# Contrasting Mind-Wandering, (Dark) Flow, and Affect During an Auditory Vigilance Task and Slot Machine Play: Implications for Gambling to Escape

by

Tyler Kruger

A thesis

presented to the University of Waterloo

in the fulfilment of the

thesis requirement for the degree of

Master of Arts

in

Psychology

Waterloo, Ontario, Canada, 2020

© Tyler Kruger 2020

## Author's Declaration

This thesis consists of materials all of which I authored or co-authored: see Statement of Contributions included in the thesis. This is a true copy of the thesis, including any required final revision, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

## Statement of Contributions

**Tyler Kruger** was the primary author of the manuscript, conceived the experimental design, collected and analyzed the data.

**Mike J. Dixon** guided the research process, including the experimental design, data analysis, and the writing of the manuscript.

**Candice Graydon** assisted with data collection, the experimental design and framing the findings.

**Chanel J. Larche** assisted with data collection, the experimental design and framing the findings.

**Madison Stange** assisted with data collection, the experimental design and framing the findings.

**Stephen D. Smith** assisted with the consultation of the design and editing the manuscript.

**Daniel Smilek** also guided the research process, including the experimental design, data analysis, and editing the manuscript.

**Abstract**

Slot machines are a pervasive form of gambling in North America. In Experiment 1 and 2, we assessed gamblers for mindfulness, gambling problems, depressive symptoms, and boredom proneness. In Experiment 1, participants played both a multiline and single-line slot machine simulator and were occasionally interrupted with thought probes to assess whether they were thinking about the game or something else. After playing each game, we retrospectively assessed dark flow and affect during play. The number of "on-game" reports during the multiline game were significantly higher than the single-line game. We also found significantly greater flow and lower negative affect during the multiline game than the single-line game. Using hierarchical multiple regression, we found that dark flow accounted for unique variance when predicting problem gambling severity (over and above depression, mindfulness, and boredom proneness). In Experiment 2, participants played a multiline slot machine simulator and completed an auditory vigilance task. Similar to Experiment 1, participants were occasionally interrupted with thought probes and retrospective flow and affect was assessed after completing each task. Players reported greater negative affect following the vigilance task (when compared to slots) and greater positive affect following slots (when compared to the vigilance task). We also found that those who scored higher in problem gambling were more likely to use deliberate mind-wandering during the vigilance task. Using hierarchical multiple regression, we found that the number of "deliberately mind-wandering" responses accounted for unique variance when predicting problem gambling severity (over and above depression, mindfulness, and boredom proneness).

**Acknowledgements**

I would like to thank my supervisors, Dr. Mike Dixon and Dr. Dan Smilek for their guidance and support over the course of this thesis. I am deeply grateful for their enthusiasm and insights, which continue to push me to grow as a researcher, as a professional, and as a person. I am very excited for the opportunity to continue working with you. I would also like to thank my readers, Dr. James Danckert and Dr. Jonathan Fugelsang, their expertise and feedback are appreciated.

I would also like to thank Dr. Candice Graydon for organizing and collaborating with the Ontario Lottery and Gaming Corporation and Elements Casino Brantford on the behalf of the Gambling Research Lab. Thank you to my labmates, Allison, Alyssa, Bruno, Chanel, Emilie, Jeremy, Lydia, and Madison, for making our lab a safe space and for the words of encouragement over the years. I am also very grateful for my Research Assistants, Dayne, Katrina, Molly, and Tenaaz, for helping with data collection.

Thank you to the National Science and Engineering Research Council of Canada (NSERC) and the Manitoba Liquor and Lotteries who supports our lab through funding. These studies are currently under review at the *Journal of Gambling Studies* and the *Journal of Behavioural Addictions*.

Lastly, I would also like to thank Rose Gregorio and her responsible gambling team at the Brantford Casino, as well as all of the people who participated in these studies, without them, this research would not be possible.

## Dedication

To my friends and loved ones, my parents, Debbie and Brad, my sister and brother-in-law, Katelyn and Kyle, and my partner, Fabiola. Thank you for your constant love and support, and your untiring belief in me and what I am capable of. I couldn’t have done this without you.

**Table of Contents**

## List of Figures

## List of Tables

## Introduction

Slot machine gambling is one of the most ubiquitous forms of casino gaming in North America (Schüll, 2014). According to the 2018-2019 annual report, the Ontario Lottery and Gaming Corporation generated approximately $8.3 billion in total revenue with approximately half (46.5%) coming from land-based gaming where slot machines are housed (Ontario Lottery and Gaming Corporation, 2019). In a report conducted for the Ontario Problem Gambling Research Centre and the Ontario Ministry of Health and Long-Term Care, Willams and Volberg (2013) estimated that problem gamblers account for approximately one quarter (24.1%) of the revenue generated from government-sponsored gambling. They also note that the proportion of revenue generated from problem gamblers playing electronic gambling machines (e.g., slot machines) is even higher (Williams & Volberg, 2013). Despite their unique appeal, research has recognized that slot machines can pose serious problems for a small proportion of gamblers (Dowling et al., 2019; Pfund, Peter, Whelan, Meyers, Ginley, & Relyea, 2020). Problem gamblers face a variety of difficulties ranging from financial troubles to health and/or relationship problems (Blaszczynski, Sharpe, Walker, Shannon, & Coughlan, 2005; Lahn, 2005; Li, Browne, Rawat, Langham, & Rockloff, 2017). Researchers are unified in the view that slot machines can create problems for some individuals (Dowling et al., 2019; Pfund, Peter, Whelan, Meyers, Ginley, & Relyea, 2020)—for example, in 2017, the Ontario Problem Gambling Helpline received more calls from gamblers regarding slot machines than any other type of gambling (Graydon, Dixon, Harrigan, Fugelsang, & Jarick, 2017). Thus, it is essential to understand why slot machines have the propensity to create such problems and which players are most likely to be negatively impacted by slots play.

In slot machine play, players can spin and immediately receive feedback. When a player spins and wins, the machine celebrates the win by providing the player with feedback and reinforcement in the form of jingles and animations—with the length of the feedback proportional to the win size. Conversely, when the player spins and loses their entire wager, the machine goes into a state of quiet and the player isn't provided with sounds or animations. On single-line slot machines these are the only outcomes that a player can receive. In single-line games, slots play is characterized by long chains of losses where the machine remains quiet. These prolonged losing streaks are occasionally interrupted by wins and their accompanying sights and sounds (Dixon, Graydon, Harrigan, Wojtowicz, Siu, & Fugelsang, 2014). However, in most modern machines, players can bet on multiple lines per spin. The lines can be either horizontal, vertical, diagonal, or form a zig-zag pattern. Given the complexity of these combinations, it can be very difficult for players to tell if they won or lost based on the machine's end-of-spin symbol arrangement alone. Thus, many players attend to the high-fidelity attention-grabbing sights and sounds to tell if they won or lost money on that spin (Griffiths & Parke, 2005; Haas & Edworthy, 1996). In addition to the regular losses and wins found on single-line slot machines, on multiline slots there is a third and arguably problematic outcome called a 'loss disguised as a win' or LDW (Dixon, Harrigan, Sandhu, Collins, and Fugelsang, 2010). For example, if a player bets $1.00 spread across a number of lines, but only wins back $0.20, the machine still provides the player with reinforcing sights and sounds despite the player incurring a net loss of $0.80—the machine essentially celebrates the fact that the player lost money on that spin. LDWs are more frequent than actual wins (Dixon et al., 2010) and on some slot machines, players will experience reinforcing stimuli almost every other spin (Dixon et al., 2014). Thus, relying on the machine's feedback to tell if you won or lost can be problematic since the majority of novice players believe that LDWs are true wins (Jenson, Dixon, Harrigan, Sheepy, Fugelsang, & Jarick, 2013). Even frequent slot players tended to overestimate the number of times they actually won credits during a multiline slots session—likely an effect of conflating true wins with LDWs in memory (Dixon et al., 2014).

The presence of LDWs also serve to elevate the frequency of celebratory, attention capturing feedback from the machine, keeping player's attention locked in during the game. Dixon et al. (2014) investigated whether players preferred multiline slot machines over single-line machines and how players interacted with the different machines. The researchers had players bet either 1-cent on a single-line (1-cent per spin) or bet 1-cent on each of 20-lines (20-cents per spin). Despite losing more on the 20-line game, the majority of players still preferred the multiline game over the single-line game. Dixon and colleagues replicated this preference for multiline games in another study in which they equated the total bet per spin for the single and multiline games (Dixon et al., 2017). In one session they had slots players bet 1-cent on each of 20-lines on a "penny" machine for a total bet size of 20-cents. In another session, players bet 4 credits on a "nickel" machine where each credit was 5-cents for a total bet size of 20-cents. Once again, they found that players preferred the multiline game over the single-line game. Playing the maximum number of lines with a minimum bet per line (the so-called "maximin strategy") appears to be a strategy favoured by frequent players (Williamson & Walker, 2001; Walker, 2004; Livingstone, Woolley, Zazryn, Bakacs, & Shami, 2008; Templeton, Dixon, Harrigan, & Fugelsang, 2015). Since the number of LDWs received increase with the number of lines played, this strategy ensures the highest possible reinforcement rate for a given machine—even though many of the spins that are reinforced with elaborate feedback cost the players money.

Some slot machine players describe entering a trance-like state while playing the slot machine, a feeling which they call the "slot machine zone" (Schüll, 2005; Murch, Chu, & Clark, 2017). Gamblers report a strong desire to be alone in order to enter this zone and once in this state, problem gamblers become so absorbed with the machine that they experience an extreme narrowing of attention and feelings of positive affect (Diskin & Hodgins, 1999; Diskin & Hodgins, 2001; Murch, Chu, & Clark, 2017; Dixon et al., 2019b). This extreme narrowing of attention and trance-like state that gamblers describe is somewhat reminiscent of flow states referred to in positive psychology: total engagement with the current environment to the point where attending to task-relevant stimuli is effortless (Csikszentmihalyi & Csikszentmihalyi, 1992; Marty-Dugas & Smilek, 2018). Flow states also result in unusual cognitive experiences (e.g., distortions of time, losing the sense of self, etc.; Csikszentmihalyi & Csikszentmihalyi, 1992; Csikszentmihalyi, Abuhamdeh, & Nakamura, 2014). Although flow is typically viewed as something favorable, Dixon and colleagues (2017/2019b) refer to the slot machine zone as a state of "dark flow" because of the potentially negative consequences this state engenders for the player (e.g., spending more time or money than initially planned at the slot machine).

Dark flow may also temporarily help alleviate symptomology attributable to mood disorders such as anxiety and/or depression. In attempting to regulate mood, some motivations for gambling may pose a greater risk for developing gambling related problems than other motivations. In particular, using gambling to provide relief from emotional distress or to help alleviate symptomology attributable to mood disorders may be particularly problematic (Matheson, Sztainert, Lakman, Steele, Ziegler, & Ferentzy, 2018). Since depression is the most common comorbidity among gamblers (with estimates as high as 40%), there may be a large subset of problem gamblers using gambling as a way to self-medicate their depressive symptomology (Abbott & Volberg, 1996; Bjelde, Chromy, Pankow, 2008; Getty, Watson, & Frisch, 2000; Blaszczynski & Nower, 2002; Griffiths & Auer, 2013, Dixon et al., 2017; Dixon et al., 2019b). While the dark flow state may temporarily elevate mood in these gamblers, financial losses resulting in further hardship ultimately gives the already depressed gambler more to be depressed about—this sets up a continuous, downward spiral cycle of depression and gambling to escape. Thus, this repetitive cycle of depression and gambling to escape depression may be why the state of dark flow is so dangerous for those with problem gambling—it provides temporary relief, but at the expense of further worsening gambling problems.

A study conducted by Dixon et al. (2017) investigated the relationships between dark flow, depression, and problem gambling status during multiline slot-machine play. Dark flow was characterized by distortion of time and engagement with the slot machine. They found a strong positive relation between problem gambling severity and in-game flow scores as well as a strong positive relation between flow and depression scores. Taken together, individual differences in the propensity to become immersed during slot machine play may contribute to the development of pathological gambling. That is, depressed players may find themselves in the highly pleasurable "slot machine zone"—a flow state which provides an escape and temporary relief from ruminating about their depressed lives.

There also appears to be an association between depression and mindfulness (i.e., the antithesis of mind-wandering). Mind-wandering occurs when attention is shifted away from the current task in the external environment towards unrelated self-generated internal thoughts (Smallwood & Schooler, 2006; Bertossi, Peccenini, Solmi, Avenanti, & Ciaramelli, 2017; Seli et al., 2018). Mind-wandering can also be demarcated into deliberate (i.e., intentional) and spontaneous (i.e., unintentional) mind-wandering with previous studies showing that deliberate and spontaneous mind-wandering are indeed dissociable cognitive experiences (see Seli, Risko, Smilek, & Schacter, 2016, for a review). Mind-wandering is estimated to occupy almost half of all waking activity and has been associated with negative affect, whereas an occupied mind generates positive affect (Killingsworth & Gilbert, 2010). Conversely, mindfulness is present-focused and refers to moment-to-moment mental awareness of one's emotions, bodily sensations, and mental states (Bishop et al., 2004; Wheeler, Arnkoff, & Glass, 2017). An important characteristic of mindfulness involves directing and focusing attention. Previous research has shown that problem gamblers score lower on measures of mindfulness than their non-problem counterparts (de Lisle, Dowling, & Allen, 2011; Reid, Di Tirro, & Fong, 2014; Dixon et al., 2019a; Dixon et al., 2019b). A study conducted by Dixon et al. (2019b) investigated the relationships between problem gambling severity, mindfulness, depression, and dark flow during slot machine play. They found a moderate negative relation between problem gambling severity and mindfulness in everyday life (i.e., the greater the problem gambling severity, the more mindfulness problems). They then assessed mindfulness while playing multiline slots. Specifically, they interrupted slots play to assess whether players were either on-task (i.e., focused on the game) or off-task (i.e., thinking about anything unrelated to the game) just before the thought probe appeared. In contrast to the strong correlation between problem gambling severity and mindfulness problems in everyday life, when players were probed during slots play, there was no correlation between problem gambling status and their tendency to mind-wander *while playing slots*. They concluded that the frequent celebratory feedback (on wins and LDWs) during multiline slot machine play may have served to rein-in minds of problem gamblers that would otherwise wander. The researchers also explored the relations between depression and (dark) flow. They found a positive moderate relation between depression and dark flow and a weak positive relation between depression and problem gambling severity. The authors suggested that for problem gamblers, the sharp contrast between the propensity to mind-wander in everyday life and their experience of locked-in attention while playing multiline slots may prompt strong endorsements of dark flow during slots play. Given that flow states are associated with positive affect (Rogatko, 2009), this creates a situation where gambling becomes a maladaptive means of elevating mood—in other words, gambling to escape. The reining in of attention during multiline slots play also might have the potential to explain why frequent players prefer multiline games over single-line games—a hypothesis we test in Experiment 1. In single-line games where there are long chains of losses, players may find their minds wandering. If wandering minds are unhappy minds, as suggested by Killingsworth and Gilbert (2010), such mind-wandering may induce negative affect in these games. However, in multiline games, players receive attention-capturing feedback far more frequently (due to LDWs)—a factor which may prevent depressed minds from mind-wandering to negative places and ultimately induce flow and its accompanying positive affect. This may help explain why players prefer multiline games, and why there is greater flow experienced for multiline games than single-line games.

In addition to the relatively robust correlations between depression, mindfulness problems and problem gambling severity, there is also a relationship between boredom and problem gambling. Boredom is a pervasive, subjectively unpleasant state that can emerge during monotonous or dull situations (Eastwood, Frischen, Fenske, & Smilek, 2012). Boredom has also been construed as a failure to engage with one’s environment despite the motivation to do so (Eastwood et al., 2012). Compared to non-problem gamblers, problem gamblers score higher on self-report measures of boredom proneness (Blaszczynski, McConaghy, & Frankova, 1990). Trait boredom proneness (i.e., the tendency to experience boredom regularly) has also been associated with increased mind-wandering and poorer sustained attention (Cheyne, Carriere, & Smilek, 2006; Isacescu, Struk, & Danckert, 2017; Hunter & Eastwood, 2018). Researchers have also shown that having a lower tolerance for boredom is a significant factor in repetitive gambling behaviour. Gambling may be, in part, a maladaptive coping strategy to alleviate boredom and its accompanying negative affect (Blaszczynski, Wilson, & McConaghy, 1986; Blaszczynski, McConaghy, & Frankova, 1990; Turner, Zangeneh, & Littman-Sharp, 2006). Thus, problem gamblers may experience boredom regularly in their everyday lives; but, while at the slot machine, they find their attention is regularly captured by the intermittent reinforcing feedback. If boredom is a failure to engage with the current environment (despite the motivation to do so), problem gamblers may use *deliberate* mind-wandering as a means to cope with a monotonous and unexciting task (i.e., if problem gamblers are unable to engage with a boring task, they may intentionally choose to think about something else; Seli, Cheyne, Xu, Purdon, & Smilek, 2015; Seli et al., 2016). We test this hypothesis in Experiment 2. Additionally, in previous experiments (e.g., Dixon et al., 2019b), the MAAS measure used to measure mindfulness problems in everyday life is a *trait* measure whereas the thought probes interrupting slots play measures *state* mindfulness. Thus, there is the potential that method variance impacted the strong correlations between mindfulness problems and problem gambling (assessed at the trait level), and the absence of such correlations when mindfulness is assessed in the slot context (i.e., state mindfulness). One overarching goal of Experiment 2 was to provide a *state* measure of mindfulness outside of slot machine play. This would allow us to evaluate whether state mindfulness problems among problem gamblers are present during an attentionally demanding task (i.e., a vigilance task) but can be effectively eliminated in the slots context. Specifically, using the same thought probe methodology, we could demonstrate higher instances of mind-wandering during a vigilance task and lower instances of mind-wandering during slot machine play. A state-to-state comparison would reduce method variance and bolster the conclusion that slots rein in the wandering mind and eliminates the mind-wandering that problem gamblers' experience in everyday life.

## Experiment One

In Experiment 1, we assessed a wide range of gamblers. Our goal was to examine if the more frequent reinforcing sights and sounds of the multiline slot machine serve to rein in the attention of minds that are prone to mind-wandering, fostering entry into "the zone," and facilitate positive affect. We also sought to show that players would have a greater propensity to mind-wander during single-line play due to the prolonged losing streaks—a situation that should increase negative affect relative to the multiline game. Thus, we sought to test the following hypotheses: (1) we expected to see more flow, more positive affect, and less negative affect during multiline play than single-line; (2) more instances of mind-wandering during single-line play than multiline play; (3) greater preference for multiline over single-line play; (4) based on previous research from our lab, we also expected to see a correlation between mindfulness problems in everyday life and problem gambling severity; (5) this correlation should be eliminated when we assess mindfulness during multiline slots play; and (6) show that depression, mindfulness problems, and boredom proneness are all correlated with problem gambling severity, but that dark flow can account for unique variance when predicting problem gambling status—over and above depression, mindfulness, and boredom proneness. This last hypothesis sought to show the dangerousness of dark flow for those with gambling problems—i.e., those that experience dark flow and its positive affect may find that they use this state to maladaptively cope with their problems; but in actuality, they spend more time gambling which leads to greater gambling severity.

## Method

**Participants.** A total of 120 slot machine players were recruited from Elements Casino in Brantford, Ontario, Canada. The casino is a very popular 30,000 square foot venue with 539 slot machines and 48 table games. Recruitment was conducted from October 21, 2019 to November 1, 2019, during this time period we aimed to collect 120 participants at minimum. Participants were pre-screened during recruitment to ensure that they were at least 19 years of age (the legal age to play a slot machine in Ontario), were not in treatment for problem gambling, and played a slot machine at least monthly. Ten participants were excluded for various reasons (e.g., falling asleep at the slot machine, for being intoxicated, withdrawing from the study early, etc.). This left 110 participants for analysis (56 female, 53 male, 1 non-binary). One participant did not disclose their age. The ages of the other 109 participants ranged from 22-82, with a mean of 59.93 years ($SD$ = 13.46).

**Apparatus.**

***Slot machine simulator.*** Participants played a five-reel, slot machine simulator housed in a slot machine casing so that it looked and played like an actual slot machine (see Figure 1). Participants played two slot machine games, a multiline game and a single-line game. In the multiline game, participants played 20-lines on each spin and bet 1-cent per line (20 cents per spin). The 20-line playing session consisted of 300 spins, comprised of 197 losses, 40 wins, and 63 LDWs. In the single-line game, participants also bet 20 cents per spin (credits were worth 5 cents each and players bet 4 credits on the one line that they played). The playing session also consisted of 300 spins comprised of 284 losses and 16 wins. These relative frequencies of the different outcomes for both the single and multiline games were based on the programming documents of a commercially available machine, and the payback percentage (92.01%) was one commonly used in slot machines in Ontario. Outcomes in which participants lost their entire spin wager were followed by a lack of feedback (i.e., no sounds or animations) and winning outcomes were accompanied by auditory feedback and animations. The length of the sound was proportional to the win size.


Figure 1. Our slot machine simulator, Sands of Splendor

**Materials.**

***Demographic Questions.*** Participants completed demographic items regarding their age and gender.

***Depression.*** Participants completed the depression subscale from the 21-item Depression, Anxiety, and Stress Scale (DASS-21; Lovibond & Lovibond, 1995). The depression subscale includes items such as, "I couldn't seem to experience any positive feeling at all" and "I felt that I had nothing to look forward to." Items were answered on a 4-point scale with the following options: (0) Did not apply to me at all, (1) Applied to me to some degree, or some of the time, (2) Applied to me to a considerable degree, or a good part of the time, and (3) Applied to me very much or most of the time. The seven-items were multiplied by two and summed to generate severity scores in order to make scores comparable to the DASS-42 (see Lovibond & Lovibond, 1995). The depression subscale of the DASS-21 has demonstrated excellent reliability (measured using Cronbach's alpha, 0.88; Henry & Crawford, 2008).

***Boredom Proneness Scale—Short Form (BPS).*** The BPS (Struk, Carriere, Cheyne, & Danckert, 2017) is an 8-item measure of trait boredom. The BPS contains items such as "Many things I have to do are repetitive and monotonous" and "Much of the time, I just sit around doing nothing." Items were answered on a 7-point scale with the following options: (1) Strongly disagree, (2) Disagree, (3) Somewhat disagree, (4) Neither disagree nor agree, (5) Somewhat agree, (6) Agree, and (7) Strongly agree. The BPS demonstrates good internal consistency and comparable construct validity to the original Boredom Proneness Scale (Struk et al., 2017).

***Canadian Problem Gambling Index (CPGI).*** Participants also completed an item from the CPGI (Ferris & Wynne, 2001) that assesses the frequency in which players engage with slot machine gambling. The item was, "in the past 12 months, how often did you bet or spend money on slot machines or what some people call video lottery terminals (VLT)? When answering please base your answer on playing any kind of slot machine (i.e., a slot machine or VLT at either a physical or online casino." They answered this item by choosing one of the following frequencies: daily, 2-6 times a week, about once a week, 2-3 times a month, about once a month, between 6-11 times a year, between 1-5 times a year, never, or I prefer not to say.

***Problem Gambling Severity Index (PGSI).*** The PGSI (Ferris & Wynne, 2001) is a nine-item screening tool that assesses gambling problems in the general population (Cronbach's alpha of 0.84; Ferris & Wynne, 2001). Items were answered on a 4-point scale with the following options: (0) Never, (1) Sometimes, (2) Most of the time, and (3) Almost always. The nine-items were summed to produce a score for problem gambling (ranging from 0 to 27) with higher scores indicating greater risk for problem gambling.

***Mindful Attention Awareness Scale (MAAS).*** The MAAS (Brown & Ryan, 2003) is a 15-item questionnaire that assesses mindfulness in everyday life outside of gambling. The MAAS contains items such as, "I could be experiencing some emotion and not be conscious of it until sometime later" and "I tend to walk quickly to get where I am going without paying attention to what I experience along the way." Items were answered on a 6-point scale with the following options: (1) Almost always, (2) Very frequently, (3) Somewhat frequently, (4) Somewhat infrequently, (5) Very infrequently, and (6) Almost never. The 15-items were averaged to produce a score for mindfulness with higher scores reflecting higher levels of dispositional mindfulness.

***Game Experience Questionnaire (GEQ).*** Participants completed three subscales (flow, positive affect, and negative affect) from the core version of the GEQ (IJsselisteign, de Kort, & Poels, 2013) to assess their experience of the slot machine and tone timing sessions. For (dark) flow, the items were: "I was fully occupied with the game," "I forgot everything around me," "I lost track of time," "I was deeply concentrated in the game," and "I lost connection with the outside world." For positive affect, the following items were administered: "I felt content," "I thought it was fun," "I felt happy," "I felt good," and "I enjoyed it." For negative affect, the follow items were administered: "It gave me a bad mood," "I thought about other things," "I found it tiresome," and "I felt bored." Items were answered using a 5-point scale with the following options: (0) Not at all, (1) Slightly, (2) Moderately, (3) Fairly, (4) Extremely. The items from each subscale were averaged to compute scores for positive affect and (dark) flow. The full GEQ has demonstrated good reliability, with a Cronbach's alpha ranging from 0.71 to 0.89 for the various subscales included (Poel, de Kort, & IJsselsteijn, 2007).

***Thought probes.*** During both the single-line and multi-line slot machine sessions, participants were prompted with a thought probe after every 50 spins. The thought probe asked the participant to verbally indicate to the experimenter whether their thoughts were: on-game (i.e., thinking about the game), spontaneously mind-wandering (i.e., despite their best intentions to focus on the game, their mind had wandered), or deliberately mind-wandering (i.e., they intentionally chose to think about something else); see Seli, Risko, and Smilek (2016) and Seli, Risko, Smilek, and Schacter (2016) for further distinction between spontaneous and deliberate mind-wandering. The experimenter recorded the participant's response on the tablet used for administering the survey measures. The total number of "on-game" responses were summed to produce an in-game mindfulness score with the scores ranging from 0-6 for each slot machine session.

***Slot machine preference.*** At the end of play participants were asked "what slot machine did you prefer playing?" They were asked to endorse one of the following options: the multiline slot machine, single-line slot machine, or neither.

**Design.** The experiment employed a within-subjects design with all participants playing both games. Half of the participants played the multiline slot machine game first, followed by the single-line, whereas the other half of the participants played the single-line slot machine first. After the 600th spin a pop-up message appeared on the slot machine telling participants their final balance.

**Procedure.** All participants approached the experiment station situated in the front lobby of the casino. After determining eligibility, participants were given an information synopsis of the study and gave written, informed consent before participating in this study. The University of Waterloo's Office of Research Ethics approved all procedures in the study. Players were informed that they would be given a $25 Walmart gift card for participating, and that they would be able to win up to an additional $10.00 CAD (in cash) depending on their slot machine balance at the end of play. The simulator was pre-loaded with $20.00, and since all participants received the same outcomes, all participants ended up with $15.00 after the first game and $9.80 after the second game, regardless of their counterbalance order. The $9.80 was rounded up to $10.00 for each participant.

Using the online survey software Qualtrics, participants first completed the demographic questions, CPGI, PGSI, MAAS, depression questions, and BPS on a Lenovo tablet (model #TB-X103F). Participants then played either the multiline or single-line slot game (depending on their counterbalanced order). After completing each session, participants answered the positive affect, negative affect, and flow items of the GEQ on the tablet as well as the preference question. Participants were given a $25.00 Walmart gift card and their (rounded up) slot machine balance ($10.00 CAD for all participants). Participants were also given responsible gambling resources and the opportunity to take a feedback letter debriefing them of the studies purposes.

## Results

**Problem Gambling and Depression Scores.** Using the interpretive categories of the PGSI suggested by Currie, Hodgins, and Casey (2013), the sample consisted of: 30 non-problem gamblers (PGSI score of 0), 52 low level problem gamblers (PGSI score ranging from 1 to 4), 15 moderate level problem gamblers (PGSI score ranging from 5 to 7) and 13 problem gamblers (PGSI score of 8 or greater). Using the interpretive categories of the DASS-21 suggested by Lovibond and Lovibond (1995), the sample contained a majority (n = 82) within the normal range of depression (scores of 0 to 9), 7 participants were characterized with mild depression (scores of 10 to 13), 11 with moderate depression (scores of 14 to 20), 5 with severe depression (scores of 21 to 27), and 4 with extremely severe depression (scores of 28 or more). One participant failed to fill out the entire DASS-21 and was not included in subsequent analyses involving depression. When filling out the slots frequency-of-play question, two participants indicated that they played less than once per month (despite our attempt to recruit players who played at least once per month or more), and one participant did not want to answer how often they played a slot machine.

**Game Preference.** The majority of players (n = 83, 75.5%) preferred the multiline game, 21 players (19%) preferred the single-line game, and 6 players (5.5%) preferred neither game, $\chi^2(2, N = 110) = 90.89$, $p < .001$.

**Order Effects.** In studies involving mind-wandering measures such as thought probes there might be a time-on-task effect. Therefore, it is crucial to assess whether there were effects of which game was played first. Since such effects could also influence affect and flow, for all planned analyses we first assessed whether there were order effects (a change in effect sizes depending on which game was played first). Where effects of order, or any interactions involving order were found, the files were split to directly compare those who played the multiline game first to those who played the single-line game first since this is the only comparison uncontaminated by order. A significant main effect of order was found for our in-game measure of mindfulness, $F(1, 108) = 4.26$, $p = .042$. We also found a significant main effect of order for our retrospective measure of negative affect, $F(1, 108) = 4.52$, $p = .036$, as well as an order by game interaction, $F(1, 108) = 7.79$, $p = .006$—such that there was greater negative affect for the game that was played second. There were no indications of order effects for the other measures (i.e., smallest $p \geq .054$).

**Dark Flow.** When comparing retrospective accounts of dark flow during multiline and single-line slots play, we included PGSI as a covariate in a repeated-measures analysis of covariance (see Delaney & Maxwell, 1981) because previous research has shown that problem gambling status positively relates to flow during slots play (Dixon et al., 2014; Dixon et al., 2017; Murch, Chu, & Clark, 2017; Dixon et al., 2019b). We found significantly greater flow during the multiline game ($M = 1.42$; $SD = 1.02$) than the single-line game ($M = 1.32$; $SD = 0.99$), $F(1, 108) = 4.08$, $p = .046$. For a full summary of the means and standard deviations, see Table 1.

Table 1. Means and Standard Deviations for Experiment 1 Study Variables

| Variable | Multiline Slots *M* (*SD*) | Single-line Slots *M* (*SD*) |
|---|---|---|
| Dark Flow | 1.42 (1.02) | 1.32 (0.99) |
| Positive Affect | 1.89 (1.02) | 1.87 (0.99) |
| Negative Affect | 0.80 (0.62) | 1.16 (0.90) |
| "On-task" Responses | 4.34 (1.59) | 3.32 (2.32) |
| "MW-S" Responses | 1.15 (1.53) | 1.45 (1.72) |
| "MW-D" Responses | 1.06 (1.68) | 0.99 (1.51) |

*Note.* MW-S = Spontaneous mind-wandering; MW-D = Deliberate mind-wandering

Retrospective dark flow ratings following multiline slots play were significantly correlated with: PGSI status $r(108) = .195$, $p = .041$, retrospective positive affect ratings $r(108) = .623$, $p < .001$, retrospective negative affect, $r(108) = –.270$, $p = .004$, and our in game measure of mindfulness during multiline slots play, $r(108) = .346$, $p < .001$. Similarly, retrospective dark flow ratings following single-line slots play was significantly correlated with PGSI status, $r(108) = .245$, $p = .01$, retrospective positive affect ratings during single-line play, $r(108) = .586$, $p < .001$, retrospective negative affect during single-line play, $r(108) = –.341$, $p < .001$, and our in game measure of mindfulness during single-line play, $r(108) = .406$, $p < .001$. We compared the magnitude of the correlations between retrospective dark flow ratings following multiline slots and PGSI status and retrospective dark flow ratings following single-line slots and PGSI status using Steiger's *Z* (Steiger, 1980) and found that these two correlations were not significantly different, $Z(107) = -1.02$, $p = .31$. A correlation matrix for all Experiment 1 study variables is included in Table 2.

Table 2. Zero Order Correlations for all Experiment 1 Study Variables

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. PGSI | — | | | | | | | | | | |
| 2. MAAS | –.478*** | — | | | | | | | | | |
| 3. Dep. | .406*** | –.578*** | — | | | | | | | | |
| 4. BPS | .293** | –.552*** | .502*** | — | | | | | | | |
| 5. ML Mind. | –.170 | .060 | –.084 | .029 | — | | | | | | |
| 6. SL Mind. | –.213* | .092 | –.190* | .006 | .749*** | — | | | | | |
| 7. ML Flow | .195* | –.168 | –.023 | .054 | .346*** | .349*** | — | | | | |
| 8. SL Flow | .245* | –.123 | .006 | .133 | .310** | .406*** | .862*** | — | | | |
| 9. ML Pos. | –.039 | .063 | –.119 | .022 | .178 | .235* | .623*** | .535*** | — | | |
| 10. SL Pos. | .031 | .041 | –.081 | .020 | .112 | .254** | .566*** | .586*** | .849*** | — | |
| 11. ML Neg. | .080 | –.100 | .060 | –.034 | –.324** | –.343*** | –.270** | –.230* | –.500*** | –.445*** | — |
| 12. SL Neg. | .125 | –.066 | .056 | –.079 | –.275** | –.424*** | –.319** | –.341*** | –.508*** | –.514*** | .751*** |

*Note.* PGSI = Problem Gambling Severity Index; MAAS = Mindful Attention Awareness Scale; Dep. = Endorsement of depression items on the DASS-21; BPS = Boredom Proneness Scale; ML = Multiline slot machine; SL = Single-line slot machine; Mind. = number of "on game" responses; Pos. = Endorsement of positive affect items on the GEQ; Neg. = Endorsement of negative affect items on the GEQ. $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$

**Affect During Slots Play.** Contrary to our prediction, we found no statistical difference in positive affect between the multiline slots game ($M$ = 1.89; $SD$ = 1.02) and single-line slots game ($M$ = 1.87; $SD$ = 0.99), $t(109) < 1$, $p = .76$. For negative affect, because there was an effect of which game was played first, we directly compared only those who played the multiline slot machine first to those who played the single-line slot machine first (the only contrast uncontaminated by order). We found that negative affect was significantly higher during the single-line game ($M$ = 1.16; $SD$ = 0.90) relative to the multiline game ($M$ = 0.80; $SD$ = 0.62), $t(108) = 2.42$, $p = .017$.

**Mindfulness.** Since the number of on-task responses were found to be influenced by whichever game was played first, we once again restricted our analyses to compare those who played the multiline slot machine first to those who played the single-line slot machine first. We found that the number of "on-game" reports during the multiline game ($M$ = 4.34; $SD$ = 1.59) was significantly higher than during the single-line game ($M$ = 3.32; $SD$ = 2.32), $t(108) = 2.68$, $p = .009$. There were significantly fewer instances of spontaneous mind-wandering during the multiline game ($M$ = 1.15; $SD$ = 1.53) than the single-line game ($M$ = 1.45; $SD$ = 1.72), $t(109) = 2.62$, $p = .010$, but no significant difference in deliberate mind-wandering between the two games, $t(109) < 1$, $p = .55$.

Based on previous research, we expected to see a significant correlation between mindfulness (from the MAAS) and PGSI scores, however, when assessing mindfulness during slots play and PGSI scores, we expected to see a non-significant correlation (i.e., the correlation should disappear). In this study, we replicated the correlation between mindfulness from the MAAS and PGSI, $r(108) = –.478$, $p < .001$. When we assessed mindfulness during multiline slots play, we found that the correlation between mindfulness during slots and PGSI disappeared,

$r(108) = -.170$, $p = .077$. Using Steiger's $Z$ (Steiger, 1980) we also showed that the correlation between mindfulness from the MAAS and PGSI was significantly different from the correlation between our in-game measure of mindfulness and PGSI, $Z = -2.56$, $p = .010$. Although the correlation between mindfulness during single-line slots play and PGSI remained significant, $r(108) = -.213$, $p = .025$, it was also significantly different from the correlation between mindfulness measured by the MAAS and PGSI, $Z = -2.26$, $p = .024$. Thus, it appeared as if our slot machine, and in particular our multiline slot machine, did indeed rein in the wandering mind.

**Hierarchical Regression Predicting PGSI.** We used hierarchical regression in order to investigate whether the relatively newer concept of dark flow could account for unique variance when predicting problem gambling severity (over and above depression, mindfulness, and boredom proneness). Recall that the correlations between single-line and multiline dark flow and problem gambling status were not significantly different. To get the most stable estimate of dark flow during gambling, we combined participants dark flow ratings by averaging their retrospective multiline and single-line dark flow scores to create a total dark flow score. This score was used to predict PGSI scores in the last step of the hierarchical multiple regression after the more well-established measures had already been entered in prior steps. Specifically, depression ratings were entered at Step 1, mindfulness scores (from the MAAS) at Step 2, boredom proneness at Step 3, and total dark flow ratings at the final step. At Step 1, depression significantly contributed to the regression model, $F(1, 107) = 21.10$, $p < .001$, and accounted for 16.5% of the variation in PGSI score variance. At Step 2, mindfulness scores explained an additional 8.6% of the variation in PGSI scores and this increase in $R^2$ was significant, $\Delta F(1, 106) = 12.11$, $p = .001$. At Step 3, boredom proneness did not account for any additional variance in PGSI scores, $\Delta R^2 = 0.0\%$, $\Delta F(1, 105) < 1$, $p = .90$. At the final step, total dark flow ratings explained an additional 3.2% of the variation in PGSI scores—a significant change in the $R^2$, $\Delta F(1, 104) = 4.69$, $p = .033$. The overall regression model was significant when all four independent variables were included in Step 4, $F(4, 104) = 10.25$, $p < .001$, and accounted for 28.3% of PGSI status variance. For a full regression summary see Table 3.

Table 3. Experiment 1 Hierarchical Regression for Variables Predicting PGSI

| Model | *b* | *SE* | β | $R^2$ | $\Delta R^2$ |
|---|---|---|---|---|---|
| Step 1 | | | | .165*** | |
| Constant | 1.88 | 0.43 | | | |
| Depression | 0.18 | 0.04 | 0.41*** | | |
| Step 2 | | | | .250*** | .086*** |
| Constant | 9.28 | 2.86 | | | |
| Depression | 0.09 | 0.05 | .20 | | |
| Mindfulness | –1.44 | 0.41 | –0.36*** | | |
| Step 3 | | | | .250*** | .000 |
| Constant | 9.51 | 2.86 | | | |
| Depression | 0.09 | 0.05 | 0.20 | | |
| Mindfulness | –1.46 | 0.44 | –0.37** | | |
| Boredom | –0.01 | 0.05 | –0.01 | | |
| Step 3 | | | | .283*** | .032* |
| Constant | 7.85 | 2.91 | | | |
| Depression | 0.10 | 0.05 | 0.23* | | |
| Mindfulness | –1.30 | 0.44 | –0.32** | | |
| Boredom | –0.01 | 0.05 | –0.03 | | |
| Total Flow | 0.70 | 0.32 | 0.18* | | |

*Note*. PGSI = Problem Gambling Severity Index; Depression = Endorsement of the depression items of the DASS-21; Mindfulness = Scores from the MAAS; Boredom = Scores from the Boredom Proneness Scale; Total Flow = Endorsement of the flow items from the GEQ, averaged between the multiline game and single-line game

**p* < .05; ***p* < .01; ****p* < .001

## Discussion

In Experiment 1, we showed that, as predicted, players experienced greater flow during multiline play than during single-line play. For this analysis, we capitalized on previous research that shows that problem gambling severity significantly correlates with flow during play (Dixon et al., 2014; Dixon et al., 2017; Dixon et al., 2019b; Murch, Chu, & Clark, 2017). Therefore, we used dark flow as a covariate in order to reduce error variance. Although we found that players reported greater flow during the multiline game than the single-line game the effects were not as strong as anticipated (based on previous findings in our lab), and indeed we did not find stronger correlations between multiline dark flow and PGSI scores compared to single-line dark flow and PGSI scores—a pattern that has been shown previously (Dixon et., al 2017).

Even though players reported greater dark flow in the multiline game, contrary to our predictions, we found no statistical difference in positive affect when comparing between the multiline and single-line games. We also replicated a strong correlation between dark flow and positive affect while playing the multiline games. We did, however, find a difference in negative affect—players reported significantly more negative affect during the single-line game than the multiline game. One potential explanation for the failure to find differences in positive affect between the single-line and multiline games involves a trade-off between win size and win frequency across the games. In actual slot machine games (upon which our simulator was based), there were relatively frequent wins (n = 40) among the 300 spins of the multiline line game. By contrast, in the single-line game there were only 16 wins among the 300 spins. Despite this disparity in frequency—the overall amount of money paid back to the player was the same in both games. In slot machine parlance, the payback percentage of the two games did not differ (a situation which mimics real slot machines whose payback percentage does not change depending on how many lines are played). This matching of the payback percentage meant that when the infrequent wins in the single-line game did occur, their average size was far larger than the average size of wins encountered in the multiline game. The intermittent large wins in the single-line game may have caused dramatic fluctuations in positive affect. In other words, there may have been infrequent, but large "spikes" in positive affect caused by the large wins in the single-line game. It is well known that physiological arousal accompanies large wins in slot machine play (e.g., Dixon, Harrigan, Santesso, Graydon, Fugelsang, & Collins, 2014) presumably due to their inherently exciting properties. When polling participants after play, they may have taken into account both the long lulls in positive affect during losing streaks, but also the spikes in positive affect due to the excitement of the 16 relatively large wins. Thus, positive affect in the single-line game may have averaged out to the same value as the positive affect in the multiline game (which in part, may have been maintained by the smaller but far more frequent wins and LDWs).

While there was no difference in positive affect between games, the single-line game caused players to experience significantly greater *negative affect*. The long chains of losses in the single-line game may have contributed to a lowering of mood relative to the multiline game where the rate of reinforcing feedback was far higher. In interpreting the more pronounced negative affect in the single-line games it is imperative to also consider mind-wandering. Recall that players reported more instances of mind-wandering during the single-line game (compared to the multiline game). If a wandering mind is an unhappy mind as suggested by Killingsworth and Gilbert (2010), it makes sense that one would see more negative affect in the single-line games—the long losing streaks provide more opportunities to mind-wander, which resulted in an increase in negative affect. This increase in negative affect may also explain why the majority of gamblers preferred the multiline game.

Another important finding concerning the greater degree of mind-wandering during the single-line game involves the *type* of mind-wander that players displayed. Players reported significantly more spontaneous mind-wandering (i.e., unintentional mind-wandering) during the single-line game than the multiline game but no significant difference in deliberate mind-wandering (i.e., intentional mind-wandering) between the two games. Thus, during the long losing streaks of single-line play, players found that their minds *unintentionally* wandered.

Consistent with previous research, we found a negative correlation between mindfulness in everyday life and depressive symptomology outside of the gambling context. Such findings replicate previous studies (de Lisle et al., 2011; Lakey et al., 2007; Reid et al., 2014; Dixon et al., 2014; Dixon et al., 2017). We also showed a correlation between mindfulness problems in everyday life and problem gambling severity (Dixon et al., 2019a; Dixon et al., 2019b). Crucially, this correlation between mind-wandering and problem gambling disappears when mind-wandering is assessed during multiline slots play—a finding that replicates Dixon et al. (2019b). It appears that multiline slot machine play (with its more frequent presentation of attention capturing feedback) is capable of reining in the wandering mind. A novel finding is that single-line slots play, with its long losing streaks, appears less effective at curtailing mind-wandering in these same players. Here we showed that the propensity to mind-wandering among problem gamblers (as shown by the correlation between MAAS and PGSI scores) was still evident when mind-wandering was assessed during single-line play.

Parallel findings emerged when we consider mind-wandering amongst those who were depressed. When mind-wandering is assessed in everyday life there is a strong correlation with depression. However, when mind-wandering is assessed during slot machine play, this correlation disappears during the multiline game but remains significant during single-line play. These assessments of mindfulness in everyday life versus our in-game measures of mindfulness while playing slots help bolster our previous assertions about escape gambling (see Dixon et al., 2019b). If some players are prone to having their mind-wander, the frequent (but unpredictable) reinforcement of multiline slot machines may help rein in the wandering mind and prevent minds from unintentionally wandering. Our findings show that less relief may be provided by single-line games. For both depressed individuals and problem gamblers, the propensity to mind-wander (likely during the long losing streaks) remains.

Another novel finding in this study involves the hierarchical multiple regression predicting problem gambling severity. We first replicated the positive correlations between problem gambling and depression (Dixon et al., 2017; Dixon et al., 2019b) problem gambling and mind-wandering (Dixon et al., 2019b) and problem gambling and boredom proneness (Blaszczynski, McConaghy, & Frankova, 1990). These are well established relationships in the problem gambling literature. We also replicated the more novel relationship between problem gambling and (dark) flow (Dixon et al., 2017; Dixon et al., 2019b). When we used multiple regression to predict problem gambling scores, we found that retrospective ratings of flow while playing slots significantly accounted for unique problem gambling severity variance, after accounting for depression, mindfulness, and boredom proneness. This indicates that there is something particular about this flow state that may be particularly nefarious for problem gamblers. The final model indicated that depression, mindfulness, and flow were significant predictors of problem gambling severity. This multifaceted relationship between depression, mindfulness problems, dark flow (and ultimately positive affect) may help elucidate why slot machines are especially appealing to those who gamble to escape. One possibility is that while some depressed (and bored) players may play slots to modulate their arousal levels (Mercer & Eastwood, 2010). Others (those who experience high levels of flow during play) may find that it elevates their mood. Thus, in this study, the depth of flow may be capturing those who gamble to escape—namely those who rectify their depressed mood via the positive affect they feel during a (dark) flow state. We think the ability of dark flow to capture problem gambling severity variance over and above depression, mindfulness problems, and boredom relates to the cyclical, downward spiral of those who gamble to escape. Players who may be bored, depressed and/or plagued by a wandering mind may find immense relief while gambling. However, the relief they experience comes at the cost of spending more time gambling, accruing greater monetary losses, which essentially exacerbates their gambling problems.

## Experiment Two

In Experiment 2, we also assessed a wide range of gamblers. Given that previous research has shown that problem gambling status is positively related to depression, boredom, and mindfulness problems, our goal was to provide concrete evidence that the reinforcing sights and sounds of the slot machine serve to rein in the attention of bored minds that are prone to mind-wandering, fostering entry into "the zone," and ultimately elevating mood. More specifically, we also wanted to explore and validate whether those with more gambling problems do indeed mind-wander more than those without gambling problems by using an in-lab measure of mind-wandering. Here we sought to show that when problem gamblers are faced with a monotonous task, they would use deliberate mind-wandering as a maladaptive[1] means of attempting to regulate their affect. Specifically, we surmised that a prolonged, attention demanding task should induce boredom and negative affect which would prompt problem gamblers (more so than non-problem gamblers) to intentionally mind-wander as a means of coping with the negative affect. Importantly, if multiline slot machine play reins in the wandering mind and induces dark flow and positive affect, there would be no need for the problem gamblers to intentionally mind-wander during slots play, as there is no negative affect to avoid. Seen in this light, the ineffectiveness of intentionally mind-wandering to avoid negative affect, may actually relate to gambling for the purpose of escape—slots provide relief by inducing flow and positive affect, and thereby curtail the very need for intentional mind-wandering.

Given that mindfulness problems, boredom proneness, and depression are all correlates of problem gambling and also relate to negative affect, it seems reasonable to suggest that

[1] It can be construed that deliberate mind-wandering is an *adaptive* way to deal with a monotonous task, however, using deliberate mind-wandering to disengage with the task at hand is maladaptive when participants were asked to perform a specific task.

deliberate mind-wandering may be a means to alleviate the negative state induced by these traits by problem gamblers. If so, the propensity to employ this maladaptive coping strategy may uniquely account for problem gambling variance (over and above the traits related to negative affect). In sum, by comparing slots play to a repetitive vigilance task, we sought to test the following hypotheses: (1) we expected to see more flow, more positive affect, and less negative affect during slots play than during our vigilance task; (2) we hypothesised that there would be more instances of mind-wandering during our vigilance task than during slots play; (3) based on previous research from our lab, we expected to see a correlation between mindfulness problems in everyday life and problem gambling severity; (4) this correlation should be eliminated when we assess mindfulness during slots play; (5) based on previous research, we expected to replicate that depression, mindfulness, and boredom proneness are all correlated with problem gambling severity; and (6) show that *deliberate* mind-wandering during our vigilance task can account for unique variance when predicting problem gambling status—over and above depression, mindfulness, and boredom proneness.

## Method

**Participants.** A total of 124 slot machine players were recruited from the same Casino as in Experiment 1. Recruitment was conducted from September 16, 2019 to September 27, 2019, during this time period we aimed to collect 120 participants at minimum. Participants were pre-screened during recruitment to ensure that they were all 19 years of age or older (the legal age to play a slot machine in Ontario), were not in treatment for problem gambling, and played a slot machine at least monthly. Thirteen participants were excluded for various reasons (e.g., falling asleep at the slot machine, withdrawing from the study early, etc.). This left 111 participants for analysis (56 female and 55 male). One participant did not disclose their age. The ages of the other 110 participants ranged from 23-92, with a mean of 59.25 years (*SD* = 12.89).

**Apparatus.**

***Slot machine simulator.*** Participants played the same simulator as in Experiment 1 (see Figure 1). They played 20-lines on each spin and bet 1-cent per line. Thus, players bet 20 cents per spin. Outcomes in which participants lost their entire spin wager were followed by a lack of feedback (i.e., no sounds or animations) and winning outcomes were accompanied by animations and auditory feedback provided by Bose speakers housed within the slot machine casing. The length of the sound was proportional to the win size. The simulator also contained losses disguised as wins (LDWs) in which the outcomes provided the player with auditory and visual feedback, but the total number of credits gained was less than the wager. The playing session consisted of 301 spins, comprised of 202 losses, 40 wins, and 59 LDWs. The overall payback percentage of the game was 92.01%. These relative frequencies of the different outcomes were based on the programming documents of a commercially available machine, and the payback percentage was one commonly used in slot machines in Ontario.

***Force Transducer.*** A force transducer was attached to a specially constructed mouse during our vigilance task described below. When depressed, the amount of pressure applied to the mouse button was translated to a millivolt signal recorded by AD Instruments PowerLab model 4/30. Force data was collected for purposes peripheral to this experiment.

***Vigilance Task.*** Participants completed a “force in sync task” in which they were instructed to press a modified mouse in synchrony with a series of presented tones. The task was presented using SuperLab 5.0 (Cedrus Corporation). The tones consisted of a -20 decibel (dB) (soft) tone, a -10 dB (medium) tone and a 0 dB (relatively loud) tone. Tones were presented in triplets in the same repeating order of soft, medium, and loud. The tones were played over the built-in speaker of a Macintosh iMac. In addition to pressing the transducer in synchrony with the tones, participants were also instructed to modulate the force with which they pressed the transducer (i.e., for the soft tone they were instructed to apply a soft press; for the medium tone, a medium press; and for the loud tone, a hard press). Triplets were presented in six blocks. Blocks 1, 3, and 5 consisted of 42 triplets and blocks 2, 4, and 6 consisted of 43 triplets for a total of 255 triplets (or 765 mouse presses). Before beginning our vigilance task, participants were shown in the software program LabChart how the force transducer was sensitive to different forces and before beginning the experimental trials, participants completed a practice block in order to familiarize themselves with the task. An example of the force tracings is shown in Figure 2.

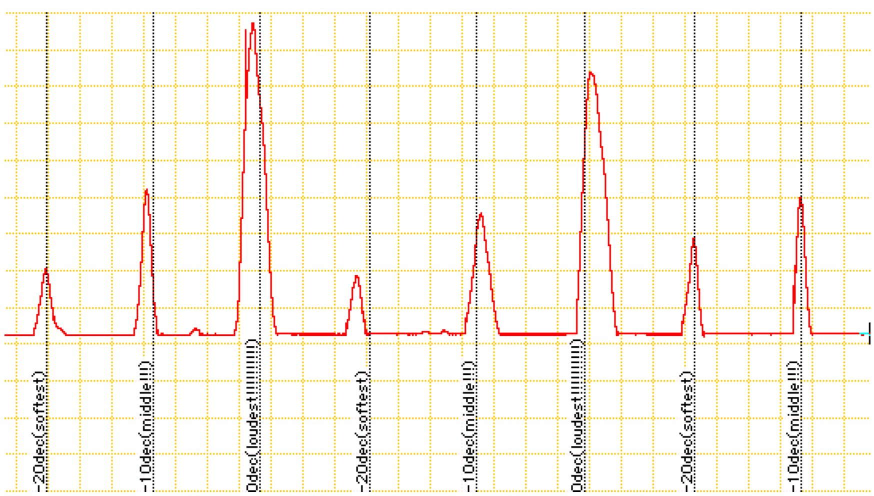

Figure 2. A sample of the LabChart force tracings during the vigilance task. Starting from the left side, the tones were presented in a repeating order of soft (-20db), medium (-10db), and loud (0db).

**Materials.**

***Demographic Questions.*** Participants completed demographic items regarding their age and gender.

***Depression.*** Participants completed the depression subscale from the 21-item Depression, Anxiety, and Stress Scale (DASS-21; Lovibond & Lovibond, 1995). The depression subscale includes items such as, “I couldn’t seem to experience any positive feeling at all” and “I felt that I had nothing to look forward to.” Items were answered on a 4-point scale with the following options: (0) Did not apply to me at all, (1) Applied to me to some degree, or some of the time, (2) Applied to me to a considerable degree, or a good part of the time, and (3) Applied to me very much or most of the time. The seven-items were summed and multiplied by two to generate severity scores in order to make scores comparable to the DASS-42 (see Lovibond & Lovibond, 1995). The depression subscale of the DASS-21 has demonstrated excellent reliability (measured using Cronbach’s alpha, 0.88; Henry & Crawford, 2005).

***Boredom Proneness Scale—Short Form (BPS).*** The BPS (Struk, Carriere, Cheyne, & Danckert, 2017) is an 8-item measure of trait boredom. The BPS contains items such as “Many things I have to do are repetitive and monotonous” and “Much of the time, I just sit around doing nothing.” Items were answered on a 7-point scale with the following options: (1) Strongly disagree, (2) Disagree, (3) Somewhat disagree, (4) Neither disagree nor agree, (5) Somewhat agree, (6) Agree, and (7) Strongly agree. The BPS demonstrates good internal consistency and comparable construct validity to the original Boredom Proneness Scale (Struk et al., 2017).

***Canadian Problem Gambling Index (CPGI).*** Participants also completed an item from the CPGI (Ferris & Wynne, 2001) that assesses the frequency in which players engage with slot machine gambling. The item was, “in the past 12 months, how often did you bet or spend money on slot machines or what some people call video lottery terminals (VLT)? When answering please base your answer on playing any kind of slot machine (i.e., a slot machine or VLT at either a physical or online casino.” They answered this item by choosing one of the following frequencies: daily, 2-6 times a week, about once a week, 2-3 times a month, about once a month, between 6-11 times a year, between 1-5 times a year, never, or I prefer not to say.

***Problem Gambling Severity Index (PGSI).*** The PGSI (Ferris & Wynne, 2001) is a nine-item screening tool that assesses gambling problems in the general population (Cronbach's alpha of 0.84; Ferris & Wynne, 2001). Items were answered on a 4-point scale with the following options: (0) Never, (1) Sometimes, (2) Most of the time, and (3) Almost always. The nine-items were summed to produce a score for problem gambling (ranging from 0 to 27) with higher scores indicating greater risk for problem gambling.

***Mindful Attention Awareness Scale (MAAS).*** The MAAS (Brown & Ryan, 2003) is a 15-item questionnaire that assesses mindfulness in everyday life outside of gambling. The MAAS contains items such as, "I could be experiencing some emotion and not be conscious of it until sometime later" and "I tend to walk quickly to get where I am going without paying attention to what I experience along the way." Items were answered on a 6-point scale with the following options: (1) Almost always, (2) Very frequently, (3) Somewhat frequently, (4) Somewhat infrequently, (5) Very infrequently, and (6) Almost never. The 15-items were averaged to produce a score for mindfulness with higher scores reflecting higher levels of dispositional mindfulness.

***Game Experience Questionnaire (GEQ).*** Participants completed three subscales (flow, positive affect, and negative affect) from the core version of the GEQ (IJsselisteign, de Kort, & Poels, 2013) to assess their experience of the slot machine and tone timing sessions. For (dark) flow, the items were: "I was fully occupied with the game," "I forgot everything around me," "I lost track of time," "I was deeply concentrated in the game," and "I lost connection with the outside world." For positive affect, the following items were administered: "I felt content," "I thought it was fun," "I felt happy," "I felt good," and "I enjoyed it." For negative affect, the follow items were administered: "It gave me a bad mood," "I thought about other things," "I found it tiresome," and "I felt bored." Items were answered using a 5-point scale with the following options: (0) Not at all, (1) Slightly, (2) Moderately, (3) Fairly, (4) Extremely. The items from each subscale were averaged to compute scores for positive affect and (dark) flow. The full GEQ has demonstrated good reliability, with a Cronbach's alpha ranging from 0.71 to 0.89 for the various subscales included (Poel, de Kort, & IJsselsteijn, 2007).

***Thought probes.*** During the slot machine session, participants were prompted with a thought probe after every 50-spins. The thought probe asked the participant to verbally indicate to the experimenter whether their thoughts were: on-game (i.e., thinking about the game), spontaneously mind-wandering (i.e., despite their best intentions to focus on the game, their mind had wandered), or deliberately mind-wandering (i.e., they *intentionally* chose to think about something else) immediately prior to the probe showing up; see Seli, Risko, and Smilek (2016) and Seli, Risko, Smilek, and Schacter (2016) for further distinction between spontaneous and deliberate mind-wandering. The experimenter recorded the participant's response on the tablet used for administering the survey measures. The total number of "on-game" responses were summed to produce an in-game mindfulness score with the scores ranging from 0-6.

During the force in sync task, participants were prompted with a thought probe after 126 or 129 force transducer presses depending on the block (126 for blocks 1, 3, and 5, and 129 for blocks 2, 4, 6). Similar to the slot machine session, there were six thought probes in which participants were to verbally indicate to the experimenter whether they were: on-task, spontaneously mind-wandering, or deliberately mind-wandering. The experimenter recorded the participant's response on the tablet used for administering the survey measures. The total number of “on-task” responses were summed to produce an in-game mindfulness score with the scores ranging from 0-6.

**Design.** The experiment employed a within-subject design with all participants playing slots and completing our vigilance task. Half of the participants played the slot machine first, followed by our vigilance task, whereas the other half completed our vigilance task first. After the final spin, a pop-up message appeared on the slot machine telling the participants their final balance.

**Procedure.** All participants approached the experiment station situated in the front lobby of the casino. After determining eligibility, participants were given an information synopsis of the study and gave written, informed consent before participating in this study. The University of Waterloo’s Office of Research Ethics approved all procedures in this study. Players were informed that they would be given a $25 Walmart gift card for participating, and that they would be able to win up to an additional $10.00 CAD (in cash) depending on their slot machine balance at the end of play. The simulator was pre-loaded with 1000 credits (i.e., $10.00), and since all participants received the same outcomes, all participants ended up with 519 credits ($5.19). The $5.19 was rounded up to $10.00 for each participant.

Using the online survey software Qualtrics, participants first completed the demographic questions, CPGI, PGSI, MAAS, depression questions, and BPS on a Lenovo tablet (model #TB-X103F). Participants then played the slot machine or completed our vigilance task (depending on their counterbalance order). After completing each session, participants answered the positive affect, negative affect, and flow items of the GEQ on the tablet as well as the preference question. Participants were given a $25.00 Walmart gift card and their (rounded up) slot machine balance ($10.00 CAD for all participants). Participants were also given responsible gambling resources and the opportunity to take a feedback letter debriefing them of the studies purposes.

## Results

**Problem Gambling and Depression Scores.** Using the interpretive categories of the PGSI suggested by Currie, Hodgins, and Casey (2013), the sample consisted of: 26 non-problem gamblers (PGSI score of 0), 55 low level problem gamblers (PGSI score ranging from 1 to 4), 21 moderate level problem gamblers (PGSI score ranging from 5 to 7) and 9 problem gamblers (PGSI score of 8 or greater). Using the interpretive categories of the DASS-21 suggested by Lovibond and Lovibond (1995), the sample contained a majority (n = 86) within the normal range of depression (scores of 0 to 9), 15 participants were characterized with mild depression (scores of 10 to 13), 7 with moderate depression (scores of 14 to 20), 2 with severe depression (scores of 21 to 27), and 1 with extremely severe depression (scores of 28 or more). When filling out the slots-frequency of play question, one participant indicated that they played less than once per month (despite our attempt to recruit players who played at least once per month or more) and one participant did not want to answer how often they played a slot machine.

**Order Effects.** In studies involving measures of mind-wandering (such as thought probes) there may be a time-on-task effect. Therefore, it is crucial to assess whether there were effects of which task was completed first. Since these effects could also impact other measures such as affect or flow, for all planned analyses we first assessed whether there were order effects (i.e., a change in effect sizes depending on which game was played first). If there were any effects of order, or any interactions involving order found, the files were split to directly compare those who played the slot machine simulator first to those who completed our vigilance task first since this is the only comparison uncontaminated by order. A significant main effect of order was found for our retrospective measure of positive affect, $F(1, 109) = 4.15$, $p = .044$, and a significant order by task interaction was found for our retrospective measure of negative affect, $F(1, 109) = 5.22$, $p = .024$—such that the negative affect during our vigilance task influenced negative affect scores during slots play (i.e., negative affect during slots was greater if participants completed our vigilance task first). There were no other indications of order effects for the other measures (i.e., the smallest $p \geq .26$). For a full summary of the means and standard deviations see Table 4, and for a correlation matrix for all Experiment 2 study variables see Table 5.

Table 4. Means and Standard Deviations for Experiment 2 Study Variables

| Variable | Multiline Slots *M* (*SD*) | Vigilance Task *M* (*SD*) |
|---|---|---|
| Dark Flow | 1.52 (0.86) | 1.54 (0.91) |
| Positive Affect | 2.12 (0.88) | 1.16 (0.94) |
| Negative Affect | 0.90 (0.73) | 1.45 (0.94) |
| "On-task" Responses | 4.00 (2.01) | 3.73 (2.13) |
| "MW-S" Responses | 1.04 (1.43) | 1.25 (1.49) |
| "MW-D" Responses | 0.91 (1.56) | 1.01 (1.58) |

*Note.* MW-S = Spontaneous mind-wandering; MW-D = Deliberate mind-wandering

Table 5. Zero Order Correlations for all Experiment 2 Study Variables

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. PGSI | — | | | | | | | | | | | | | | |
| 2. Dep. | .423*** | — | | | | | | | | | | | | | |
| 3. MAAS | –.440*** | –.441*** | — | | | | | | | | | | | | |
| 4. BPS | .481*** | .517*** | –.601*** | — | | | | | | | | | | | |
| 5. Slots Mind. | –.124 | –.170 | .091 | –.131 | — | | | | | | | | | | |
| 6. Slots Spont. | .098 | .222* | .016 | .110 | .598*** | — | | | | | | | | | |
| 7. Slots Delib. | .039 | .045 | –.119 | .047 | –.675*** | –.117 | — | | | | | | | | |
| 8. Slots Flow | .116 | .028 | –.042 | .022 | .346*** | –.174 | –.308** | — | | | | | | | |
| 9. Slots Neg. | .011 | –.016 | .056 | –.043 | –.531*** | .205* | .492*** | –.308** | — | | | | | | |
| 10. Slots Pos. | .008 | .056 | –.099 | .046 | .397*** | –.128 | –.372*** | .546*** | –.560*** | — | | | | | |
| 11. Vig. Mind. | –.203* | –.142 | .211* | –.227* | .402*** | –.344*** | –.177 | .171 | –.177 | .060 | — | | | | |
| 12. Vig. Spont. | –.031 | –.002 | –.106 | .062 | –.236** | .406*** | –.107 | –.120 | .036 | –.020 | –.670*** | — | | | |
| 13. Vig. Delib | .302** | .196* | –.187* | .245** | –.311** | .084 | .325** | –.129 | .198* | –.057 | –.717*** | –.036 | — | | |
| 14. Vig. Flow | .111 | .098 | –.049 | .072 | .218* | –.129 | –.159 | .460*** | –.217* | .303** | .478*** | –.312** | –.342*** | — | |
| 15. Vig. Neg. | .080 | .047 | –.057 | .072 | –.430*** | .252** | .314** | –.186 | .553*** | –.302** | –514*** | .304** | .396*** | –.434*** | — |
| 16. Vig. Pos | .008 | –.026 | .042 | –.034 | .222** | –.142 | –.161 | .357*** | –.357*** | .616*** | .309** | –.233* | –.194* | .476*** | –.526*** |

*Note.* Dep. = Endorsement of depression items on the DASS-21; BPS = Boredom Proneness Scale; Slots = Slot machine simulator; Vig. = Vigilance task; Mind. = number of "on game" responses; Pos. = Endorsement of positive affect items on the GEQ; Neg. = Endorsement of negative affect items on the GEQ. *$p$ < .05; **$p$ < .01; ***$p$ < .001

**Dark Flow.** Contrary to our prediction, we found no statistical difference in retrospective accounts of dark flow between slots play ($M = 1.52$; $SD = 0.86$) and our vigilance task ($M = 1.54$; $SD = 0.91$), $t(109) < 1$, $p = .82$. We also failed to replicate the previous studies showing a positive relationship between retrospective dark flow ratings following slots play and problem gambling status, $r(109) = .116$, $p = .23$—however, this relationship is trending in the hypothesized direction. As expected, retrospective dark flow ratings following slots play significantly correlated with: the in-game measure of mindfulness during slots play, $r(109) = .346$, $p < .001$, retrospective ratings of positive affect following slots play, $r(109) = .546$, $p < .001$, and retrospective ratings of negative affect following slots play, $r(109) = -.308$, $p = .001$.

One participant failed to fill out the entire flow subscale of GEQ following the vigilance task and was not included in the subsequent analyses. Retrospective ratings of dark flow following our vigilance task were significantly correlated with: our measure of mindfulness during our vigilance task, $r(108) = .478$, $p < .001$, retrospective positive affect ratings following our vigilance task, $r(108) = .476$, $p < .001$, and retrospective ratings of negative affect following our vigilance task, $r(108) = -.434$, $p < .001$.

Interestingly, retrospective ratings of dark flow following slots also significantly correlated with retrospective ratings of dark flow following our vigilance task, $r(108) = .460$, $p < .001$, and retrospective ratings of positive affect following our vigilance task, $r(109) = .357$, $p <.001$. Similarly, retrospective ratings of dark flow following our vigilance task also significantly correlated with our in-game measure of mindfulness during slots play, $r(108) = .218$, $p = .022$, retrospective ratings of negative affect following slots play, $r(108) = .-.217$, $p = .023$, and retrospective ratings of positive affect following slots play, $r(108) = .303$, $p = .001$.

**Affect.** Since both positive and negative affect were found to be influence by whichever task was completed first, we restricted our analyses to compare those who played slots first to those who completed our vigilance task first (the only contrast uncontaminated by order). We found that negative affect was significantly lower during slot machine play ($M = 0.90$; $SD = 0.73$) relative to our vigilance task ($M = 1.45$; $SD = 0.94$), $t(109) = -3.49$, $p < .001$. Similarly, we also found that positive affect was significantly higher during slot machine play ($M = 2.12$; $SD = 0.88$) relative to our vigilance task ($M = 1.16$; $SD = 0.94$), $t(109) = 5.56$, $p < .001$.

**Mindfulness.** Contrary to our predictions, we found no statistical difference in the number of on-task responses between slots play ($M = 4.00$; $SD = 2.01$) and our vigilance task ($M = 3.73$; $SD = 2.13$), $t(110) = 1.26$, $p = .21$. Similarly, we also found no statistical difference in spontaneous mind-wandering between slots play ($M = 1.04$; $SD = 1.43$) and our vigilance task ($M = 1.25$; $SD = 1.49$), $t(110) = -1.43$, $p = .16$; there was also no statistical difference in deliberate mind-wandering between slots play ($M = 0.91$; $SD = 1.56$) and our vigilance task ($M = 1.01$; $SD = 1.58$), $t(110) < 1$, $p = .57$.

When assessing mindfulness during our vigilance task, we found a significant negative correlation between mindfulness during our vigilance task and PGSI, $r(109) = -.203$, $p = .032$, indicating that those who had trouble staying on-task in the vigilance task had more gambling problems. Further, based on previous research, we expected to see a significant correlation between mindfulness (from the MAAS) and PGSI scores. We also expected to see a non-significant correlation (i.e., the correlation should disappear) when assessing mindfulness during slots play and PGSI scores. In this study, we replicated the correlation between mindfulness from the MAAS and PGSI, $r(109) = -.440$, $p < .001$. When assessing mindfulness during slots play, we found that the correlation between mindfulness during slots and PGSI disappeared, $r(109) = -$

.124, $p$ = .19. Using Steiger's $Z$ (Steiger, 1980) we found that these correlations were significantly different, $Z$ = -.262, $p$ = .009.

When we explored the *type* of mind-wandering during our different tasks, we found no significant relation between spontaneous mind-wandering during our vigilance task and PGSI. However, we found a significant relation between deliberate mind-wandering during our vigilance task and PGSI, $r(109)$ = .302, $p$ = .001. We found no significant relationships between spontaneous or deliberate mind-wandering during slot machine play and PGSI. Using Steiger's $Z$ (Steiger, 1980), we found that the correlation between deliberate mind-wandering during our vigilance task and PGSI was significantly different from the correlation between deliberate mind-wandering during slot machine play and PGSI, $Z$ = -2.41, $p$ = .016, indicating that those who score higher on problem gambling are more likely to report deliberately mind-wandering during our attentionally demanding (and likely boring) vigilance task, but not during slots play.

We found no significant relationship between spontaneous mind-wandering during our vigilance task and boredom proneness. However, we found a significant positive correlation between deliberate mind-wandering during our vigilance task and boredom proneness, $r(109)$ = .245, $p$ = .009. We also found no significant relationships between spontaneous and deliberate mind-wandering during slot machine play and boredom proneness. When using Steiger's Z (Steiger, 1980) to comparing the magnitude of the correlations between deliberate mind-wandering during slots and boredom proneness, $r(109)$ = .047, $p$ = .63, and deliberate mind-wandering during the vigilance task and boredom proneness, $r(109)$ = .245, $p$ = .009, we found that the differences in the magnitude of the correlations approached, but ultimately fell short of significance, $Z$ = 1.80, $p$ = .071.

**Hierarchical Regression Predicting PGSI.** We used hierarchical regression in order to investigate whether problem gamblers in a situation that induces negative affect might *deliberately* mind-wander as a means of coping with the negative affect, and if so, whether this propensity would predict problem gambling status—over and above depression, mindfulness, and boredom proneness. Specifically, we used four independent variables to predict problem gambling status (measured by the PGSI). Depression ratings were entered at Step 1, mindfulness scores (from the MAAS) at Step 2, boredom proneness at Step 3, and the number of "deliberately mind-wandering" responses from our vigilance task at the final step. At Step 1, depression significantly contributed to the regression model, $F(1, 109) = 23.73$, $p < .001$, and accounted for 17.9% of the variation in PGSI score variance. At Step 2, mindfulness scores explained an additional 8.0% of the variation in PGSI score variance and this increase in $R^2$ was significant, $\Delta F(1, 108) = 11.61$, $p = .001$. At Step 3, boredom proneness explained an additional 3.7% of PGSI score variance and this increase in $R^2$ was also significant, $\Delta F(1, 107) = 5.70$, $p = .019$. At the final step, the number of "deliberately mind-wandering" responses explained an additional 2.8% of variation in PGSI score variance and this increase in $R^2$ was also significant, $\Delta F(1, 106) = 4.42$, $p = .038$. The overall regression model was significant when all four independent variances were included in Step 4, $F(4, 106) = 12.71$, $p < .001$, and accounted for 32.41% of PGSI score variance. Thus, in a situation that induces negative affect (like our vigilance task), it appears that problem gamblers may use deliberate mind-wandering as a means to cope with negative affect. For a full regression summary see Table 6.

Table 6. Experiment 2 Hierarchical Regression for Variables Predicting PGSI

| Model | $b$ | $SE$ | β | $R^2$ | $\Delta R^2$ |
|---|---|---|---|---|---|
| Step 1 | | | | .179*** | |
| Constant | 2.13 | 0.35 | | | |
| Depression | 0.23 | 0.05 | 0.42*** | | |
| Step 2 | | | | .258*** | .080** |
| Constant | 7.52 | 1.62 | | | |
| Depression | 0.15 | 0.05 | 0.28** | | |
| Mindfulness | –1.06 | 0.31 | –0.32** | | |
| Step 3 | | | | .296*** | .037* |
| Constant | 3.51 | 2.31 | | | |
| Depression | 0.11 | 0.05 | 0.20* | | |
| Mindfulness | –0.66 | 0.35 | –0.20 | | |
| Boredom | 0.10 | 0.42 | 0.26* | | |
| Step 4 | | | | .299*** | .028* |
| Constant | 3.34 | 2.27 | | | |
| Depression | 0.10 | 0.05 | 0.19 | | |
| Mindfulness | –0.63 | 0.35 | –0.19 | | |
| Boredom | 0.09 | 0.42 | 0.23* | | |
| Vig. Delib. | 0.34 | 0.16 | 0.17* | | |

*Note*. PGSI = Problem Gambling Severity Index; Depression = Endorsement of the depression items of the DASS-21; Mindfulness = Scores from the MAAS; Boredom = Scores from the Boredom Proneness Scale; Vig. Delib = number of "deliberately mind-wandering" responses from the vigilance task

$^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$

## Discussion

In Experiment 2, we expected to see greater retrospective ratings of flow following slot machine play when compared to our vigilance task. Although the degree to which flow was experienced was correlated with how much positive affect was experienced, contrary to our prediction, we failed to find any significant differences in flow following slots play and our vigilance task. One potential explanation for the failure to find differences in flow between slots play and our vigilance task involved testing under less than ideal circumstances. The lobby of the casino that we were stationed in was quite loud—louder than we anticipated. This was not a problem for our slot machine simulator as we were able to increase the volume on the Bose speakers in order to overcome the background noise. However, even at maximum volume on the built-in speakers of the Macintosh computer that administered our vigilance task, some participants mentioned that the tones were harder to hear than the celebratory sounds of the simulator. Thus, participants may have been deeply concentrated with the slots game due to (dark) flow, but just as deeply concentrated in the vigilance task as they kept tight rein on their attention in order to fully hear the different tones. Since the GEQ flow measure asks participants to rate how "deeply concentrated" they were during both tasks, the extra effort participants devoted to hearing the tones in the vigilance task may have led to similar flow ratings.

Contrary to our prediction, we also found no significant difference in the number of "on-task" responses between the two tasks. Once again, the failure to find such differences may be attributable to participants straining to hear the tones in the vigilance task (i.e., compensating by focusing their attention to discriminate the tones). Even though we failed to find a difference in flow and mindfulness, we did find significant differences in affect as predicted. Players reported greater negative affect following the vigilance task compared to the slot-machine session as well as the corollary—greater positive affect following slot machine play and lower positive affect following the vigilance task. In terms of negative affect, the repetitive and dull nature of our vigilance task likely contributed to a lowering of mood relative to the more exciting slots play. Similarly, the reinforcing feedback of the slot machine may have caused an elevation in mood relative to our vigilance task.

A novel and important finding involves the correlation between *deliberate* mind-wandering during our vigilance task and problem gambling severity. It appears that those who scored higher in problem gambling used deliberate mind-wandering as a maladaptive means of attempting to cope with the negative affect induced by the highly repetitive and boring vigilance task. By contrast, there was no relation between deliberate mind-wandering and problem gambling status during slots play. One interpretation is that since slots play induced positive affect, there was no longer a reason for problem gamblers to deliberately mind-wander since there was no negative affect from which to escape. We also showed similar relations between deliberate mind-wandering and boredom proneness—significant correlations in the (negative) vigilance task, non-significant correlations in the (positive) slots task. It appears that those who score higher in trait boredom may be using deliberate mind-wandering as a means of avoiding negative affect associated with boredom. However, we are more cautious about these claims since the magnitudes of the differences between these correlations in the vigilance and slots conditions fell just short of significance.

Consistent with previous research, we replicated a negative correlation between mindfulness in everyday life and depressive symptomology outside of the gambling context (de Lisle et al., 2011; Lakey et al., 2007; Reid et al., 2014; Dixon et al., 2014; Dixon et al., 2017). We also replicated a negative correlation between mindfulness in everyday life and problem gambling severity (Dixon et al., 2019a; Dixon et al., 2019b). This correlation between mindfulness in everyday life and problem gambling disappeared when mindfulness during slots play was assessed, a finding that replicates Dixon et al. (2019b) and Experiment 1. Thus, it appears that slots play—with its more frequent reinforcing feedback—is capable of reining in the wandering mind.

Another novel finding in this study involves the hierarchical multiple regression predicting problem gambling severity. We first replicated the well-established relationships in the problem gambling literature between problem gambling severity, depression, mindfulness, and boredom proneness. We showed significant correlations between problem gambling and depression (Dixon et al., 2017; Dixon et al., 2019b), problem gambling and mindfulness problems (Dixon et al., 2019b), and problem gambling and boredom proneness (Blaszczynski, McConaghy, & Frankova, 1990). When we used multiple regression to predict problem gambling scores, we found that the number of "deliberately mind-wandering" responses significantly accounted for unique problem gambling severity variance, after accounting for depression, mindfulness, and problem gambling. This indicates that there is something particular about problem gambling that triggers these people to *deliberately* mind-wander during a task that induces negative affect—perhaps problem gamblers are using deliberate mind-wandering as a means of attempting to alleviate such negative affect. Such a coping strategy is in all likelihood maladaptive as mind-wandering itself is associated with and may contribute to negative affect (Killingsworth & Gilbert, 2010).

## Limitations and Conclusions

Slot machine gambling is a pervasive form of casino gambling in North America and can create exceptional problems for some players. During play, some players describe a narrowing of attention and flow-like state in which they call the “slot machine zone.” During this state of deep, effortless concentration, players report distortions of time and often describe this state as very pleasant.

In both experiments, we sought to explore whether the reinforcing sights and sounds of the slot machine serve to rein in the attention of bored minds that are prone to mind-wandering and fostering entry into “the zone,” ultimately elevating mood. However, both Experiments have some limitations. In Experiment 1, we failed to replicate previous studies showing a positive relationship between dark flow during multiline slots and depression outside of the gambling context. We also failed to replicate a significantly larger correlation between dark flow and PGSI status for the multiline slots versus the single-line slots. Both limitations may be attributable to interrupting players during slots play to assess their “in-game” mindfulness. We likely broke the players flow state every time we interrupted them. This breaking of flow would have more profound effects in the multiline game. If depressed gamblers seek out and experience periods of unbroken flow when they normally play their favourite multiline slots game, when they play our multiline game (with its interruptions every 50 spins) it may have reduced the amount of flow they usually experience. Even though our data supported our prediction that players would experience greater flow during the multiline game than single-line game, the effect sizes were much smaller than anticipated—a limitation that is also likely attributable to the thought-probe methodology.

Even though we recruited participants from the same casino in previous studies, in Experiment 2, there were far fewer problem gamblers that participated in this study ($n = 9$) compared to previous ones ($n = 39$, Dixon et al., 2017; $n = 26$, Dixon et al., 2019b) which may have accounted for the failure to replicate the positive correlation between dark flow during slots play and depression outside of the gambling context as well as the positive correlation between dark flow ratings and problem gambling severity.

In conclusion, compared to single-line slots (Experiment 1), it seems that multiline slot machines are capable of reining in the wandering mind by providing a highly captivating experience for the player. Depressed individuals may ruminate about their problems and seek relief from the frequent yet unpredictable reinforcement of the multiline slot machine. When compared to the less frequent feedback from single-line slots, the more frequent reinforcement provided by the multiline slot machine may foster greater entry into the “slot machine zone.” Further, in environments that induces negative affect (Experiment 2), it appears that problem gamblers may (maladaptively) use deliberate mind-wandering as a means of attempting to cope with their current situation. Across both experiments we provide evidence that those with mindfulness problems in everyday life (who are also likely bored and depressed) appear to have their attention reined in by the frequent (yet unpredictable) reinforcement during slots play. Such a reining in of attention induces a flow state and elevate positive affect. This elevation of positive affect may induce bored and depressed players to play slots to alleviate the negative affect that characterizes their day-to-day lives. This complex relationship between problem gambling, mindfulness problems in everyday life, depression, boredom, and dark flow afforded by multiline slots may further help explain the motivations of those who gamble to escape.

# References


Abbott, M. W., & Volberg, R. A. (1996). The New Zealand national survey of problem and pathological gambling. *Journal of Gambling Studies*, *12*(2), 143-160.

Bertossi, E., Peccenini, L., Solmi, A., Avenanti, A., & Ciaramelli, E. (2017). Transcranial direct current stimulation of the medial prefrontal cortex dampens mind-wandering in men. *Scientific reports*, *7*(1), 16962.

Bishop, S. R., Lau, M., Shapiro, S., Carlson, L., Anderson, N. D., Carmody, J., ... & Devins, G. (2004). Mindfulness: A proposed operational definition. *Clinical psychology: Science and practice*, *11*(3), 230-241.

Bjelde, K., Chromy, B., & Pankow, D. (2008). Casino gambling among older adults in North Dakota: A policy analysis. *Journal of Gambling Studies*, *24*(4), 423-440.

Blaszczynski, A. P., Wilson, A. C., & McConaghy, N. (1986). Sensation seeking and pathological gambling. *British Journal of addiction*, *81*(1), 113-117.

Blaszczynski, A., & Nower, L. (2002). A pathways model of problem and pathological gambling. *Addiction*, *97*(5), 487-499.

Blaszczynski, A., McConaghy, N., & Frankova, A. (1990). Boredom proneness in pathological gambling. *Psychological reports*, *67*(1), 35-42.

Blaszczynski, A., Sharpe, L., Walker, M., Shannon, K., & Coughlan, M. J. (2005). Structural characteristics of electronic gaming machines and satisfaction of play among recreational and problem gamblers. *International Gambling Studies*, *5*(2), 187-198.

Brown, K. W., & Ryan, R. M. (2003). The benefits of being present: mindfulness and its role in psychological well-being. *Journal of personality and social psychology*, *84*(4), 822.

Cheyne, J. A., Carriere, J. S., & Smilek, D. (2006). Absent-mindedness: Lapses of conscious awareness and everyday cognitive failures. *Consciousness and cognition*, *15*(3), 578-592.

Csikszentmihalyi, M., & Csikszentmihalyi, I. S. (Eds.). (1992). *Optimal experience: Psychological studies of flow in consciousness*. Cambridge University Press.

Csikszentmihalyi, M., Abuhamdeh, S., & Nakamura, J. (2014). Flow. In *Flow and the foundations of positive psychology* (pp. 227-238). Springer, Dordrecht.

Currie, S. R., Hodgins, D. C., & Casey, D. M. (2013). Validity of the problem gambling severity index interpretive categories. *Journal of gambling studies*, *29*(2), 311-327.

de Lisle, S. M., Dowling, N. A., & Allen, J. S. (2011). Mindfulness-based cognitive therapy for problem gambling. Clinical Case Studies, 10, 210–228. http://dx.doi.org/10.1177/1534650111401016

Delaney, H. D., & Maxwell, S. E. (1981). On using analysis of covariance in repeated measures designs. *Multivariate Behavioral Research*, *16*(1), 105-123.

Diskin, K. M., & Hodgins, D. C. (1999). Narrowing of attention and dissociation in pathological video lottery gamblers. *Journal of gambling studies*, *15*(1), 17-28.

Diskin, K. M., & Hodgins, D. C. (2001). Narrowed focus and dissociative experiences in a community sample of experienced video lottery gamblers. *Canadian Journal of Behavioural Science/Revue canadienne des sciences du comportement*, *33*(1), 58.

Dixon, M. J., Graydon, C., Harrigan, K. A., Wojtowicz, L., Siu, V., & Fugelsang, J. A. (2014). The allure of multi-line games in modern slot machines. *Addiction*, *109*(11), 1920-1928.

Dixon, M. J., Gutierrez, J., Larche, C. J., Stange, M., Graydon, C., Kruger, T. B., & Smith, S. D. (2019a). Reward reactivity and dark flow in slot-machine gambling: “Light” and “dark” routes to enjoyment. *Journal of behavioral addictions*, *8*(3), 489-498.

Dixon, M. J., Gutierrez, J., Stange, M., Larche, C. J., Graydon, C., Vintan, S., & Kruger, T. B. (2019b). Mindfulness problems and depression symptoms in everyday life predict dark flow during slots play: Implications for gambling as a form of escape. *Psychology of Addictive Behaviors*, *33*(1), 81.

Dixon, M. J., Harrigan, K. A., Sandhu, R., Collins, K., & Fugelsang, J. A. (2010). Losses disguised as wins in modern multi-line video slot machines. *Addiction*, *105*(10), 1819-1824.

Dixon, M. J., Harrigan, K. A., Santesso, D.L., Graydon, C., Fugelsang, J. A. & Collins, K. (2014). The impact of sound in modern multiline video slot machine play. *Journal of Gambling Studies*, *30*(10), 913-929.

Dixon, M. J., Stange, M., Larche, C. J., Graydon, C., Fugelsang, J. A., & Harrigan, K. A. (2017). Dark flow, depression and multiline slot machine play. *Journal of gambling studies*, *34*(1), 73-84.

Dowling, N. A., Merkouris, S. S., Dias, S., Rodda, S. N., Manning, V., Youssef, G., ... & Volberg, R. A. (2019). The diagnostic accuracy of brief screening instruments for problem gambling: A systematic review and meta-analysis. *Clinical psychology review*, 101784.

Eastwood, J. D., Frischen, A., Fenske, M. J., & Smilek, D. (2012). The unengaged mind: Defining boredom in terms of attention. *Perspectives on Psychological Science*, *7*(5), 482-495.

Ferris, J., & Wynne, H. (2001). The Canadian problem gambling index: Final report. Submitted for the Canadian Centre on Substance Abuse.

Getty, H. A., Watson, J., & Frisch, G. R. (2000). A comparison of depression and styles of coping in male and female GA members and controls. *Journal of gambling studies*, *16*(4), 377-391.

Graydon, C., Dixon, M. J., Harrigan, K. A., Fugelsang, J. A., & Jarick, M. (2017). Losses disguised as wins in multiline slots: using an educational animation to reduce erroneous win overestimates. *International Gambling Studies*, *17*(3), 442-458.

Griffiths, M. D., & Auer, M. (2013). The irrelevancy of game-type in the acquisition, development, and maintenance of problem gambling. *Frontiers in psychology*, *3*, 621.

Griffiths, M. D., & Parke, J. (2005). The psychology of music in gambling environments: An observational research note. *Journal of Gambling Issues (JGI)*, (13).

Haas, E. C., & Edworthy, J. (1996). Designing urgency into auditory warnings using pitch, speed and loudness. *Computing & Control Engineering Journal*, *7*(4), 193-198.

Henry, J. D., & Crawford, J. R. (2005). The short-form version of the Depression Anxiety Stress Scales (DASS-21): Construct validity and normative data in a large non-clinical sample. *British Journal of Clinical Psychology, 44*, 227–239. http://dx.doi.org/10.1348/014466505X29657

Hunter, A., & Eastwood, J. D. (2018). Does state boredom cause failures of attention? Examining the relations between trait boredom, state boredom, and sustained attention. *Experimental Brain Research*, *236*(9), 2483-2492.

IJsselsteijn, W. A., de Kort, Y. A. W., & Poels, K. (2013). The Game Experience Questionnaire. Eindhoven:Technische Universiteit Eindhoven.

Isacescu, J., Struk, A. A., & Danckert, J. (2017). Cognitive and affective predictors of boredom proneness. *Cognition and emotion*, *31*(8), 1741-1748.

Jacobs, D. F., Marston, A. R., Singer, R. D., Widaman, K., Little, T., & Veizades, J. (1989). Children of problem gamblers. *Journal of Gambling Behavior*, *5*(4), 261-268.

Jensen, C., Dixon, M. J., Harrigan, K. A., Sheepy, E., Fugelsang, J. A., & Jarick, M. (2013). Misinterpreting 'winning'in multiline slot machine games. *International Gambling Studies*, *13*(1), 112-126.

Killingsworth, M. A., & Gilbert, D. T. (2010). A wandering mind is an unhappy mind. *Science*, *330*(6006), 932-932.

Lahn, J. (2005). Gambling among offenders: Results from an Australian survey. *International Journal of Offender Therapy and Comparative Criminology*, *49*(3), 343-355.

Lakey, C. E., Campbell, W. K., Brown, K. W., & Goodie, A. S. (2007). Dispositional mindfulness as a predictor of the severity of gambling outcomes. Personality and Individual Differences, 43, 1698–1710. http://dx.doi.org/10.1016/j.paid.2007.05.007

Li, E., Browne, M., Rawat, V., Langham, E., & Rockloff, M. (2017). Breaking bad: Comparing gambling harms among gamblers and affected others. *Journal of Gambling Studies*, *33*(1), 223-248.

Livingstone, C. H., Woolley, R., Zazryn, T. R., Bakacs, L., & Shami, R. G. (2008). *The relevance and role of gaming machine games and game features on the play of problem gamblers*. Independent Gambling Authority.

Lovibond, P. F., & Lovibond, S. H. (1995). The structure of negative emotional states: Comparison of the Depression Anxiety Stress Scales (DASS) with the Beck Depression and Anxiety Inventories. *Behaviour research and therapy*, *33*(3), 335-343.

Marty-Dugas, J., & Smilek, D. (2018). Deep, effortless concentration: re-examining the flow concept and exploring relations with inattention, absorption, and personality. *Psychological research*, 1-18.

Matheson, F. I., Sztainert, T., Lakman, Y., Steele, S. J., Ziegler, C. P., & Ferentzy, P. (2018). Prevention and treatment of problem gambling among older adults: a scoping review. *Journal of Gambling Issues*, (39).

Mercer, K. B., & Eastwood, J. D. (2010). Is boredom associated with problem gambling behaviour? It depends on what you mean by 'boredom'. *International Gambling Studies*, *10*(1), 91-104.

Murch, W. S., Chu, S. W., & Clark, L. (2017). Measuring the slot machine zone with attentional dual tasks and respiratory sinus arrhythmia. *Psychology of Addictive Behaviors*, *31*(3), 375.

Ontario Lottery and Gaming Corporation. (2019). *2018-19 ANNUAL REPORT ONTARIO LOTTERY AND GAMING CORPORATION.* (ISSN 1499 4887). Retrieved from https://about.olg.ca/wp-content/uploads/2019/10/OLG-Annual-Report-2018-19_EN.pdf.

Pfund, R. A., Peter, S. C., Whelan, J. P., Meyers, A. W., Ginley, M. K., & Relyea, G. (2020). Is more better? A meta-analysis of dose and efficacy in face-to-face psychological treatments for problem and disordered gambling. *Psychology of Addictive Behaviors*.

Poels, K., de Kort, Y. A. W., & IJsselsteijn, W. A. (2007). D3.3: Game Experience Questionnaire: Development of a self-report measure to assess the psychological impact of digital games. Eindhoven: Technische Universiteit Eindhoven.

Reid, R. C., Di Tirro, C., & Fong, T. W. (2014). Mindfulness in patients with gambling disorders. *Journal of Social Work Practice in the Addictions*, *14*(4), 327-337.

Rogatko, T. P. (2009). The influence of flow on positive affect in college students. *Journal of happiness studies*, *10*(2), 133.

Schüll, N. D. (2005). Digital gambling: The coincidence of desire and design. *The Annals of the American Academy of Political and Social Science*, *597*(1), 65-81.

Schüll, N. D. (2014). *Addiction by design: Machine gambling in Las Vegas*. Princeton University Press.

Seli, P., Beaty, R. E., Cheyne, J. A., Smilek, D., Oakman, J., & Schacter, D. L. (2018). How pervasive is mind wandering, really?. *Consciousness and cognition*, *66*, 74-78.

Seli, P., Cheyne, J. A., Xu, M., Purdon, C., & Smilek, D. (2015). Motivation, intentionality, and mind wandering: Implications for assessments of task-unrelated thought. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *41*(5), 1417.

Seli, P., Kane, M. J., Smallwood, J., Schacter, D. L., Maillet, D., Schooler, J. W., & Smilek, D. (2018). Mind-wandering as a natural kind: A family-resemblances view. *Trends in cognitive sciences*, *22*(6), 479-490.

Seli, P., Risko, E. F., & Smilek, D. (2016). On the necessity of distinguishing between unintentional and intentional mind-wander. *Psychological science*, *27*(5), 685-691.

Seli, P., Risko, E. F., Smilek, D., & Schacter, D. L. (2016). Mind-wandering with and without intention. *Trends in cognitive sciences*, *20*(8), 605-617.

Smallwood, J., & Schooler, J. W. (2006). The restless mind. *Psychological bulletin*, *132*(6), 946.

Steiger, J. H. (1980). Tests for comparing elements of a correlation matrix. *Psychological bulletin*, *87*(2), 245.

Struk, A. A., Carriere, J. S., Cheyne, J. A., & Danckert, J. (2017). A short boredom proneness scale: Development and psychometric properties. *Assessment*, *24*(3), 346-359.

Templeton, J. A., Dixon, M. J., Harrigan, K. A., & Fugelsang, J. A. (2015). Upping the reinforcement rate by playing the maximum lines in multi-line slot machine play. *Journal of Gambling Studies*, *31*(3), 949-964.

Turner, N. E., Zangeneh, M., & Littman-Sharp, N. (2006). The experience of gambling and its role in problem gambling. *International Gambling Studies*, *6*(2), 237-266.

Walker, M. (2004). The seductiveness of poker machines. *Gambling Research: Journal of the National Association for Gambling Studies (Australia)*, *16*(2), 52.

Wheeler, M. S., Arnkoff, D. B., & Glass, C. R. (2017). The neuroscience of mindfulness: How mindfulness alters the brain and facilitates emotion regulation. *Mindfulness*, *8*(6), 1471-1487.

Williams, R. J., & Volberg, R. A. (2013). *Gambling and problem gambling in Ontario*. Ontario Problem Gambling Research Centre & The Ontario Ministry of Health and Long Term Care.

Williamson, A., & Walker, M. (2001). Strategies for solving the insoluble: Playing to win Queen of the Nile. *Lessons of the Past*, 202