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Effect of within-session breaks in play on responsible gambling behaviour during sustained monetary losses

Adrian Parke[1,2] · Patrick Dickinson[3] · Louise O'Hare[4] · Liam Wilson[3] · Greg Westerman-Hughes[2] · Kathrin Gerling[5]

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Abstract
Rapid, continuous gambling formats are associated with higher risks for gambling-related harm in terms of excessive monetary and time expenditure. The current study investigated the effect on gambling response latency and persistence, of a new form of within-game intervention that required players to actively engage in response inhibition via monitoring for stop signals. Seventy-four experienced electronic gaming machine gamblers, with a mean age of 35.28 years, were recruited to participate in a rapid, continuous gambling task where real money could be won and lost. Participants were randomly allocated to either the control condition where no intervention was presented, or either a condition with a passive three minute break in play or a condition with a three minute intervention that required participants to engage in response inhibition. Although there was no main effect for experimental condition on gambling persistence, both interventions were effective in elevating response latency during a period of sustained losses. It was concluded that within-game interventions that create an enforced break in play are effective in increasing response latency between bets during periods of sustained losses. Furthermore, within-game interventions that require active involvement appear to be more effective in increasing response latency than standard, passive breaks in play.

Keywords Problem gambling · Response latency · Within-game intervention · Persistence · Impulsivity

Introduction

Gambling-Related Harm and Rapid, Continuous Gambling Formats

Continuous forms of gambling that provide rapid feedback and immediate reinforcement, such as electronic gaming machines (EGMs) and online casino games, are recognised as being the most 'addictive' form of gambling (Belisle and Dixon 2016; Thompson and Corr 2013; Williams and Wood 2004). Even at moderate levels of engagement EGMs can lead to gambling-related harm, such as excessive monetary and time expenditure (Afifi et al. 2014; LaPlante et al. 2011). Coates and Blaszczynski (2013) argued that rapid, continuous forms of gambling have elevated risk for harm because of the combination of a variable schedule of reinforcement and an absence of natural breaks-in-play. This combination of structural characteristics may lead to maladaptive responding to reinforcement i.e. deficient reinforcement learning for some gamblers (Goudriaan et al. 2005, 2015). Rapid, continuous forms of gambling are known to stimulate dissociative states (Stewart and Zack 2008) and in addition make accurate evaluation of the level of reinforcement difficult due to the high turnover of gambling events within a single session (Loba et al. 2001).

Thompson and Corr (2013) proposed that impaired responding to gambling outcomes in rapid continuous gambling formats comes from incurred losses simultaneously stimulating both arousal which promotes action continuation, and an inhibiting response which ultimately for many gamblers is weaker than the aforementioned arousal response. In addition to suppressing the maladaptive emotional, reward-

✉ Adrian Parke
Adrian.Parke@uws.ac.uk

1 School of Education and Social Sciences, Psychology Division, University of the West of Scotland, Paisley PA1 2BE, UK

2 Forensic and Clinical Research Group, School of Psychology, University of Lincoln, Brayford Way, Brayford Pool, Lincoln LN6 7TS, UK

3 INTLAB, School of Computer Science, University of Lincoln, Brayford Way, Brayford Pool, Lincoln LN6 7TS, UK

4 Perception Action Cognition Research Group, School of Psychology, University of Lincoln, Brayford Way, Brayford Pool, Lincoln LN6 7TS, UK

5 eMedia Research Lab, Leuven, KU, Belgium

driven desire to continue gambling in the face of losses, the implementation of top-down rule-governed rational decision-making is also required to enable adaptive responding to gambling outcomes (Verbruggen et al. 2012). Fundamentally, executive control, and more specifically response modulation, enables the suppression of emotional, appetitive behaviour and the evaluation of current reinforcement rate (Newman and Lorenz 2003; Newman and Wallace 1993) to make beneficial changes in behaviour.

Previous research has demonstrated that individuals with high levels of disinhibition are less likely to pause to evaluate behavioural outcomes, and instead initiate subsequent behaviour rapidly, leading to less adaptive responding to punishment (Patterson et al. 1987). Problem gamblers are acknowledged to have higher levels of negative urgency and lower levels of premeditation in relation to behavioural responding when gambling (MacLaren et al. 2011). Negative urgency refers to a tendency to respond rashly to distress and negative emotion, and lack of premeditation relates to the lack of time spent evaluating stimuli before behaviour initiation (Whiteside and Lynam 2001). Deficient reinforcement learning, negative urgency and lack of premeditation could be operationalised behaviourally as low response latency after losses, with response latency referring to the pause between feedback of a gambling outcome and the initiation of subsequent bet (Belisle and Dixon 2016). A longer response latency after losses will increase the probability of activating attentional control processes that may override arousal-driven, prepotent responding, and increase the probability of responding adaptively to changes of reinforcement in an activity, such as ending a gambling session in response to sustained losses (Corr 2010; Thompson and Corr 2013).

Speed of Play and Gambling-Related Harm

Previous research has demonstrated that EGMs with higher levels of event frequency, i.e. *faster reel spins*, are reported to be more exciting and lead to an increased desire to play (Choliz 2010; Linnet et al. 2010; Loba et al. 2001). Furthermore, in behavioural terms, gamblers playing EGMs with faster reel spins have been observed to gamble more money, to gamble for longer and be more resistant to extinction in the face of recurrent losses (Delfabbro et al. 2005; Ladouceur and Sévigny 2005), and also to make riskier bets (Mentzoni et al. 2012). However, it is possible that the correct frame in which to understand speed of play in rapid, continuous forms of gambling is not the event duration, such as reel spin length, but rather the duration between outcome feedback from the previous bet and the opportunity to initiate further gambling (Parke and Parke 2017).

Research conducted in commercial gambling venues, and also in the more controlled environment of the laboratory, have observed that gamblers show reduced response latency in response to losing rather than winning outcomes (Delfabbro and Winefield 1999; Dixon and Schreiber, 2002, 2004; Schreiber and Dixon, 2001). This phenomenon could be accounted for by an increase in state negative urgency; where the gambler is strongly motivated to dissipate the negative affect of accumulating repeated monetary losses by persisting gambling in an attempt to recover past losses rapidly (Gaher et al. 2015). In contrast, further research demonstrated that by enforcing a five second delay after each bet, persistence in gambling when losing was reduced (Corr and Thompson 2014). Corr and Thompson (2014) concluded that by enforcing a brief pause in play, gamblers' attention shifted from appetitive prepotent responding to evaluation of stimuli and reinforcement. From this, it could be interpreted that an effective strategy to reduce behavioural persistence i.e. non-adaptive responding, and therefore problematic expenditure in rapid, continuous forms of gambling, could be to increase the pause between the outcome of the previous bet and the initiation of further gambling.

Response Latency and Monitoring for Stop-Signals

Executive intervention is required in response to suboptimal outcomes, such as experiencing a period of sustained gambling losses, to limit the negative consequences for the individual (Monsell and Driver 2000); and without executive intervention to suppress appetitive urges to continue gambling it is probable that the gambler will experience impaired decision-making (Verbruggen et al. 2012). Rather than responding with urgency to losing outcomes, it is important for the gambler to engage in executive control in order to identify the consequential punishment of gambling and adjust behaviour accordingly.

There is evidence that the neurological mechanisms that regulate monetary risk-taking and motor control inhibition overlap within the Dorsolateral Prefrontal Cortex (DLPFC: Cohen and Lieberman 2010). Verbruggen et al. (2012) proposed that activation in one mechanism may transfer to the other, and therefore rather than interfering with the suppression of risk-taking urges, activation of the motor inhibitory mechanism may stimulate cautiousness and reduced risk-taking. In laboratory research, participants can be stimulated to engage in motor inhibitory processes via stop-signal tasks (Verbruggen and Logan 2008), where they must be vigilant to suppress prepotent motor responses when they observe a signal to inhibit responding to a conditioned stimulus. Verbruggen et al. (2012) observed in a series of experiments that if participants were required to monitor for stop-signals when gambling they made fewer risky bets and had increased response latency to gambling outcomes, and moreover this motor caution transfer effect was observable even after a two hour time lag. This finding was partially replicated by Harris et al. (2018) who were able to demonstrate that adjusting the structural characteristics of a gambling activity to induce motor caution by requiring participants to monitor for stop signals had an effect on post-gambling cognitive performance; specifically increasing delay discounting and reducing impulsive decision-making.

Essentially, when participants are consciously monitoring for stop-signals and therefore engaging in motor control, risk taking is modulated by the gambler making pro-active adjustments and, in general, approaching the activity with more caution (Aron 2011; Verbruggen et al. 2012). The act of observing for and responding to stop-signals reduces behavioural persistence and motivation to continue ongoing behaviour; and therefore pairing losing gambling outcomes with the requirement to stop via a stop-signal may be an effective way to reduce excessive expenditure in rapid, continuous forms of gambling (Stevens et al. 2015).

The Present Study

The objective of the current study is to investigate the change in response latency in response to different gambling outcomes, including magnitude of reinforcement, in a rapid, continuous gambling format. Essentially, the current aims to extend the research of Verbruggen et al. (2012), by attempting to observe the impact of monitoring for stop signals on risk taking behaviour in a gambling context that is more equivalent to commercial gambling products in terms of rapidity and continuity of play, magnitude of losses and aesthetic quality. Furthermore, the current study aims to measure change in response latency as a result of two types of within-game responsible gambling interventions; of which one comprises of a standard mandatory break-in-play. The newly developed within-game intervention assessed within the present study was developed specifically to integrate stop-signals within its structure, and require participants to monitor for stop-signals and engage in motor control when cued within the gambling task. Specifically, the brief within-game intervention attempted to apply findings from Verbruggen et al. (2012) and Harris et al. (2018) within a realistic gambling activity where significant monetary losses could be accrued. The aim was to observe whether engaging in motor control during a gambling task would increase response latency, or at least limit the response latency reduction in response to accumulating losses. Moreover, the current study also aimed to investigate whether engaging in motor control during the gambling task reduced behavioural persistence when experiencing reduced reinforcement i.e. in response to a period of sustained losses.

Hypotheses H1a: Response latency (time in milliseconds) between feedback of previous bet outcome and initiating a subsequent bet will increase as the level of monetary reinforcement increases.

H1b: Response latency will be shorter after incurring a losing outcome in comparison to a winning outcome.

H2: Response latency of participants who were presented with the Stop Signal Game Intervention will be reduced less during a period of sustained losses, in comparison to participants presented with a standard break-in-play intervention or no intervention.

H3: Participants who were presented with the Stop Signal Game Intervention will stop gambling during a period of sustained losses more rapidly, in comparison to participants presented with a standard break-in-play intervention or no intervention.

Method

Participants

The inclusion criteria required participants to have gambled within the last four week period, and to have had played a rapid, continuous gambling format within the preceding six month period. Rapid, continuous gambling formats were determined to be either EGMs or any offline or online casino games. The rationale for the inclusion criteria was to ensure that the participants were not naïve to the operational structure of the gambling task used within the experiment. A sample of 74 adult gamblers were recruited through posters advertising the study placed in local community and sports groups, in addition to a large urban university campus. The mean age of the sample was 35.28 years (SD = 14.7), with a range of 18 and 74 years; and 66.2% of the sample were male. In terms of gambling behaviour, in the last 12 months 44.6% of the sample had participated in two different forms of gambling, and 13.5% of the sample participated in at least five different gambling formats. There was no statistically significant differences across the experimental conditions for gambling experience in the preceding six-month period $F(2, 70) = 1.51$, $p = 0.23$. The mean amount of gambling activities that participants engaged in during the previous-six month period were 3.00 (SD = 1.67) for the Control Group, 3.21 (SD = 1.91) for the Break in Play Intervention Group and 3.87 (SD = 1.84) for the Stop Signal Game Intervention Group.

Materials and Instruments

The experiment was conducted on an Asus Iconia One tablet with a seven inch screen and utilising the Android 6.0 operating system.

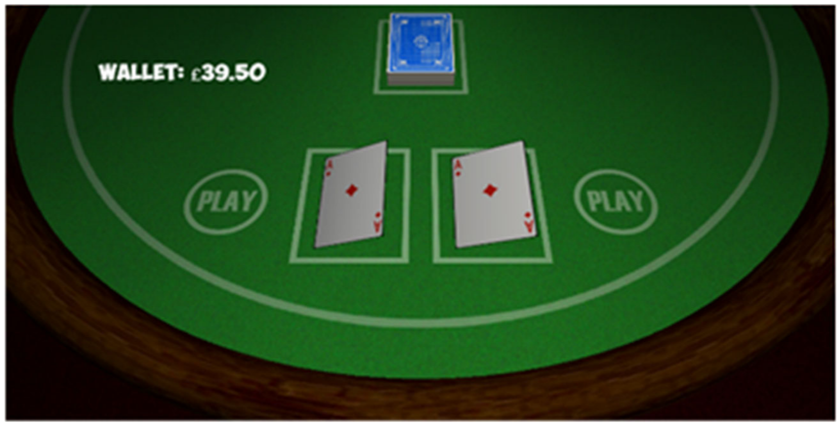

Fig. 1 'Diamond pairs' gambling task (duration: 2500ms per trial)

Gambling Task

The gambling task used in the experiment was created by the authors. Each trial consisted of two cards being drawn from a limitless deck of diamond suited cards (See Fig. 1). If the two cards matched as a pair the participant would win. The magnitude of the win was determined by multiplying the numerical value of the pair[1] with the stake. As stakes were set at £0.50 per trial, a pair of tens, for example, would return a win of £5 to the player (£0.50 × 10). In order to increase the excitement of the gambling task, Joker cards were *wild*, meaning that a drawn Joker card would automatically pair with the other card drawn (e.g. drawing a Joker and a 6 would provide a win of £3). Each trial had a duration of 2500 ms, and participants were permitted to initiate a subsequent bet immediately after the result of the previous bet had been revealed. The game had high tempo background music (>90 bpm), and sound effects for losing and winning outcomes, and for cards being drawn from the deck, consistent with commercially available rapid, continuous digital gambling activities. From a technical perspective, the *Diamond Pairs* gambling task was developed using Unity 3D (Unity Technologies SF), and standardised trial outcomes were pre-loaded from text-based files.

In-Game Interventions

For the participants within the standard break-in-play condition, at the intervention point (i.e. after trial 100) they were presented with a screen that only said 'Freeze', and the participant would not be permitted to interact with the gambling activity for a period of three minutes. Upon cessation of the break-in-play the participants were permitted to resume gambling again.

An alternative within-game intervention was created by the authors by integrating the propositions of Verbruggen et al. (2012) and Harris et al. (2018), who concluded that engaging in motor control and response inhibition may stimulate reduced monetary risk taking in gambling activities. Therefore, a game, with a total duration of three minutes, was developed that required participants to initially develop a prepotent response and subsequently inhibit the prepotent response when the stop-signal was presented. The Stop Signal Game Intervention was structured in a format that required participants to build up a prepotent response through repetitive, automatic responding, and subsequently, occasionally 'cancel' and override their built-up prepotent response when presented with a stop signal. The game format consistent two identical dice which had alternate red and black sides, which rapidly rotated during each trial, with the dice stopping simultaneously to reveal either a red or black face (See Fig. 2). Participants were instructed to '*Ignore the black die and press the red die as quickly as possible without making errors*.' Participants were further instructed that on some trials they will hear a 'Stop-Signal' in the form of a bell sound-effect, and when they heard the bell they were required to not respond at all, and therefore not press the red die in that trial. On trials containing a stop-signal, the bell sound effect was initiated 150 ms after the dice had stopped rotating, and participants were required to cancel their action of pressing the red die. Feedback was provided after each trial regarding the accuracy of participant response (see Fig. 2). The duration of the game was three minutes, providing 90 trials of the Stop Signal Game Intervention. In order to build up prepotent, automatic responding in the game, the first 30 trials contained no stop signals. However, 15 stop signals were randomly dispersed across the 60 remaining trials within the intervention.

UPPS-P Scale

Trait impulsivity can be reliably differentiated into five distinct domains, including: Negative Urgency, Lack of Premeditation, Lack of Perseveration, Sensation Seeking and Positive Urgency (Cyders and Smith 2008; Whiteside and Lynam 2001). Negative and positive urgency refers to acting

[1] For the purposes of the gambling task royal cards i.e. Jacks, Queens and Kings were assigned a numerical value of 10, and Aces were valued as 11.

Fig. 2 Screenshot of stop-signal game intervention (duration: 3 minutes)

emotionally to negative and positive stimuli respectively, and lack of premeditation refers to acting without thinking (Whiteside and Lynam 2001). Additionally, Whiteside and Lynam (2001) defined lack of perseveration as an inability to remain focussed on a task, and finally, sensation seeking as seeking out novelty (Whiteside and Lynam 2001). A valid and reliable 59-item scale to measure the five domains of trait impulsivity (UPPS-P; Lynam et al. 2007) was employed to measure the multiple dimensions of the participants' impulsivity. The UPPS-P has been previously used to successfully identify the specific prediction value of various impulsivity domains on appetitive behaviour (e.g. nicotine use behaviour, *see* Flory and Manuck 2009; Spillane et al. 2010). Estimates of internal reliability of the UPPS-P Scale for this sample included: Negative Urgency (a = 0.88), Lack of Premeditation (a = 0.85), Lack of Perseveration (a = 0.86), Sensation Seeking (a = 0.85) and Positive Urgency (a = 0.93).

Experimental Design and Procedure

A between-groups experiment was conducted, comparing the impact of three experimental conditions on participants' gambling persistence and response latency. Gambling persistence was operationalised as the number of bets placed during a period of non-reinforcement (i.e. sustained losses) after the minimum amount of trials was completed. Response latency was operationalised as the time in milliseconds between the outcome of the previous bet and the initiation of a subsequent bet. The three experimental conditions included a standard three minute break-in-play where the participant is restricted from gambling during this period, a three minute Stop Signal Game Intervention game where participants are required to engage in stop-signal monitoring and inhibitory motor control. In addition to the interventions, a control condition where no intervention was presented was included for comparison. The experiment was conducted using a portable tablet, and conducted in either the participant's home or in a quiet public setting such as an empty room on the university campus. The variation in experimental environment was reflective of the varying environments in which online gambling is regularly conducted. In all instances, the tablet was placed flat on a table and participants were instructed not to hold the tablet but rather use their fingers to operate the device. Participants used earphones, provided by the researcher, to hear the background music and sound effects of the game during the experiment.

Before the experiment participants were provided with detailed instructions of the structure and requirements of the tasks, followed by a check for understanding. Participants were given 20 practice trials to experience the gambling task; and the participants in both intervention conditions were also provided an opportunity to briefly experience their specific intervention for a period of 30 s. Participants were provided with £40 in virtual credits to risk on the *Diamond Pairs* gambling task and informed that after they completed the minimum number of trials required, they were allowed to retain any money not lost during the experiment, in addition to any money that they had won during the experiment. In order to observe sufficient data points to enable analysis, participants were informed that they were required to play at least 100 trials before they could collect their monetary total, and that they may choose to stop gambling and collect the monetary total at any point after reaching that minimum. The gambling task did not provide any indicator of the trial count, and the 'cash out' button was available throughout the game. Participants were informed that they could attempt to cash out and collect their total at any stage, but if pressing the cash out button did not stop the gambling task this meant that they had not reached the minimum required trials and therefore needed to continue playing.

Independent of experimental group, all participants experienced identical gambling sequences. Put simply, trials 1–100 were standardised, in order to attempt to isolate the effect of the intervention types. However, the participants believed that the sequence of outcomes they experienced during the

Fig. 3 Standardised sequence of gambling outcomes of diamond pairs gambling task (160 trial maximum)

experiment were determined at random. As demonstrated in Fig. 3, the gambling task provided a series of wins (between £0.50 and £5.50) dispersed between Trials 1 and 91, after which no further wins were provided until Trial 160 where the participant's funds would be depleted and the game would cease. After Trial 100 had elapsed participants could choose to stop gambling and collect the remaining money; at this point the monetary total was £30, representing a 25% monetary loss from the original sum provided. In the experimental conditions that contained interventions, they were presented immediately after the completion of Trial 100 to standardise the sequence, even though participants were informed that the intervention would emerge at a random point during the game. Before the experiment commenced participants were provided with the following information '*Please note that Diamond Pairs operates on a payback percentage similar to other forms of commercial gambling, and therefore in the long-term the probability of winning is not in your favour*'.

After the participants had stopped the gambling task, they were asked to complete the 59-item UPPS-P Scale and a brief questionnaire recording information about recent gambling participation and preferences and demographic variables.

Ethical Statement

The experimental design of this study was approved by the University of XXXXXXX School of Psychology Ethical Review Board. The experimental protocol was designed in accordance with the guidelines of the Declaration of Helsinki. Informed consent was obtained from all individual participants included in the study. All participants were debriefed at the end of the experiment. Prior to study commencement participated were asked if they have previously experienced or are currently experiencing problems with gambling. If a participant answered in the affirmative then they were excluded from participating in the study.

Results

Differential Response Latency to Gambling Outcomes

All participants fully completed the first 100 trials of the gambling task, and the mean response latency between the outcome of the previous bet and the initiation of the subsequent bet for all participants[2] was 230.48 ms (SD = 56.27). The mean response latency in response to a loss was 209.21 ms (SD = 42.8) and the mean response latency for any win received was 368.37 ms (SD = 189.01), and this difference was statistically significant $t(70) = -8.09$, $p < 0.001$. Furthermore, as demonstrated in Fig. 4, there was a statistically significant difference in participants' mean response latency in response to losing outcomes, and in response to small (M = 308.46 ms, SD = 225.16), moderate (M = 347.7 ms, SD = 208.47) and large wins (M = 405.73 ms, SD = 192.93), categorised as being less than £2.50, between £2.50 -£4.50, and £5 or more respectively, $F(3, 207) = 24.97$, $p < 0.001$. There were no statistically significant interaction effects between any of the five domains of impulsivity and response latency to gambling outcome; Negative Urgency ($p = 0.68$), Lack of Premeditation ($p = 0.72$), Lack of Perseveration ($p = 0.86$), Sensation Seeking ($p = 0.40$) and Positive Urgency ($p = 0.97$).

[2] Three outliers were removed from the analysis, as their mean response latency during the pre-intervention stage to all trials was more than three standard deviations from the mean of the sample.

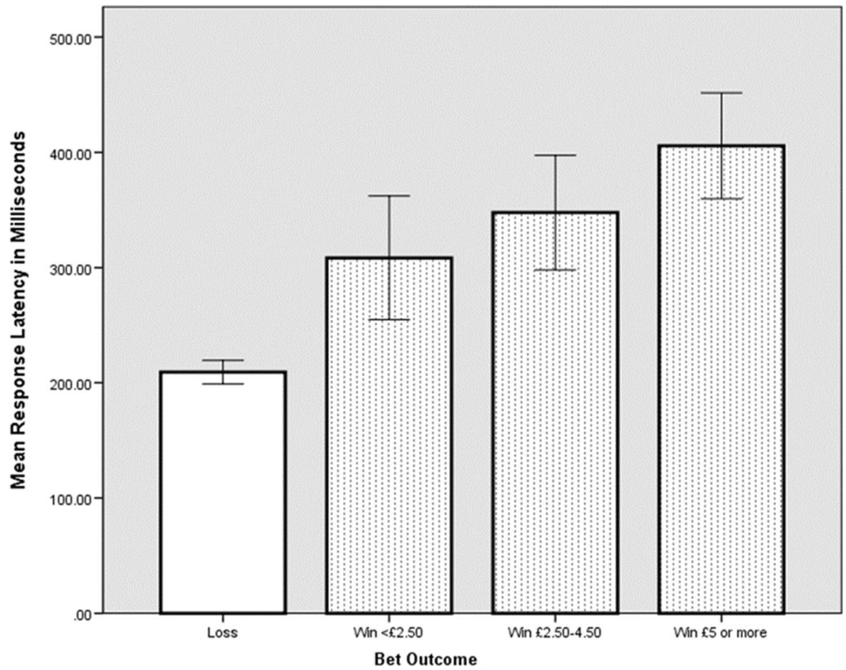

Fig. 4 Differential response latency to various gambling outcomes

Linear Mixed Effect Model of Response Latency

Although possible to conduct a simple pre- and post-intervention comparison of mean response latency across each experimental condition, it was determined that this analysis would not reflect the true change in behavioural patterns in response to the independent variables. Instead behavioural change in response to the interventions was conducted using an analytical approach that would take into account the dynamically varying aspects of the gambling task, such as increases in total losses as the post-intervention stage progressed. Furthermore, stablishing a linear mixed effect model accounting for response latency change, in contrast to Ancova analyses, would improve the sensitivity of measuring behavioural change by controlling for variation in individual differences within the sample as random effects. In order to establish the change in response latency, the data for each participant[3] were normalised to their own individual median response latency in the pre-intervention stage i.e. Trials 1–100. Median response latency was preferred rather than mean response latency, as being more representative of individual response latency to each outcome. By normalising the data in this way, it was easier to detect subtle behavioural change by allowing linear comparison of change across participants, while allowing substantial between-participant variability.

From earlier findings (see Fig. 4), it was evident that participants' response latency changed as a function of the gambling outcome. Therefore, individual *Reward Sensitivity* level, defined as the participant's response to winning trials in the study was included as a fixed factor in the model. In addition, Losses Total, defined as the level of monetary loss incurred since the start of the experiment was also included as a fixed factor in the model, given that gamblers are known to escalate speed of play as total losses increase (Dixon and Schreiber 2002, 2004; Schreiber and Dixon 2001).

A linear mixed effects model was fitted using (R Core Team 2013), and the packages "lme4" (Bates et al. 2015), "lsmeans" (Lenth 2016) and "afex" (Singmann et al. 2017). Following the method of Winter (2013), the effect of a factor of interest was estimated by comparing the full model with a null model, omitting the variable of interest. In this case, there were two a priori factors of interest, firstly the intervention condition, and secondly the reward sensitivity. In order to assess the effect of intervention condition, the full model was compared to a null model omitting the factor of interest, in this case intervention condition. There was a significant improvement in prediction value when the model included the interaction of intervention condition and pre and post intervention change (See Table 1). The model including the intervention condition interaction on pre - post intervention change was significantly different to the Null Effect Model X^2 (4) = 46.89, $p < 0.001$. The Bayes Information Criterion (BIC) for the model including the intervention condition interaction on pre - post intervention change was BIC = 44,475.5, and when excluded, BIC = 44,485.3 (deviance 9.8). More specifically, response latency increased post intervention for the participants in the standard Break in Play Intervention condition and in the Stop Signal Game

[3] In these analyses three participants were removed as outliers, as their median response latency in the pre-intervention stage was more than three standard deviations from the median of the sample.

Table 1 Comparison of linear mixed effect models for gambling response latency in period of sustained losses

		k	BIC
	Model 1 (*with Intervention Condition*)		
(fixed)	Intervention Condition*Pre-Post Response Latency Interaction, Losses Total, Reward Sensitivity		
(random)	Participant	4	44,475.5
	Model 1 (Null)		
(fixed)	Pre-Post Response Latency, Losses Total, Reward Sensitivity		
(random)	Participant	4	44,485.3
X^2 (4) = 46.89, p < 0.001			
		k	BIC
	Model 2 (*with Reward Sensitivity*)		
(fixed)	Intervention Condition*Pre-Post Response Latency Interaction, Losses Total, Reward Sensitivity		
(random)	Participant	4	44,475.5
	Model 2 (Null)		
(fixed)	Intervention Condition*Pre-Post Response Latency Interaction, Losses Total		
(random)	Participant	3	44,542.6
X^2 (1) = 76.35, p < 0.001			

Intervention condition, by 0.25 (±0.09) standard errors and 0.62 (±0.09) standard errors, respectively. This demonstrates that both within game interventions were successful in increasing response latency before the next bet, when including reward sensitivity level and losses total into the model, with the Stop Signal Game Intervention having the stronger effect of the two interventions.

Focussing specifically on the prediction value of reward sensitivity of participants in response latency change across different intervention groups, there was a statistically significant difference between the full model and the null model where reward sensitivity was omitted (X^2 (1) = 76.35, $p <$ 0.001). The model with Reward Sensitivity excluded had a BIC = 44,542.6, showing a deviance of 67.1 from the full model (See Table 1). This indicates that pausing for longer after winning outcomes i.e. higher reward sensitivity, is predictive of greater response latency to gambling outcomes during a period of sustained losses. Table 2 provides further information regarding the individual contribution value of each of the fixed effects included in the full model, as well as their confidence intervals and p-values.

Differences in Gambling Persistence during Post-Intervention Stage

In the post-intervention stage after Trial 100, there was no further monetary reinforcement as all gambling outcomes were losses. Gambling persistence was defined as the number of bets the participant would play during the post-intervention stage. There was substantial variation in the number of bets participants would play during the post-intervention stage (M = 20.23 bets played, SD = 18.61). The mean number of bets played in the Control condition was 21.67 (SD = 22.04), and 17.34 bets (SD = 14.15) and 21.54 bets (SD = 19.08) in the standard Break-In-Play Intervention condition and the Stop-Signal Game Intervention condition, respectively. However, using one-way between-groups ANOVA, this difference in gambling persistence in the Post-Intervention stage was determined as not statistically significant $F(2, 68) = 0.4$, $p = 0.67$, indicating that the presentation of either intervention

Table 2 Coefficients, confidence intervals and *p* values for fixed effects within response latency prediction model

	Coefficient (β)	Lower confidence interval (2.5%)	Upper confidence interval (97.5%)	p
Reward Sensitivity	0.60	0.47	0.74	<0.001
Losses Total	0.01	0.01	0.02	<0.001
Pre-post Response Latency	2.49	2.31	2.66	<0.001
Interaction (Break-in-Play Intervention * Pre-post Response Latency)	0.26	0.07	0.44	<0.01
Interaction (Stop Signal Game Intervention * Pre-post Response Latency)	0.68	0.44	0.80	<0.001

did not affect how long participants would persist in gambling in response to sustained losing outcomes. Furthermore, the variance in gambling persistence was not accounted for by mean response latency ($\beta = -0.19$, $p = 0.12$) or by recent gambling experience in terms of the number of gambling activities that the participant had participated in during the preceding 12 months ($\beta = -0.07$, $p = 0.55$). In addition, the variance in gambling persistence could also not be accounted for by the participants' level of Negative Urgency ($\beta = 0.04$, $p = 0.8$), Lack of Premeditation ($\beta = -0.24$, $p = 0.15$), Lack of Perseverance ($\beta = 0.09$, $p = 0.56$), Sensation Seeking ($\beta = -0.08$, $p = 0.73$) or Positive Urgency ($\beta = -0.18$, $p = 0.23$).

Discussion

Differential Response Latency to Magnitude of Gambling Outcomes

Participants were more likely to bet again faster when the outcome of the previous bet was a loss rather than a win. In addition, the larger the size of the win, the greater the pause before betting again. The finding that players have paused for longer in response to wins rather than losses is supportive of the existing literature (Dixon and Schreiber 2002, 2004; Schreiber and Dixon 2001). It could be interpreted that gamblers are more likely to engage in cognitive activity such as evaluation after experiencing a win, which in turn may increase the opportunity for more informed gambling decision-making. The findings show that the tendency to pause for longer after a winning outcome in comparison to a loss, could not be accounted for by individual differences in terms of trait impulsivity, given that negative and positive urgency traits did not create a statistically significant interaction effect.

Critically, it appears that gamblers played faster in response to losing outcomes, which may initially appear as a counter-intuitive finding given that reflecting on punishment in terms of loss may have as much utility as reflecting on winning outcomes. With respect to problematic patterns of gambling, it appears that precisely when gamblers are experiencing negative consequences that may require response modulation and cognitive control, they are appearing to pay less attention to the outcome of bets made. The greater the delay in responding to negative gambling outcomes the more scope there is for the gambler to evaluate the impact of their behaviour and potentially change behaviour and limit the accruing negative consequences from gambling. Therefore, a strategy to promote responsible, informed gambling behaviour may be to encourage greater response latency between bets. This approach may be effective regardless of whether this is encouraged via internal processes, triggered by pop-up messaging for example, or in contrast via top-down changes in the gambling activity structural characteristics, such as restricting the possible speed of play. Potentially, if gamblers are in a more attentive and reflective state after receiving a win, it is probable that gamblers will be more likely to adhere and respond to responsible gambling pop up messages that occur directly after experiencing a win, particularly if the win is relatively large. In contrast, if gamblers are playing faster and are less cognitively engaged in response to losing outcomes it may be more effective to use external mechanisms to encourage responsible gambling in this context. For example, the introduction of a brief time lag after experiencing a loss before being able to initiate a subsequent, may be beneficial. Thompson and Corr (2014) observed that restricting the rapidity in which a gambler can play again led to reduced risk-taking and a decrease in the total number of bets made. However, rather than introducing a time-lag after all bets, it could be that restricting instant re-betting may only be required dynamically in response to losing outcomes, given that gamblers tend to naturally pause for longer in response to winning outcomes.

Response Latency Change during Periods of Sustained Losses

In the first 100 trials, the losing outcomes were interspersed with winning outcomes of various sizes (13% of trials were wins). After trial 100 was completed and the interventions were delivered (where applicable), all gambling outcomes experienced were losses. The gambling task was designed in this format to observe change in response latency in a period of no monetary reinforcement and consistent punishment in the form of sustained losses. The findings demonstrated that when gamblers experience no intervention they increase their speed of play during an extended losing streak. Whereas, when gamblers were presented with a within-game intervention during a period of sustained losses their response latency increased. Effectively, this increased delay in responding after the interventions increased their scope for evaluation, and therefore potential response modulation during periods of sustained losses. Essentially, as the total loss level for the gambling session increased, participants in the intervention conditions were slower in initiating further bets. This phenomenon may have significant implications for the likelihood of gamblers engaging in informed, rational decision-making when they are accumulating sustained losses.

Using a linear mixed effects modelling approach, which controlled for the natural variation between participants in terms of pre-intervention median response latency, it was evident that both interventions were predictive of increased latency of responses during a period of sustained losses. Although both interventions led to improvements in response latency, the Stop Signal Game Intervention was slightly more effective than the standard Break in Play. This provides support for Verbruggen et al.'s (2012) and Harris et al.'s (2018) conclusion that monitoring for stop signals can increase motor cautiousness in gambling contexts. However, although this finding is promising, extensive replication is required before the conclusion can be firmly accepted.

Notwithstanding the need for extensive replication, it is appears that when no intervention is present gamblers tend to respond with more urgency during periods of sustained losses. Furthermore, it appears that any break in play during a period of sustained gambling losses will reduce speed of play and therefore increase the scope for more cognitive engagement in gambling behaviour. This provides further impetus for continued research into the impact of enforced breaks in play and gambling-related harm (e.g. playing for longer or for more money than one can realistically afford). Future research must investigate how to maximise effectiveness of different formats of breaks in play, as it is evident that a break in play that is static and passive is less effective in increasing response latency than a break in play requiring active engagement monitoring for stop signals and response inhibition.

Although research into the effect of breaks in play on gambling behaviour is in its infancy, consideration should also be given to the interaction of individual differences to different forms of within-game interventions. For example, problem gamblers were not observed in the current study and it could be that the interventions shown to be relatively effective in the current study may not increase response latency in problems gamblers.

In addition, the current study indicates that commercial providers of rapid, continuous gambling formats must consider their facilitation of automatic, cognitively unengaged gambling behaviour of their customers during periods of sustained losses, as there appears to be specific vulnerability for gambling-related harm in this context. For example, in online gambling there has been a shift in the ease and rapidity in which a gambler can deposit further funds when they have exhausted the funds in their account, such as an *instant deposit pop-up*[4] facility becoming increasingly available on multiple formats (Parke and Parke 2017). Essentially, rather than facilitating non-evaluative, automatic responding to a period of sustained losses, the depletion of one's account funds is an ideal opportunity to enforce a break in play to provide scope for a gambler to make cognitively engaged, informed decisions about whether to continue gambling.

Gambling Persistence during Periods of Sustained Losses

There was no main effect of experimental condition (Stop-Signal Game Intervention, Break-In-Play Intervention, No Intervention) on gambling persistence in terms of number of bets made during the post-intervention period of sustained losses. Previous research had identified faster rates of play on rapid, continuous forms of gambling as a predictor of gambling-related harm, with respect to expenditure and risk-taking (Ladouceur and Sévigny 2005; Mentzoni et al. 2012). The interventions presented in the current study were not more likely to reduce gambling persistence despite being effective in increasing response latency in response to sustained losses. Not only was gambling persistence not related to experimental condition or change in response latency, but gambling persistence could not be accounted for with respect to differences in the five domains of trait impulsivity. Furthermore, there was no statistically significant relationship between gambling persistence and reward sensitivity, defined as the magnitude of response latency to winning outcomes. From this, it could be interpreted that the determinant of gambling persistence during a period of sustained losses is more idiosyncratic and multifactorial than one would have initially anticipated.

Given that existing literature emphasises the importance of response latency in disordered patterns of EGM gambling behaviour (Corr 2010; Thompson and Corr 2013), it is possible that the absence of a reduction in gambling persistence in the current study even when latency of responding increases, may be reflective of methodological limitations of experimental gambling research. For example, participants' awareness that they had a finite amount of money to gamble with, i.e. *that they could not withdraw more personal money to sustain a longer gambling session*, affected the persistence of the participants in chasing their losses. In other words, the awareness that the scope for recouping losses was strictly limited by the value of current funds made participants more willing to *cut their losses* quicker than they normally would have in a commercial gambling setting.

Another possible explanation of the absence of a relationship between reduced response latency and chasing losses observed in the present study was that the participants were not disordered gamblers, and therefore most were able to respond adaptively to the accumulating losses. On closer inspection, the sample appeared to have reached behavioural extinction relatively rapidly. In simple terms, most gamblers, regardless of experimental condition, were able to adjust their behaviour and stop gambling and collect when faced with a period of sustained losses. When the study design permitted, the majority of participants were able to stop gambling and limit the negative consequences before they had lost 50% of their original stake. Therefore the lack of observable effect of the interventions on gambling persistence may be a consequence of the sample responding adaptively to the changing rate of reinforcement, rather than evidence of a lack of

[4] The instant deposit pop up, where available, is presented to the gambler immediately after the last of their account funds are lost. The facility will provide a suggested amount to deposit, and a player can confirm the deposit instantly with one click.

interaction between response latency and gambling persistence. In retrospect, it may have been prudent to observe problem gamblers in the current study to determine the impact of the proposed interventions on gambling persistence.

Methodological Limitations

Arguably, it may not be suitable to utilise an existing effect size from a single study (i.e. Verbruggen et al. 2012) to conduct an a priori power analysis to calculate a sample size estimate. However, without conducting a power analysis to calculate a sample size estimate there remains the risk of committing a Type II error. This is relevant in the current study with respect to observing a non-significant effect of the interventions on gambling persistence.

Furthermore, observing the interaction of problem gambling status with changes in response latency may have added clarity into the behavioural impact of the Stop-Signal Game Intervention. Fundamentally, it is evident that the behavioural response to sustained losses in terms of response latency and gambling persistence does not appear to be straightforward. Therefore, in hindsight, it would have been beneficial to measure further factors, such as problem gambling, that may be relevant in accounting for behavioural change in response to these within-session gambling interventions.

In addition, although the paradigm of providing gamblers money to risk during gambling tasks is an established experimental approach (e.g. Harris et al. 2018; Parke, Harris, Goddard & Parke, 2016, etc.), and an improvement in ecological validity terms on studies where significant sums of real money are not gambled, this approach remains not entirely representative of real-world gambling. Essentially, although incurred losses in the present study did lead to negative consequences for the participants in terms of a reduction in money extracted from taking part in the study, and the associated opportunity cost of retaining less money, it is likely that the negative consequences of losing were limited. In other words, the difference in the negative consequences of losing money that has been personally generated, and therefore part of one's expected income, versus money unexpectedly awarded without cost, is likely to impact one's risk-taking perception and intention. Although there would be significant ethical considerations to address beforehand, evaluation of the effectiveness of within-session gambling interventions should ideally be conducted in controlled environments where participants are observed to risk personal funds, to enhance the internal validity of the findings.

Conclusion

In conclusion, the findings indicate gambling sessions that are interrupted with a brief break in play lead to longer response latencies during periods of sustained losses, in comparison to no break in play. Moreover, the findings indicate that if the gambler is required to monitor for stop signals during the brief intervention, this is more effective in increasing response latency during losing streaks in comparison to a break in play where a gambler is simply *frozen out* from playing. Given the relationship between speed of play and gambling-related harm, if the findings are consistently supported through multiple replication studies, there are implications for responsible gambling strategies across commercial operators. Primarily, it appears that gamblers may be less cognitively engaged in decision-making during periods of sustained losses, therefore consideration must be given to how gamblers can be assisted to evaluate gambling behaviour during losing periods, such as, for example, the dynamic slowing down of the reels during losing streaks.

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Compliance with Ethical Standards

Conflict of Interest Dr. Adrian Parke has received research grants from GambleAware (formerly known as Responsible Gambling Trust) within the last three years.

Dr. Patrick Dickinson declares that he has no conflict of interest.

Dr. Louise O'Hare declares that she has no conflict of interest.

Mr. Liam Wilson declares that he has no conflict of interest.

Mr. Greg Westerman-Hughes declares that he has no conflict of interest.

Dr. Kathrin Gerling declares that she has no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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