation for this finding would be that the amount of cognitive task demand does not affect psychological detachment as previous work has suggested (e.g., Bowman, 2018; Klimmt & Hartmann, 2006; Reinecke, 2009a; Sherry et al., 2006). Another explanation for this unexpected finding could be that while subjective cognitive task demand actually differed between all conditions in the expected direction, objective measures (reaction times) only indicated a difference between playing (either high or low cognitive demand) and not playing (control condition). In other words, while players differed in their subjective experience between the two gaming conditions, the objective cognitive task demand was comparable and response speed to the audio signal was similar across gaming conditions. These findings may indicate that psychological detachment could depend on the actual allocation of cognitive resources rather than the subjective experience of doing a cognitively demanding task. Furthermore, we might assume that psychological detachment does not directly connect to cognitive task demand or task difficulty but rather to other characteristics of the game, such as the complexity of the game world, story narration, or control elements that encourage people to immerse deeper into the game (e.g., Sherry et al., 2006). In the current study, participants in both gaming conditions used the same controls to play the same game which had the same visual features.

Second, we found no difference between any of the conditions regarding relaxation outcomes. It could be that video games—due to their interactive nature—are

Table 2. Univariate analyses and simple comparisons between conditions for all recovery experiences with previous gaming experiences held constant at a value of 2.

	Conditions					
	No Game Control *M* (*SE*)	**Low Cognitive Demand Game** *M* (*SE*)	**High Cognitive Demand Game** *M* (*SE*)	***F*-Test** *F* (*df*)	***p***	η_p^2
Psychological Detachment	2.50[a] (.17)	3.55[b] (.12)	3.29[b] (.12)	**12.79** (2,144)	< .001	.16
Relaxation	2.57[a] (.20)	3.19[b] (.15)	2.78[a,b] (.14)	**3.73** (2,144)	.026	.06
Mastery Experiences	1.90[a] (.17)	2.66[b] (.13)	2.64[b] (.12)	**7.59** (2,144)	.001	.10
Control Experiences	2.06[a] (.16)	3.35[c] (.12)	2.87[b] (.11)	**20.26** (2,144)	< .001	.22

Notes: Within rows, means with no superscripts in common differ significantly. 1 = never play games; 5 = often play games.

not able to reduce arousal levels below a certain point. For relaxation, non-interactive media such as movies might be the better choice (Rieger & Bente, 2018). However, controlling for previous gaming experiences, there was a difference in relaxation between the low cognitive demand gaming and the no-game control condition (with the high cognitive demand gaming condition scoring in between the two, but without being significantly different from any of them). For participants who play games at least seldomly, the low cognitive demand gaming condition achieved more relaxation than the no-game condition. These findings imply that relaxation as a recovery experience from playing video games depends on the fit between pre-experiences/skill and the cognitive task demand of a given game. To investigate this further, future research might consider targeting several player samples with different skill levels and assign them to conditions with different cognitive task demands.

For the experience of control, our findings showed that participants in the low cognitive demand gaming condition experienced most control, participants not playing a game reported the lowest control, and players in the high cognitive demand condition scored in between these conditions. These results are in line with research connecting experiences of self-efficacy with playing video games (e.g., Klimmt et al., 2007; Trepte & Reinecke, 2011). Participants in the low cognitive demand condition experienced the highest levels of control given that they were able to successfully respond to all in-game challenges, whereas participants in the high cognitive demand condition struggled to keep the gaming environment under control. Surprisingly, controlling for previous gaming experiences did not change these findings. It appears plausible that experienced players might find it easier to master a high cognitive demand version of the game, resulting in more control experiences compared to the same game being played by an inexperienced player. However, this finding may also imply that the experience of control is not connected to skill but to the perceived freedom of being able to choose how much subjective effort is invested in a given task. Again, subjective cognitive task demand (and not implicit measures) significantly differed between the high and low cognitive demand gaming condition. All players—independent of their gaming experiences—realized that in the hard condition more demands were placed on their cognition in order for them to control the situation.

Finally, we found a significant difference in mastery experiences between the two gaming conditions and the control condition, but not between the low and high cognitive demand gaming conditions. While it appears plausible that playing a game comes with more mastery experiences than just reacting to an audio signal, we had expected that cognitive task demand in the gaming situation would affect the experience of mastery. Although previous research suggests that cognitive task demand—as a proxy for challenge and difficulty—affects feelings of mastery and competence (Klimmt et al., 2007; Rieger, Wulf, et al., 2014; Ryan et al., 2006; Sherry et al., 2006), our findings imply that such experiences may occur independent of a game's cognitive demands or might depend more heavily on related outcomes such as success. If players are able to successfully cope with in-game challenges in both gaming conditions, those in the high cognitive demand condition should experience more mastery because they solved the more difficult task. Whereas, if the high cognitive demand condition was too difficult, players in the low cognitive demand condition should experience more mastery than the high cognitive demand condition. Given that controlling for gaming experiences did not change the results, both of these explanations do not seem to apply to our findings. Indeed, video game researchers found that success plays a crucial role in the experience and appraisal of gaming episodes (e.g., Rieger et al., 2015; Schmierbach et al., 2014; Trepte & Reinecke, 2011). Future research, therefore, might be interested to use the game score as an indicator for success and further explore its relationship with recovery outcomes (given that the current article focusses on task demand and recovery, we decided to refrain from analyzing the success/score variable; however, we encourage researchers to use the data in our OSF repository for further exploratory analyses). Noteworthy in this regard, Tetris offers only limited feedback and cues about actual performance beyond the game score (which is difficult to evaluate if players do not have the scores of other players for comparison). Thus, players have to rely on their own gut feeling of how successful they were at playing which may influence experiences of mastery (to account for the possibility that the dropped false-feedback factor may have impacted this analysis, we conducted an additional t-test with feedback condition—positive vs. negative performance feedback—on mastery experiences; there was no significant difference for mastery experiences between participants in the positive [$M = 2.55$, $SD = .97$] and negative [$M = 2.72$, $SD = .98$] feedback condition, $t[114] = -.95$, $p = .34$). Another explanation why the gaming groups did not differ might be that both conditions are not optimal for the experience of mastery: The low cognitive demand condition might have been too easy while the high cognitive demand condition may have been too difficult. Bowman and Tamborini (2012) found similar levels of affect in their low and high cognitive demand conditions with the medium cognitive demand condition between those two showing highest affect ratings (see Bowman & Tamborini, 2012). Future research might apply such a design instead of using a non-gaming condition to identify the optimal cognitive task demand for mastery experiences.

Taken together, these findings suggest that it is necessary for future research to differentiate between the subjective levels of cognitive task demand (as measured with the NASA-TLX in the current study) and the actual cognitive capacity objectively demanded (as measured with an implicit reaction time task). Our findings imply that these dimensions of cognitive task demand and its appraisal hold different implications for psychological constructs, in our case recovery experiences. While the distraction from a fatiguing task in terms of psychological detachment seems connected to the actual cognitive workload, experiences of control within the gaming experience appear to depend on subjective levels of cognitive task demand. Thus, future research should account for these nuances in the experience of cognitive task demand.

Beyond the open questions already raised above, some further methodological limitations of the present study have to be considered. First, there may be some questions regarding how our findings can be applied to real gaming situations. We instructed participants to play a certain game in a predefined mode. While we chose Tetris because cognitive task demand could easily be modified, participants were not able to not choose a game or a difficulty level to suit their needs on their own, threatening external validity. Another limitation in this regard is the assessment of cognitive task demand with a secondary reaction time task. Usually, players do not have to react on an audio signal while playing games. This task might have impacted the actual recovery experience of players in our study. Finally, for ecological reasons, we used a single-item measure as a proxy to account for variance in participants' previous gaming experiences. However, a single item cannot broadly map participants' complex history, skills, and encounters with video games. Thus, the covariate analysis conducted herein should be interpreted carefully and extended by future research.

7. Conclusion

The current study replicated and extended previous work on the intersection of video games, cognitive task demand, and recovery experiences. Findings showed that playing interactive video games could have beneficial effects on recovery. However, one has to account for different dimensions of recovery to see the whole picture. In the current study, playing a game contributed to psychological detachment and mastery experiences (independent of its difficulty). For the control dimension of recovery, findings indicate that difficulty plays a crucial role in the way that low cognitive task demand contributes particularly to control recovery experiences. Finally, accounting for previous gaming experiences, the low cognitive task demand condition also showed higher levels of relaxation than no gameplay. These findings show that research on entertainment media and recovery experiences should account for the different dimensions of recovery and their interaction with different levels of cognitive task demand. This might help to further uncover the underlying processes of recreation from everyday stress and strain.

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Conflict of Interests

The authors declare no conflict of interests.

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