




Stress-Reducing Effects of Playing a Casual Video Game among Undergraduate Students

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Abstract

Objective To assess the potential effectiveness of playing a simple, casual video game (Flower) in reducing stress relative to participating in a mindfulness-meditation session (body scan) among undergraduate students. Eighty undergraduate student participants (mean age = 19.46 years, $SD = 1.43$; gender: 48 females, 29 males, 3 preferred not to answer) were assigned to one of two groups in alternating order: one who played Flower and the comparison group who participated in a body scan, each lasting 20 min. Psychological and physiological stress measurements were made before and after each intervention. Self-perceived psychological stress was measured using a modified version of the nine-item Psychological Stress Measure (PSM-9), and physiological stress (heart rate, systolic and diastolic blood pressure) was measured using an electronic blood-pressure cuff. The results were analyzed with a 2 (measurement: pre, post) \times 2 (intervention: video game, mindfulness-meditation) mixed model analysis of variance (ANOVA) for each of the four outcome measures. There was a statistically significant reduction (pre- to post-intervention) across all outcome measures. Notably, there was a significant measurement \times intervention interaction ($p < .001$) for the psychological stress measure; participants in the mindfulness-meditation group reported greater stress reduction after the intervention than participants in the video game group. Although these results suggest mindfulness-meditation provides a slight advantage for stress reduction than casual video games, the similarity in reduction across all physiological measures between the two interventions nevertheless suggests casual video games may also be an effective medium. This finding is especially promising given casual video games' accessibility, ease of use, and popularity among students. These results may inform initiatives by colleges and universities to better support students during peak times of stress and especially during the current COVID-19 pandemic.



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Undergraduate student stress is prevalent across the world, which can lead to low self-esteem and a low external locus of control (Abouserie 1994; Campbell et al. 1992; Saleh et al. 2017; Stanley and Bhuvanewari 2016; Zhang et al. 2012). A recent survey by the American College Health Association (2019) revealed that nearly 60% of students in the USA reported experiencing above-average levels of stress within the last 12 months of completing the survey, and about 35% reported that stress had negatively impacted their studies in the last year. Indeed, accumulating evidence suggests stress can negatively impact learning and memory retrieval (Vogel and Schwabe 2016). As such, a large number of studies have been published highlighting the effectiveness of a variety of stress-reducing techniques, including meditation, yoga-based programs, counseling services, listening to music, adult coloring, nature therapy, and pet therapy (Barker et al. 2010; Chafin et al. 2004; Hansen et al. 2017; Jiang et al. 2016; Mantzios et al. 2019; Mantzios and Giannou 2018; Regehr et al. 2013; Shearer et al. 2016; Warnecke et al. 2011).

More recently, there has been growing interest in the stress-reducing effects of mindfulness, defined by Kabat-Zinn (1994) as “paying attention in a particular way: on purpose, in the present moment, and non-judgmentally” (p. 4). Mindfulness is popularly achieved through guided meditation, with an increasing number of studies showing its effectiveness in reducing both psychological and biological markers of stress, e.g., blood pressure and heart rate (Barnes et al. 1999, 2001; Burton et al. 2017; Hoge et al. 2018; Kang et al. 2009; Khoury et al. 2015). Intriguingly, Palmer and Rodger (2009) observed an inverse relationship between self-reported levels of mindfulness and stress among university students. Moreover, the literature has highlighted how mindfulness-meditation can help college students manage their stress in response to the academic, cognitive, and emotional challenges associated with university life (Bamber and Schneider 2016; Huberty et al. 2019; Lemay et al. 2019; Ratanasiripong et al. 2015; Rosenzweig et al. 2003; Warnecke et al. 2011).

Although mindfulness-meditation has shown promise as a method of stress reduction, it may not be a favored technique among undergraduate students. Video games, by contrast, appear to be particularly popular among this population (Thomas and Martin 2010). In 2008, the Pew Research Center reported that 57% of individuals who have some form of post-secondary education are video game players; this statistic increases substantially to 76% for current students (Lenhart et al. 2008). In addition to video games’ popularity as a pastime, several studies have reported that people of all ages turn to video games to cope with stress (Bledsoe et al. 2018; Ferguson and Olson 2013; Reinecke 2009; Wack and Tantleff-Dunn 2009; Whitbourne et al. 2013); and accumulating evidence has linked playing video games to relaxation and stress reduction (Jones et al. 2014; Rieger et al. 2015; Roy and Ferguson 2016; Soyoof and McLay 2019).

Although research examining the therapeutic effects of serious video games has started to gain traction, the stress-reducing potential of simple, easy-to-learn casual video games that can be played for a short duration has not been well researched. For example, in a recent systematic review, Pine et al. (2020) reported only three studies that examined the impact of playing casual video games on stress, with all three studies reporting that playing casual video games led to lower levels of stress (Fish et al. 2014;

Rupp et al. 2017; Russoniello et al. 2009). To date, however, no studies have investigated how playing a casual video game compares to the more widely studied method of mindfulness-meditation in reducing stress.

To that end, in the present study, we assessed whether playing a casual video game could serve as a viable alternative to participating in a mindfulness-meditation session as a method of stress reduction among undergraduate students. Moreover, given the demands of post-secondary education, we were also interested in investigating the potential stress-reducing effects of these interventions if used for a brief period of time (20 min in our study). For our video game intervention, we used “Flower,” a casual free-form video game with minimal instruction that, in contrast to more traditional video games, can be played for short periods at a time. In addition to its ease of use, another feature of Flower that makes it particularly attractive is it is accessible on a variety of platforms (e.g., iOS, PlayStation, Windows).

For our mindfulness-meditation intervention, we used a body scan, a form of meditation in which the participant is made consciously aware of the different parts of their body. We decided to utilize a body scan meditation due to its simplicity and link with the well-established mindfulness-based stress reduction program (MBSR), which has shown much promise in improving a number of health outcomes, including stress reduction (Grossman et al. 2004; Hughes et al. 2013; Levoy et al. 2017; Momeni et al. 2016; Nyklíček et al. 2013; Parswani et al. 2013; Rush and Sharma 2017; Shapiro et al. 1998). Additionally, some studies have shown that body scan meditation alone leads to similar results (Corbett et al. 2019; Ditto et al. 2006; Schultchen et al. 2019; Ussher et al. 2014).

Ultimately, we aimed to assess the relative effectiveness of playing a casual video game to participating in a mindfulness-meditation session. If we find that playing a casual video game leads to similar, if not better, levels of stress reduction to participating in a mindfulness-meditation session, this would suggest casual video games may be an effective stress-reducing intervention for undergraduate students, which is especially promising given their accessibility, ease of use, and popularity among this population.

Method

Participants

A total of 80 undergraduate students (mean age = 19.46 years, $SD = 1.43$; gender: 48 females, 29 males, 3 preferred not to answer) from a Midwestern university in the USA participated in the present study for course credit (Table 1). Participants self-enrolled via an advertisement posted on an online participant management platform (Sona Systems). We excluded individuals who had been diagnosed with anxiety and/or depressive disorders in order to better investigate our interventions on typical undergraduate students. This study was approved by the local ethics review board.

Materials and Measurements

The video game intervention used in the present study was the video game, Flower (developed by “Thatgamecompany”). In this game, the user controls the wind, moving

Table 1 Participant demographics

Demographic	Mindfulness-meditation	Video game	All
Age			
Minimum	18	18	18
Maximum	23	27	27
<i>M</i>	19.50	19.43	19.46
<i>SD</i>	1.24	1.62	1.43
Gender			
Male	13	16	29
Female	26	22	48
PNTA	1	2	3

Note. This table lists the age and gender of the participants in the present study

PNTA, prefer not to answer

an initial flower petal through the air, which participants in our study accomplished by tilting and turning a 10.5-inch iPad Pro (Apple Inc.). Flying the petal close to flowers results in the initial petal being followed by subsequent flower petals, eventually building a trail of petals. The mindfulness-meditation intervention featured a guided body scan session (played out loud via a 21.5-inch iMac, Apple Inc.) adapted from the theory of yoga nidra (Saraswati 2009) and courteously provided by Dr. Parmjit Singh (McMaster University).

The participant sat alone in the center of a small, relatively empty room at the university containing only some furniture (e.g., iMac on desk, chair for participant, file cabinet), most of which were used in the experiment. The iMac from which the body scan was played was situated to the right of the participant.

To measure psychological stress, we administered a modified version of the nine-item Psychological Stress Measure (PSM-9) (Lemyre and Tessier 2003). The original survey has been validated and used in other studies (Lemyre and Lalande-Markon 2009; McFadden et al. 2012). The modification we made to the PSM-9 was very minor; rather than asking participants to reflect on their mood in the last 4 to 5 days, we asked participants to reflect on their mood currently (see Table 3 in the Appendix). Cronbach's alpha calculations revealed our modified PSM-9 had fairly good reliability (pre: $\alpha = .77$; post: $\alpha = .81$).

To measure physiological stress, we used an Omron 10 Series electronic blood pressure cuff to capture participant heart rate and blood pressure. To minimize potential white coat hypertension, these measurements were taken by an undergraduate student researcher (Myers 2014; Myers et al. 2010). Such physiological measures were used in previous stress-related investigations (Barnes et al. 2001; Ditto et al. 2006; Nyklíček et al. 2013). Additionally, in the typical stress response, cortisol may induce sodium retention and nitric oxide suppression leading to hypertension (due to volume expansion and systemic vasoconstriction) and increased heart rate (Gerra et al. 2001; Kelly et al. 1998). Thus, a reduction in heart rate and blood pressure may be indicative of lowered physiological stress.

Procedure

Participants underwent a series of pre-intervention measurements (PSM-9, heart rate, systolic blood pressure, diastolic blood pressure) and were assigned in alternating order to the video game group or the mindfulness-meditation group. Participants were then seated comfortably on a chair in the center of the room and either played Flower or followed a guided body scan session for a duration of 20 min. Once this was complete, participants underwent the pre-intervention measurements once more.

Data Analysis

Kolmogorov-Smirnov tests revealed the data were non-normally distributed for the pre ($p = .004$) and post ($p = .009$) PSM-9 measurements of the video game group; pre ($p = .027$) systolic blood pressure measurement of the mindfulness-meditation group; and post ($p = .026$) diastolic blood pressure measurement of the video game group. Thus, all PSM-9, systolic blood pressure, and diastolic blood pressure data were log-transformed prior to analysis. The results of each of the outcomes measures (PSM-9, heart rate, systolic blood pressure, diastolic blood pressure) were then analyzed with a 2 (measurement: pre, post) \times 2 (intervention: video game, mindfulness-meditation) mixed model analysis of variance (ANOVA). Descriptive statistics reported herein reflect the raw data (Manikandan 2010). All statistical analyses were performed using SPSS Statistics v25 (IBM) for MacIntosh.

Results

PSM-9 Survey

The ANOVA revealed a significant main effect of measurement, $F(1,78) = 159.00$, $p < .001$, $\eta^2_p = .67$, indicating that participants reported lower levels of perceived stress after the interventions ($M = 2.53$, $SD = 0.81$) than before ($M = 3.30$, $SD = 0.89$). Additionally, there was a main effect of group, $F(1,78) = 11.64$, $p = .001$, $\eta^2_p = .13$, indicating that participants in the mindfulness-meditation group ($M = 3.16$, $SD = 0.97$) reported lower overall levels of perceived stress than participants in the video game group ($M = 3.43$, $SD = 0.79$). There was also a significant measurement \times intervention interaction, $F(1,78) = 18.71$, $p < .001$, $\eta^2_p = .19$. On average, participants in the mindfulness-meditation group (pre: $M = 3.16$, $SD = 0.97$; post: $M = 2.17$, $SD = 0.67$) reported greater stress reduction than participants in the video game group (pre: $M = 3.43$, $SD = 0.79$; post: $M = 2.88$, $SD = 0.80$) (Fig. 1) (See Table 2 for summary statistics of all outcome measures).

Heart Rate

The ANOVA revealed a significant main effect of measurement, $F(1,78) = 52.12$, $p < .001$, $\eta^2_p = .40$, but not of group. There was no significant measurement \times intervention interaction. On average, heart rate was lower after ($M = 71.50$ beats/min, $SD = 11.36$) the intervention than before ($M = 76.58$ beats/min, $SD = 14.21$) (Fig. 2).

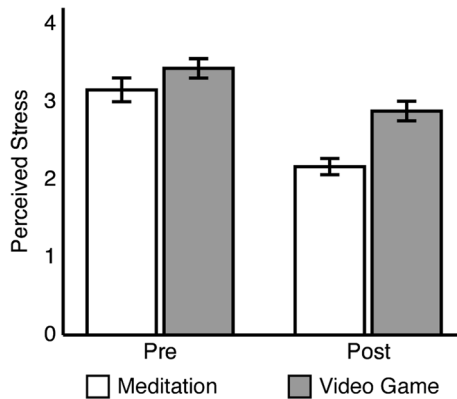


Fig. 1 Pre- and post-PSM-9 scores of participants in the mindfulness-meditation (white bars) and video game (grey bars) groups. Participants overall reported lower PSM-9 scores after participating in the interventions ($p < .001$). There was greater PSM-9 reduction among participants in the mindfulness-meditation group than participants in the video game group ($p < .001$). $M \pm 1 SE$

Systolic Blood Pressure

The ANOVA revealed a significant main effect of measurement, $F(1,78) = 40.80$, $p < .001$, $\eta^2 p = .34$, but not of group. There was no significant measurement \times intervention interaction. On average, systolic blood pressure was lower after ($M = 113.09$ mmHG, $SD = 12.51$) the intervention than before ($M = 120.23$ mmHG, $SD = 13.97$) (Fig. 3).

Table 2 Summary statistics

Outcome measure	Mindfulness-meditation		Video game		All	
	Pre	Post	Pre	Post	Pre	Post
PSM-9						
<i>M</i>	3.16	2.17	3.43	2.88	3.30	2.53
<i>SD</i>	0.97	0.67	0.79	0.80	0.89	0.81
Heart rate						
<i>M</i>	75.68	70.39	77.48	72.60	76.58	71.50
<i>SD</i>	13.79	10.97	14.74	11.76	14.21	11.36
Systolic BP						
<i>M</i>	118.95	111.85	121.52	114.33	120.23	113.09
<i>SD</i>	15.22	15.13	12.67	9.21	13.97	12.51
Diastolic BP						
<i>M</i>	71.65	70.81	71.61	69.06	71.63	69.93
<i>SD</i>	8.91	9.06	8.45	9.87	8.63	9.45

Note. This table lists the means and standard deviations of each of the four outcome measures in the present study

PSM-9, Psychological Stress Measure; heart rate measured in beats/minute; systolic and diastolic blood pressure (BP) measured in mmHG

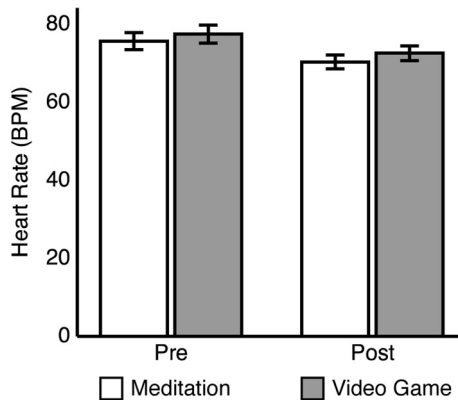


Fig. 2 Pre- and post-heart rate of participants in the mindfulness-meditation (white bars) and video game (grey bars) groups. There was a statistically significant reduction in heart rate in both participant groups after the intervention ($p < .001$). $M \pm 1 SE$

Diastolic Blood Pressure

The ANOVA revealed a significant main effect of measurement, $F(1,78) = 7.96$, $p = .006$, $\eta^2_p = .09$, but not of group. There was no significant measurement \times intervention interaction. On average, diastolic blood pressure was lower after ($M = 69.93$ mmHG, $SD = 9.45$) the intervention than before ($M = 71.63$ mmHG, $SD = 8.63$) (Fig. 4).

Discussion

Overall, our data show that playing a casual video game such as Flower for a short duration can be nearly as effective in reducing stress among undergraduate students as participating in a body scan session for the same duration. There was a statistically significant decrease across all four stress measures (PSM-9, heart rate, systolic blood pressure, diastolic blood pressure) pre- to post-intervention. With the exception of

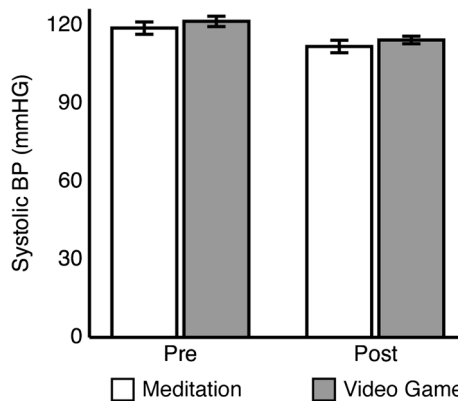


Fig. 3 Pre- and post-systolic blood pressure scores of participants in the mindfulness-meditation (white bars) and video game (grey bars) groups. There was a statistically significant reduction in systolic blood pressure in both participant groups after the intervention ($p < .001$). $M \pm 1 SE$

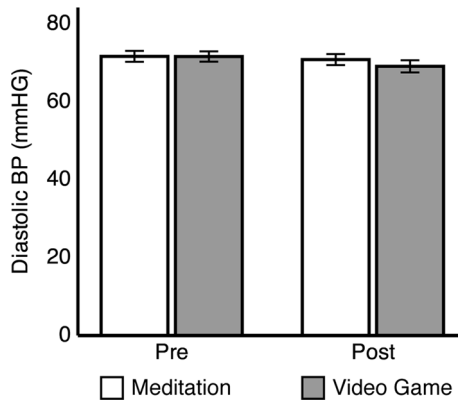


Fig. 4 Pre- and post-diastolic blood pressure scores of participants in the mindfulness-meditation (white bars) and video game (grey bars) groups. There was a statistically significant reduction in diastolic blood pressure in both participant groups after the intervention ($p = .006$). $M \pm 1 SE$

perceived stress, there was no difference in the degree of reduction across the stress measures between playing a casual video game and participating in a mindfulness-meditation session. Thus, playing casual video games may be a viable method for stress reduction among undergraduate students.

Casual Video Games and Stress Reduction

Our study is part of an emerging mosaic of research investigating the effectiveness of casual video games for stress reduction. We found that playing a casual video game, such as *Flower*, can be an effective medium to lowering psychological and physiological student stress, a finding that is consistent with several studies from the literature (Fish et al. 2014; Pine et al. 2020; Rupp et al. 2017; Russoniello et al. 2009). Among those studies, the most relevant to ours is one by Russoniello et al. (2009), who also explored the connection between casual video games and stress reduction after a 20-min session. In their study, individuals were randomized between a casual video game group and an internet research (control) group. The study observed that those who played a casual video game experienced improved mood and reduced physiological stress compared to baseline, thus supporting our study's observation of casual video games' potential stress-reducing benefit.

To our knowledge, our study is the first to directly compare the effects of playing a casual video game to participating in guided mindfulness-meditation. Although we found that playing a casual video game was just as effective as meditating for physiological stress reduction, we found that participants in the mindfulness-meditation group enjoyed greater reductions in self-perceived stress. It is possible this finding is due to participant expectation, whereby individuals in our study were more inclined to report greater reductions after meditating than after playing a casual video game because of meditation's widely perceived benefit. Alternatively, it is possible that playing casual video games may be more of a distraction-based strategy, which has been suggested to be less effective than mindfulness-based strategies in reducing stress (Broderick 2005).

Mindfulness-Meditation and Stress Reduction

We found that a brief period of body scan meditation reduced blood pressure, heart rate, and self-perceived stress among our participants, findings that are in general agreement with the meditation literature (Barnes et al. 1999; Ditto et al. 2006; Grégoire and Lachance 2015; Hoge et al. 2018; Oman et al. 2008; Park and Han 2017; Pramanik et al. 2010; Rush and Sharma 2017).

Of notable interest is a study by Ditto et al. (2006), who also administered a 20-min body scan and subsequently observed a reduction in the heart rate of their participants. However, unlike our study which found global reductions in blood pressure, Ditto et al. had mixed results. In one experiment, the authors reported no reduction in blood pressure after their participants underwent a body scan session, but in a follow-up experiment, there was evidence for systolic blood pressure to decrease. Although our blood pressure results appear statistically at odds with Ditto et al., they are descriptively quite similar. That is, we observed a much greater decrease of systolic, than diastolic, blood pressure (over four folds greater) among our participants who underwent a body scan and only a marginal decrease in diastolic blood pressure. This finding is also strikingly similar to the MBSR literature, which also reported greater decreases in systolic than diastolic blood pressure following MBSR (Hughes et al. 2013; Momeni et al. 2016; Parswani et al. 2013). A possible explanation for the differences in reduction between systolic and diastolic blood pressures is that, physiologically, systolic blood pressure varies to a greater degree than diastolic blood pressure (Musini and Wright 2009).

Intriguingly, Ditto et al. (2006) observed no difference in the extent to which heart rate and blood pressure decreased between their three intervention groups: body scan, muscle relaxation, and sitting quietly. Our results are generally consistent with this finding, as we also observed no differences in the extent to which heart rate and blood pressure decreased between our two intervention groups: mindfulness-meditation and video game. This lack of difference between undergoing a body scan and other relaxation activities (e.g., playing a casual video game) may suggest, as recently reported in a systematic review, that mindfulness-meditation in general is no better at reducing stress than other relaxation activities (Goyal et al. 2014). That said, it is interesting to note that Ditto et al. (2006) found that a body scan resulted in greater increases in heart rate variability, indicative of reduced stress/anxiety, among their participants than all their other interventions; and we found that self-perceived stress also reduced to a greater extent among the mindfulness-meditation than the video game group. Regardless, our results nevertheless suggest playing a casual video game may offer a viable alternative for stress reduction to mindfulness-meditation, which is especially important given casual video games' accessible nature, ease of use, and popularity among students.

Physiological Effects of Stress-Reducing Activities

Mindfulness-meditation focuses on increasing self-awareness towards one's situational emotional responses, in the present moment and non-judgmentally (Hölzel et al. 2011; Kabat-Zinn 1994; Tang et al. 2015). Over time, this may lead to decreases in an individual's reactivity towards a negative emotional stimulus. These changes are

thought to be mediated by brain areas including the ventromedial prefrontal cortex (vmPFC), which may mediate amygdala activity; patients practicing mindfulness-meditation show increased activity in the vmPFC and reduced activity in the amygdala (Chau et al. 2018; Hölzel et al. 2011; Kral et al. 2018; Zeidan et al. 2014). These neural changes have been associated with increased parasympathetic tone and reduced cortisol levels, presumably reducing physiological and psychological responses to stress (Hölzel et al. 2011). Patients playing non-violent video games have also demonstrated increased vmPFC activity during emotional stimulation (Palau et al. 2017; Wang et al. 2009). Taken together, these studies suggest the stress-reducing capabilities of mindfulness-meditation and casual video games, such as Flower, may be mediated by upregulation of vmPFC activity.

Limitations and Future Directions

There is a small possibility that our measurements were influenced by white coat hypertension, a phenomenon where blood pressure is elevated (beyond baseline levels) from fear of visiting a clinician (Myers et al. 2010). Thus, it is possible our participants' initial blood pressure and heart rate were artificially elevated from fear of visiting a research study. If this is the case, the reductions in blood pressure and heart rate we observed might simply reflect a decrease of white coat hypertension (rather than the interventions themselves) as the participants became accustomed to the research environment. Although we acknowledge this possibility, we believe this effect is unlikely in our study. White coat hypertension has previously been shown to be drastically reduced if the blood pressure is taken by a technician rather than a physician (Myers et al. 2010). With this in mind, participants in our study were greeted by an undergraduate student, dressed in their typical attire, and participant blood pressure (and heart rate) subsequently measured by an automated electronic blood pressure cuff. Furthermore, white coat hypertension has been suggested to overestimate blood pressure by ~ 5 mmHg (Myers 2014), while we observed a reduction greater than 5 mmHg in systolic blood pressure (7.14 mmHg). However, there was only a small decrease in diastolic blood pressure (1.70 mmHg) that is not beyond the average reported white coat hypertension effect. Lastly, our study was not a medical study nor was it conducted in a clinical setting. Nevertheless, future studies of this nature could further decrease the possibility of the white coat hypertension by allowing the experimenter to momentarily leave the room while blood pressure is measured electronically (Myers et al. 2010).

Although the psychological stress measurement used in our study was based on a previously validated survey, PSM-9 (Lemyre and Tessier 2003), we recognize that with any changes, the validity of the original survey may be altered. While we did not test the validity of our modified PSM-9, the changes we made were very minor (see Table 3 in the Appendix) and the calculated Cronbach's alpha suggests both the pre- and post-surveys have good reliability. Nevertheless, it would be important to further assess the psychometric properties of our modified survey instrument in future studies.

Elevated secretion of cortisol is the typical endocrine response to stress. Although heart rate and blood pressure are proxies of stress (Gasparin et al. 2009), cortisol may provide a more accurate measurement. Thus, future studies should investigate how

cortisol and other primary markers of stress are impacted by interventions such as playing casual video games relative to participating in mindfulness-meditation sessions.

We recognize the elements found within Flower may not be consistent across this entertainment medium. Flower does not share the same gameplay mechanisms as other commercial video games such as Call of Duty or Mario Kart. As highlighted in Mondéjar et al. (2016), video games can contain different components that may elicit different reactions and emotions in their users. For example, it is possible the effectiveness of our video game is due, in part, to the serene environment and music of the game. Flower is based entirely in a simulated outdoor environment, encompassing elements such as meadows, mountains, and trees. Studies have shown, for example, that watching a nature video or listening to calming music can have stress-reducing effects (Chafin et al. 2004; Hansen et al. 2017; Jiang et al. 2016; Parsons et al. 1998). Similarly, we used only one form of meditation in our study. Thus, it is possible that other forms of meditation (e.g., transcendental) may have differential effects on stress. In fact, Sauer-Zavala et al. (2013) reported that a body scan was less effective in improving psychological well-being (e.g., depression/anxiety, emotion regulation) than both sitting meditation and mindful yoga. Thus, future research should explore how different genres of video games and different forms of meditation affect the psychological and physiological levels of stress of their users.

Lastly, one interesting aspect of video game play is its proposed ability to induce a state of flow, which may elicit positive emotions (Michailidis et al. 2018). Although it is unclear if participants in our study achieved a flow state, we think this is unlikely given the game mechanics of Flower. For example, a flow state is thought to be achieved through tasks that are both challenging and have a clear goal (Klasen et al. 2012). Flower, however, is not a particularly challenging game nor does it present the player with clear, explicit goals. Nevertheless, because we did not test for this directly, it would be interesting to investigate in future studies whether a simple, casual video game like Flower is capable of inducing a flow state in participants.

Conclusion

Overall, we found that playing a casual video game, such as Flower, is an effective strategy to reduce stress. Although mindfulness-meditation was found to have a slight advantage, casual video games may benefit more students, as they are more accessible, easier to use, and more popular among this population. We hope these results could inform initiatives by colleges and universities to better support students, especially during peak stressful times. Additionally, in light of the current COVID-19 pandemic, undergraduate students are facing higher levels of stress and anxiety due to concerns such as fear of infection, finance, and uncertainty about the future (Martinez and Nguyen 2020). Post-secondary institutions could, for example, set up video game stations in student spaces or encourage the use of this medium online, especially during the current COVID-19 pandemic. It would also be important to further investigate the extent to which playing casual video games is beneficial in the long term and whether those benefits are specific to particular game mechanics.

Appendix

Table 3 Modified nine-item Psychological Stress Measure (PSM-9)

Check the number that best indicates the degree to which each statement applies to you currently.								
Description of Mood	NOT AT ALL	NOT REALLY	VERY LITTLE	A BIT	SOMEWHAT	QUITE A BIT	VERY MUCH	EXTREMELY
	1	2	3	4	5	6	7	8
I feel calm.								
I feel rushed; I do not seem to have enough time.								
I have physical aches and pains: sore back, headache, stiff neck, stomach ache.								
I feel preoccupied, tormented, or worried.								
I feel confused; my thoughts are muddled; I lack concentration; I cannot focus.								
I feel full of energy and keen.								
I feel a great weight on my shoulders.								
I have difficulty controlling my reactions, emotions, moods, or gestures.								
I feel stressed.								

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Declarations

Ethics Approval This study was approved by the local ethics review board at the University of Wisconsin-La Crosse.

Consent to Participate All participants signed an informed consent form prior to participation in the study.

Conflict of Interest The authors declare no competing interests.

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