Scratch Card Game Type Impacts Psychophysiological Reactivity, but Not Subjective Evaluations of Experienced Outcomes

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Abstract

Although many types of scratch cards exist, research on gamblers' physiological responses to scratch card wins, losses, and near misses has been limited to a single type of game. We created two distinct scratch card types. In a "Match Three" game, we expected arousal to rise with each successive matching symbol—hence arousal would change even before the final outcome was known. In a "Number Matching" game, where players were given a set of lucky numbers and hoped to find a match within a scratch-off play area, we expected arousal to rise only once a match was made. A near miss in a Match Three game involved uncovering two large-prize symbols (but not the third). A near miss in a Number Matching game involved just missing a match (lucky number 18, uncovering a 17). For each game type, participants played four cards (small win, near miss, and two losses) while their physiological arousal was recorded. Participants rated each outcome on a number of subjective measures. For wins, arousal changes occurred as predicted (pre-outcome changes for Match Three vs. only post-outcome changes for Number Matching games). Participants rated near-miss outcomes in both card types as being more subjectively arousing, disappointing, negative, frustrating, and urge inducing than for regular losses, but we found no strong evidence for physiological near-miss effects. We provide evidence that the structure of scratch card games influences the timing of individuals' physiological responses to various outcomes.

Keywords: scratch cards, psychophysiology, lottery, motivation, arousal

Résumé

Bien qu'il existe de nombreux modèles de cartes à gratter, les recherches menées jusqu'ici sur les réactions physiologiques des joueurs face à un gain, une perte ou un quasi-gain se limitent à un seul type de jeu. Nous avons conçu deux jeux de cartes à gratter distincts. Le premier était un jeu « à trois correspondances »; nous nous

attendions à ce que le degré d'excitation monte à chaque apparition d'un symbole identique - et ce, avant même que le résultat final soit connu. Le second jeu consistait à donner aux joueurs un jeu de chiffres chanceux avec instruction de dévoiler un chiffre correspondant dans la partie à gratter de la carte; nous nous attendions à ce que l'excitation monte seulement après le dévoilement d'une correspondance. Dans le premier jeu, un quasi-gain consistait en la découverte de deux symboles représentant un lot important (mais pas du troisième). Dans le second jeu, un quasi-gain consistait en l'obtention d'un nombre très proche du chiffre gagnant (obtention d'un 17 alors que le gagnant est le 18). Les participants ont été invités à gratter quatre cartes par jeu (un petit gain, un quasi-gain et deux pertes) tandis qu'on enregistrait leurs réactions physiologiques, puis à donner une évaluation subjective de chaque résultat. Les réactions anticipées se sont produites dans le cas des gains (soit avant le dévoilement du résultat dans le premier jeu et seulement après dans le second). Peu importe le type de carte, les sujets ont qualifié le quasi-gain, comparativement aux pertes régulières, d'expérience excitante, décevante, négative, frustrante et propre à attiser le désir de jouer, mais nous n'avons recueilli aucune preuve de réaction physiologique dans ce cas précis. Selon nos conclusions, la structure des jeux de cartes à gratter a une incidence sur le moment de la réaction physiologique aux différents résultats de jeu.

Introduction

Scratch cards are a popular and accessible form of lottery gambling available at many retail locations (e.g., convenience stores and gas stations) at a relatively low price point (between $1 and $30) and with a variety of different game types (approximately 80 unique games are offered per year in the Canadian province of Ontario alone; Ontario Lottery and Gaming Corporation [OLG], 2019a). In contrast to traditional lotteries in which gamblers select a set of numbers and sometimes have to wait days for a draw to occur, scratch card gamblers simply scratch off an opaque layer that covers symbols or numbers to immediately reveal whether their card is a winner. These games can be played quickly and offer the opportunity for continuous play, such that gamblers are able to immediately exchange winnings for more cards. The rapid event frequency and continuous nature of these games has led to concerns about potential harms (Griffiths, 1995), with some researchers likening scratch cards to paper slot machines (Ariyabuddhiphongs, 2011; Griffiths, 2002). Despite these concerns, scratch card games are remarkably popular and reportedly one of the fastest growing lottery areas in North America (Skerritt, 2017).

Existing literature on scratch cards has largely focused on youth accessing these games despite legal age restrictions, suggesting that sizeable percentages of this demographic in many countries engage in scratch card gambling (Boldero et al., 2010; Donati et al., 2013; Elton-Marshall et al., 2016; Felsher et al., 2004). Some authors have also

described cases of problematic adolescent scratch card gambling (Wood & Griffiths, 1998). Although estimates of the number of individuals uniquely addicted to scratch cards are low (DeFuentes-Merillas et al., 2003; Hendriks et al., 1997), case studies of pathological scratch card gambling have been reported (Raposo-Lima et al., 2015), and in a longitudinal study, the frequency of scratch card play predicted problem gambling over time (Williams et al., 2015). Further, the frequency of scratch card gambling accounted for significant independent variance in a predictive model of problem gambling, over and above demographic variables and draw-based lottery gambling frequency (Short et al., 2015). Although typically seen as an innocuous "impulse buy" for adults, research suggests that these games are illegally purchased by youth and may be associated with harm.

To ensure a profit for the lottery operator, most scratch cards result in a monetary loss. For example, in a popular scratch card game available in Ontario, 15,422,400 scratch cards were printed, but only 4,468,561 contained prizes (OLG, 2019b), meaning that 71% of cards in this game were losses. Wins (only 29% of cards) tend to be small: In the current example, 99.99% of the prizes were $100 or less (OLG, 2019b). Recent research indicates that even small wins can trigger increases in psychophysiological arousal and motivate individuals to continue gambling (Stange, Grau, et al., 2017; Stange, Graydon, & Dixon, 2017). If gamblers do indeed act on this urge and purchase additional cards, even small wins could lengthen play times and ultimately increase gamblers' costs, as the most probable outcome of the next card is a loss. Despite the large number of different game types available, these effects have been investigated in only one type of scratch card. Stange, Graydon, and Dixon (2016) designed custom scratch cards and examined the motivating properties of small wins. They patterned these cards after a popular scratch card in which gamblers aim to uncover three matching symbols within a matrix of various symbols. Uncovering successive matching symbols triggered increases in arousal prior to the gambler knowing whether they won or lost (Stange et al., 2016; Stange, Grau, et al., 2017). It remains unknown whether scratch card games with different structural characteristics, such as those that do not contain a period of anticipation before the outcome reveal, also promote the urge to continue gambling.

Small wins are not the only outcome that increase gambling urge. Near misses are a special type of losing outcome (DeFuentes-Merillas et al., 2003; Griffiths, 2000, 2002) commonly used in slot machines (Harrigan, 2008) that appear to come close to a jackpot win but fall short (Reid, 1986). Despite being an objective loss, slot machine near misses have been shown to increase psychophysiological arousal (M. J. Dixon et al., 2011), to cause gamblers to move on to their next spin more quickly (M. J. Dixon et al., 2013), to prolong slot machine play (Coté et al., 2003; Kassinove & Schare, 2001), and to increase the urge to continue gambling and engage reward-related brain areas (Clark et al., 2009). Although scratch card near misses have long been acknowledged (Griffiths, 1995; Moran, 1979; Reid, 1986), empirical investigations have only recently emerged. Studies suggest that near misses in scratch cards (as in slot machines) increase psychophysiological arousal (Stange

et al., 2016; Stange, Grau, et al., 2017) and subjective frustration, disappointment, and urge to gamble (Stange, Graydon, & Dixon, 2017) relative to regular losses.

One framework for conceptualizing near misses is skill learning. In skilled tasks, near misses indicate improvement and that future attempts may be successful (Clark, 2014). This belief that near misses indicate the acquisition of skill and therefore proximity to wins is incorrect when applied to pure chance scenarios, where near-miss outcomes only appear to signal relevant information. Regardless, these outcomes prove extremely compelling to gamblers. A study of slot machine gamblers found that participants who reported a high likelihood of winning following a near miss in chance-based gambling (i.e., those who spuriously "learned" from the near miss) were more likely to persist at gambling than were those who did not (Clark et al., 2013). These findings highlight the importance of information encountered prior to the outcome in the anticipatory period when a win appears imminent, before the gambler's hopes are dashed. Experiments investigating scratch card near misses in which participants must collect three matching top prize symbols have shown increases in psychophysiological reactivity during the anticipatory phase of these outcomes as sequential jackpot symbols are uncovered (Stange et al., 2016; Stange, Grau, et al., 2017). This increase is in contrast to physiological responses in slot machine games, where the arousal response occurs after the outcome reveal (M. J. Dixon et al., 2011). This finding suggests that in scratch cards, cues of impending success may be misconstrued as useful, causing an increase in psychophysiological reactivity leading up to the outcome and comparably heightened subjective responses following it, at least in games in which participants must gather three matching top prize symbols to win. The impact of game structure on scratch card near-miss effects remains unknown in terms of the pre-outcome anticipatory period. For example, do scratch card games with no pre-outcome anticipatory phase still result in increased physiological arousal after the near-miss outcome has been revealed?

In the current study, we examined the effects of small wins and near misses in two types of scratch cards: games in which participants uncover symbols hoping to find three matching symbols (Match Three) and games in which participants aim to match a lucky number with a given number (Number Matching). Previous studies (Stange et al., 2016) have examined only Match Three games, despite many other card types being available for purchase. Examination of these two game types allows for the comparison of games with (Match Three) and without (Number Matching) an anticipatory pre-outcome phase. Although Number Matching games may provide reduced opportunity for anticipatory processing, they still contain near misses and may create an opportunity for increased physiological arousal following the completion of an outcome. For example, the goal of a Number Matching game may be to find a match to the "lucky" number 27. When uncovering the other numbers in the game, finding a 26 may be viewed as narrowly missing a win. Since both game types contain near-miss outcomes, but differ structurally in terms of their outcome processing phases, we can assess how structural differences in scratch card games affect a gambler's experience in terms of the timing of psychophysiological arousal

and subsequent subjective evaluations. We also sought to replicate previous findings of near-miss effects in Match Three scratch card games in terms of psychophysiological and subjective reactivity.

We hypothesized that for both game types, participants would show elevated psychophysiological arousal and heightened subjective reactions to small wins and near-miss outcomes relative to regular losses. Crucially, we hypothesized that Match Three games would result in psychophysiological reactivity before the outcome reveal (replicating previously observed results; Stange et al., 2016; Stange, Grau, et al., 2017), whereas Number Matching games would result in reactivity after the outcome reveal. For Match Three games, we also sought to replicate past findings concerning small wins and near misses (Stange et al., 2016; Stange, Graydon, & Dixon, 2017), such that these outcomes would result in significantly greater ratings of subjective arousal, disappointment, frustration, and urge to gamble than occurs with regular losses.

Method

Participants

A sample of 66 participants was recruited from the University of Waterloo's Research Experiences Group. All participants were at least 18 years of age (the legal age to purchase scratch cards in Ontario), had experience playing scratch cards, were not in treatment for problem gambling, were not in treatment or taking medication for an anxiety disorder, and did not have any allergies or sensitivities to adhesives or sanitizing agents used in psychophysiological data recording (the latter two criteria included to optimize psychophysiological recordings). Participant's self-reported age, gender, problem gambling severity level, and frequency of scratch card play are reported in Table 1.

Participants were undergraduate students enrolled in a psychology course and received a 0.5% course credit for participating. All participants received $10.00 in remuneration corresponding to the scratch card outcomes that they encountered during the experiment (see Materials section; all amounts expressed in CAD). All procedures were reviewed and received ethics clearance from a University of Waterloo Research Ethics Committee.

Materials

Sample Characteristics

The Problem Gambling Severity Index (PGSI) is a nine-item subscale of the Canadian Problem Gambling Index (CPGI) that assesses gambling-related symptoms (Ferris & Wynne, 2001). To assess frequency of scratch card gambling, we included the instant lottery frequency question from the CPGI. These items were administered to characterize our sample; no predictions were made on the basis of PGSI scores or gambling

Table 1

Descriptive and Demographic Characteristics

Measure	Value
Age, mean (*SD*)	19.26 (1.71)
Gender, *n* female, *n* male	50, 12
Frequency of scratch card gambling, *n* (%)	
1–5 times	51 (82%)
6–10 times	7 (11%)
11–15 times	4 (6%)
16–24 times	0 (0%)
24 or more times	0 (0%)
Problem Gambling Severity Index, *n* (%)	
Non-problem gambling	33 (53%)
Low-risk gambling	28 (45%)
Moderate-risk gambling	1 (2%)
Problem gambling	0 (0%)

frequency. PGSI-based gambling problem severity categories were established by using the criteria of Currie et al. (2013).

Scratch Cards

Participants played two types of custom-made scratch cards (Match Three and Number Matching), modelled after commercially available games in Ontario, Canada.

Match Three Game ("Cash for a Month"). In this game type, participants are presented with a matrix of six symbols under an opaque scratch-off layer (see Figure 1A). To play, the participant sequentially uncovers each symbol within the matrix, with three matching symbols indicating a win of that prize. The top prize is "Cash for a Month" ($25 a week for 4 weeks, totalling a one-time payout of $100).

Number Matching Game ("Diamond Payout"). In this game type, participants scratch an opaque layer to reveal two lucky numbers. They then sequentially scratch off a six-number matrix hoping to uncover a match to a lucky number (see Figure 1B). If a match is found, the participant wins the corresponding prize amount (printed underneath the matrix numbers). The top prize of this game is $100.

Subjective Evaluations

To assess the subjective experience of the participants following each outcome type, we asked them to respond to an item for each subjective dimension (arousal, frustration, positive emotion, negative emotion, disappointment, and urge to gamble). For each item, participants placed a marker along a sliding scale (ranging from 0 to 100) at the location that best reflected their experience. All items were

Figure 1
Scratch Card Game Types.

Note. Panel A: Example of a Match Three scratch card game. Panel B: Example of a Number Matching scratch card game.

presented by using the same structure: "How would you rate your level of [subjective dimension] on scale from 0 (no presence of the dimension) to 100 (extreme amounts of the dimension)?" All six items were presented in randomized order following each scratch card outcome.

Apparatus

Display Case

To simulate real scratch card gambling, we had participants choose their scratch cards from two display cases, each containing 96 scratch cards of one game type. Each scratch card display case contained two trays, each containing 48 scratch cards. Each tray contained two sections, resulting in four sections overall, one per outcome type (i.e., a near-miss section, a win section, and two loss sections).

Video Recording

To time-lock the psychophysiological responses of the participants to specific outcomes, we recorded their scratch card play with LabChart software (ADInstruments, version 7.0), using the built-in camera on the MacBook Pro laptop for psychophysiological recording.

Skin Conductance Recording

Skin conductance was recorded with non-gelled passive electrodes attached to the index and ring fingers of participants' non-dominant hand. These electrodes were connected to an ADInstruments PowerLab (model 8/30) equipped with a galvanic

skin response amplifier. LabChart 7.0 software was used to analyse skin conductance data on the basis of temporal windows specified from video recordings.

Heart Rate Recording

Heart rate was recorded with three electrodes in a modified Mason-Likar arrangement (Mason & Likar, 1966), with two electrodes placed in the infraclavicular fossae 2 cm medial to the deltoid border and a third electrode placed on the left anterior abdomen in the axillary line, 3-4 cm inferior to the costal margin (acting as an earth ground). Electrodes were connected to the PowerLab and sampled at 1000 Hz. LabChart 7.0 software was used to analyse heart rate data from event markers derived from the video recording.

Scratching Platform

As each participant's non-dominant hand was used for skin conductance recording, scratch cards were inserted into a scratching platform during gameplay to hold each card in an upright position while the participant scratched with their dominant hand (see Stange et al., 2016).

Design

We used a within-subjects design, with each participant experiencing all outcomes (loss, near miss, win) for each game type (Match Three, Number Matching). Participants were randomly assigned to an outcome order that ensured adequate counterbalancing. Half of the sample played Match Three cards first and Number Matching cards second, and the other half experienced the reverse. Within each game type, half of the participants experienced the near miss before the small win, and the other half experienced the reverse. For both card types, the near miss and small win were preceded by a regular loss. Therefore, each participant played eight scratch cards, four of each game type. Within both game types, participants experienced two regular losses (no matching symbols), a small win of $5.00 (three matching $5.00 symbols in the Match Three game; a match between a lucky number and a matrix number corresponding to $5.00 in the Number Matching game), and a near miss (two MONTH symbols in the Match Three game; a matrix number one digit away from a lucky number corresponding to $100.00 in the Number Matching game).

Procedure

All participants confirmed their eligibility and provided written informed consent. They completed the PGSI and CPGI item by using Qualtrics survey software on a laptop computer (Lenovo model #4446). The researcher then explained that participants would be playing eight scratch cards in the study (four cards for each game type) and explained each game's rules. For the Match Three game, participants were told that the goal was to find three matching symbols within one game matrix, indicating a win. The researcher explained that the top prize was denoted by the

MONTH symbol and that three MONTH symbols indicated a top prize win. Participants were given approximate odds of winning this top prize (1 in 192). For the Number Matching game, participants were told that the goal was to find a match between a lucky number and a matrix number, indicating a win of the prize printed below the matrix number. The researcher demonstrated scratching patterns to ensure consistent outcome delivery: for the Match Three game, uncovering symbols in three rows (top to bottom, left to right), and for the Number Matching game, uncovering the lucky numbers (from left to right), followed by the matrix numbers in three rows (top to bottom, left to right). Participants were given instructions for completing the subjective evaluations on the tablet (10-in. [25.4 cm] Lenovo model #TB-X103F).

Participants chose scratch cards to play by selecting cards from four different sections of two trays contained in two display cases (see the Apparatus subsection) and were instructed by the researcher to choose one card from each section, which ensured that each participant received the correct number of cards for each outcome. Participants washed their hands in an adjacent room prior to attaching their heart rate electrodes. The researcher then connected the PowerLab leads to the heart rate electrodes and attached the skin conductance electrodes to the participant's non-dominant hand. LabChart settings were configured to ensure optimal recording, and the recording laptop was arranged to video record participants' game play.

The researcher placed the first scratch card in the scratching platform and provided a metal washer for the participant to scratch with. After scratching, the participant completed subjective measures on the tablet for the outcome they had just experienced. The researcher removed the completed scratch card and inserted the next card into the scratching platform. The participant scratched the next card and again completed subjective measures. This process was repeated for all eight scratch cards, with outcomes presented in the randomly assigned counterbalanced order (see Design subsection).

When all eight scratch card games were completed, the researcher stopped the psychophysiological and video recordings, detached the skin conductance electrodes, and instructed the participant to disconnect the heart rate leads. Participants were remunerated with two sets of $5.00 in scratch card winnings ($10.00 total; $105.00 if participants won a top prize) and given a feedback letter and responsible gambling resources.

Data Reduction

Skin conductance data were separated into epochs so that we could examine changes in the pre- and post-outcome periods of scratch card play. The pre-outcome epoch started when participants began scratching the first game symbol and ended once the final symbol was uncovered (revealing the outcome). The variable length of the pre-outcome period (dependent on rate of scratching) precluded the use of traditional analysis techniques. Therefore, anticipatory skin conductance changes were assessed by using the slope of the skin conductance level over the entire epoch. Slope values

were calculated with all data points in the pre-outcome epoch and represent the average change in skin conductance level over the duration of this window. For example, a participant may show a decreasing skin conductance level over time during the pre-outcome phase for regular losses (as observed in previous studies; Stange, Grau et al., 2017) but during a near miss, experience transient increases in skin conductance when uncovering the two top prize symbols. Although these top prize symbols may occur at different times for different participants, this phasic skin conductance activity will still reliably perturb the downward slope of skin conductance over time. Therefore, this analysis helped to circumvent variability in pre-outcome epoch lengths and allowed us to examine skin conductance changes during this period. This same pre-outcome epoch was used to examine changes in heart rate leading up to the outcome reveal, as measured by the average number of beats per minute (BPM).

The post-outcome recording epoch began following the final symbol reveal and was used to examine post-outcome skin conductance responses (SCRs). This analysis moved forward 1 s from the end of the outcome reveal and examined the peak of the SCR within a 3-s window following this 1-s advance. Square-root-transformed SCR values were then used for statistical analysis.

Statistical Analysis and Analytical Strategy

Of the 66 participants who were recruited, one was excluded from participating because of ineligibility (resultant $N = 65$). Three participants who won a top prize were excluded from all analyses, as they experienced different outcomes from the rest of the sample (resultant $N = 62$). Twelve participants were excluded from all psychophysiological analyses because of incorrect scratching patterns (leading to inconsistent outcome delivery) or technical errors, resulting in the loss of certain outcome recordings (resulting in a final $n = 50$ for heart rate analysis). One additional participant was excluded from skin conductance analyses because of a technical error (resulting in $n = 49$ for skin conductance analysis). Participants who did not submit a subjective evaluation for a specific outcome were excluded listwise for the analysis of that specific subjective dimension (resulting in a minimum of $n = 33$ for each subjective analysis).

For each participant, six values were entered for each measure (for each game type: a win, a near miss, and the average of the two losses). If only one loss data point was artefact free, this loss value was used. Scores outside 3 SDs of the mean were excluded as outliers. Factorial repeated measures analyses of variance (ANOVAs) were conducted for each dependent variable. Sphericity assumption violations are presented with corrected degrees of freedom and F values (Greenhouse-Geisser). To localize the source of significant differences between outcome types following a significant main effect, we conducted further comparisons between outcome types within a given game type and across game types by using least significant difference pairwise comparisons. Following from our hypotheses, comparisons of

psychophysiological responses to outcomes within each game type constituted a priori comparisons (and therefore were not further corrected). For Match Three games, previous findings of significant increases in pre-outcome arousal for near misses versus losses (Stange et al., 2016; Stange, Grau, et al., 2017) justified planned directional comparisons.
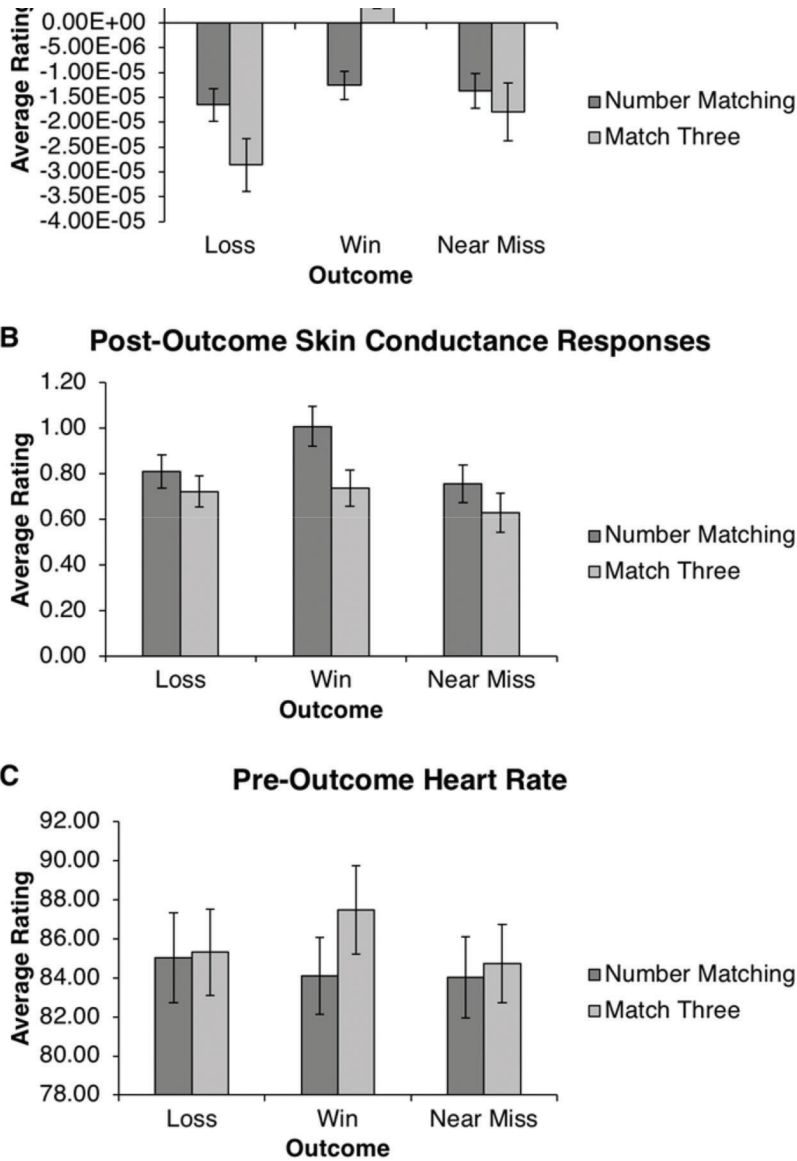
Results

Pre-Outcome Skin Conductance Slopes

A factorial repeated measures ANOVA with outcome and game type as the repeated measures factors revealed a main effect of outcome, $F(2, 90) = 13.58$, $p < .001$, $\eta_p^2 = .23$, and an outcome by game type interaction, $F(2, 90) = 10.00$, $p < .001$, $\eta_p^2 = .18$ (see Figure 2A). A repeated measures ANOVA that examined the Match Three game with outcome as the repeated measures factor revealed a main effect of outcome, $F(2, 92) = 15.33$, $p < .001$, $\eta_p^2 = .25$. Pairwise comparisons revealed significant differences between losing ($M = -2.82^{-5}$ µS/s, $SD = 3.56^{-5}$ µS/s) and winning outcomes ($M = 6.50^{-6}$ µS/s, $SD = 2.21^{-5}$ µS/s, $p < .001$); near-miss ($M = -1.82^{-5}$ µS/s, $SD = 3.93^{-5}$ µS/s) and winning outcomes ($p = .001$); and losing and near-miss outcomes ($p = .047$; one-tailed). An equivalent analysis that examined the Number Matching game revealed no significant main effect of outcome ($p = .394$).[1] To further test the comparison between losses and near misses across both game types (i.e., to determine whether the difference between losses and near misses was significantly different between games), we conducted a repeated measures ANOVA with outcome (loss, near miss) and game type (Number Matching, Match Three) as the repeated measures factors. This analysis revealed no significant outcome by game type interaction, $F(1, 46) = 1.11$, $p = .30$, $\eta_p^2 = .02$.

Post-Outcome SCRs

A factorial repeated measures ANOVA with outcome and game type as the repeated measures factors revealed a main effect of outcome on SCRs, $F(2, 96) = 5.71$, $p = .005$, $\eta_p^2 = .11$, and of game type, $F(1, 48) = 13.03$, $p = .001$, $\eta_p^2 = .21$, but no outcome by game type interaction ($p = .09$; see Figure 2B). A follow-up repeated measures ANOVA for the Match Three game revealed no significant effects of outcome on SCRs ($p = .246$). An analogous analysis of the Number Matching game revealed a main effect of outcome, $F(1.80, 86.15) = 7.49$, $p = .001$, $\eta_p^2 = .14$. Pairwise comparisons revealed significant differences between losing ($M = .81$ µS, $SD = .52$ µS) and winning outcomes ($M = 1.01$ µS, $SD = .61$ µS, $p = .006$), and winning and near-miss outcomes ($M = .76$ µS, $SD = .58$ µS, $p = .002$), but no significant difference between losing and near-miss outcomes ($p = .345$).

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[1]To ensure that epoch length was not systematically related to calculated skin conductance slope values, we conducted correlations between these two variables for each outcome type (average of both losses, win, and near miss for each game type). None of these correlations remained significant following a Bonferroni correction ($\alpha/6$; p = .008).

Figure 2

Psychophysiological Responses by Game Type and Outcome Type.

Note. Panel A: Pre-outcome skin conductance slopes by game type and outcome type. Panel B: Post-outcome skin conductance responses by game type and outcome type. Panel C: Pre-outcome heart rate by game type and outcome type. Values presented are derived from participants with valid data for all variables in the omnibus model. All error bars ± 1 *SEM*.

Pre-Outcome Heart Rate

Data from 24 participants were not analysed, because of excessive artefacts (instances in which individual r-waves could not be distinguished from movement artefacts and therefore could not be labelled) or technical errors. A factorial repeated measures ANOVA revealed a main effect of outcome, $F(2, 50) = 3.58$, $p = .035$,

$\eta_p^2 = .13$; a main effect of game type, $F(1, 25) = 6.58$, $p = .017$, $\eta_p^2 = .21$; and an outcome by game type interaction, $F(2, 50) = 5.93$, $p = .005$, $\eta_p^2 = .19$ (see Figure 2C). A repeated measures ANOVA for the Match Three game revealed a main effect of outcome, $F(1.42, 35.53) = 7.15$, $p = .006$, $\eta_p^2 = .22$. Pairwise comparisons revealed significant differences between losing ($M = 85.31$ BPM, $SD = 11.21$ BPM) and winning outcomes ($M = 87.48$ BPM, $SD = 11.53$ BPM, $p = .003$), and between winning and near-miss outcomes ($M = 84.71$ BPM, $SD = 10.21$ BPM, $p = .009$), but no significant difference between losing and near-miss outcomes ($p = .33$). An analogous analysis for the Number Matching game revealed no significant effects ($p = .259$).

Subjective Evaluations

Urge to Gamble

The factorial repeated measures ANOVA revealed only a main effect of outcome, $F(1.69, 87.84) = 14.68$, $p < .001$, $\eta_p^2 = .22$ (see Figure 3A). Collapsing across game type, pairwise comparisons revealed significant differences between urge to gamble ratings following losses and wins ($p < .001$), wins and near misses ($p = .005$), and losses and near misses ($p = .0096$).

Frustration

Our analysis of participants' frustration ratings revealed a main effect of outcome, $F(1.56, 49.88) = 32.44$, $p < .001$, $\eta_p^2 = .50$, and a significant main effect of game, $F(1, 32) = 5.18$, $p = .03$, $\eta_p^2 = .14$, indicating that the Match Three game was higher in frustration than the Number Matching game overall (see Figure 3B). Collapsed across game type, pairwise comparisons revealed significant differences between frustration ratings for losses and wins ($p < .001$), wins and near misses ($p < .001$), and losses and near misses ($p = .002$).
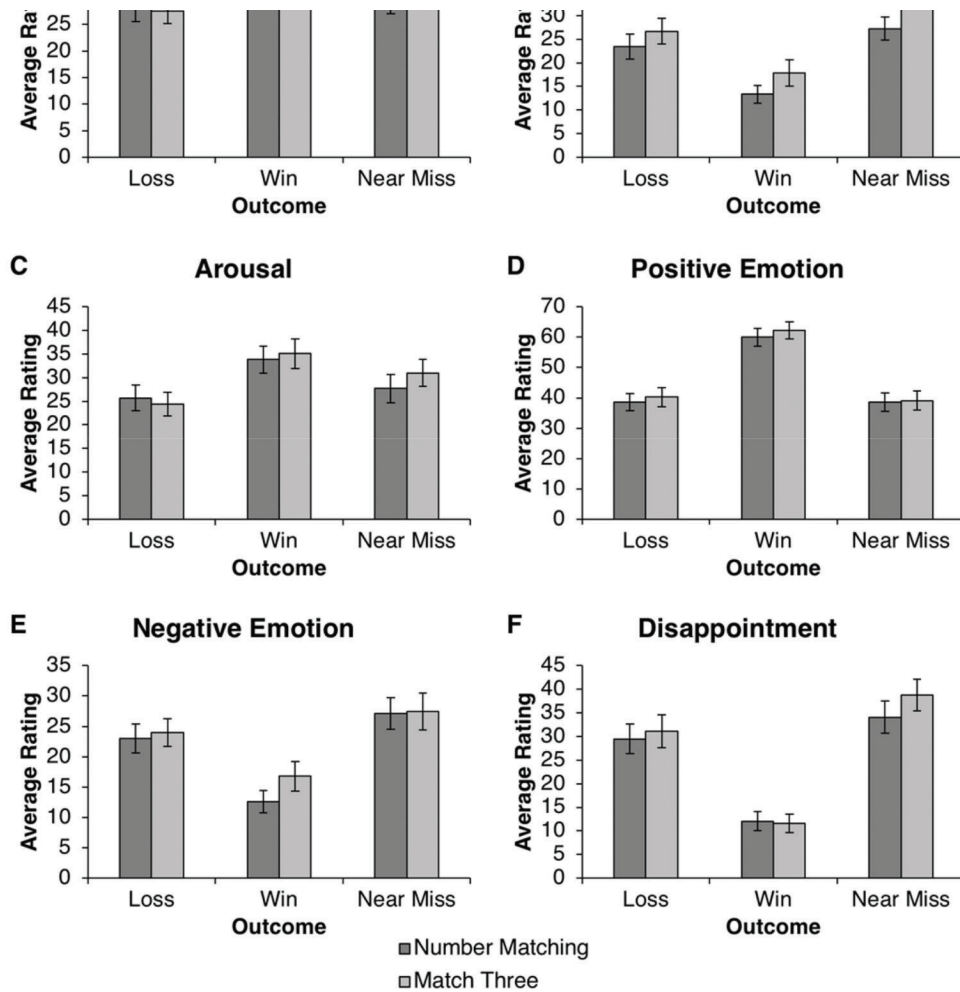
Arousal

The analysis of subjective arousal revealed a main effect of outcome, $F(1.57, 75.50) = 15.24$, $p < .001$, $\eta_p^2 = .24$ (see Figure 3C). Pairwise comparisons revealed significant differences between arousal ratings for losses and wins ($p < .001$), wins and near misses ($p = .005$), and losses and near misses ($p = .001$).

Positive Emotion

A main effect of outcome was revealed when we analysed participants' positive emotion ratings, $F(1.25, 64.99) = 84.31$, $p < .001$, $\eta_p^2 = .62$ (see Figure 3D). Pairwise comparisons revealed significant differences between ratings of positive emotion following losses and wins ($p < .001$) and wins and near misses ($p < .001$), but no differences between losses and near misses ($p = .564$).

Figure 3

Subjective Ratings by Game Type and Outcome Type.

Note. Panel A: Urge to gamble. Panel B: Frustration. Panel C: Arousal. Panel D: Positive emotion. Panel E: Negative emotion. Panel F: Disappointment. Values presented are derived from participants with valid data for all variables in the omnibus model. All error bars ± 1 *SEM*.

Negative Emotion

Analysis of participants' negative emotion ratings revealed a main effect of outcome, $F(1.45, 47.77) = 39.13$, $p < .001$, $\eta_p^2 = .54$ (see Figure 3E). Pairwise comparisons revealed significant differences between negative emotion ratings for losses and wins ($p < .001$), wins and near misses ($p < .001$), and losses and near misses ($p = .001$).

Disappointment

Our analysis of participants' disappointment ratings revealed a main effect of outcome, $F(1.52, 50.13) = 72.02$, $p < .001$, $\eta_p^2 = .69$ (see Figure 3F). Pairwise

comparisons revealed significant differences between ratings following losses and wins ($p < .001$), wins and near misses ($p < .001$), and losses and near misses ($p = .002$).

Discussion

In the current study, we examined the impact of scratch card game structure on psychophysiological and subjective outcome reactivity. We compared two game types: Match Three, where one aims to uncover three matching symbols, and Number Matching, where one aims to find a match between a lucky number and a matrix number. Because of the structural differences, we predicted that game type would influence psychophysiological reactivity. Specifically, we predicted that Match Three games, containing an anticipatory period, would garner an increase in psychophysiological arousal as successive matching symbols were uncovered in the pre-outcome period for wins and near misses (i.e., leading up to the outcome reveal). Support for this prediction was partially found in skin conductance: Although there was a relatively steep decline in anticipatory skin conductance levels for losses, this trajectory was less steep for near misses and positive for wins, indicating that skin conductance rose as participants uncovered the matching $5.00 symbols. Although we predicted positive slopes for near misses in addition to wins, our results did not support this prediction. Further, skin conductance slopes for near misses were found to be only marginally significantly different from regular losses in a one-sided, uncorrected test. Overall, winning outcomes showed the strongest pre-outcome effect in Match Three games. Converging evidence for this effect is found in the heart rate analysis, with the highest BPM during the anticipatory period for Match Three small wins. Contrary to our predictions, heart rate did not differ between Match Three near misses and losses. Therefore, our results suggest that there are clear psychophysiological arousal changes during the pre-outcome period for Match Three small wins; evidence for psychophysiological changes leading up to Match Three near misses is not as strong.

We compared these Match Three games to Number Matching games, which have a sequential matching process and no anticipatory period. For Number Matching games, we predicted significant differences post-outcome, with our hypotheses partially supported. Number Matching wins led to significantly larger SCRs than did losses and near misses, but, contrary to our expectations, Number Matching near misses had SCRs that were equivalent to those for losses. Thus, overall, wins in the Match Three games triggered pre-outcome increases in arousal, whereas wins in the Number Matching game triggered arousal increases after the outcome reveal.

To further understand the impact of game structure on near-miss-related psycho-physiological arousal, we conducted a test of the restricted interaction between losses and near misses across game types for pre-outcome skin conductance slopes. This analysis revealed no significant interaction, suggesting that the difference in skin conductance levels between losses and near misses was not significantly different across games. Although the comparison between pre-outcome slope values for near misses and losses in the Match Three game replicated past work with a one-tailed,

uncorrected test, we suggest interpreting this analysis with a high degree of caution, given the lack of effect in the restricted interaction analysis. Nonetheless, although our predictions concerning near misses were not strongly supported by our psychophysiological dependent variables, participants' subjective ratings suggest that these outcomes are very influential in shaping their experience of scratch cards and the urge to engage in further scratch card gambling.

Participants rated near-miss outcomes in both game types as being significantly more disappointing, arousing, negatively valenced, frustrating, and urge inducing than regular losses. It appears that changes in psychophysiological reactivity during gameplay are not necessary in order to reach downstream differences in subjective evaluations after the outcome reveal. One curious finding concerns discrepancies between the psychophysiological and subjective arousal responses. Although both presumably measure arousal, it is possible that they account for different aspects of this construct. Psychophysiological arousal, as measured in the current investigation, represents a rather low-level physiological response to external stimuli. In contrast, asking participants to reflect on their experience and assign a quantitative value to a verbal descriptor may encompass a higher order cognitive evaluation. Although both may be conceptualized as measures of arousal per se, there are inherent differences between these two measures that may account for this discrepancy.

Structural differences also exist between the two types of near-miss outcomes. In the Match Three game, the participant uncovers two of the three necessary symbols required for the top prize, whereas in the Number Matching game, the participant finds that if their number had been one digit lower, they would have won. The uncovering of required symbols in the anticipatory period of gameplay is possibly the source of near-miss effects observed in Match Three games that have been reported in previous investigations when using similar cards (Stange et al., 2016). However, in the Number Matching game, near-miss effects likely stem from realizing that the outcome was only one digit away from a top prize. In the Match Three game, it is not unreasonable to believe that a top prize may be imminent if two of three necessary symbols for winning it are obtained. However, in the Number Matching game, a near-miss effect must necessarily occur after the symbol in the game matrix has been uncovered and the gambler realizes that they were one digit away. Despite these structural differences, which we predicted would result in differing near-miss experiences, our results provide no substantial evidence for differences in psychophysiological near-miss effects between these games. Nevertheless, both types of near misses evoked significantly greater disappointment, frustration, subjective arousal, urge, and negative emotion than regular losses did.

In Match Three games, participants uncover symbols that directly represent prizes available to be won. However, in Number Matching games, participants aim to match numbers unrelated to a prize, and if a match is made, a prize is then associated with that number. In this way, Number Matching symbols are one step removed from the prizes themselves. This difference may impact outcome processing by altering the subjective proximity to a game's prizes. From a cue reactivity

perspective, Match Three games provide stimuli directly related to the top prize, possibly eliciting a larger psychophysiological response for near misses than in Number Matching games, in which the near miss is delivered indirectly through numbers assigned to prizes. Despite weak evidence of psychophysiological near-miss effects in the Match Three game, and no significant difference between near-miss and losing outcome SCRs in the Number Matching game, participants still rated near-miss outcomes in both games as the most frustrating, disappointing, and negatively valenced of all three outcomes. Further, near misses were rated as being significantly more arousing and urge inducing than regular losses, despite their objective equivalence. Therefore, despite structural differences between games, near misses appear to preserve some consistency across game types.

Near-miss effects in the present study highlight parallels between scratch card and slot machine games regarding the experience of near-miss outcomes. Slot machine near misses are capable of increasing physiological arousal (M. J. Dixon et al., 2011) and motivation to continue gambling (Clark et al., 2013), as well as encouraging continued gambling (Coté, et al., 2003; Kassinove & Schare, 2001), despite being monetary losses. The present study suggests that scratch card near misses are capable of exerting somewhat similar effects on gamblers, even in scratch cards with divergent game structures. Specifically, our results provide evidence for the subjective effects of near misses, with the effects of near-miss outcomes on psychophysiological variables less clear. One framework put forth for understanding near-miss outcomes includes conceptualizing them as a signal of skill learning (Clark, 2014), such that the proximity of the present attempt to the goal suggests that future attempts will be successful. Therefore, the consistent increases in urge (relative to regular losses) that we observed in both scratch card types could reflect participants' belief that near misses are a harbinger of a future win. Future research that further examines participants' cognitions surrounding these outcomes may shed light on this possibility.

Overall, these results indicate that participants subjectively react to near misses and losses differently (despite objective equivalence). It may be that scratch card designers include these outcomes to capitalize on their motivating properties, as, unlike wins, near misses result in no cost to the operator and provide an added "boost" of motivation for games otherwise made up of nearly 70% full losses. In addition, our results suggest that scratch card small wins also increase psychophysiological and subjective arousal, as well as positive valence and urge to continue gambling. These results replicate our past findings (Stange et al., 2016; Stange, Grau, et al., 2017) and attest to the strong motivational power of scratch card small wins. The current study extends these findings by revealing similar effects of small wins in a previously unexplored game type.

Although participants psychophysiologically responded to wins in both games, the effects did differ. Match Three wins resulted in a positive skin conductance slope and an increase in heart rate during the anticipatory pre-outcome period, suggesting that as participants uncover successive winning symbols, their psychophysiological arousal increases. However, it was only in post-outcome SCRs that Number Matching wins

appeared to generate psychophysiological arousal increases. Therefore, although winning outcomes in Match Three games are associated with increases in psychophysiological arousal leading up to the outcome reveal, Number Matching wins appear to generate increases in arousal after the outcome reveal. These results fit with our hypotheses about game structure and outcome reactivity, based on a conceptualization of pre-outcome anticipation and post-outcome evaluation. Wins in both game types prompted not only increases in subjective arousal, but also significant increases in the urge to gamble, which may have implications for continued gambling behaviour. If gamblers act on this urge, using their winnings to buy more cards, those hoping to increase their gains may be set up for failure, as the most common outcome of most scratch card games is a loss (OLG, 2019b).

Limitations and Future Directions

A limitation of the current investigation is that participants were not gambling with their own money and therefore not risking anything of value. We also used a convenience sample of undergraduate students. Although all participants had played scratch cards at least once in the past year, few played frequently, and the results of the current study may differ if conducted with higher frequency gamblers. It is possible that through sensitization and cue-reactivity processes near-miss effects may be exacerbated if they are encountered more frequently. In addition, it is important to note that participants experienced only a small number of trials per outcome type. Future research should prioritize larger numbers of trials to ensure a stable estimate of the observed effects. Further, a number of participants were ultimately removed from the heart rate analyses because of movement artefacts, reducing statistical power. Future research should use a larger sample to account for unusable psychophysiological data. In terms of the experimental procedure, having the experimenter sequence the scratch cards for the participant may have reduced participants' perceived control, a factor that is important in processing near-miss outcomes (Clark et al., 2009).

Finally, the top prizes available to be won in our custom-made games were much smaller than those available in commercial scratch card games. However, this may suggest that the present results are an underestimate of the impact of near misses in the real world. Despite their size, it is also possible that the top prizes themselves were not perceived as equivalent by participants, given that the Cash for a Month top prize was presented as four payments of $25, whereas the Diamond Payout top prize was simply presented as $100. However, if participants had perceived these prizes differently, we would have expected an interaction between game type and outcome that was specific to near misses in any of the subjective dependent variables, and no such interaction was observed. Nevertheless, this aspect of our design may be a pertinent consideration for future studies when examining the structural characteristics of scratch cards, especially given that the perceived timing of rewards has been shown to impact reward valuations (M. R. Dixon et al., 2003; Petry, 2001).

Implications

Real-world scratch card games are available in a myriad of game structures and types. Although this study compared only two game types, our results suggest that structurally distinct scratch card games can result in different psychophysiological effects on the gambler. Future studies could examine other types of scratch cards to determine possible additional effects on the gambler (e.g., "extended play" scratch cards, such as BINGO or crossword variants; OLG, 2020). The present study also reinforces the influence of near misses, and perhaps their pervasive nature, in the experience of scratch card gambling. Both scratch card types, despite their divergent structures, resulted in subjective near-miss effects. Educational interventions designed to address the influence of these outcomes may find success in addressing erroneous cognitions concerning predictive and interpretive control, which have been shown to be related to motivation following near misses (Billieux et al., 2012).

Finally, although scratch cards (and lottery gambling in general) are often not seen as a "real" form of gambling (Lange, 2001; Wood & Griffiths, 1998), the present study shows that they can impact a gambler's physiology and subjective evaluations similarly to other forms of gambling such as slot machines (M. J. Dixon et al., 2011) and horse racing (Coventry & Norman, 1997; Wulfert et al., 2005). Given these effects on arousal and subjective experience, it may be important that clinicians consider lottery gambling and scratch card involvement when assisting individuals who seek help with their gambling. In addition, given their accessibility, low price point, and opportunity for continuous play (Griffiths, 1995), it is important to note that scratch cards represent a gambling form that is particularly popular among youth populations (Boldero et al., 2010; Donati et al., 2013; Elton-Marshall et al., 2016; Felsher et al., 2004; Wood & Griffiths, 1998). Future policy considerations surrounding near-miss outcomes in scratch cards, and perhaps scratch card characteristics in general, should take into account the growing literature examining the impact of this gambling form on individuals, as well as youth engagement with these products.

Conclusion

The current study adds to a growing body of literature examining the impact of scratch card outcomes on gamblers' experiences. Our study provides evidence that not all scratch cards should be considered equal: there are structural differences between games that appear to be associated with specific effects on the gambler, particularly on the magnitude and timing of psychophysiological responses to winning outcomes. However, we observed commonalities across game types in terms of overall subjective experience, especially for small wins and near misses. Therefore, although it is important to consider possible differences in experience created by game structure, there appears to be some degree of universality in the subjective and cognitive experience of scratch card play, particularly in response to winning and near-miss outcomes.

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