The Role of Free Spins in Slot-machine Gambling

By

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Abstract

Slot-machine gambling is disproportionately associated with problem gambling. It is therefore important to develop an understanding of how the programming and features of slot machines influence gambling. The current research programme investigated a major feature of many slot machines which has so far been neglected by experimental research – the free-spins bonus feature.

The first major focus of this research was a series of experiments that investigated whether participants prefer to play a slot-machine simulation with a free-spins bonus feature. In each experiment participants gambled on two simulations, one with a free-spins feature and a similar machine without free spins. Following this, participants could switch between the same simulations and the number of spins they made on each simulation was measured. Participants preferred the free-spins simulation, but only when the free-spins feature incorporated an increased rate of wins, music, animations, and graphics advertising the presence of the free-spins feature. In the final experiment investigating preference, we investigated whether responding was influenced by whether participants gambled with hypothetical money, or credit that could be exchanged for tangible rewards. Participants preferred the complex free-spins simulation similarly regardless of what they were gambling with, but selected larger bet amounts and gambled for longer when gambling with hypothetical money.

The second major focus of this research programme was an investigation of whether free-spins features cause increased gambling persistence – a hallmark of disordered gambling. We developed a new persistence-measuring task which was adapted from research investigating Behavioural Momentum Theory. Participants gambled on two simulations in a multiple schedule design. An initial baseline phase consisted of four alternations of each component, one of which had the complex free-spins feature demonstrated to increase preference in the earlier experiments. Baseline phases then alternated with disruption phases where video-clips were embedded into the top right corner of the simulations. The rate at which participants gambled during baseline was compared to the rate at which they gambled when the videos were present, with bigger relative decreases in response rate during the disruption phases indicating less persistence. The free-spins feature did not cause participants to gamble more persistently. Further experiments also assessed whether different frequencies of wins caused participants to gamble

more persistently, and results indicated that they did not. The findings of this research programme have implications for Behavioural Momentum Theory, suggesting that comparing response rate during disruption to response rate during baseline is not highly sensitive to small differences in reinforcement schedules. The findings are also relevant for slot-machine legislation, providing an indication that limiting or removing free-spins features may reduce player enjoyment without reducing persistent gambling. Furthermore, the task developed in the persistence investigation provides a useful tool which can be used to investigate how other features of slot machines influence persistence. Future research could, for example, investigate how free-spins features interact with other slot-machine features to influence gambling behaviour.

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Chapter 1

Preference for Slot-machine Simulations with Free-spins Bonus Features

Note: Some parts of this chapter were previously reported in a published article – Taylor, Macaskill and Hunt (2016). The relevant sections are various parts of the General Introduction, and some of the data reported in Preference Study 2.

General Introduction

Slot Machines and Harm

Problem gambling directly affects a large number of people in New Zealand and world-wide. Williams, Volberg and Stevens (2012) conducted a meta-analysis of 202 problem gambling prevalence studies. After taking into account methodological differences of suitable studies, problem gambling prevalence in the past year ranged from 0.5% to 7.6% across countries. The average across all countries was 2.3%, with New Zealand prevalence slightly lower than average at 1.5% of the population. With the population of New Zealand approaching 4.5 million people, this means that there are roughly 67,500 New Zealanders who meet clinical criteria for a gambling disorder at some point in a given year, and many more who meet criteria for a gambling disorder at some other point in their lives. These numbers do not include people who have some problems with gambling, yet do not meet clinical criteria for a disorder. In addition to the obvious financial difficulties that can occur, problem gambling is associated with depression (see Blaszczynski & Nower, 2002, for a review), suicide (see Zangeneh, 2005, for a review), anxiety disorders (American Psychiatric Association, 2013) and other mental disorders. On top of financial problems and the relationship with mental disorders, probable pathological gamblers report lower quality of life in multiple domains when compared to non-gamblers – including physical health, relationships, and their general environment (American Psychiatric Association, 2013; Loo, Shi, & Pu, 2016).

Slot machine gambling is undeniably entwined with problem gambling. Despite only approximately 18.2% of New Zealanders playing slot machines at least once per year, and only 1.6% playing at least once per week (Abbott, Bellringer, Garrett, & Mundy-McPherson, 2014), slot machines are disproportionately associated with problem gambling. Of the 7488 people located in New Zealand who the Ministry of Health lists as using its problem gambling services in the 2014/2015 year, 59% nominated slot machines as their primary mode of gambling (New Zealand Ministry of Health, 2015). The majority of problem gamblers nominating slot machines as their primary gambling mode is consistent with estimates from outside New Zealand (e.g., Delfabbro, 2008). For reference, the proportion of New Zealand's adult population who reported engaging in various gambling activities (Abbott et al., 2014), and the proportion of New Zealand Ministry of Health gambling treatment service clients who list those gambling activities as their primary mode of gambling

(New Zealand Ministry of Health, 2015) are displayed in Figure 1. This figure was constructed from these two different datasets.

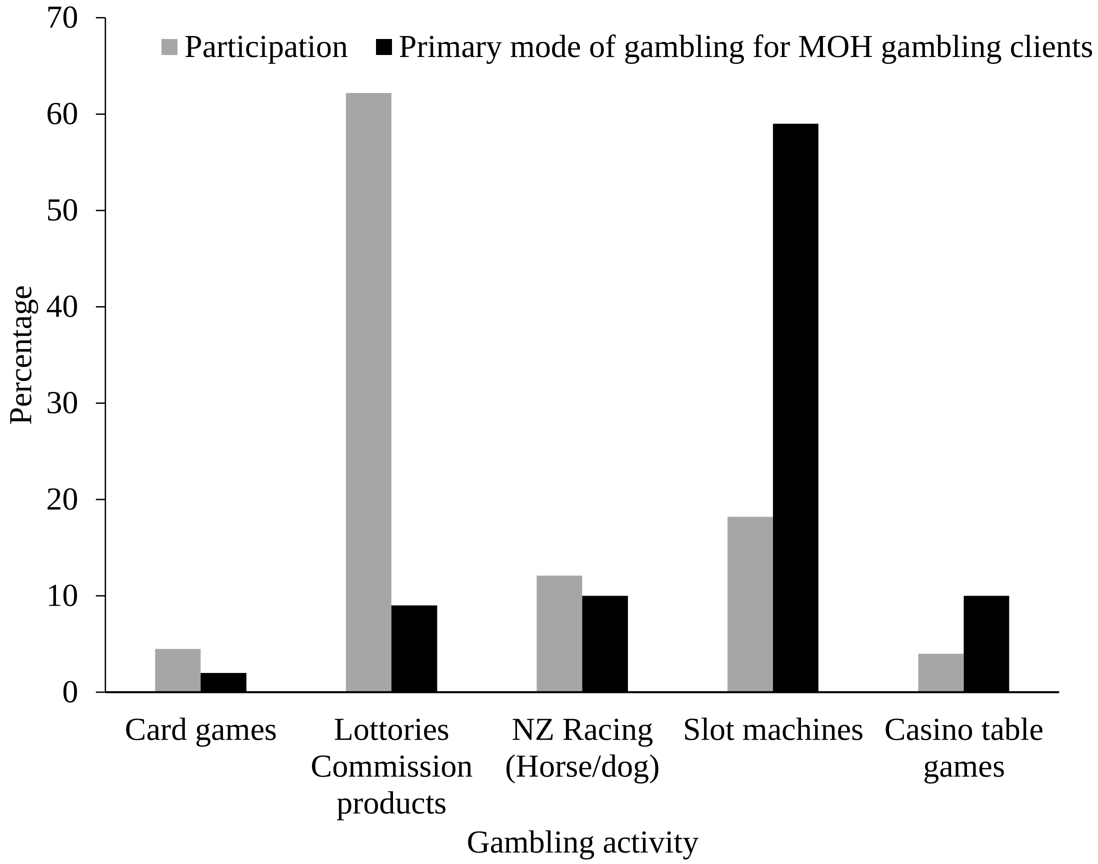

Figure 1. The percentage of adult New Zealanders who report engaging in various gambling activities at least once per week (grey bars) compared to the percentage of Ministry of Health problem gambling clients who reported those activities as their primary mode of gambling (black bars).

There are other data that support the idea that slot-machine gambling is disproportionately associated with problem gambling. In a review of Canadian problem gambling surveys, MacLaren (2016) found that the risk of meeting research criteria for problem or pathological gambling was higher among slot-machine players than for people who gamble on other activities. Furthermore, a multivariate analysis of data from the largest Australian prevalence study also revealed that gambling on slot machines was a significant predictor of gambling problems – slot-machine gambling was more associated with moderate-risk and problem gamblers compared to non-problem gamblers (Hing, Russell, Tolchard, & Nower, 2016). These studies and data show that slot-machine gambling is associated with problem gambling, and that this association is not simply due to people gambling on slot machines more than other forms of gambling.

Problem gambling also manifests much more rapidly when the mode of gambling is slot machines rather than other forms of gambling. In an interview and questionnaire study with 44 treatment-seeking problem gamblers, it took an average of 1.08 years after regular gambling on slot machines to meet clinical criteria for a gambling disorder, compared to 3.58 years after gambling on traditional forms (e.g., cards, sports betting, track betting, lottery; Breen & Zimmerman, 2002). Other interview research with slot-machine problem gamblers further supports a rapid acquisition of gambling problems. Thomas, Sullivan and Allen (2009) suggested slot-machine gamblers go through a process of change from initially non-problematic gambling on slot machines, to problematic gambling, and then, for some gamblers, a period of recovery. The change from non-problematic to problematic gambling among these gamblers generally occurred within six months of initial play on slot machines. A rapid manifestation of gambling problems on slot machines is also suggested by macro-level prevalence research. In a thorough review of studies investigating the relationship between the availability of slot machines and problem gambling prevalence, Abbott (2006) noted that as availability increased so did problem gambling rates. However, the increase in problem gambling prevalence tended to be temporary, eventually falling back to previous rates. Abbott argued the initial increase in problem gambling following increased slot-machine availability followed by a subsequent decrease is indicative of problem gambling on slot machines both manifesting and resolving itself quickly. The rapid manifestation of gambling problems for slot-machine gamblers lends some credence to the analogy of slot machines being the “crack cocaine of gambling” (Dowling, Smith, & Thomas, 2005), however, slot-machine gambling problems resolving quickly is somewhat inconsistent with the same analogy. Problem gambling manifesting quickly for slot-machine gamblers, the New Zealand Ministry of Health data provided above, and slot-machine gambling being a predictor of gambling problems, provide converging evidence that slot machines are the most hazardous form of gambling for consumers in terms of developing gambling problems.

Slot machines being untouched by the majority of the population, yet accounting for the majority of problem gambling, leads to an obvious question: just how much of slot-machine gambling is problem gambling? Orford, Wardle and Griffiths (2013) conducted an investigation into this question using data from the 2010 British Gambling Prevalence Survey. They looked at what percentage of the day’s play and how much of the day’s spend are attributable to problem gamblers across a range of different gambling activities. The authors estimated that problem gamblers accounted for a substantial amount of slot-machine gambling: 16% of slot-machine play and 10% of daily spend. This is a considerable amount of money attributable to problem gambling – the majority of gambling revenue in Canada during the decade 2002-2012 was the result of slot-machine gambling (MacLaren, 2016), and slot machines were also associated with the highest gambling expenditure of all gambling activities in New Zealand every year in the period 2009-2016 (New Zealand Department of Internal Affairs, 2016). It is likely that, similar to Britain, around 10% of this expenditure in New Zealand and Canada is accounted for by problem gamblers. So, not only is slot-machine gambling arguably the most hazardous for the consumer, problem gambling on slot machines is also very lucrative for the gambling industry.

Some of the different avenues of research described above demonstrate that slot machines are disproportionately linked to problem gambling, and that problem gambling manifests more rapidly on slot machines. However, it is not known whether these relationships between slot machines and problem gambling are causal (i.e., something about slot machines influence gamblers' behaviour to the point where their gambling becomes problematic), coincidental (i.e., problem gamblers, or the most risky gamblers, are more drawn towards slot machines for reasons unrelated to the slot machines themselves), due to the abundance of slot machines (more available gambling opportunities), or some combination of the above. Interview research with problem gamblers tends to support a causal influence of slot machines (e.g., Thomas et al., 2009 – described below), in which case it is important to identify features of slot machines that may facilitate problem gambling. If the relationship between slot machines and problem gambling was simply due to the abundance of slot machines, then the features of slot machines are unimportant. For instance, if blackjack tables were more abundant, then blackjack would be more associated with problem gambling. However, if the relationship between slot machines and problem gambling is not simply coincidental – as is indicated by some of the above research, then it is important to investigate exactly how the different features of slot machines influence gambling behaviour.

Griffiths (1993) coined the term "structural characteristics" to refer to the different features of gambling activities – for slot machines, this includes various visual and sound effects, payback schedules, and anything else the machines have been programmed to do. Various gambling theories acknowledge the importance of the structural characteristics of gambling activities in the development and maintenance of problem gambling, and experimental research is beginning to demonstrate how different structural characteristics influence slot-machine gambling.

Gambling Theories and the Structural Characteristics of Slot Machines

Thomas et al. (2009) developed their Grounded Theory Model of Slot-machine Problem Gambling based on interviews with problem gamblers and counsellors. The theory suggests that the core mechanism maintaining problem gambling on slot machines is negative reinforcement via the avoidance of life problems and emotions. The authors state that the structural characteristics of slot machines facilitate their effectiveness in functioning as an avoidance strategy; offering examples of rapid playing speed, the lights and sounds associated with the machines, and the crediting of wins to player balances (so they can be gambled with immediately). One theme emerging from the interviews was that the distracting qualities of slot machines were important in this avoidance by demanding the gamblers' attention – "By 'tuning in' to the machines, the gamblers could tune out their problems temporarily (Thomas et al., 2009). In this way, slot-machine gambling is incompatible with worrying or unpleasant thoughts for these gamblers. The authors suggest that the features described as facilitating the effectiveness of slot-machine gambling as an avoidance strategy do this through controlling the attention of gamblers. For example, crediting wins directly to player balances reduces the need to leave the machine to withdraw more money to gamble with, and the rapid playing speed may leave little time and attention to think of things outside of the task at hand. It is also entirely possible that other features of slot machines influence the effectiveness of slot-machine gambling functioning as an avoidance strategy.

The Integrative Behavioral Model of Gambling (Weatherly & Dixon, 2007) also suggests the structural characteristics of gambling activities play a role in problem gambling. It proposes three key mechanisms that interact with contextual factors to develop or maintain problem gambling: contingencies, rules, and establishing operations/setting events. With regard to contingencies, the Integrative Behavioral Model of Gambling states that the consequences of gambling are varied, numerous, and may differ across gamblers. They include monetary outcomes (i.e., losses, wins), negative reinforcement if gambling for escape purposes, social reinforcement, excitement, and more. To further zoom in on the contingencies aspect of Weatherly and Dixon's model, the structural characteristics of gambling activities are clearly influential to the consequences associated with gambling. For example, features of slot machines will influence how exciting they are – lights and sounds influence arousal levels (Dixon et al., 2014), as do near wins (Dixon, MacLaren, Jarick, Fugelsang, & Harrigan, 2013). Slot-machine features will also influence how useful the machines are at functioning as an escape strategy – problem gamblers suggest lights and sounds, rapid playing speed, and crediting of wins to player balances keep their mind focussed on the slot machine (Thomas et al., 2009). Slot-machine features also determine the proportion of money gambled that is returned as winnings.

Structural characteristics may also influence verbal rules that gamblers may be following, although the relationship between these characteristics and rule following is not explicitly explained by Weatherly and Dixon (2007). For instance, the random ratio (RR) schedule of payouts on slot machines mean that wins are probabilistic, and this may influence a gambler to follow a rule that if they have been losing, then they are likely to win soon. Advertising on machines may also influence gamblers' rules – this will be explained in relation to free-spins bonus features later on. The structural characteristics of slot machines seem not to directly relate to motivating operations or setting events, so this aspect of the model won't be explained here (but see Weatherly & Dixon, 2007, for a review of how motivating operations or setting events may influence gambling behaviour).

The Pathways Model of Problem and Pathological Gambling (Blaszczynski & Nower, 2002) proposes three distinct subgroups of problem gamblers: behaviourally conditioned, emotionally vulnerable, and antisocial impulsivist. The authors argue there are three pathways that lead to problem gambling for these subgroups. Each pathway contains some similar and some different processes. Behaviourally conditioned gamblers are characterised by an absence of premorbid psychopathology – their gambling is controlled by operant and classical conditioning processes (Blaszczynski & Nower, 2002). Typically, they will initially gamble for entertainment or social reasons, before their gambling becomes controlled by other factors. For example, these gamblers may then continue gambling for subjective excitement or physiological arousal they gain as a consequence of gambling. Mood or anxiety disorders, as well as substance abuse, may develop but the authors stress these are consequences of excessive gambling for this subgroup of problem gamblers, rather than a cause

The second pathway, emotionally vulnerable gamblers, present with premorbid anxiety/mood disorders, poor coping skills, and stressful histories and developmental factors.

These gamblers are also exposed to the same behavioural conditioning as the behaviourally conditioned subgroup, but primarily gamble to escape aversive mood or anxiety. Problem gambling by the emotionally vulnerable subgroup is the result of an interaction between both pathways – behavioural conditioning due to characteristics of the gambling activity as well as negative reinforcement through the avoidance of negative emotions or cognitions.

The third subgroup, antisocial impulsivist problem gamblers, is characterised by features of impulsivity, antisocial personality disorder, and attentional deficit disorders. This subgroup typically has the same emotional and biological vulnerabilities of the emotionally vulnerable subtype, with impulsive traits on top. These pathways are seen as additive – each subtype is exposed to the same classical and operant conditioning processes, emotionally vulnerable gamblers also have premorbid psychological difficulties, and the antisocial/impulsivist subgroup is exposed to all of the above in addition to pathological impulsivity, risk taking and antisocial behaviour (Blaszczynski & Nower, 2002). The authors don't state directly how structural characteristics of slot-machines may influence problem gambling, but it is somewhat implicit in their model. For slot machine gamblers in any subgroup, the structural characteristics of the machines influence the arousal/excitement/entertainment induced by gambling. For slot machine gamblers in the emotionally vulnerable and impusivist/antisocial subgroups, the structural characteristics of the machines also influence how useful playing the machines are as strategy to avoid mood or other psychological difficulties.

There are a number of other models or theories of problem gambling. In most models, including the ones described above, the structural characteristics of the gambling activity are assumed to influence gambling behaviour. The authors either directly state this themselves (e.g., Grounded Theory Model of Slot-machine Problem Gambling), or it is a logical progression from the authors' ideas (e.g., the Integrative Behavioural Model of Gambling; the Pathways Model of Problem and Pathological Gambling). While these theories implicate structural characteristics in the development and maintenance of problem gambling, they do not examine exactly which features influence gambling, or how. It is important to identify and investigate the effects of individual features. Some features may be more problematic than others (e.g., promote overly persistent gambling), and some problematic features may be discarded or adjusted without major impact to the enjoyment that non-problem gamblers experience. Experimental research has the ability to identify cause and effect relationships among the structural characteristics of slot machines and gambling behaviour, and a growing body of research has begun to demonstrate these relationships.

Slot-machine Structural Characteristics Research

Experimental research with slot-machine simulations has potential to shed some light on how the features of slot machines influence gambling, and also how they may influence problem gambling development. For instance, participants can be exposed to machines which are identical with the exception of one feature, and in this way the feature is isolated and its effect on behaviour can be determined. Investigating these features may indicate why people prefer certain slot machines, what draws risky gamblers to slot machines, or how slot machines facilitate problem gambling. Slot-machine simulation experiments are typically carried out on computers in a laboratory, with a computer program simulating real slot machines. In the past two decades, an increasing amount of this experimental research has focussed on the structural characteristics of slot machines (see Griffiths, 1993; Parke & Griffiths, 2006, for reviews) which Griffiths (1993) argues reinforce the gambling activity and may facilitate problem gambling. Much of this research investigates how different features of slot machines influence gambling behaviour.

One feature of slot machines that has been examined is the "near win", also called the "near miss". A near win is a loss that is visually similar to a win. For instance, if a simple slot machine requires five matching symbols in a row for a win, a near win might be four matching symbols in a row. These outcomes happen more often than would be expected by chance (Reid, 1986). Experimental slot-machine simulation research has demonstrated that near wins affect gambling behaviour. Near wins cause players to persist longer on slot machines that no longer produce wins (Cote, Caron, Aubert, Desrochers, & Ladouceur, 2003; Kassinove & Share, 2001; Maclin, Dixon, Daugherty, & Small, 2007). Various studies have also demonstrated that participants prefer to play a simulation that produces near wins rather than a simulation without near wins (Giroux & Ladouceur, 2006; Kormendi & Kurucz, 2010; Taylor, Macaskill, & Hunt, in prep.). When participants can choose between simulations that offer different rates of near wins, they generally have no preference (Taylor et al., in prep.; MacLin et al., 2007).

Griffiths (1993) highlighted the fact that payout interval, event frequency, and schedule of reinforcement are important structural characteristics influencing play. The payout interval refers to how quickly winnings are received after initiation of a gamble. On slot-machines, winnings are generally paid into the player's credit balance immediately after a spin is completed, and can be immediately gambled again. In an experiment with 10 problem gamblers, Choliz (2010) demonstrated that people persist longer on simulations when payout intervals are short (2s) compared to long (10s). Other gambling forms have much longer payout intervals. One example is a national lottery, where the outcome may be multiple days after a bet is placed. Other examples include sports or track betting. Blackjack and roulette have shorter payout intervals than the lottery/track/sports betting, but gamblers still have to wait for the cards to be dealt or the roulette wheel to spin. Slot machine payout intervals are extremely short compared to these other mainstream forms of gambling.

Event frequency refers to the number of opportunities the player has to gamble in a set period of time. As with payout interval, the opportunities to gamble on slot machines are only limited by the speed of the slot-machine mechanisms, resulting in a high event frequency and potential for rapid responding (Griffiths, 1993). Variable ratio (VR) schedules, which include RR schedules that slot machines employ, produce a rate of responding that can be described as both rapid and steady (Ferster & Skinner, 1957). These characteristics of slot machines have a profound influence on how players gamble. The RR schedule promotes a steady, rapid rate of play which is enabled by high event frequencies and immediate payouts into credit balances. This culminates in players averaging 400 spins in just 30 minutes (Dickerson & O'Connor, 2006).

The presence of jackpots on slot machines also influences gambling behaviour. The winning of small jackpots increases risky gamblers' desire to continue gambling on a slot-machine simulation (Young, Wohl, Matheson, Baumann, & Anisman, 2008), and leads to increased physiological arousal (Wilkes, Gonsalvez & Blaszczynski, 2010) which then influences players' bet sizes (decreasing bet sizes for players with many gambling problems, increasing bet sizes for players with few or no gambling problems; Rockloff, Signal, & Dyer, 2007). More recently, researchers have found the type of jackpot (deterministic/non-deterministic and progressive/non-progressive) influences bet sizes, with players placing larger bets on machines with deterministic and non-progressive jackpots (Li, Rockloff, Browne, & Donaldson, 2015). The size of wins smaller than jackpots also affects how long it takes gamblers to make their next spin on a slot machine simulation – gamblers tend to have longer post-reinforcement pauses after receiving a large win in comparison to losses or small wins (Delfabbro & Winefield, 1999; Dickerson, 1993).

In contrast to the single betting lines on older style slot machines, modern slot machines have a large number of betting lines (sometimes up to 50 – see Figure 2) which influence the outcomes gamblers receive (Dixon, Harrigan, Sandhu, Collins, & Fugelsang, 2010). For instance, gambling on multiple lines presents the opportunity to win an amount smaller than the amount bet. To illustrate, if a player bets 1c on 20 different betting lines on one spin – a total wager of 20c. The player may win on any of these lines. If they win on one of the betting lines, and the amount won is equal to the amount bet (1c) multiplied by 15 (the size of the win), the player "won" 15c in total. However, the player actually lost 5c on this wager. Slot machines typically present this outcome the same as other wins where the player has actually made a profit – sounds are activated, lights flash, and other features associated with winning outcomes occur (Dow Schull, 2012).

Figure 2. Example of multiple betting lines on a modern slot machine. Different betting lines are indicated by the coloured lines and numbers. Gamblers can bet on multiple lines, which means they are placing more than one bet on each spin. Image retrieved from https://www.quora.com/Do-people-reall-win-on-slots on 25

This phenomenon on multi-line machines was first described by Dixon et al. (2010), and coined losses disguised as wins, or LDWs. LDWs have been demonstrated to increase physiological arousal in the same manner/magnitude as other wins (Dixon et al., 2010). In addition to the emergence of LDWs, playing on multiple lines increases the chance of winning on each spin, essentially increasing the rate of reinforcement overall (Templeton, Dixon, Harrigan, & Fugelsang, 2014). Gamblers prefer playing on multiple lines (Dixon, Miller, Whiting, Wilson, & Hensel, 2012; Templeton et al., 2014), and these LDWs cause them to overestimate their actual win frequency after a session (Templeton et al., 2014).

Slot-machine sound effects also increase players' arousal levels (Dixon et al., 2014), and interact with LDWs to influence gamblers' win-rate estimations. Dixon, Collins, Harrigan, Graydon, and Fugelsang (2015) demonstrated that when LDWs were paired with negative (losing) sounds on a simulation, participants had relatively accurate estimations of the number of spins where they won more than the amount bet. However, when LDWs were paired with celebratory sounds (the status quo), or no sounds, participants overestimated the number of times they won. Generally, people also prefer to play slot machines with sound effects over machines without sound (Dixon et al., 2014).

The above descriptions of research, mostly experimental, demonstrate causal relationships between slot-machine features and gambling behaviour. Near wins and jackpots cause players to persist longer than they would otherwise when gambling on slot-machine simulations. Variable-ratio (VR) schedules of reinforcement promote a fast and steady rate of responding, which interacts with other structural characteristics (high event frequencies, immediate payouts into credit balances) to cause players to gamble quickly. LDWs interact with sound effects to cause players to over-estimate the number of wins they receive, and various features influence players' arousal and slot-machine preferences.

Despite the abundance of research on these structural characteristics, cumulatively it is a good example of how slot-machine research has struggled to keep up with the modernisation of slot machines. Generally, research has been conducted on older style slot-machine simulations which lack the complexity and features of more modern machines. This has begun changing somewhat in the past decade, with the above described research on jackpots and LDWs investigating features that are currently relevant with regard to modern machines. However, one feature of modern slot machines has been entirely neglected by experimental gambling research: The slot-machine bonus feature.

Bonus Features and Free Spins

Part of the developing complexity of slot machines over the past two decades has been the introduction of bonus features. Bonus features are activated when a winning combination of special symbols appear following a spin. There are different types of bonus features. Free spins are one of the more common forms, where the player gets a number of spins for "free". This "freeness" is more of an illusion than reality – no money is subtracted from the player balance for the free spins, but the overall frequency/magnitude of wins at other times is decreased to account for this. Bonus features are often designed around the theme of the machine, and advertising on the machine alerts the player that they might win a bonus feature. During bonus features, monetary payouts are often multiplied or the probability of winning itself is enhanced (e.g. Walker, 2004; Harrigan, Dixon, & Brown, 2015). In some cases, major jackpots can only be won during bonus features. This shift away from wins dependent on reel order towards wins dependent on bonus features was first noted by Parke and Griffiths (2006). In an analysis of two real slot machines in their laboratory, Harrigan and Dixon (2009) found that wins during bonus features accounted for 21.63% and 24.39% of the overall return to player (RTP; amount won divided by amount bet – a measure of how much of the gambled money the machines pay back) of the machines. This return is higher than during spins outside of bonus features, and seems particularly high when contrasted with the percentage of time that players can expect to spend in bonus modes. Harrigan et al. (2015) simulated a commercially available slot machine for millions of spins, and found that when the maximum number of lines was wagered, a common "strategy" of experienced gamblers, players spent approximately 11% of their gambling time in the free-spins bonus mode. Activating bonus features is therefore a relatively common occurrence, and they account for a significant proportion of the money returned to the player. Of course, the multiplication or enhanced frequency of wins during bonus features is accommodated by a lower payback rate during standard play.

Self-report evidence suggests that bonus features are one of the biggest influences on players' decisions about which slot-machine to play. Millhouse and Delfabbro (2008) asked problem and non-problem gamblers to rank various slot machines with differing features in terms of which machines they would prefer to play. Rankings revealed that the gamblers rated bonus features as the second most important feature influencing preference, behind only machine denomination (the price of play; lower denomination machines being more preferred). Other questionnaire data and interview-based studies have produced similar results (Blaszczynski, Walker, & Sharpe, 2001; Landon et al., 2016; Livingstone, Woolley, Zazryn, Bakacs, and Shami, 2008; Templeton et al. 2014). Livingstone et al. (2008), for example, noted that when researchers discussed slot-machine features with gamblers, almost every participant referred to and stressed the importance of free spins, while describing other features as relatively unimportant. Blaszczynski et al. (2001) also noted that problem gamblers made a number of spontaneous statements referring to how attractive free-spins features are in their interview study with a focus group of problem gamblers. These problem gamblers even rated free-spins features as *the most addictive* element of modern slot machines (Blaszczynski et al., 2001). As a result of focus groups with problem gamblers, a report for the New Zealand Ministry of Health (Palmer du Preez et al., 2014) stated that "Free spins were discussed as the most attractive and important feature of EGM gambling, and were clearly associated with increased gambling". In addition to this self-report research, data supplied by a Norwegian state-owned gambling company further suggest bonus features influence gambling decisions. Leino et al. (2015) analysed records of video-lottery-terminal play from January 2010 in Norway. Of the eight available games, the three most played games (most unique players, most bets made, highest expenditure) included bonus features. Four of the remaining five games did not have bonus features (Leino et al., 2015).

At this stage, the above studies provide some converging, although no experimental, evidence that gamblers prefer machines with bonus features, and there are several potential explanations for this. Bonus features may facilitate gamblers "tuning in" to the slot machines (described by Thomas et al., 2009), or entering "the zone" (described by Oakes, 2014). The descriptions of "tuning in" to the slot machines or entering "the zone" are both similar to Csikszentmihalyi's (2002) concept of being in a state of "flow", which can be briefly described as complete absorption in a process or activity (Csikszentmihalyi, 2014). According to Csikszentmihalyi, one of the prerequisites for entering a state of flow is that the person is working towards achieving a goal. One way that bonus features may facilitate "tuning in" to the machines, or entering a state of flow or "the zone" is by providing a goal. Focus group interviews with both problem and non-problem gamblers have revealed that "winning" free-spins features is something that gamblers focus on when gambling on slot machines (Landon et al., 2016; Livingstone et al., 2008), thus providing a goal that meets one of Csikszentmihalyi's goals for attaining a state of flow.

In addition to the need for a goal, the other preconditions for flow as described by Csikszentmihalyi are that: there need to be clear rules for how to achieve the goal, the activity must give immediate feedback so that the person can evaluate their performance, and the task must be appropriately matched with the person's skill (Csikszentmihalyi, 2002). Slot machine gambling meets these criteria. The rules for activating bonus features are clearly advertised on the machines (e.g., "match these three symbols to activate free spins!"). As described above, slot machines also provide near immediate feedback on the outcome of a spin. Gambling on slot machines requires little skill – all is needed is a deposit and then the motor capabilities to select buttons. However, gamblers often mistakenly believe there is skill involved, and slot-machine manufacturers intentionally design some aspects of machines to make it appear gamblers have some control over the outcome, when in reality, they do not (Dow Schull, 2012). One of the aspects described by Dow Schull in this regard was the design of bonus features – on some machines, bonus features seem to require an element of skill. One example was a bonus feature where, once it had been activated, players had to aim a ten-pin bowling ball on the screen towards some pins – with the number of pins being knocked down relating to an amount of money won during the bonus feature. While gamblers could "aim" the ball, the result was already predetermined and not affected by their "aim" (Dow Schull, 2012). Interactive bonus features such as the one described may facilitate the illusion that slot-machine gambling requires skill, and therefore Csikszentmihalyi's last criteria for flow is met – the skill required for the task is appropriately matched with the person's skill.

Gamblers may also prefer machines with bonus features as they provide signalled periods of increased reinforcement, and activating a bonus feature may become a conditioned reinforcer through this association. As discussed earlier, advertising on the slot machines alerts gamblers to both the presence of a bonus feature, as well as the increased RTP during the bonus feature (e.g., higher magnitude wins, higher frequency wins). Research with both animals (e.g., Wyckoff, 1952) and humans (e.g., Case & Fantino, 1989) has demonstrated that organisms prefer stimuli correlated with more reinforcement over stimuli correlated with less reinforcement, or extinction, and will actively make observing responses to produce those stimuli. Due to the increased payout during bonus spins in comparison to spins outside the bonus feature, the bonus feature is correlated with increased reinforcement, and the start of the feature (i.e., receiving a bonus or free-spins feature), and the music and animations that occur, may become conditioned reinforcers associated with the increased rate or magnitude of wins. If these elements become conditioned reinforcers, then a person may prefer bonus feature machines over machines without bonus features as the bonus machine has a higher "average" reinforcement due to the addition of the conditioned reinforcers.

Preference for machines with bonus or free-spins features may also be a result of generalisation from other situations where "bonus" or "free" have positive meanings. Most people have a learning history where "free" and "bonus" are associated with something desirable – gaining something for nothing. This relationship may then generalise to slot machines with "free" or "bonus" spins, such that the slot machines are seen as more desirable than machines without those words or features.

One way this generalisation may occur is a transfer of the stimulus functions of the words "free" or "bonus" to slot machines with advertising bearing those words. As suggested above, most people have a long learning history of what “free” or “bonus” mean, and these words are likely in a relational frame (Hayes, Barnes-Holmes, & Roche, 2001) with positive concepts. Gamblers may derive associations between slot machines with bonus features and properties that the words “free” or “bonus” hold for them in other contexts, thereby developing a preference for these machines over machines without bonus features. For example, “free” may be related to “good” for a person, due to their history with the word “free” – gaining something for nothing. “Free” is related to “good”, and “free spins” are related to “free”. As a result, “free spins” and “good” are now mutually entailed. Emergent relations such as these do not always accurately describe reality. For example, as described above, free-spins features provide the illusion of the spins being free, with RTP being decreased outside of the free spins. In any case, this process may be one contributing mechanism through which bonus features may be preferred. Whether this hypothetical relation has any control over gambling has not yet been explored, but there is some evidence that other derived relations are relevant to gambling.

In one such study, Zlomke and Dixon (2006) conducted an experiment where participants gambled on concurrently available slot machine simulations that differed only in their colour (yellow, blue). In an initial exposure period, participants were presented with both machines on screen, and had to select one to play. After each spin, participants were again presented with both machines and required to choose again. Pretest continued for 50 trials in this manner, and participants had generally allocated an equal number of spins to each machine. Following pretest, conditional discrimination training began where participants were trained to associate the colours yellow and blue with the concepts “greater than” or “less than”. To achieve this, participants were required to match a visual sample stimulus (e.g., a picture of a $5 note) to one of three comparison stimuli (e.g., $1, $10, $20 notes) presented on the screen. There were three sets of sample/comparison stimuli (notes, coins, letter grades, all of which had a clear hierarchy). Surrounding the comparison stimuli was either the colour blue or yellow. Participants received points and celebratory feedback for clicking the correct comparison stimuli, and negative feedback for incorrect responses. For instance, if a yellow rectangle engulfed the comparison stimuli, then when presented with the $5 sample, a correct response would be to select either the $10 or $20 since 10 and 20 are greater than 5. If a blue rectangle engulfed the comparison stimuli, then a correct response would be to select the $1 since 1 is less than 5. First, blue was paired in this way with the concept “less than” for 18 trials, and then yellow was paired with “greater than” for 18 trials, followed by 18 trials where "greater than" and "less than" training trials were randomly ordered. Following this conditional discrimination training was a test period comprised of 30 trials with the trained stimuli in the manner above, as well as 24 trials with novel stimuli (playing cards, words, numbers – all with a clear hierarchy). The coloured rectangles again surrounded the comparison stimuli, but in this phase no feedback was provided for correct or incorrect responses. This relational test period was designed to assess whether there was a transfer of function from the "greater than" or "less than" coloured cues to novel stimuli. Finally, participants were again exposed to the exact same slot machines as at the beginning of the experiment.

Eight of the nine participants had clearly transferred the function from the coloured cues to the novel stimuli, indicated by above 89% accuracy in the 54 trial test period described above (Zlomke & Dixon, 2006). In addition, the same eight participants clearly increased the number of spins made on the yellow machine compared to the initial baseline test. Participants allocated on average 81% of their 50 spins to the yellow machine, and 19% to the blue machine. As alluded to above, the only participant who failed to allocate more spins to the yellow machine was the same participant who failed the relational responding test. This finding indicates a transference of the learned properties associated with the colours, to the slot-machine simulations with the same colours. As described above, it is possible that gamblers may transfer properties associated with "free" or "bonus" from their long learning histories with those words, to slot machines with advertising bearing those same words, in a similar manner to participants in the Zlomke and Dixon (2006) study.

Tan, Macaskill, Harper, and Hunt (2015) also demonstrated derived verbal relational influences on slot-machine preference. In another matching to sample task, 18 participants were trained to associate arbitrary visual stimuli with the word "almost", another 18 participants were trained to associate arbitrary visual stimuli with "loss". Participants were also trained to either associate images representing near wins with either the stimuli that had been associated with "almost" or "loss". There was no direct training of near win images to either "almost" or "loss". Participants who were trained to associate visual stimuli with near wins in the "almost" condition subsequently preferred to gamble on a simulation that had 30% near win outcomes in comparison to a machine with no near wins. Participants who were trained to associate visual stimuli with near wins in the "loss" condition displayed idiosyncratic preference, most often for the machine without near wins. This provides more evidence that derived verbal relations involving a structural characteristic of slot machines influence preference, as well as suggesting that verbal relations are a mechanism through which gamblers may come to prefer slot machines with near wins. Other studies have also demonstrated that derived verbal relations influence slot machine preference (e.g., Dymond, McCann, Griffiths, Cox, & Crocker, 2012; Hoon, Dymond, Jackson, & Dixon, 2008).

Examining the mechanisms through which gamblers may come to prefer slot machines with free-spins features is an interesting research avenue, and this could be a step towards developing interventions for problem gambling. However, first it is important to determine whether people actually prefer to gamble on machines with free spins or bonus features, and under what conditions they are preferred. Despite bonus features being prominent in slot machine designs and being recognised as important features nearly a decade ago, the research on free-spins features described above appears to be the combined sum of research on bonus features. Laboratory simulations of slot-machine gambling provide the opportunity to experimentally manipulate selected machine structural characteristics, isolating the effect of one specific feature – here free spins – while holding all other aspects of the machine constant. This allows researchers to determine how slot-machine features directly affect gambling. For example, Li et al. (2015) used slot machine simulations to (among other things) demonstrate that the presence of a large jackpot ($25000) *caused* participants to place larger bets than a smaller jackpot ($500). By holding other features of the simulations constant (i.e., win frequency, magnitude of wins, presence of bonus feature), it was possible to attribute differences in participants' responding on the two machines to the effect of jackpot magnitude. In addition to isolating variables of interest, laboratory simulations also allow direct observation of participants' actions and choices while gambling, rather than (or complementary with) self-report of gambling motivations.

This thesis reports an experimental investigation of the effect of free-spins features on gambling behaviour using slot-machine simulations in the laboratory, generally with hypothetical money as the reinforcer and student samples as participants. The general research question proposed was: "What is the influence of free-spins features on slot-machine gambling behaviour?" The first major aspect of this investigation focussed on whether participants prefer to play a slot-machine simulation with free spins, over a simulation without free spins (Preference Study 1). Subsequent experiments investigated which elements of a free-spins feature made participants prefer it (Preference Study 2), and whether participants playing with real money also preferred free-spins simulations (Preference Study 3). This research on preference would clarify whether free spins are likely to be a useful target for reducing problem gambling in future. The second major focus of this investigation was whether free-spins features influence gambling persistence. I first developed a persistence-measuring task (Task Development Studies 1 & 2). This task was then used to assess whether free-spins features cause increased gambling persistence (Persistence Study 1), and whether varying win frequencies influence gambling persistence (Persistence Study 2). In addition to investigating the effect of free-spins features on preference and persistence, a number of other gambling behaviours were investigated. The effect of free spins on bet amounts, response rates, and number of spins completed were also analysed.

Preference Study 1

Preference Study 1 investigated whether participants preferred slot-machine simulations that had free-spins bonus features over simulations that did not, but which were otherwise close to identical in terms of their outcomes (e.g., programmed RTP percentages, win frequency, magnitude of wins available). Preference was measured by recording how many spins participants allocated to the free-spins simulation and the control simulation following an exposure phase. This provided a graded measure of preference that offered evidence of not only whether participants prefer the free-spins machine, but by how much they prefer it. For instance, a participant who allocates 100% of their spins to the free-spins machine (after being exposed to both machines), demonstrates more preference for this machine than a participant who allocates 60% of their spins to the same machine. This graded measure of preference is an improvement over simply asking participants which machine they prefer, which results in a categorical response without data pertaining to the extent of their preference.

Preference for two different types of free-spins features were investigated. In the Without-features Condition, participants gambled on a simulation with a simple free-spins feature, in addition to a similar simulation without free spins. The free-spins feature was activated by getting three “free-spins symbols” in a row. Following this, a congratulatory JPEG image was displayed, and participants received five spins without money being subtracted from their balance, and without having to initiate the spins. In the Added-features Condition, the free-spins feature was more complex. Congratulatory GIF images replaced the JPEG images, music played, and win frequency was increased during free spins (while being decreased outside free spins). These conditions were selected because unpublished work from our laboratory previously indicated participants did not prefer a simple free-spins feature. However, as outlined earlier, gamblers consistently highlight the importance of free spins as an attractive feature of slot machines. This discrepancy suggests there were important drivers of preference missing from the simple free-spins feature previously used in our laboratory. Exploratory visits to gambling establishments indicated the additional elements listed above for the Added-features Condition, or similar ones, are usually incorporated into free-spins features on real-world slot machines. Including a simple and a more complex free-spins feature also facilitated some investigation into what may cause participants to prefer a machine with free spins.

Based on gamblers reporting they prefer machines with free spins in the self-report data described earlier, it was expected that participants would display a consistent preference for the free-spins machine in the Added-features Condition. Based on unpublished work from our laboratory, it was expected participants in the Without-features condition would not prefer the simple free-spins machine. If these hypotheses are supported by the data, this would suggest that the additional features in the Added-features Condition, or some combination of them, are important drivers of preference for free-spins features. This would be an interesting contradiction with gamblers' reports, which suggest the "freeness" of free-spins features and "extra time on the machine for the same price" are the most important factors (Livingstone et al., 2008). The free-spins in the Without-features Condition and the Added-features Condition were both equally "free", and, assuming consistent bet-amount selections, provide the same number of spins for the same price (i.e., provided equal time on device). On the other hand, if participants in both conditions prefer the free-spins machine, this would provide additional evidence that the gamblers' accounts accurately describe the important drivers of preference for free-spins features. If participants in neither condition prefer the free-spins machine, this would indicate that "freeness", "time on device", and the additional features are not important drivers of preference.

The effect of RTP on preference was also investigated. Programmed RTP was equal across machines, however, allowing participants to select different bet amounts resulted in the RTP experienced on each machine fluctuating from that programmed. For instance, if a participant happened to bet large amounts before big wins, yet bet low amounts before other outcomes, their RTP on that machine would be increased over the programmed value. Most research investigating whether different RTP percentages affect gambling has failed to find an effect. Weatherly and Brandt (2004) found no effect of RTP on bet amounts or number of bets made. Brandt and Pietras (2008) found no effect of RTP on number of bets made, and Schreiber and Dixon (2001) found no effect of RTP on either response latencies or number of bets made. Research specifically looking at whether RTP affects preference has produced mixed findings. Weatherly, Thompson, Hodny, and Meier (2009) found that participants were generally insensitive to differences in RTP. Haw (2008) found that RTP did not affect preference in a similar design as the current study with two forced exposures and then a preference phase. However, when separately analysing participants who switched machines at least once in the preference phase, Haw found that 80% of them preferred the machine that had a higher RTP in the exposure phases. Other research has found that participants played more on the machine with higher RTP (Coates & Blaszczynski 2013), while the same researchers also found that participants played more on a machine with lower RTP (Coates & Blaszczynksi, 2014). On the weight of evidence above, it was expected that RTP would not affect participants' preference in the current study.

Variables other than preference were also investigated. We investigated whether free-spins features increased the amount participants wagered. Participants may wager more on machines with free spins because wagering more on the spin that triggers a free spin typically increases the amount that can be won during free spins. To capture this element of free-spins features in the current study, the bet amount made on the spin that activated the free-spins feature was used as the bet amount for all of the free spins. It was expected that participants would bet more on the free-spins machine in both conditions.

We also investigated whether different outcomes (i.e., losses, LDWs, different sized wins, free spins, different lengths of strings of losses) affect subsequent bet amounts. People generally incorrectly view chance as self-correcting, such that deviations from underlying probability in one direction will be cause deviations in the other direction, so that the underlying probability is expressed (Tversky & Kahneman, 1971). This phenomenon is called the "gambler's fallacy", the "Monte Carlo fallacy" and the "fallacy of the maturity of chances". Here it will be referred to as the "gambler's fallacy". In slot-machine gambling, this may be reflected by gamblers expecting a win is "due" if they have had several losses in a row. Due to the likelihood the "gambler's fallacy" would bias participants responding, it was expected that participants would bet more following larger strings of losses, in anticipation of upcoming wins.

Lastly, whether participants were more likely to switch machines following different outcomes was also investigated, an analysis which is infrequently used in gambling studies. This analysis was exploratory, and so no hypothesis was developed.

Method

Participants. Thirty-two psychology students enrolled in a first year psychology course at Victoria University of Wellington participated in partial fulfilment of a course requirement. Sixteen participants participated in the Added-features Condition, and the others participated in the Without-features Condition. All participants completed an informed consent form before participating and were debriefed following participation. All aspects of this study were reviewed and approved by the university's ethics committee. Each participant completed the South Oaks Gambling Screen (SOGS; Lesieur & Blume, 1987) after completing the experimental tasks described below. The SOGS is a standardized measure of problem gambling and problem gambling risk; no participant scored in a problematic range on the SOGS. The above consent process, debriefing, ethical approval information, and SOGS use were the same for all studies in this thesis.

Materials and Stimuli. Slot-machine simulations were created in Microsoft Visual Studio Express. Two different slot-machine themes (*Blackbeard's Revenge*, and *Thor's Hammer*) were created with different backgrounds and symbols. In front of each background there were three slot-machine betting lines, with five symbols per line, bet amount options (1c, 5c, 10c, 20c, 50c, and $1), a balance display and free-spins counter, and a button labelled "MAX LINES." See Appendix A for arrangement of machine elements on the screen.

To initiate a spin, participants first selected a bet amount which revealed the "MAX LINES" button. When participants clicked this button, it was removed from the screen, the selected bet amount multiplied by three (the number of lines bet) was deducted from the balance, and a spinning animation began accompanied by relevant sound effects. Specifically, the slot-machine reels stopped spinning in sequential order, from left to right every 300ms (1500ms of spinning reels in total). After each spin, one of three outcome types occurred. Each outcome was accompanied by on-screen messages presented for one second after which time the bet amount buttons were re-presented: A "win" consisted of three, four or five consecutive identical symbols beginning on the first reel. There were eight different winning symbols, and the participant won between two and 30 times the amount bet depending on the symbol; the win amount was multiplied by the bet amount so programmed payback rate was constant across bet amounts. The statement "you have won $[win size] was presented for one second during which time the winning symbols were brightened and all non-winning symbols darkened. Large wins were accompanied by one sound and small wins by another. A "free spins" event occurred when the first three symbols on any line were "free spins" symbols. All other outcomes were losses and accompanied by the statement "you have won $0".

Experimental Conditions. Participants in each condition played on two simulated slot machines: a free-spins machine and a control machine. On the control machine, no free spins occurred, and there were no free-spins symbols displayed on the reels. On the free-spins machine, free spins occurred on 2.5% of spins. The machine then automatically displayed five free spins without the participant pressing any button and with no deduction made from their balance. To determine win size (bet amount multiplied by the outcome multiplier) the program treated all free spins as having the same bet amount as was selected on the spin that triggered the free-spins sequence.

When free spins were won in the Without-features Condition, the machine displayed an image that related to the slot-machine theme for 3.5 seconds. On this image was text that read “Congratulations, you have won 5 free spins!” The free spins began when the image disappeared. A screenshot of the JPEG images from both machines is displayed in Appendix B. When free spins were won in the Added-features Condition, the machine displayed animated GIF images instead of the JPEG images. The Blackbeard’s Revenge themed GIF was a cartoon pirate ship flying through the sky. The Thor’s Hammer themed GIF was a lightning storm above a far-away city. A screenshot of the GIFs from both themes are displayed in Appendix C.

In addition to the differences between the free-spins and control machines mentioned above, in the Added-features Condition an additional label was located directly underneath the reels on the free-spins machine. The text of this label read: “Match 3 of these to gain 5 free spins”. Directly to the right of this label was a picture of a free-spins symbol. During a free-spins sequence, the text of this label changed to “Win chance multiplied!”, and changed back again at the end of the sequence. Furthermore, in addition to the new sound that played when a free-spins symbol hit, music now played during the free-spins sequence. As soon as the GIF image was displayed at the start of the free-spins sequence, the Windows sound “Flourish” played, which continued until the final spin of the sequence ended.

Win frequency during the free-spins sequence was increased, relative to non-free spins, on the free-spins machine in the Added-features Condition. Both machines in both conditions had equivalent programmed RTP. Programmed outcome frequencies for both machines are displayed in Table 1 for the Without-features Condition. Programmed outcome frequencies for both machines are displayed in Table 2 for the Added-features Condition. Note that the top part of the tables display probabilities for a given outcome occurring on any one of the three lines. The final three rows display overall win frequencies (of any magnitude) per three-line spin. A summary of the extra features unique to the Added-features Condition is displayed in Table 3.

Table 1.

Programmed Outcome Probabilities on each Slot Machine in the Without-features Condition

Outcome	Free-spins machine	Control machine
Per individual line		
loss	.89	.86
2*	.04	.05
5*	.03	.05
8*	.02	.03
10*	.01	.02
30*	.01	.01
5 free spins	.01	0
Resultant outcome frequencies per spin (three lines per spin)		
Programmed RTP Percentage	87%	87%
Programmed/experienced probability of win	.30	.38
Programmed/experienced probability of win during free-spins feature	.20	n/a
Programmed/experienced probability of win outside free-spins feature	.32	.38

Note. *Programmed outcome is multiplied by the bet-amount selected

Table 2.

Programmed Outcome Probabilities on each Slot Machine in the Added-features Condition

Outcome	Free-spins machine	Control machine
Per individual line		
loss	.86	.83
2*	.06	.08
5*	.03	.06
8*	.02	.01
10*	.01	.01
30*	.01	.01
5 free spins	.01	0
Resultant outcome frequencies per spin (three lines per spin)		
Programmed RTP Percentage	89%	89%
Programmed/experienced probability of win	.35	.44
Programmed/experienced probability of win during free-spins feature	0.60	n/a
Programmed/experienced probability of win outside free-spins feature	.22	.44

Note. *Programmed outcome is multiplied by the bet-amount selected

Table 3.

Summary of Extra Features on the Free-spins Machine in the Added-features Condition

Feature
Unique sound for individual free spins symbol
Animated GIF replaced still JPEG to signal start of free-spins sequence
Additional labels signalling presence of free-spins/increased win frequency during free spins
Music plays during the free-spins sequence
Higher frequency of wins during free-spins sequence, lower frequency during normal spins

Incorporating many changes to the free-spins feature across conditions was done to achieve an effect at the cost of being able to tell exactly what change drove any potential differences in preference across conditions. This decision was informed by the above-mentioned unpublished finding of a lack of preference for a simple free-spins feature.

Procedure. Data from the Without-features Condition were collected entirely before data were collected for the Added-features Condition. The procedure was the same for both conditions. The study was conducted in a room approximately 5m x 5m, on PCs equipped with 19 inch monitors, mouses, and headphones. Up to four participants took part in any given session on separate computers. No real money was won, lost, or wagered during the experiment. Upon entering the room, participants sat at a table positioned in the middle of the room where they were reminded that the study was expected to take one hour, how their participation helped to fulfil a course requirement for them, and were then asked to turn their cell phones off. They were then given two identical consent forms to read and sign. These consent forms outlined the general tasks involved, explained that participants were free to withdraw at any time, explained what their data would be used for, and stated that the study was approved by the university’s ethics committee. The participants were required to name, sign, and date their consent forms to take part in the study. After signing consent forms, participants were asked whether they had any questions. Participants then selected a computer and were instructed to wear the provided headphones. When all participants were seated with headphones on they were instructed to begin. All further instructions were presented on the computer screens, which read as follows:

> You are about to play a slot machine task. You should play the slot machines as if you were playing a real slot machine for real money. To place a bet, click the button indicating how much you want to bet on each line, then click the MAX LINES button. To change to the other machine, click SWITCH.

At the bottom of these instructions was a “start task” button, which began the experiment. The experiment consisted of two phases: first an exposure phase ensured that participants were familiar with the free-spins and control machines and the outcomes and stimuli presented. Then a preference phase assessed preference for the two machines. During the exposure phase, participants played for 200 spins on each machine with order and slot-machine theme counterbalanced across participants. After participants had completed 200 spins on the first machine, they read a message stating:

> You will now be gambling on a different slot machine. Please keep responding as you would if you were gambling on a real slot machine.

These 200 spin forced-exposure sequences had predetermined outcomes which were identical across participants in each condition, with the programmed outcome percentages shown in Tables 1 and 2. This means that, within each condition, each participant had exactly the same outcomes in the same order during the exposure phase and the same programmed RTP on each machine in both phases. Only win size varied because this was partially determined by participants' bet amounts.

Real-world slot machines generate an outcome at random each time the player makes a spin, as a result RTP percentages approximate the programmed mean over large numbers of spins, but may vary widely over smaller numbers of spins. Given the number of spins participants made in this experiment, generating outcomes at random following each spin would likely have produced RTP percentages that differed markedly from the programmed value and from one machine to the other. For this reason, before data collection began, we generated multiple sequences of outcomes in the same random manner that a real-world machine would. We then calculated the likely RTP percentage each would produce and selected a sequence for each machine where this value approximated a realistic value that was equivalent across both machines, given the same bet amount was selected on each spin. This held RTP constant to the extent possible given that participants were able to select their own bet amounts. A different outcome sequence was generated for both machines in each condition. Every participant experienced the same outcome sequences as the other participants in their condition.

Following the second forced exposure, participants were presented with a message which read:

> You can now choose between the two machines you have played on so far. Click on the red button labelled SWITCH to change between them. You can do this whenever you like.

In this preference phase, participants were then presented with the slot-machine they last played with the addition of a red "SWITCH" button located above the bet-amount buttons.

Participants were prompted to make two switches using this button to ensure they were familiar with its functionality. They could not continue with the task until they had done so. Participants then played for 200 spins or a total session length of 45 minutes, whichever came first. The outcomes of these spins were drawn from the same predetermined sequence used in the exposure phase. In the Without-features Condition, six participants did not complete 200 spins within the time limit. Participant numbers 4, 5, 13, 14, 15, and 16 completed 104, 176, 186, 199, 187, and 153 spins in the preference phase respectively. In the Added-features Condition, five participants did not complete 200 spins within the time limit. Participants 18, 19, 29, 30, and 32 completed 85, 146, 177, 183, and 138 spins in the preference phase.

Data Analysis. For planned comparisons data for individuals are presented individually in figures and inferential statistics with Bonferroni corrections were used. For more exploratory analyses where random assignment to pre-planned groups was not carried out (such as analyses with RTP) visual analyses were used as type 1 error rates are not controlled. An α value of .05 was used for all statistical tests.

Preference was measured by comparing the number of spins made on each machine in the preference phase. Free spins were excluded from this analysis, so each spin that counted towards the preference measure was initiated by participants. Early analysis revealed a strong effect of order of exposure on preference, so preference data were analysed using mixed-design analyses of variance (ANOVAs) with a within-subject factors of machine (free-spins, control) and a between subjects factor of exposure order (first exposed to free-spins machine, first exposed to control machine). Depending on whether participants completed all spins in the experiment, the number of spins made on one machine sometimes predicted the number of spins made on the other. Due to this feature of the experiment, it could be argued that comparing the proportion of total responses made on one machine to a test statistic of .5 would be more appropriate than inferential statistics with the count data. In response to this concern, the count data were also converted to proportions and analysed using one-sample Wilcoxon signed rank tests. These results were reported in Appendix D.

To investigate whether experienced RTP affected preference, we calculated each participant's experienced RTP during the exposure phase on each machine separately, separated participants according to whether the free-spins machine or the control machine had the higher RTP, and displayed associated preference data in a figure.

The global effect of the free-spins feature on bet amounts was investigated by comparing the mean amount wagered on each machine in the exposure phase. The preference phase was not considered in this analysis as participants may bet differently following experience on each machine, and because they may not allocate enough spins to one machine in the preference phase to facilitate a fair comparison. Local effects of different outcomes (including free spins) on bet amounts were analysed by comparing the mean bet amount following those outcomes for each participant across both exposure and preference phases.

Participants' switching patterns were investigated by analysing how often each participant switched to the alternate machine following different outcomes in the preference phase, compared to how often those outcomes occurred. For example, if a participant received 20 big wins in the preference phase, and switched to the alternate machine following a big win two times, their probability of switching following a big win was .1.

Results

To investigate whether participants preferred the free-spins machine, the proportion of preference-phase responses they allocated to the free-spins machine were analysed and displayed in Figure 3. In the Without-features Condition, the majority of participants made a greater number of spins on the control machine, compared to the free-spins machine. The ANOVA revealed this difference trended towards statistical significance, $F(1,14) = 4.175$, $p = .06$, $\eta_p^2 = .230$, such that participants allocated more spins to the control machine (M = 117.750, SD = 64.418) than the free-spins machine (M = 62.563, SD = 51.624). This effect size is considered large. In the Added-features Condition, the majority of participants made a greater number of spins on the free-spins machine (M = 98.438, SD = 52.992) than the control machine (M = 71.188, SD = 56.691). However, the ANOVA for the Added-features Condition revealed no significant main effect of machine, $F(1,14) = 1.806$, p =ns.

In both conditions, the order of exposure to the simulations influenced participants' preference, such that participants were more likely to prefer the machine they were exposed to first. This effect is displayed in Figure 3, and is present in both conditions. Participants on the left side of the reference line were first exposed to the control machine, and were more likely to prefer this machine. Participants on the right side of the reference line were first exposed to the free-spins machine, and were more likely to prefer this machine. The ANOVAs provided partial support for this interpretation. In the Without-features Condition, the ANOVA revealed no significant interaction between order and machine preference, *F*(1,14) = 2.542, *p* = ns, indicating participants did not allocate a significantly greater number of spins to the free-spins machine when it was the first machine exposed to (*M* = 80.250, *SD* = 46.466) than when it was the second machine (*M* = 44.875, *SD* = 53.261). In the Added-features Condition, the ANOVA revealed a statistically significant interaction between order and preference, *F*(1,14) = 11.163, *p* = .005, η_p^2 = .444, such that participants allocated a greater number of spins to the free-spins machine when it was the first machine exposed to (*M* = 126.625, *SD* = 47.946) than when it was the second machine (*M* = 70.250, *SD* = 43.618). This effect is considered large.

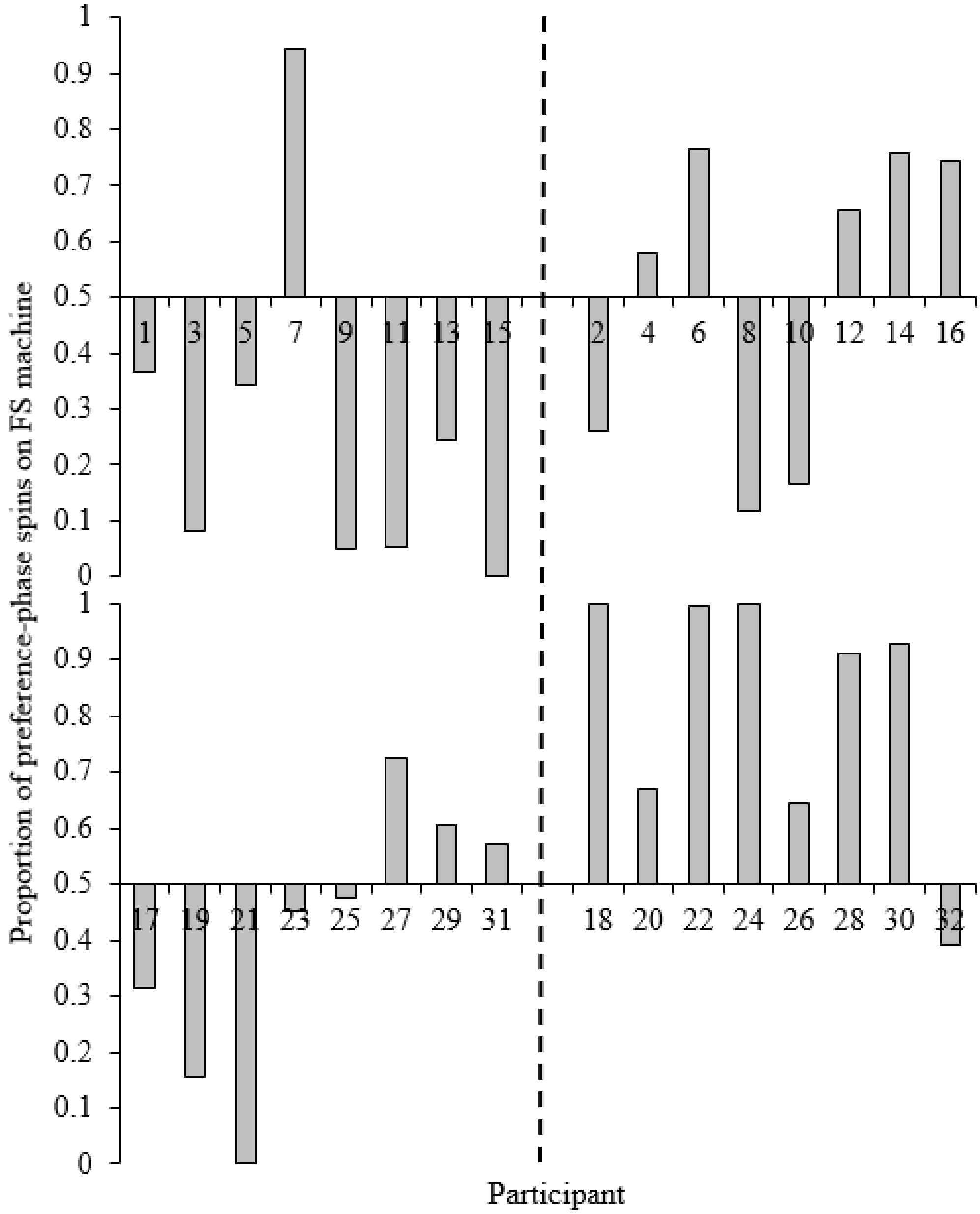

Figure 3. The proportion of preference-phase spins participants made on the machine with free spins. The top half of the figure displays data from the Without-features Condition, the bottom half displays data from the Added-features Condition. Bars above .5 indicate a

preference for the machine with free spins. Bars below .5 indicate a preference for the machine without free spins. The length of the bars indicate the extent of participants' preference. Participants on the left of the reference line were exposed to the control machine first, participants on the right were exposed to the free-spins machine first.

In the Without-features Condition, whether the free-spins machine had a higher RTP in the exposure phase had no discernible effect on preference. In the Added-features Condition, participants were more likely to prefer the free-spins machine if it had a higher RTP in the exposure phase. These data are displayed in Figure 4 (note that Figure 4 presents the same data presented in Figure 3 but re-plotted based on exposure order). Participants being more likely to prefer the free-spins machine when it had a higher RTP in the exposure phase is evidenced by a greater proportion of participants preferring the free-spins machine when it was also the machine with the higher RTP (Figure 4, left side of reference line).

To determine whether participants bet more on either machine, participants' mean bet-amount selections in the exposure phase were displayed in Figure 5. In both conditions, there was variability in the mean bet amounts across participants. However, there was no clear pattern of participants betting more on either machine. For the Without-features Condition, a mixed ANOVA with a within-subjects factor of machine (free-spins, control) and between-subjects factor of exposure order revealed no significant main effect of machine on mean bet amounts during exposure, $F(1,14) = 0.033$, p = ns, such that participants bet no more (in cents) on the free-spins machine ($M = 38.613$, $SD = 29.492$) or the control machine ($M = 37.817$, $SD = 28.180$). The ANOVA also revealed no significant interactions between machine and order, $F(1,14) = 0.307$, p = ns, such that participants bet no more on either machine regardless of whether they experienced the control machine first (free-spins machine: $M = 48.282$, $SD = 32.202$; control machine: $M = 37.817$, $SD = 28.180$), or the free-spins machine first (free-spins machine: $M = 28.943$, $SD = 24.762$; control machine: $M = 30.573$, $SD = 31.650$). A mixed ANOVA for the Added-features Condition also revealed no significant main effect of machine on mean bet amounts, $F(1,14) = 2.759$, p = ns, such that participants bet no more on either the free-spins machine ($M = 36.492$, $SD = 28.355$) or the control machine ($M = 43.021$, $SD = 33.772$). The ANOVA also revealed no significant interaction between machine and order, $F(1,14) = 0.055$, p = ns, such that participants bet no more on either machine regardless of whether they experienced the control machine first (free-spins machine: $M =40.619$, $SD = 30.612$; control machine: $M = 46.223$, $SD = 29.145$), or the free-spins machine first (free-spins machine: *M* = 32.364, *SD* = 27.330; control machine: *M* = 39.819, *SD* = 39.639).

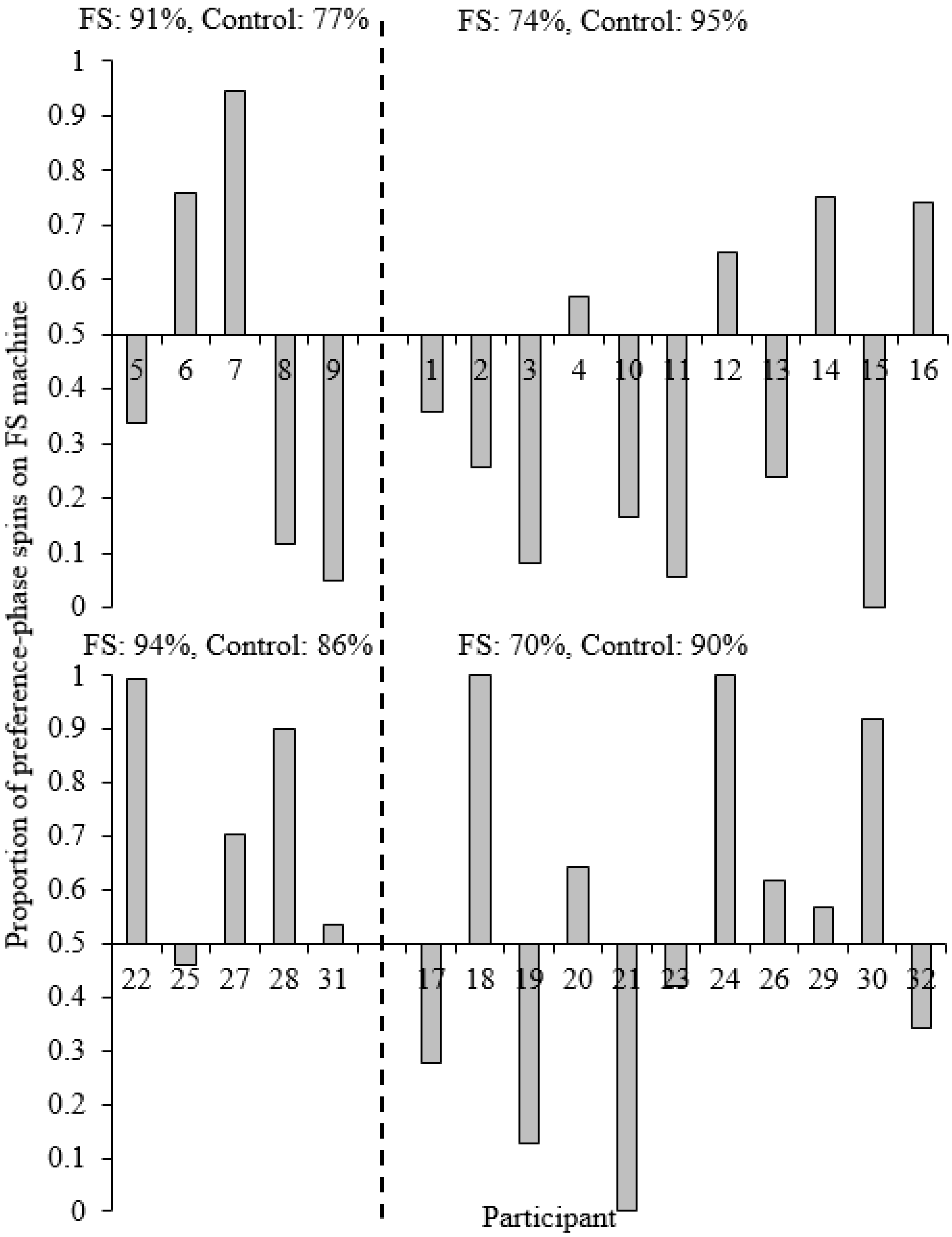

Figure 4. The proportion of preference-phase spins participants made on the machine with free spins. The top half of the figure displays data from the Without-features Condition, the bottom half displays data from the Added-features Condition. Bars above .5 indicate a preference for the free-spins machine. Bars below .5 indicate a preference for the control machine. The length of the bars indicate the extent of participants' preference. Participants on the left of the reference line had a higher RTP on the free-spins machine in the exposure phase, participants on the right had a higher RTP on the control machine. Mean experienced RTP percentages across participants in these groups are displayed above the graphs.

In the Without-features Condition, there was no clear effect of RTP on bet amounts. In the Added-features Condition, participants tended to bet more on the machine that had the higher RTP in the exposure phase. These data are displayed in Figure 5. As seen in the lower panel of Figure 5, 13 of 16 participants bet more on the machine that had the higher RTP in the exposure phase.

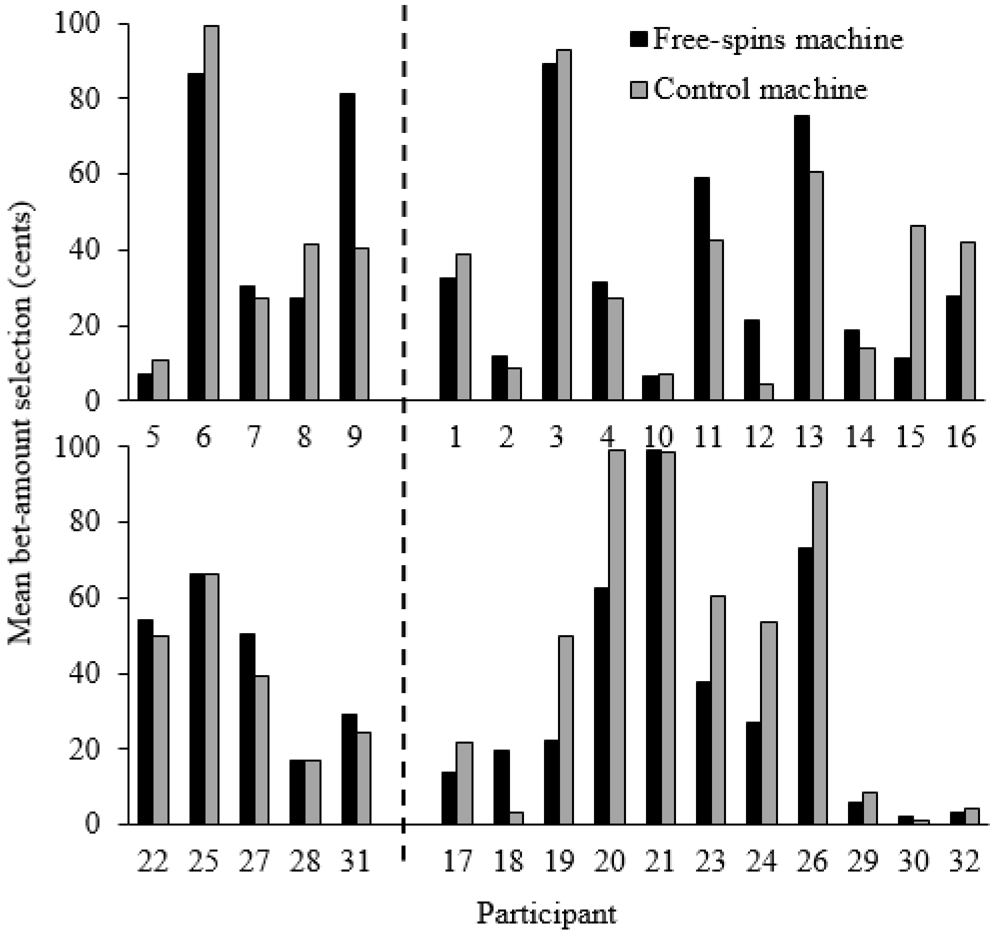

Figure 5. The mean bet-amount selection made by participants in the exposure phase. The top half of the figure displays data from the Without-features Condition, the bottom half displays data from the Added-features Condition. Participants on the left of the reference line had a higher RTP on the free-spins machine, participants on the right had a higher RTP on the control machine. Higher bars indicate higher average bet amounts.

To investigate whether participants' betting patterns varied as a function of preceding outcome, their bet amounts following each outcome across both exposure and preference phases were analysed and displayed in Figure 6. There was variability between participants in how many cents they generally bet. However, different outcomes had no consistent effect on bet sizes. Repeated measures ANOVAs (with Greenhouse-Geisser corrections for non-sphericity) supported these interpretations, indicating no significant main effect of outcome type on subsequent amount bet for either the Without-features Condition, $F(2.590,38.854) = 0.677$, p = ns, (loss: $M = 41.767$, $SD = 28.831$; LDW: $M = 38.236$, $SD = 29.621$; medium win: $M = 40.541$, $SD = 29.084$; big win: $M = 41.469$, $SD = 30.297$; free spins: $M = 37.983$, $SD = 31.568$), or the Added-features Condition, $F(2.004,30.061) = 2.173$, p = ns, (loss: $M = 53.625$, $SD = 32.223$; LDW: $M = 43.883$, $SD = 32.467$; medium win: $M = 43.149$, $SD = 33.002$; big win: $M = 45.852$, $SD = 34.082$; free spins: $M = 40.503$, $SD = 29.459$).

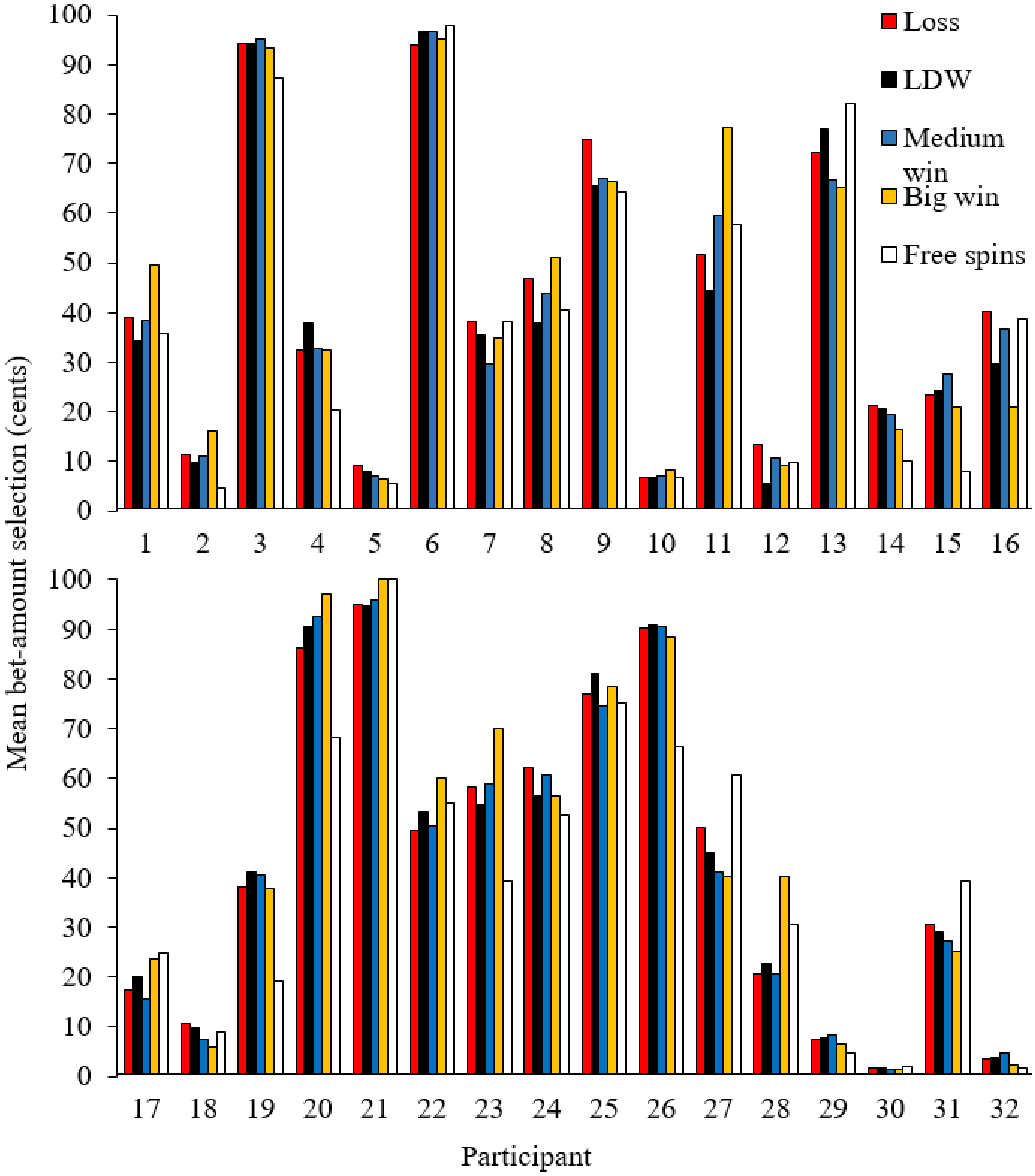

Figure 6. The mean bet amounts made by participants following various outcomes in both exposure and preference phases. The top half of the figure displays data from the Without-

features condition, the bottom half displays data from the Added-features condition. Higher bars indicate greater average bet amounts.

To investigate whether participants' betting patterns varied as a function of number of previous losses in a row, participants' bet amounts following different sized strings of losses during both exposure and preference phases were analysed and displayed in Figure 7. Different sized loss strings also had no consistent effect on bet sizes. Repeated measures ANOVAs (Greenhouse-Geisser corrected) supported this interpretation, revealing no main effect of loss-string length on subsequent bet amounts for either the Without-features Condition, $F(1.578, 23.676) = 0.599$, p = ns, (one loss: $M = 38.928$, $SD = 29.868$; two losses: $M = 37.862$, $SD = 30.341$; three losses: $M = 40.450$, $SD = 28.597$; four losses: $M = 39.936$, $SD = 29.483$; five or more: $M = 38.265$, $SD = 28.020$) or the Added-features Condition, $F(2.124, 31.862) = 1.418$, p = ns, (one loss: $M = 43.625$, $SD = 32.223$; two losses: $M = 43.134$, $SD = 32.609$; three losses: $M = 41.382$, $SD = 31.386$; four losses: $M = 39.325$, $SD = 36.280$; five or more: $M = 39.126$, $SD = 31.186$).

To investigate whether participants' machine-switching behaviour varied as a function of preceding outcome, probability of switching machine following outcomes (loss, LDW, medium win, big win) was analysed for the preference phase and displayed in Figure 8. There was variability between participants in how likely they were to switch slots in general, although a pattern emerged regarding individual participants' likelihood of switching to the alternate machine depending on the previous outcome. For the purpose of this analysis, a LDW was categorised as any "win" that resulted in a net loss for participants (i.e., the smallest win possible on only one of the three betting lines). A medium win was categorised as a win of between three to eight times the amount bet on a line. A big win was categorised as a win that was larger than eight times the amount bet.

Participants in both conditions were generally more likely to switch to the alternate machine following losses, LDWs, and medium wins than following big wins. Participants were least likely to switch machines following a big win, with all but three participants (across both conditions) never switching following a big win. For reference, participants in the Without-features Condition experienced between 2 and 6 big wins in the preference phase, with a mean of 4.2. Participants in the Added-features Condition experienced between 1-7 big wins with a mean of 4.5. Free-spins outcomes were not included in this analysis, as a number of participants never received a free-spins sequence in the preference phase (particularly in the Without-features Condition, where participants were more often playing the control machine). Of the 25 participants who did receive free spins in the preference

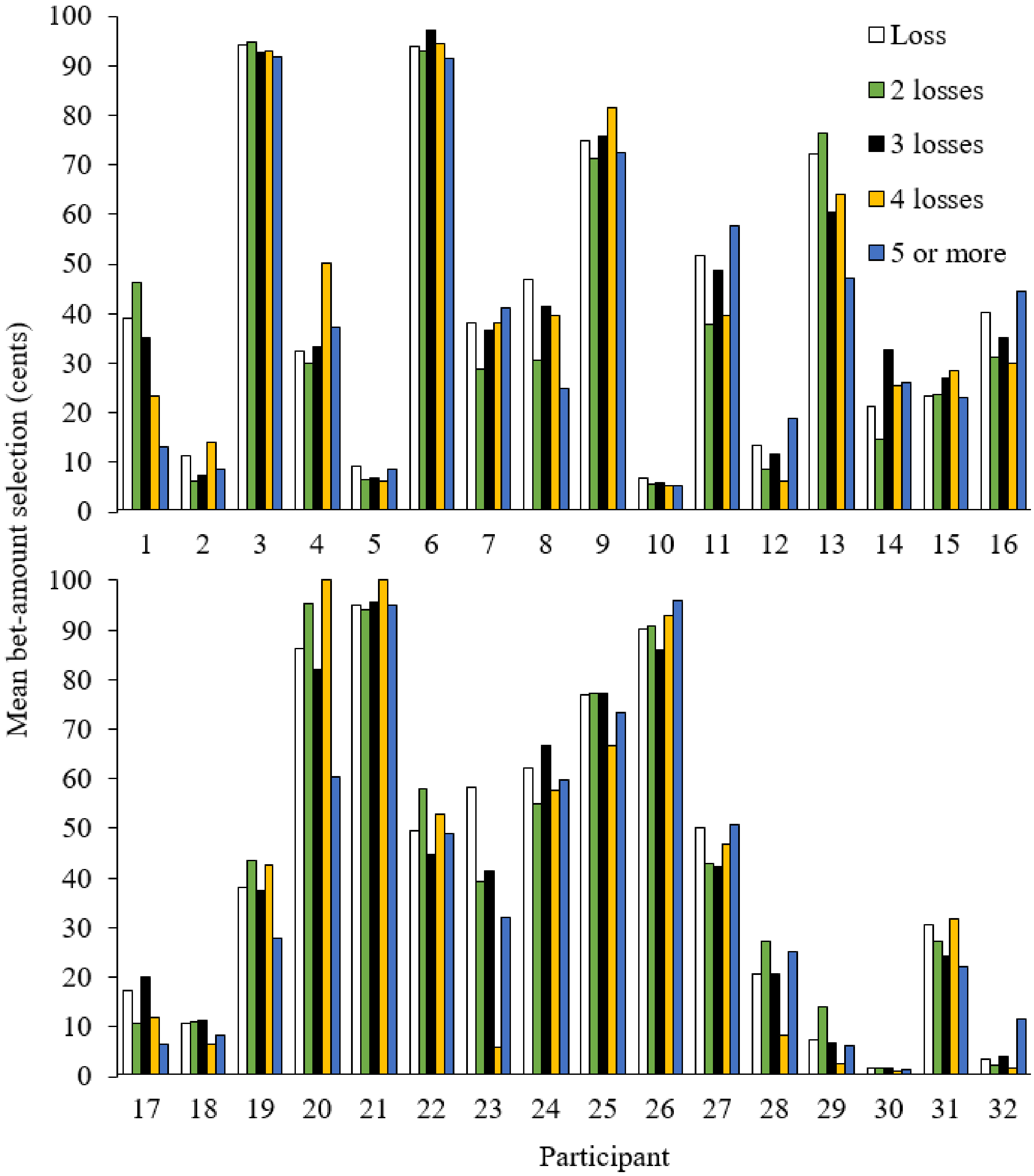

Figure 7. The mean bet amounts made by participants following various-sized strings of losses in both exposure and preference phases. The top half of the figure displays data from the Without-features Condition, the bottom half displays data from the Added-features Condition. Higher bars indicate greater average bet amounts.

phase, 22 never switched to the alternate machine following this outcome. Overall, there was a consistent effect where participants stayed on the machine that had just produced a big win or free spins, rather than switching away, although this interpretation is tentative due to a lack of data following these outcomes.

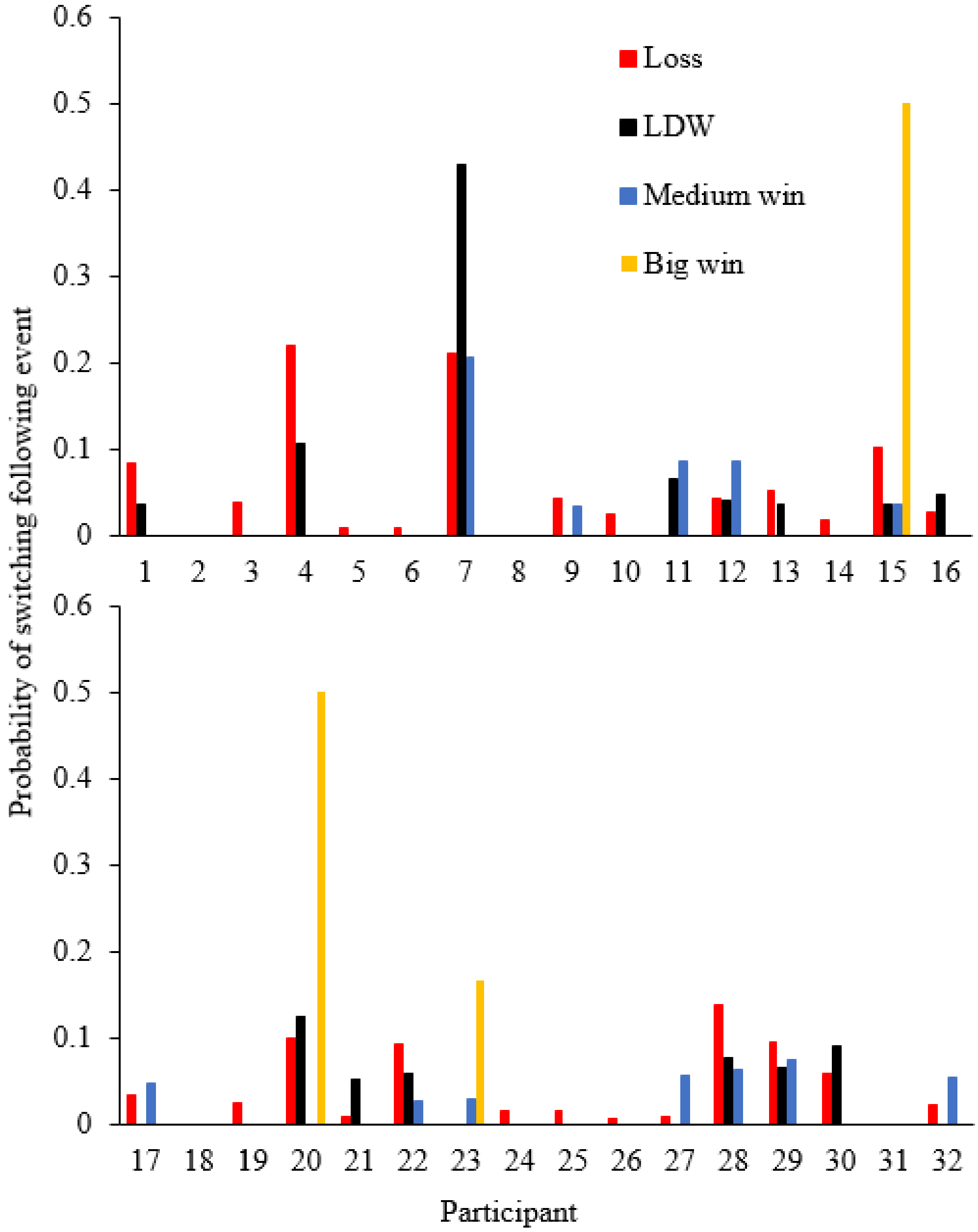

Figure 8. The probability of participants switching to the alternate machines following various outcomes in the preference phase. The y-axis displays the proportion of outcomes that participants switched machines after. Higher bars indicate more switching. The top half of the figure displays data from the Without-features Condition, the bottom half displays data from the Added-features Condition.

Discussion

The current study investigated whether participants prefer to gamble on a slot-machine simulation with a free-spins feature over a similar simulation without a free-spins feature. It was expected that participants would only consistently prefer the free-spins machine in the Added-features Condition, and this was supported by the data. Participants in the Added-features Condition generally preferred the free-spins machine, and participants in the Without-features Condition generally preferred the machine without free spins. However, these patterns were not consistent enough to reach statistical significance.

Participants generally preferring the free-spins machine in the Added-features Condition, yet not preferring it in the Without-features Condition, indicates that (effects of order aside) preference for the free-spins machine was primarily driven by the additional features in the Added-features Condition (GIF images, music, advertising, increased RTP during free spins combined with decreased RTP outside free spins). Due to the large number of changes between the free-spins feature in the different conditions, it is not currently known which of these features had an effect on preference, or whether some or all of them combine additively.

This result also suggests that the “freeness” of a free-spins feature is not an important driver of preference, despite this being one of the two aspects of free spins gamblers report finding desirable (Livingstone et al., 2008). In both conditions of the current study, free spins did not require a response (the spins happened automatically), and did not subtract from the participants’ balances. Despite the free-spins feature in both conditions being “free”, participants in the Without-features Condition did not prefer it.

The second desirable aspect of free-spins features reported by gamblers were that they afford “extra time” on the slot machine for a given dollar amount wagered (Livingstone et al., 2008). The free-spins features in both conditions also incorporated this element. Programmed RTP between the free-spins machines and the machines without free spins were equal. However, due to the way RTP is calculated (amount won divided by amount bet), combined with the fact that fewer gambles were made on the free-spins machines in the exposure phase (200 spin exposures, 20 of which were free spins), participants typically bet less overall on the free-spins machine – though this would depend on their bet-amount selections. Participants also won less overall on the free-spins machine so that overall RTPs were equal. This feature of the experiment meant that participants could gamble for the same number of spins on the free-spins machine as the control machine, but it would cost less money – this lines up with the "extra time for the same cost" that Livingstone et al. (2008) highlighted as important. Participants preferring the free-spins machine in the Added-features Condition, yet not in the Without-features Condition indicates that this "extra time" from free-spins features was also not an important driver of preference in the current study.

The order in which participants were exposed to the slot-machine simulations had a large effect on their preference, although this effect was only statistically significant in the Added-features Condition. Participants tended to allocate more preference-phase spins to the machine they were first exposed to. The reason for this is not currently clear, however, this may be due to participants' balances not resetting at the end of the first exposure. As RTPs were less than 100%, balances tended to trend downwards over the course of the experiment. This means that the first machine participants gambled on generally had a higher balance than the second machine. Perhaps participants tended to prefer the first machine they were exposed to due to a mistaken belief that it had a higher RTP, or more wins, since the balance was higher.

Another potential cause for this order effect is that the participants may have been motivated to seek novelty or variation in reinforcers. People tend to prefer varied reinforcers over constant reinforcers, an effect consistently demonstrated in developmentally disabled populations (e.g., Egel, 1981; Milo, Mace, & Nevin, 2010). This effect tends to hold even when the varied reinforcers are of slightly lower quality than the constant reinforcer (Bowman, Piazza, Fisher, Hagopian, & Kogan, 1997). There is a lack of research investigating preference for varied reinforcers in typically developed adults, although it seems reasonable to assume this population also prefers varied reinforcers. The different backgrounds and stimuli may become conditioned reinforcers as they are associated with winning outcomes, and may therefore function as different reinforcers. Participants tending to prefer the first simulation exposed to is consistent with these ideas – as familiarity with the second machine grows over its 200 spin exposure period, participants may have been motivated to seek more variety by gambling on the first machine again, when given the switching button in the preference phase.

It was expected that participants' preference for the free-spins machine would not be influenced by experienced RTP differences between machines in the exposure phase. This was not conclusively supported by the data. In the Without-features Condition, RTP did not affect preference. However, in the Added-features Condition participants were more likely to prefer the machine that had a higher RTP in the exposure phase. This finding provides tentative evidence that RTP has an effect on preference. This is consistent with an investigation into the effects of RTP on preference by Coates and Blaszczynski (2013). In their study, participants preferred the machine that had a higher RTP. It may also be consistent with a study conducted by Haw (2008). After an initial null effect of RTP on preference, Haw excluded participants from the analysis based on whether they switched at least once in a similar preference phase as the current study. Participants who switched at least once tended to prefer the machine with the higher RTP, and Haw argued switchers may be a different population than non-switchers, with the example they may have paid more attention in the exposure phases. In the current study, only three participants (22, 21, 24) never switched, indicating that the majority of the sample in both conditions were "switchers". Participants in the Added-features Condition tended to switch more often (on average switching 1.563 times) than participants in the Without-features Condition (1.113), providing some tentative evidence for Haw's idea that switching machines may be associated with sensitivity to RTP differences.

The finding that RTP had some effect on preference is inconsistent with most literature investigating RTP (Brandt & Pietras, 2008; Haw, 2008; Schreiber & Dixon, 2001; Weatherly & Brandt, 2004; Weatherly et al., 2009). Other research found opposing effects of RTP on preference, such that participants preferred the machine with the lower RTP (Coates & Blaszczynski, 2013). It appears that RTP may affect preference under some experimental conditions, but not others. At this point it is unclear what these conditions are. It is hard to imagine how the presence of a complex free-spins feature on one machine could increase sensitivity to RTP, however, this is suggested by the data. Not only did participants tend to prefer the higher RTP machine in the Added-features Condition, they also tended to bet more on the higher RTP machine. It is possible that sensitivity to moderate RTP differences in the population is typically low. This would explain why the effects of RTP on gambling behaviour are inconsistent across participants, and across the literature in general. It is also possible that sensitivity to RTP occurs given one set of experimental conditions but not others, although exactly which parameters are important is currently unknown.

Overall, the findings regarding RTP provide only an indicator that RTP may have an effect, under some conditions or for some participants. Due to the exploratory nature of this comparison and the lack of random assignment to RTP groupings (i.e., whether RTP was higher on one machine or the other was entirely controlled by participants themselves), combined with the small number of participants in each condition with a higher RTP on the free-spins machine, the findings regarding RTP (and above inferences) should be interpreted cautiously. Identifying whether and what effect RTP has on slot-machine preference requires a systematic investigation.

It was expected that participants may wager more on the free-spins machine, since amount wagered on the spin that activated free spins is reflected in potential winnings from the free-spins feature. This was not supported by the data. In both conditions, there was no clear pattern of participants wagering more on either the free-spins or control machine. This indicates that free-spins bonus features do not influence the amount that participants choose to bet on individual gambles. This is inconsistent with some interview research (Landon et al., 2016) where gamblers report making larger bet amounts due to the expectation of free spins (the bet amount on the spin that activated the free spins is usually replicated in the free spins).

The effect of free-spins features on amount wagered may be indirect. Participants in the Added-features Condition allocated more spins to the free-spins machine than the control machine in the preference phase. Thus, it can be expected that this free-spins feature may cause participants to make more gambles than they would otherwise, and therefore bet more overall. Leino et al. (2005) found that the three video-lottery terminals with the highest expenditure in Norway, and most bets made, were video-lottery terminals with bonus features. Self-report research supports this, with gamblers reporting that free-spin features cause them to gamble more or longer than they would otherwise (Landon et al., 2016; Livingstone et al., 2008). At this point, it seems likely that free-spins features do not influence individual bet-amount selections, but affect overall amounts wagered through people simply playing longer on these machines.

It was expected that participants may bet more following losses, or long strings of losses, due to the gambler's fallacy. However, participants in both conditions tended to bet similar amounts following the different outcomes (loss, LDW, medium win, big win, free spins) and different sized strings of losses. This suggests that, although logical fallacies do appear to impact gambling behaviour (e.g., Clotfelter & Cook, 1993; Croson & Sundali, 2005) there was no effect of these on bet amounts.

Participants in both conditions were generally most likely to switch machines in the preference phase following losses (i.e., more likely to stay on the same machine following wins). This is consistent with animal experiments with concurrent schedules demonstrating a general tendency to stay on the just-reinforced alternative, a phenomenon known as a preference pulse (e.g., Hachiga, Sakagami, & Silberberg, 2014; Krageloh, Davison, & Elliffe, 2005). Furthermore, participants in both conditions were least likely to switch (and therefore most likely to stay) on the current machine following big wins and free spins. Switching data following both big wins and free spins should be interpreted cautiously, particularly for the Without-features Condition, for several reasons. Firstly, of the three participants who did switch following free spins, this was the outcome they were most likely to switch after. Secondly, Participants received at most four free-spins sequences in the preference phase, and that is if they nearly exclusively played the free-spins machine. Participants in the Without-features Condition generally played more on the control machine, and many received few (or zero) free spins in the preference phase. The number of big wins experienced was also low, and a lack of switching following these outcomes may simply reflect this lack of opportunities to switch.

If a lack of switching following free-spins and big wins in the Added-features Condition is not simply a type one error, this result is further evidence of the reinforcing nature of the complex free-spins feature. Landon, Davison, and Ellife (2003) demonstrated with pigeons that larger reinforcers result in larger and longer preference pulses. This local effect of free spins on preference (staying on the free-spins machine) may suggest that free spins function as discriminative stimuli – directing behaviour by signalling consequences (i.e., more free spins) for continued play on the free-spins machine.

The current study has multiple strengths as well as contributions to gambling literature. It provided a sensitive measure of preference, and indicated that participants tended to prefer slot-machine simulations with free-spins features, but only when the feature incorporated additional elements such as an increased win frequency, music, advertising, and animated images. When the free-spins feature was without the additional features, simply providing "free" spins, participants did not prefer the free-spins machine. These results support the findings of interview research where gamblers report preferring free-spins, yet also demonstrate that gamblers' self-described reasons for preferring free spins (freeness, time on machine) may be inaccurate. At this point, this study provides the only experimental study on the effect of free-spins features on gambling behaviour, and indicates that characteristics other than the “freeness” of a free-spins feature affect preference.

There were some elements of the study that were improved for subsequent studies. There was a reasonably strong order effect where participants tended to prefer the first machine exposed to, adding noise to the analysis of whether participants preferred the free-spins machine. It was suspected that this order effect may have been due to participants seeking variation or novelty, or due to the first machine being associated with a higher balance. Preference Study 2 addressed this in two ways. Firstly, the exposure phase was shortened, and the preference phase was lengthened. Lengthening the preference phase had the additional benefit of providing more data regarding how participants respond following free spins and big wins in subsequent studies (as these events were relatively rare in the current study). Secondly, participants were given a separate balance for each machine so that each machine began with an equal balance. The number of participants was also increased since the power of the exploratory RTP analyses was assumed to be lacking due to: 1) Order influencing preference, 2) random variation (more participants happening to have greater RTP on the control machine), and 3) the assumption that participants’ sensitivity to small and moderate RTP differences is generally low.

Preference Study 2 sought to replicate and extend the findings of the current study in three separate experiments. Experiment 1 replicated the Without-features Condition, where participants chose to gamble on either a machine with a simple free-spins feature, or a control machine. Experiment 2 replicated the Added-features Condition, investigating whether participants prefer a machine with a complex free-spins feature or control machine. Experiment 3 sought to more thoroughly investigate whether the “freeness” of the free spins has any effect on preference – the bonus feature was similar to the complex free-spins feature, except the spins still cost money and participants had to click to initiate each spin.

Preference Study 2

The current study incorporated a number of changes from Preference Study 1 which were expected to improve the sensitivity of the procedure. There was a reasonably strong order effect in Preference Study 1, where participants tended to prefer the first machine exposed to regardless of whether it was the free-spins machine or not. It was argued this preference for the first machine could have been due to two different reasons: 1) Participants' balances generally being higher on the first machine exposed to, and 2) participants seeking variety or novelty in reinforcers (and so preferring the machine they had not just played 200 spins on). These potential causes for the order effect were addressed in the current study. Firstly, the length of the exposure phases were reduced from 200 spins on each machine, to 100 spins. This change was to provide participants with more variety over the initial 200 spins of the experiment, and also allowed an increase of preference-phase spins from 200 spins to 300 spins, to provide more data on preference and switching behaviour. Secondly, participants were given a separate starting balance on each machine, so that each machine started with the same amount. Since balances sometimes trended into negative credits, participants' starting balances were also increased from $50 to $100 to make this less likely to occur.

At this point, it appears that participants prefer a slot-machine simulation with a free-spins feature over a similar machine without free spins, but not when the free-spins feature simply provides "free" spins. Preference Study 1 indicated that the additional features in the Added-features Condition (higher win-rate, advertising, music, animated images) were the main drivers of preference, and that "freeness" and time on device were not. This finding contradicts gamblers' accounts of what they find attractive about free-spins features (Livingstone et al., 2008).

The current study replicated and extended Preference Study 1 with three separate experiments. In each experiment, participants played two similar slot-machine simulations, one with a free-spins (or bonus) feature, and one without. In Experiment 1 the free-spins feature was simple – a replication of the Without-features Condition from the previous study. Experiment 2 replicated the Added-features Condition, with a complex free-spins feature. Experiment 3 sought to further investigate whether "freeness" was a driver of preference – the bonus feature had all the same features as the free-spins feature from the Added-features Condition from the previous study, except the spins still subtracted money from participants' balances, and participants still needed to click the spin button to initiate spins during the bonus. Based on participants in Preference Study 1 only preferring the free-spins feature when it had added features, it was expected that participants in Experiments 2 and 3 would consistently prefer the machine with a free-spins (or bonus) feature, and that participants in Experiment 1 would not prefer the free-spins machine.

The effect of exposure order on preference was also investigated. Due to the above mentioned changes to the method aimed at reducing the order effect displayed in Preference Study 1, it was expected that participants' preference would be unaffected by the order in which they were exposed to the simulations.

The effect of RTP on preference was also investigated. As in Preference Study 1, allowing participants to select their own bet amount for each spins necessitated creating the possibility that experienced RTP differed between the machine with a bonus feature, and the one without. In Preference Study 1, participants were more likely to prefer the higher RTP machine in the Added-features Condition, but RTP had no effect on preference in the Without-features Condition. Participants in the Added-features Condition also bet more on the machine with the higher RTP. These findings provide some indication that participants in the Added-features Condition were more sensitive to RTP differences than participants in the Without-features Condition. Therefore, it was expected that participants in both Experiment 2 and Experiment 3 (complex free-spins/bonus modes) would tend to prefer the machine that had a higher exposure RTP.

Variables other than preference were also investigated. The effect of bonus features on amount wagered was explored. Participants in Preference Study 1 did not consistently bet more on either the free-spins or control machine. Therefore, it was expected that in all three experiments of the current study, participants' bet amounts would be unaffected by the presence of a bonus feature. The effect of various outcomes on bet amounts (i.e., different sized wins, losses, free spins, different sized strings of losses) were also explored. Bet amounts in Preference Study 1 were not consistently affected by previous outcomes, so it was expected that these different outcomes would not affect bet amounts in all three experiments.

The amount of time it took participants to gamble again following various events (different sized wins, losses) was also measured. Typically, gamblers take longer to respond after receiving a win in comparison to a loss (Schreiber & Dixon, 2001), and after receiving a large win in comparison to small wins (Delfabbro & Winefield, 1999; Dickerson, 1993). It was therefore expected that participants would respond quickest following losses, and slowest following big wins.

Lastly, whether participants were more likely to switch machines following different outcomes was investigated. In Preference Study 1, participants tended to switch least often following big wins and free spins, although the participants that did switch following free spins did so frequently. It was argued these results may reflect the rarity of these outcomes in the preference phase – that there was a lack of opportunity to switch following these outcomes. A greater number of participants, and a greater number of spins in the preference phase provided more data to investigate switching behaviour. It was tentatively expected that participants would be least likely to switch following big wins and free spins, especially in Experiments 2 and 3 where the bonus feature was complex.

Experiment 1

Method

Participants. Thirty-two psychology students enrolled in a first year psychology course participated in partial fulfilment of a course requirement. No participant's SOGS score indicated they were at risk of problem gambling.

Materials and Stimuli. The materials and stimuli were the same as for the Without-features Condition in Preference Study 1.

Experimental Conditions. The two different simulated slot machines participants played were the same as for the Without-features Condition in Preference Study 1. The outcome sequences differed from those in Preference Study 1. Programmed outcome frequencies for both machines in the exposure phase are displayed in Table 4. The outcome sequences for the preference phase were the same as the exposure phases. For example, if a participant exclusively preferred the free-spins machine (300 spins), the outcome sequence for these spins would be the outcome sequence for the exposure-phase free-spins machine repeated three times. Free spins were won on 3% of spins on the free-spins machine.

Table 4

Programmed Outcome Probabilities on each Slot Machine for Experiment 1

Outcome	Free-spins machine	Control machine
Per individual line		
loss	.88	.86
2*	.05	.06
5*	.03	.02
8*	.02	.01
10*	.01	.02
30*	.01	.01
5 free spins	.01	0
Resultant Outcome Frequencies Per Spin (three lines per spin)		
Programmed RTP percentage	87%	87%
Programmed/experienced Probability of win	.30	.34
Programmed/experienced Probability of win during free-spins feature	.20	n/a
Programmed/experienced Probability of win outside free-spins feature	.32	.34

Note. *Programmed outcome is multiplied by the bet-amount selected.

Procedure. Data for the three separate experiments were collected serially (although there was some overlap). The general procedure was the same as for Preference Study 1, with a number of changes. The changes are as follows:

- Exposure phases shortened to 100 spins.
- Preference phase lengthened to 300 spins.

- Starting balances increased to $100.
- Participants given a separate balance for each machine in the exposure phases (note, during the preference phase participants had the same balance for both machines which began at $100).
- Addition of an extra sentence at the end of the on-screen instructions at the beginning of the experiment: "You will always be gambling on three lines". This change was in response to some participants in Preference Study 1 reporting confusion as to why the amount they chose to bet was multiplied by three.

Data analysis. Data were analysed as in Preference Study 1, except for the addition of the response latency analyses. How quickly participants responded following different outcomes was investigated by graphing each participants' response latencies following those outcomes into frequency distributions. Making a response consisted of two separate events, selecting a bet amount, and selecting the "MAX LINES" (spin) button. The response latencies analysed represent the time between when the ability to select a bet amount becomes available after a prior spin, and when the participants select the "MAX LINES" button. Response latencies from both exposure and preference phases were included in this analysis.

Results and Discussion

To investigate whether participants preferred the machine with free spins, the proportion of responses they made on the free-spins machine during the preference phase is displayed in Figure 9. Overall, more participants preferred the free-spins machine (n = 18) than the control machine (n = 14), but preference was not consistent across participants. Confirming the lack of consistent preference seen in Figure 9, a mixed ANOVA with a within-subjects factor of machine (free spins, control), and between-subjects factor of exposure order (first exposed to free-spins machine, first exposed to control machine) indicated no significant main effect of machine on the number of spins allocated to each machine, $F(1,30) = 2.291$, p = ns, such that participants did not allocate significantly more spins to either the free-spins machine (M = 154.094, SD = 68.153) or the control machine (M = 114.156, SD = 80.010).

It was expected that participants would not prefer the simple free-spins machine, and this hypothesis was supported by the data. This finding is consistent with participants in the

Without-features Condition of Preference Study 1 not preferring a slot-machine simulation with a simple free-spins feature, and provides more evidence that both the “freeness” of a free-spins feature, and “extra time on device”, are not important drivers of preference. As discussed in Preference Study 1, this is contrary to gamblers’ reports about why they find free spins desirable (Livingstone et al., 2008).

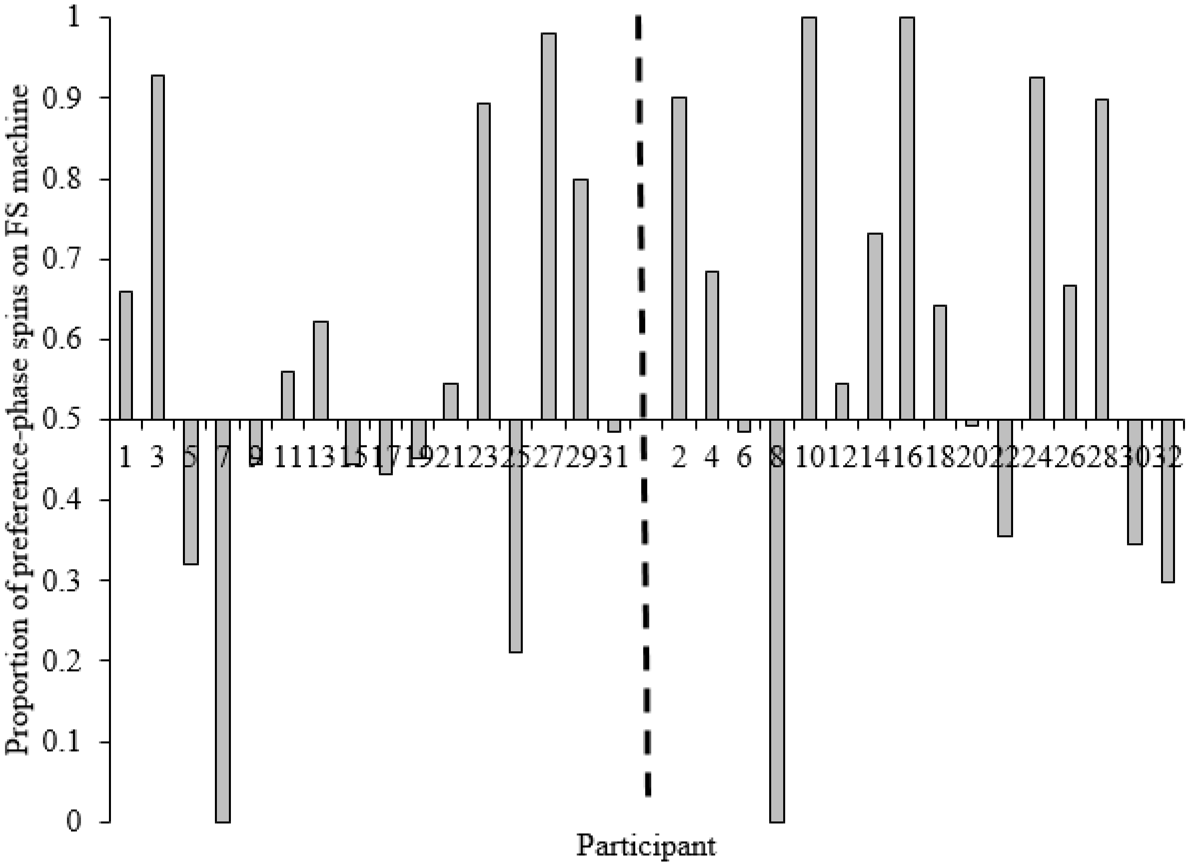

Figure 9. The proportion of preference-phase spins participants made on the free-spins machine. Bars above .5 indicate a preference for the machine with free spins. Bars below .5 indicate a preference for the machine without free spins. The length of the bars indicate the extent of participants’ preference. Participants on the left of the reference line were exposed to the control machine first, participants on the right were exposed to the free-spins machine first.

The null effect of free-spins on preference is also inconsistent with another study that investigated preference for free-spins machines which was published after the current study (Belisle, Owens, Dixon, Malkin, & Jordan, 2017). In Belisle et al.’s study, participants gambled on two simulations which were presented concurrently. The control machine contained no bonus feature, while the experimental machine included a bonus feature which, when activated on an RR-6 schedule, presented one free spin. Interestingly, the bonus feature employed somewhat resembled the simple free-spins feature used in the current experiment –

“bonus” symbols on the reels signalled the presence of the feature, and all it provided was one free spin which did not result in an increased RTP on the machine in question. There was no other advertising, and no animated images or music. Their study simultaneously investigated the effect of win frequency on preference. Essentially, participants were presented with two slot-machines concurrently, one with frequent small wins, and one with less-frequent but medium-sized wins. Both machines had the same overall RTP. The free-spins bonus feature was present on the dense machine in one half of the experiment, and on the lean machine in the other half. They found that participants consistently preferred the bonus machine when it was also the dense machine. When the bonus machine was the lean machine, there was no consistent preference. In other words, participants preferred both the simple free-spins bonus machine and the denser machine.

Taken in the context of the current experiment’s failure to find an effect of a simple free-spins feature on preference, Belisle et al.’s (2017) study indicates that in certain experimental conditions, participants do prefer a simple free-spins machine. Despite both studies investigating preference for simple free-spins features, there were major differences in the simulations across the studies. The current experiment used a three-payline simulation with LDWs and a variety of different win sizes – reasonably complex simulations. Belisle et al.’s study used a simple one-payline simulation with only type of win available – a much simpler simulation that is less representative of modern slot machines. Furthermore, the free-spins feature in Belisle et al.’s study was activated on an RR-6 schedule, on average once every six spins. This is a much more frequent activation of the bonus feature than is found on real-world slot machines. For example, in an analysis of real slot-machine outcomes in their laboratory, Harrigan et al. (2015) found that when playing only one payline, bonus features were activated once every 1429 spins. When playing the maximum lines available, bonus features were activated once every 95 spins. The current experiment had a more realistic rate of activating the free-spins feature (3% of spins) than the Belisle et al. study. It is likely that the discrepancy between the results of the current experiment and Belisle et al.’s finding is due to a large difference in how frequently the simple free-spins feature was activated, combined with a large difference in the complexity of the simulations. It appears that participants do not consistently prefer a simple free-spins machine when playing on relatively complex multi-line simulations with a realistic rate of bonus-feature activations, yet do prefer a simple free-spins machine when playing on much more basic simulations with an unrealistically high rate of bonus-feature activations.

As seen in Figure 9, order of exposure to the different slot-machine simulations had no clear effect on preference. The ANOVA supported this interpretation, indicating no significant interaction between order and preference, $F(1,30) = 0.539$, p = ns, such that the number of spins participants allocated to either machine did not depend on whether they experienced the control machine first (free-spins machine: $M = 145$, $SD = 66.011$; control machine: $M = 124.438$, $SD = 77.656$), or the free-spins machine first (free-spins machine: $M = 163.188$, $SD = 71.171$; control machine: $M = 103.875$, $SD = 83.510$). This is contrary to the results of Preference Study 1, which indicated that participants generally preferred the first machine exposed to (although it should be noted this effect failed to reach statistical significance for the Without-features Condition). This indicates that changes to the method aimed at reducing the order effect displayed in Preference Study 1 were successful (reducing exposure length, resetting balance at beginning of each exposure and preference phase). At this point, it is unknown whether one of these changes or both combined to reduce the order effect.

Figure 10 displays the same preference data with participants separated based on which machine had the higher RTP in the exposure phase. Participants were more likely to prefer the free-spins machine when it was also the machine that had a higher RTP in the exposure phase (left side of reference line). This is inconsistent with the Without-features Condition of Preference Study 1, where RTP had no effect on preference. On the other hand, this result is consistent with the Added-features Condition of Preference Study 1 where participants appeared to be more likely to prefer the free-spins machine when it was also the higher RTP machine, as well as some other literature where RTP has affected preference (Haw, 2008; Coates & Blaszczynski, 2013; Coates & Blaszczynksi, 2014). As in the Added-features Condition of Preference Study 1, this finding provides only tentative evidence that participants were sensitive to RTP differences.

Participants tended to wager larger amounts (in cents) on the free-spins machine ($M = 51.362$, $SD = 26.422$) compared to the control machine ($M = 44.771$, $SD = 27.994$), with 21 of 32 participants displaying this pattern (Figure 11). A mixed ANOVA with a within-subjects factor of machine and a between subjects factor of exposure order indicated this difference reached statistical significance, $F(1,30) = 5.570$, $p = .025$, $\eta_p^2 = .157$. This effect size is considered large. This finding is in contrast to both conditions of Preference Study 1, where there was no consistent effect of participants wagering more on either machine, however, it is consistent with some of the interview research cited, where gamblers reported free-spins features cause them to gamble more than they would otherwise (Landon et al., 2016; Livingstone et al., 2008). The ANOVA also revealed no significant interaction between bet amounts on each machine and exposure order, $F(1,30) = 1.116$, p = ns, such that bet amounts on the free-spins and control machines did not depend on whether participants were first exposed to the control machine (free-spins: $M = 49.501$, $SD = 27.155$; control: $M = 53.223$, $SD = 26.419$) or the free-spins machine (free-spins: $M = 46.021$, $SD = 29.030$; control: $M = 43.775$, $SD = 27.687$).

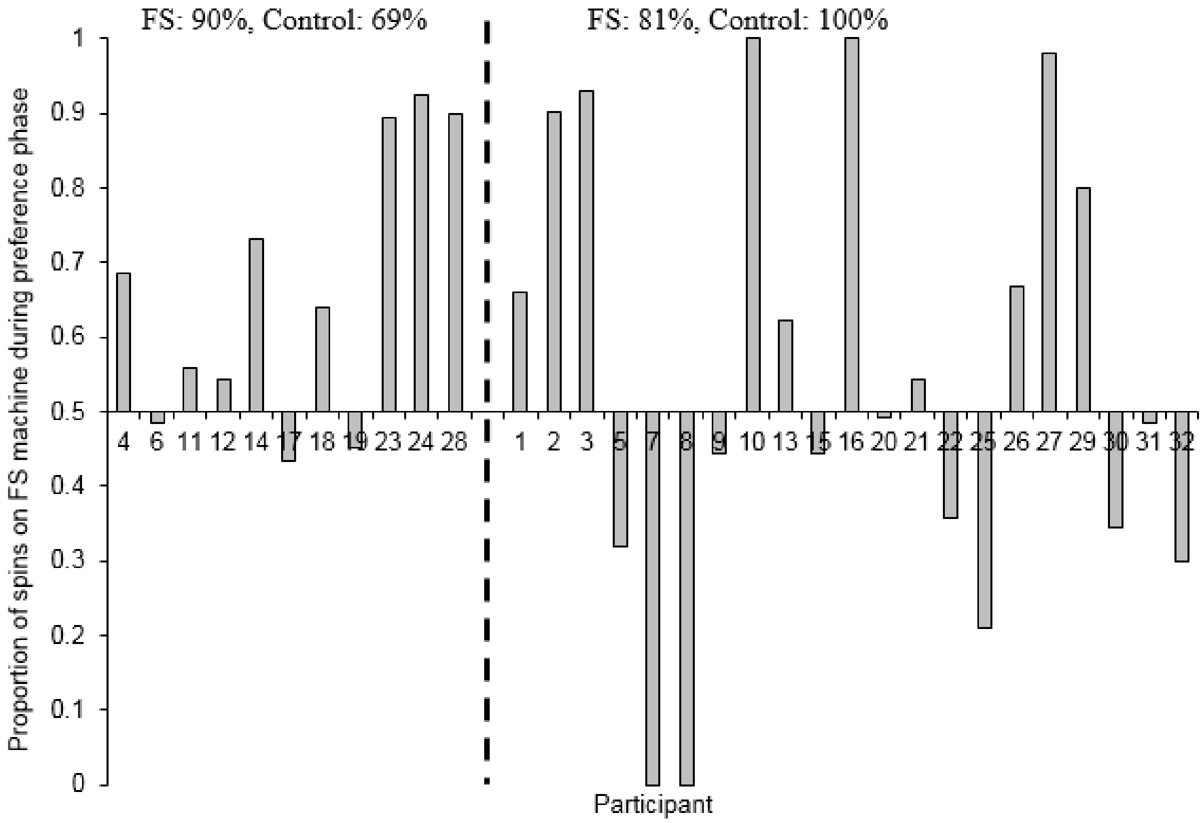

Figure 10. The proportion of preference-phase spins participants made on the free-spins machine. Bars above .5 indicate a preference for the free-spins machine. Bars below .5 indicate a preference for the control machine. The length of the bars indicate the extent of participants' preference. Participants on the left of the reference line had a higher RTP on the free-spins machine in the exposure phase, participants on the right had a higher RTP on the control machine. Mean experienced RTP percentages across participants in both groups are displayed above the figure.

RTP had no discernible effect on bet amounts. This is evidenced by participants being no more likely to bet more on the free-spins machine if this machine was also the higher RTP machine (Figure 11, left side of reference line) than participants with a higher RTP on the control machine (right side of reference line). This is consistent with the Without-features

Condition of Preference Study 1 where participants' bet amounts were also insensitive to RTP differences across the two machines. Due to lacking experimental control over which group participants were allocated, inferences from this data are limited. However, this result combined with the finding that participants were sensitive to RTP differences provides some tentative evidence that bet amounts may be less sensitive to RTP differences than preference.

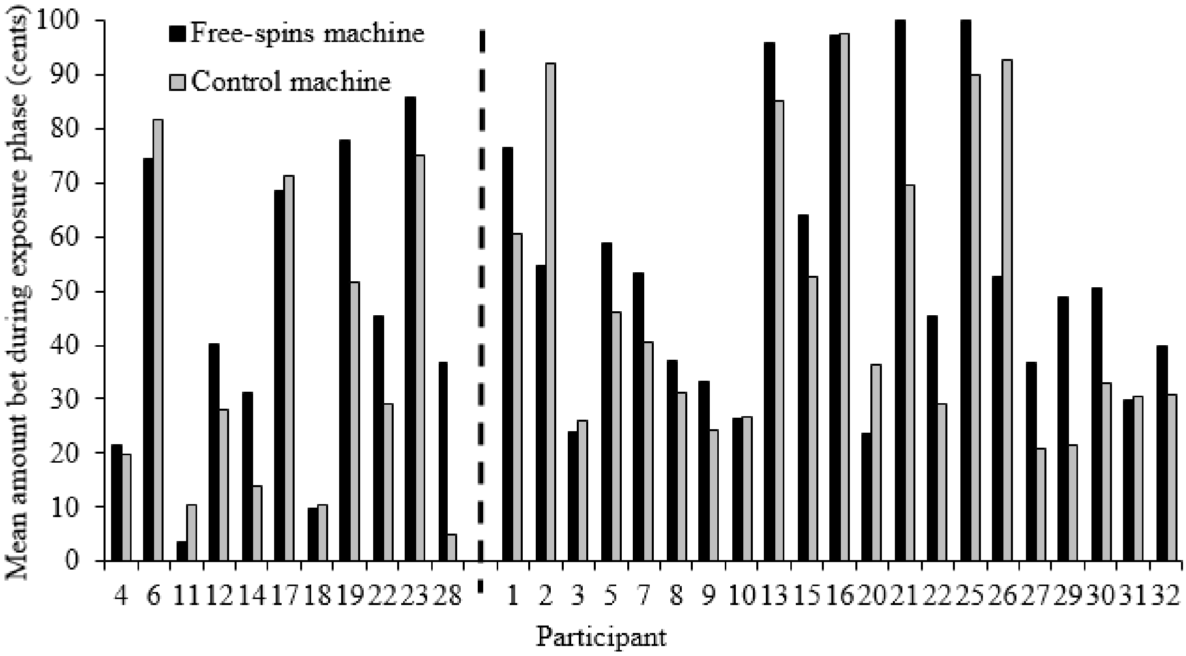

Figure 11. The mean bet-amount selection made by participants in the exposure phase. Participants on the left of the reference line had a higher RTP on the free-spins machine, participants on the right had a higher RTP on the control machine. Higher bars indicate higher average bet amounts.

To investigate whether participants' betting patterns varied as a function of preceding outcome, their bet amounts (in cents) following each outcome across both exposure and preference phases were analysed and displayed in Figure 12. There was variability in how much participants tended to bet in general, but participants tended to bet similar amounts following different outcomes. A repeated measures ANOVA with a within-subjects factor of outcome type (loss: $M = 53.493$, $SD = 29.601$; LDW: $M = 53.389$, $SD = 28.946$; medium win: $M = 56.297$, $SD = 28.808$; big win: $M = 54.636$, $SD = 28.614$; free spins: $M = 54.877$, $SD = 29.520$) indicated no significant difference in the mean amount bet following different outcomes, $F(1.711,53.042) = 0.851$, p = ns (Greenhouse-Geisser corrected for non-sphericity). This replicates the same finding from Preference Study 1, and provides some more support for the idea that logical fallacies such as the gambler's fallacy are not affecting participants' selection of bet amounts following these different outcomes.

Participants' bet amounts following different sized strings of losses during both exposure and preference phases are displayed in Figure 13. There was a pattern where participants tended to bet more in response to longer strings of losses, evidenced by 18 of 32 participants having the largest bet amounts following a string of five losses or more. However, only seven participants bet the lowest amount following one loss, indicating a precise linear trend of increasing bet amounts in response to increasing numbers of consecutive losses was not consistent across participants. A repeated measures ANOVA with a within-subjects factor of loss string (one: M = 51.343, SD = 31.645; two: M = 51.688, SD = 30.151; three: M = 54.131, SD = 28.075; four: M = 56.309, SD = 27.320; five or more: M = 61.128, SD = 27.866) revealed that the number of losses prior had a significant effect on bet-amount selections, $F(1.514,46.935) = 5.972$, $p = .009$ (Greenhouse-Geisser corrected for non-sphericity), $\eta_p^2 = .162$. This is considered a large effect size. Tests of within-subjects contrasts indicated that this pattern was well described by a linear trend, $F(1,31) = 6.964$, $p = .013$, $\eta_p^2 = .183$. This effect size is also considered large. This trend is apparent in Figure 13, however, only four participants show the exact linear trend described (9, 27, 30, 32). Increasing bet amounts in response to increasing numbers of losses in a row may reflect the gambler's fallacy, where people mistakenly believe prior events (e.g., number of losses in a row) provide a valid signal as to the likelihood of future events (e.g., upcoming wins), when in reality these events are independent from each other. Participants increasing bet sizes in response to longer strings of losses may reflect this mistaken belief – the idea that since they have lost several times in a row, they are "due" for a decent win.

To investigate whether participants' machine-switching behaviour varied as a function of preceding outcome, probability of switching machine following outcomes (loss, LDW, medium win, big win, free spins) were analysed for the preference phase and displayed in Figure 14. It was tentatively expected, based on the results of Preference Study 1, that participants would be least likely to switch following big wins and free spins. This was not supported by the data. Only 13 participants switched at least once following a free-spins sequence, fewer than the number who switched following all other outcomes (Losses, 29; LDWs, 19; medium wins, 17; big wins, 17), however, free-spins sequences were also more rare than these other outcomes. When participants did switch following free spins, the free-spins sequence was generally the outcome that was switched after the most frequently, with nine of 32 participants displaying this pattern. For reference, only Participants 7 and 8 never received a free-spins sequence in the preference phase. Participants received between 0 and 9 free-spins sequences in the preference phase with a mean of 6.375. Participants received between 15 and 33 big wins with a mean of 21.875. A repeated-measures ANOVA on participants' probability of switching slots following different outcomes, with a within-subjects factor of outcome (loss: $M = .044$, $SD = .048$; LDW: $M = .069$, $SD = .169$; medium win: $M = .073$, $SD = .173$; big win: $M = .086$, $SD = .173$; free-spins sequence: $M = .111$, $SD = .195$) indicated no main effect of outcome on subsequent switching, $F(2.275,70.522) = 2.130$, p = ns (corrected for non-sphericity).

Despite failure to reach statistical significance, this result has practical significance in that it does not replicate the finding from Preference Study 1 that participants were least likely to switch following free spins. While fewer participants switched following free spins than other outcomes, when participants did switch following free spins they were often, proportionally, the most switched after outcome. This provides some evidence that one previously outlined explanation for the Preference Study 1 switching result – lack of data – is most likely correct. At the same time, this result suggests that the lengthened preference phase in the current study also did not provide enough data to conclusively demonstrate whether participants switch more or less following free spins. If participants switched one time following a free-spins sequence, this was generally enough to make this proportionally the most switched-after event for them. This was due to the low frequency of free-spins sequences in comparison to other outcomes.

To investigate whether outcome type had an effect on the amount of time taken for subsequent responding, the response latencies made by participants were analysed and displayed in Figure 15. (Note, this figure represents the frequency of all participants' response latencies. Individual graphs for each participant are presented in Appendix E.) It was expected that participants would take longer to spin following larger sized wins, and this was supported by the data. There was a consistent pattern where responses following big wins (yellow lines) tended to be longer than responses following medium wins (green lines), which tended to be longer than responses following LDWs (blue lines). Responses following losses (red lines) were consistently shorter than responses following the above outcomes. In other words, larger sized wins resulted in longer pauses before the next spin. Frequency distributions also tended to be flatter when the amount won on the preceding spin was higher.

This indicates that response latencies following larger wins are more variable than response latencies following losses, or smaller wins. A Greenhouse-Geisser corrected repeated measures ANOVA with a within-subjects factor of outcome type (loss, LDW, medium win, big win) supported the above interpretation, revealing that outcome type had a significant effect on response latencies, $F(1.923,59.691) = 98.118$, $p < .001$, $\eta_p^2 = .760$. This is considered a substantial effect size. Tests of within-subjects contrasts indicated that this pattern was well described by a linear trend, $F(1,31) = 142.309$, $p < .001$, $\eta_p^2 = .821$, such that participants took the shortest amount of time (in seconds) to spin following losses (*M* = 1.246, *SD* = 0.164), longer following LDWs (*M* = 1.394, *SD* = 0.249), longer again following medium wins (*M* = 1.508, *SD* = 0.238), and the longest amount of time following big wins (*M* = 1.508, *SD* = 0.350). This effect size is also considered substantial.

These patterns are consistent with research showing that response latencies for both humans and animals tend to increase as a function of reward size (Delfabbro & Winefield, 1999; Dickerson, 1993; Peters et al., 2010). These extended latencies following wins may be interpreted as post-reinforcement pauses. Following this interpretation, the response latency findings may indicate that greater sized wins are more reinforcing than smaller wins or losses. Regardless of the reason behind the observed pattern, it is clear that participants discriminate the different outcome types and these outcome types have different effects on subsequent response latency.

Another potential explanation for the observed effect of outcome type on response latency is that the differing frequency of outcomes (big wins, medium sized wins, LDWs, losses) influences the time it takes participants to respond. For instance, participants may habituate to outcomes and respond more quickly to more frequent outcomes. This would explain the pattern observed in Figure 15 where the most frequent outcomes (losses) were associated with the shortest response latencies, and increasing rarity of outcomes (in order: LDWs, medium sized wins, big wins) were associated with longer response latencies. In an attempt to control for the confound of outcome frequency, participants' median response latencies following the first five outcomes of each type were compared with a Greenhouse Geisser corrected repeated measures ANOVA. The ANOVA revealed a significant difference in the time taken to respond following these outcomes, $F(2.239,69.399) = 4.999$, $p = .003$, $\eta_p^2 = .139$. This effect size is considered large. There was no significant linear trend. However, follow-up pairwise comparisons indicated that there was a significant difference between the response latencies (in seconds) following losses (*M* = 2.813, *SD* = 1.267) and LDWs (*M* = 2.213, *SD* = 0.892; *p* = .005). There was no significant difference in the time taken to respond following medium sized wins (*M* = 2.355, *SD* = 0.799), and big wins (*M* = 2.688, *SD* = 1.062), in comparison to any outcome type.

The above finding that participants respond more quickly following LDWs than losses is inconsistent with research showing that response latencies tend to increase as a function of reward size (Delfabbro & Winefield, 1999; Dickerson, 1993; Peters et al., 2010), and with research showing that participants respond faster after losses than wins (Schreiber & Dixon, 2001). The contrasting response latency findings when comparing results from the first five trials of each outcome type to all trials provide an indication that participants may have habituated to more frequent outcomes, resulting in the faster response latencies following losses observed in Figure 15 and the linear trend revealed by the ANOVA. Analysing the first five outcomes for each type is also not a perfect analysis. Participants tended to respond more quickly throughout the experiment, and the order of outcome exposure was the same across participants. This potentially confounds the first five trials of each outcome type analysis. Losses were the most frequent outcome, and the first five losses occurred earlier in the experiment than the first five outcomes of the other outcome types. The five losses occurring earlier in the experiment could explain participants taking longer to respond following these outcomes. Further research could systematically investigate the effect of outcome type on response latency while controlling for outcome frequency. This was not the focus of the current investigation, and due to the possible confounds described, response latency analyses were not included in subsequent experiments investigating preference for free-spins/bonus features.

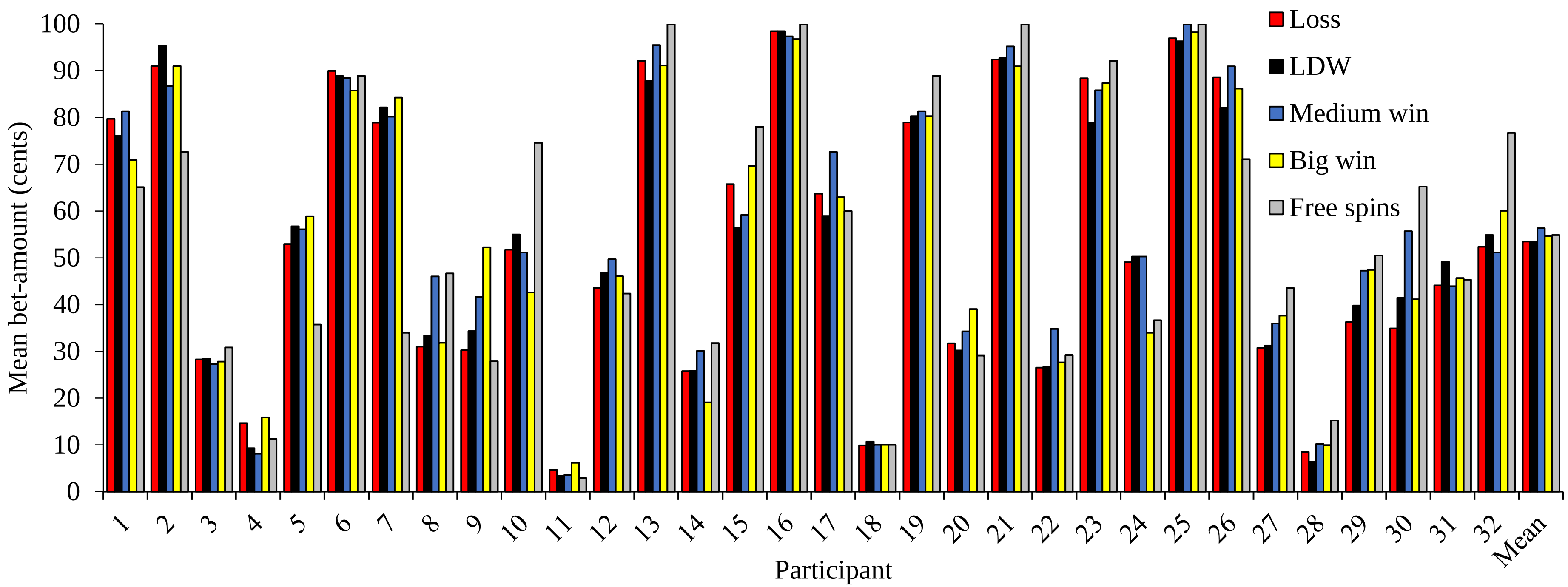

Figure 12. The mean bet-amount selection made by participants following various outcomes in both exposure and preference phases. Higher bars indicate greater average bet amounts following that event. Mean bet amounts following outcomes across participants are displayed on the right.

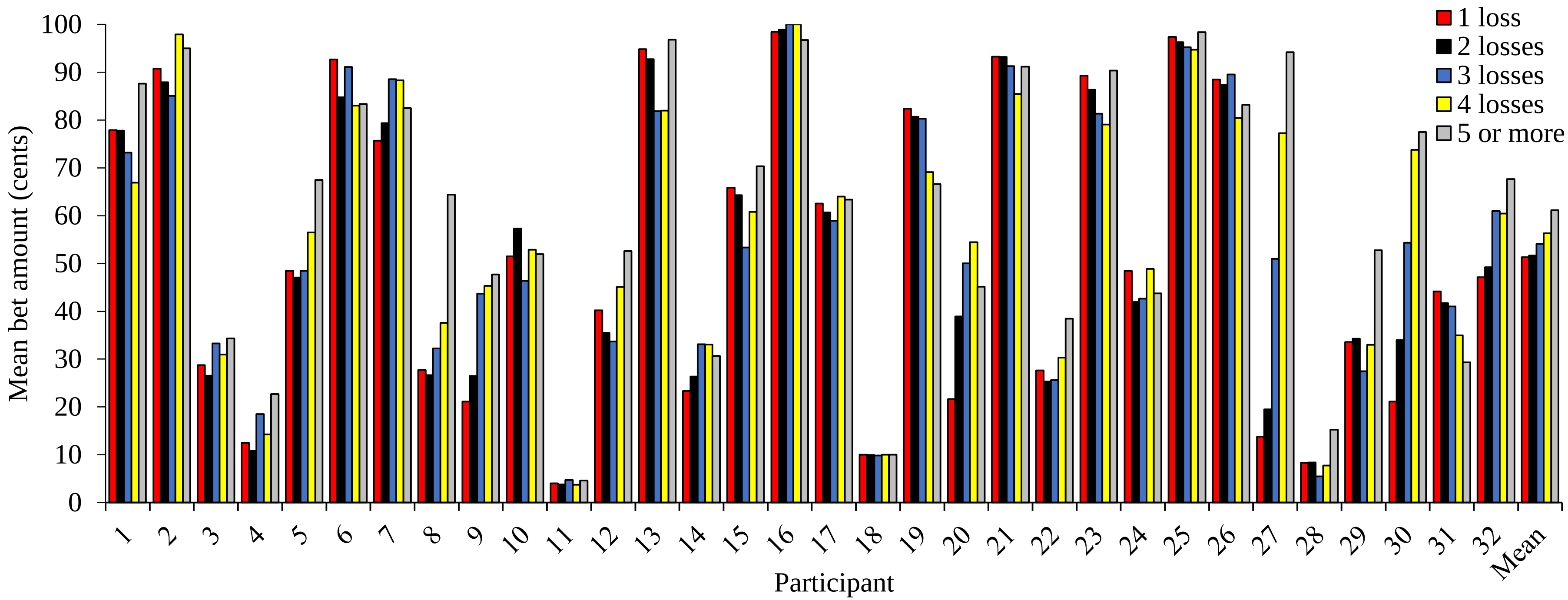

Figure 13. The mean bet amount selection made by participant following various sized strings of losses in both the exposure and preference phases. Higher bars indicate greater average bet amounts following those events. Mean bet amounts following outcomes across participants are displayed on the right.

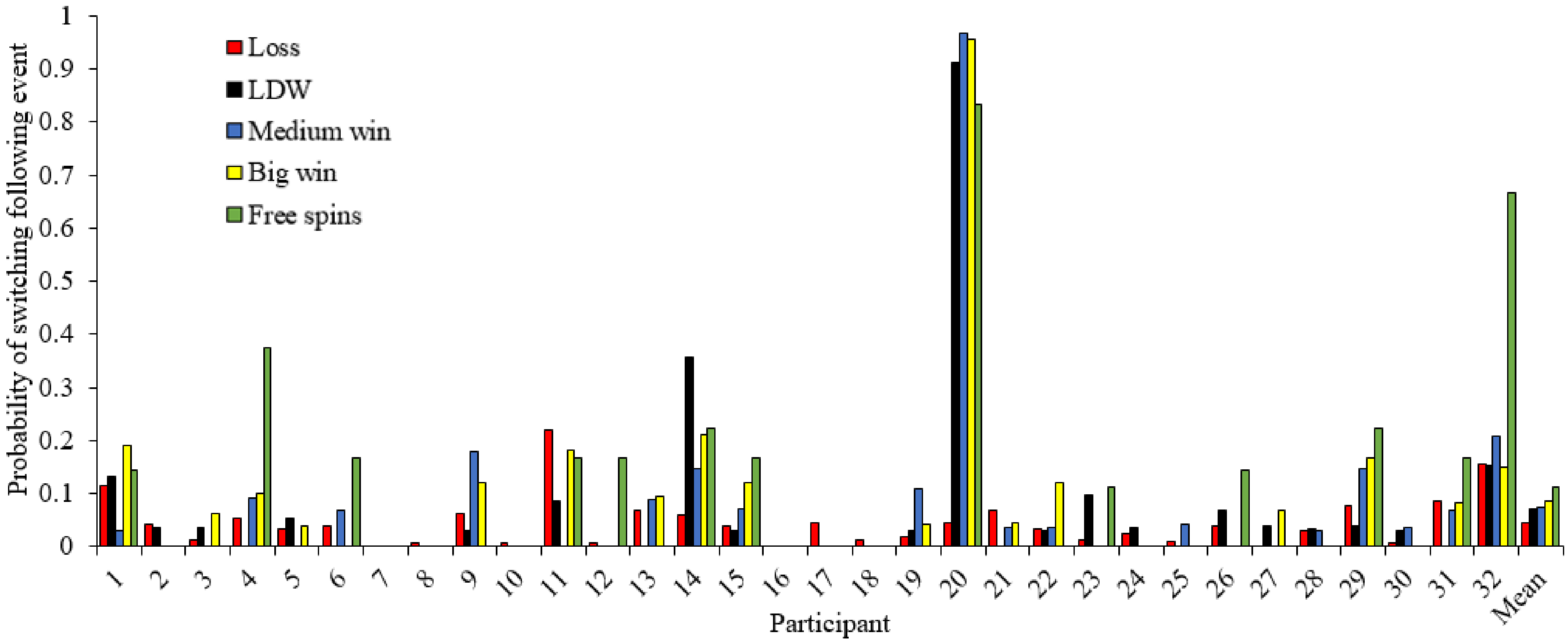

Figure 14. The probability of participants switching to the alternate slot following various outcomes in the preference phase. The y-axis displays the proportion of outcomes that participants switched slots after. Higher bars indicate more switching. Means across participants are displayed on the right.

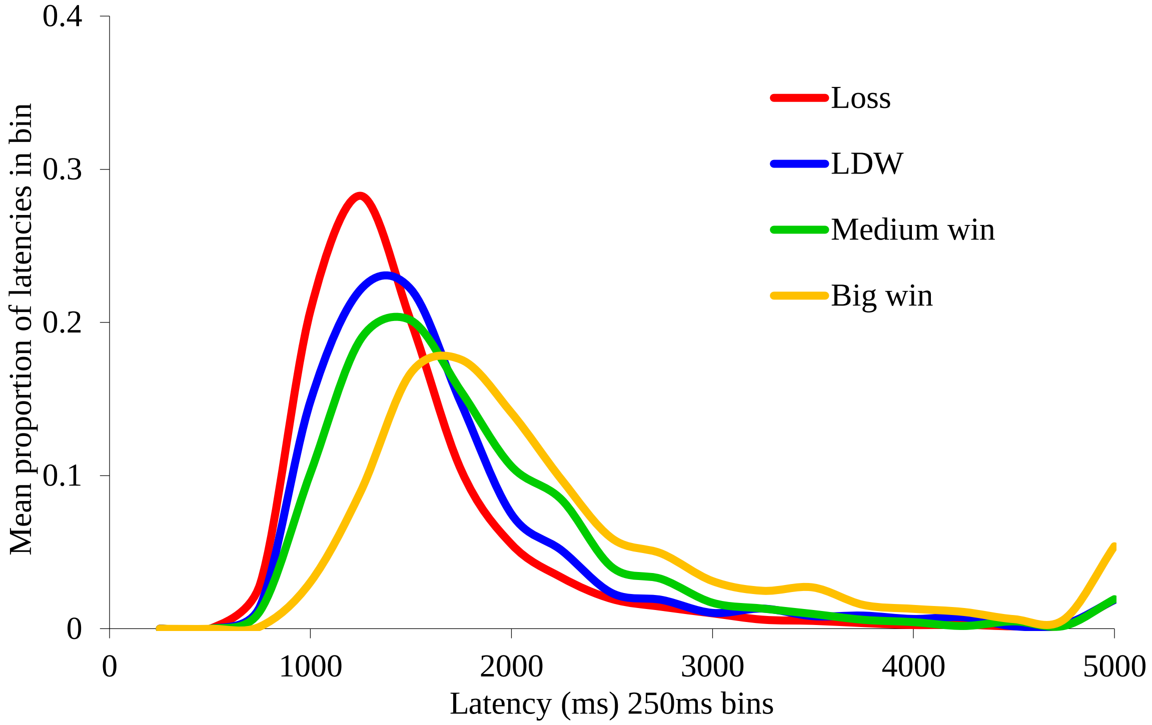

Figure 15. The mean frequency distributions of response latencies made by participants following various outcomes. The y-axis displays the mean proportion of participants' response latencies that fell in a bin, the x-axis displays latency in 250 ms bins. Numbers on the x-axis reflect the top of a bin, except for the last bin which included all latencies longer than 4751ms. Distributions to the left indicate less time taken to respond following an outcome, distributions to the right indicate more time taken to respond.

Experiment 2

The aim of this experiment was to investigate whether participants prefer a slot-machine simulation with free spins over a simulation without free spins, when the free-spins machine was associated with extra features that exploratory visits to gambling establishments and the Added-features Condition of Preference Study 1 indicated were important drivers of preference. It was expected that participants would consistently prefer the free-spins machine.

Method

Participants. Thirty two additional psychology students enrolled in a first year psychology course participated in partial fulfilment of a course requirement. The consent and debriefing process, and completion of the SOGS was the same as in Experiment 1. No participant's SOGS score indicated that they were at risk of problem gambling.

Materials and Stimuli. The materials and stimuli were the same as for Experiment 1.

Experimental Conditions. The slot-machine simulations were the same as those for Experiment 1, but with the following changes to the free-spins machine:

- When free-spins were won, participants saw a GIF image related to the slot-machine theme and text stating “Congratulations, you have won 5 free spins!” This animated image replaced the JPEG image participants saw in Experiment 1.
- When the GIF was presented, participants were required to click a red button labelled “start feature” to initiate the free-spins sequence.
- Music played during the free spins sequence (the Windows sound “flourish”). No music played at any other time.
- The free-spins machine displayed the message “Match three of these [free-spins symbols] to gain 5 free spins”
- When each reel stopped spinning, a distinctive sound played if a free-spins symbol had landed on one of the betting lines. This occurred whether one, two, or three free-spins symbols appeared (three symbols were required to trigger the free-spins sequence).
- Wins that occurred during free-spins sequences were added to the balance differently, this is explained in more detail below.
- An increased rate of wins during the free-spins feature. This was conveyed to participants during the free spins sequence with an on-screen message reading “Win chance multiplied!”.

Programmed outcome frequencies for both machines in the exposure phase are displayed in Table 5. Note that the top part of the table displays probabilities for a given outcome occurring on any one of the three lines. The final three rows display overall win frequencies (of any magnitude) per three-line spin. Free spins were won on 3% of spins on the free-spins machine.

During the free spins sequence, the cumulative amount won was tracked by a balance display to the left of the main balance. Each win was added to this balance in one cent increments if the total win size was smaller than or equal to $1.50, or in 10 cent increments if the total win size was greater than $1.50. After the final free spin of the sequence, this separate balance (the total amount won during the free spins) was added to the main balance by a similar animation – the separate balance counted down while the main balance counted up.

Table 5.

Programmed Outcome Probabilities on each Slot Machine for Experiment 2

Outcome	Free-spins machine	Control machine
Outcome Probability Per Individual Line		
loss	.85	.87
2*	.06	.05
5*	.03	.04
8*	.03	.02
10*	.01	.02
30*	.01	.01
5 free spins	.01	0
Resultant Outcome Frequencies Per Spin (betting lines collapsed)		
Programmed RTP	0.89	0.89
Programmed / experienced probability of win	.35	.36
Experienced/programmed probability of winning during free-spins feature	.60	n/a
Experienced/programmed probability of winning outside free spins	.32	.36

Note. *Programmed outcome is multiplied by the bet-amount selected

Procedure. This experiment was conducted in the same room as Experiment 1, and on the same computers. Participants completed two exposure phases and one preference phase in the same manner as Experiment 1. All participants completed 300 spins in the preference phase within the time limit.

Data analysis. Data were analysed in the same manner as in Experiment 1.

Results and Discussion

To investigate whether participants preferred the machine with free spins, the proportion of responses they made on the machine with free spins during the preference phase is displayed in Figure 16. Participants consistently preferred the free-spins machine. Twenty nine participants allocated more spins to the free-spins machine, while three allocated more to the control machine. A mixed ANOVA with a within-subjects factor of machine (free-spins, control), and between-subjects factor of exposure order (first exposed to free-spins machine, first exposed to control machine) supported this interpretation, revealing a substantial main effect of the free-spins feature on preference, $F(1,30) = 16.361$, $p < .001$, $\eta_p^2 = .353$, such that participants allocated more spins to the free-spins machine (M = 185.840, SD = 67.317) than the control machine (M = 81.660, SD = 79.388).

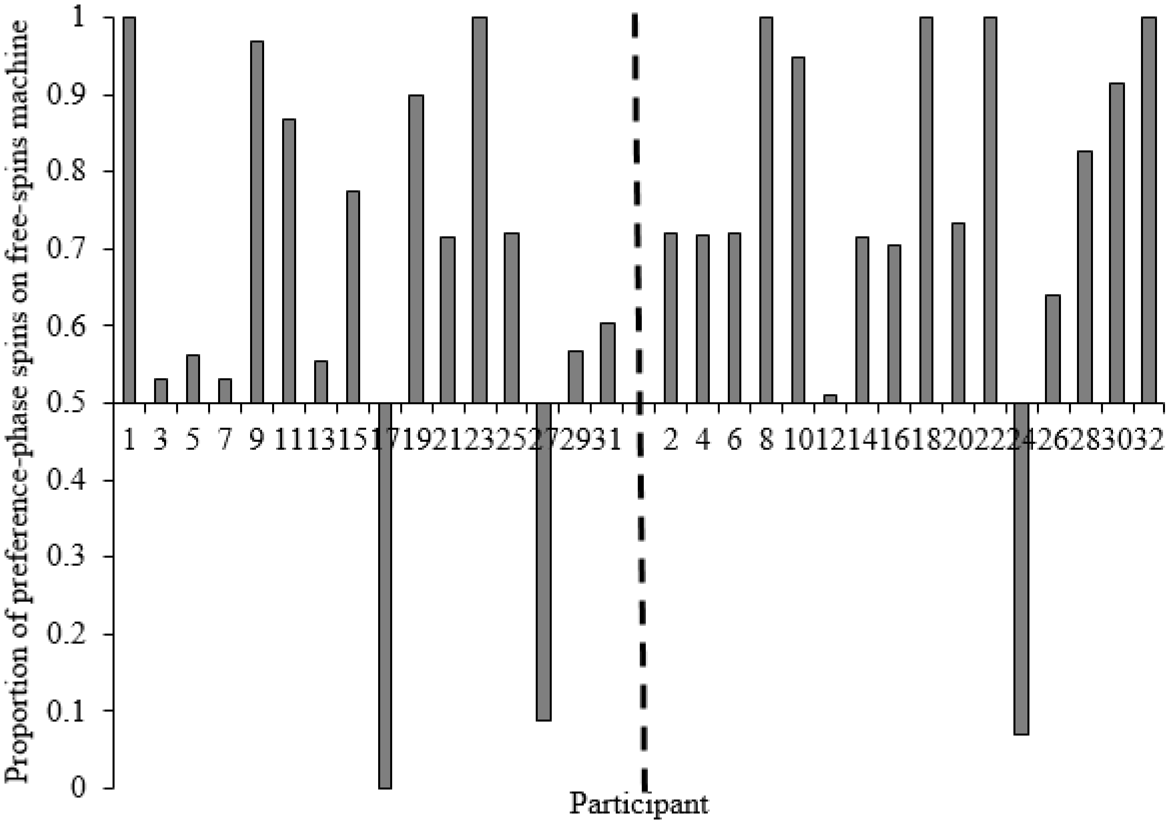

Figure 16. The proportion of preference-phase spins participants made on the free-spins machine. Bars above .5 indicate a preference for the machine with free spins. Bars below .5 indicate a preference for the machine without free spins. The length of the bars indicate the extent of participants' preference. Participants on the left of the reference line were exposed to the control machine first, participants on the right were exposed to the free-spins machine first.

It was expected that participants would prefer the free-spins machine. This hypothesis was supported as nearly every participant preferred it. This is consistent with the research outlined above where participants report preferring free-spins machines, and also replicates the finding from the Added-features Condition of Preference Study 1 that participants preferred the free-spins machine when it was associated with additional features such as an increased reinforcement rate, animations and music. As in Preference Study 1, the contrasting preference results between Experiments 1 and 2 suggest that the additional features added to the free-spins sequence are drivers of preference for a free-spins machine. However, at this point it is unknown what the influence of each individual added feature is. Preference for the free-spins machine in this experiment, in contrast to the results of Experiment 1, suggests that the "freeness" of the free spins – the fact that they cost the gambler nothing while affording the opportunity to win money – is not an important driver of preference for free spins. To investigate this more thoroughly in Experiment 3, the free-spins machine used in Experiment 2 was adapted to retain all features of the free spins feature apart from "freeness".

As seen in Figure 16, order of exposure to the different slot-machine simulations had no clear effect on preference. The ANOVA supported this interpretation, indicating no significant interaction between order and preference, $F(1,30) = 1.419$, p = ns, such that the number of spins participants allocated to the free-spins and control machines did not depend on whether they experienced the control machine first (free-spins: $M = 171.563$, $SD = 73.916$; control: $M = 98.063$, $SD = 86.527$), or the free-spins machine first (free-spins: $M = 200.125$, $SD = 58.878$; control: $M = 65.250$, $SD = 70.456$). This is consistent with the results of Experiment 1, where there was also no effect of exposure order on preference. However, this result is contrary to the results of Preference Study 1, where participants generally preferred the first machine exposed to. This provides further evidence that changes to the method between Preference Study 1 and the current study (described in Experiment 1) reduced the effect of exposure order on the number of spins participants subsequently allocated to each machine.

Figure 17 displays the same preference data with participants separated based on which machine had the higher RTP in the exposure phase. Experienced RTP in the exposure phase had no clear discernible effect on preference – regardless of which machine had the higher RTP participants preferred the free-spins machine. Participants failing to discriminate moderate RTP differences across different slot-machine simulations is consistent with Experiment 1 of the current study, as well as the Without-features Condition of Preference Study 1. Generally, other research has failed to find an effect of RTP on gambling behaviour (Brandt & Pietras, 2008; Haw, 2008; Schreiber & Dixon, 2001; Weatherly & Brandt, 2004; Weatherly et al., 2009). This result also indicates that participants' preference for the free-spins machine was not simply driven by experiencing a higher RTP on that machine – even when the higher RTP machine was the control machine, participants still preferred the free-spins machine.

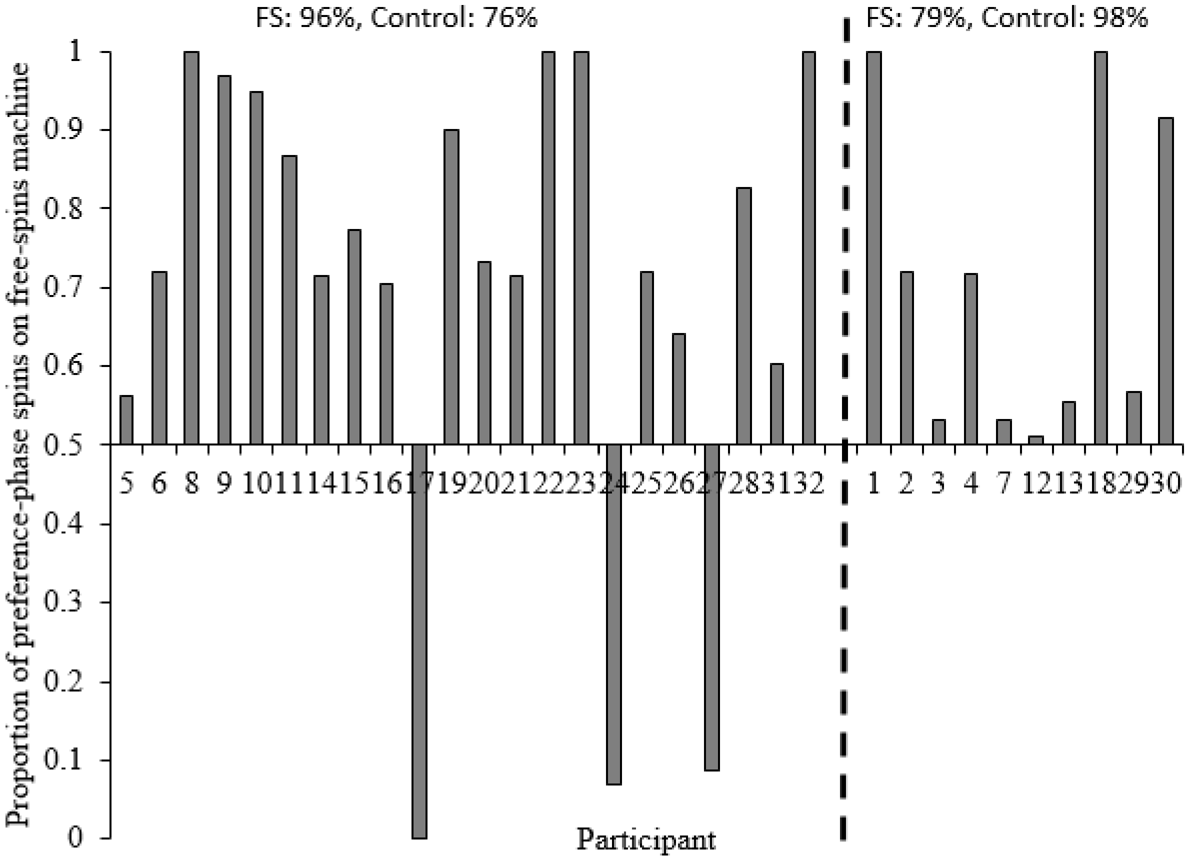

Figure 17. The proportion of preference-phase spins participants made on the free-spins machine. Bars above .5 indicate a preference for the free-spins machine. Bars below .5 indicate a preference for the control machine. The length of the bars indicate the extent of participants' preference. Participants on the left of the reference line had a higher RTP on the free-spins machine in the exposure phase, participants on the right had a higher RTP on the control machine. Mean experienced RTP percentages across participants in these groups are displayed above the graph.

There was no clear pattern of participants wagering more cents on either the free-spins (*M* = 44.462, *SD* = 30.381) or control machine (*M* = 45.537, *SD* = 28.038), these data are displayed in Figure 18. A mixed ANOVA with a within-subjects factor of machine (free-spins, control) and a between-subjects factor of exposure order indicated no significant main effect of machine on the amount bet in the exposure phase, $F(1,30) = 0.176$, p = ns. The ANOVA also revealed no significant interaction between bet amounts on each machine and exposure order, $F(1,30) = 0.209$, p = ns, such that bet amounts on the free-spins and control machines did not depend on whether participants were first exposed to the control machine (free-spins: *M* = 40.768, *SD* = 30.763; control: *M* = 40.672, *SD* = 27.552) or the free-spins machine (free-spins: *M* = 48.156, *SD* = 30.529; control: *M* = 50.402, *SD* = 28.549).

These findings regarding bet amount are inconsistent with Experiment 1 of the current study, where participants tended to wager larger amounts on the free-spins machine. However, these findings are consistent with both conditions of Preference-Study 1 (one of which is systematically replicated by the current experiment), where participants bet similar amounts on both machines. This result provides evidence that free-spins features have a negligible effect on bet-amount selections, and also suggests that preference and bet-amount selections have different underlying drivers – even when the free-spins machine is consistently preferred, participants do not wager more (or less) on it.

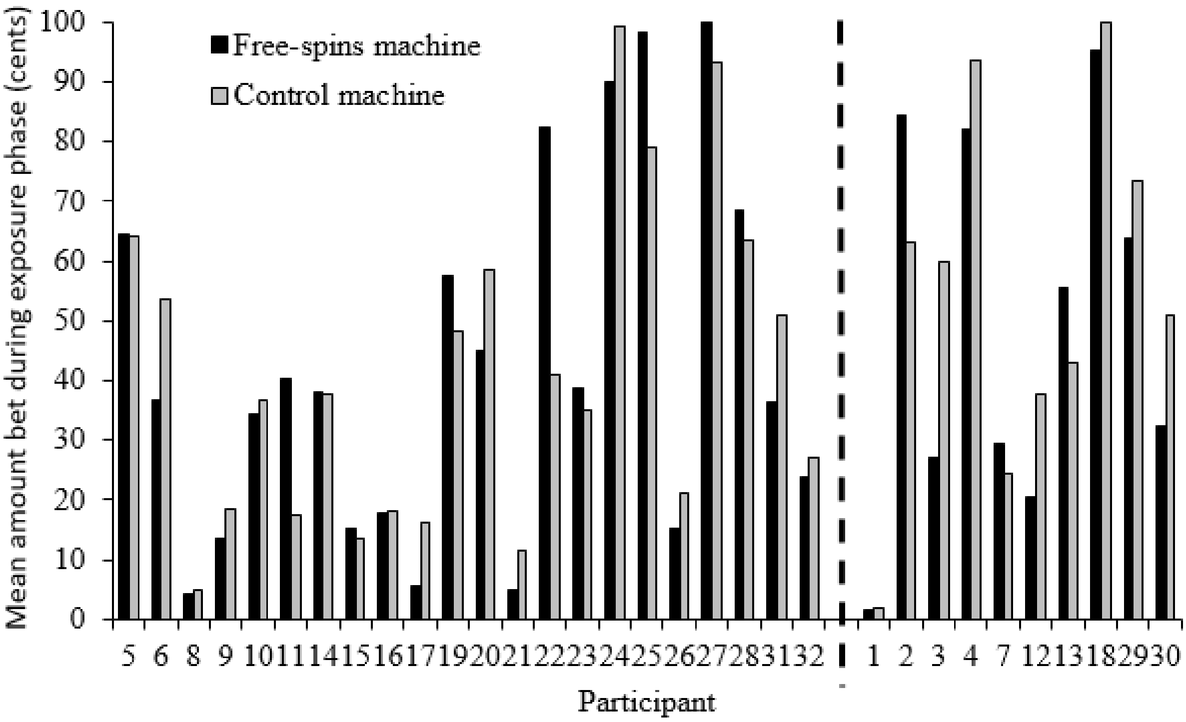

Figure 18. The mean bet-amount selection made by participants in the exposure phase. Participants on the left of the reference line had a higher RTP on the free-spins machine, participants on the right had a higher RTP on the control machine. Higher bars indicate higher average bet amounts.

As seen in Figure 18, participants tended to bet more on the control machine when it was also the higher RTP machine (right side of reference line), this pattern was displayed by seven of the 10 participants in this group. However, participants who had a higher RTP on the free-spins machine (left side of reference line) were not more likely to bet more on the higher RTP machine. Overall, it appears participants' bet amounts were insensitive to RTP differences. This is consistent with Experiment 1, as well as the Without-features Condition of Preference Study 1, where participants did not tend to bet more on the higher RTP machine. However, this is inconsistent with the Added-features Condition of Preference

Study 2 which this experiment replicates. In that Condition, participants tended to wager more on the higher RTP machine, and also tended to prefer the higher RTP machine. Taken together, these results indicate that participants' apparent sensitivity to RTP differences in the Added-features Condition of Preference Study 1 was not driven by the added features in the free-spins feature. It seems more likely that sensitivity to small to moderate RTP differences in the population is generally low, but that the Added-features Condition of Preference Study 1 happened to sample a greater proportion of participants who did have some sensitivity to RTP differences.

To investigate whether participants' betting patterns varied as a function of preceding outcome, their bet amounts following each outcome across both exposure and preference phases were analysed and displayed in Figure 19. There was variability in how much participants tended to bet in general, but participants tended to bet similar amounts following different outcomes. The most consistent pattern was that participants tended to bet larger amounts (in cents) following free-spins sequences in comparison to other outcomes, with 12 of 32 participants displaying this pattern. However, a repeated measures ANOVA with a within-subjects factor of outcome type (loss: M = 49.400, SD = 29.234; LDW: M = 51.601, SD = 27.805; medium win: M = 51.840, SD = 29.188; big win: M = 52.178, SD = 28.776; free spins: M = 54.061, SD = 32.885) indicated no significant difference in the mean amount bet following different outcomes, $F(2.119,65.676) = 1.919$, p = ns (corrected for non-sphericity). Bet amounts being unaffected by prior outcome type replicates the same finding from Preference Study 1, as well as the same finding in Experiment 1 of the current study, and provides more support for the idea that logical fallacies are not affecting participants' selection of bet amounts following these different outcomes.

Participants' average bet amounts (in cents) following different sized strings of losses during both exposure and preference phases are displayed in Figure 20. There was no consistent pattern of participants betting more or less following different sized strings of losses. Approximately 13 of 32 participants showed a general trend of betting more in response to longer strings of losses, however no participant showed the exact linear trend of larger bets following more previous losses. A repeated measures ANOVA (corrected for non-sphericity) with a within-subjects factor of loss string (one: M = 47.468, SD = 29.686; two: M = 47.786, SD = 29.675; three: M = 47.800, SD = 30.789; four: M = 50.045, SD = 29.903; five or more: M = 47.724, SD = 30.669) indicated the number of previous losses in a row had no significant effect on bet-amount selections, $F(2.574,79.789) = 1.256$, p = ns.

Most participants in the current experiment did not show a linear pattern of betting more in response to longer strings of losses, indicating that the gambler's fallacy was not affecting their betting behaviour. If the linear trend observed in Experiment 1 was due to the gambler's fallacy, it is possible that only some participants succumb to the false belief that more recent losses indicate wins are "due". If a participant believes (accurately) that slot-machine events are independent from one another, then they would not expect a lack of wins to indicate upcoming wins, and would not be expected to increase bet sizes in response to longer strings of losses. It is possible that Experiment 1 happened to sample more participants who fell victim to the gambler's fallacy, and/or who were more sensitive to different sized strings of losses.

Participants' probability of switching machine following outcomes (loss, LDW, medium win, big win, free spins) in the preference phase are displayed in Figure 21. As in Experiment 1, when participants switched following a free-spins sequence, it tended to be the event they switched after the most. This pattern is displayed by 10 of 32 participants. However, only 12 participants ever switched after a free-spins sequence. Participants were more likely to switch at least once following losses (26 participants), LDWs (15), and medium sized wins (19). Participants generally switched the least often following big wins. For reference, participants received between 0 and 9 free-spins sequences in the preference phase with a mean of 6.594. Participants received between 24 and 26 big wins with a mean of 24.844. A repeated-measures ANOVA on participants' likelihood of switching slot machines following different outcomes with a within-subjects factor of outcome (loss; $M = .044$, $SD = .051$; LDW: $M = .036$, $SD = .055$; medium win: $M = .058$, $SD = .076$; big win: $M = .026$, $SD = .044$; free-spins sequence: $M = .074$, $SD = .116$) indicated a significant main effect on outcome type on subsequent switching, $F(1.716,53.209) = 3.445$, $p = .046$ (Greenhouse-Geisser corrected), $\eta_p^2 = .100$. This effect size is considered large. Pairwise comparisons indicated this difference was driven by participants switching more often following medium sized wins in comparison to big wins.

The finding that participants tended to switch the least often following big wins is consistent with the preference-pulse research described earlier. Pigeons tend to stay on a just-reinforced alternative, and larger reinforcers prompt larger and longer preference pulses (Landon et al., 2003). The fewest participants switched following free-spins sequences, while at the same time participants who did switch following free spins switched proportionally more following this event than following other outcomes. This suggests that more free-spins sequences are needed to draw strong conclusions (i.e., more opportunities to switch following free spins). As in Experiment 1, when a participant switched just one time following a free-spins sequence, this was generally enough for the free-spins sequence to be, proportionally, their most switched after event, given the small number of opportunities to switch after them.

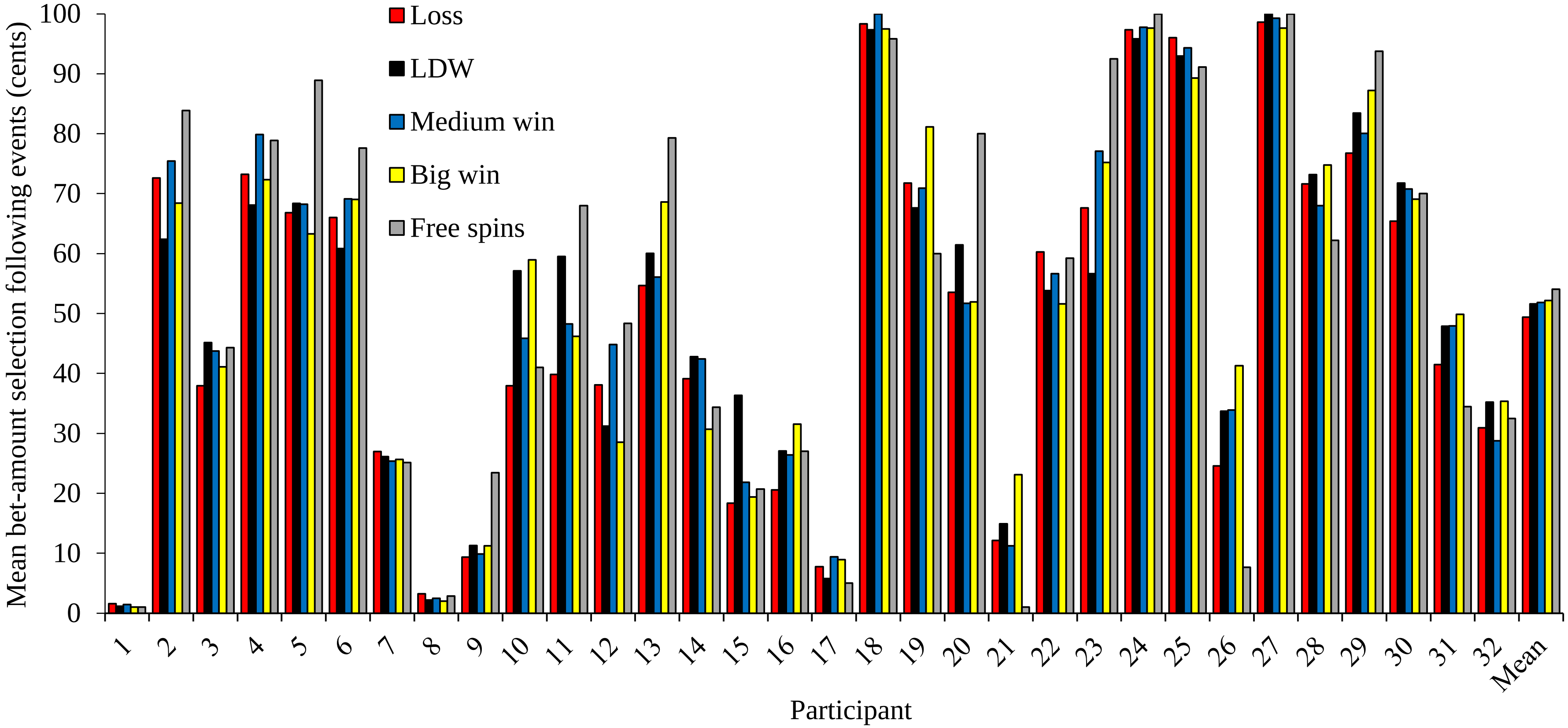

Figure 19. The mean bet-amount selection made by participants following various outcomes in both exposure and preference phases. Higher bars indicate greater average bet amounts following that event. Mean bet amounts following outcomes across participants are displayed on the right.

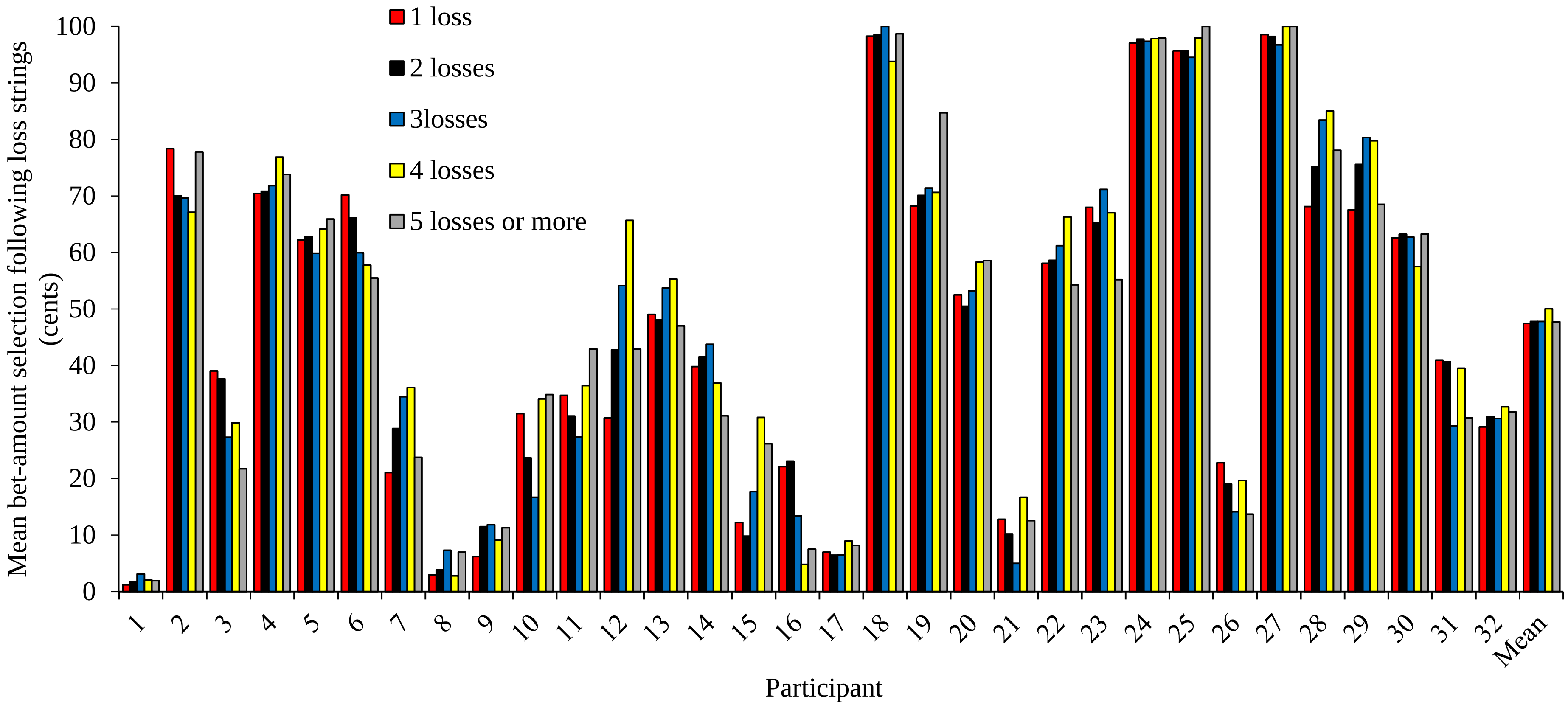

Figure 20. The mean bet-amount selection made by participants following different sized strings of losses in both exposure and preference phases. Higher bars indicate greater average bet amounts following that event. Mean bet amounts following different loss strings across participants are displayed on the right.

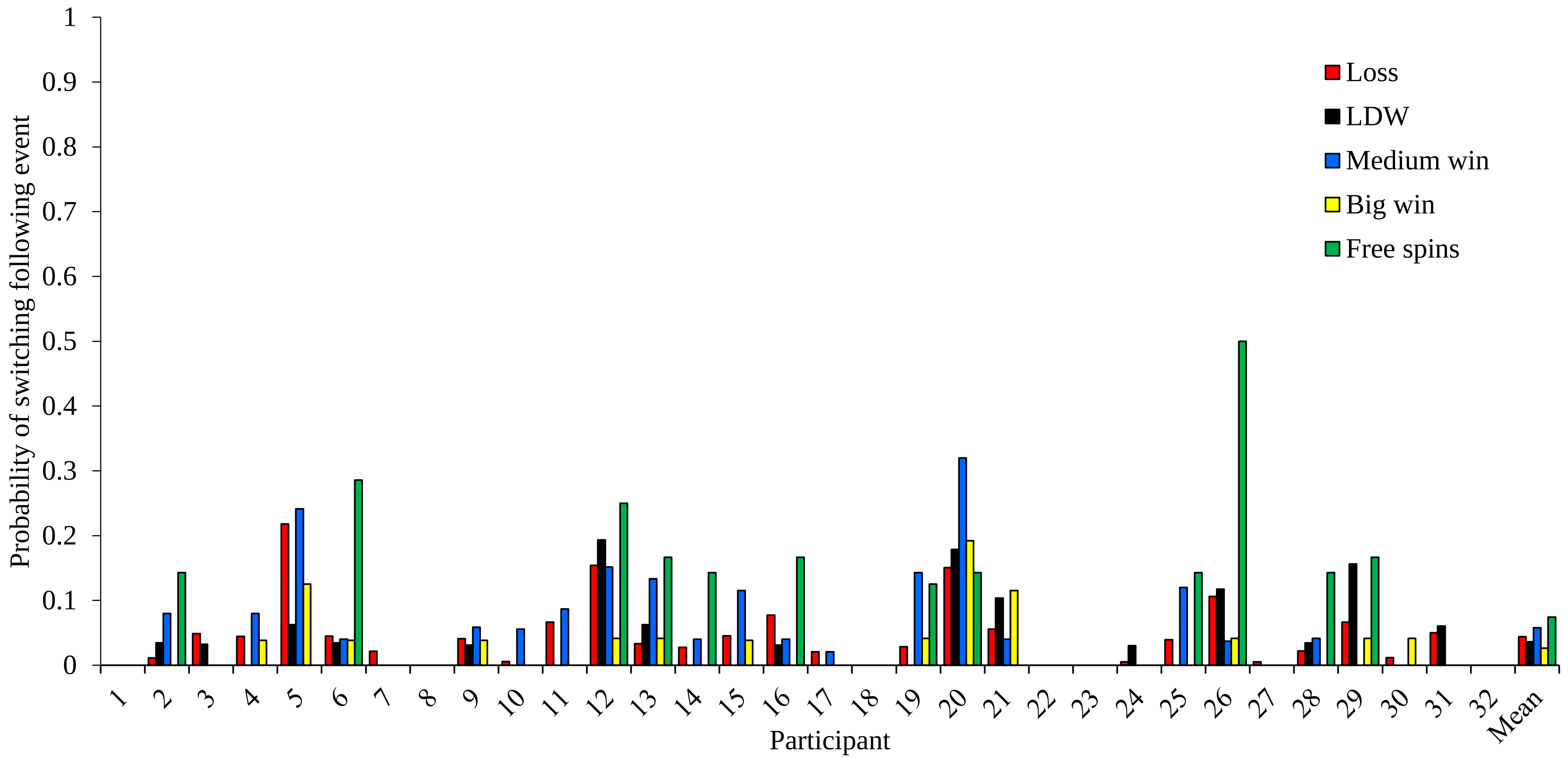

Figure 21. The probability of participants switching to the alternative slot machine following various outcomes in the preference phase. The y-axis displays the proportion of outcomes that participants switched slot machines after. Higher bars indicate more switching. Means across participants are displayed on the right.

Experiment 3

The results of Experiments 1 and 2 suggest that the higher win rate and added sounds, labels and animations during free-spins sequences are the important drivers of preference for free spins, and suggest that the "freeness" of free spins are not. The current experiment tested this last conclusion more directly. The free-spins machine from Experiment 2 was adjusted to no longer be free – spins during the bonus sequence still took money from participants' balances, and participants were still required to click the "MAX LINES" button to initiate each spin during the bonus mode. As this bonus sequence was no longer free, it will be referred to as the "bonus machine". As the bonus machine retained all the features that the results of Experiment 2 suggested were important drivers of preference, it was expected that participants in this experiment would consistently prefer the bonus machine.

Method

Participants. Thirty-two additional first year psychology students took part in Experiment 3 in partial fulfilment of a course requirement. The consent and debriefing process, and completion of the SOGS was the same as the prior experiments. One participant (participant number 15) scored in a problematic range on the SOGS. This participant was provided with contact information for local problem gambling support services.

Materials and stimuli. The materials and stimuli were the same as Experiments 1 and 2.

Experimental conditions. The slot-machine simulations were the same as those used in Experiment 2, with some changes to the free-spins machine as listed below:

- Participants clicked the "MAX LINES" button to initiate each spin during the bonus mode (instead of spins initiating automatically).
- Each bonus-mode spin cost the same amount as the spin that had triggered the bonus mode (participants could not chose bet amounts during the bonus mode as this would enable a strategy of increased bet and win amounts during this time that would inflate their RTP percentage).
- The message displayed during the animated image at the start of the bonus mode read "Congratulations, you have won the bonus feature!"

- The text on the free-spins symbols was changed from “Free spins” to “Wildcard” and the bonus machine displayed the message “Match three of these [wildcard symbol] to enter the bonus mode”.

Programmed outcome frequencies for both machines in the exposure phase are displayed in Table 6. Note that the top part of the table displays probabilities for a given outcome occurring on any one of the three lines. The final three rows display overall win frequencies (of any magnitude) per three-line spin. The bonus mode was won on 3% of spins on the bonus machine.

Table 6.

Programmed Outcome Probabilities on each Slot Machine for Experiment 3

Outcome	Bonus machine	Control machine
Per Individual Line		
loss	.88	.86
2*	.05	.05
5*	.03	.04
8*	.02	.02
10*	.01	.02
30*	.01	.01
5 free spins	.01	0
Resultant Outcome Frequencies (each bet is on three lines)		
Programmed RTP	92%	92%
Programmed/ experienced probability of win	.36	.35
Programmed/experienced probability of winning during Bonus Mode	.60	n/a
Programmed/experienced probability of winning outside Bonus Mode	.32	.35

Note. *Programmed outcome is multiplied by the bet-amount selected

Procedure. This experiment was conducted in the same room and on the same computers as Experiments 1 and 2. Participants completed two exposure phases and one preference phase in the same manner as Experiments 1 and 2. All participants completed 300 spins in the preference phase within the time limit except participants 4 (204 spins) and 28 (287 spins).

Data analysis. Data were analysed as in Experiments 1 and 2.

Results and Discussion

To investigate whether participants preferred the bonus machine, the proportion of responses they made on the bonus machine during the preference phase is displayed in Figure 22. Participants generally preferred the bonus machine, with 23 of 32 participants allocating more spins to the bonus machine. A mixed ANOVA with a within-subjects factor of machine (bonus, control), and between-subjects factor of exposure order (first exposed to bonus machine, first exposed to control) supported this interpretation, revealing a substantial main effect of the bonus feature on preference, $F(1,30) = 14.886$, $p = .001$, $\eta_p^2 = .332$, such that on average participants allocated more spins to the bonus machine ($M = 175.500$, $SD = 60.819$) than the control machine ($M = 86.469$, $SD = 69.076$).

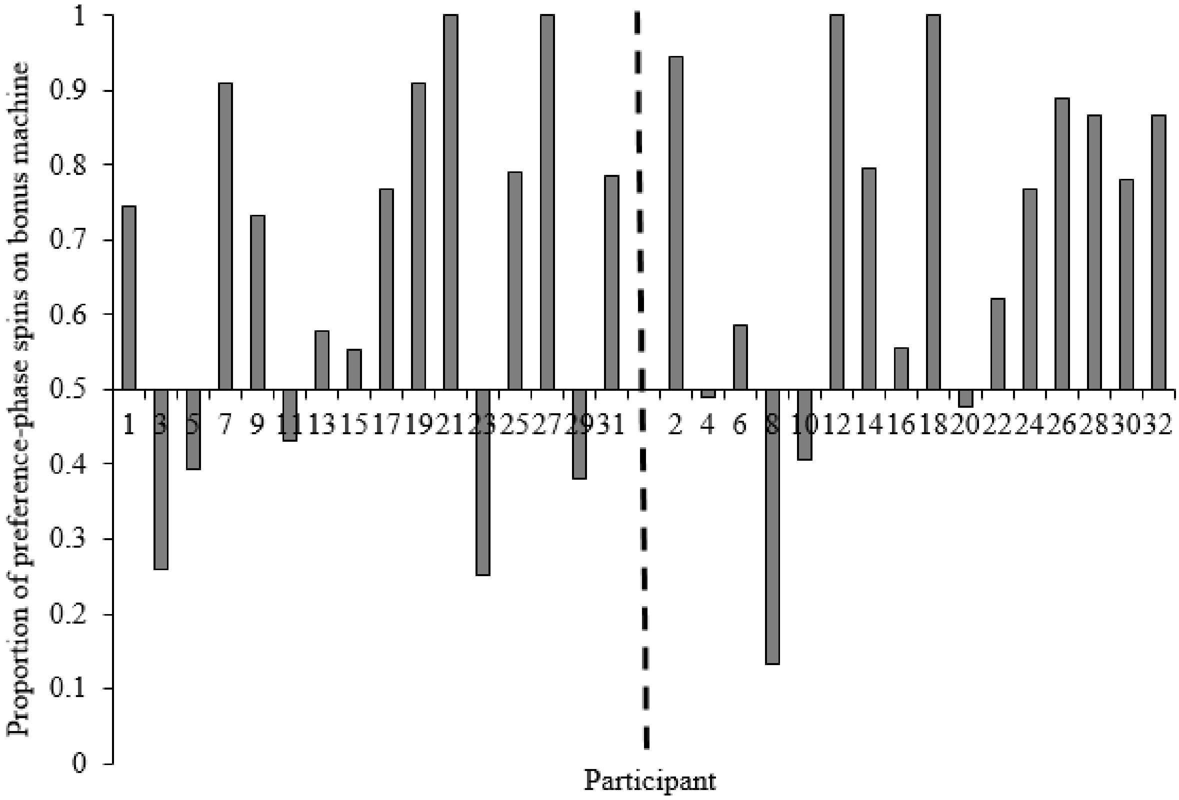

Figure 22. The proportion of preference-phase spins participants made on the bonus machine. Bars above .5 indicate a preference for the bonus machine. Bars below .5 indicate a preference for the control machine. The length of the bars indicate the extent of participants'

preference. Participants on the left of the reference line were exposed to the control machine first, participants on the right were exposed to the bonus machine first.

It was expected that participants would prefer the bonus machine, and this hypothesis was supported by the results. Preference for the bonus machine was fairly consistent across participants and this interpretation was supported by the mixed ANOVA. The results of Experiments 1 and 2 suggested that the "freeness" of the free-spins bonus mode was not an important driver of preference, and the results of Experiment 3 further support that idea. Participants still preferred the bonus machine even when spins cost money, and participants still had to click a button to initiate each spin. This result also further supports the idea that the additional features added to the free-spins machine in Experiment 2 (which were retained for the current experiment) result in preference for the machine with those features.

As seen in Figure 22, order of exposure to the simulations had no clear effect on preference. The ANOVA supported this interpretation, revealing no significant interaction between order and preference, $F(1,30) = 0.236$, p = ns, such that the number of spins participants allocated to the bonus and control machines did not depend on whether they experienced the control machine first (free-spins $M = 172.250$, $SD = 61.165$; control: $M = 94.438$, $SD = 72.169$), or the bonus machine first (free-spins: $M = 178.750$, $SD = 62.296$; control: $M = 78.500$, $SD = 67.211$). This lack of order effect is consistent with both Experiments 1 and 2 of the current study, and provides further evidence that increasing the length of the preference phase, shortening the exposure phases, and resetting participants' balances at the beginning of each exposure phase and the preference phase resulted in greatly reducing the order effect seen in Preference Study 1.

Figure 23 displays the same preference data with participants separated based on which machine had the higher RTP in the exposure phase. Experienced RTP in the exposure phase had a clear effect on preference – 17 of the 19 participants who experienced a higher RTP on the bonus machine preferred the bonus machine, whereas only seven of the 13 participants who experienced a higher RTP on the control machine preferred the bonus machine. This result is in contrast to Experiments 1 and 2, where RTP had no clear effect on preference.

Unlike in Experiments 1 and 2, experienced RTP in the exposure phase had a clear effect on preference in Experiment 3. Participants generally preferred the bonus machine, but responding was also pushed towards the machine with higher RTP, resulting in consistent preference for the bonus machine across participants when it was also the higher-RTP

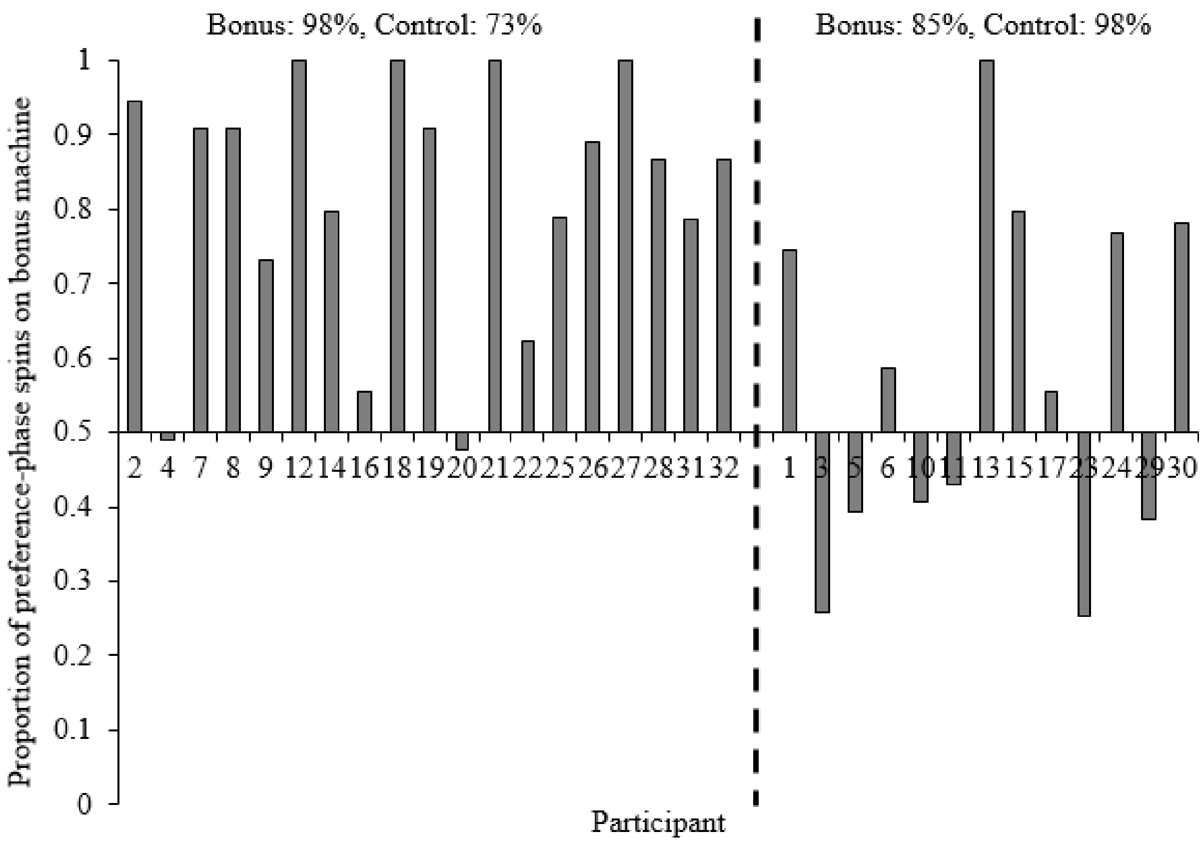

Figure 23. The proportion of preference-phase spins participants made on the bonus machine. Bars above .5 indicate a preference for the bonus machine. Bars below .5 indicate a preference for the control machine. The length of the bars indicate the extent of participants' preference. Participants on the left of the reference line had a higher RTP on the bonus machine in the exposure phase, participants on the right had a higher RTP on the control machine. Mean experienced RTP percentages across participants in these groups are displayed above the graph.

machine, and idiosyncratic preference across participants when the control machine was the higher-RTP machine. This interaction between RTP and preference reflects the fact that the magnitude of the effect of the bonus feature on preference depended on whether the bonus feature was also the higher-RTP machine. It was previously argued that sensitivity towards RTP differences is generally low, based on several experiments finding no effect of RTP on gambling behaviour (Without-features Condition of Preference Study 1; Experiments 1 and 2 of the current study; Brandt & Pietras, 2008; Haw, 2008; Schreiber & Dixon, 2001; Weatherly & Brandt, 2004; Weatherly et al., 2009). Other research has found an effect of

RTP on preference (Added-features Condition of Preference Study 1; Coates & Blaszczynski, 2013; Coates & Blaszczynski, 2014; Haw, 2008 – but only when participants were separated based on switching behaviour). These mixed findings could reflect procedural differences – it could be that under certain experimental conditions participants are generally sensitive to small to moderate RTP differences. However, at this point it is unknown what these procedural differences may be. Participants being sensitive to RTP in the Added-features Condition of Preference Study 1, yet not being sensitive in the replication of this experiment in Experiment 2 of the current study (which was reasonably close to an exact replication), suggests that procedural differences may not be the cause for mixed findings. It may be more likely that sensitivity to RTP differences is generally low, but some participants are better able to discriminate these differences. Different experiments sampling different proportions of participants who are sensitive to RTP differences seems at this point to be likely. However, at this point, it is unclear exactly what drives sensitivity to RTP differences.

There was no clear pattern of participants betting more on either the bonus or control machine, these data are displayed in Figure 24. A mixed ANOVA with a within-subjects factor of machine, and a between-subjects factor of exposure order supported this interpretation, revealing no significant main effect of machine on the amount bet in the exposure phase, $F(1,30) = 0.215$, p = ns, such that participants did not bet more cents on average on either the bonus machine ($M = 48.472$, $SD = 29.635$) or the control machine ($M = 49.580$, $SD = 28.527$). However, participants tended to bet more on the machine they were exposed to last. This pattern was displayed by 23 of 32 participants, and the ANOVA indicated the interaction between machine and order was statistically significant, $F(1,30) = 10.294$, $p = .003$, $\eta_p^2 = .255$. Participants bet more on the bonus machine in comparison to the control machine when first exposed to the control machine (bonus: $M = 47.556$, $SD = 30.523$; control: $M = 40.993$, $SD = 22.431$), and less on the bonus machine in comparison to the control machine when first exposed to the bonus machine (bonus: $M = 49.389$, $SD = 29.691$; control: $M = 58.168$, $SD = 31.959$). This effect size is considered large.

Despite preferring the bonus machine, participants did not tend to wager more on it compared to the control machine, consistent with both conditions of Preference Study 1 and Experiment 2 of the current study. This provides more evidence that bonus features have negligible effects on bet-amount selections, and that the finding in Experiment 1 where participants tended to bet more on the free-spins machine is not robust. This result also provides some support for the idea introduced in Experiment 2 that preference and bet-amount selections have different underlying drivers – participants tend to prefer machines with complex bonus features, but do not tend to place larger individual bets on them.

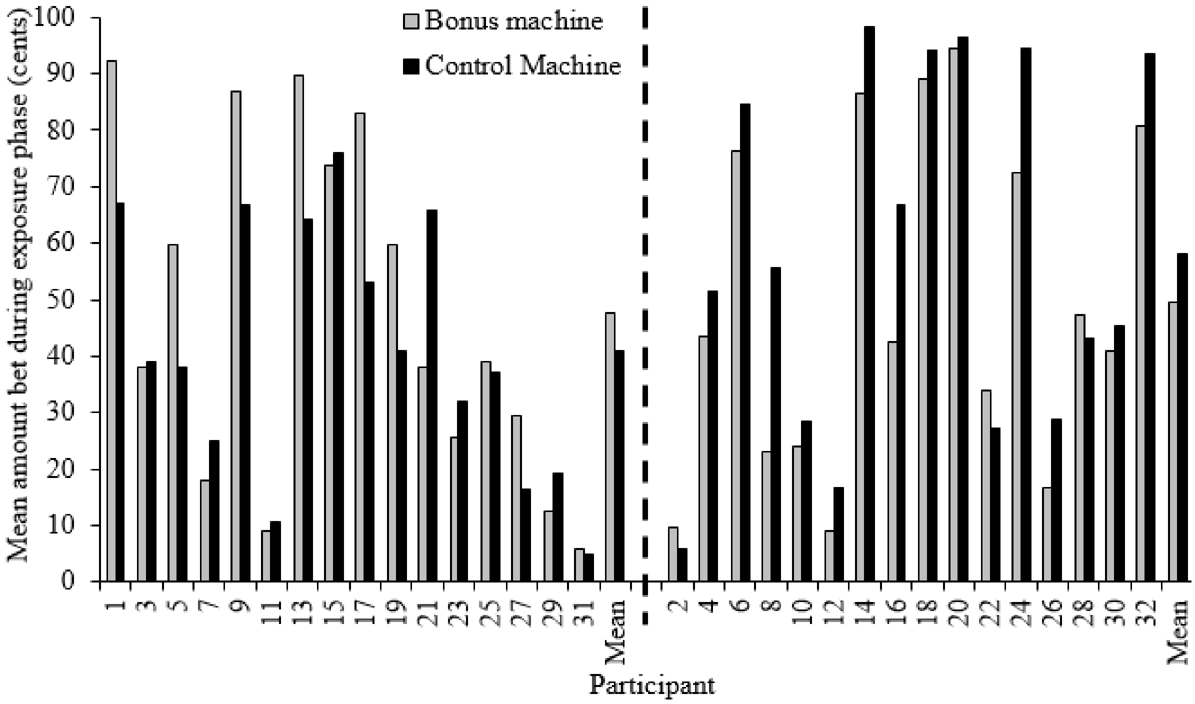

Figure 24. The mean bet-amount selection made by participants in the exposure phase. Participants on the left of the reference line were first exposed to the control machine. Participants on the right were first exposed to the bonus machine. Higher bars indicate higher average bet amounts. The mean bet amounts for participants in each order are displayed on the right of each grouping.

Participants tended to wager more on the machine they were exposed to last. This suggests that changes to the method between Preference Study 1 and the current study may have reduced the effect that order of slot-machine exposure has on gambling behaviour, rather than eliminating it entirely.

Figure 25 shows the same bet-amount data with participants separated based on which machine had a higher RTP in the exposure phase. RTP did not have a consistent effect on participants' bet amounts. 19 participants had a higher RTP on the bonus machine (left side of reference line), yet only 8 participants bet more on that machine. 13 participants had a higher RTP on the control machine (right side of reference line), and 8 participants bet more on that machine.

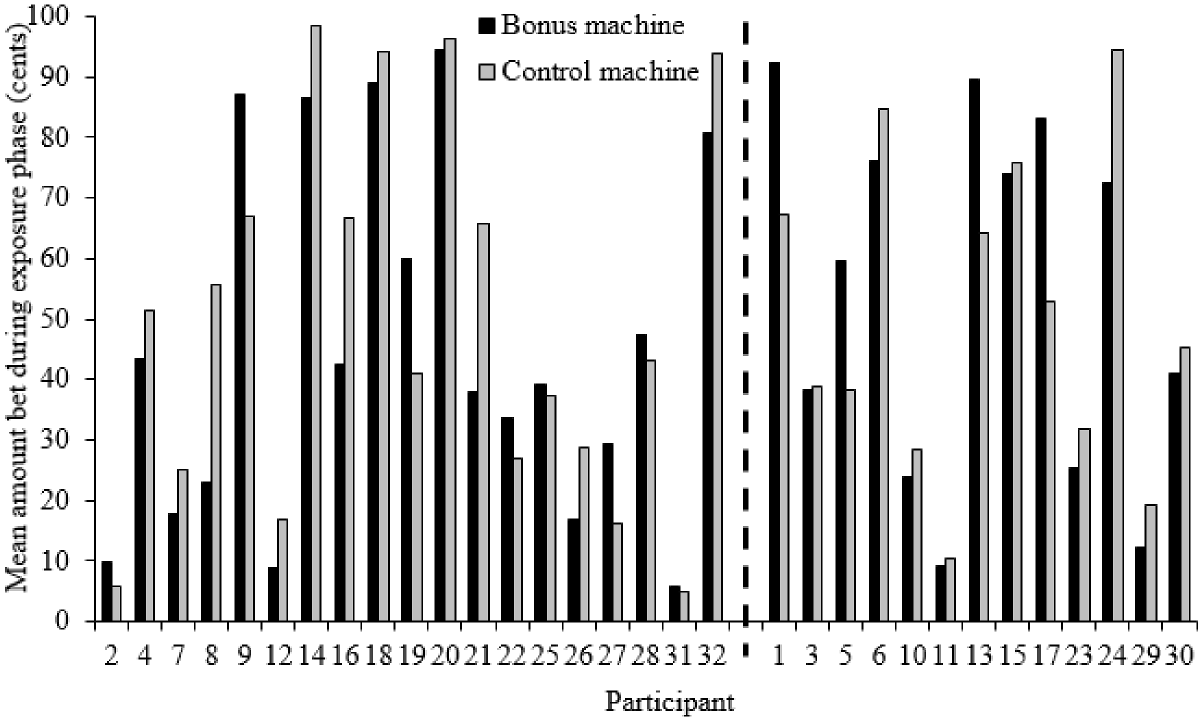

Figure 25. The mean bet-amount selection made by participants in the exposure phase. Participants on the left of the reference line experienced a higher RTP in the exposure phase on the bonus machine. Participants on the right experienced a higher RTP on the control machine. Higher bars indicate higher average bet amounts.

To determine whether participants' betting patterns varied as a function of preceding outcome, their bet amounts following each outcome across both exposure and preference phases were analysed and displayed in Figure 26. There was variability in how much participants bet in general, but participants tended to bet a similar amount following different outcomes. No consistent pattern of participants wagering more cents on average following different outcomes compared to others emerged. However, participants tended to bet the most following big wins or free-spins. Nine participants wagered the most following big wins, and 13 wagered the most following a bonus sequence. A repeated measures ANOVA with a within-subjects factor of outcome type (loss: $M = 52.597$, $SD = 30.160$; LDW: $M = 56.072$, $SD = 30.889$; medium win: $M = 56.780$, $SD = 31.349$; big win: $M = 58.821$, $SD = 31.575$; bonus sequence: $M = 55.898$, $SD = 35.154$) revealed these trends failed to reach statistical significance, $F(1.699,52.661) = 2.310$, $p =$ ns (corrected for non-sphericity). This result replicates the same finding from both conditions in Preference Study 1, as well as the same finding in Experiments 1 and 2 of the current study, providing more support for the idea that logical fallacies are not affecting participants' bet amount selections following these different outcomes.

Participants' bet amounts following different sized strings of losses during both exposure and preference phases are displayed in Figure 27. Overall, there was no clear pattern of participants betting more or less following different sized strings of losses. A number of participants did tend to bet either more or less in response to longer strings of losses, but this was not consistent across participants. A repeated measures ANOVA with a within-subjects factor of loss string (one: M = 52.556, SD = 31.423; two: M = 52.116, SD = 31.344; three: M = 52.184, SD = 29.687; four: M = 54.118, SD = 28.979; five or more: M = 52.698, SD = 28.269) revealed no main effect of different sized loss strings on the amount subsequently bet, $F(2.024,62.755) = 0.490$, p = ns (corrected for non-sphericity). This finding is consistent with the results of Experiment 2 which found no significant effect of different sized loss strings. However, this finding is in contrast to Experiment 1, where participants showed a linear trend of betting more in response to longer strings of losses. Only three participants in the current study showed an exact linear trend where bet amounts were successively larger following longer strings of losses.

It was argued in Experiment 1 that a significant linear trend of larger bets in response to longer strings of losses may reflect the gambler's fallacy, where independent events (different slot machine outcomes) are mistakenly interpreted as discriminative stimuli that signal the likelihood of future outcomes. Following Experiment 2 failing to find a similar pattern, it was suggested these contrasting results may reflect only some participants falling victim to the gambler's fallacy. The current findings support this interpretation. Despite the analysis overall failing to reach statistical significance, three participants did display the linear trend of betting more in response to longer strings of losses. While three out of thirty two participants showing the trend is by no means consistent, this is a much greater proportion than would be expected by chance. The likelihood of a participant displaying this pattern by chance is 0.825%, meaning less than one in 100 participants would be expected to show this pattern by chance. These results, the lack of a trend observed in Experiment 2, and the significant trend in Experiment 1 support the idea that only some participants fall victim to the gambler's fallacy.

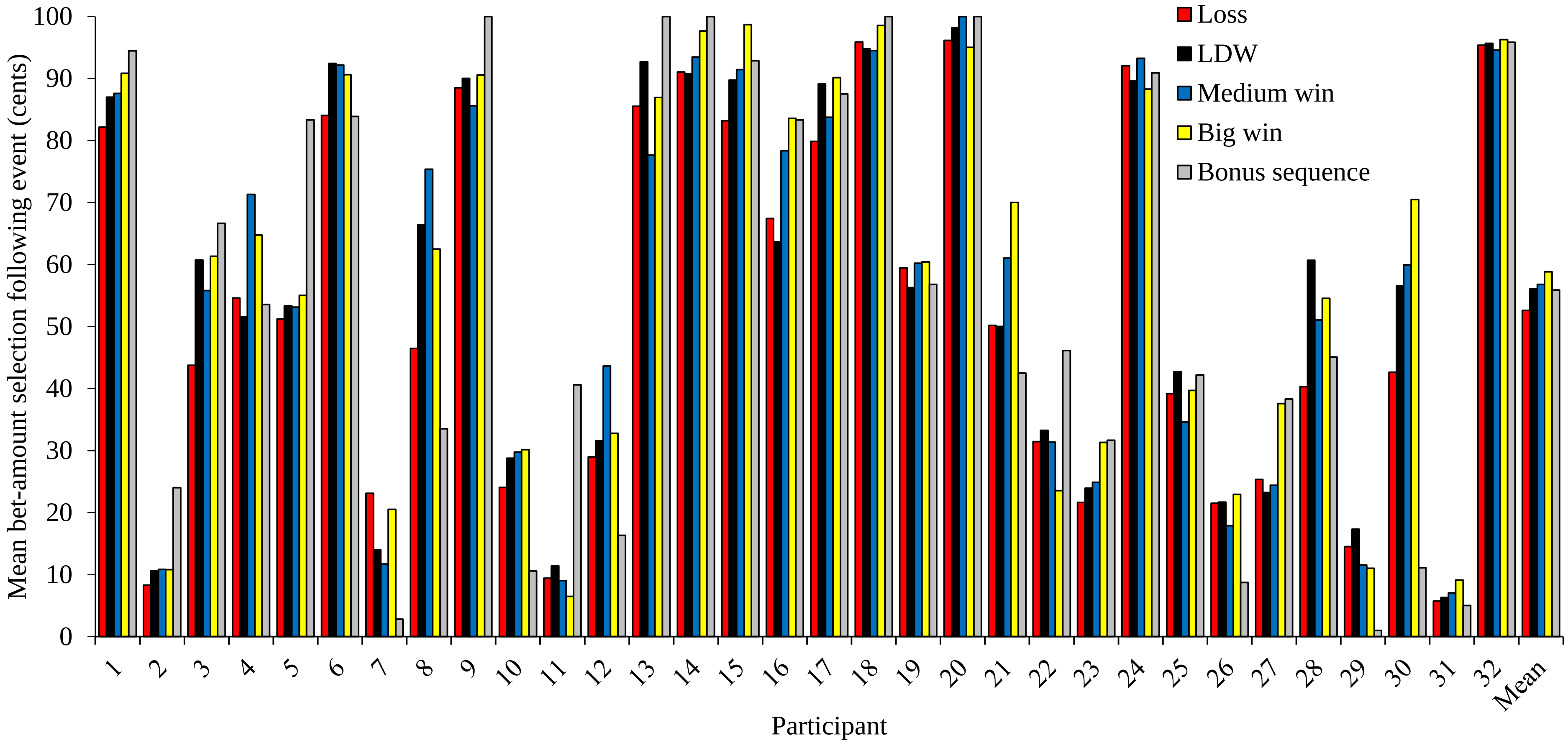

Figure 26. The mean bet-amount selection made by participants following various outcomes in both exposure and preference phases. Higher bars indicate greater average bet amounts following that event. Mean bet amounts following outcomes across participants are displayed on the right.

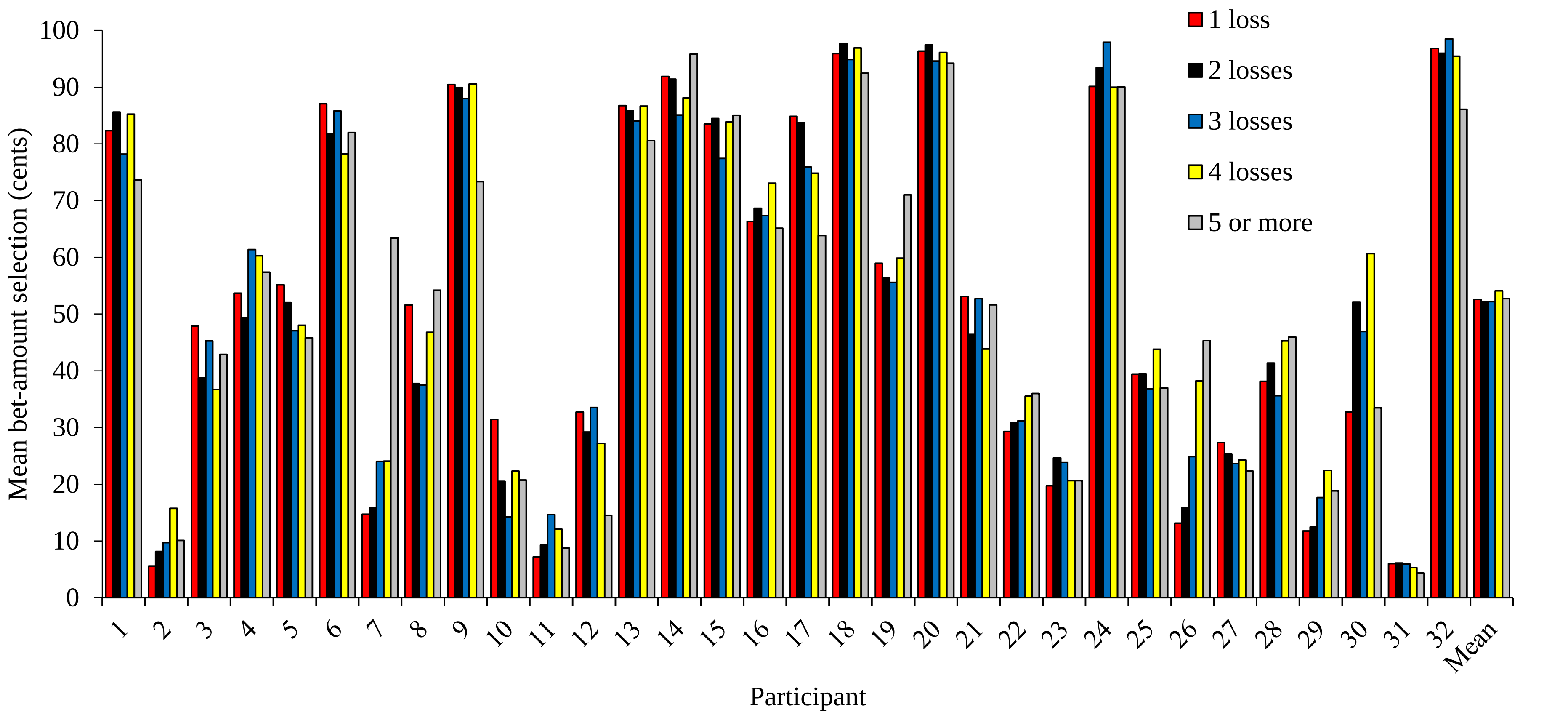

Figure 27. The mean bet-amount selection made by participants following various sized strings of losses in both exposure and preference phases. Higher bars indicate greater average bet amounts following that event. Mean bet amounts following different sized loss strings across participants are displayed on the right.

Participants' probability of switching slot machine following outcomes (loss, LDW, medium win, big win, bonus sequence) in the preference phase are displayed in Figure 28. It was expected, based on the results of Experiments 1 and 2, that individual participants would switch the highest proportion of the time following a bonus sequence. This was supported by the data – when participants switched following a bonus sequence, it was the most frequently switched after outcome with 14 of 32 participants showing this pattern. Fourteen participants switched at least once following the bonus feature, more than the number who switched after a medium sized win (11), or a big win (9). More participants switched at least once following a loss (28) or an LDW (17), however losses were the most frequently presented outcome, relative to the others, by far. The least frequently switched after outcome tended to be large wins. For reference, every participant received at least one bonus sequence in the preference phase. Participants received between 3 and 9 bonus sequences in the preference phase with a mean of 7.031. Participants received between 17 and 29 big wins with a mean of 20.875. Other outcomes were more frequent. A repeated-measures ANOVA on the likelihood of participants switching slots after various outcome types with a within-subjects factor of outcome (loss: $M = .056$, $SD = .057$; LDW: $M = .048$, $SD = .068$; medium win: $M = .024$, $SD = .040$; big win: $M = .024$, $SD = .045$; free-spins sequence: $M = .128$, $SD = .211$) indicated a significant main effect of outcome type on switching, $F(1.157, 35.842) = 9.635$, $p = .003$ (corrected for non-sphericity), $\eta_p^2 = .237$. This effect size is considered large. Pairwise comparisons indicated that participants switched a significantly greater proportion following a bonus sequence than following LDWs ($p = .032$), medium sized wins ($p = .035$), and big wins ($p = .027$). Participants also switched a significantly greater proportion of opportunities following losses in comparison to LDWs ($p < .001$), medium wins ($p = .006$), and big wins ($p < .001$).

As in both Experiments 1 and 2, when participants switched following a bonus sequence, it was generally the most frequently switched after outcome. In Experiments 1 and 2, one switch following a free-spins sequence was generally enough to drive free spins to be the most switched after outcome. In the current experiment, seven participants switched one time following a bonus sequence, and seven switched following a bonus sequence on more than one occasion. More switching following bonus sequences in the current study provides some indication that the switching data from Experiments 1 and 2, where individual participants tended to switch most often following free spins, was not simply an artefact of there being fewer free-spins outcomes. However, this interpretation is tentative given the small frequency of bonus sequences in comparison to other outcomes. Switching away from the bonus machine following bonus spins, despite it also being the preferred machine, may again reflect the gamblers fallacy. The likelihood of activating a bonus sequence is relatively low (occurred on 3% of spins), participants may mistakenly believe that the chance of activating two in a row is slimmer than it is in reality, and switch to the control machine to achieve variation in the reinforcers available.

A number of participants who switched following bonus sequences were also participants who tended to prefer the control machine. Participants 3, 5, 29, and 10 preferred the control machine and also switched the greatest proportion of the time following the bonus sequence. For these participants, switching away from the bonus machine following bonus spins may reflect their distaste for the bonus sequence, and the bonus sequence functioning as a discriminative stimulus indicating further play on that machine will result in more bonus sequences.

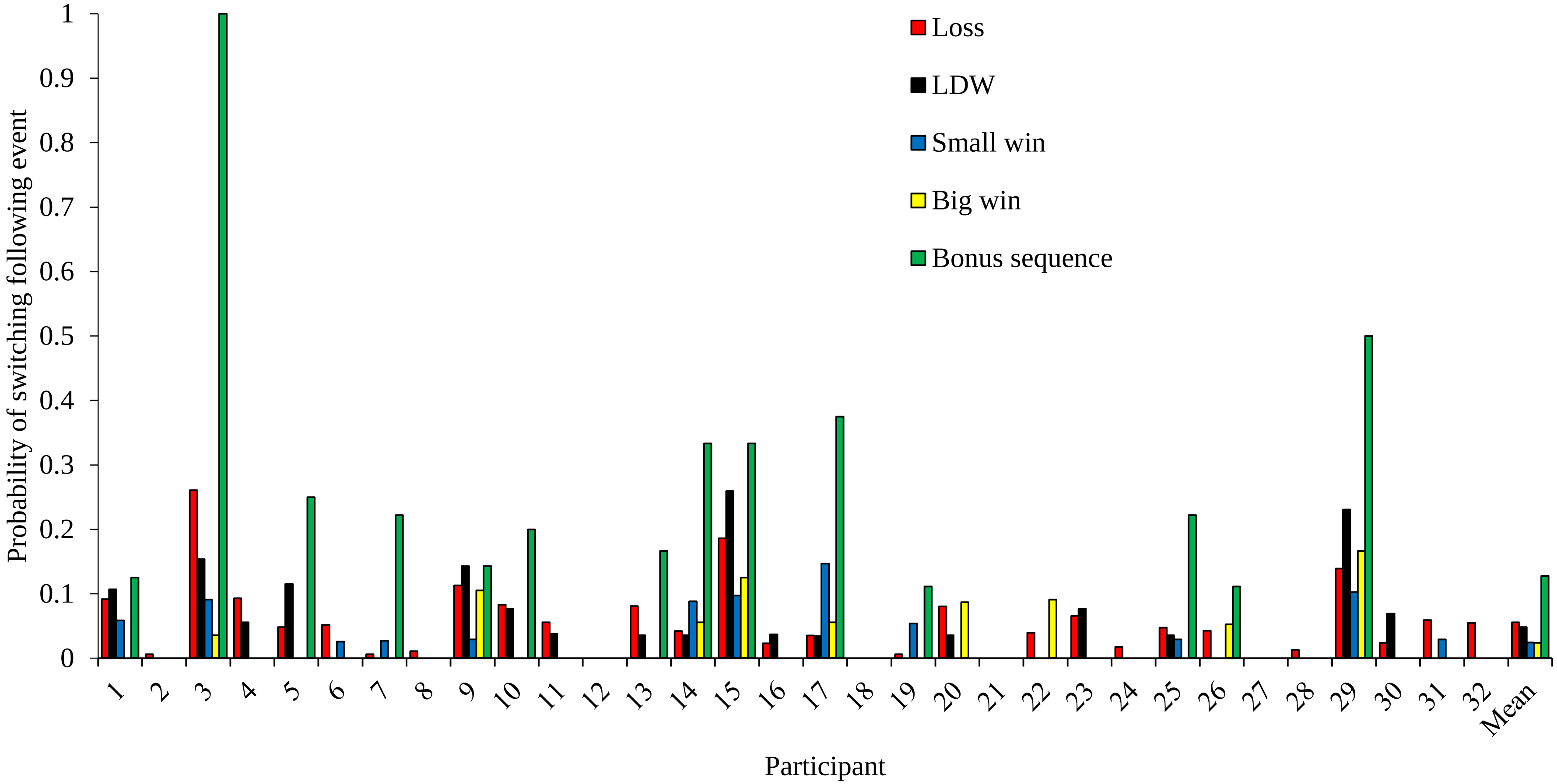

Figure 28. The probability of participants switching to the alternative slot machine following various outcomes in the preference phase. The y-axis displays the proportion of outcomes that participants switched slot machines after. Higher bars indicate more switching. Means across participants are displayed on the right.

General Discussion

The current experiments investigated the effects of free-spins bonus modes on slot-machine gambling behaviour. In particular, the experiments sought to examine whether participants prefer to play a slot-machine simulation with a free-spins feature over a simulation without free spins when all other aspects of the machines were close to identical. The results of Experiment 1 indicated that the "freeness" of a free-spins feature was not an important driver of preference for a machine with free spins, as participants did not consistently prefer the free-spins machine. In Experiment 2 additional features were added to the free-spins sequence (increased reinforcement rate, advertising, music, a GIF animation, a click-to-start-feature button). Participants in this experiment consistently preferred the free-spins machine, indicating that the addition of these features played a causal role in preference for the free-spins machine. Given that Experiment 1 indicated that the "freeness" of the free-spins was not an important driver of preference, and Experiment 2 indicated the additional features were, Experiment 3 sought to more closely examine whether "freeness" was an unimportant factor in participants' preference for bonus features. The free-spins machine that was consistently preferred in Experiment 2 was adjusted to no longer have "free" spins – participants paid for spins during the bonus feature and the machine did not spin automatically. Participants consistently preferred this machine, indicating that the "freeness" of free-spins bonus features are not particularly important drivers of preference, despite the prevalence of free-spins bonus features in the real world.

The current study's finding that the "freeness" of the bonus feature is not an important driver of preference supports the results of Preference Study 1 – both studies directly contradict the gamblers' accounts in the interview research where gamblers identified two aspects of free spins that contributed to their overall appeal: 1) Freeness – the idea that they were playing for free during those spins, or could win something for nothing, and 2) The perception of gaining extra time on the machine (Livingstone et al., 2008). Preference Study 1 went into detail about how these ideas were disputed by the current investigation, and this won't be rehashed in detail here. Essentially, the results indicate that both "freeness" and "time on device" are not important drivers of preference for free-spins (or bonus) features.

While the results of these experiments suggest "freeness" is not a particularly important driver of preference for bonus features, the experiments provide some evidence that freeness does have an effect. The free-spins machine in Experiment 2 was more consistently preferred across participants than the bonus machine in Experiment 3. This suggests that freeness might have a slight influence on preference. Furthermore, as a number of features were added to the free-spins machine in Experiment 2, it is not known what the effects of each additional added feature were. It may be the case that all of the features unique to the free-spins machine in Experiment 2 (as well as freeness) have an additive effect, culminating in participants consistently preferring the machine with the free-spins bonus mode. Future research could investigate how each of the individual features added to the free-spins sequence in Experiment 2 influence gambling behaviour. To investigate the individual effect of each additional feature, a component analysis could be conducted with a similar method across a number of experiments – having one machine differ from the control machine in only one of the added features and then comparing the number of spins participants make on each machine in the preference phase.

In all three experiments, the order in which participants were exposed to the slot-machine simulations had a negligible effect on their preference. As discussed following each experiment, this indicates that changes made to the method between Preference Study 1 and the current study were successful in greatly reducing participants preferring the first machine exposed to. As a number of changes were made (reduced exposure-phase length, increased preference-phase length, balance resetting at the beginning of each exposure/phase), it is unknown exactly what change, or combination of changes, achieved this. A thorough examination of these variables would inform this discussion. For instance, an experiment where participants play two similar slot machines, only differing in the amount of credits they began with, would identify whether resetting the balances was an important factor influencing preference.

Due to the inability to determine exactly which change reduced the effect of exposure order on preference, it is not possible to discount or support previous possible explanations for the presence of the effect in Preference Study 1. This investigation was more concerned with reducing the order effect to clarify the effect of bonus features on preference, rather than investigating the causes of the order effect.

RTP had no effect on preference for the free-spins machine in either Experiment 1 or 2, yet there was an interaction between RTP and the bonus mode in Experiment 3, such that participants' preference for the bonus machine depended on whether it was also the higher-RTP machine. These mixed findings are consistent with the wider literature – under some conditions RTP has been shown to influence gambling behaviour (Coates & Blacsczynski, 2013 & 2014; Haw, 2008) yet under other conditions RTP has no effect (Brandt & Pietras, 2008; Schreiber & Dixon, 2001; Weatherly & Brandt, 2004; Weatherly et al., 2009). These mixed findings highlight how unpredictable and as yet poorly understood the effects of RTP are on slot-machine gambling behaviour. The above studies employed simulations that differed on various aspects (e.g., number of lines bet, bet-amount selections, background images and symbols, use of single or multiple monitors, audio effects, RTP differences), and a likely explanation for the contrasting results is that the different features and samples in each study create variance in the effect that RTP has. Due to a lack of experimental control over the RTP participants experienced on each machine in the current study, strong inferences about the effect of RTP are difficult to make. Future research that directly manipulates experienced RTP is needed to clarify under which conditions RTP does or does not influence responding. This could be investigated systematically, as comparing across studies becomes difficult when there are so many differences in the simulations and features employed.

The three experiments' investigation into the effect of bonus-features on bet sizes was inconclusive. Participants in Experiment 1 bet significantly more on the free-spins machine than the control machine, while there was no difference in corresponding analyses in Experiments 2 and 3. There are potential explanations for these results. For example, free-spins bonus features may only cause participants to bet more when they are not associated with the additional features added in Experiments 2 and 3. It also seems reasonably plausible that the finding in Experiment 1 where participants bet significantly more on the free-spins machine may simply be a type-one error, especially when viewed in the context of Preference Study 1 finding no effect of free-spins features on bet amounts.

In all three experiments, participants bet roughly the same amount following different individual outcomes (losses, LDWs, medium sized wins, large wins). As discussed previously, this suggests that participants' bet amounts are not being affected by cognitive distortions in response to these outcomes. However, bet amounts did tend to be affected by the number of losses in a row participants had experienced. In Experiment 1, there was a statistically significant linear trend where participants tended to bet more in response to longer strings of losses in a row. In Experiments 2 and 3, this trend did not reach statistical significance, although a greater percentage of participants than would be expected by chance showed a pattern of increasing bet amounts in response to longer strings of chance. These inconsistent findings indicate that the effect of loss strings on bet amounts varies considerably across individuals. It is likely that a trend of increasing bet amounts in response to longer strings of losses is a manifestation of the gambler's fallacy – the erroneous belief that the result of an upcoming spin is somehow predicted by results of previous spins. It seems plausible that only some proportion of the population is prone to this cognitive distortion, resulting in different findings across (and within) experiments.

In all three experiments, on average participants tended to switch to the alternative slot machine the most often following a free-spins (or bonus) sequence. However, this difference in mean switching rate across participants was not consistently displayed when viewing individual participant's data. Essentially, some participants switched the most often following bonus features, whereas others never switched following bonus features. It is difficult to draw strong inferences from these results, given that participants switched the most often following the bonus feature both when it was was not consistently preferred (Experiment 1) and when it was the consistently preferred complex bonus features (Experiments 2 and 3). One possibility for this result is that there were relatively few bonus sequences. Elevated rates of switching following these for some participants, combined with no switching following them for other participants, may indicate the need for a greater amount of switching data to make valid inferences. This interpretation is supported by the results of Preference Study 1, where participants tended to switch the *least* often following free spins. To achieve more opportunities to switch following bonus features, the preference phase could be lengthened again, and the frequency of activating a bonus mode could be increased (possibly while decreasing the numbers of spins involved in the bonus).

Limitations of the current study include the experiments taking place in an academic setting, the use of undergraduate psychology students as participants, and the use of hypothetical money as opposed to a real-money gambling situation. Undergraduate psychology students are not representative of student gamblers, differing on a number of characterstics: They are younger, more likely to be female, more likely to never have been married, and less likely to drink alcohol while gambling (Gainsbury, Russell, & Blaszczynski, 2014). It may be that student and other gamblers respond differently on slot machines than the relatively inexperienced undergraduate students used in the current study. Level of gambling problems/gambling risk influences gambling behaviour (e.g., Rockloff et al., 2007; Young et al., 2008), and the participants in the current study generally reported low or no gambling involvement on the SOGS. Future research should investigate whether the effect of bonus feature characteristics interact with participant characteristics.

The use of hypothetical money as opposed to real-money also limits the external validity of the study. Participants tend to bet more when credits are worth less (Weatherly & Brandt, 2004; Weatherly & Meier, 2007), and since the credits are not worth actual money in the current study, their value is limited to the extent that participants follow the instruction to pretend they are playing with real money. There is no reason to expect this would differentially affect the experimental conditions, but the bet-amount data are not indicative of how people bet on real slot machines. It may be the case that in more naturalistic gambling environments, with more experienced gamblers or with real money, bonus features may have different effects on gambling behaviour. Follow-up studies using a different sampling method and a real-money gambling task are currently underway. The current study was carried out on slot-machine simulations that share many features of modern slot machines, which strengthens the external validity of the findings when compared to older-style simulations that are often used in the literature, yet are no longer available in gambling venues.

The current finding that free spins features are an important driver of slot-machine selection is consistent with the analysis of real-world Norwegian gambling data conducted by Leino et al. (2015). A key strength of the current study was careful experimental control while external validity was a potential limitation. Leino et al.'s analysis was of real-world gambling data, but there was no experimental control of machine features and so aspects of the machines other than the presence of a free spin feature were not held constant. Together, though, these results provide convergent evidence from complementary research approaches about the role of bonus features in driving slot machine gambling.

This research adds to the growing experimental literature examining how the structural characteristics of slot machines influence gambling behaviour, and together with Preference Study 1, provides the first experimental analysis of the effects of bonus features. Experiment 1 compared participants' responding on a simulation with a simple free-spins bonus feature to their responding on a concurrently available simulation without a bonus feature. Participants did not consistently prefer the free-spins machine. Experiment 2 added additional features to the free-spins sequence that are found on real-world slot machines, and participants in this experiment consistently preferred the free-spins machine. Experiment 3 investigated the importance of freeness to the preference for free spins – participants paid for spins during the bonus feature and had to click to initiate all spins. Participants still preferred the bonus machine. These results indicate that freeness of the free-spins bonus features is not an important driver of people preferring machines with free spins. This research was conducted on multi-line simulations with variable bet amounts and reasonably realistic bonus features. These factors culminated in participants receiving multiple wins on some spins, losses disguised as wins (Dixon et al., 2010), bonus spins, and a gambling experience that is more alike to real-world slot-machine gambling than much of the previous experimental research.

Preference Study 3

The previous two studies demonstrated that participants preferred to play slot-machine simulations with complex free-spins features. However, a number of factors may impact on the extent to which these results may generalise to real-world gamblers. Firstly, the above studies included only first-year psychology students as participants. As discussed in Preference Study 2, first year psychology undergraduate students are not typically representative of the wider gambling population or of student gamblers – differing on a number of variables such as: gender, age, likelihood to consume alcohol while gambling, marital status, and risk of developing gambling problems (Gainsbury et al., 2014). Some of these factors have been shown to influence gambling: consuming alcohol before gambling caused participants to play longer and lose more money on a slot-machine simulation (Kyngdon & Dickerson, 1999); and gender influences both the function of problem gambling, as well as the mode, with females more likely to gamble for avoidance, and more likely to gamble on slot machines (Pierce, Wentzel, & Loughman, 1997). Gainsbury et al. (2014) demonstrated that psychology undergraduates in their study gambled less frequently and at different times from that of the general and student gambling population. However there was no difference in the frequency of slot-machine play specifically. Slot-machine gambling behaviour of psychology undergraduates may therefore not be different to the general gambling population on any dependent measures used by Preference Studies 1 and 2, but given the relative homogeneity of this population compared to typical gamblers the possibility remains. The current study addressed this possibility by recruiting participants via a different sampling method than the previous studies, resulting in a student sample with more diverse levels of study and subject majors.

A second characteristic of Preference Studies 1 and 2 that reduce ecological validity is that participants were gambling with hypothetical money. Other slot-machine simulation research has demonstrated that credit worth (i.e., the value of the gambling currency) influences slot-machine gambling behaviour. Weatherly and Brandt (2004) investigated the effect of credit worth on computer-simulated slot-machine gambling. Participants were staked with 100 credits, and credit worth was manipulated (0, 1c, 10c; resulting in a 0, $1, $10 total stake). The 0c condition reflected hypothetical money. Participants generally made fewer gambles and bet fewer credits when credits were worth more. These findings suggest that participants behave differently when gambling for real money compared to hypothetical money. Weatherly and Meier (2007) also demonstrated that participants bet less when gambling with hypothetical money than when gambling with real money on video poker simulations. However these findings only indicate that credit value influences the amount of gambling (i.e., bet-amount selections, number of spins completed). The pattern of responding in relation to other aspects of the gambling situation such as the presence of free spins may be less sensitive to the use of hypothetical money. The wider literature provides an indication that people behave similarly when making decisions for hypothetical and real rewards: Weatherly and Meier (2007) found that accuracy of video poker play was unaffected by whether participants gambled with real or hypothetical money; probability-discounting rate is not influenced by whether participants expected to actually incur the consequence of their decisions (Wiseman & Levin, 1996); the "framing effect" in decision making (risk aversion for gains, more risk seeking for losses) is unaffected by whether the reward is hypothetical or real (Kuhberger, Schulte-Mecklenbeck, & Perner, 2002); and delay-discounting rates are unaffected by whether participants make decisions between hypothetical or real rewards (Madden, Begotka, Raiff, & Kastern, 2003). Based on the above literature, we expected that the use of real/hypothetical rewards would influence the amount of gambling but not patterns of gambling behaviour related to the characteristics of simulated slot machines and their outcomes.

The purpose of the current study was to investigate whether the results of Preference Studies 1 and 2 replicated with a sample more representative of the student gambling population and when participants are gambling with real money – factors which provide more ecological validity. One half of the participants recruited were staked a small amount of money to gamble with, and also given a movie voucher for participation. At the end of the study, they could exchange their remaining credit for items from a shop which included candy and coffee vouchers. The remaining participants gambled with hypothetical money. These participants were also rewarded with a movie voucher for participation. The Hypothetical-money Condition was included due to the different sampling method employed and the use of a slightly modified version of the simulations used in Experiment 2 of Preference Study 2. Participants in both conditions gambled on a modified version of these simulations – starting balances and credit worth were reduced, and instructions were included that made it possible to investigate differences in gambling session duration. Due to the findings that participants generally bet more credits in total (Weatherly & Brandt, 2004), and make more gambles when credits are worth less (Weatherly & Brandt, 2004; Weatherly & Meier, 2007), it was expected that the participants in the Real-money Condition would wager less and end the gambling session earlier than participants in the Hypothetical-money Condition. Based on the results of Preference Study 2 and other research which has found similar patterns of responding regardless of the type of currency used, it was also expected that participants in both conditions would display a consistent preference for the machine with free spins.

Method

Participants. Thirty-six participants participated in return for a movie voucher. They were recruited via posters that were posted at various locations around Victoria University of Wellington's Kelburn campus. For ethical reasons, it was necessary to inform people that they would be gambling with real money in the Real-money Condition before they signed up to participate. Therefore, the study was advertised with different posters for each condition, and random assignment to experimental groups was not possible. Nineteen participants responded to a poster stating they would be staked a small amount of money to gamble with, and also be given a movie voucher for participating (Real-money Condition). The other 17 participants responded to a poster stating they would be given a movie voucher for participating in a gambling study (Hypothetical-money Condition). All participants completed an informed consent form before participating and were debriefed following participation. All aspects of this study were reviewed and approved by the university's ethics committee. Each participant completed the SOGS (Lesieur & Blume, 1987) after completing the experimental tasks described below. Four participants in the Real-money Condition scored in a problematic range on the SOGS. Participant Seven and Participant 11 scored six, Participant 10 scored 16, and Participant 12 scored five. According to Lesieur and Blume (1987), scores above five indicate probable pathological gambling. No participants in the Hypothetical-money Condition scored in a problematic range on the SOGS.

Materials and stimuli. The materials and stimuli were the same as for Preference Study 2, Experiment 2, with some adjustments to the simulations. The changes to the simulations were as follows:

- Bet size options were reduced in number and magnitude (1c, 2c, 3c, 5c).
- Starting balance was reduced to $8.
- On-screen instructions were altered to more clearly inform participants they could stop gambling at any point (see below).

These changes were made for ethical and practical reasons. In the previous studies, participants were gambling with either $50 (Preference Study 1) or $100 (Preference Study 2) of hypothetical money. It was not practical for participants to be staked with so much real money, and ethical approval only allowed for up to $15 in winnings.

Experimental conditions. Programmed outcome frequencies for both machines in the exposure phase are displayed in Table 7. Both the Real-money Condition and the Hypothetical-money Condition had the exact same outcome sequences, which are identical to those used in Preference Study 2 Experiment 2. Note that the top part of the table displays probabilities for a given outcome occurring on any one of the three lines. The final three rows display overall win frequencies (of any magnitude) per three-line spin. Free spins were won on 3% of spins on the free-spins machine in both conditions.

Table 7.

Programmed Outcome Probabilities on each Slot Machine for the Real-money Condition and the Hypothetical-money Condition.

Outcome	Free-spins machine	Control machine
Per Individual Line		
loss	.85	.87
2*	.06	.05
5*	.03	.04
8*	.03	.02
10*	.01	.02
30*	.01	.01
5 free spins	.01	0
Resultant Outcome Frequencies Per Spin (three lines per spin)		
Programmed RTP	0.89	0.89
Programmed / experienced probability of win	.35	.36
Programmed / experienced probability of winning during free-spins feature	.60	n/a
Programmed / experienced probability of winning outside free spins	.32	.36

Note. *Programmed outcome is multiplied by the bet-amount selected

Procedure. This experiment was conducted in the same room as Preference Studies 1 and 2, and on the same computers. Up to four participants took part in any given session on separate computers. Participants in the Real-Money Condition were told the following information by the experimenter:

- You will be participating in a real-money gambling experiment
- There will be three different phases. The first two are practice phases where you are not playing with real money. This is so you get used to the task. The third phase is when you are gambling for real money.
- We wish that you complete both practice phases. In the real-money gambling phase, you can stop playing at any point – it is up to you whether you continue gambling.
- At the end of the experiment you can exchange your remaining balance for items from our shop which include candy, chocolate, and coffee vouchers

Following these verbal instructions, participants in the Real-Money Condition took their seat at a computer and read the following instructions before they began the experimental tasks:

> You are about to play a slot machine task. There are two practice phases followed by a real-money gambling phase. You should always respond as if you are playing a real slot machine for real money.
>
> To place a bet, click the button indicating how much you want to bet on each line, then click the MAX LINES button. You will always be betting on three lines.

At the bottom of these instructions was a “Start task” button, which began the experiment.

Participants in the Hypothetical-money Condition were told the following information by the experimenter:

- You will be participating in a gambling experiment
- There will be three different phases. The first two are practice phases. This is so you get used to the task. The third phase is a testing phase.

- We wish that you complete both practice phases. In the third phase, you can stop playing at any point – it is up to you whether you continue gambling.

Following these verbal instructions, participants in the Hypothetical-money Condition took their seat at a computer and read the following instructions before they began the experimental tasks:

> You are about to play a slot machine task. You should always respond as if you are playing a real slot machine for real money.
>
> To place a bet, click the button indicating how much you want to bet on each line, then click the MAX LINES button. You will always be betting on three lines.

At the bottom of these instructions was a "start task" button, which began the experiment.

Participants in both conditions completed two exposure phases and one preference phase in the same manner as in Preference Study 2. Participants in the Real-money Condition read slightly different instructions in between the practice phases and the preference phase. Following the second practice phase, they read the following information:

> "You will now be gambling with real money. The balance has been reset to $8. Starting now, this belongs to you. You can now choose whether and on what machine to gamble. Click on the red button labelled SWITCH to change between them. You can do this whenever you like."

To begin the preference phase, participants then had to click a button which read: "I understand I am now gambling with real money that belongs to me. I am ready to continue". Participants in the Hypothetical-money Condition read:

> "You can now choose whether and on what machine to gamble. Click on the red button labelled SWITCH to change between them. You can do this whenever you like."

To begin the preference phase, participants then had to click a button which read "Continue".

Data analysis. Data analysis was as per the previous preference studies, with one notable exception. In previous studies, to investigate whether RTP affected preference, we calculated each participants' experienced RTP on each machine during the exposure phase separately, and separated participants according to whether the free-spins machine or the control machine had the higher RTP. However, due to an inadequate number of participants with a higher RTP on the control machine (3/16 in the Real-money Condition, 6/17 in the Hypothetical-money Condition), it was not possible to consider each group separately in analyses to isolate the effect of RTP and free spins. Instead, participants' number of responses made on each machine in the preference phase was examined as a function of RTP differences between machines in the exposure phase, to determine the effect of RTP on preference (i.e., proportion of preference for the free-spins machine was plotted against RTP differences). Participants who did not make any spins in the preference phase were excluded from this analysis.

Results

To investigate whether participants in the Real-money Condition wagered more than participants in the Hypothetical-money Condition, mean bet-amount selections during the preference phase (both free-spins and non-free spins machines combined) are displayed in Figure 29. More participants had lower average bet amounts in the Real-money Condition in comparison to the Hypothetical-money Condition. An independent samples one-tailed *t*-test was used to compare the mean bet sizes (in cents) of participants in the Real-money Condition (M =2.27, SD = 1.56) to the mean bet sizes of participants in the Hypothetical-money Condition (M = 3.13, SD = 1.56). On average, participants wagered 0.85 cents, 95% CI [-0.24, 1.95], more on the machines in the Hypothetical-money Condition. This difference approached statistical significance, $t(34) = 1.58$, p =.06, and was of medium to large magnitude, $d = 0.53$. Participants who made zero spins in the preference phase were excluded from this analysis.

The number of spins participants completed during the preference phase are displayed in Figure 30. Participants more consistently completed the maximum 300 spins in the Hypothetical-money Condition compared to the Real-money Condition. In the Hypothetical-money Condition, 15 out of 17 (88%) participants completed 300 spins. In the Real-money Condition, only 10 out of 19 (53%) participants completed 300 spins. An independent samples one-tailed *t*-test was used to compare the total number of spins made during the preference phase by participants in the Real-money Condition (M = 220.16, SD = 119.19) to the number of spins made by participants in the Hypothetical-money Condition (M = 279.41, SD = 73.01). On average, participants in the Hypothetical-money Condition made 59.25 more spins during the preference phase, 95% CI [-8.69, 127.20]. This difference was statistically significant, $t(34) = 1.82$, $p = .04$, and was of large magnitude, $d = 0.62$.

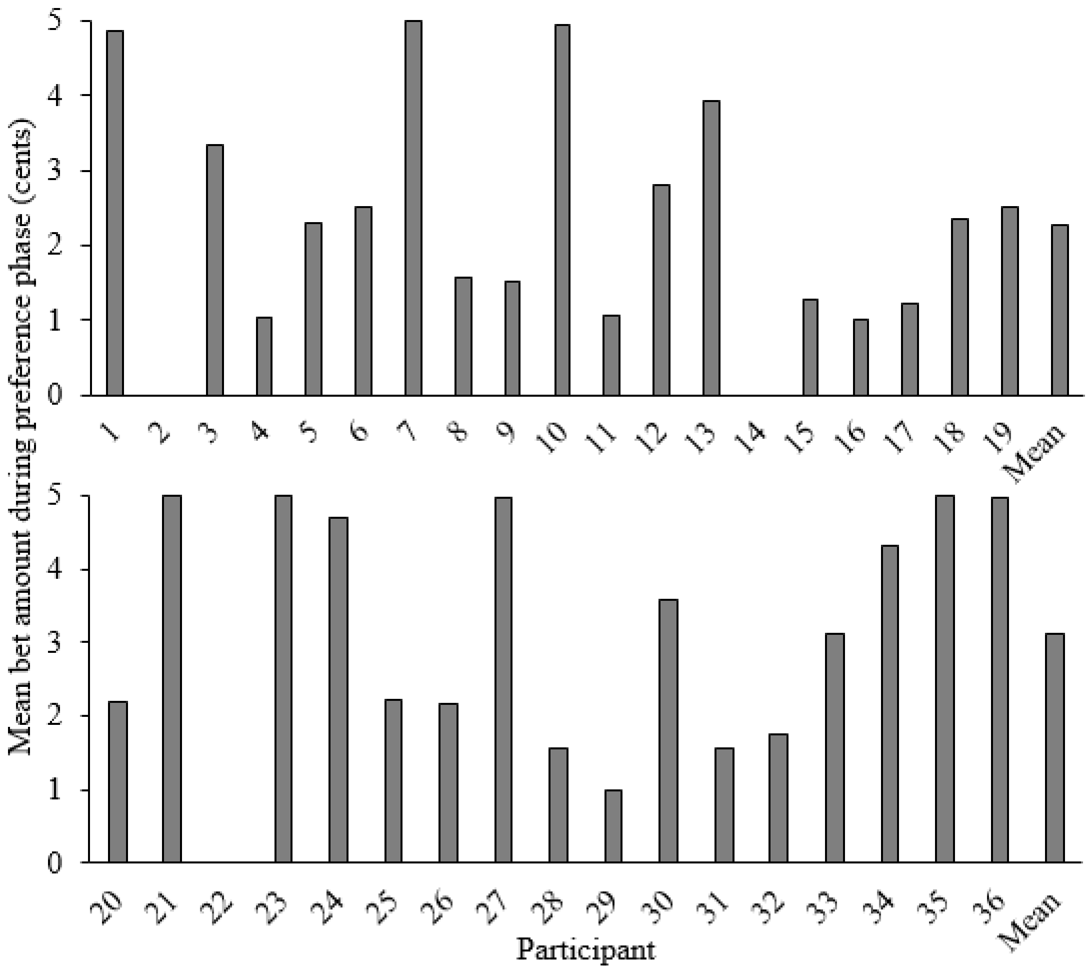

Figure 29. Participants' mean bet amount selections during the preference phase. The top panel displays the Real-money Condition, the bottom panel displays the Hypothetical-money Condition. A score of zero reflects a participant who made no spins in the preference phase. Means are displayed on the right of participants.

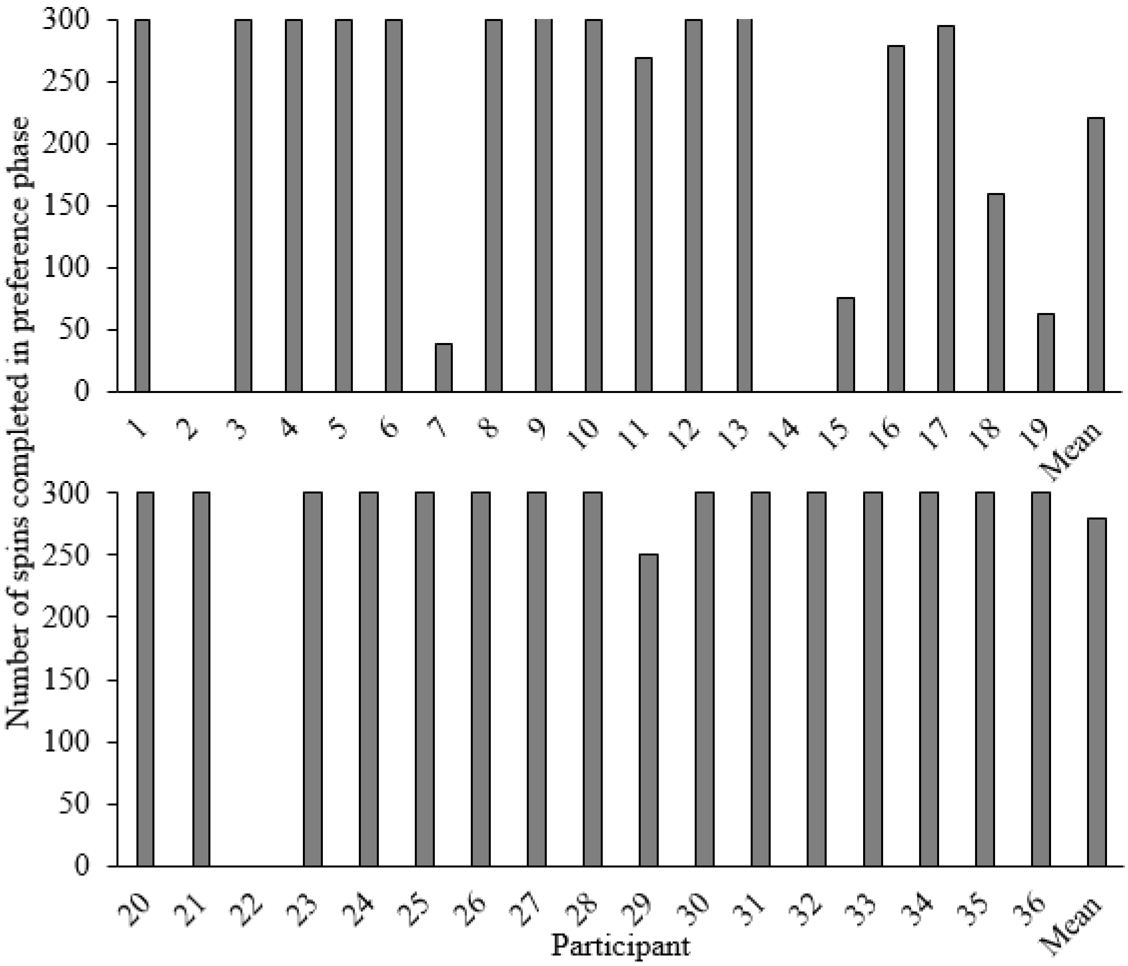

Figure 30. Number of spins completed during the preference phase. The top panel displays data from the Real-money Condition, the bottom panel displays data from the Hypothetical-money Condition. Means are displayed on the right of participants.

To investigate whether participants preferred the free-spins machine, the proportion of responses they made on the free-spins machine during the preference phase for both conditions is displayed in Figure 31. There was a consistent preference for the free-spins machine in both the Real-money (top panel) and Hypothetical-money (bottom panel) conditions. A mixed ANOVA with a within-subjects variable of machine (free-spins, control) and between subjects variables of exposure order and condition revealed a significant main effect of machine, such that across conditions participants allocated more spins to the free-spins machine (M = 148.306, SD = 84.682) than the control machine (M = 74.833, SD = 78.105), $F(1,32) = 10.171$, $p = .003$, $\eta_p^2 = .241$. This effect size is considered large. The ANOVA revealed no statistically significant interaction between preference and condition, $F(1,32) = 0.224$, p = ns, supporting the interpretation that participants similarly allocated more spins to the free-spins machine over the control machine in both the Real-money

Condition (free-spins: M = 131.110, SD = 88.886; control: M = 67.211, SD = 76.433) and the Hypothetical-money Condition (free-spins: M = 167.529, SD = 77.787; control: M = 83.353, SD = 81.402). The ANOVA revealed no statistically significant interaction between preference and exposure order, $F(1,32) = 0.209$, p = ns, such that for participants first exposed to the control machine the number of spins they allocated to the free-spins machine (M = 160.222, SD = 81.235) and control machine (M = 79.778, SD = 69.932) did not differ significantly from participants who were first exposed to the free-spins machine (free-spins: M = 156.222, SD = 93.844; control: M = 77.667, SD = 95.811). The ANOVA also revealed no statistically significant three-way interaction between these variables, $F(1,32) = 0.396$, p = ns.

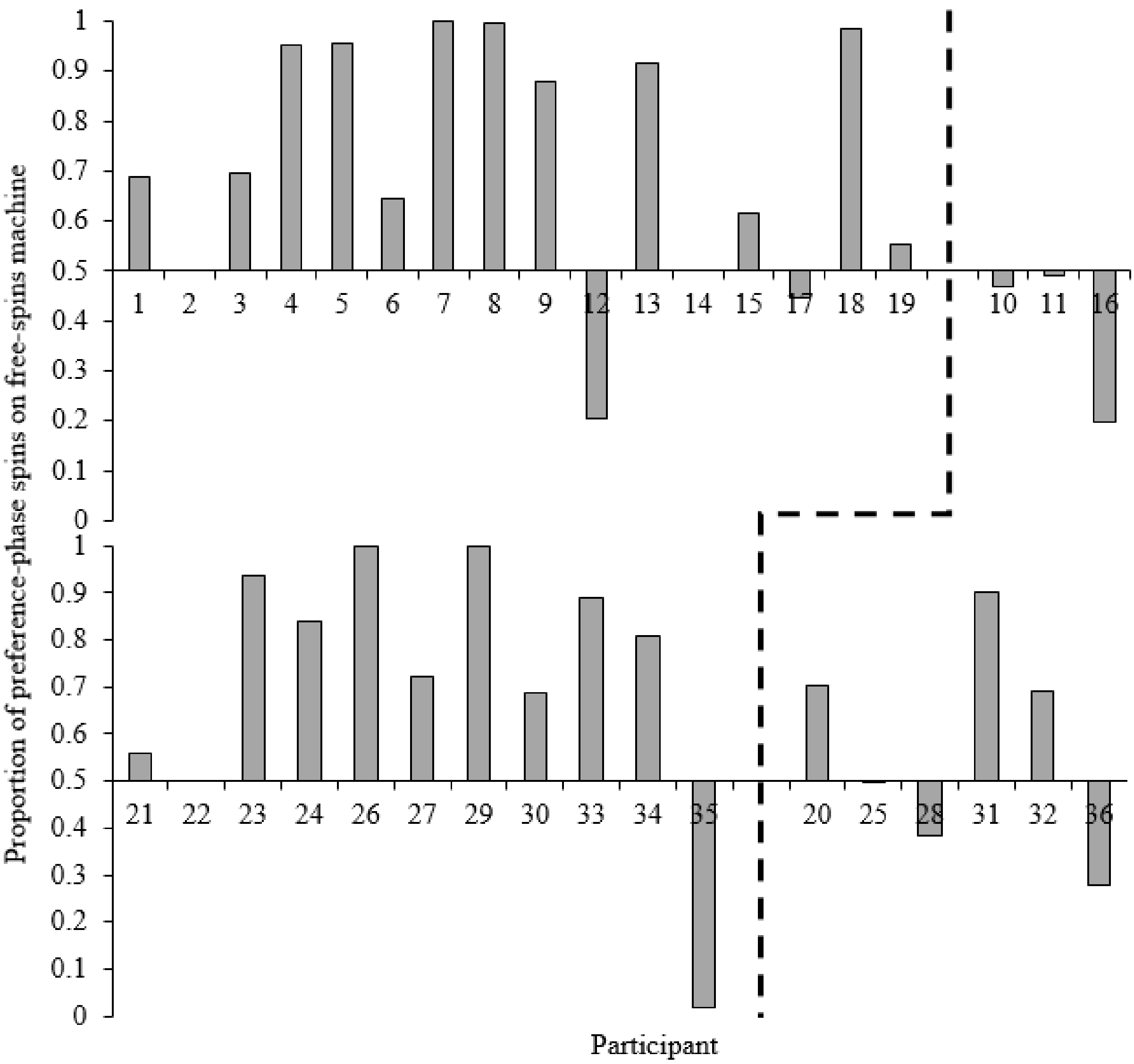

Figure 31. The proportion of preference-phase spins participants made on the machine with free spins. The top half of the figure displays data from the Real-money Condition, the bottom half displays data from the Hypothetical-money condition. Bars above .5 indicate a

preference for the machine with free spins. Bars below .5 indicate a preference for the machine without free spins. The length of the bars indicate the extent of participants' preference. Participants on the left of the reference lines had a higher RTP on the free-spins machine during the exposure phase. Participants on the right of the reference lines had a higher RTP on the machine without free spins.

To determine whether experienced RTP in the exposure phase influenced preference, participants' preference for the free-spins machine was plotted against their experienced RTP ratio in the exposure phase (RTP on free-spins machine / RTP on control machine) and is displayed in Figure 32. Participants tended to be more sensitive to RTP differences in the Real-money Condition (left panel) – the greater the difference in RTP on the two machines, the more participants tended to prefer the machine with higher RTP (most participants in this condition had a greater RTP on the free-spins machine). In the Hypothetical-money Condition, there was only a weak relationship between RTP and preference. However, inferences from these particular data are limited due to the small range on the x-axis variable for the Real-money Condition.

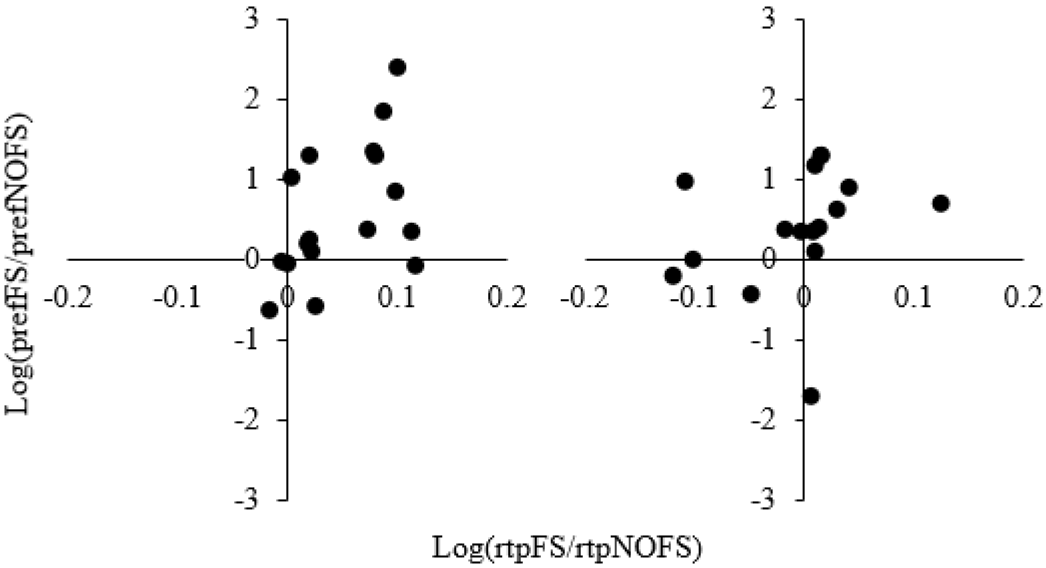

Figure 32. Preference for the free-spins machine as a function of experienced RTP in the exposure phase. The Y-axis represents the log of the proportion of preference-phase responses made on the free-spins machine. Values above 0 indicate preference for the free-spins machine, values below 0 indicate preference for the control machine. Values further from 0 indicate greater preference. The X-axis represents the log of experienced RTP on the free-spins machine during exposure divided by experienced RTP on the control machine. Values greater than 0 indicate greater RTP on the free-spins machine, values less than 0

indicate greater RTP on the control machine. Values further from 0 indicate a greater discrepancy in the experienced RTP on the two machines. Data points represent each participant's preference and experienced RTP ratios. The left panel displays data from the Real-money Condition, the right panel displays data from the Hypothetical-money condition.

To determine whether participants wagered more on either the free-spins machine or the control machine within conditions, participants' mean bet-amount selections in the exposure phase were displayed in Figure 33. In both the Real-money Condition and the Hypothetical-money Condition there was variability in the mean bet amounts across participants, but individuals bet roughly the same amount on each machine. Note that in the Real-money Condition, in the exposure phase participants were not yet playing with real money. A mixed ANOVA with a within-subjects factor of machine (free-spins, control) and a

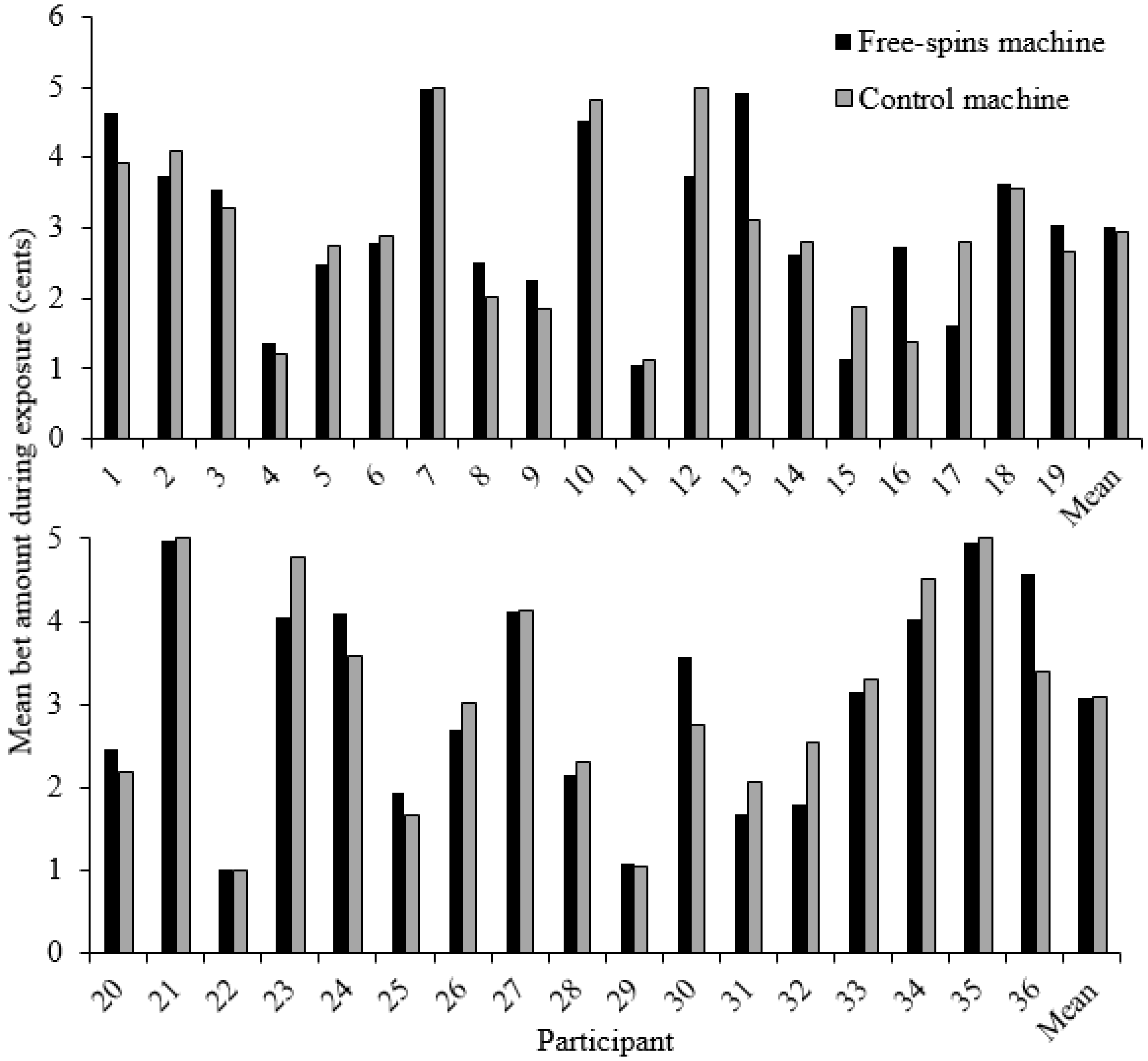

Figure 33. Mean bet amount selections during exposure phases. The top panel displays data from the Real-money Condition. The bottom panel displays data from the Hypothetical-

money Condition. Black bars represent mean bet amount selections on the free-spins machine, grey bars represent mean bet amount selections on the machine without free spins.

between-subjects factor of condition (Hypothetical-money, Real-money) supported these interpretations, revealing no statistically significant main effect of machine on bet amounts during the exposure phase, $F(1,34) = 0.097$, p =ns, and no significant interaction between machine and condition, $F(1,34) = 0.085$, p = ns. Descriptive statistics for these analyses are displayed in Table 8.

Table 8.

Mean Bet Amounts On Each Machine In Cents During Exposure Phase

	Free-spins machine		Control machine	
	M	*SD*	*M*	*SD*
Both conditions	3.046	1.262	3.011	1.245
Real-money Condition	3.019	1.237	2.954	1.224
Hypothetical-money Condition	3.078	1.327	3.075	1.303

To investigate whether participants' betting patterns varied as a function of preceding outcome, their mean bet amounts following different outcomes across both exposure and preference phases were analysed and displayed in Figure 34. There was variation across participants in how much they tended to bet, but individual participants tended to bet similar amounts following each outcome. A Greenhouse-Geisser corrected mixed ANOVA with a within-subjects factor of outcome, and a between subjects factor of condition supported this interpretation, revealing no significant main effect of outcome on subsequent bet amounts, $F(3.135,106.593) = 0.339$, p = ns. This indicates that participants did not bet a significantly different number of cents following losses (M = 2.966, SD = 1.320), LDWs (M = 2.924, SD = 1.385), medium wins (M = 2.965, SD = 1.413), big wins (M = 2.911, SD = 1.438), or free-spins sequences (M = 2.901, SD = 1.605). There was also no significant interaction between condition and outcome types, $F(3.135,106.593) = 0.514$, p = ns.

To investigate whether participants' betting patterns varied as a function of number of previous losses in a row, participants' bet amounts following different sized strings of losses during both exposure and preference phases were analysed and displayed in Figure 35. Overall, there was no clear pattern in either condition of participants betting more or less in

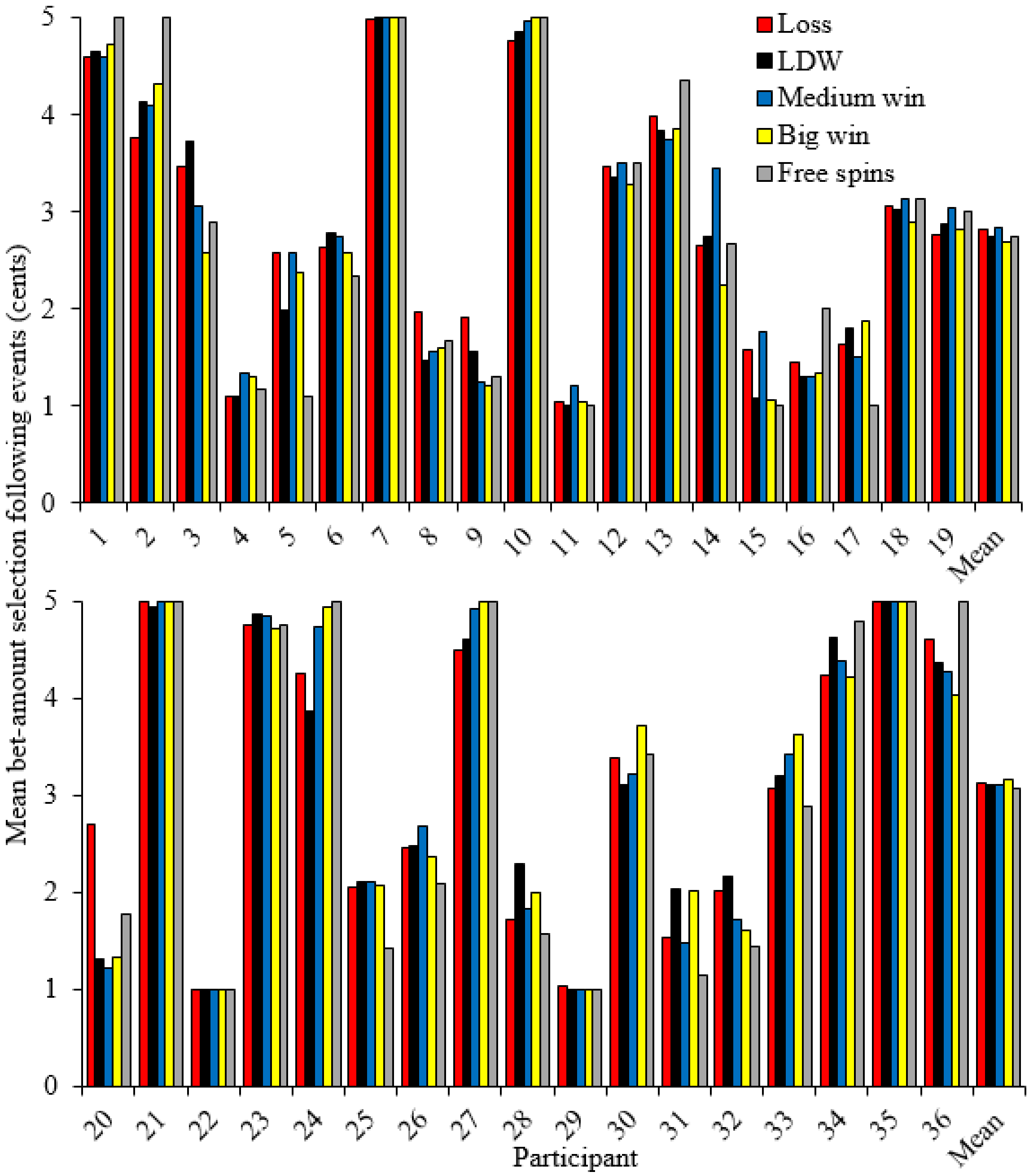

Figure 34. The mean bet amounts made by participants following various outcomes in both exposure and preference phases. The top half of the figure displays data from the Real-money Condition, the bottom half displays data from the Hypothetical-money Condition. Higher bars indicate greater average bet amounts. Mean bet amounts across participants are displayed on the right.

response to longer strings of losses. However, some participants tended to bet more in response to longer strings of losses (e.g.. participants 8, 9, 16, 20), and some tended to bet less (e.g., participants 23 & 24). A Greenhouse-Geisser corrected mixed ANOVA with a within-subjects factor of loss-string length and a between-subjects factor of condition indicated no significant main effect of loss-string length on subsequent bet amounts, $F(1.452,49.368) = 2.310$, p = ns. This indicates that participants did not bet a significantly different number of cents following one loss ($M = 2.895$, $SD = 1.422$), two losses ($M = 2.921$, $SD = 1.326$), three losses ($M = 3.069$, $SD = 1.299$), four losses ($M = 3.077$, $SD = 1.266$), or five or more ($M = 3.071$, $SD = 1.271$). There was also no significant interaction between loss-string length and condition, $F(1.452,49.368) = 0.622$, p = ns.

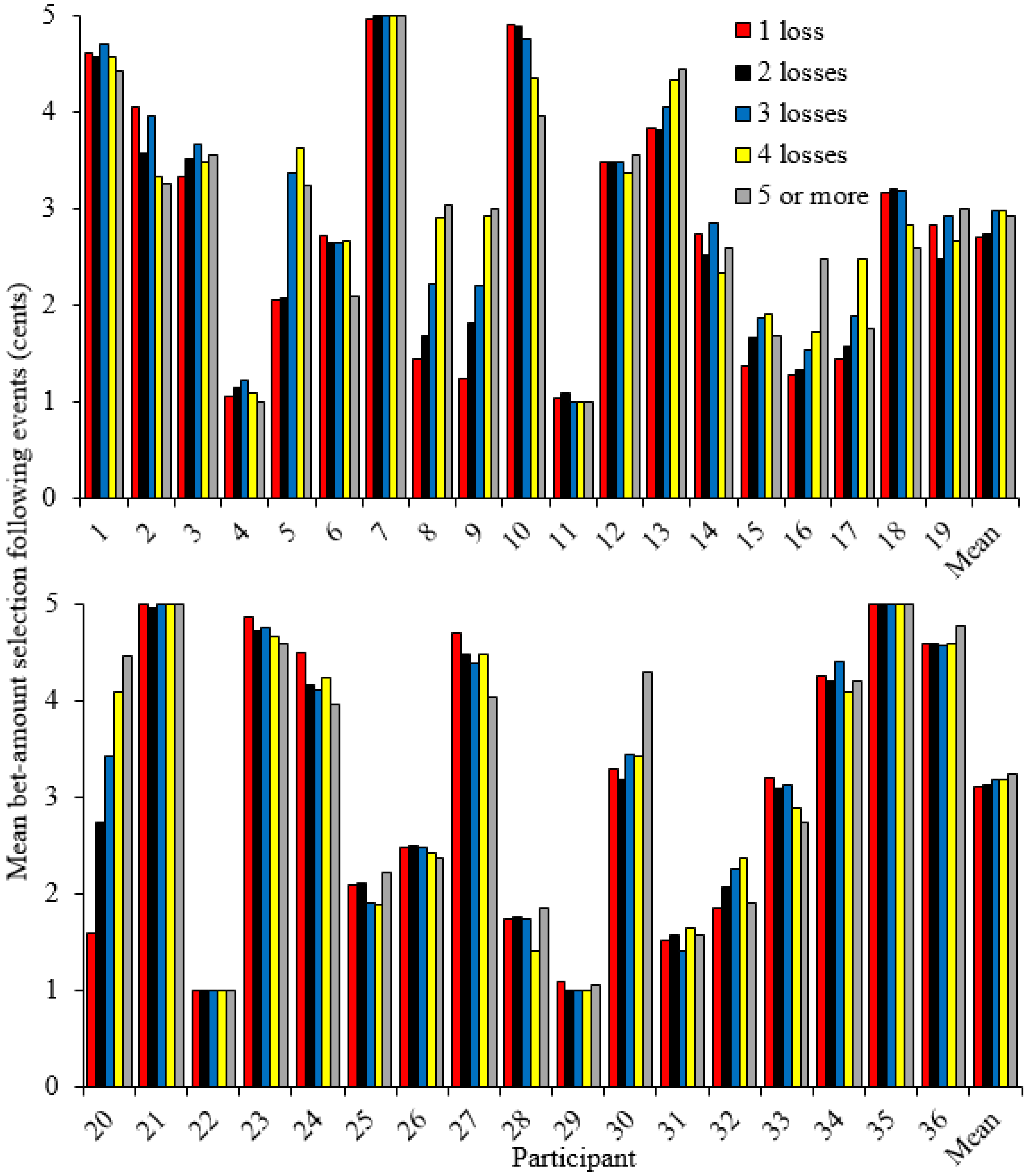

Figure 35. The mean bet amounts made by participants following various different-sized strings of losses in both exposure and preference phases. The top half of the figure displays data from the Real-money Condition, the bottom half displays data from the Hypothetical-

money Condition. Higher bars indicate greater average bet amounts. Mean bet amounts across participants are displayed on the right.

To investigate whether participants' machine-switching behaviour varied as a function of preceding outcome, the proportion of times participants switched machines following different outcomes (loss, LDW, medium win, big win, free-spins sequence) was analysed for the preference phase and displayed in Figure 36 for both conditions. In the Real-money Condition there was a large amount of variability between participants in how likely they were to switch machines in general. This is evidenced by greater ranges and inter-quartile spreads in the Real-money Condition data, compared to the Hypothetical-money Condition which had much less variability. No clear pattern emerged in how frequently participants switched following different outcomes, although participants in the Hypothetical-money Condition tended to switch the least following big wins, and the most following free-spins sequences. Switching following big wins and free spins should be interpreted cautiously, due to small sample sizes of these outcomes – refer to Table 9 for the frequency of these outcomes. A Greenhouse-Geisser corrected mixed ANOVA with a within-subjects

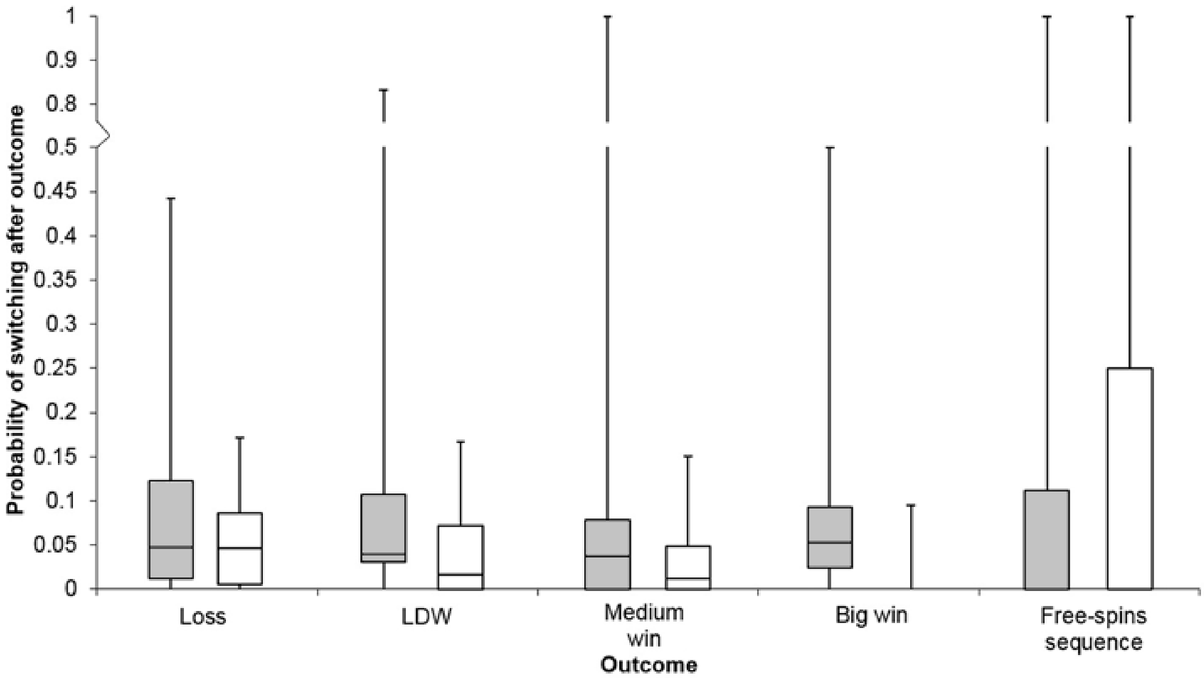

Figure 36. Probability of switching to other slot-machine simulation following different outcomes. The grey boxes display data from the Real-money Condition, the white boxes display data from the Hypothetical-money Condition. Whiskers represent the range. Lower and upper extremities of the boxes represent quartiles one and three respectively. The middle line of each box represents the median.

factor of outcome type and a between-subjects factor of condition revealed a main effect of outcome on the proportion of opportunities where participants switched machine that trended towards statistical significance, $F(1.437,41.675) = 3.000$, $p = .076$, $\eta_p^2 = .094$. This is a medium effect size, however, follow-up pairwise comparisons indicated no statistically significant effects. Descriptive statistics for this analysis are displayed in Table 9.

There was also no statistically significant interaction between switching following the different outcomes and condition, $F(1.437,41.675) = 1.186$, p = ns, and no main effect of condition on switching collapsed across outcomes, $F(1,29) = 0.939$, p = ns. Descriptive statistics for these analyses are also displayed in Table 10.

Table 9.

Mean Event Frequency During Preference Phase for Participants With At Least One Spin.

Outcome	Real-money (range)	Hypothetical-money (range)
Loss	136 (21-188)	171 (145-192)
LDW	21 (3-33)	28 (18-36)
Medium win	27 (3-55)	33 (20-57)
Big win	16 (0-35)	19 (5-30)
Free spin	5 (1-9)	6 (0-9)

Table 10.

Likelihood of Participants Switching Following Various Outcomes

	Both conditions		Real-money Condition		Hypothetical-money Condition	
	M	*SD*	*M*	*SD*	*M*	*SD*
Loss	.070	.076	.086	.090	.038	3037
LDW	.075	.143	.104	.190	.058	.122
Medium win	.087	.200	.138	.270	.099	.125
Big win	.084	.196	.157	.260	.068	.142
Free spins	.149	.278	.131	.278	.170	.287
Outcomes collapsed	.080	.105	.108	.134	.050	.050

Discussion

The current study extended the results of Preference Study 1 and Preference Study 2 by investigating whether participants preferred to play a simulation with a complex free-spins feature over a simulation without free spins when gambling with real money. It was expected that participants gambling with real money would wager lower amounts than participants gambling with hypothetical money. This particular hypothesis was supported by the data. Participants in the Real-money Condition generally had lower average bet sizes than participants in the Hypothetical-money Condition, however this difference only approached statistical significance (p = .06). Due to a relatively small sample size, it is plausible that the between-groups analysis of mean bet sizes simply lacked the power to find a statistically significant difference. Despite the failure to find a statistically significant difference, the effect size in this comparison was medium to large. If reliable, the effect of whether participants were wagering hypothetical or real money on bet size is consistent with Weatherly and Brandt's (2004) between-groups investigation into credit worth on bet sizes. Weatherly and Brandt found that participants bet fewer credits in total when staked with $0 (i.e., gambling with hypothetical money) in comparison to $1 or $10 and this effect was statistically significant. Participants also generally wagered less when staked with $1 in comparison to $10, although this effect did not reach statistical significance. In a follow-up experiment using a within-subjects design, Weatherly and Brandt found that participants bet significantly fewer credits when staked with $10 than when staked with $1, although no statistically significant difference was found between a stake of $0 and either $1 or $10. Both experiments in Weatherly and Brandt's study support the idea that participants generally bet more when credits are worth less, which is consistent with participants tending to bet more in the current study when playing with hypothetical money. The bet-amount results of the current study are also consistent with Weatherly and Meier's (2007) finding that participants generally bet more when playing video poker simulations with hypothetical money as compared to playing with real money.

It should be noted that Weatherly and Brandt (2004) analysed total number of credits bet as their measure of amount wagered, which co-varied with the number of trials participants played (they also found participants played fewer trials when credits were worth more). Combining these variables (trials played, bet sizes) into one dependent measure (total amount wagered) increases the likelihood of finding a significant effect – essentially, two moderate differences in the same direction in the individual variables results in a larger difference when they are combined into one dependent measure. In the current study, the individual variables were both analysed to give a more complete picture of participants' betting behaviour.

In addition to generally betting lower amounts, participants in the Real-money Condition completed significantly fewer spins in the preference phase than participants in the Hypothetical-money Condition. These findings are consistent with those of Weatherly and Brandt's (2004) between-subjects experiment. Their participants generally made significantly fewer spins when credits were worth more ($10 total stake) compared to when they were worthless ($0 total stake). However, both Weatherly and Brandt's follow-up within-subjects experiment, as well as Weatherly and Meier's (2007) study found no effect of credit worth on number of trials played. Due to these mixed findings, the result of the current experiment that participants made significantly fewer spins when credits had an extrinsic value contributes to the literature by adding more evidence that credit worth affects persistence.

It was expected that participants gambling with both real money and hypothetical money would prefer the free-spins machine over the control machine. This hypothesis was supported. This finding indicates that studies investigating preference for free-spins features are likely unhindered by the use of hypothetical money. Preference for the free-spins machine was fairly consistent across participants in both conditions, and there was no interaction between condition and the number of spins allocated to each machine. The results from Preference Study 2 demonstrated that participants preferred slot machines with complex free-spins features, and this result was replicated when participants were gambling with real money. This finding is also consistent with gamblers' self-reported preference for slot machines with free spins or other bonus features (Landon et al., 2016; Livingstone et al., 2008; Millhouse & Delfabbro, 2008; Templeton et al., 2014), and real gambling data (Leino et al., 2015).

The order of slot-machine exposure had a negligible effect on preference in both conditions. This is consistent with Preference Study 2, and provides further evidence that the procedural changes implemented there were effective in reducing the order effect seen in Preference Study 1 where participants tended to prefer the first machine exposed to. At this stage, since multiple changes were made (balances reset at end of each exposure, exposure phases shortened and preference phase lengthened) it is unclear exactly which factor (or combination of factors) affected preference in Preference Study 1.

The Hypothetical-money Condition was included in the study in part to determine whether any potential differences in preference between participants gambling with real money and participants from Preference Study 2 were due to sampling differences – participants in the current study were recruited with posters around the university campus, while participants in Preference Study 2 were first year psychology students participating as part of mandatory course requirements. However, no major differences in preference were found between participants in the Added-features Condition of Preference Study 2 and the current study – in both studies preference for the machine with free spins was reasonably consistent across participants. This may indicate that participants who gambled for hypothetical money in the current study, as well as in Preference Studies 1 and 2, successfully followed the instructions to gamble as if they were gambling for real money, to a certain extent. The finding that participants gambling with real money tended to make fewer gambles, and bet less, indicates that participants' ability to pretend they are gambling for real money is somewhat limited. An advantage of directly comparing how participants respond when gambling with real and hypothetical money is that this enabled identification of which variables were affected by this difference (bet amounts, number of spins made), and which variables were not (preference for free-spins feature, bet amounts following different outcomes).

Inferences that can be made from the RTP data in the current study are limited, due to the small sample of participants who had a higher RTP on the control machine (particularly in the Real-money Condition). Generally, participants in the Real-money Condition tended to be more sensitive to RTP differences, whereas participants in the Hypothetical-Money Condition tended to be relatively insensitive. However, due to a rather limited range in the experienced RTP differences across machines in the Real-money Condition, this interpretation is speculative. Future research could directly manipulate RTP and whether participants are playing with real versus hypothetical money to answer this question more directly. In any case, RTP did not appear to be the major driver of preference for either slot machine.

The (speculative) finding that participants' preference was more influenced by RTP in the Real-money Condition is consistent with some literature. In Preference Study 2, Experiment 3 (the bonus mode experiment), participants preference was similarly pushed towards the machine with the higher RTP during exposure. Coates and Blaszczynski (2013) found that participants played more on a machine with a higher RTP, although the same researchers also found that participants played less on a machine with a higher RTP (Coates & Blaszczynski, 2014). The finding that participants' preference was not influenced by RTP in the Hypothetical-money Condition is inconsistent with the above literature, but in line with other research. In Preference Study 2 – Experiments 1 and 2, there was no effect of RTP on preference using a similar procedure. Other researchers have also failed to find an effect of RTP on various independent variables (Brandt & Pietras, 2008; Schreiber & Dixon, 2001; Weatherly & Brandt, 2004; Weatherly et al., 2009). It was suggested in Preference Study 2 that RTP may affect gambling behaviour under some conditions but not others. While it is still unclear exactly what these particular conditions are, this study provides some evidence that RTP differences will be more influential when gambling with real money in comparison to hypothetical money. The Coates and Blaszczynski studies can both be conceptualised as gambling with real money (more specifically, gambling for entries to a $50 prize draw) and they found that RTP influenced gambling behaviour. However, in the other studies mentioned above participants were also gambling for a monetary prize and the studies failed to find an effect of RTP (Brandt & Pietras, 2008; Schreiber & Dixon, 2001; Weatherly & Brandt, 2004; Weatherly et al., 2009).

Within each condition, participants tended to have similar average bet sizes on the free-spins machine as the control machine. This replicates the results from Preference Study 1 and Preference Study 2 (Experiments 2 and 3) where participants tended to bet the same amount on both machines. Even when participants have a clear preference for the free-spins machine, they tend to select the similar bet sizes on the less preferred machine. This indicates that bet sizes and preference have different underlying drivers.

Participants also tended to bet similar amounts following different events (losses, LDWs, medium wins, big wins, free-spins sequences) in both conditions. This indicates that these outcomes, taken individually, do not drive cognitive biases that influence gambling behaviour.

There was also no statistically significant effect of participants betting more following different sized strings of losses. However, visual analysis of individual participants' bet amounts following different sized strings of losses indicated that for roughly half of participants, bet sizes did tend to be affected by the number of losses they had just received consecutively. Across both conditions four participants showed the exact trend of betting more in response to longer strings of losses – a higher percentage of participants (11%) than would be expected by chance (0.825%). This replicates the findings from Preference Study 2, where in all three experiments some participants tended to bet more in response to longer loss strings. This effect only reached statistical significance in Experiment 1 where participants more consistently increased bet sizes in response to longer loss strings. It was argued in Preference Study 2 that the effect of loss strings on bet amounts varies considerably across individuals, and that perhaps only some proportion of the population is prone to making cognitive errors such as the gambler's fallacy when gambling on slot machines. This data is consistent with these interpretations. For participants who bet similar amounts following different sized strings of losses, this can be interpreted as an accurate assessment of the lack of predictive power of these outcomes.

Switching between simulations was a relatively rare occurrence for most participants in both conditions – the median switching rates after various outcomes were typically at or lower than 5%. These tended to be slightly higher in the Real-money Condition, however, the inferential statistics revealed no significant differences in switching behaviour following different outcomes or across conditions. There was also more variability between participants in the Real-money Condition in how often they switched machines, in comparison to participants in the Hypothetical-money Condition. Coates and Blaszczynski (2013) suggested that switching between slot-machine simulations in a concurrent alternatives design may be an attempt to "forage" for information about RTP. It makes intuitive sense that participants gambling for real money may be more motivated to seek information about RTP differences between the simulations, as this could help them select the more profitable simulation to play. If this motivation is the driver behind some participants switching more frequently in the Real-money Condition, it would be expected that participants would be more sensitive to RTP differences between the machines in the Real-money Condition. As described above, there was tentative evidence for this. While participants could not switch machines in the exposure phase, it is possible that participants were motivated to continue gathering information about RTP during the preference phase, since this is where they began gambling with real money. Outcome sequences in the preference phase were identical to those in the exposure phase. It is unlikely participants would pick up on this feature of the experiment, but switching in the preference phase may help them realise the machines are the same (or similar) as the exposure phase, and provide some explanation for their increased sensitivity to RTP differences in the exposure phase compared to participants in the Hypothetical-money Condition.

An interesting feature of the current study was that four of 19 participants who were recruited to participate via the Real-money Condition poster scored in a problematic range on the SOGS, while no participants recruited via the Hypothetical-money Condition poster did. This is quite a striking difference – only when the posters stated that participants would be staked real money to gamble with did participants with potentially problematic gambling behaviour choose to participate. Level of gambling problems/gambling risk influences some gambling behaviour (e.g., Rockloff et al., 2007; Young et al., 2008), however, in the current study no discernible difference was found between the gambling behaviour of participants who scored in a problematic range and other participants in the Real-money Condition. Intuitively, it would be expected that participants with higher levels of gambling problems would be more likely to gamble longer or for larger amounts, however, this was not the case in the current study.

Limitations of the current study include it taking place in an academic setting, and the fact that participants were staked money (rather than risking something they previously owned). Both of these factors reduce how far these results can be generalised. Whether participants treat money that is given to them to gamble with the same as their own money is an empirical question. It is possible that participants may view the staked money as a reward for participating rather than as something they are personally risking, despite instructions before the preference phase (where the Real-money Condition began gambling with real money) that the money belongs to them. In any case, the main purpose of the current study was to replicate the finding of Preference Study 2 that participants prefer to gamble on a simulation with free spins, and to do this with participants who were gambling with real money. This was convincingly demonstrated with a sample more representative of the student gambling population than the participants in Preference Studies 1 and 2. This research contributes to a growing amount of literature on slot-machine gambling behaviour, and is the first real-money gambling experiment investigating the effects of free-spins features on gambling behaviour.

Chapter 2

An Investigation into the Effect of Slot-machine Features on Gambling Persistence

Introduction

Thus far the above research has focused on *preference* – whether participants prefer to play simulations with free spins and what the characteristics of the free spins that contribute to this preference are. It is also important to investigate what influences *persistence* in gambling – continued gambling in the face of adverse consequences. Problem gambling is persistent by definition – the Diagnostic and Statistical Manual of Mental Disorders (5th edition; American Psychological Association, 2013, p585) defines it as: "Persistent and recurrent problematic gambling behaviour leading to clinically significant impairment or distress", and then lists a number of diagnostic criteria, some of which can be conceptualised as indicating gambling behaviour that is overly persistent:

- Unsuccessful efforts to control, cut back, or stop gambling
- After losing money gambling, often returns another day to get even

Identifying features of slot-machines that promote persistent gambling may facilitate problem-gambling interventions that reduce the persistence of slot-machine play. For example, legislation could outlaw or restrict specific game features that research has indicated facilitate problem gambling acquisition and maintenance. Before such interventions can be implemented, research needs to identify which slot-machine features promote persistent play.

A number of experiments using slot-machine simulations have investigated how different structural characteristics of machines influence persistence. Near wins and RTP percentages are two variables which research has focussed on, although other characteristics have been investigated. In a within-subjects experiment, Brandt and Pietras (2008) investigated the effect of RTP percentages (four levels – 50%, 75%, 95%, 110%) on persistence in five college students who were staked with money to gamble. Persistence was measured by the number of trials played and the number of credits remaining at the end of the task. Participants played simulations with each level of programmed RTP, and could click a button to quit at any point (a single-option quitting procedure). Only one participant showed an effect of RTP on persistence, playing longer on machines with higher RTPs. All other participants showed no effect. In a second experiment, Brandt and Pietras (2008) fixed RTP (75%) and varied win frequency/size across three conditions (frequent small wins, medium frequency/medium sized wins, infrequent large wins) with three additional participants. Only one participant showed an effect of win frequency/size, playing longer on simulations with more frequent/smaller wins. Both other participants showed no effect. Overall, the study failed to find a consistent effect of either RTP or win frequency/size on persistence when using a single-option quitting procedure.

Schreiber and Dixon (2001) also investigated the effect of win frequency on persistence. Recreational gamblers played simple one-payline slot-machine simulations of varying win frequencies and RTP percentages (20%, 40%, 60% of spins resulting in wins; RTP and win frequency co-varied) for 50 forced trials. Following this, participants were able to continue playing and could choose to stop at any point. Participants had no difference in number of trials completed across these conditions – RTP and win frequency had no effect on this measure of persistence. Weatherly and Brandt (2004) conducted a similar study investigating the effect of RTP and credit worth on gambling behaviour. Participants played a different version of simple one-payline simulations, each with varying RTP percentages (75%, 83%, 95%) and credit worth ($0, $1, $10 total stake). Again, participants could stop gambling at any time – another one-shot measure of persistence. RTP generally had no effect on trials played across participants. On the other hand, credit worth did influence persistence, with participants playing fewer trials when credits were worth more.

As a whole, the research investigating whether win frequency or RTP influence persistence has failed to find any effect. Interestingly, this research has also tended to examine persistence with a single-option quitting procedure in *normal reinforcement conditions* (i.e., persistence was measured by the number of trials completed in conditions where there is no disruption to the existing contingencies of reinforcement). Other experimental gambling-persistence research has focussed on near wins, and has generally found that the presence of near wins increase persistence. Cote, Caron, Aubert, Desrochers, and Ladouceur (2003) demonstrated that participants persisted longer during extinction on machines that contain near wins. Kassinove and Schare (2001) found an “inverted U” of persistence – slot-machine simulations with 30% near wins promoted more persistence than simulations with 45% or 15%. On the other hand, other researchers have found no significant difference in persistence on simulations with rates of 15%, 30%, and 45% near wins (Maclin et al., 2007). In contrast to the research examining win frequency or RTP described above, this near-win research has tended to examine persistence with a single-option quitting procedure in *extinction conditions*. This may indicate that putting behaviour into extinction conditions results in gambling tasks that are more sensitive to differences in persistence than procedures examining persistence without such disruptions (e.g., the win-frequency/RTP research). However, it is also possible that near wins simply increase persistence, whereas win frequency or RTP has no effect.

Despite the possibility that measuring persistence in extinction conditions is more sensitive than measuring persistence in normal reinforcement conditions, it is questionable whether this type of measure is a fair estimate of persistence. Animal research has demonstrated that under certain conditions, how quickly a behaviour extinguishes in extinction is affected by different variables to those that affect how quickly another disruptor, pre-feeding, causes behaviour to cease (Craig & Shahan, 2016). This suggests that how quickly a behaviour ceases in extinction may not be representative of how that behaviour responds to other disruptors (e.g., the addition of non-contingent reinforcement, pre-feeding, alternative reinforcement available for different responses). Research investigating the persistence of gambling should not rely exclusively on extinction as the disruptor, especially when seeking to generalise experimental results to real-world gambling behaviour where the behaviour is rarely in extinction.

Another issue with extinction-persistence research is that once participants decide to stop gambling, the session is over and no further gambling takes place. However, after real gamblers choose to end a session of gambling, they can reinstate their behaviour whenever they choose. This reinstatement is another form of persistence that cannot be measured in these one-shot persistence studies using extinction as the disruptor. Fortunately, extinction is not the only method that researchers can use to disrupt behaviour. Outside of experimental gambling research, there is a wealth of research on persistence of behaviours which has used a number of different disruptors. This research has focussed on investigating Behavioural Momentum Theory (Nevin, 1992) – a behavioural theory which has good explanatory power with regard to the persistence of behaviours.

Behavioural Momentum Theory (Nevin, 1992) proposes that the strength of a behaviour is comprised of two different aspects – response rate, and response persistence. The theory draws an analogy from the field of physics, where the momentum of a moving object is also made up of two different aspects of the object – velocity, and mass. In Behavioural Momentum Theory, response rate is analogous to velocity, and persistence is analogous to mass. Response rate is determined by operant response-reinforcer contingencies (i.e., schedules/magnitude of reinforcement obtained by responding). Persistence on the other hand is determined by Pavlovian stimulus-reinforcer contingencies – for example, if stimulus

A is associated with a greater overall rate of reinforcement (non-contingent reinforcement and reinforcement contingent on responses) than stimulus B, all behaviours associated with stimulus A should be more persistent than the same behaviours associated with stimulus B. Measuring the momentum of an object is relatively easy, it is a product of the object's speed and the object's mass, both of which can be accurately measured. Measuring the momentum of a behaviour is more difficult – while we can easily measure response rate if the behaviour in question is discrete, it is much harder to measure persistence. To do this requires establishing a baseline response rate and then applying a disruptive force and measuring the proportional change in response rate (Nevin, 1992).

Behavioural Momentum research typically has the same general design – a multiple-schedule paradigm where a subject is exposed to two different schedules of reinforcement, each signalled by a different stimulus. After these two components alternate a number of times, usually until response rates are stable, identical disruptors are added to each component. The function of these disruptors is to decrease response rates. The rate of responding under disruption relative to the rate of responding in baseline for each component provides a measure of how persistent the behaviour is (Nevin, 1992). This design allows the measurement of both response rate and persistence, and has been utilised in both animal and human research on Behavioural Momentum Theory. There is now a large base of research supporting the core ideas of the theory – that response rate is determined by response-reinforcer contingencies, and that persistence is determined by stimulus-reinforcer contingencies.

There are several types of disruptors that have been used in animal research on Behavioural Momentum Theory. All of them function to decrease response rate. Pre-feeding is when subjects have access to food immediately prior to the experimental session. This satiation causes them to be less likely to work (e.g., button press) for food reinforcers, and so decreases response rate compared to baseline sessions where subjects are food deprived. Reinforcement for alternative behaviours is another commonly used disruptor. This is where reinforcement is made available for responses other than the dependent variable during the disruption phases. Extinction is another commonly used disruptor, where responses are no longer reinforced during disruption sessions. Non-contingent reinforcement is another type of disruptor. Here, reinforcers are provided on time-based schedules independent of responses. This weakens the contingency between responding and reinforcement, and so decreases response rate. All of these disruptors have been shown to decrease response rates. Therefore, these are effective disruptors to be used when investigating persistence of behaviour.

Animal research has consistently demonstrated that behaviour in contexts with a richer rate of reinforcement is more resistant to disruption (i.e., persistent) than behaviour in a context with a leaner rate of reinforcement (for a review, see Nevin & Grace, 2000a). This research also demonstrates that persistence is largely independent of response rate. There is also an emerging base of literature demonstrating effects consistent with Behavioural Momentum Theory in humans. This research usually focuses on participants with developmental disabilities. Of the little research that has been conducted with typically developed adults, some of this has had some methodological issues that make inferences about persistence difficult.

Human behavioural momentum research using participants with developmental difficulties has convincingly demonstrated effects consistent with Behavioural Momentum Theory. Dube, Mazzitelli, Lombard, and McIlvane (2000) tested whether responding on a computer touchscreen for token reinforcers by two adults with intellectual disabilities was more persistent on a richer schedule. There were up to 100 baseline sessions of four one-minute alternating components on a multiple schedule. There were two different baselines schedules. In the first, in one component, responses on a touchscreen were reinforced on a VI-10s schedule. On the other component, responses were also reinforced on a VI-10s, and a concurrent VT-7s schedule was also running (response independent reinforcement). In the second set of baseline sessions, the disruptor was presented alone for the first minute of each session to create a reinforcement history for responding to it. The disruptor was an alternative stimulus that participants could make responses to, which were reinforced on a VI-7s schedule. In the test (disruption) phases, the disruptor was presented during the last one-minute period of each component, and responding while the disruptor was present was compared to responding in that component before the disruptor was present. Each subject received five tests distributed over 17 sessions in this manner.

Behavioural Momentum Theory (Nevin, 1992) would predict that responding on the richer schedule would be *more* resistant to disruption, as the stimulus signalling that schedule should be associated with a greater overall rate of reinforcement. Both participants were clearly more disrupted on the leaner schedule when the disruptor was present. This effect was also quite consistent, being demonstrated in all five tests for one participant, and three of five for the other if data are interpreted conservatively. This study quite convincingly demonstrated effects consistent with Behavioural Momentum Theory.

Other research with developmentally delayed participants has also convincingly shown effects consistent with Behavioural Momentum theory. Ahearn, Clark, Gardenier, Chung, and Dube (2003) found that stereotypic behaviour in children with autism was more resistant to disruption following periods of access to preferred stimuli (rich schedule) compared to periods without that access (lean schedule). Groskreutz (2010) investigated whether different staff could serve as contexts for four children with autism. On a sorting task, three out of four participants showed more resistance to disruption in the context associated with a richer schedule of reinforcement. Parry-Cruwys et al. (2011) investigated behavioural momentum effects in six children with various developmental disabilities. On familiar leisure tasks, five out of six had higher resistance to disruption in the context associated with the richer schedule. Dube and McIlvane (2001) also found that two adults with developmental disabilities were more resistant to disruption during a computer touch-screen task in the context associated with a richer reinforcement schedule. There has been relatively little human research in comparison to animal research investigating behavioural momentum. However, there is a consistent finding that behaviour is more resistant to disruption in a context associated with a richer reinforcement schedule compared to a leaner context, regardless of whether the additional reinforcement was contingent on responding or not.

Effects consistent with Behavioural Momentum Theory have been less convincingly demonstrated in research with typically developed adults. Plaud and Gaither (1996) conducted an experiment where the effects of various disruptors were tested on typically developed young adults. Different reinforcement schedules were signalled by alternating computer screen colours (red, green), and the behaviour required was pressing a key for points (one key during red screen, a different key during green screen). Key presses in both contexts were reinforced on VI-45s schedules. In the green context, reinforcers were valued at one point, in the red, reinforcers were worth 10 points, creating a lean and a rich context. Baseline sessions consisted of 25 presentations of each component (red screen, green screen), and participants completed six baseline sessions. Following baseline, three participants were exposed to an extinction procedure. One participant was exposed to a VI-30s condition (richer than baseline). One participant was exposed to a VI-60s condition (leaner than baseline). One participant was exposed to a response independent reinforcement schedule

(VT-30s), and two participants were exposed to a leaner response independent reinforcement schedule (VT-60s). Resistance to disruption was generally higher when the background screen was the colour associated with the denser schedule, although closer analysis of the results suggest some issues with data analysis. Participants in the extinction condition all responded less compared to baseline in both components (i.e., all were disrupted), and participants responded more during both baseline and extinction on the richer key. However, the data are presented as mean number of responses, rather than responses during extinction *as a proportion of baseline responding*. This means it is rather hard to conclude that all participants were more disrupted during extinction on either key. To conclude this requires comparison of extinction response rate and baseline response rate. Differences in responding on the different keys were quite similar between baseline and extinction, so appropriate comparison is difficult to achieve through visual analysis of the figures.

The participants who were exposed to the VT schedules (one on VT-30s, two on VT-60s) as disruptors were all clearly more disrupted on the leaner schedule (Plaud & Gaither, 1996), in accordance with predictions derived from Behavioural Momentum Theory. The participants who were exposed to the VI-30s and VI-60s schedules were not effectively disrupted (i.e., their response rates did not decrease compared to baseline). Overall, it appears that participants who were disrupted at all were either more disrupted on the leaner key, or roughly equally disrupted on the leaner and richer keys. Presenting responding during disruption as a function of responding during baseline would allow more convincing conclusions to be drawn, although the data generally appear to be consistent with that predicted by Behavioural Momentum Theory.

Plaud, Plaud, and Von Duvillard (1999) conducted a follow-up study with older adults, using the same baseline and experimental conditions as above. These participants also generally responded more on the key associated with the rich context. The authors claim the participants showed more persistence on the richer key when the contingencies changed from baseline; however, this claim is impossible to ascertain from the data they present. Mean number of responses per minute are presented, but only for the changed contingencies (i.e., during disruption), not for baseline. This means that it is impossible to compare baseline responding to the responding under disruption in this study. While the authors can rightfully claim response rates were generally higher on the rich key during disruption, they have not presented the data in a way that is appropriate for analysis of persistence. For example, the differences presented may have reflected operant contingencies maintaining response rate in the two components rather than the associative relations that Behavioural Momentum Theory suggests determine persistence. In the first study with younger adults, data were presented in a way that made determination of persistence difficult, yet possible if the effect was big enough (sometimes it was). In this study, determination of persistence was impossible as no baseline response rates were presented. Overall, these two studies suggest that typically developed adult humans tend to respond in ways consistent with Behavioural Momentum Theory, although this is not compellingly demonstrated.

The other two studies investigating Behavioural Momentum Theory in typically developed adults have more convincingly demonstrated effects consistent with the theory. Cohen (1996) investigated persistence in the typing behaviour of healthy adults and found that participants responded in accordance with Behavioural Momentum Theory. In experiment one, 16 undergraduate participants completed a typing task, where they were presented with three letters and had to type these for points. Typing behaviour was reinforced on a multiple VI-4s VI-24s schedule, with the different components signalled by background colours on the screen. Each component lasted for 90 seconds, and each session lasted until each component had been completed eight times. There were four baseline sessions conducted in the above manner, and four test sessions where a disruptor was present. The disruptor was reinforcement provided for an alternative behaviour – finding Waldo (a character hidden in a popular picture book). Participants were allocated points for each time they found Waldo in the books, and were supposed to do this while also completing the typing task – participants were to choose how much time to allocate to each task. In 50 out of 60 comparisons (15 participants with four baseline/disruption pairs each), typing behaviour was more persistent in the context associated with the richer schedule. In experiment two, seven participants completed a similar task (fewer baseline/disruption sessions) with different reinforcement schedules (multiple VI-16s VI-16s+VT). In 11 out of 13 comparisons, typing behaviour was more persistent on the richer schedule (Cohen, 1996).

Similarly, Kuroda, Cancado and Podlesnik (2015) investigated persistence on a computer task in four undergraduate students. Following extensive baseline testing on a VI-15s/VI-60s multiple schedule where the target response was to click a moving button for points, the researchers tested persistence with two measures. In Phase Two, the target behaviour was extinguished while responding to a new, different button was reinforced (differential reinforcement for alternative behaviour). All participants were more persistent at clicking the target button on the rich schedule. In Phase Four, a video was embedded into the computer task (also differential reinforcement for alternative behaviour). Responding to a show-video button was reinforced with one second of video. Multiple responses on this button stacked video time up to a maximum of 15 seconds. Three of four participants were more persistent at clicking the target button on the rich schedule during this phase, with the other participant not responding on the target button at all on either component. Overall, participants in this study consistently displayed effects consistent with Behavioural Momentum Theory. Despite issues with the analyses in two of the above four studies with typically developed humans on Behavioural Momentum Theory, the above research consistently demonstrates that behaviour is more persistent in contexts associated with richer schedules of reinforcement.

The consistent finding in behavioural momentum research that behaviour is more persistent in contexts associated with richer reinforcement is at odds with the experimental slot-machine research on RTP and win frequency. When RTP and/or win frequency are higher on one machine than another, there are clearly both rich and lean schedules of reinforcement. Behavioural Momentum Theory would suggest that gambling on the richer schedule would be more persistent; however, the research outlined above collectively failed to demonstrate a consistent effect of RTP or win frequency on persistence. This contradiction between Behavioural Momentum Theory and the RTP/win frequency research may be due to the way persistence was measured. In Behavioural Momentum Theory research, a disruptive force is always applied to the behaviour. Then, responding during disruption is compared to responding during baseline. This may provide a more sensitive measure of persistence than the single-option quitting procedure in normal reinforcement conditions often used in the RTP/win frequency research. It is also possible that RTP and win frequency simply do not increase persistence; however, this would not be easily explainable by Behavioural Momentum Theory.

Behavioural Momentum Theory and research investigating it are directly relevant to research on gambling behaviour. As described at the start of this chapter, problem gambling can somewhat be thought of as overly persistent gambling – gambling that is persistent in the face of major disruption (financial and other problems resulting from or exacerbated by gambling). Behavioural Momentum Theory and research have potential to elucidate some of the causes of this persistence, and possibly inform intervention and regulation.

Slot-machine simulations appear to be suitable for studying behavioural momentum in humans. Firstly, they involve discrete responses (pressing the "spin" button). Secondly, the time between responses is determined partly by machine characteristics, but also by the player. For instance, players may not always choose to immediately spin again as soon as the option presents itself. These two factors mean that response-rate measures can be employed. Furthermore, using slot-machine simulations allows the use of disruptors with some ecological validity such as video disruptors. When gambling at a casino or pub, there are often LCD monitors in view which may act as alternate sources of reinforcement. Players may occasionally watch these screens instead of, or while gambling. As for online gambling, it is a common occurrence for people to watch television shows or movies while doing other tasks at the computer. People may have their laptop out while they watch TV, or they may watch something on their computer while simultaneously doing another activity. It is reasonable to assume that some online gamblers may also watch or have other entertainment playing while they gamble. Therefore, video disruptors may be a disruptor with quite good ecological validity for use in slot-machine simulation research investigating Behavioural Momentum Theory. Slot-machine gambling is also an activity that a significant proportion of the population engages in – 18.2% of adult New Zealanders reported they had engaged in some form of slot-machine gambling during the past year in the 2012 New Zealand National Gambling Study (Abbott et al., 2014). In sum, slot-machine simulations provide a task that is suitable for studying behavioural momentum for logistical reasons, allow ecologically valid disruptors, and resemble gambling that some adults engage in outside of experimental situations.

The current study investigated whether free-spins features contribute to persistence in slot-machine gambling using slot-machine simulations and an experimental design. A multiple schedule with two components was employed as in other behavioural momentum research. Background themes of the simulations and the presence of a bonus feature on one machine served as contextual variables. Gambling in both components resulted in a roughly equal number of wins, and an equal RTP percentage. However, one component included a free-spins bonus feature. As demonstrated by the earlier preference studies, participants generally prefer playing a simulation that has a free-spins feature over one that does not. The presence of this free-spins feature should therefore cause that component to be interpreted as a richer schedule compared to the simulation without free spins. Video disruptors were embedded into the slot-machine simulation during certain phases of the experiment. These videos provide a source of reinforcement for a behaviour in competition with gambling (watching the video cf. continuing to gamble). Two hypotheses logically follow from Behavioural Momentum Theory and research:

1) Gambling will be disrupted to some extent when videos are playing.
2) Gambling on the free-spins machine will be more resistant to the video disruption than the machine without free spins.

Task Development Study 1

Method

Participants. Sixteen students enrolled in a first year psychology course participated in partial fulfilment of a course requirement. All participants completed an informed consent form prior to participating, and were debriefed following participation. All aspects of this study, as well as the following studies in this chapter, were reviewed and approved by the university's ethics committee. Each participant completed the SOGS (Lesieur & Blume, 1987) after completing the experimental tasks described below. No participant scored in a problematic range on the SOGS.

Materials and stimuli. The materials and stimuli were the same as for Preference Study 2, Experiment 2, with adjustments to the simulations. Video clips were embedded into the top right corner of the slot-machine simulations during specific stages of the gambling task. These videos played through Shockwave Media Player. A total of four videos were played – two were compilations of amusing animal clips from Youtube, and two were compilations of the best National Rugby League (NRL) tries from the 2013/2014 seasons. All videos had music and other sounds included, which played simultaneously with sounds from the simulations. Videos were presented on top of the slot-machine theme. In stages of the experiment without videos, they were neither visible nor audible.

The wording of "MAX LINES" on the button that began the simulations' spinning animations was changed to "SPIN". The location of the bet amount and spin buttons were slightly adjusted to allow for space for the embedded videos. (See Figure 37 for arrangement of machine elements on the screen.) The pre-task on-screen instructions were also altered, as described below.

Experimental conditions. Participants played on the simulated slot machines from Preference Study 2, Experiment 2: One machine had the complex free-spins feature that participants in the preference studies consistently preferred, and the other machine was the control machine without free spins. On the free-spins machine, 4% of spins produced a free-spins sequence.

Figure 37. Screenshot of free-spins machine, captured while one of the NRL video disruptors was playing.

Procedure. This experiment was conducted in the same room as the previous studies, and on the same computers. Up to four participants took part in any given session on separate computers. No real money was won, lost, or wagered during the experiment. The entire process (informed consent, experimental tasks, debriefing) took approximately one hour. Participants read the following instructions before they began the experimental tasks:

> You are about to play a slot machine task. You will play two different slot machines, and have a separate balance for each machine. You should play the slot machines as if you were playing a real slot machine for real money.
>
> You will sometimes be presented with videos to watch. During these videos, you can still play the slot machines, if you want to.
>
> To place a bet, click the button indicating how much you want to bet on each line, then click the SPIN button. You will always be betting on three lines at once.

At the bottom of these instructions was a “Start Task” button, which began the experiment.

The experiment consisted of a two-component multiple schedule: one component with free spins, and one component without free spins. The active component was signalled by the different slot-machine themes. Each component lasted for either 25 bets (for a total of 25 spins if the free-spins feature was not activated or 30, if the free-spins feature was activated), or three minutes, which ever came first.

***Baseline*.** During the baseline phase, components alternated four times, (an ABABABAB design). Whether the free-spins component was first was counterbalanced across participants. Disruptors (videos) were not present during baseline. The purpose of these initial eight components was for participants to familiarise themselves with the simulations and learn about differences between them (i.e., the presence or absence of the free-spins feature), and to develop associations between the free-spins machine/control machine and their relevant background stimuli.

***Distributed sessions disruption test*.** During the final eight components of the experiment video disruptors were repeatedly introduced and removed. These phases followed an AA BB AA BB design, with the video disruptors playing only in the second phase of each component pair listed above – the first phase of each pair acted as another baseline phase. The baseline session immediately prior to each disruption session acted as a comparison session, to allow analysis of responding under disruption to responding during baseline. The first disruptors for each component were the animal videos, the second were the NRL videos.

Credit balances started at $30 on both components. When components changed, the on-screen balance after the final spin on the previous phase in the same component replaced the current on-screen balance. In other words, both components had separate balances which tracked throughout the different phases. Both components had fixed outcome sequences which were identical across participants – the outcome percentages for each sequence (free-spins machine, control machine) are displayed in Table 11. Note that the top part of the table displays probabilities for a given outcome occurring on any one of the three lines. The final three rows display overall win frequencies (of any magnitude) per three-line spin. These outcome sequences covered the first four phases on each component (i.e., initial baseline phases), and were then repeated for the final four phases on each component (i.e., baseline/disruption pairs). Assuming participants completed all spins within the three minute limit for each component, a free-spins sequence was activated once during every free-spins component phase. However, if a participant completed only (for example) 20 spins before the component changed, when the machine changed back to that component the next outcome would be number 21 in the outcome sequence. Due to this feature of the experiment, some participants may have had a free-spins component phase where no free-spins sequences occurred, or two free-spins sequences were activated.

Table 11.

Programmed Outcome Probabilities on each Slot Machine for Task Development Study 1.

Outcome	Free-spins machine	Control machine
Per individual line		
loss	.84	.83
2*	.06	.08
5*	.05	.05
8*	.01	.03
10*	.02	.01
30*	.01	.01
5 free spins	.01	0
Resultant Outcome Frequencies Per Spin (three lines per spin)		
Programmed RTP percentage	92%	93%
Programmed/experienced Probability of win	.41	.43
Programmed/experienced Probability of win during free-spins feature	.50	n/a
Programmed/experienced Probability of win outside free-spins feature	.39	.43

Note. *Programmed outcome is multiplied by the bet-amount selected.

Data analysis. Response rate for each component was measured by dividing the number of spins in a component by the time taken during each component, and expressed as response rate per minute. This measure includes the time where the reels were spinning. For a fair comparison of persistence across components, all free spins, the spin immediately prior to and after the free-spins sequence, and the time taken for these events to occur were removed from this analysis. Free-spins were removed due to the spins happening automatically, and wins during free spins counting into the balance differently than wins outside free spins (as per Preference Study 2, Experiment 2). Observation revealed that participants often removed their hand from the mouse during free-spins sequences, sometimes stretching their arms, and including the spin after the free-spins sequence would have artificially decreased their response rate. The time taken for participants to select "Start feature" at the beginning of free-spins sequences was included to the time taken to make the spin that activated the free-spins sequence by the program, so this spin (the one prior to the free spins) was also removed from response rate analyses.

Persistence was measured by dividing the logged response rate during each disruption phase by the logged response rate in the baseline session immediately prior to disruption. These response rates were logged to facilitate visual analysis of figures – this ensures that if response rate actually increased in the disruption phase, this increase would appear proportionally equivalent to data where response rate decreased by the same magnitude. In cases where response rate was zero (i.e., the participant made no spins during the baseline phase, or were disrupted to the floor during the disruption phase), their response rate per minute was changed from 0 to 0.01 to allow this comparison.

Results

The first goal of data analysis was to analyse was whether the video disruptors reduced response rates relative to the baseline sessions immediately prior. Without a reduction in response rates during disruption, analysis of persistence would not be possible. Figure 38 displays participants' responding under disruption as a proportion of their responding in the baseline session immediately prior. Participants' responding was generally disrupted on both the free-spins machine and the control machine, indicated by bars below the x-axis, although for most participants this disruption was minor (values somewhere between 0 and -0.1). The animal videos (presented first) generally disrupted participants' responding more than the NRL videos.

For participants who were disrupted, there was no clear pattern of participants' responding being more disrupted on either the free-spins machine or the control machine.

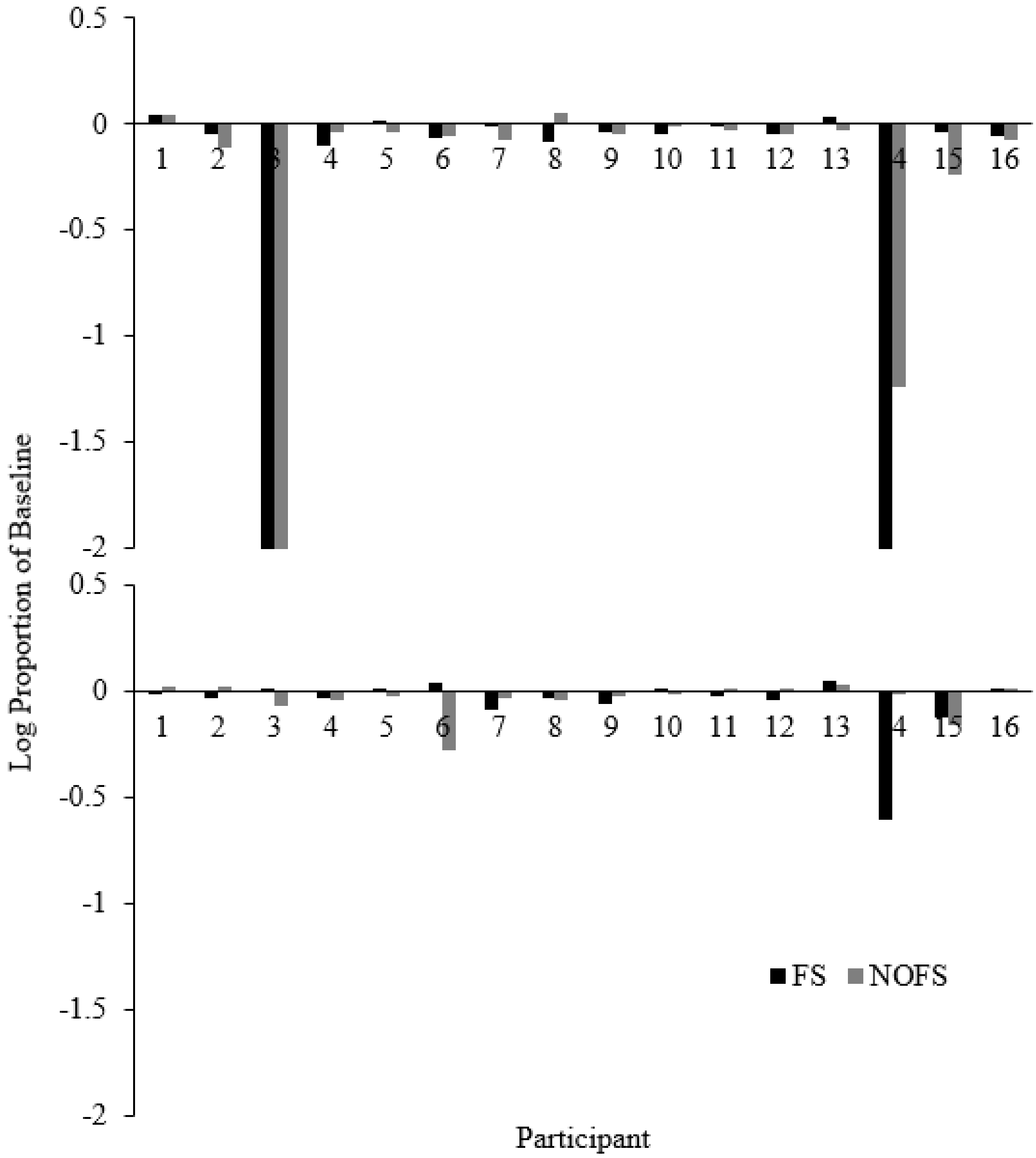

Figure 38. Logged response rate during disruption as a proportion of response rate during the baseline phase immediately prior. Black bars represent responding on the free-spins machine, grey bars represent responding on the control machine. Bars below the x-axis indicate responding was disrupted, the length of the bars indicate the extent of disruption. The top panel displays data from the first disruptor experienced on both components (animal videos), the bottom panel displays data from the final disruptor (NRL videos).

Discussion

Participants’ response rates during disruption phases were generally lower than their rates in the baseline phases immediately prior, indicating the disruptors were working to some extent. However, the extent of this disruption was very minor. For comparison, Dube and McIlvane (2001) conducted a similar analysis of persistence with two participants. Across seven analyses with two components in each one, participants’ logged responding during disruption as a proportion of their responding during baseline ranged from approximately -0.05 to approximately -0.5. However, in only one of Dube and McIlvane’s analyses was responding on either component less than -0.1 (-0.05), generally around -0.2 or more. In the current study, disruption values for individual participants were frequently around -0.05. Other studies investigating persistence through procedures typical of behavioural momentum research with humans display consistently more disruption (e.g., Cohen, 1996; Dube et al., 2009; Dube et al., 2000; Dube et al., 2003; Kuroda et al., 2016; Mace et al., 1990).

It was expected that participants would consistently be more disrupted on the control machine. This hypothesis was not supported – participants were not consistently disrupted more on either the free-spins machine or the control machine. This null finding may be due to a failure in the video disruptors to effectively disrupt behaviour. For participants who did show decreased response rate during the videos, it is also possible that rather than disruption being due to the videos, this decrease may have been due to fatigue or general variability in response rate.

When prompted in debriefing sessions following the experimental tasks, participants often stated that it was easy to watch the videos while gambling. It is likely that this was why participants were not disrupted to the same extent as in previous studies – the buttons that were required to be pressed to gamble (bet-amount buttons, SPIN button) were close to the video and attention did not need to be diverted away from the video to gamble at a similar speed to baseline. Previous studies typically had disruptors that participants could not engage with while also making the target response (e.g., Dube & McIlvane, 2001), but Mace et al. (1990) found sufficient disruption where participants could conceivably watch video disruptors while making target responses. The participants in the current study may have found it easier to make target responses while also viewing the videos than the participants with developmental disabilities in the Mace et al. study. A follow-up study sought to rectify this situation by having the SPIN button move randomly around the screen, thereby making it harder for participants to attend to the video without much disruption in their gambling response rate.

Task Development Study 2

Method

Participants. Thirty students enrolled in a first year psychology course participated in partial fulfilment of a course requirement. No participant scored in a problematic range on the SOGS.

Materials and stimuli. The materials and stimuli were the same as for Task Development Study 1 described above, with one adjustment to the simulations. In the previous studies, the "SPIN" button that began the spinning animation was invisible until participants selected a bet amount, at which point it appeared below the bet-amount buttons. In this study, when a bet amount was selected, the "SPIN" button appeared at a random location on the screen. This could be in front of the slot-machine reels, or in front of bet amount buttons, or in front of the video disruptor, or anywhere else on the screen. This change was an attempt to have participants' responding more disrupted while watching the disruptor videos – for instance, participants had to visually search for the "SPIN" button before making a spin, or repeatedly click a bet-amount button (this would cause the "SPIN" button to keep appearing in different locations, making it easier to find). The "SPIN" button operated in this fashion throughout each phase of the experiment. It was expected that participants would be unable to attend to the videos while also visually searching for the "SPIN" button, making gambling and watching the videos more incompatible with each other than they were in Task Development Study 1.

Experimental conditions. The experimental conditions were as used in Task Development Study 1. The outcome sequences were also identical to those used in Task Development Study 1.

Procedure. The procedure was as used in Task Development Study 1.

Data analysis. Data analysis was as per Task Development Study 1.

Results

Figure 39 displays participants' target response rate during disruption as a proportion of their response rate in the baseline session immediately prior to disruption. Participants were generally disrupted on both the free-spins machine and the control machine when the videos were playing. However, disruption was, again, generally minor and not retained for the second disruptor (bottom graph).

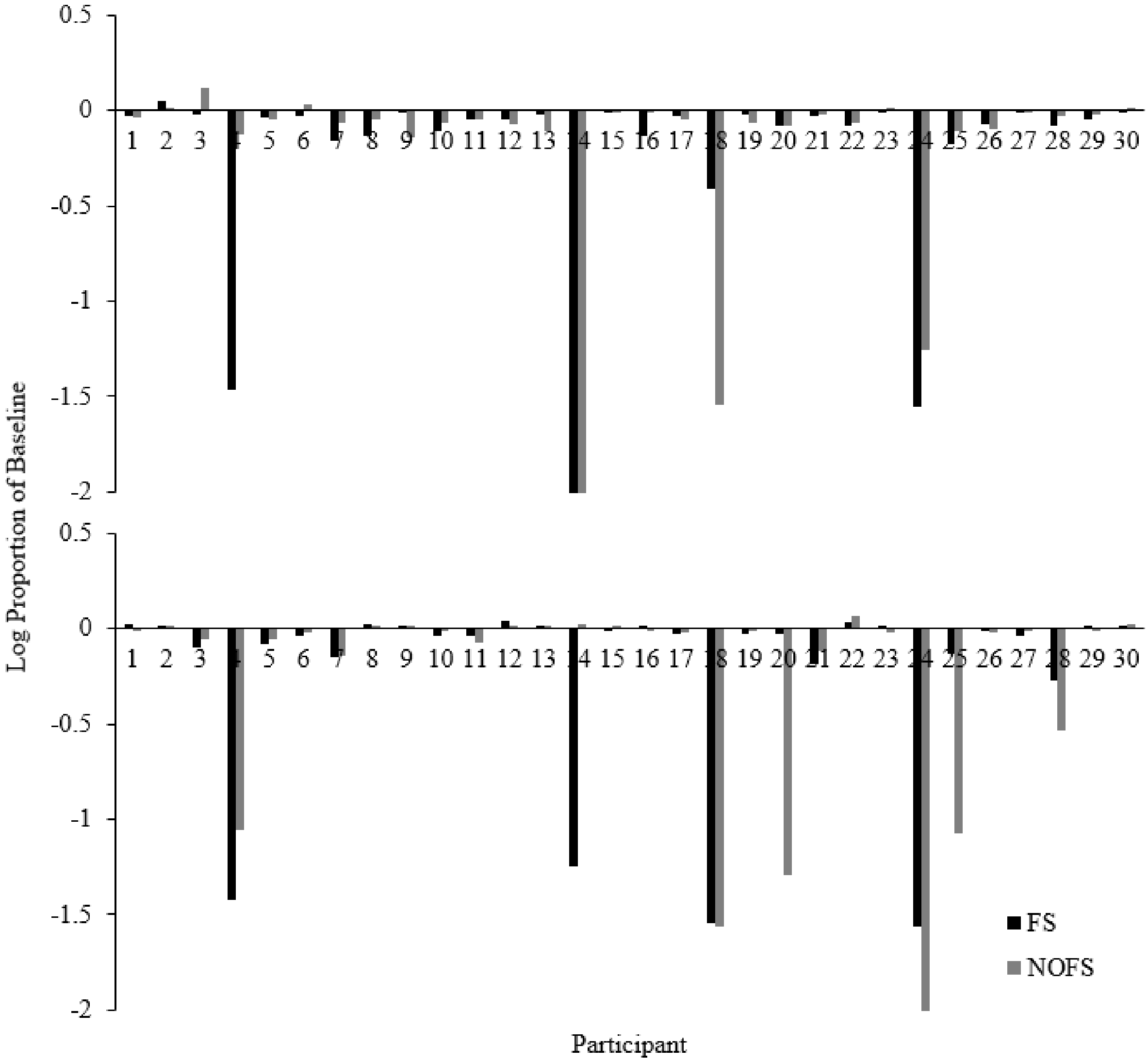

Figure 39. Logged response rate during disruption as a proportion of response rate during the baseline phase immediately prior. Black bars represent responding on the free-spins machine, grey bars represent responding on the control machine. Bars below the x-axis indicate responding was disrupted, the length of the bars indicate the extent of disruption. The top panel displays data from the first disruptor experienced on both components (animal videos), the bottom panel displays data from the final disruptor (NRL videos).

For participants who were disrupted, there was no consistent effect of participants' responding being more disrupted on either the free-spins machine, or the control machine. This was true for both the animal and the NRL videos.

Discussion

As in Task Development Study 1, participants were generally disrupted, although the extent of this disruption for most participants was again minor – roughly comparable to the extent of disruption in Task Development Study 1. Having the "SPIN" button appear in a random location on the screen did not result in lowering response rates during disruption as a proportion of response rates during baseline.

It was again expected that participants would be consistently more disrupted on the control machine. As in Task Development Study 1, this hypothesis was not supported by the data. Participants were not consistently more disrupted on either the free-spins machine or the control machine. As in Task Development Study 1, this null finding may be due to a failure in the video disruptors to effectively disrupt the gambling behaviour. Other potential reasons for this null finding will be discussed later in this thesis.

Due to the minor amount of disruption for most participants, there was insufficient data to conclusively demonstrate whether or not free-spins features influence gambling persistence. Due to this reason, another study was designed with adjustments made to the disruptors. A "show video" button was introduced which granted three seconds of access to videos during parts of the experiment where the videos were available, after which the videos disappeared. This change made the behaviour of watching the videos more in competition with the target gambling response.

Persistence Study 1

Thus far, the video disruptors described above failed to adequately disrupt participants' gambling behaviour. In this study, a separate "show video" button was added which granted three seconds of video when clicked. In order to continuously watch the video, participants needed to repeatedly click the "show video" button. It was expected this change would produce more disruption as clicking the "show video" button would compete with the gambling behaviour (clicking bet amount and "SPIN" buttons). This change brings the task more in line with that of Kuroda et al. (2016), who included a similar video disruptor in a computer task. In their task, clicking a similar "show video" button granted one second of access to a Youtube browser embedded in the task, and this disrupted participants' target responding in both a rich and lean schedule, with participants generally more disrupted on the lean schedule.

In the Task Development Studies described above, participants' gambling behaviour tended to be more disrupted by the animal videos than the NRL videos. However, it is not known whether this is due to the sample population (undergraduate psychology students, mostly young females) being more interested in those videos and therefore more motivated to watch them at the expense of gambling, or whether it was an order effect where participants are generally more disrupted by the first set of videos experienced. This experiment included a second condition where the order of the videos was reversed (NRL videos first, animal videos second), to elucidate the cause of participants being consistently more disrupted by the first set of video disruptors.

It was expected that gambling behaviour would be disrupted during the video-disruptors to a greater extent than in the Task Development Studies. Due to the free-spins machine being consistently preferred over the control machine in prior experiments, this machine should be interpreted as a richer reinforcement schedule. Therefore, it was also expected that participants' gambling behaviour would be more persistent (i.e., less disrupted) on the free-spins machine.

Method

Participants. Thirty-two psychology students enrolled in a first year psychology course participated in partial fulfilment of a course requirement. No participant's SOGS score indicated they were at risk of problem gambling.

Materials and stimuli. The materials and stimuli were the same as for the Task Development Studies, with adjustments to the simulations. The "SPIN" button was fixed in location below the bet amount buttons, and was (like previous studies) hidden until a bet amount was selected. To the right of the "SPIN" button was a button with the text "Show video". This button was coloured red to make it more salient for participants.

Experimental conditions. The experimental conditions were as used in the Task Development Studies. The outcome sequences for both components (free-spins machine, control machine) were identical to those in the Task Development Studies.

Procedure. The procedure was as used in the Task Development Studies, with one deviation. Half of the participants (Condition Two) had the order of the videos reversed, such that the NRL videos were the first disruptors experienced, and the animal videos after. The remaining half of the participants experienced the videos in the same order as the Task Development Studies (Condition One; animal videos first, NRL videos after).

Data analysis. Data for individuals are presented individually. In addition, data were analysed using a mixed-design ANOVA with within-subjects factors of machine (free spins, control) and disruptor (first pair, second pair), and between-subjects factors of condition (animal videos presented first, NRL videos first) and component order (first disruptor on free-spins machine, first disruptor on control machine). An α value of .05 was used for all statistical tests.

Results

In both conditions, participants' gambling was generally disrupted when the videos were available. Figure 40 displays Condition One (animal videos first) participants' response rate during the disruption phases as a proportion of their response rate in the baseline sessions immediately prior. In Condition One, participants' responding was consistently disrupted during the first pair of disruption phases in comparison to the baseline phases immediately prior, indicated by bars in the top panel generally below the x-axis. Responding was less consistently disrupted by the second pair of disruptors (NRL videos). Only eight of 16 participants were disrupted by the NRL videos on either component in Condition One. As in the Task Development Studies, the animal videos generally disrupted participants' responding more than the NRL videos.

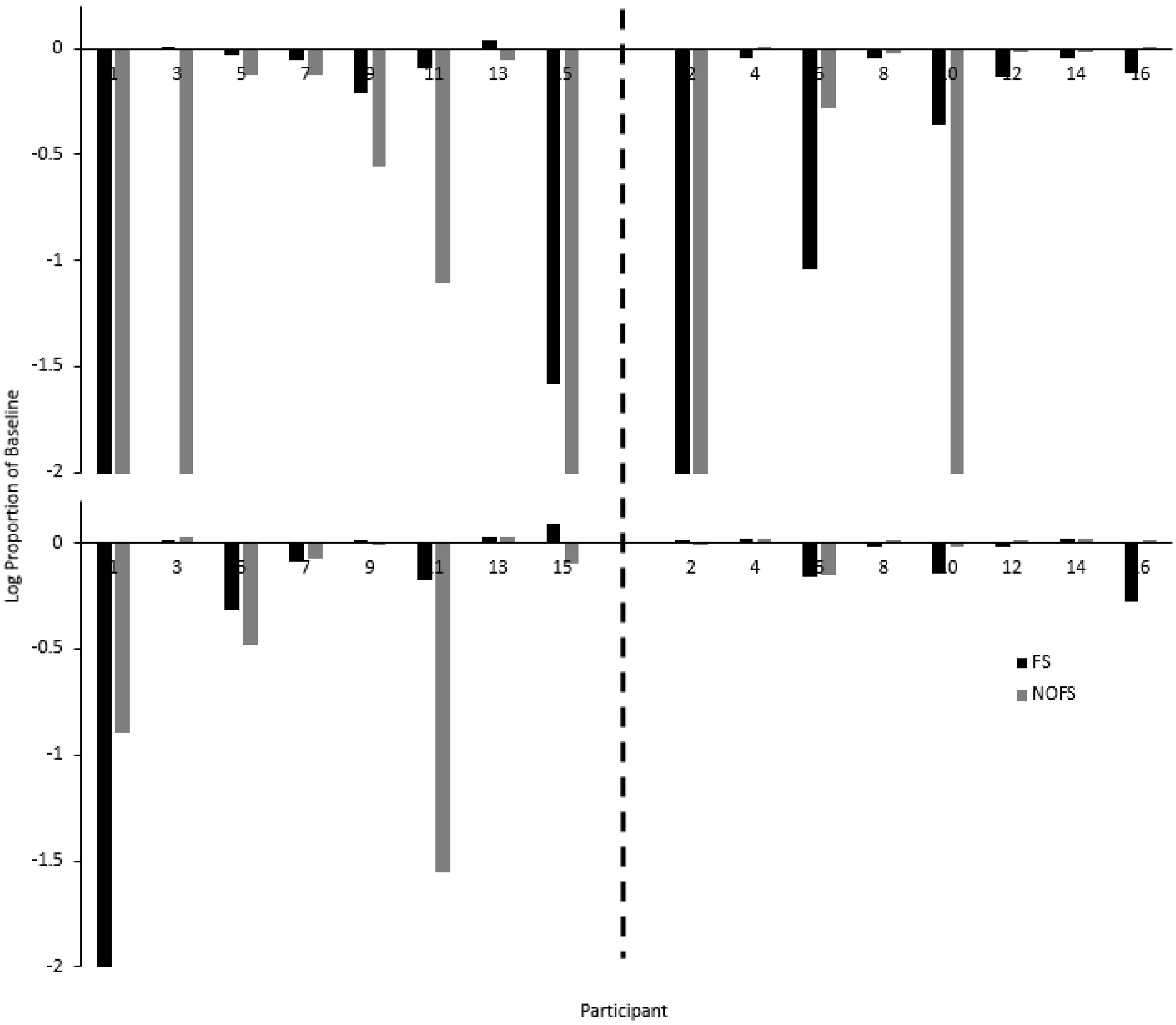

Figure 40. Condition 1 participants' logged response rate during disruption as a proportion of their response rate in the baseline phase immediately prior. Black bars represent responding on the free-spins machine, grey bars represent responding on the control machine. The top panel displays data from the first pair of baseline/disruption phases on each component (animal videos), the bottom panel displays data from the second pair (NRL videos). Participants on the left side of the reference line were first exposed to disruptors on the control machine, participants on the right side were first exposed to disruptors on the free-spins machine. Bars pointing down from 0 indicate responding was disrupted, the length of the bars indicate the extent of the disruption. Note the y-axis minimum value is -2 – values occasionally reached below this. In every case where disruption values were greater than -2 on both machines, they were equally disrupted on both machines to a value between -2 and -3.5.

Figure 41 displays Condition Two (NRL videos first) participants' response rate during the disruption phases as a proportion of their response rate in the baseline sessions immediately prior. Participants' responding was consistently disrupted during the first pair of disruption blocks of spins (top panel Figure 41, NRL videos). The extent and consistency of disruption across participants here was greater than in Condition One where the NRL videos were presented last. Responding was also consistently disrupted during the second pair of disruption blocks of spins – all 16 participants were disrupted by these animal videos (if minimal amounts of disruption are included; bottom panel Figure 41). In contrast to Condition One, the NRL videos (presented first) were generally about as disruptive as the animal videos overall.

There was no clear pattern of participants' gambling being more disrupted on either the free-spins or control machines. In Condition One, nine of 16 participants were more disrupted on the control machine during the animal videos, while seven participants were more disrupted on the free-spins machine (these numbers include instances where there were only minimal differences in disruption for participants across machines; top panel of Figure 40). During the NRL videos (presented last), there was no clear pattern of participants being more disrupted on either machine (bottom panel of Figure 40). In Condition Two, 10 of 16 participants were more disrupted on the free-spins machine during the animal videos (presented last; bottom panel of Figure 41), while six were more disrupted on the control machine. During the NRL videos, there was no clear pattern of participants being more disrupted on either machine (top panel of Figure 41). Taken together, these data reflect no clear difference in participants' gambling being more persistent on either machine. In support of this interpretation, the ANOVA indicated there was no significant main effect of free spins on persistence, $F(1,28) = 2.557$, p = n.s, such that participants were not significantly more disrupted on either the free-spins machine ($M = -0.423$, $SD = 0.668$) or the control machine ($M = -0.586$, $SD = 0.812$).

Participants tended to be more disrupted on the machine where they first experienced a disruptor, and this was especially true for the first pair of disruptors. Participants in Condition One were consistently more disrupted by the very first video disruptor compared to the second, regardless of whether the first video was experienced on the free-spins machine or the control machine. As can be seen in Figure 40, when participants first experienced a disruptor on the control machine (top panel, left side of reference line), seven out of eight participants were more disrupted on that machine (one participant was equally disrupted to the floor on both schedules). When participants first experienced a disruptor on the free-spins machine (top panel, right side of reference line), six of eight participants were more disrupted on that machine (one participant was equally disrupted to the floor on both schedules, and

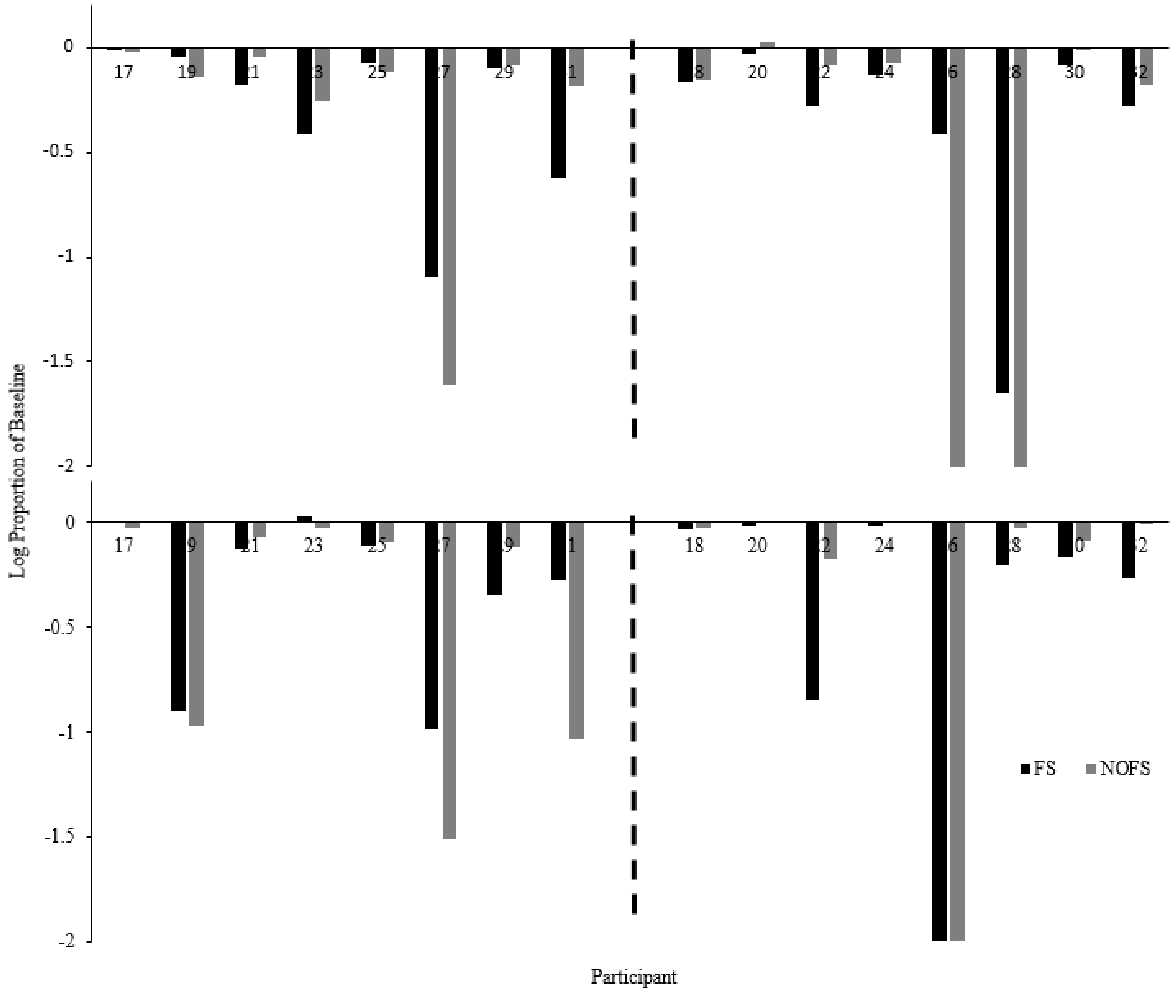

Figure 41. Condition Two participants' logged response rate during disruption as a proportion of their response rate in the baseline phase immediately prior. Black bars represent responding on the free-spins machine, grey bars represent responding on the control machine. The top panel displays data from the first pair of baseline/disruption phases on both components (NRL videos), the bottom panel displays data from the second pair (animal videos). Participants on the left side of the reference line were first exposed to disruptors on the control machine, participants on the right side were first exposed to disruptors on the free-spins machine. Bars pointing down from 0 indicate responding was disrupted, the length of the bars indicate the extent of the disruption. Note the y-axis minimum value is -2 – values occasionally reached below this. In every case where disruption values were greater than -2 on both machines, they were equally disrupted on both machines to a value between -2 and -3.5.

one participant was more disrupted on the control machine). This order effect was not as apparent for the second set of disruptors (NRL videos, bottom panel of Figure 40), although for participants who were disrupted, they were generally more disrupted on the first NRL video experienced.

Participants in Condition Two also tended to be more disrupted on the machine where they first experienced a disruptor, although this order effect was only present for the second set of disruptors (animal videos). With regard to the second set of disruptors, when participants were first exposed to an animal video on the control machine, five of eight participants were more disrupted on the control machine – three participants were more disrupted on the free-spins machine. When participants were first exposed to an animal video on the free-spins machine, seven of eight participants were more disrupted on the free-spins machine, although these numbers include where participants were only minimally disrupted or there was a small difference in the extent of disruption on the two schedules. One participant was equally disrupted to the floor on both schedules. These data are displayed in Figure 41.

The ANOVA generally supported these interpretations. There was a trending main effect of disruptor sequence on persistence, $F(1,28) = 3.940$, $p = .057$, $\eta_p^2 = .123$, such that participants were more disrupted by the first pair of disruptors ($M = -0.666$, $SD = 0.961$) than the second pair ($M = -0.343$, $SD = 0.681$). This effect size is considered medium. There was also a trending interaction between condition (animal videos first, NRL videos first) and disruptor sequence, $F(1,28) = 3.807$, $p = .061$, $\eta_p^2 = .120$, such that in Condition One, participants were more disrupted by the first set of videos ($M = -0.869$, $SD = 1.138$) than the second set ($M = -0.229$, $SD = 0.533$). This effect size is considered medium. There was also a significant interaction between free spins and disruptor sequence, $F(1,28) = 4.958$, $p = .034$, $\eta_p^2 = .150$, such that during the first set of disruptors, participants were more disrupted on the control machine ($M = -0.846$, $SD = 1.268$) compared to the free-spins machine ($M = -0.486$, $SD = 0.821$). This effect size is considered large. Descriptive statistics broken down by each factor are presented in Table 12 for Condition One and Table 13 for Condition Two.

Table 12

Average Disruption for Participants in Condition One

Machine	Disruptor	Exposure Order	*M*	*SD*
Control	First (animal)	Control first	-1.404	1.436
		Free-spins first	-0.821	1.426
		Total	-1.112	1.415
Free-spins	First (animal)	Control first	-0.635	1.152
		Free-spins first	-0.615	1.071
		Total	-0.625	1.075
Control	Second (NRL)	Control first	-0.381	0.573
		Free-spins first	-0.013	0.057
		Total	-0.197	0.437
Free-spins	Second (NRL)	Control first	-0.449	1.107
		Free-spins first	-0.071	0.108
		Total	-0.260	0.785

Table 13

Average Disruption for Participants in Condition Two

Machine	Disruptor	Exposure Order	*M*	*SD*
Control	First (NRL)	Control first	-0.307	0.533
		Free-spins first	-0.851	1.431
		Total	-0.579	1.081
Free-spins	First (NRL)	Control first	-0.316	0.376
		Free-spins first	-0.378	0.528
		Total	-0.347	0.444
Control	Second (animal)	Control first	-0.481	0.594
		Free-spins first	-0.428	1.096
		Total	-0.455	0.852
Free-spins	Second (animal)	Control first	-0.339	0.397
		Free-spins first	-0.583	1.062
		Total	-0.461	0.785

Participants' gambling response rates per minute across each block of spins for the entire experiment are displayed in Appendix F (Condition One) and Appendix G (Condition Two). Comparing initial exposures to each component, participants consistently had a lower response rate on the very first machine experienced – even numbered participants began on the free-spins machine and odd numbered participants began on the control machine. Following these initial exposures, baseline response rates increased and stabilised for the majority of participants. In Condition One, regardless of which machine participants began on, after the first two components they consistently had slightly higher response rates during baseline phases on the control machine. This pattern was also present in Condition Two, although it was slightly less consistent across participants.

To investigate whether the type of outcome participants experienced following spins had an effect on the amount of time taken for subsequent responding, the response latencies made by participants during the first four initial baseline blocks of spins on each component were analysed and displayed in Figure 42 (Condition One) and Figure 43 (Condition Two). Making a response required selecting a bet amount, and clicking the "SPIN" button. The response latencies analysed here represent the time between when the ability to select a bet amount becomes available after a prior spin, and when participants select the "SPIN" button. Free spins are not included in this analysis. As shown in Figures 47 and 48, the time participants took to spin during baseline was affected by prior outcomes. There was a consistent pattern across both conditions where responses following big wins (blue lines) tended to be longer than responses following losses (yellow lines), LDWs (grey lines), and medium sized wins (red lines). Frequency distributions for big wins also tended to be flatter than for other outcomes, indicating that response latencies following big wins were more variable than other outcomes. Response latencies following medium sized wins tended to be longer than for LDWs or losses, and response latencies following LDWs tended to be longer than for losses. However, these effects were less consistent across participants than the effect of big wins on following response latencies. Generally, the greater the win size, the longer it takes participants to make a subsequent spin, although for some participants response latencies following losses and LDWs were equivalent to response latencies following medium sized wins. A Greenhouse-Geisser corrected mixed ANOVA with a within subjects factor of outcome type and a between subjects factor of condition supported the above interpretations, revealing that outcome type had a significant effect on response latencies, $F(1.689,52.371) = 54.635$, $p < .001$, $\eta_p^2 = .638$. This is a substantial effect size. Tests of within-subjects contrasts indicated that this pattern was well described by a linear trend, *F*(1,31) = 80.680, *p* <.001, η_p^2 = .722, such that participants took the shortest amount of time (in seconds) to spin following losses (*M* = 1.303, *SD* = 0.220), longer following LDWs (*M* = 1.430, *SD* = 0.282), longer again following medium wins (*M* = 1.468, *SD* = 0.282), and the longest amount of time following big wins (*M* = 1.799, *SD* = 0.430). This effect size is also considered substantial. The interaction between condition and outcome type was not significant, *F*(1.715,51.463) = 1.346, *p* = ns.

Overall win frequency was approximately equal across both the free-spins machine and the control machine in both conditions. However, one element of the free-spins feature is that the rate of wins is increased during free spins, and therefore necessarily decreased outside the free-spins sequence to ensure the overall win frequency across machines is equivalent. One result of this feature is that when participants can actually respond (i.e., outside the free-spins sequence), the win frequency on the free-spins machine is slightly lower (39%) than the win frequency on the control machine (43%). Since participants generally take longer to respond following wins, and there are more wins on the control machine when participants can make responses, this should result in a slight decrease in response rates on the control machine relative to the free-spins machine. To disentangle the effects of differing win frequency on response rates, response latencies following losses during the second, third and fourth block of spins on each component (i.e., not including the first exposure to each component where response rates were consistently lower on the first machine exposed to, and prior to any disruptor) were analysed and displayed in Figures 49 (Condition One) and 50 (Condition Two). In Condition One, participants generally either had a slight tendency to respond slower on the free-spins machine, or the same on both machines. Two participants (Participant 5 and Participant 7) responded more quickly on the free-spins machine. In Condition Two, roughly one third of participants responded more quickly on the free-spins machine, one third more quickly on the control machine, and one third responded at the same speed on both machines. Generally, when participants had a faster response rate on either machine, the difference in response rate was very slight – this is true for both conditions. A within subjects mixed ANOVA with a within subjects factor of machine (free-spins, control) and a between subjects factor of condition generally supported the above interpretations, revealing a significant main effect of machine on response latencies, *F*(1,30) = 6.031, *p* = .020, η_p^2 = .167, such that participants tended to respond slower (in seconds) on the free-spins machine (*M* = 1.258, *SD* = 0.241) than the control machine (*M* = 1.211, *SD* = 0.187). This is a medium effect size. The interaction between machine and condition was not significant, $F(1,30) = 1.196$, p = ns.

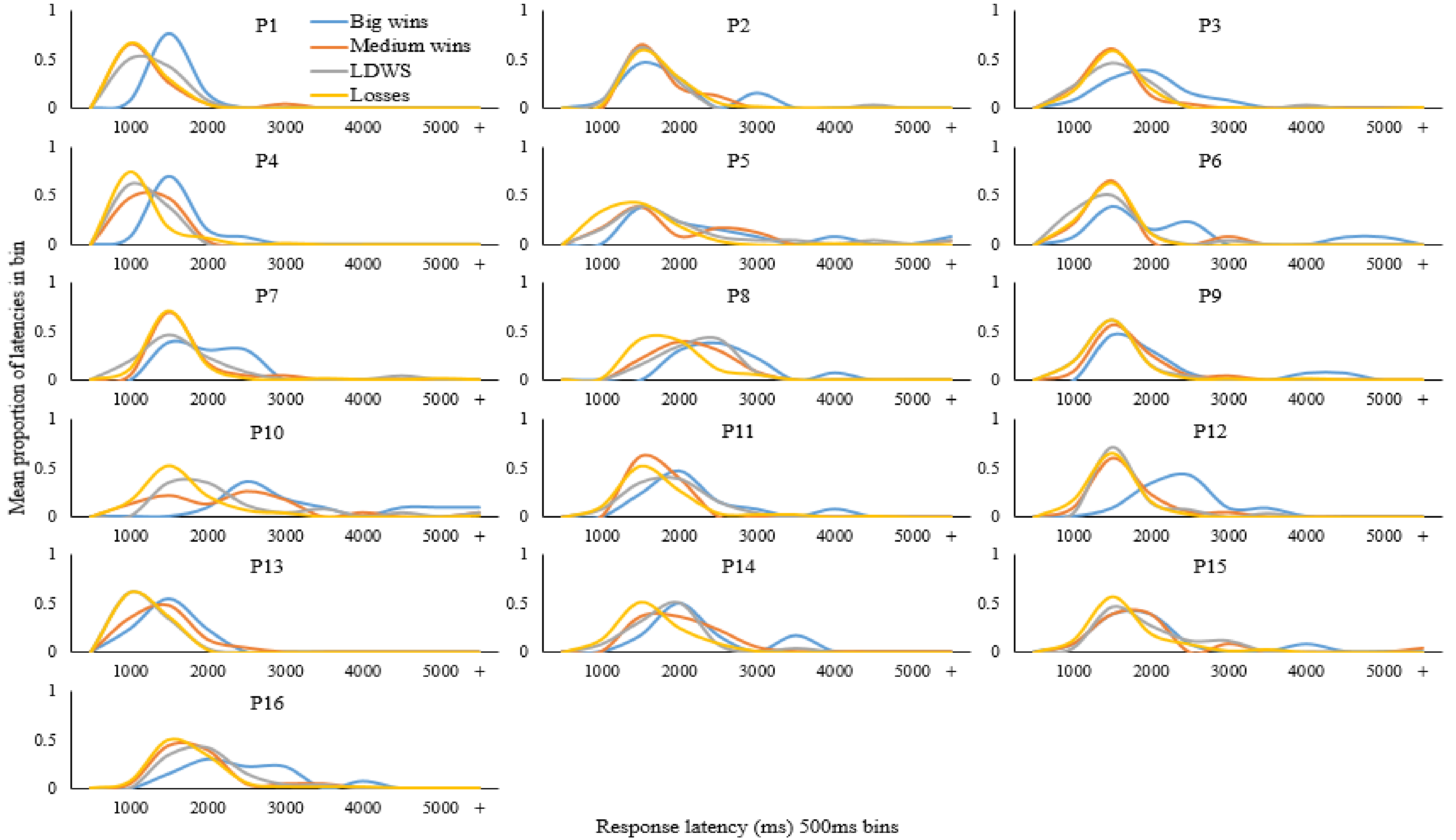

Figure 42. Frequency distributions of Condition One participants' response latencies following each outcome, measured as time taken to select spin button following the previous outcome. The y-axis displays the mean proportion of a participant's latencies that fell in a bin, the x-axis displays latency in 500ms bins. Distributions to the left indicate less time taken to respond, distributions to the right indicate more time taken to respond. Responses following losses (yellow lines, tend to be shorter than responses following LDWs (grey lines) and medium sized wins (red lines). Responses following big wins (blue lines) tend to be the longest.

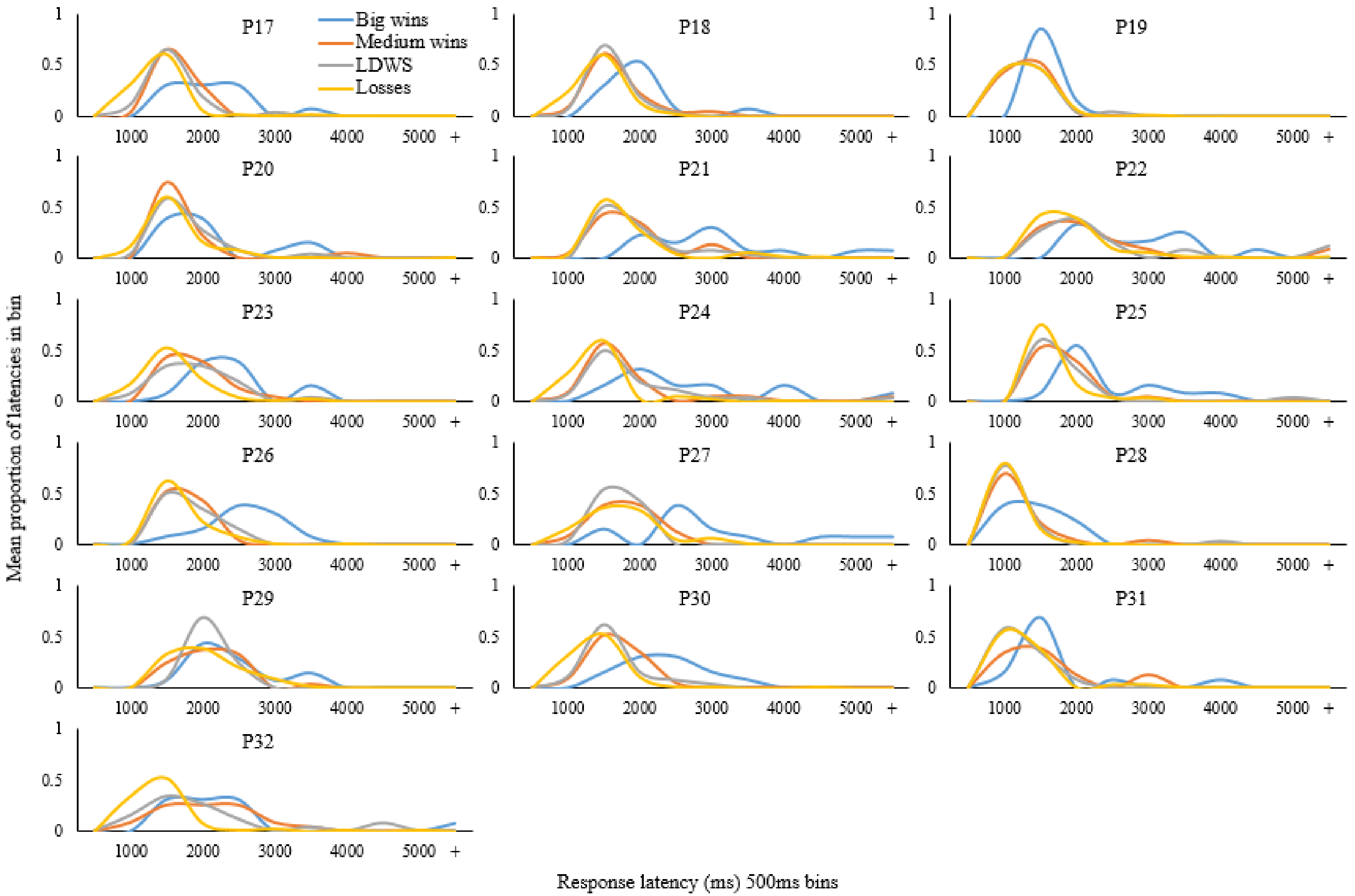

Figure 43. Frequency distributions of Condition Two participants' response latencies following each outcome, measured as time taken to select spin button following the previous outcome. The y-axis displays the mean proportion of a participant's latencies that fell in a bin, the x-axis displays latency in 500ms bins. Distributions to the left indicate less time taken to respond, distributions to the right indicate more time taken to respond. Responses following losses (yellow lines, tend to be shorter than responses following LDWs (grey lines) and medium sized wins (red lines). Responses following big wins (blue lines) tend to be the longest.

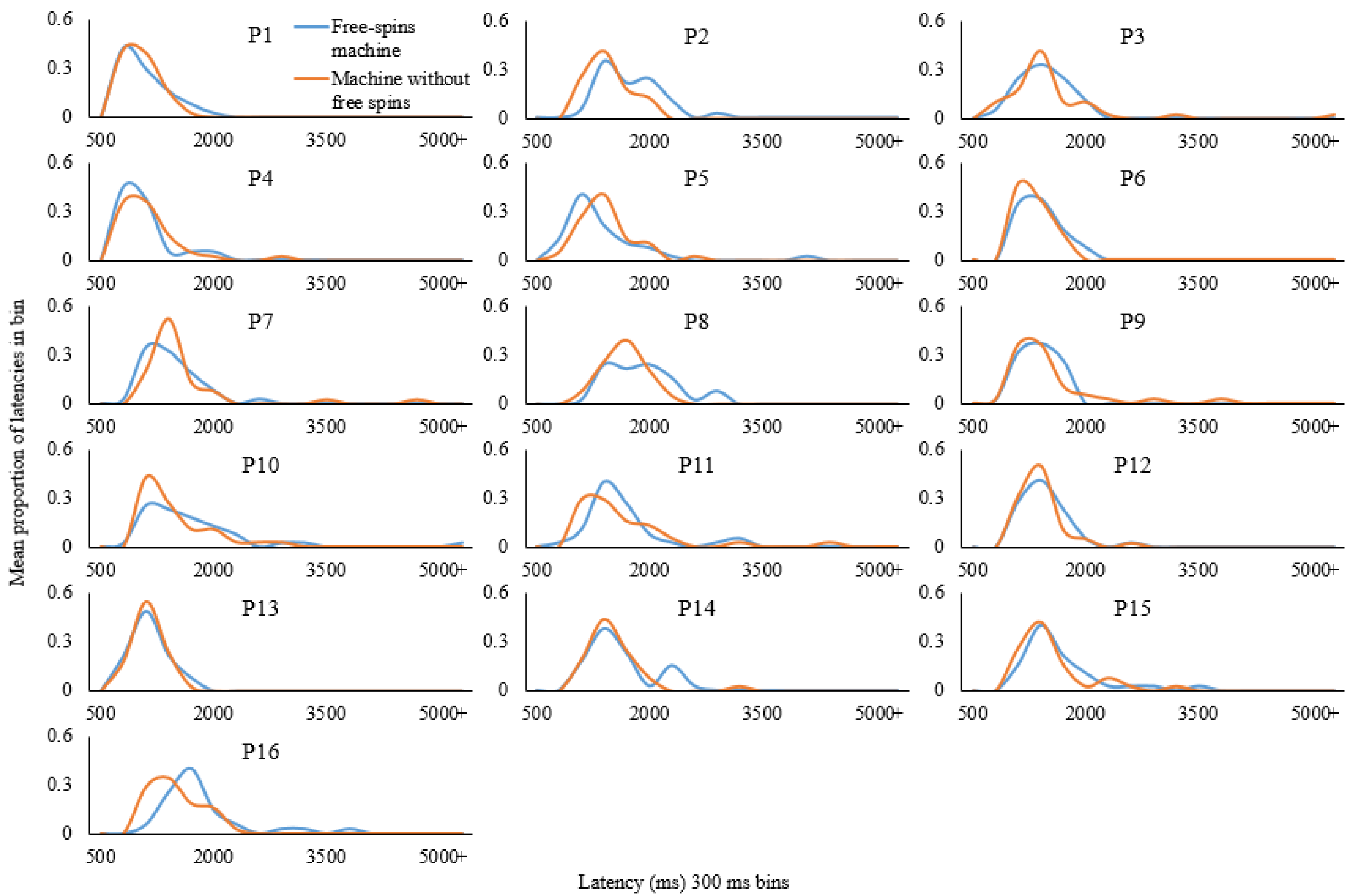

Figure 44. Frequency distributions of Condition One participants' response latencies following losses. The y-axis displays the mean proportion of a participant's latencies that fell in a bin, the x-axis displays latency in 300 ms bins. Blue lines represent data from the free-spins machine, red lines represent data from the machine without free spins. Distributions to the left indicate faster responses, distributions to the right indicate longer responses.

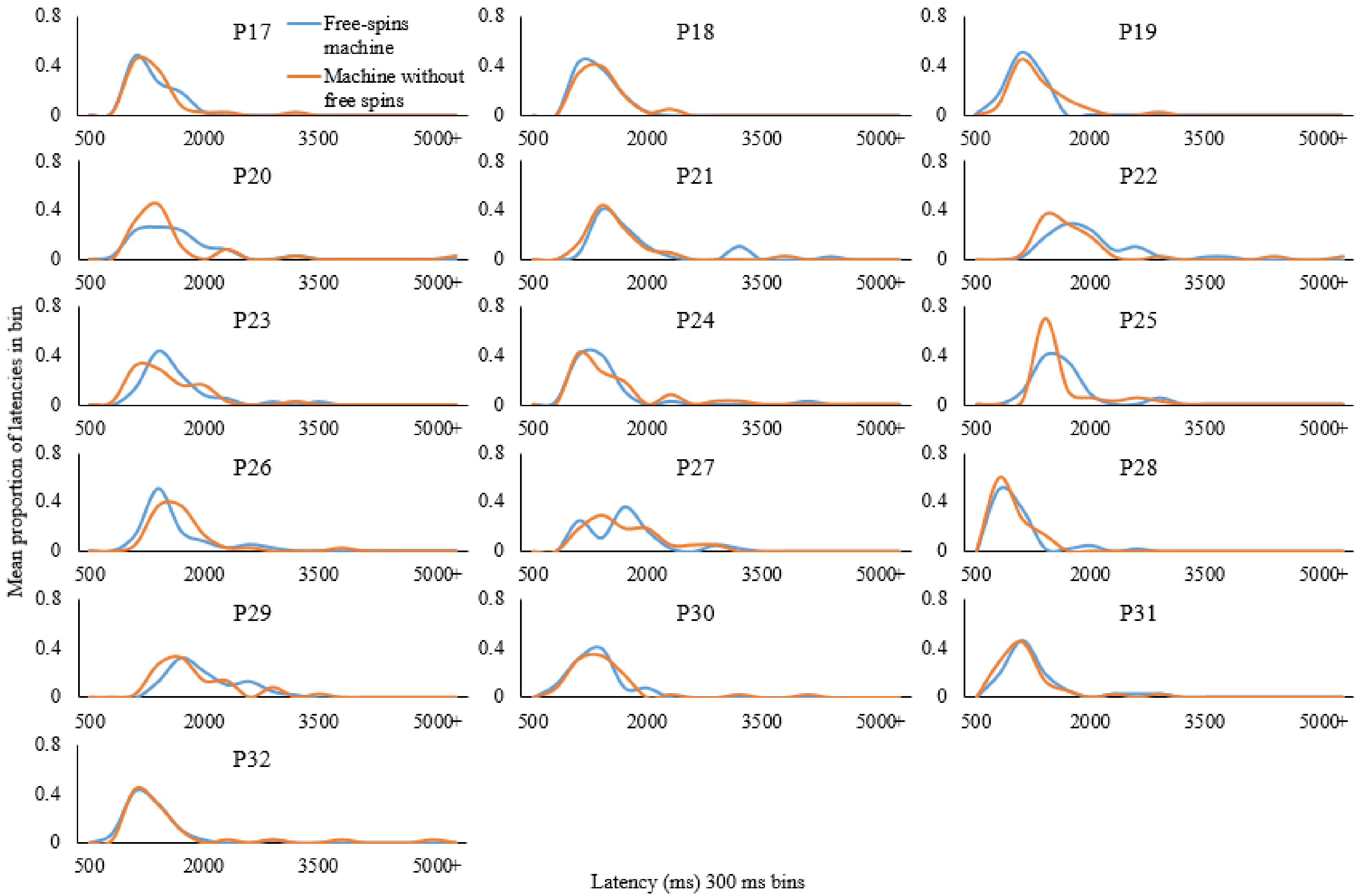

Figure 45. Frequency distributions of Condition Two participants' response latencies following losses. The y-axis displays the mean proportion of a participant's latencies that fell in a bin, the x-axis displays latency in 300 ms bins. Blue lines represent data from the free-spins machine, red lines represent data from the machine without free spins. Distributions to the left indicate faster responses, distributions to the right indicate longer responses.

Discussion

Overall, participants were disrupted to a greater extent than participants in the Task Development Studies. This indicates that the addition of the "show video" button worked as intended – causing the video-watching behaviour to compete more with the target behaviour (gambling).

It was expected that participants would be more persistent on the free-spins machine relative to the control machine, however, this was not supported by the data. Both visual analysis of Figures 45 and 46 as well as the ANOVA revealed no significant main effect of free spins. This null result would be surprising if not for the same null result in both Task Development Studies. Behavioural Momentum Theory (Nevin, 1992) would predict that responding on the richer schedule of reinforcement would be more resistant to disruption than responding on the leaner schedule – the stimulus signalling that schedule (background theme, free-spins advertising and symbols) should be associated with greater overall reinforcement (i.e., a greater stimulus-reinforcement association), resulting in a higher behavioural mass of gambling on that machine. While the win-frequency between the two machines was equal, it was conclusively demonstrated in earlier studies of this thesis that participants consistently prefer the free-spins machine – an effect that was replicated a number of times. Preference and persistence co-vary – the variables that affect preference also affect persistence (see Grace, Bedell, & Nevin, 2002; Grace & Nevin, 1997; Nevin & Grace, 2000a; Nevin & Grace, 2000b;). Nevin and Grace (2000a) suggested preference and persistence were convergent measures of behavioural mass. Therefore, since participants consistently prefer the free-spins machine, their responding on that machine should be more resistant to the video disruptors than responding on the control machine.

In the Task Development section, it was argued that the failure to find an effect of free spins on persistence may simply be due to the videos failing to effectively disrupt gambling behaviour. This explanation is unlikely, given the videos effectively disrupting gambling behaviour in the current study, combined with the same null result. A more likely explanation for the null result is that while the complex free-spins sequence is a strong enough reinforcer to drive preference (i.e., participants consistently prefer the machine with this feature), it may not be strong enough to drive persistence. In other words, while we expected the free-spins machine to be the "richer" or "better" machine, the size of this difference may be smaller than required to drive persistence. Nevin and Grace (2000a) demonstrated that persistence and preference are driven by the same underlying processes, however, they also found that persistence is generally less sensitive than preference to differences in relative reinforcer rate between two schedules (Grace, Bedell, & Nevin, 2002; Grace & Nevin, 1997; Nevin & Grace, 2000b). This means that participants may prefer one schedule of reinforcement (free-spins machine) over another (control machine), but differential effects of those schedules on a measure of persistence should be expected to be smaller than the effects on preference.

As in the current investigation, Podlesnik, Jimenez-Gomez, Thrailkill, and Shahan (2011) found that pigeons' preference was sensitive to reinforcement rate whereas persistence was not. They used a concurrent chains procedure to investigate the effects of initial-link length on preference and persistence. In one experiment, they found that preference (measured by response rates to initial links) was sensitive to differences in terminal-link reinforcement rate, yet persistence was not (Experiment 2). This could imply that preference and persistence do not co-vary, as Behavioural Momentum Theory suggests, or it could imply that persistence was simply not sensitive to differences in the reinforcement rates. In a third experiment, they increased the differences in terminal-link reinforcement rates, and subsequently found persistence was sensitive to the different reinforcement schedules when initial links were short, with pigeons' responding more persistent in the context associated with the richer schedule. When initial links were long, persistence was not sensitive to the different rates of reinforcement. These findings suggest, among other things, that a failure to find an effect of reinforcer rate on persistence in their second experiment was due to a lack of sensitivity to the difference in reinforcement schedules, and that preference and persistence do co-vary (Podlesnik et al., 2011). This research provides some credibility to the above explanation for the current study's failure to find a main effect of free spins – that the overall reinforcement gained from the free-spins machine was not great enough, relative to the control machine, to drive more persistent gambling.

If the above explanation is correct, there may be at least a very slight effect of free-spins on persistence, even if the main effect failed to reach statistical significance. The analyses do provide limited support for this. There was a significant interaction between free spins and disruptor sequence, such that during the first set of disruptors, participants were more disrupted on the control machine. The effect size for this analysis was also large. While the main effect of free spins did not reach statistical significance, this analysis indicates that there was an effect of free spins on persistence under certain experimental conditions.

Tentatively, this may have been due to the first set of disruptors producing more disruption overall. Participants tended to be more disrupted by the first set of disruptors compared to the second, and this may indicate that when there was greater disruption, participants tended to be more persistent on the free-spins machine.

Animal videos were generally more disruptive to participants' gambling than NRL videos, and participants were generally more disrupted on the first pair of videos compared to the second. These effects interacted, such that participants were more disrupted by the animal videos, with this effect being exacerbated when the animal videos were presented first (Condition One). The ANOVA revealed both the main effect of disruptor sequence (first pair of videos, second pair) and the interaction between disruptor sequence and condition (animal videos first, NRL videos first) to be trending towards statistical significance. While these effects failed to reach statistical significance, they were trending and the effect sizes were at the higher end of the medium range outlined by Cohen (1988). These analyses may also be somewhat underpowered due to small sample sizes and the involvement of a between-groups comparison (condition). The combination of these reasons (trending significance, higher medium effect sizes, low sample sizes) indicate that while these analyses failed to reach the threshold for statistical significance, they are of practical significance. The animal videos may be more disruptive than NRL videos in general, or this may be due to sample characteristics – the majority of participants were female undergraduate psychology students.

I will now move on from the null effect of free spins on persistence, to the response rate findings. During initial baseline exposures to each component, participants in both conditions consistently had a lower response rate on the first component exposed to. This was most likely due to participants taking some time to familiarise themselves with the different stimuli and with how the slot machine simulations worked.

Following these initial exposures, participants in Condition One consistently had slightly higher response rates during baseline on the control machine. This pattern was also evident in Condition Two, although less consistent across participants. Slightly higher response rates during baseline on the control machine could be the result of a number of causes. Firstly, while free-spins sequences are contingent on responding, the following free spins (and resultant winning outcomes) are non-contingent on responding. Typically, introducing non-contingent reinforcers to a reinforcement schedule degrades the contingency between responding and reinforcement, decreasing response rates. This is such an effective method of decreasing response rate that added non-contingent reinforcers are frequently used as disruptors in behavioural momentum studies (e.g., Ahearn et al., 2003; Dube & McIlvane, 2001; Lionello-deNolf, Dube, McIlvane, & William, 2010; Plaud et al., 1999; Plaud & Gaither, 1996). Dube et al. (2000) compared responding on a VI-10s schedule to a VI-10s VT-7s schedule. Across both participants, response rates were slightly higher on the leaner VI-10s component, indicating the addition of non-contingent reinforcers reduced response rate. Thus, slightly lower baseline response rates on the free-spins machine in Condition One may be due to free spins degrading the contingency between response and reinforcer and lowering response rates, an effect which is consistent with some prior research (also see Nevin, Tota, Torquato, & Shull, 1990; Podlesnik & Shahan, 2010).

Another potential cause for slightly higher response rate on the free-spins machine is that in ratio schedules higher contingent reinforcement rate is generally associated with faster responding (Ferster & Skinner, 1957). While win frequency was equal across machines, free-spins sequences had an increased win frequency combined with a decreased win frequency outside free-spins sequences to keep overall win rates equal. Free spins were excluded from response rate analyses, which meant that in periods where response rates were measured (outside of free-spins sequences), win frequency was actually slightly higher on the control machine. Both of these reasons (free spins acting as non-contingent reinforcement, higher win frequency on control machine during measurement periods) would function to increase response rate on the control machine relative to the response rates on the free-spins machine.

On the other hand, as win frequency was higher on the control machine during response-rate measurement periods, and since it was demonstrated that responses following wins were generally slower than responses following losses, there would be more of these post-reinforcement pauses on the control machine. This should function to decrease response rate on the machine without free-spins, opposing the effects described above. Despite this, analysis of response latencies following losses only indicated that responding following losses only was also generally faster on the control machine, consistent with the above explanation that free spins degraded the response-reinforcer contingency and reduced response rate.

Where there were some differences in response rate across machines, these were slight. Similar response rates on both machines, combined with a failure to detect a main effect of free spins on persistence, could indicate a failure of participants to discriminate differences between the machines. However, this explanation is weak for a number of reasons. Participants could discriminate machine differences in the earlier preference studies, indicated by consistent preference for the free-spins machine. The exposure phase in Preference Studies 2 and 3 were 100 spins on one machine, followed by 100 spins on the other machine. In the current study there were the same number of exposure spins initiated by participants prior to disruption (although this depended on how many spins participants made in the three minute time limit for each component), and more frequent alternations between components. More frequent alternations (or lower component durations) are generally accepted as producing greater sensitivity to reinforcement rates (Charman & Davison, 1982; Williams 1989), and so should be expected to facilitate easier discrimination between the machines. Secondly, following experimental sessions, as part of debriefing, participants were asked open-ended questions such as "what do you think the experiment was about?" and "what was the main difference between the two machines you played?" Invariably, at least one participant in each session reported that one machine had free spins, with others generally nodding in agreement.

Regardless of the potential reasons for response rate generally being slightly lower on the free-spins machine, since response rate is mostly independent of behavioural mass (Nevin & Grace, 2000a), it is not necessary for participants to have a clear differentiation in baseline response rates on different schedules for those schedules to have different effects on persistence. Some previous behavioural momentum studies with humans have failed to find clear differences in baseline response rates on two different schedules, with target responding on those schedules later being clearly more persistent on the richer schedule (e.g., Cohen, 1996; Groskreutz, 2010; Mace et al., 1990; Nevin & Grace, 2000b).

Overall, this study contributes to experimental literature on slot-machine gambling by demonstrating that the complex free-spins feature did not increase persistence. This indicates that free spins may not be a valid target for legislative intervention (e.g., limiting their availability), as this may reduce player enjoyment without reducing overly persistent gambling. However, this implication is necessarily tentative as it is drawn from a null result. For instance, by increasing the realism of the free-spins feature (and simulations in general), free-spins features may be demonstrated to increase persistence. Further study on the response-strengthening effects of free-spins is clearly warranted, given that gamblers report free spins have strong influences on their behaviour (e.g., Blaszczynski et al., 2001; Landon et al., 2016).

There are some limitations of the current study which may hinder the ability to find an effect of greater persistence on the free-spins machine. Firstly, gambling on both schedules had a negative expected value. Responding on both machines (and slot machines in general) is generally punished. Wins are frequent, but losses are more frequent and credit balances typically trend down over time. In all of the other behavioural momentum studies summarised in this investigation, target responding had a positive expected value. This concern is somewhat alleviated by the fact that most participants continued gambling right to the end of the experiment, even after (and through) disruptors, indicating that gambling was not solely controlled by RTP – as in that case gambling would eventually be expected to cease.

Secondly, the entire procedure for each participant took less than one hour, and there may be some concern there was not enough time to develop associations between stimuli (backgrounds/free-spins advertising and symbols) and the reinforcement schedules associated with them. In most behavioural momentum research with both animals and humans, the procedure extends over a number of days (sometimes many weeks), giving participants an extensive learning history on the different reinforcement schedules and associated stimuli. Part of the reason for this is that most studies have been conducted on animals or humans with limited verbal ability, creating a necessity for participants/animals to have more time to learn the task and the reinforcement schedules through experience. In the current study, participants read task instructions which reduced the need for extensive training. Participants' response rates quickly stabilised during baseline, and the relatively brief exposure periods (100 responses during baseline) were long enough in the preference studies for participants to develop preference for the free-spins machine. As described above, if anything, more frequent component changes in the current study would facilitate faster learning than the 100 spin exposure phases in the preference studies. However, it is possible that the baseline exposure to the different machines was enough to increase the behavioural mass of target responding enough to drive preference, but not persistence.

As of yet, there is no literature investigating how long human participants need to be exposed to a stimulus-reinforcer relation for it to affect persistence. Investigations of this nature are also scarce in the animal literature, although Craig, Cunningham and Shahan (2015) recently directly tested this with pigeons. They conducted an experiment where two multiple schedule components had equal reinforcer rates overall, but differed in the sessions immediately prior to a disruption test (extinction). One schedule initially delivered food on a

VI-30s scheduled, while the other was a VI-120s. These components (and associated discriminative stimuli) alternated every 3 minutes until 30 minutes had elapsed (i.e., each component was in effect 5 times during a given session). Occasionally, in between sessions the discriminative stimuli switched, such that the stimuli formerly associated with the rich schedule was then associated with the lean schedule for the entirety of the next session, and vice versa. The number of sessions between these switches were (one, two, three, five, or 20 – the different conditions). Both discriminative stimuli were associated with both the rich and lean schedules for an equal number of sessions prior to extinction. In the 20, five, and three session conditions, persistence was greater in the context that was most recently associated with the richer reinforcement schedule. In the one and two session conditions, there was no difference in relative persistence in either context. These findings indicate that three sessions or more of steady reinforcement schedules (at least 90 minutes overall on each schedule) were required for pigeons to develop more persistent behaviour in the context more recently associated with the higher rate of reinforcement. However, the authors note that the one and two session conditions, where discriminate stimuli alternated more frequently, may have also promoted more persistent behaviour in the recently richer context that was more transient than the longer alternations. These findings suggest that extended baseline periods common in behavioural momentum research may not be necessary for subjects/participants to learn stimulus-reinforcer relations enough to have more persistent behaviour in a context associated with more reinforcement, and that recently experienced reinforcer rates influence behavioural mass (Craig et al., 2015).

Potentially, a more extensive learning history on both machines could have further influences on the behavioural mass of gambling, increasing it more on the free-spins machine relative to the control machine. It took pigeons 90 minutes of exposure to stimuli-reinforcer relations before they showed increased persistence in the recently richer context. However, the ability to generalise these results to humans is very limited. There are no indications that the relatively short amount of baseline exposure to each machine in the current study (100 participant-initiated spins, or a maximum 12 minutes on each machine) is not sufficient to learn the stimulus-reinforcer relations enough to drive persistence. In the current study, the disruptor was in effect immediately after a baseline session on the same component. In the pigeon study described above, extinction began in a following session (i.e., a day later). If stimulus-reinforcer relations degrade over time, and degrade faster when stimuli frequently alternate between being associated with rich and lean schedules, as the authors suggested may have happened in the one and two session conditions, then applying the disruptor immediately following baseline is ideal. A thorough investigation of the temporal effects of reinforcer rate on persistence in humans is required to assert anything beyond speculation on this issue. In any case, an important question remains: is it possible to attain effects consistent with Behavioural Momentum Theory on gambling simulations with a relatively brief procedure?

Persistence Study 2 sought to answer this question. Due to a failure to find a main effect of free-spins on persistence, a different independent variable, win frequency/RTP (these co-varied), was employed in a similar procedure to the current study. It was expected that the failure to find an effect of free spins on persistence was due to the free-spins feature not influencing the behavioural mass of gambling enough to drive persistence. Therefore, it was important to ensure that the rich and lean machines in Persistence Study 2 were sufficiently different in terms of the total reinforcement they provided. This goal was approached in two different ways. In Condition One, participants played on hypothetical-money simulations with either 9% of outcomes being wins (11% RTP) or 33% of outcomes being wins (90% RTP) – a huge difference in win frequency and RTP. In Condition Two, participants played on real-money simulations with either 33% of outcomes being wins (90% RTP) or 43% of outcomes being wins (118% RTP). Gambling for more valuable reinforcers in Condition Two increases the total reinforcement value provided by both machines as well as increasing the magnitude of the difference in reinforcement value between the machines. Both of these approached were expected to increase the conditioned value of the stimuli associated with the richer machine (and therefore behavioural mass of gambling on that machine) to a level clearly greater than the conditioned value of the stimuli associated with the leaner machine.

Persistence Study 2

Persistence Study 1 demonstrated that the video disruptors adequately disrupted behaviour with the addition of a "show video" button. However, participants were not disrupted more on either the free-spins machine or the control machine. This study investigated the effect of a different independent variable on persistence in slot machine gambling, the rate of wins, using the same procedure in Persistence Study 1. The purpose of this study was three-fold: 1) To investigate whether the brief procedure developed is capable of attaining effects consistent with Behavioural Momentum Theory (i.e., more persistence on richer machine); 2) To have a more clear and objective difference in the relative value of gambling on each machine than in Persistence Study 1; 3) To investigate whether win rate/RTP increases persistence on a slot-machine simulation in response to disruption. Finding a difference in persistence between gambling on the rich and lean machine would confirm this procedure is sensitive to differences in this independent variable. Failing to find an effect of the independent variable could reflect the procedure being insensitive, or, could reflect the rate of wins not influencing behavioural mass enough to drive persistence in this task.

Previous studies have failed to find an effect of win frequency on persistence when measured with a single-option quitting procedure in *normal reinforcement conditions* (Brandt & Pietras, 2008; Schreiber & Dixon, 2001; Weatherly & Brandt, 2004). As described earlier, studies have found an effect of a different independent variable, near wins, on persistence when measured with a single-option quitting procedure in *extinction conditions* (Cote et al., 2003; Kassinove & Schare, 2001). Different findings in these two lines of research may reflect differential effects of near wins and win frequency on persistence. On the other hand, they may also reflect the addition of a disruptor (extinction) to the single-option quitting procedure causing a more sensitive procedure. Due to the use of a procedure incorporating disruptors, the current task may provide a more sensitive test of whether win frequency influences persistence in slot-machine gambling than the single-option quitting procedure in normal reinforcement conditions which has predominantly been used in win frequency research.

Some research has found that participants fail to discriminate between slot machines with different win frequency when the differences are generally small (Coates & Blaszczynski, 2014; Haw, 2008). Other research has indicated that participants prefer machines with a higher win frequency when there is a large difference in win frequency on the two machines (Dixon, Maclin, & Daugherty, 2006; Coates & Blaszczynski, 2013). Thus, it seems likely that participants do prefer machines with higher win frequency, but they fail to discriminate small differences. Behavioural Momentum Theory would predict that if win frequency affects preference, it will also affect persistence, but to a smaller degree.

Due to the possibility that the free-spins feature in Persistence Study 1 was not a strong enough reinforcer to drive more persistent behaviour in this task, and the possibility that participants fail to detect small differences in win frequency outlined above, it was important to have objective and clear differences in the rate of wins in the current study. This was achieved in two ways. In Condition One, participants played on hypothetical-money simulations with either 9% of outcomes being wins (11% RTP) or 33% of outcomes being wins (90% RTP) – a huge difference in win frequency and RTP. Player balances were expected to trend downwards much faster on the leaner machine where 91% of outcomes were losses. This difference was expected to be easily discriminated by participants.

The second method to achieve discriminable differences in the independent variable was to use real money as the reinforcer. In Condition Two, participants played on real-money simulations with either 33% of outcomes being wins (90% RTP) or 43% of outcomes being wins (118% RTP). Gambling for more valuable reinforcers in Condition Two increases the total reinforcement value provided by both machines, and also increases the difference in total reinforcement value between the machines. In the real-money preference study reported previously (Preference Study 3), it was argued that participants' preference for the free-spins machine was partially driven by whether that machine had the higher experienced RTP – but that this effect was stronger in the Real-money Condition. RTP and win-frequency co-varied in this study, so it was expected that using real money in Condition Two would facilitate participants to discriminate the smaller win-rate (and RTP) differences than were present in Condition One. Participants in both conditions were expected to clearly discriminate the presence of richer and leaner machines.

One of the limitations of Persistence Study 1 was that gambling on both machines had a negative expected value – a feature uncommon in behavioural momentum research. Whether target responding with a negative expected value drives behaviour similarly to target responding with a positive expected value is not yet clear. In Condition Two, the richer machine had a positive expected value. Condition Two is thus the first known circumstance where target responding on different components had a positive expected value in one component, and a negative expected value in the other component.

Both approaches to increasing the conditioned value of the richer machine relative to the leaner machine (large difference in RTP, use of real money with moderate differences in RTP) were expected to increase the behavioural mass of gambling on the richer machine more than the behavioural mass of gambling on the leaner machine. Therefore, it was expected that participants' gambling behaviour would be more persistent (i.e., less disrupted) on the richer machine in both Condition One and Condition Two.

Method

Participants. Thirty two participants took part in this study. Sixteen were students enrolled in a first year psychology course who participated in partial fulfilment of a course requirement (Condition One). The remaining sixteen participants were recruited via posters which were posted at various locations around Victoria University of Wellington's Kelburn campus (Condition Two). These posters stated they would be staked a small amount of money to gamble with, and also be given a movie voucher for participating. Two participants in Condition One scored in a problematic range on the SOGS. Participant Three and Participant Eight both scored 5. One participant in Condition Two scored in a problematic range, also with a score of 5 (Participant 10). According to Lesiur and Blume (1987), scores above five indicate probable pathological gambling.

Materials and stimuli. The materials and stimuli were the same as for Persistence Study 1, with some adjustments made to the simulations. The changes to the simulations were as follows:

- Starting balance reduced for Condition Two ($7). Starting balance for Condition One remained at $30.
- The free-spins feature, symbols, and advertising were removed entirely.
- Different outcome sequences were used.

The balance reduction for Condition Two was for ethical and practical reasons. Ethical approval allowed for up to $15 dollars in winnings. The rich machine had a positive expected value, so it was necessary to reduce the balance to a point where: 1) participant balances didn't reach below $0, and 2) participant balances didn't reach above $15. The free-spins feature was removed as this feature was not investigated in this study, and this necessitated different outcome sequences to be created.

Experimental conditions. Participants played on the adjusted simulated slot machines from Persistence Study 1. For participants in Condition One, 33% of outcomes on the richer machine were wins (90% RTP). Only 9% of outcomes on the leaner machine were wins (11% RTP). For participants in Condition Two, 43% of outcomes on the richer machine were wins (118% RTP). 33% of outcomes on the leaner machine were wins (90% RTP). The outcome sequences for the richer machine in Condition One were identical to the outcome sequences for the leaner machine in Condition Two. Programmed outcome frequencies for both machines in Condition One and Condition Two are displayed in Table 14.

Table 14.

Programmed Outcome Probabilities on each Slot Machine for Persistence Study 2.

Outcome	Condition One Lean	Condition One Rich/Condition Two Lean	Condition Two Rich
Per individual line			
loss	.97	.89	.83
2*	.02	.05	.08
5*	.01	.02	.04
8*	.01	.02	.01
10*	0	.02	.03
30*	0	.01	.02
Resultant Outcome Frequencies Per Spin (three lines per spin)			
Programmed RTP percentage	11%	90%	118%
Programmed / experienced Probability of win	.09	.33	.43

Note. *Programmed outcome is multiplied by the bet-amount selected.

Procedure. The procedure was as used in Persistence Study 1, with some adjustments. Participants in both conditions experienced the videos in the same order, animal videos first, NRL videos second. Participants in Condition One received the same instructions and procedure as in Persistence Study 1. Participants in Condition Two received slightly different instructions before they began the experimental tasks, with the adjustments relating to the use of real money:

> You are about to play a slot machine task. You will play two different slot machines, and have a separate balance for each machine. Starting now, this money belongs to you. At the end of the task, you will receive the average of the two balances, and can spend this on items from our shop (lollies, chocolate, coffee vouchers).
>
> You will sometimes be presented with videos to watch. During these videos, you can still play the slot machines, if you want to.
>
> To place a bet, click the button indicating how much you want to bet on each line, then click the SPIN button. You will always be betting on three lines at once.

The experiment consisted of a two-component multiple schedule: one richer component, and one leaner component. The active component was signalled by the different slot-machine themes. Each component lasted for either 25 bets, or three minutes, which ever came first. Baseline and disruption phases were as used in Persistence Study 1.

Data analysis. Data analysis was as in Persistence Study 1. The mixed-design ANOVA for the disruption data had within-subjects factors of machine (Rich, lean) and disruptor (first pair, second pair), and between-subjects factors of condition (real money, hypothetical money) and component order (first disruptor on rich machine, first disruptor on lean machine). An α value of .05 was used for all statistical tests.

Results

There was no clear consistent pattern of participants being more disrupted on either the rich or lean machine in either condition. In Condition One (hypothetical money), six of 16 participants were more disrupted on the lean machine during the animal videos, while eight were more disrupted on the rich machine (these numbers include instances where there were only minimal differences in disruption for participants across machines). One participant was equally disrupted on both machines, and one was not disrupted on either machine. These data are displayed in the top panel of Figure 46. Seven participants were more disrupted on the lean machine during NRL videos (bottom panel of Figure 46), while five were more disrupted on the rich machine. Four were not disrupted on either machine. In Condition Two (real money), nine of 16 participants were more disrupted on the lean machine during the animal videos, while seven were more disrupted on the rich machine. These data are displayed in the top panel of Figure 47. Seven participants were more disrupted on the lean machine during NRL videos (bottom panel of Figure 47), while four were more disrupted on the rich machine. Five were not disrupted at all during NRL videos, and one was disrupted to the same extent on both machines. Overall, there was no clear pattern of participants in either condition being more disrupted on either component. The ANOVA supported this interpretation, indicating there was no significant main effect of win-frequency/RTP on persistence $F(1,28)= 0.319$, p = n.s, such that participants were not significantly more disrupted on either the rich machine (M = -0.342, SD = 0.653) or the lean machine (M = -0.384, SD = 0.706). There was also no significant interaction between condition and win frequency/RTP $F(1,28)= 1.874$, p = n.s

As in Persistence Study 1, participants tended to be more disrupted on the machine where they first experienced a disruptor. However, this effect was not consistent across participants for either Condition One or Condition Two. As seen in Figure 46, comparing the first set of disruptors (top panel) in Condition One, when participants first experienced a disruptor on the lean machine (left side of reference line), five of eight participants were more disrupted on that machine (three more disrupted on the rich machine). When participants first experienced a disruptor on the rich machine (right side of reference line), five of eight were more disrupted on that machine (one equally disrupted on both, one not disrupted, and one more disrupted on lean machine). Comparing the second set of disruptors (bottom panel of Figure 46), when participants first experienced the disruptor on the lean machine (left side of reference line), three of eight participants were more disrupted on that machine. Please note that only four participants in this comparison were disrupted on either machine, so the majority of the participants who were disrupted, were disrupted on the first machine experienced here. When participants first experienced the disruptor on the rich machine (right side of reference line), three of eight participants were more disrupted on that machine (four more disrupted on lean machine, one not disrupted on either). So, overall, participants in

Condition One tended to be more disrupted on the first machine exposed to, although this pattern was not as consistent as it was in Persistence Study 1.

A similar pattern was observed in Condition Two (Figure 47). Comparing the first set of disruptors (top panel), when participants first experienced a disruptor on the lean machine (left side of reference line), seven of eight participants were more disrupted on that machine (one more disrupted on the rich machine). When participants first experienced a disruptor on the rich machine (right side of reference line), five of eight were more disrupted on that machine (one equally disrupted on both, one not disrupted on either, and one more disrupted on the lean machine). Comparing the second set of disruptors (bottom panel), when participants first experienced a disruptor on the lean machine (left side of reference line), six of eight participants were more disrupted on that machine (one not disrupted on either, one more disrupted on the rich machine). When participants were first disrupted on the rich machine (right side of reference line), four of eight were more disrupted on that machine (four more disrupted on the lean machine). As in Condition One, participants in Condition Two tended to be more disrupted on the first machine exposed to.

While I have reported above there was a somewhat inconsistent tendency for participants to be more disrupted on the first machine exposed to, the ANOVA failed to support this interpretation. There was no significant interaction between machine (rich, lean) and order in which disruptors were experienced (rich first, lean first), $F(1,28) = 2.605$, p = n.s. There was also no significant main effect of disruptor set (animal videos vs NRL videos), $F(1,28) = 1.771$, p = n.s, no significant main effect of condition, $F(1,28) = 0.566$, p = n.s, and no significant main effect of component order (first disruptor on rich, first disruptor on lean), $F(1,28) = 0.258$, p = n.s. Furthermore, there were no significant interactions between any of the factors in the ANOVA. Descriptive statistics broken down by each factor are presented in Table 15 for Condition One and Table 16 for Condition Two.

Participants' gambling response rates per minute across each block of spins for the entire experiment are displayed in Appendix H (Condition One) and Appendix I (Condition Two). Comparing initial exposures to each component, participants consistently had a lower response rate on the very first machine experienced – even numbered participants began on the rich machine and odd numbered participants began on the lean machine. Following these initial exposures, baseline response rates tended to increase and then stabilise. In Condition One, after the initial exposure to each component, participants tended to have slightly higher response rates during baseline blocks of spins on the lean machine. This pattern was consistent across participants. Participants in Condition Two also tended to have slightly higher response rates during baseline on the lean machine, although this was less consistent.

Table 15

Average Disruption for Participants in Condition One

Machine	Disruptor	Exposure Order	*M*	*SD*
		Lean first	-0.098	0.080
Rich	First (animal)	Rich first	-0.252	0.328
		Total	-0.175	0.244
		Lean first	-0.091	0.103
Lean	First (animal)	Rich first	-0.310	0.526
		Total	-0.200	0.383
		Lean first	-0.008	0.036
Rich	Second (NRL)	Rich first	-0.857	1.419
		Total	-0.432	1.064
		Lean first	-0.056	0.150
Lean	Second (NRL)	Rich first	-0.521	0.698
		Total	-0.288	0.544

Table 16

Average Disruption for Participants in Condition Two

Machine	Disruptor	Exposure Order	*M*	*SD*
		Lean first	-0.128	0.101
Rich	First (animal)	Rich first	-0.400	0.596
		Total	-0.264	0.436
		Lean first	-0.087	0.114
Lean	First (animal)	Rich first	-0.854	1.395
		Total	-0.470	1.035
		Lean first	-0.131	0.313
Rich	Second (NRL)	Rich first	-0.861	1.433
		Total	-0.496	1.071
		Lean first	-0.197	0.402
Lean	Second (NRL)	Rich first	-0.954	1.380
		Total	-0.576	1.057

Since the rich machine in both conditions had a higher frequency of wins than the lean machine, and since participants tended to take longer to respond following wins in Persistence Study 1, we wanted to investigate whether participants in the current study also took longer following wins than losses. If so, this would explain the slightly faster response rates on the lean machine during baseline described above. Response latencies made by participants during the first four initial baseline blocks of spins on each component were analysed and displayed in Figures 53 (Condition One) and 54 (Condition Two). (Response latencies were measured as in Persistence Study 1.) The time participants took to spin during baseline was affected by prior outcome. Across both conditions, participants consistently responded fastest following losses (yellow lines), and slowest following big wins (blue lines). Response latencies for LDWs (grey lines) and medium wins (red lines) tended to be intermediary between losses and big wins. As in Persistence Study 1, generally, the greater the win size, the longer it took for participants to make a subsequent spin. A Greenhouse-Geisser corrected mixed-design ANOVA supported these interpretations, revealing a significant main effect of outcome type on response latencies, $F(2.038,61.139) = 32.410$, $p < .001$, $\eta_p^2 = .519$. This is a large effect size. Tests of within-subjects contrasts revealed that the pattern was well described by a linear trend, $F(1,30) = 50.408$, $p < .001$, $\eta_p^2 = .627$, such that participants took the shortest amount of time (in seconds) to respond following losses (M = 1.285, SD = 0.270), longer following LDWs (M = 1.539, SD = 0.456), longer again following medium wins (M = 1.631, SD = 0.491), and longest following big wins (M = 1.924, SD = 0.629). This is also considered a large effect size.

Since participants generally took longer to respond following wins than losses, and since there was a clear difference in the rate of wins across components, these factors could combine to drive the observed lower baseline response rate on the rich components relative to the lean components. To investigate whether participants' response rates are faster on the lean machine following losses only, response latencies following losses during the second, third, and fourth block of spins on each component (i.e., not including the first exposure to each component where response rates were consistently lower on the first machine exposed to, and prior to any disruptor) were analysed and displayed in Figures 55 (Condition One) and 56 (Condition Two). In both conditions, participants tended to respond following losses at approximately the same speed on the rich and lean components, as indicated by overlapping frequency distributions in Figures 55 and 56. A mixed-design ANOVA with a within subjects factor of machine (rich, lean) and a between subjects factor of condition supported the above interpretation, revealing no significant main effect of machine on response latencies, $F(1,30) = 0.003$, p = ns, such that participants did not take a significant different amount of time (in seconds) to respond following losses on the rich machine ($M = 1.232$, $SD = 0.257$) than the lean machine ($M = 1.231$, $SD = 0.273$). There was no significant interact between machine and condition, $F(1,30) = 0.195$, p = ns. These findings indicate that slightly faster baseline response rates on the lean component (all outcomes included) were likely due to local effects of higher win frequency on the rich component. That is, participants took longer to make spins following wins than losses, and had more wins on the rich component, resulting in slightly faster overall response rate on the lean component. This pattern was likely more consistent in Condition One because that condition had a greater difference in win frequency across the two machines.

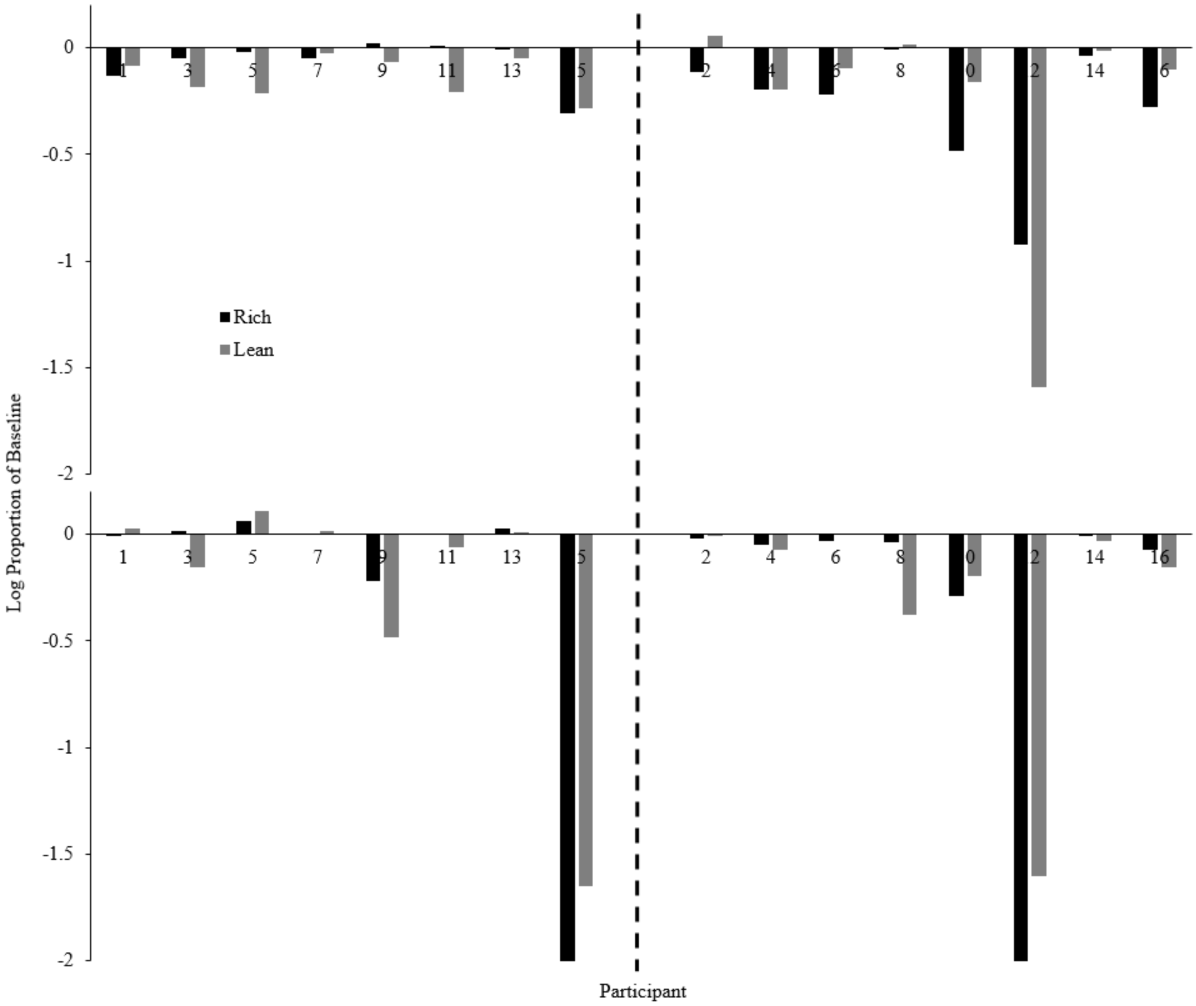

Figure 46. Condition One participants' logged response rate during disruption as a proportion of their response rate in the baseline phase immediately prior. Black bars represent responding on the rich machine, grey bars represent responding on the lean machine. The top panel displays data from the first pair of baseline/disruption phases on both components (animal videos), the bottom panel displays data from the second pair (NRL videos). Participants on the left side of the reference line were first exposed to disruptors on the lean machine, participants on the right side were first exposed to disruptors on the rich machine. Bars pointing down from 0 indicate responding was disrupted, the length of the bars indicate the extent of the disruption. Note the y-axis minimum value is -2 – values occasionally reached below this. In every case where disruption values were greater than -2 on both machines, they were equally disrupted on both machines to a value between -2 and -3.5.

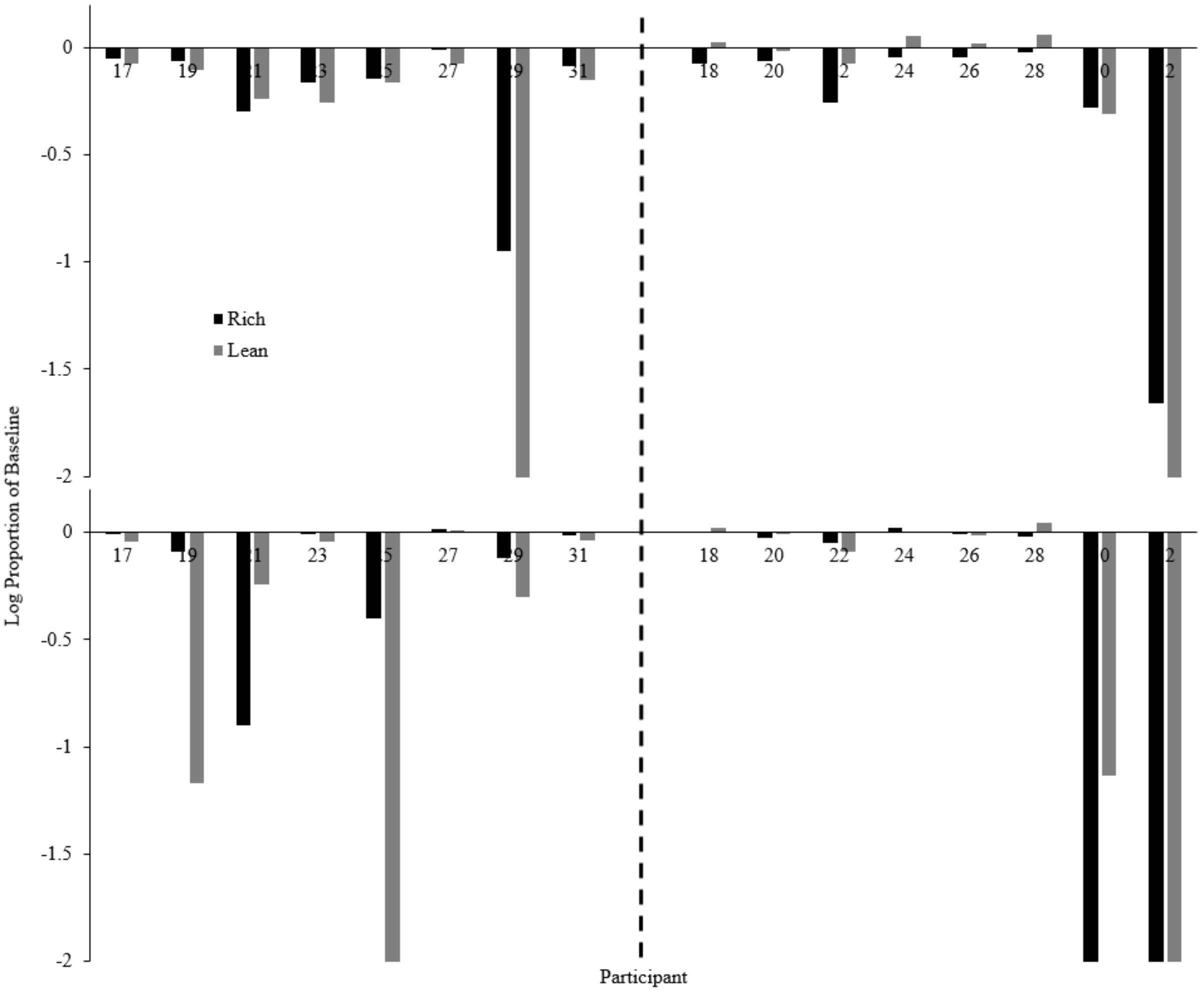

Figure 47. Condition Two participants' logged response rate during disruption as a proportion of their response rate in the baseline phase immediately prior. Black bars represent responding on the rich machine, grey bars represent responding on the lean machine. The top panel displays data from the first pair of baseline/disruption phases on both components (animal videos), the bottom panel displays data from the second pair (NRL videos). Participants on the left side of the reference line were first exposed to disruptors on the lean machine, participants on the right side were first exposed to disruptors on the rich machine. Bars pointing down from 0 indicate responding was disrupted, the length of the bars indicate the extent of the disruption. Note the y-axis minimum value is -2 – values occasionally reached below this. In every case where disruption values were greater than -2 on both machines, they were equally disrupted on both machines to a value between -2 and -3.5.

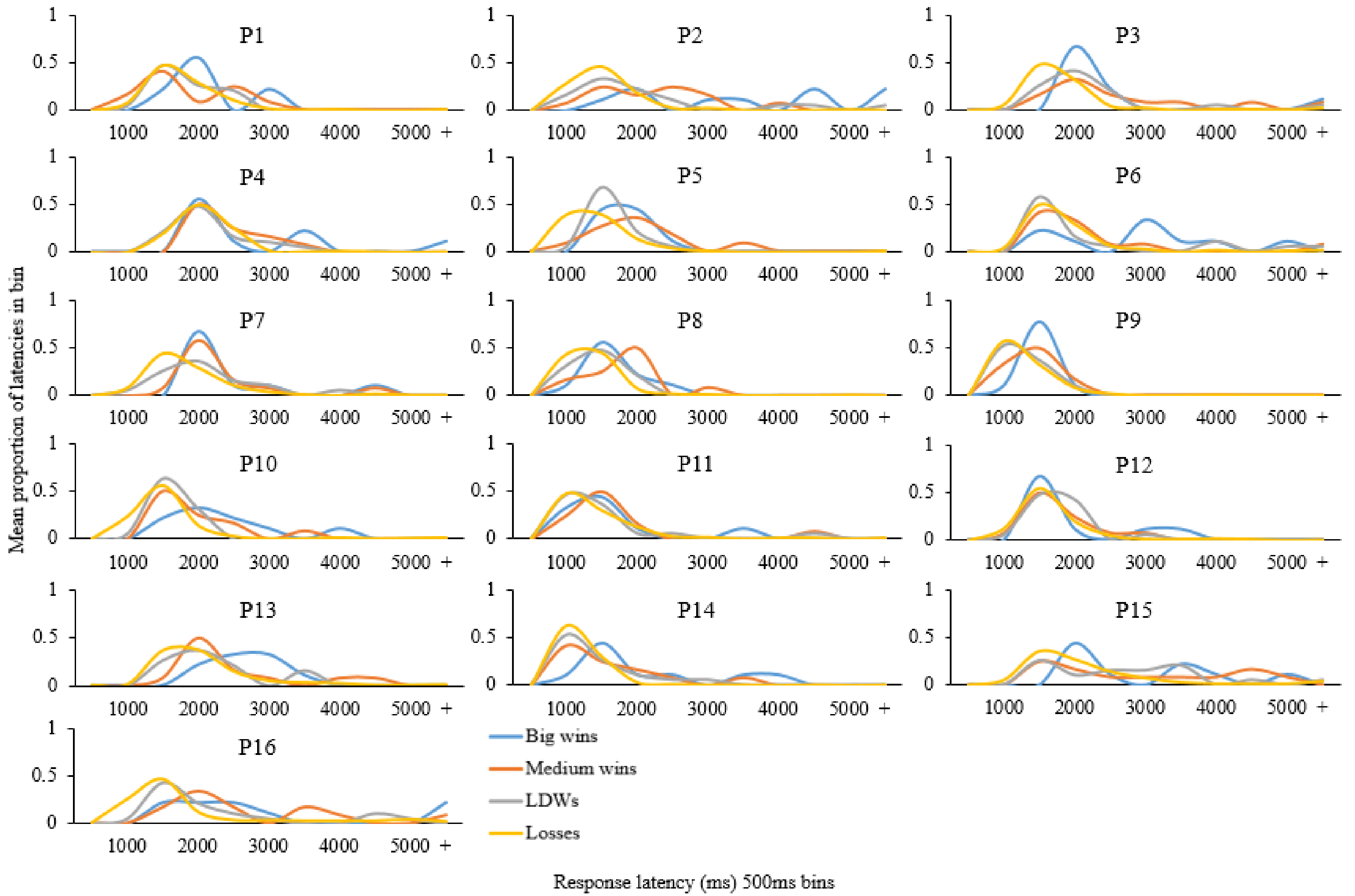

Figure 48. Frequency distributions of Condition One participants' response latencies following each outcome, measured as time taken to select spin button following the previous outcome. The y-axis displays the mean proportion of a participant's latencies that fell in a bin, the x-axis displays latency in 500ms bins. Distributions to the left indicate less time taken to respond, distributions to the right indicate more time taken to respond. Responses following losses (yellow lines, tend to be shorter than responses following LDWs (grey lines) and medium sized wins (red lines). Responses following big wins (blue lines) tend to be the longest.

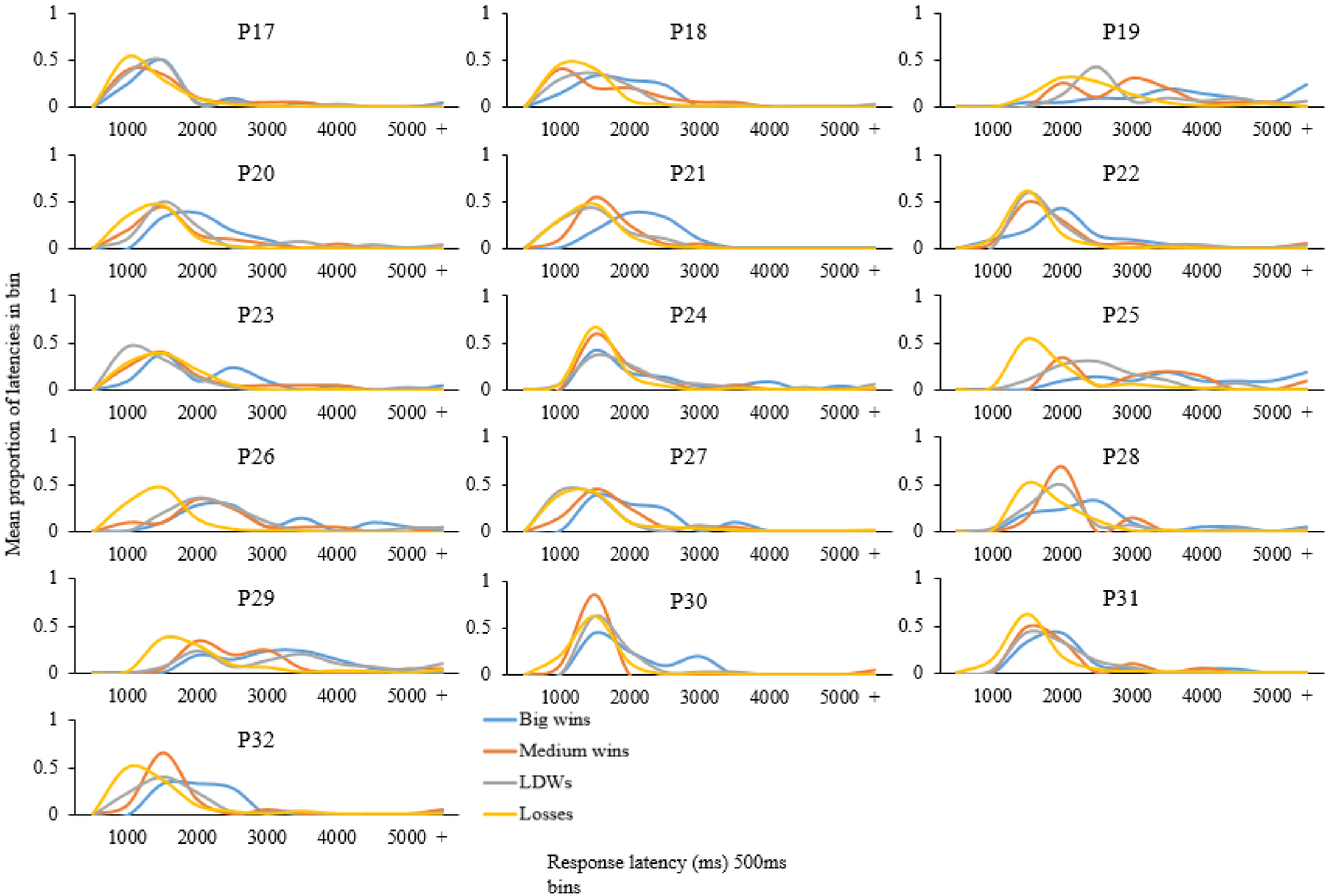

Figure 49. Frequency distributions of Condition Two participants' response latencies following each outcome, measured as time taken to select spin button following the previous outcome. The y-axis displays the mean proportion of a participant's latencies that fell in a bin, the x-axis displays latency in 500ms bins. Distributions to the left indicate less time taken to respond, distributions to the right indicate more time taken to respond. Responses following losses (yellow lines) tend to be shorter than responses following LDWs (grey lines) and medium wins (red lines). Responses following big wins (blue lines) tend to be the longest.

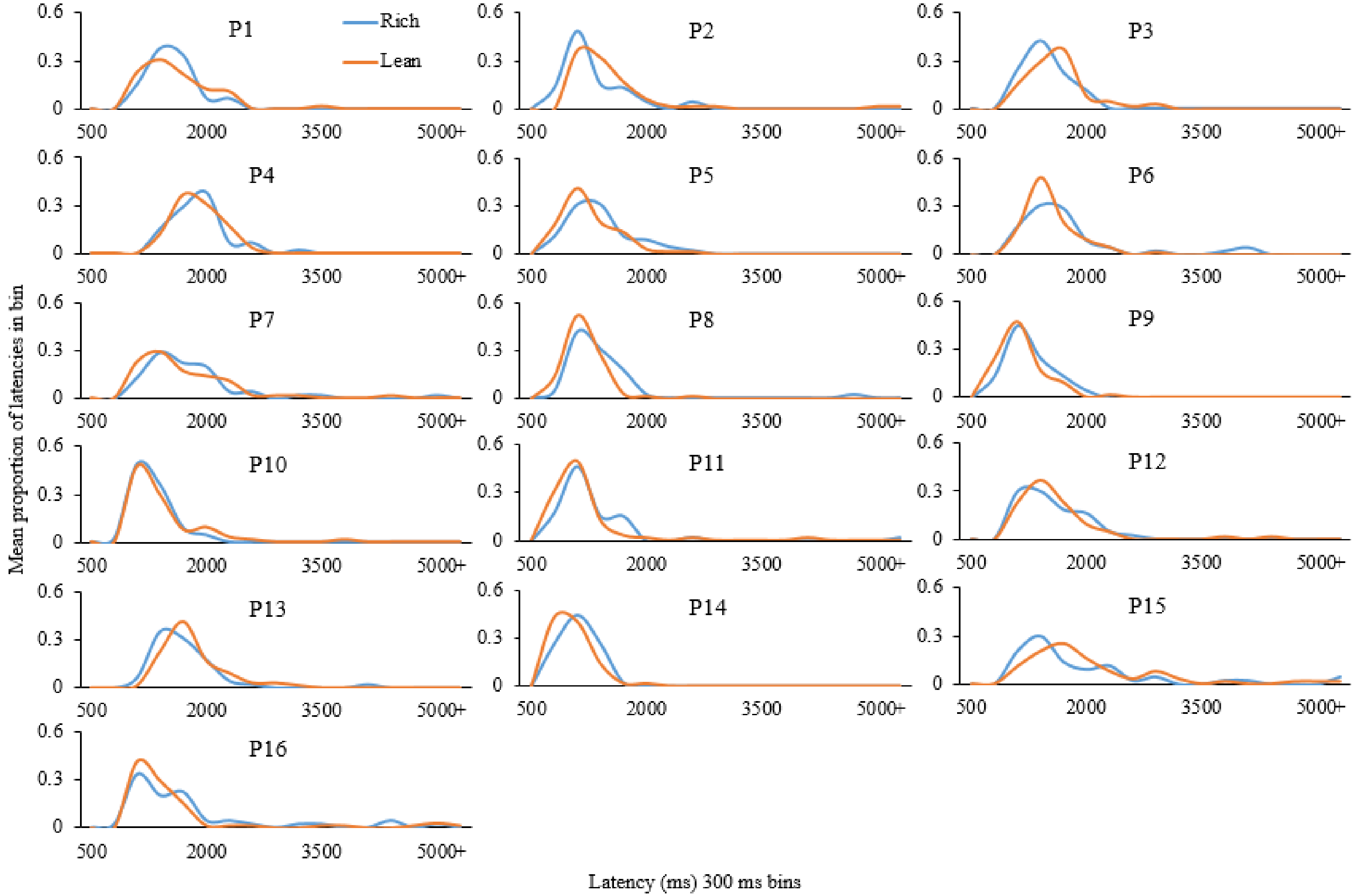

Figure 50. Frequency distributions of Condition One participants' response latencies following losses. The y-axis displays the mean proportion of a participant's latencies that fell in a bin, the x-axis displays latency in 300 ms bins. Blue lines represent data from the rich component, red lines represent data from the lean component. Distributions to the left indicate faster responses, distributions to the right indicate longer responses.

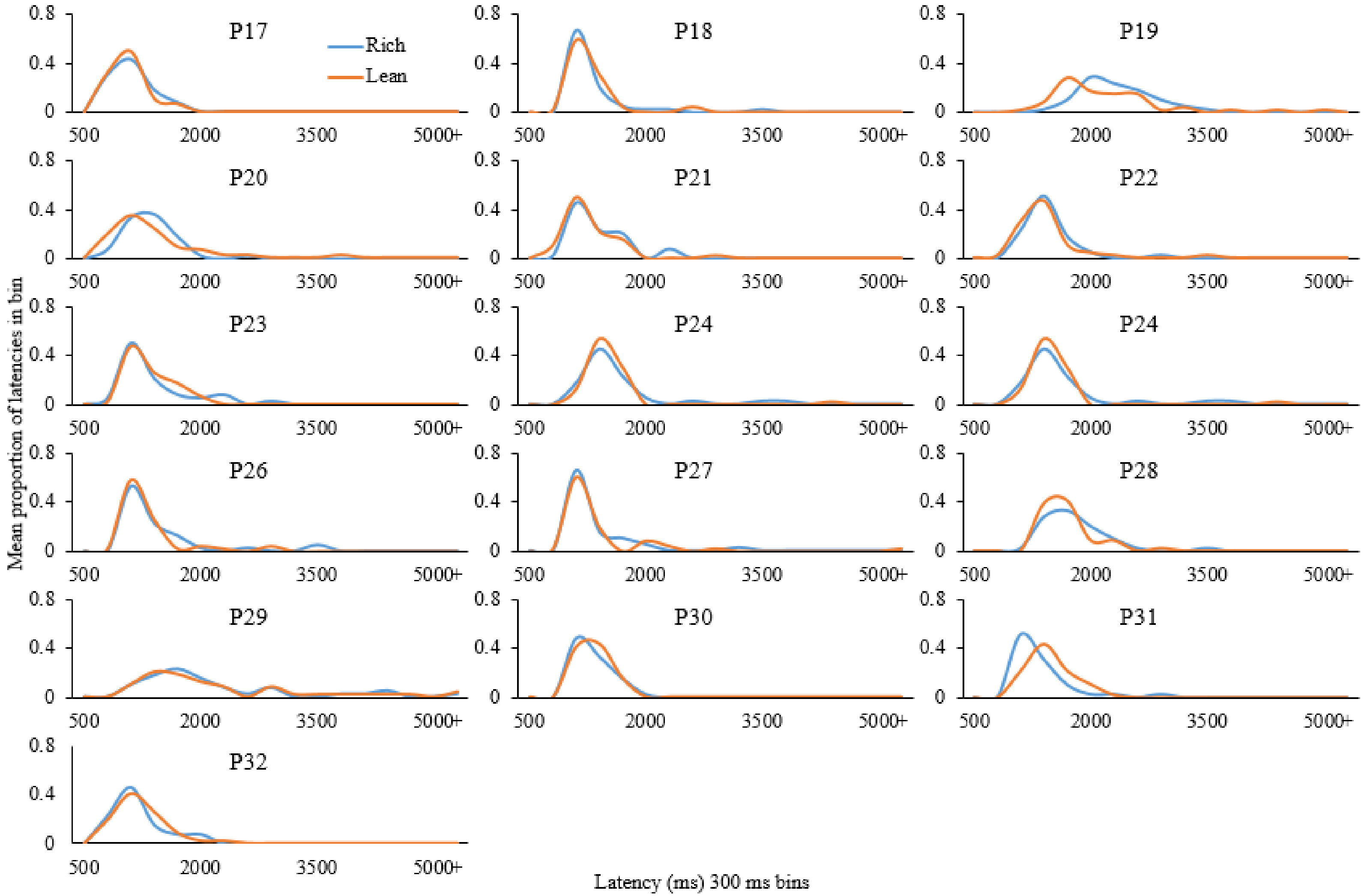

Figure 51. Frequency distributions of Condition Two participants' response latencies following losses. The y-axis displays the mean proportion of a participant's latencies that fell in a bin, the x-axis displays latency in 300 ms bins. Blue lines represent data from the rich component, red lines represent data from the lean component. Distributions to the left indicate faster responses, distributions to the right indicate longer responses.

Discussion

It was expected that participants' gambling would be more persistent in the face of disruption on the rich machine, relative to the lean machine. This hypothesis was not supported by the data. Roughly half of participants in Condition One were more persistent on the lean machine, and roughly half were more persistent on the rich machine. This was true for both sets of disruptors. In Condition Two, more participants were disrupted to a greater extent on the lean machine (9/16 for animal videos, 7/16 for NRL videos with 5 not being disrupted at all during NRL videos). However, this difference was not consistent or large enough to reach statistical significance: the ANOVA indicated no main effect of win frequency/RTP and no significant interaction between condition and win frequency/RTP.

This null effect of win-frequency/RTP on gambling persistence is consistent with some literature. Several studies have used a single-option quitting procedure in *normal reinforcement conditions* and failed to find an effect of win frequency on persistence (Brandt & Pietras, 2008; Schreiber & Dixon, 2001; Weatherly & Brandt, 2004). Other studies have found an effect of a different independent variable (near wins) when using a single-option quitting procedure in *extinction conditions* (Cote et al., 2003; Kassinove & Schare, 2001). In the introduction to this study, it was suggested that these different findings may reflect the addition of a disruptor, in this case extinction, to the single-option quitting procedure causing a more sensitive procedure. It was expected that due to the use of a procedure applying a disruptor to the target behaviour, it may be a more sensitive test of whether win frequency influences gambling persistence than the win frequency studies listed above. The null effect of win frequency/RTP on gambling persistence in the current study provides some evidence that these factors do not influence gambling persistence. Win frequency/RTP did not affect persistence when differences between machines were large (Condition One), or when gambling on one component had a positive expected value and participants were gambling with real money (Condition Two).

There are other potential explanations for failing to find an effect of win frequency/RTP on persistence. The rate of wins and RTP may not influence behavioural mass enough to drive persistence in this task. Participants generally prefer to play machines with higher RTP and win frequency when differences between two machines are large (Coates & Blaszczynski, 2013; Dixon et al., 2006). The current study incorporated large differences between the rate of wins and RTP in Condition One (9% vs 33%), yet participants were not consistently more persistent on the rich machine. Since preference and persistence are driven by the same underlying processes (conditioned value; Nevin & Grace, 2000a), these findings may indicate that a higher rate of wins or RTP in gambling simulations increase the conditioned value of that machine enough to drive preference, but not persistence on this task.

The null effect of win frequency/RTP on persistence is, like Persistence Study 1, another case where conditioned reinforcers (slot machine wins) failed to affect the conditioned value of the signalling stimuli. An argument exists that conditioned reinforcers may not strengthen behaviour in the same was as primary reinforcers (e.g., Shahan, 2010). This argument will be explored in relation to failing to find an effect of both free spins and win frequency on persistence in the General Discussion

It is possible, although I argue unlikely, that participants failed to distinguish the difference between the two slot machines. When differences in win frequency are small, participants often fail to discriminate them (Coates & Blaszczynski, 2014; Haw, 2008). However, the difference in win frequency across machines in this study was large – especially in Condition One. During debriefing, when asked the difference between the two machines played on, participants consistently reported that one machine had more wins (this was especially true for participants in Condition One).

It is also possible that the procedure developed, in its current form, is incapable of attaining effects consistent with Behavioural Momentum Theory with a small sample. The procedure has so far failed to demonstrate differential effects of two independent variables on persistence (free spins, win frequency/RTP). However, participants' gambling was generally disrupted when the videos were available, and to an acceptable level between the ceiling (no disruption) and floor (target behaviour ceases entirely). The target behaviour (gambling) is a discrete response which is easily measured, and response rates stabilised quickly during baseline. These factors reflect a procedure that should, in theory, be suitable for studying persistence. Further adjustments to the procedure may be of use. For instance, exposing participants to the disruptors earlier in the procedure, before testing periods, might be expected to reduce any effect of the order in which disruptors are experienced.

While participants in both conditions tended to be more disrupted on the first machine that experienced a disruptor, this effect failed to reach statistical significance. Visual analysis of Figures 51 and 52 revealed this effect was reasonably consistent, especially with regard to the first sets of disruptors. The discrepancy between visual analysis of the figures and the

ANOVA may be due to this analysis being underpowered – when looking at an interaction between order of disruptor exposure, persistence on rich versus lean machines, and disruptor set (animals or NRL videos), there are only 16 participants in each cell. When adding an analysis of condition to the above, there are now only eight participants in each cell. Attaining a significant effect would require a large effect size, given these sample sizes. It is reasonable to assume that participants may be more disrupted by the first disruptor experienced because it takes some time to familiarise themselves with this novel feature of the experiment.

During initial baseline exposures to each component, participants in both conditions consistently had a lower response rate on the first component exposed to. This mirrors the same finding in Persistence Study 1, and is likely due to participants taking extra time to familiarise themselves with the different stimuli and with how the simulations worked.

Following these initial exposures, participants in both conditions tended to have slightly higher response rates during the baseline blocks of spins on the lean machine, although this pattern was more consistent for Condition One. An analysis of response latencies following different outcomes demonstrated that the greater number of wins and subsequent longer response latencies were likely driving this effect. The analysis of response latencies following losses only supported this interpretation, indicating that participants generally took about the same time to respond following losses on the rich and lean components.

A potential limitation of the current study was that the brief procedure developed may not be enough time to develop associations between stimuli (contextual background of each machine/symbols) and the reinforcement schedules associated with them, as discussed in Persistence Study 1. This will be explored further in the General Discussion. At this point, there is no literature examining how long human participants need to be exposed to a stimulus-reinforcer relation for it to affect persistence.

The current study failed to find an effect of win frequency or RTP on persistence in slot-machine gambling. This finding, along with the null result in Persistence Study 1 with the presence of a free-spins feature as the independent variable, call into question the generality of Behavioural Momentum Theory. However, the majority of behavioural momentum research has found effects consistent with the theory. The inconsistency between the results of the persistence research in this investigation and the wealth of behavioural momentum research will be focussed on in the General Discussion.

Chapter 3

General Discussion

General Discussion

This research programme was conducted in response to lack of research examining the effect of free-spins bonus features on slot-machine gambling. This void was particularly salient because gamblers report free-spins features have important effects on their behaviour (Blaszczynski et al., 2001; Landon et al., 2016; Livingstone et al., 2008; Templeton et al., 2014). In particular, the studies presented aimed to 1) Identify whether people prefer to gamble on a slot-machine simulation with a free-spins feature over a similar machine without such a feature; and 2) identify whether free-spins features cause more persistent slot-machine gambling behaviour.

Based on unpublished work from our laboratory, it was expected that participants would not prefer a simulation with a simple free-spins feature over a similar simulation without such a feature, and this was supported by the data. In both Preference Study 1 and Preference Study 2, participants did not consistently prefer a simulation with a simple free-spins feature. Participants only consistently preferred a simulation with free spins when the free-spins feature was relatively complex, incorporating an increased win rate, advertising, and unique sounds and visuals. This particular finding was displayed in the Added-features Condition of Preference Study 1, replicated in Preference Study 2 (Experiment 2), and replicated again in Preference Study 3 where participants gambled with credits that could be exchanged for tangible rewards. Interestingly, despite gamblers reporting they prefer free-spins machines because they provide “free” spins, and “extra time on device” (Livingstone et al., 2008), the current experimental investigation did not identify these particular elements as major drivers of preference. Instead, the data collected across the three preference studies indicate that the characteristics of the free-spins (or bonus) features were, in some combination, the factors that drove preference for the simulations with these features.

Preference Study 3 directly examined whether “freeness” was a driver of preference in Experiment 3. The bonus feature in this experiment still required participants to click to initiate spins during the bonus feature, and these spins still removed credits from their balance. Participants consistently preferred the simulation with the bonus feature, indicating that “freeness” was not a major driver of preference. Despite not being identified as a major driver of preference, “freeness” may have had a slight impact, with preference for the bonus-feature simulation slightly less consistent across participants than preference for the free-spins simulation in Experiment 2 of the same study. These findings afford some implications for the potential mechanisms through which gamblers come to prefer machines with bonus features.

This discussion focusses on the important findings and how these fit within the context of the theoretical literature regarding persistence. It will also discuss implications for the wider gambling context, formulate avenues for future research, and outline the limits of the investigation.

The Mechanisms Driving Preference for Free-spins Machines

In the General Introduction, I suggested that bonus features may facilitate gamblers "tuning in" to the slot machines (Thomas et al., 2009), or entering "the zone" (Oakes, 2014), and that these researchers' ideas both seem related to Csikszentmihalyi's idea of being in a state of flow (Csikszentmihalyi, 2002). It was proposed that the way bonus features may facilitate this process was through providing a specific goal to achieve. Focus group interview research suggested that "winning" free-spins features was something that gamblers focus on when gambling on slot machines (Landon et al., 2016; Livingstone et al., 2008), and Csikszentmihalyi (2002) indicates that striving to attain a goal is one of the prerequisites for attaining a state of flow. Both the complex, as well as the simple bonus features employed in the current investigation provided a "goal" for participants to attain, the same way the interview research described above suggests free-spins features do for gamblers. However, participants only preferred the free-spins simulations when the free-spins features were complex which demonstrated that the presence of a goal is not alone sufficient for participants to prefer free spins. These findings may reflect a process other than the provision of a goal facilitating getting into a flow state through which people come to prefer gambling on machines with free spins. As the current investigation did not collect any data regarding whether participants attained a state of flow while gambling, it is hard to draw any additional conclusions regarding the role of this potential mechanism in driving preference. Other research has shown that playing on machines with multiple wagering lines increases subjective measures of flow, and that this effect was stronger for problem gamblers (Templeton et al., 2015). Potential ways to directly investigate whether free spins facilitate getting into a flow state are discussed further on.

I also suggested that gamblers may prefer free-spins machines as the features provide signalled periods of increased reinforcement, and that the free-spins features may become a conditioned reinforcer through the association of the feature with significant winning outcomes. It was argued that this process may cause the free-spins machine to provide greater "average" reinforcement than a machine without free spins that has a similar overall RTP, due to the addition of conditioned reinforcement to the reinforcement schedule. The data as a whole do not support this process driving preference. The failure to find that the free-spins feature increases gambling persistence suggests that the free-spins feature was not successfully established as a conditioned reinforcer (this point is discussed below). On the other hand, participants only consistently preferred the free-spins feature when the feature incorporated an increased rate of reinforcement. When the feature did not signal an increase in reinforcement (i.e., the simple free-spins machines), participants did not prefer them. This finding was replicated across all of the preference studies. However, in the development of the complex free-spins features, other elements were also incorporated – unique sounds for individual free-spins symbols, animated images that signalled the start of the feature, advertising signalling the presence of a free-spins feature, and music that played during the feature. The addition of these elements mean that the preference studies did not isolate the effect of increasing win rate during the free-spins sequence, and therefore do not provide strong evidence for the individual role of the signalled periods of increased reinforcement. For instance, perhaps another, or some combination, of these other elements that were added are what drove preference.

Belisle et al. (2017) found consistent preference for a simulation with a simple free-spins feature that did not incorporate an increased rate of reinforcement. However, as discussed in Preference Study 2 (Experiment 1), Belisle et al.'s study used simple one-payline slot-machine simulations with only one type of win available. Additionally, their study had an unrealistically high rate of bonus feature activations – approximately 238 times higher than what might be expected on real slot machines when playing one payline (Harrigan et al., 2015). These features of their experiment limit the ability to generalise their findings to real-world gambling on complex modern slot machines with a variety of win sizes and multiple gambling lines. Therefore, it would be premature to conclude from Belisle et al.'s (2017) finding that free-spins do not drive preference by signalling periods of increased reinforcement. The experiments which examined preference for simple free-spins features in the current investigation (Preference Study 1; Experiment 1 of Preference Study 2) used more complex simulations that are more similar to modern slot machines, and incorporated a more realistic rate of bonus-feature activations. As such, it is likely that the results of these experiments (i.e., no consistent preference for simple-free spins features) are more representative of how people gamble on modern slot machines.

Another potential mechanism driving preference outlined in the General Introduction may be considered unlikely based on the results of this investigation. I suggested that people may prefer free-spins features due to generalisation from other situations where “free” or “bonus” have positive meanings. I argued that this may be a result of the transfer of the stimulus functions of the words “free” or “bonus” to slot-machines which bear those words. If this was the mechanism through which people come to prefer free-spins features, then participants would be expected to similarly prefer both the simple and complex free-spins simulations – the simulations in both cases had symbols that read “free spins”, as well as images at the start of the free-spins sequences that included the words “free spins” or “bonus”. As described above, participants did not prefer the simulations with simple free-spins features. These data indicate that a transfer of stimulus functions of the words “free” or “bonus” to the free-spins (or bonus) machines are not the main mechanism through which people come to prefer free-spins machines. I should note at this point that the complex free-spins simulations did have extra advertising underneath the slots indicating the presence of free spins, and it is not currently possible to entirely dismiss the role this advertising played in participants’ preference. Verbal relations have been shown to influence slot-machine preference (e.g., Dymond, et al., 2012; Hoon et al., 2008; Tan et al., 2015), but the data suggest that it is unlikely they were the main driver of preference for the free-spins features in the current investigation.

The implications of the results presented for the above mechanisms are necessarily tentative. The studies presented in this thesis were not aimed at answering which underlying mechanisms are behind participants’ preference for free-spins features. Because of this, potential confounds were not controlled. Therefore the studies do not provide overwhelming support either for or against the role of these potential mechanisms influencing gambling behaviour through a free-spins feature. Potential experiments that could assess the role of these mechanisms will be discussed further on.

Preference and Persistence: Contrasting Findings

The second major investigation reported in this thesis was the development of a task to measure persistence in slot-machine gambling, specifically in relation to free spins. The gambling task used in the preference studies was adapted to a multiple schedule design, and participants' gambling was disrupted by the addition of videos during certain phases in the experiment. This task was developed to facilitate a comparison of response rate during disruption and response rate during baseline, the measure of persistence commonly used in behavioural momentum research. Participants gambled on two simulations, one of which had the free-spins feature which participants consistently preferred in Preference Studies 2 and 3. Since participants preferred this simulation, it was expected that their gambling would also be more persistent on that simulation compared to a control machine. This hypothesis was in line with behavioural momentum research demonstrating that preference and persistence are convergent measures of the same underlying construct (e.g., Nevin & Grace, 2000a). However, participants in Persistence Study 1 did not gamble more persistently on the free-spins machine. Persistence Study 2 investigated the effect of a different independent variable, win frequency, on persistence using a similar design. In this study, participants unexpectedly did not gamble more persistently in the richer context. The failure to find an effect of free-spins causing more persistent slot-machine play is particularly interesting when viewed in the context of participants consistently preferring the same free-spins feature in the preference studies. There are a number of potential explanations for this discrepancy, along with the failure to find an effect of win frequency on persistence. These explanations are discussed below.

Conditioned reinforcers do not influence persistence. A core assumption of Behavioural Momentum Theory is the idea that conditioned value drives both persistence and preference. However, the findings of consistent preference for complex free-spins features, combined with a failure of those free-spins features to increase persistence, may indicate this assumption is not as robust as a search of the behavioural momentum literature suggests. A historic argument concerns whether conditioned reinforcers actually strengthen behaviour in the same way as primary reinforcers (for reviews see Kelleher and Gollub, 1962; and Shahan, 2010).

Shahan (2010) reviewed the available evidence for the idea that conditioned reinforcers strengthen behaviour as measured by resistance-to-disruption measures. Previous arguments that conditioned reinforcers increase resistance-to-disruption were typically based on studies using concurrent chains procedures. Shahan re-introduced a criticism of this conclusion based on the fact that, in concurrent-chains procedures, rates of conditioned reinforcement are confounded with rates of unconditioned reinforcement. To illustrate, I describe a standard concurrent chains procedure with pigeons. The pigeon is presented with two response keys concurrently. Both of these keys have the same colour, and responding on both of these keys is reinforced on equivalent schedules of reinforcement (say, VI-20s schedules), with the reinforcer being access to separate schedules of reinforcement. Responding on the left key leads to an FR-5 schedule on a blue key, while responding on the right key leads to an FR-30 schedule on a red key. The starting concurrent schedules are called the initial links, and the separate schedules they produce are called the terminal links. As initial link responding is reinforced by a subsequent schedule of reinforcement, which is signalled by a coloured key, that coloured key becomes a conditioned reinforcer. However, the confound described above is that while initial link responding is somewhat a result of access to a conditioned reinforcer, access to a primary reinforcer in the terminal schedule is also dependent on the initial link responding. Therefore, using this task it becomes difficult to separate the effects of the conditioned and primary reinforcers on responding and to examine how conditioned reinforcers alone strengthen behaviour (Shahan, 2010).

Shahan and others moved towards using the observing-response procedure to measure the response-strengthening effects of conditioned reinforcers, as this task more clearly isolates the effect conditioned reinforcers have on behaviour. Briefly, key responses are reinforced on a VI schedule which alternates with extinction. Both of these contingencies are unsignalled. Responses on a separate "observing" key are reinforced on a schedule which provides access to stimuli that either signal the VI schedule or extinction. The stimuli that signal the VI schedule are considered conditioned reinforcers through their association with primary reinforcers and since they maintain responding to the observing key. Using this procedure, the primary reinforcement schedule can be held constant while the rate of the conditioned reinforcer can be varied, and thus the effect of conditioned reinforcers on behaviour – operating the observing key – can be measured without different rates of primary reinforcers confounding the study. The problem for Behavioural Momentum Theory is that varying rates of the conditioned reinforcer did not affect persistence (Shahan & Podlesnik, 2005). Similarly, varying the magnitude of the conditioned reinforcer had no effect on persistence (Shahan & Podlesnik, 2008). In both studies, response rates on the observing key varied as expected (i.e., more responding for greater rate/magnitude conditioned reinforcer). Shahan concluded that if response strength is measured by resistance to change (persistence), then stimuli established as conditioned reinforcers do not affect response strength the same way as primary reinforcers (Shahan, 2010).

Shahan (2010) went on to discuss the idea that conditioned reinforcers may not strengthen behaviour in the same way as primary reinforcers. He suggested instead that conditioned reinforcers may signal where to allocate responding to receive primary reinforcers. Applying these ideas to the results of the current investigation, the persistence studies may support Shahan's idea that conditioned reinforcers do not strengthen behaviour. Participants were not more persistent on a complex free-spins machine, or a machine with a much richer rate of wins. Participants were also not more persistent on a richer machine when gambling for a token reinforcer, hypothetical money, which was exchangeable for a primary reinforcer (chocolate, candy). Despite a failure of these conditioned reinforcers to increase persistence, when provided with the opportunity to gamble on machines with large differences in win rates, participants generally prefer the higher win-rate machine (Coates & Blaszczynski, 2013, Dixon et al., 2006). The findings reported in this thesis, in combination with the research cited above, may provide reasonable evidence that conditioned reinforcers in the current investigation did not strengthen gambling, despite driving preference. This provides support for Shahan (2010) calling into question the generality of Behavioural Momentum Theory, as this may be a situation where the conditioned value of the stimuli did not influence persistence. However, it is difficult to understand how the conditioned reinforcers available may have signalled where to allocate behaviour to receive primary reinforcers, particularly in the studies reported where the conditioned reinforcers were not exchangeable for chocolate, candy, and coffee vouchers.

Shahan focussed his review on the animal literature, however, there are a few human behavioural momentum studies which demonstrate the response-strengthening effects of conditioned reinforcers. As described in the introduction to the persistence studies, there is a limited number of behavioural momentum studies that used human participants. Of these, there are even fewer studies that have examined the use of conditioned reinforcers, and again fewer where the conditioned reinforcers did not directly signal where to respond to receive primary reinforcers. These studies have generally found that behaviour is more persistent in the context associated with a richer schedule of conditioned reinforcement. Plaud and Gaither (1996) used points as the reinforcer with college students, and despite the limitations of their data analysis outlined previously, their results generally suggest participants were more persistent on the richer schedule. Groskreutz (2010) used physical and verbal attention from experimenters as reinforcers for childen with developmental disabilities, and found that children were generally more persistent in the richer schedule. Parry-Cruwys et al. (2011)

used tokens as the reinforcer for two participants (food/drink reinforcers for others) and found that both participants were more persistent in the richer schedule. For reference, the tokens lead to toy or video-game access. Lastly, in two experiments with college students, Cohen (1996) found that typing behaviour was more persistent when reinforced with points on richer schedules. The above studies provide examples of where conditioned reinforcers have been demonstrated to strengthen behaviour. It is difficult to determine how the conditioned reinforcers in the above studies may have signalled where to respond to receive primary reinforcers, particularly in the studies with college students where points were the only reinforcer. Thus, it can be considered somewhat unlikely that the reason for null findings in the persistence studies of the current investigation are due to conditioned reinforcers being unable to strengthen behaviour.

The rich and lean slot-machine schedules were too similar. One notable element of the human behavioural momentum studies reported above is that the difference in reinforcement rate or magnitude on the schedules was rather large. The smallest difference in schedules was roughly a three-fold increase in reinforcement rate on the richer schedule relative to the leaner (Cohen, 1996; Experiment 2). Other behavioural momentum research with humans has also typically had large differences in reinforcement across the schedules where behaviour is evaluated. On occasions where there was only a small difference in obtained reinforcement across schedules, persistence has not consistently been greater in the richer context (e.g., Dube & McIlvane, 2001). In the real-money condition of Persistence Study 3, the difference across schedules was only moderate, with 33% of responses reinforced on the lean schedule, and 43% reinforced on the rich schedule. When compared to the schedule differences listed above, this difference is comparatively small. Finding no effect of persistence on the richer schedule may therefore be interpreted as consistent with data from Dube and McIlvane (2001).

The hypothetical-money experiment in Persistence Study 2 had a much larger difference in reinforcement rate, with 33% of responses reinforced on the rich schedule and only 9% of responses reinforced on the lean schedule. However, again gambling was not more persistent on the rich schedule. As conditioned reinforcers derive their reinforcing properties from their association with other reinforcers, the conditioned reinforcers may often be less powerful. The conditioned reinforcers in this study (points, winning stimuli) were far removed from any primary reinforcers, and assumed to operate as generalised conditioned reinforcers. The points, and associated winning outcomes, may therefore have been only weakly reinforcing. Persistence as measured by methods typical of behavioural momentum research has not been demonstrated to be sensitive to small differences in reinforcement schedules with human participants (e.g., Dube & McIlvane, 2001). The current study may have failed to find more persistent gambling on the free-spins machine and higher win-rate machines because the task was insensitive to small differences in reinforcement schedules. It is hard to quantify how reinforcing the free-spins feature is, but as overall reinforcement rate in the form of winning outcomes on the control machine was equivalent, it may be reasonably expected that the addition of the free-spins feature did not produce a large difference in the conditioned value of the free-spins machine and the control machine. This interpretation is consistent with participants not gambling more persistently on the free-spins machine – the conditioned value of that machine, and therefore the behavioural mass of gambling on that machine, was not much greater than the control machine.

The addition of the free-spins feature may have increased the overall reinforcement of the free-spins machine enough for preference to be clear in the preference tasks, but not enough to drive more persistent play when measured with a behavioural momentum task that may be insensitive to small differences in reinforcement schedules. As discussed earlier, preference is generally more sensitive than persistence to differences in reinforcement (Nevin & Grace, 2000b). Podlesnik et al. (2011) also failed to demonstrate increased persistence in the context of preferred stimuli, but, by further increasing the difference in reinforcement across two contexts was able to find the expected effect of greater persistence in the context associated with greater reinforcement. The pattern of results observed in the current investigation is consistent with the interpretation that the free-spins feature functioned as a weak conditioned reinforcer. If behavioural momentum tasks are also insensitive to small differences in reinforcement schedules, it may be no surprise that the persistence tasks failed to find more persistent play on the richer machines.

The Conditioned Reinforcing Properties of the Free-spins Feature

The basic literature about conditioned reinforcement is consistent with the conclusion that the current slot-machine simulations likely created the conditions under which the free-spins feature would develop some, but weak, conditioned reinforcing efficacy. Rescorla (1988) described some of the circumstances that are important for establishing a stimulus as a conditioned reinforcer. One obviously important variable is contiguity between the stimulus and the reinforcer with which it is to be associated. The complex free-spins feature in the current investigation incorporated this element – there was an increased rate of wins, and therefore points, during the free-spins feature. Furthermore, the music and animations available during the free-spins feature were only presented during the feature, although it is unknown whether these acted as reinforcers, stimuli that signalled the increased rate of wins, or both. In any case, it was reasonably expected that the contiguity between winning outcomes and the free-spins feature would lead to participants associating the free-spins feature with those outcomes. However, the base rate of the (unconditioned) stimuli is also an important determinant of conditioning. In a classic experiment with tone as the conditioned stimulus, and electric shock as the unconditioned stimulus, Rescorla (1988) demonstrated how base rates influence associative learning in rats. If the shock only occurred during the tone, then the more shocks that occurred during the tone the greater conditioning to the tone was. This finding is unsurprising. However, regardless of the likelihood of shock during the tone, conditioning to the tone was an inverse function of base-rate shocks. For example, when shocks outside the tone were as frequent as shocks during the tone, little to no conditioning was observed. When the base rate of shocks outside the tone was low, conditioning to the tone was observed. Holding the contiguity between shocks and tone constant, conditioning ranged from excellent to non-existent simply by increasing the base rate of shocks. This could potentially explain the failure of the free-spins feature to drive persistent gambling. There was contiguity between the free-spins feature and winning outcomes, but the difference between the base rate of wins outside the free-spins feature (39%) and during the feature (50%) in the persistence studies was not large. (For reference, the difference between the rate of wins outside (32%) and during the free-spins feature (62%) in Preference Studies 2 and 3 was slightly greater.) This small to moderate difference in win rate (and RTP) could be expected to result in many trials needed to condition the free-spins feature to asymptote, especially given, as I have previously argued, sensitivity to small/moderate RTP differences is generally low. On the other hand, the base rate of the free-spins music and animations outside the free-spins feature was zero. If the increased rate of wins during the free spins were a driver of preference, then one might expect conditioning to the free-spins feature to be very slow. If the music and animations were more important drivers of preference than winning outcomes, conditioning should be faster.

In addition to base rates of the reinforcing stimuli, and contiguity between the to-be-conditioned stimulus and the reinforcers, a number of pairing trials are needed for conditioning to reach asymptote. As part of a thorough review of historic conditioned reinforcement literature, Kelleher and Gollub (1962) identified that more pairings generally leads to greater conditioned reinforcement, up until asymptote. Across the baseline phases of the persistence studies, the free-spins feature was activated only four times, once in each baseline component on the free-spins machine. (For reference, the free-spins feature was activated only three times during the exposure phase in Preference Studies 2 and 3.) Including both the baseline and disruption phases, the free-spins feature was activated eight times. It is unlikely this number of pairings between the free-spins feature and subsequent reinforcers is enough for conditioning to reach asymptote. There are many features of the conditioning stimuli and their arrangement that affect how many pairings are needed for conditioning to reach asymptote, (e.g., saliency of the unconditioned stimulus), so it is hard to draw direct inference from previous research to the current investigation. However, for reference, Bersh (1951) and Miles (1956) found that roughly 100 pairings were needed between a conditioned reinforcer and unconditioned reinforcer for the conditioned reinforcing effect to reach its peak in rats. In human conditioning studies where a puff of air to the eye is the unconditioned stimulus, approximately 50 to 60 pairings are needed with a neutral stimulus before the conditioned reinforcement effect reaches asymptote (Clark & Squire, 1998; Gerwig et al., 2005). It is likely that neither four pairings in baseline phases, nor eight pairings across the experiment are not enough for conditioning to the free-spins feature to reach asymptote. The studies listed above assessed conditioning by pairing an unconditioned stimulus with a neutral stimulus. When pairing a higher-order conditioned stimulus with a neutral stimulus, research generally also shows that more pairings are more effective, to a point (e.g., Baeens, Eelen, Crombez, & Van den Bergh, 1992).

Despite the (un)likelihood that the free-spins feature was conditioned to asymptote in the persistence studies, establishing the free-spins feature as an effective conditioned reinforcer does not necessarily require the conditioning to reach asymptote. The complex free-spins simulations used in this investigation may have created the conditions under which the free-spins feature develops some conditioned reinforcing efficacy, but not a great deal. Baeens et al. (1992) showed small conditioning effects were apparent after only two and five pairings between the neutral stimulus (neutrally rated faces) and conditioning stimulus (positively or negatively rated faces). Furthermore, Stuart, Shimp and Engle (1987) demonstrated effective conditioning with only a single pairing of stimuli. As variables other than the number of pairings are important determinants of the effectiveness of conditioning, it is currently unknown how many pairing trials with the method used in the persistence studies would be necessary to establish the free-spins feature as an effective conditioned reinforcer. There is currently no literature examining how long humans need to be exposed to a stimulus reinforcer relation for it to affect persistence.

To summarise the implications of the above research, it is possible that conditioning to the free-spins feature was low due to the relatively few activations of the free-spins feature, combined with the small discrepancy between the base-rate of wins during and outside the feature. This may have resulted in the stimuli associated with free-spins machine not having a much higher conditioned value than the stimuli associated with the control machine. As described earlier, small differences in conditioned value of the two machines may be reflected in the failure to find more persistent gambling on the free-spins machine.

Other factors are also important determinants of establishing a stimulus as a conditioned reinforcer, and the above literature is by no means an exhaustive review. For example, the time between pairings is important, with a shorter amount of time generally resulting in greater conditioning (Gibbon, Baldock, Locurto, & Terrace, 1977). More widely spaced pairings (i.e., more unpaired trials in between pairings) are also ideal (Gibbon et al., 1977), and conditioning is generally better in a forward direction (i.e., the neutral stimulus presented before the unconditioned stimulus). The persistence tasks appear reasonably in line with close-to-optimal conditions here, so the focus above was on potential areas where the task may have fallen short.

Potential areas to focus on regarding increasing the ability of the persistence tasks to establish the free-spins feature as a conditioned reinforcer have been highlighted, and provide an area for future research. The idea that the free-spins feature may have only been established as a weak conditioned reinforcer can be considered likely given A) the features of the pairings arranged by the slot-machine simulation described above, and B) the lack of difference observed in conditioned value between the free-spins machines and the control machines in the persistence studies. This idea also accounts for the discrepancy between the preference and persistence studies when taken in the context of persistence generally being less sensitive than preference, and the possibility that typical behavioural momentum tasks are insensitive to small differences in reinforcement schedules.

Future Research

There are many interesting avenues that future research could investigate. Improving the persistence task, conducting a component analysis to determine which of the added elements actually effect preference, examining how free-spins features interact with other slot-machine structural characteristics, and examining the mechanisms through which people prefer free-spins are the examples of future research I would like to focus on here.

Improving the persistence task. At previous points in this thesis, a number of ways to improve the sensitivity of the persistence task have been described. One way to do this is to increase the difference in reinforcement across the two schedules used in the multiple-schedule design. This was attempted in Persistence Study 2, where a) win rates were drastically reduced in one component, and b) points could be exchanged for tangible rewards. There were reasonable arguments for both of these options. Increasing the size of the difference between schedules should facilitate the creation of behavioural mass differences as well as facilitate the task being able detect these differences – as relative reinforcement rate differences increase so do differences in persistence (Nevin & Grace, 2000b). On the other hand, increasing the magnitude of reinforcers by their association with tangible rewards should also increase the magnitude of the difference between the schedules. However, due to practical and ethical limitations discussed in Persistence Study 2, it was not possible to combine these different approaches.

Another way to increase the size of the difference between schedules would be to further improve the free-spins feature, this would also have the useful effect of making the simulations yet more ecologically valid by incorporating more of the elements of free-spins features found on real-world slot machines. One of the reasons given for failing to find that free spins increase persistence was that the feature may have only become a weak conditioned reinforcer, increasing the behavioural mass of gambling on that machine enough to drive preference but not persistence. Further developing the free-spins feature to become more rewarding should further increase the conditioned value of the stimuli associated with the free-spins machine, and therefore the behavioural mass of gambling on that machine. There are a many potential ways to improve the free-spins feature. For instance, some bonus features have some sort of interactive “mini-game” incorporated into their design (Dow Schull, 2012). Adding a feature such as this could add an element of perceived skill to the slot-machine simulations. Other ideas for improving the free-spins feature are improving visual and sound effects, or having the ability to win a jackpot contingent upon activation of the free-spins feature.

Some aspects of the slot-machine simulations that may have facilitated only slow conditioning to the free-spins feature were outlined above, and altering these features should also facilitate better conditioning to the free-spins feature. Rescorla's (1988) demonstration that the base-rate at which unconditioned reinforcers are delivered affects the extent to which conditioned reinforcers are established leads to an obvious avenue to explore with future experiments. Increasing the difference between the rate of winning outcomes during and outside the free-spins feature would result in the free-spins feature providing more information about the likelihood of winning outcomes. This alone would be expected to increase the power of association between the free-spins feature and winning outcomes. Secondly, increasing the overall number of trials would increase the number of pairings between activation of the free-spins feature and the reinforcers that follow. Another approach would be to simply increase the frequency of free spins, although this would have the side effect of reducing the number of trials between pairings, as well as reducing ecological validity by causing an unrealistically high rate of free-spins feature activations. As mentioned previously, Harrigan et al. (2015) found that activating bonus features was relatively rare on real-world machines, occurring once in every 92 max-lines spins in their analysis. If a failure to establish the free-spins feature as a conditioned reinforcer accurately describes the reason why the free-spins feature did not increase gambling persistence, then these manipulations would be expected to facilitate greater conditioning to the free-spins feature, and therefore result in greater persistence on the free-spins machine.

Improving the general task developed in the persistence studies may also result in increased sensitivity of the task to detect differences in behavioural mass. Participants tended to be more disrupted by both the animal videos, as well as the first disruptor experienced, and these effects interacted making it difficult to isolate any effects of free spins or win rate on the extent of disruption. More distraction during the animal videos compared to the NRL videos may simply be a result of sample characteristics – the majority of participants in these studies were young females enrolled in a first year psychology course and this is not a demographic that is typically interested in rugby league. Perhaps allowing participants to select their own videos, as in the Kuroda et al. (2016) study, would help ensure that the videos had some sort of interest to the participants and therefore more capable of distracting them. Another option would be to allow participants to browse social media in an embedded screen similar to the way videos were presented.

To address the order effect where participants tended to be more disrupted by the first disruptor experienced, it may be sufficient to give participants experience with the disruptor earlier in the experiment. This could be incorporated in one of the baseline phases – before measuring persistence. I expect that participants were more disrupted or distracted by the first disruptor due to the novelty of them, and earlier experience with the disruptor would reduce this novelty. Behavioural momentum research frequently gives participants experience with novel disruptors prior to investigating their effect on persistence (e.g., Dube et al., 2000; Kuroda et al., 2016). The effect of order and video-type described above added noise to the analysis of whether the independent variables affected persistence. Reducing or eliminating these effects would thus help increase the sensitivity of the task to detect a difference in gambling persistence.

Component analysis of free-spins feature. Before examining whether lowering base-rate wins increases conditioning to the free-spins feature, it may be sensible to first investigate whether the increased rate of wins during the free-spins sequence actually drives preference for the free-spins simulations. I speculated above that perhaps the increased rate of wins during the free-spins feature may not have driven preference through establishing the free-spins feature as a conditioned reinforcer. Other factors may have influenced preference. For instance, the addition of advertising on the machine regarding free spins may have facilitated participants developing a verbal rule that produces preference for the free-spins machine. As mentioned numerous times in this thesis, a component analysis of the complex free-spins feature would clarify which of the added features were important drivers of the preference seen. Perhaps the most practical way to achieve this would be a series of experiments using a similar method as Preference Study 2.

Participants could gamble on a control machine with a simple free-spins feature, and a slightly improved free-spins feature that incorporates only one of the elements that was added to the complex free-spins feature, for example, an increased rate of wins during the feature. If participants consistently prefer the improved free-spins machine, this would demonstrate that the addition of the increased rate of wins during the feature was an important driver of preference. The other elements that were added to the complex free-spins machine could also be explored. Another way to achieve this would be to have the control machine feature all of the elements of the complex free-spins feature, and take one of these elements away from the experimental machine to observe whether this affects preference. Systematically investigating the elements that were added to the complex free-spins feature in one of these ways would clarify which, or which combination, are important drivers of preference.

Free-spins features' interaction with structural characteristics. The effects that free-spins and other bonus features have on gambling behaviour are not yet well understood. As it stands there are currently two examples of published experimental research. The data from one of these is reported in this thesis as Preference Study 2, the other recently published article also examined preference for a simple free-spins feature (Belisle et al., 2017). An interesting research avenue would be to examine how free-spins features interact with other modern game features in influencing gambling behaviour. For instance, the ability to select a number of different paylines in multi-line slot machines. Since the chance to activate a free-spins feature depends on the number of lines played, and people prefer free-spins machines, it may be expected that the presence of a free-spins feature will cause gamblers to gamble on more lines than they would otherwise. Indeed, gambling on the maximum number of lines with the minimum required bet is a common strategy among gamblers (Livingstone et al., 2008; Templeton et al., 2015; Williamson & Walker, 2000). An experiment could be set up where participants play on both a control and a free-spins machine, and are able to select the number of lines wagered. Results would demonstrate whether free-spins features increase the number of lines gamblers wager. In the current investigation, the number of lines wagered was held constant to help control reinforcement rate.

Near wins are one characteristic of slot machines that have received a great deal of experimental attention, although much of this research has been conducted on simple one-payline simulations. It is likely that, given the modernisation of machines with the introduction of many lines which one can choose to gamble on, it is much harder for gamblers to discriminate near wins in the form they have previously been investigated. For example, a gambler noticing that they received two out of the three symbols needed for a win on a one-payline machine would be a lot easier than noticing the same two out of three symbols when faced with the dizzying array of symbols in a 40-payline machine. Furthermore, given the importance that gamblers report placing on free-spins features, it is likely that almost activating a free-spins feature is more salient than almost winning a small or moderate amount of money. Another structural characteristic of modern slot machines likely further increases the saliency of near wins for free spins – real-world slot machines tend to produce unique sound effects for landing free-spins symbols (an element of free-spins features incorporated into the complex free-spins features in the current investigation). Parke and Griffiths (2006) suggested that near wins for bonus features are a structural characteristic that has great potential to influence gambling. Previously, research investigating simple near wins has found near wins increase persistence as measured by a single-option quitting procedure in extinction conditions (Cote et al., 2003; Kassinove & Schare, 2001). Experimentally manipulating the rate of near wins for free-spins features and then measuring the effect of these on persistence and preference is a potentially fruitful research avenue and currently represents a significant gap in the experimental slot-machine gambling literature.

Examination of the psychological mechanisms that cause preference. The current investigation provided only limited ability to make inferences about the mechanisms which underlie participants' preference for complex free-spins features. However, examining what underlies participants' preference for complex free-spins machines would be a useful contribution to gambling literature. Murch (2016) investigated the concept of flow in slot-machine gambling by incorporating different measures of immersion, including both physiological (e.g., heart rate) and self-report measures. Self-report measures included the Game Experience Questionnaire (Ijsselsteijn, Poels & De Kort, 2008) which involves questions relating to how absorbed a person felt during a task. A between-subjects experiment where participants play either a simulation with a complex free-spins feature, or a simulation without such a feature, and then complete the above questionnaire could provide evidence as to whether free-spins features facilitate entering a state of flow while gambling.

The role that verbal relations play in participants' preference for free-spins machines could also be examined experimentally. For instance, participants could first be trained using a matching-to-sample task that the words "free-spins", or free-spins symbols, are equivalent to a negative concept – a loss in points or a failure to win points for example. A control group could be trained that "free-spins" are equivalent to a good concept, or simply receive no training. Following this, participants could be presented with two slot-machine simulations, one with free spins and one without. As other studies have shown derived verbal relations can influence slot-machine preference (e.g., Tan et al., 2015), it would be expected that participants who were trained the relation "free-spins" = negative concept would be less likely to prefer the free-spins machines than participants who received no training, or training that "free-spins" were equivalent to a positive concept. This pattern of results would indicate that verbal relations do have an effect on preference for a free-spins slot machine.

Contributions to Research Literature

The research reported in this thesis makes a number of major contributions to experimental gambling literature. This research represents the first experimental analysis of free-spins features on gambling behaviour, previously a striking gap in the literature when contrasted with gamblers' reports that free-spins features are a major influence on their gambling behaviour (Landon et al., 2016; Templeton et al., 2014; Livingstone et al., 2008). The preference studies demonstrated that participants prefer to gamble on a machine with a free-spins feature. Preference for free-spins features was also found to depend on the complexity and elements incorporated into the free-spins feature, rather than the concepts of "freeness" or "time on device" that gamblers report as important. Furthermore, preference for the complex free-spins feature was demonstrated to exist among participants who gambled with hypothetical money (Preference Studies 1 and 2), as well as among participants who gambled with currency that could be subsequently be exchanged for tangible rewards (Preference Study 3). This particular finding contributes to the literature by demonstrating that experiments evaluating preference for different slot-machine features are likely un-hindered by the use of hypothetical money.

This research programme also contributes to the field of behaviour analysis more broadly. The discrepancy between the preference and persistence results questions the effectiveness of behavioural momentum techniques measuring small differences in response strength across schedules. Furthermore, as the vast majority of human behavioural momentum research has been conducted with reinforcement schedules that are drastically uneven, it is questionable whether Behavioural Momentum Theory contributes to our understanding of how small differences in reinforcement affect response strength. As much human behaviour is thought to be controlled by higher-order conditioned reinforcers and verbal rules, it becomes questionable how applicable Behavioural Momentum Theory is to the vast majority of behaviours in the general population. The above statements are tentative, given the identified areas of the persistence task which need development.

The persistence task, adapted from behavioural momentum research, represents the initial steps towards the development of a method through which gambling persistence can be measured using disruptors that don't alter the variable (conditioned value) that is being measured. This is an important development, as measuring responding in extinction is typical of experimental research on gambling persistence. Persistence is one of the hallmarks of disordered gambling, and investigating how different structural characteristics of slot-machines influence persistence may reveal fruitful interventions. If a variable causes people to persist longer than they would otherwise on a slot machine, this variable may be reduced or eliminated through legislation. This task also allows the use of more ecologically valid disruptors than typically used in gambling research, as gambling behaviour is rarely in extinction outside the laboratory.

Potentially, this task could also be used to answer research questions regarding Behavioural Momentum Theory that are not unique to gambling. For example, an interesting question that has yet to be answered is just how much exposure to different schedules is required to influence momentum effects in humans. Potentially, this task could be altered and experiments run to investigate this. An advantage of this task is that it measures a behaviour, slot-machine gambling, that a reasonably large percentage of the population engages in. This factor provides some ecological validity and facilitates easy comparisons between research and real-world behaviour. The task is also engaging for participants, and is an inexpensive way to provide reinforcers for responding. I should reiterate at this point that although some advantages of the task are described here, the task still needs further development, starting with the ideas outlined previously.

The findings reported in this thesis also have some implications for legislation. Participants preferring to play a machine with a complex free-spins feature, yet the same feature not increasing gambling persistence, may indicate that free-spins features are not a valid target for legislative intervention. For instance, limiting or eliminating free-spins features may simply reduce player enjoyment while having no influence on how persistent their gambling is. However, this implication is necessarily tentative. The complex free-spins feature used in this research is a reasonably close approximation of free-spins features on real slot machines, but it remains to be seen whether these features increase persistence. Further improving the free-spins feature and developing the persistence-measuring task in the ways outlined above are necessary before drawing strong conclusions regarding legislation. With that said, the research reported in this thesis provides the important first steps along the path to a well-developed understanding of how free-spins features influence gambling behaviour.

Limitations of the Investigation

Specific limitations for each study were reported in each study's discussion. Here I would rather focus on the general limitations that were pervasive across the majority of studies. These limitations are generally inherent to laboratory research. Essentially, determining causality in how a game feature influences gambling behaviour requires a tradeoff between ecological validity and isolating that feature so its effect can be determined. For instance, it is not possible to manipulate slot machines and measure how these manipulations affect gambling behaviour in real gambling establishments where real money is gambled. At the same time, achieving this in the laboratory results in measuring gambling behaviour in an artificial setting – a thorough understanding of how this affects gambling behaviour is currently lacking. Furthermore, due to ethical and practical considerations, it was not possible to allow participants to gamble with their own money, or to win or lose large amounts. It is not currently known how this may impact upon our measures of preference and persistence, although Preference Study 3 indicated that participants responded similarly on our measure of preference whether they were gambling for points or whether these points could be exchanged for items with a monetary value. The low starting balance in the real-money studies ($8 in the preference study, $7 in the persistence study) is also not representative of how much seasoned gamblers generally begin a gambling session with. Other research has indicated that participants tend to gamble less when credits are worth more (Weatherly & Brandt, 2004; Weatherly & Meier, 2007), however this seems unlikely to influence measures of relative preference or persistence across two simulations. Lastly, the participants in the current research were from student populations and mostly inexperienced with gambling. This may be seen as a limitation – some research has indicated first year psychology students are not typically representative of the student gambling population, and have some qualitative differences in gambling behaviour (Gainsbury et al., 2014). However, this research also indicated there was no difference in slot-machine gambling behaviour across these populations specifically. In any case, investigation of how game features influence inexperienced gamblers' behaviour is necessary step in the knowledge base and these experiments can be replicated with experienced gamblers.

Concluding Remarks

Problem gambling affects a large number of people in New Zealand and world-wide. Slot-machine gambling specifically is disproportionately associated with problem gambling, and it is therefore important to develop an understanding of whether the different structural characteristics of slot machines influence gambling behaviour, and how. Despite the importance of understanding how slot machines influence gambling, there is a significant lack of experimental research into what interview research indicates is one of the most important slot-machine structural characteristics – the free-spins bonus feature. This research programme addressed this gap in the literature by experimentally examining whether participants prefer to play slot-machine simulations with free-spins bonus features, and whether this feature caused participants' gambling to be more persistent. To conclude I would like to emphasise the important findings from this research. Participants prefer to gamble on slot-machine simulations with complex free-spins features over similar simulations without such features. This preference was driven by the different elements that make up the free-spins feature, rather than the broad concepts of "freeness" or "extra time on device" that interview research with seasoned gamblers has tended to implicate. Despite preferring simulations with complex free-spins features, participants' gambling was not more persistent on these machines. Nevertheless, applying techniques adapted from Behavioural Momentum Theory research provides the opportunity to advance our understanding of which structural characteristics of slot machines drive more persistent slot-machine gambling. The suitability of these techniques for studying gambling persistence have until this point been neglected by experimental gambling researchers.

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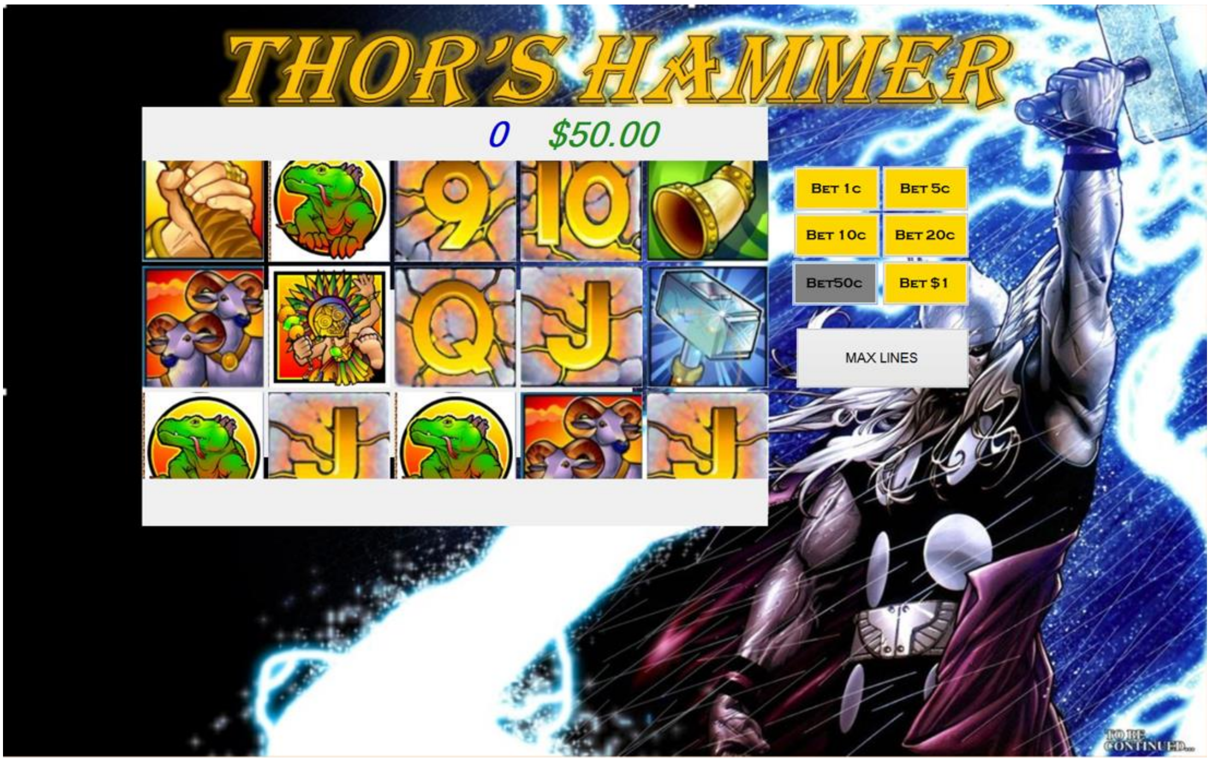
Appendix A


BLACKBEARD'S REVENGE
0
$50.00
BET 1c
BET 5c
BET 10c
BET 20c
BET50c
BET $1
MAX LINES


THOR'S HAMMER
0
$50.00
BET 1c
BET 5c
BET 10c
BET 20c
BET50c
BET $1
MAX LINES

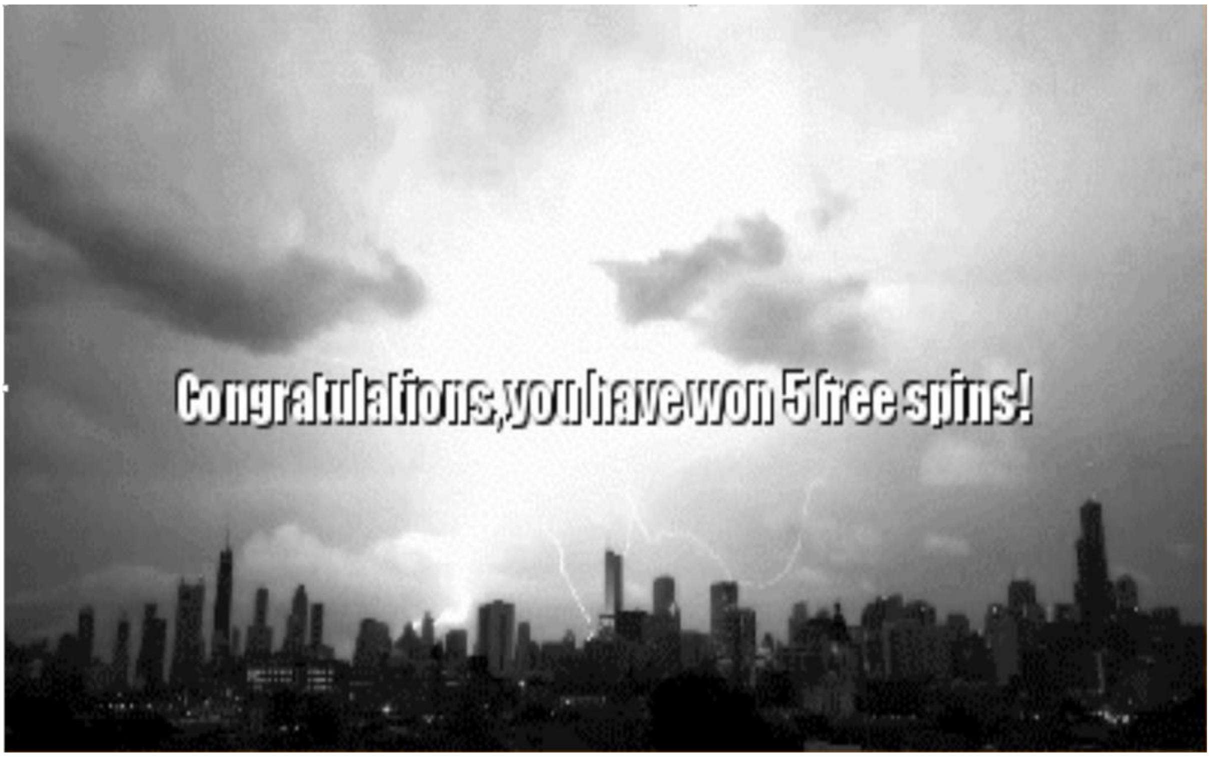
Appendix B


CONGRATULATIONS
YOU HAVE
WON
5
FREE SPINS


CONGRATULATIONS!
YOU HAVE WON
5
FREE SPINS

Appendix C


Congratulations, you have won 5 free spins!


Congratulations, you have won 5 free spins!

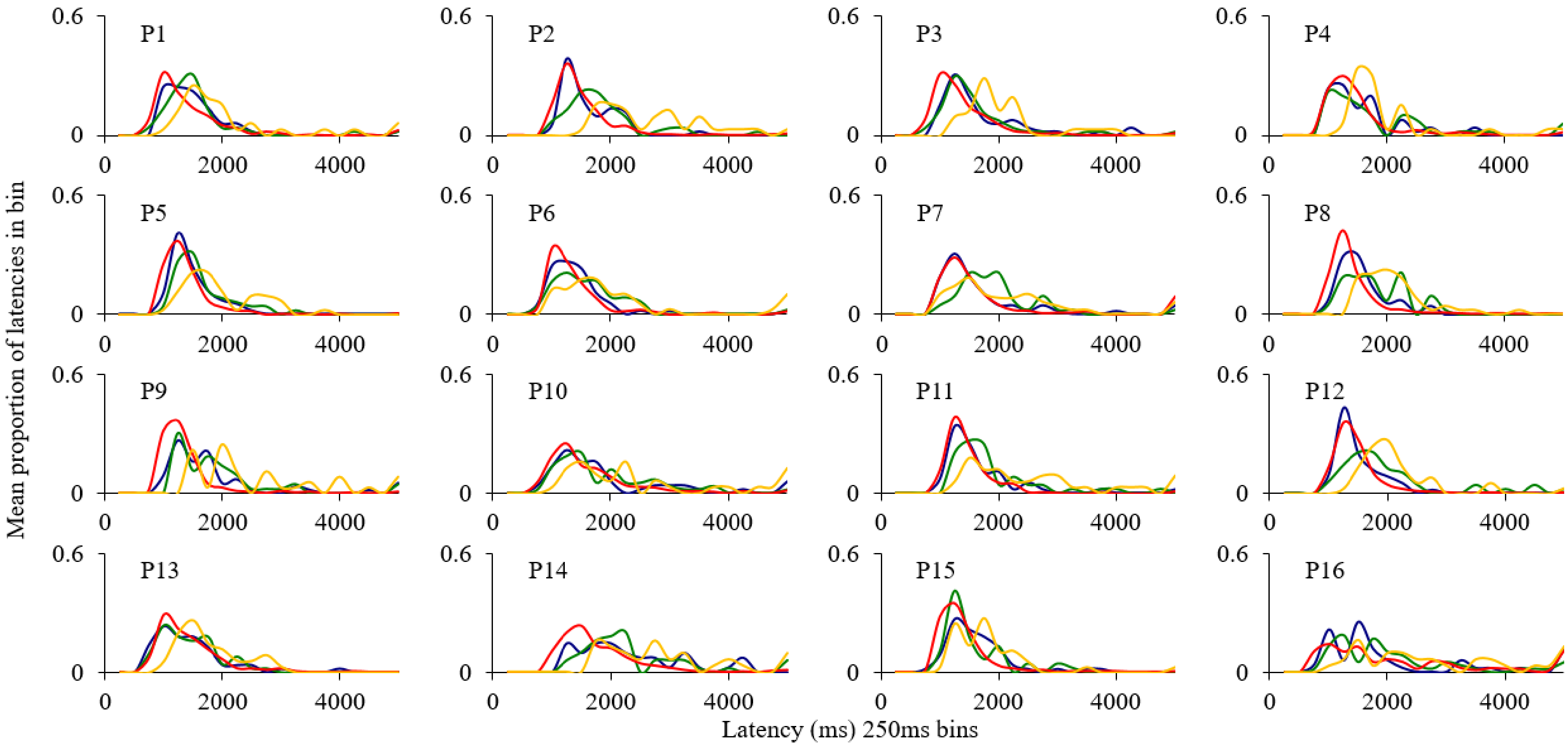
Appendix D

One-sample Wilcoxon Signed Rank Tests on Preference Data

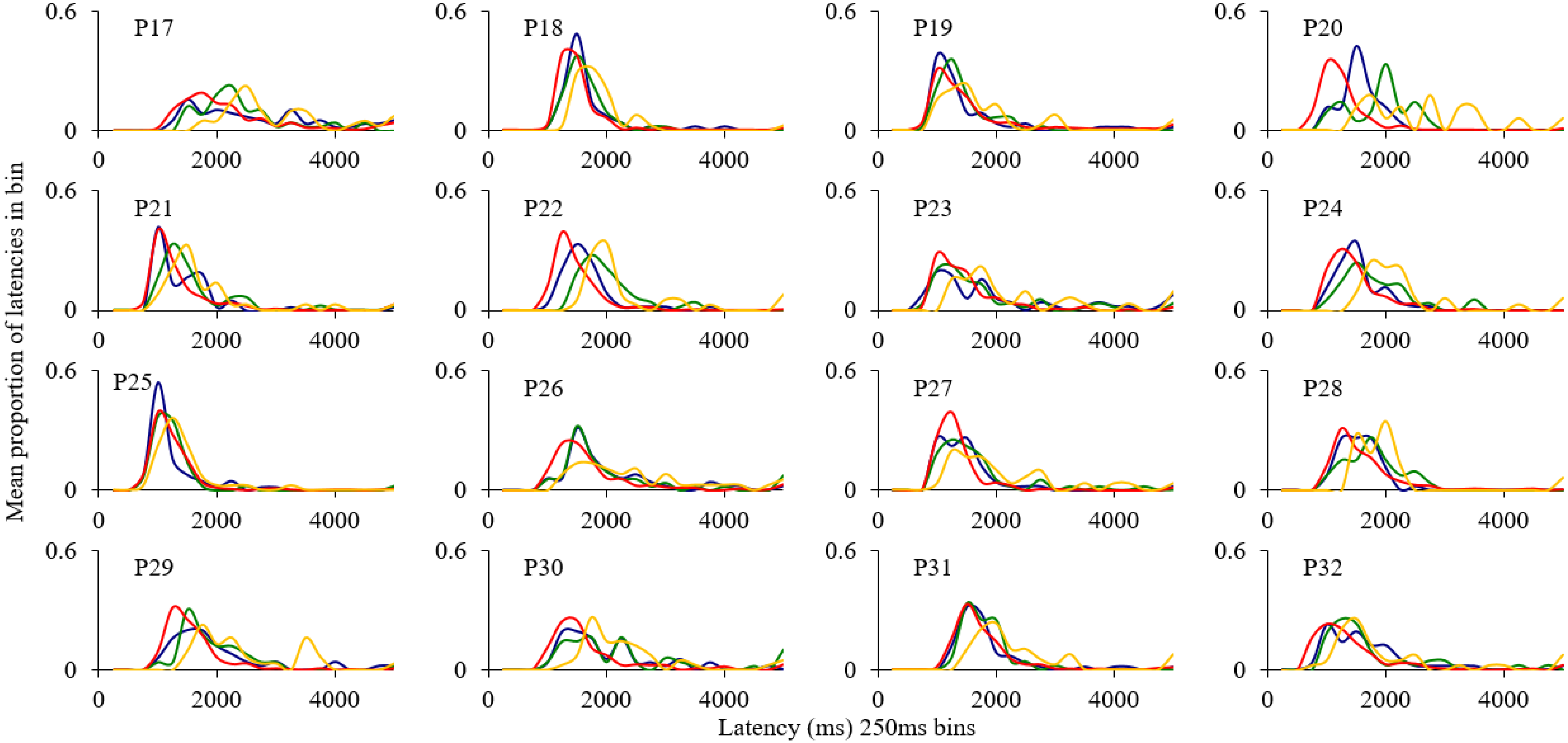
Study	Experiment	Mean proportion of spins on Free-spins/bonus machine	SD	P value	Cohen's d
Preference Study 1	Without-features Condition	.368	.304	.079	0.44
	Added-features Condition	.595	.315	ns	n/a
Preference Study 2	Experiment 1 (simple free-spins feature)	.586	.274	ns	n/a
	Experiment 2 (complex free-spins feature)	.706	.269	<.001	.063
	Experiment 3 (complex bonus feature)	.677	.245	.001	.059
Preference Study 3	Both conditions (complex free-spins feature)	.685	.268	.001	0.57

**Note.* Mean proportion of spins on free-spins/bonus machines were compared to test statistic of .5.*

Appendix E

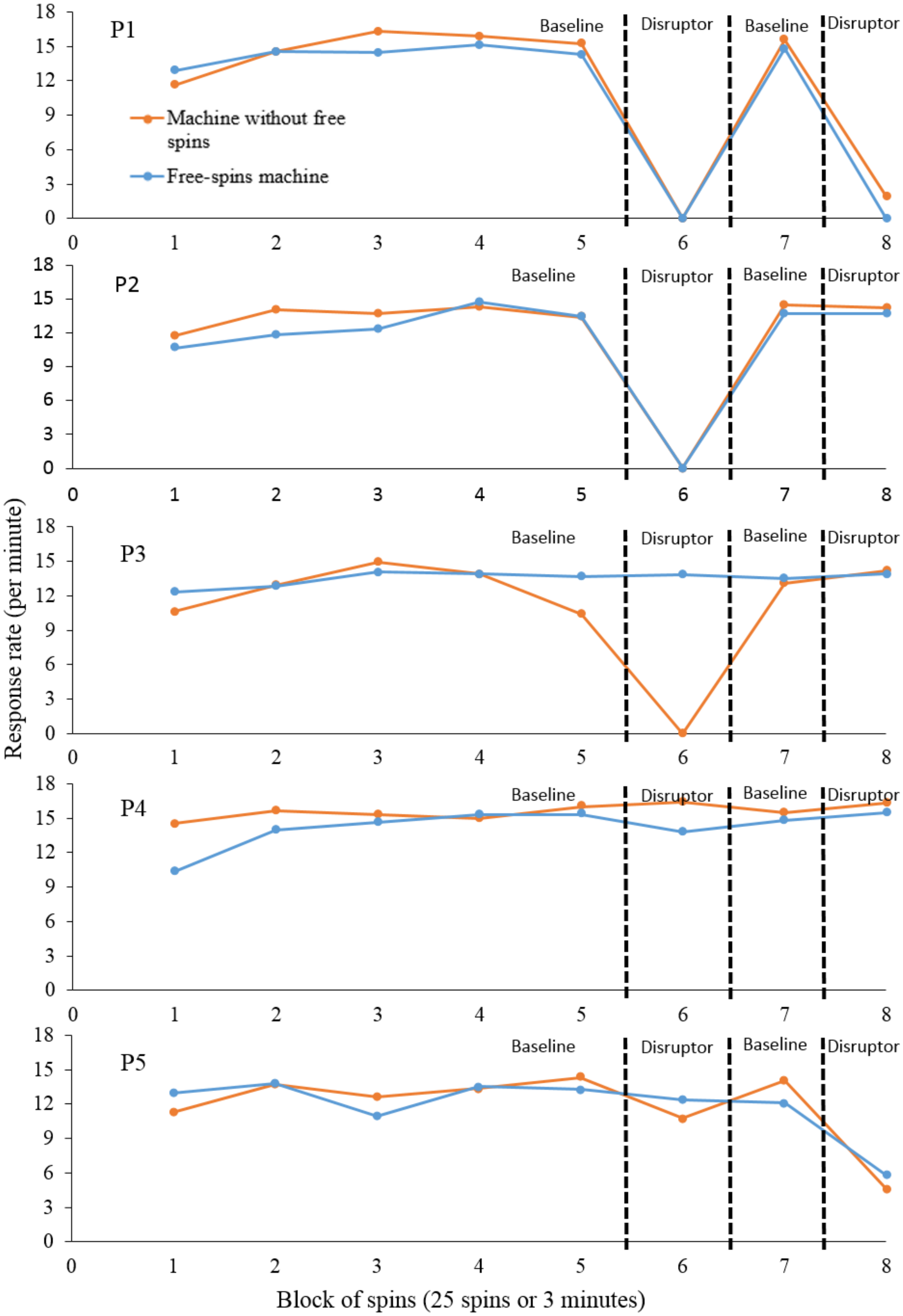


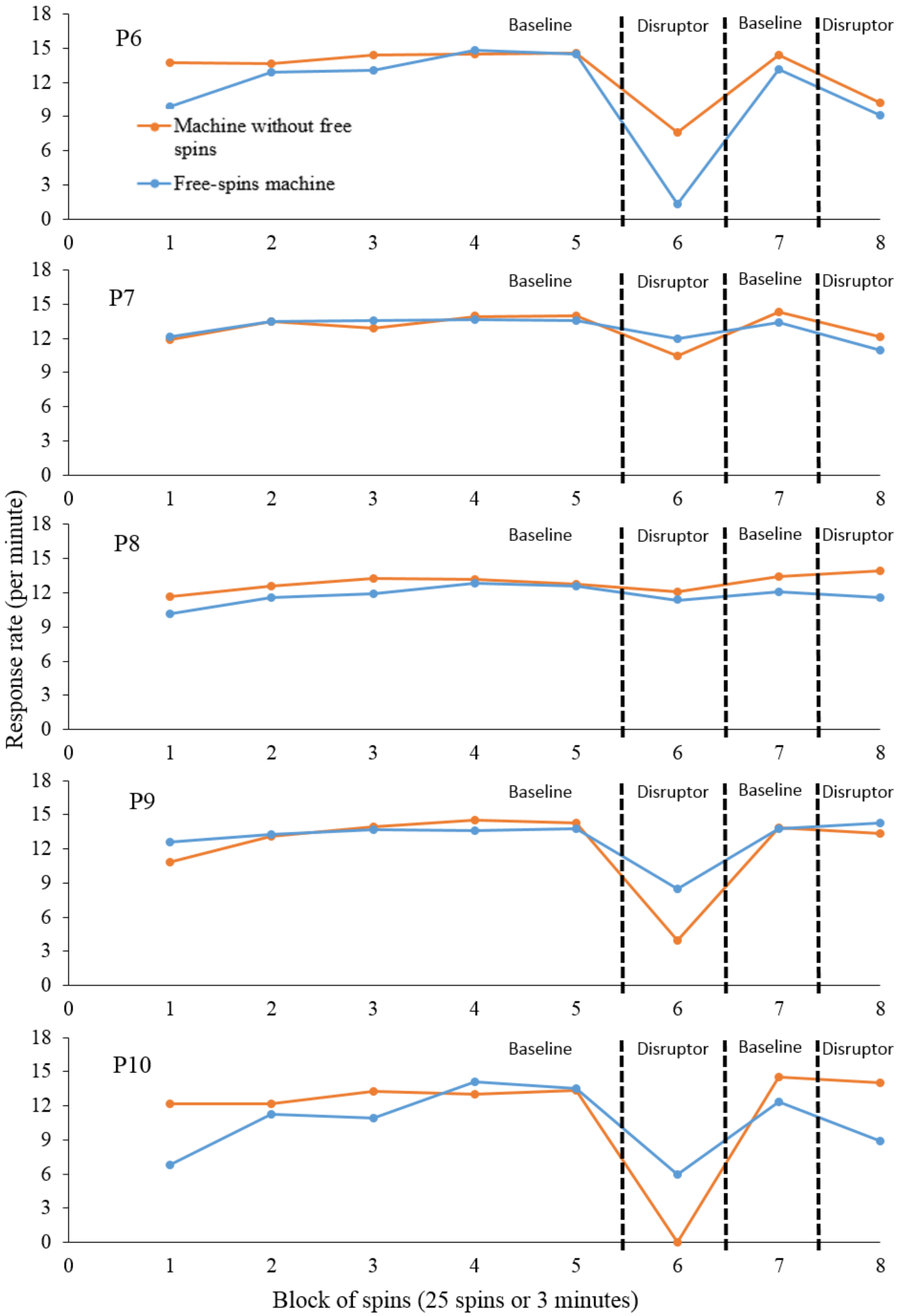
Mean proportion of latencies in bin
P1
P2
P3
P4
P5
P6
P7
P8
P9
P10
P11
P12
P13
P14
P15
P16
0.6
0
0
2000
4000
Latency (ms) 250ms bins

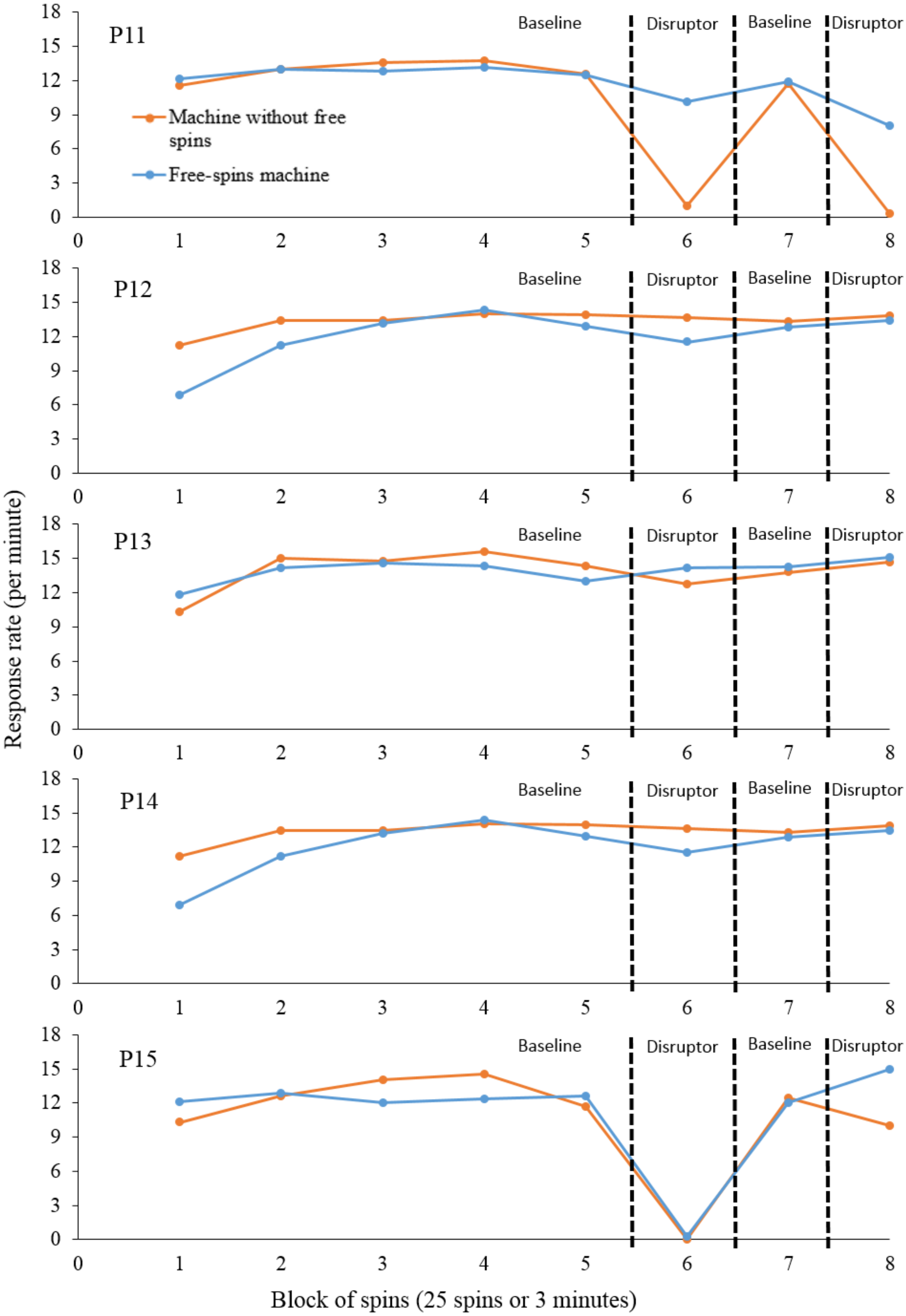


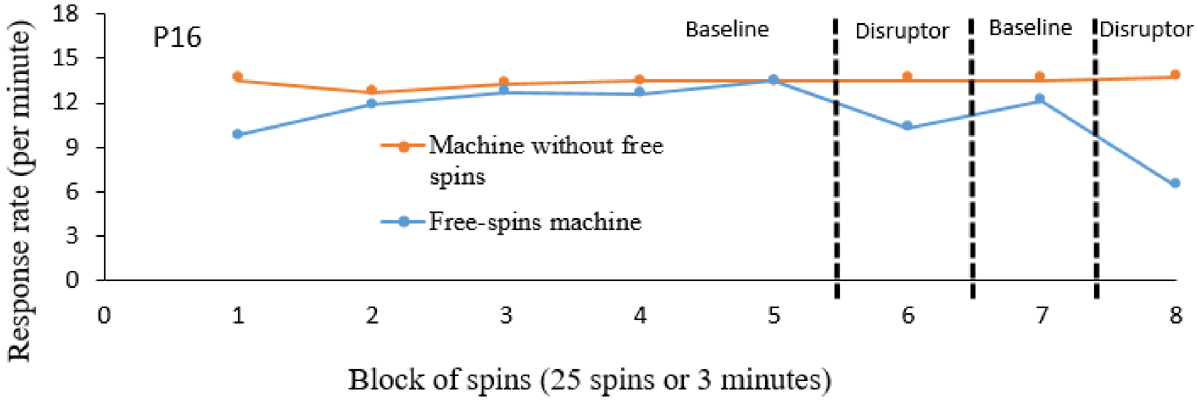
Frequency distributions of response latencies made by participants following various outcomes in Experiment 1 of Preference Study 2. The y-axis displays the mean proportion of a participant's latencies that fell in a bin, the x-axis displays latency in 250ms bins. Distributions to the left indicate less time taken to respond following an outcome, distributions to the right indicate more time taken to respond.

Appendix F


P1
P2
P3
P4
P5
Machine without free spins
Free-spins machine
Baseline
Disruptor
Baseline
Disruptor
Response rate (per minute)
Block of spins (25 spins or 3 minutes)

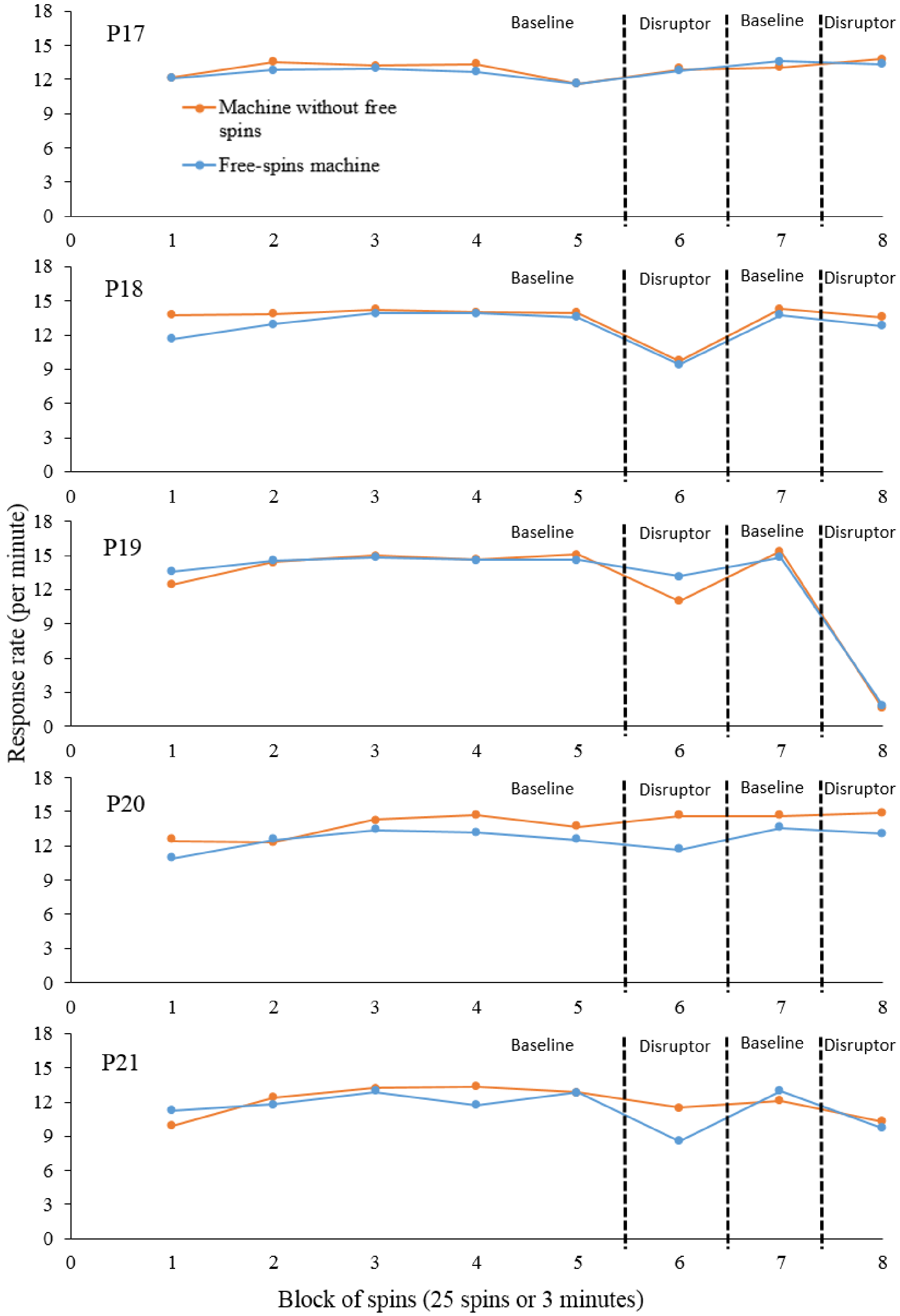

P6
P7
P8
P9
P10
Baseline
Disruptor
Baseline
Disruptor
Machine without free spins
Free-spins machine
Response rate (per minute)
Block of spins (25 spins or 3 minutes)
0
3
6
9
12
15
18
0
1
2
3
4
5
6
7
8


P11
P12
P13
P14
P15
Baseline
Disruptor
Baseline
Disruptor
Machine without free spins
Free-spins machine
0
3
6
9
12
15
18
0
1
2
3
4
5
6
7
8
Response rate (per minute)
Block of spins (25 spins or 3 minutes)

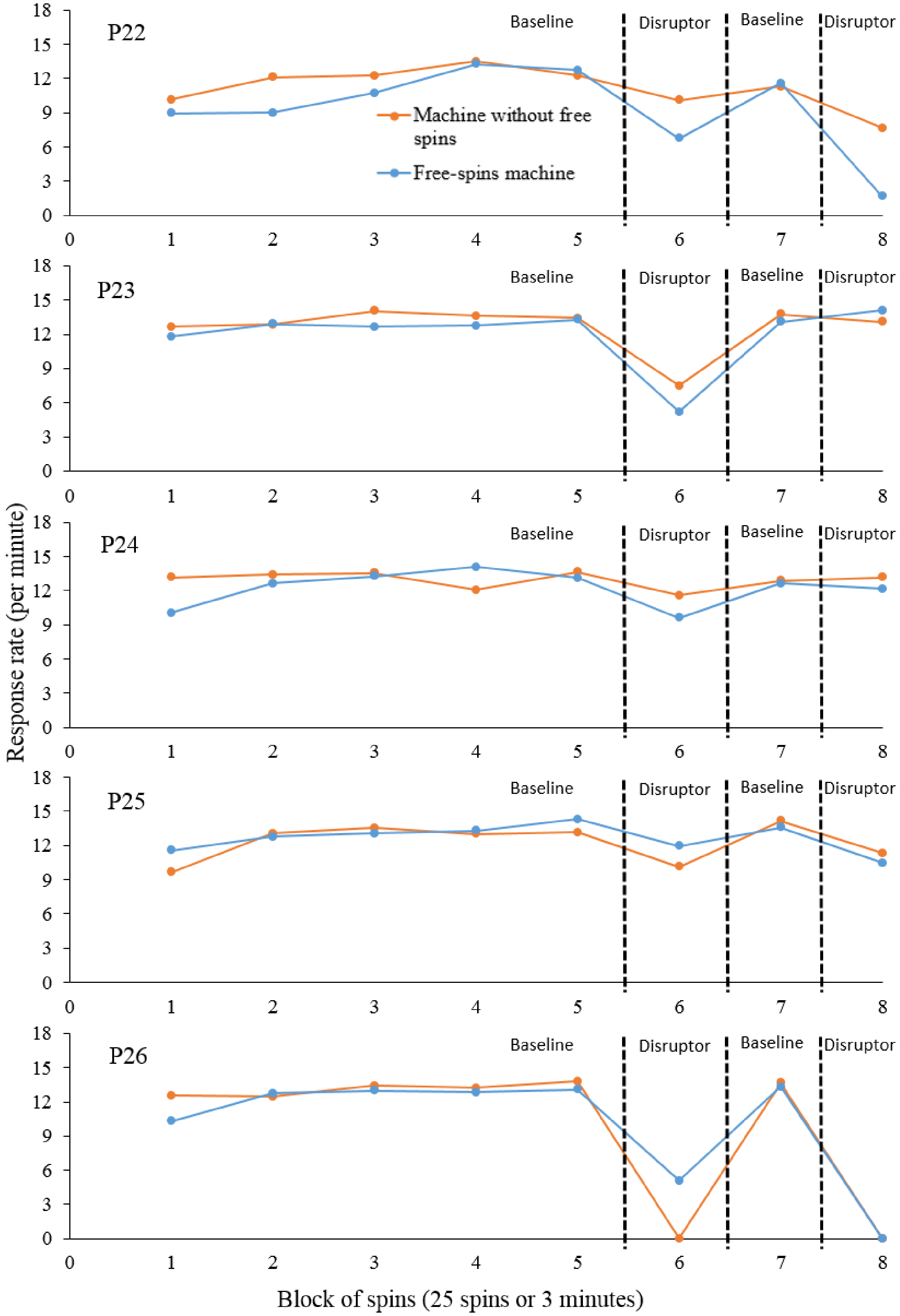


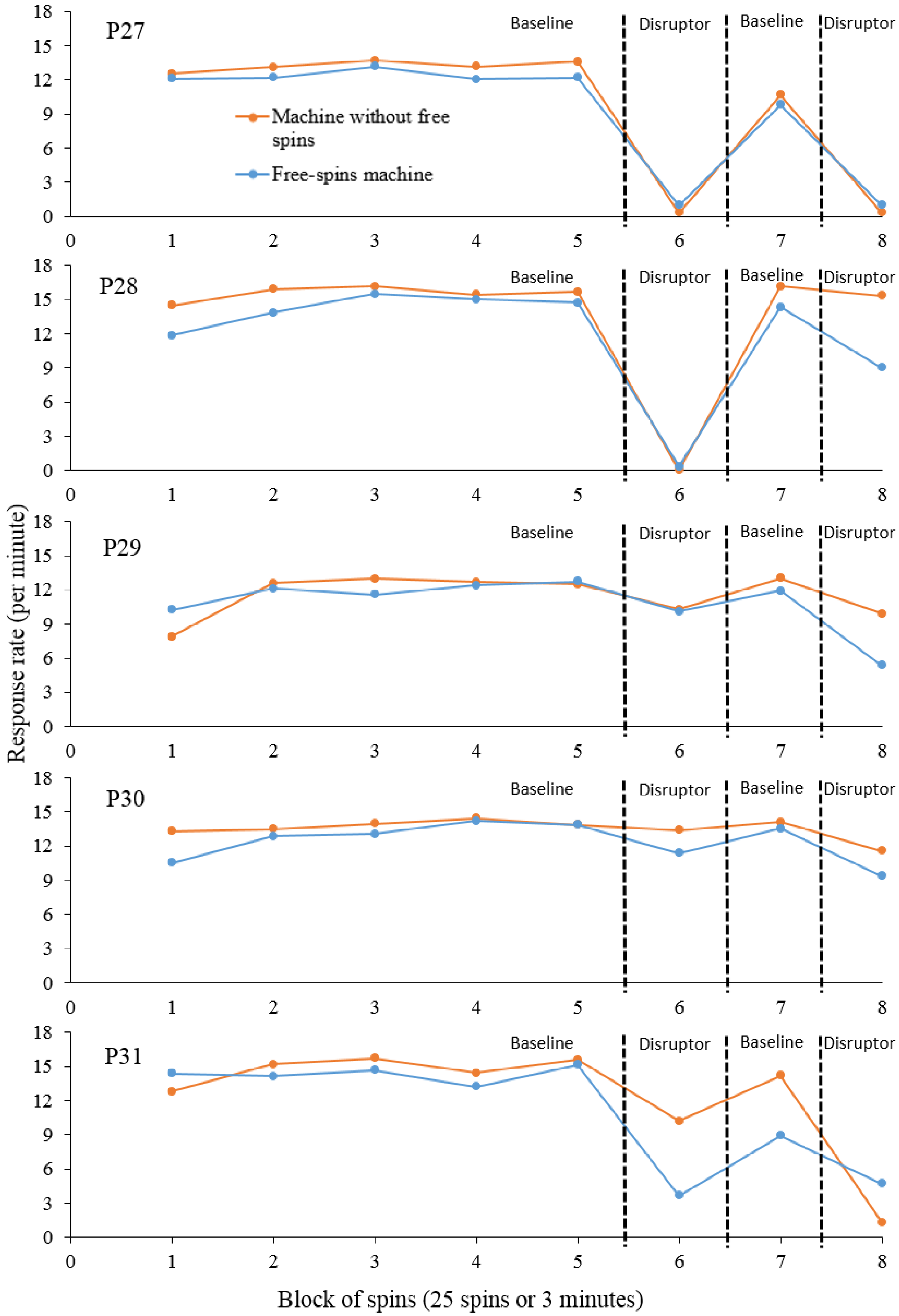
Condition One participants’ response rates per minute across all blocks of the experiment in Persistence Study 1. Blue lines display response rates on the free-spins machine, orange lines display response rates on the machine without free spins. Periods where the disruptor videos were available are marked by vertical reference lines. Even numbered participants were first exposed to the free-spins machine, while odd numbered participants were first exposed to the control machine.

Appendix G

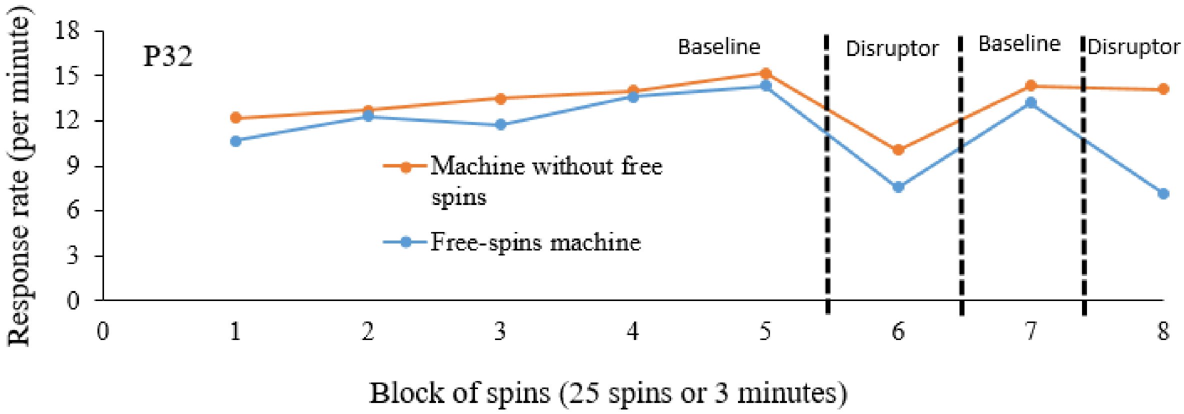


P17
P18
P19
P20
P21
Baseline
Disruptor
Machine without free spins
Free-spins machine
Response rate (per minute)
Block of spins (25 spins or 3 minutes)


P22
P23
P24
P25
P26
Baseline
Disruptor
Baseline
Disruptor
Machine without free spins
Free-spins machine
Response rate (per minute)
Block of spins (25 spins or 3 minutes)

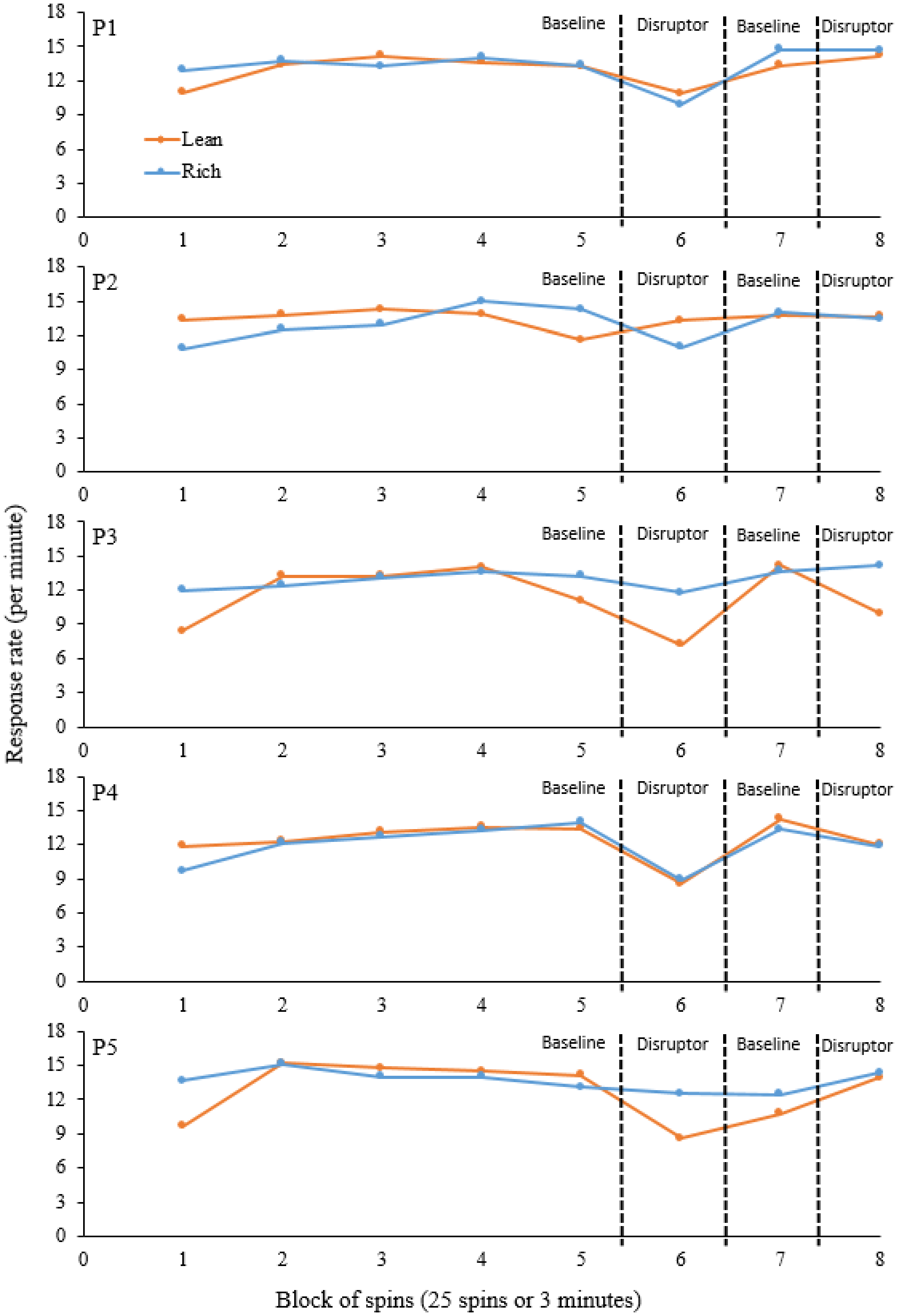


P27
P28
P29
P30
P31
Baseline
Disruptor
Baseline
Disruptor
Machine without free spins
Free-spins machine
Response rate (per minute)
Block of spins (25 spins or 3 minutes)

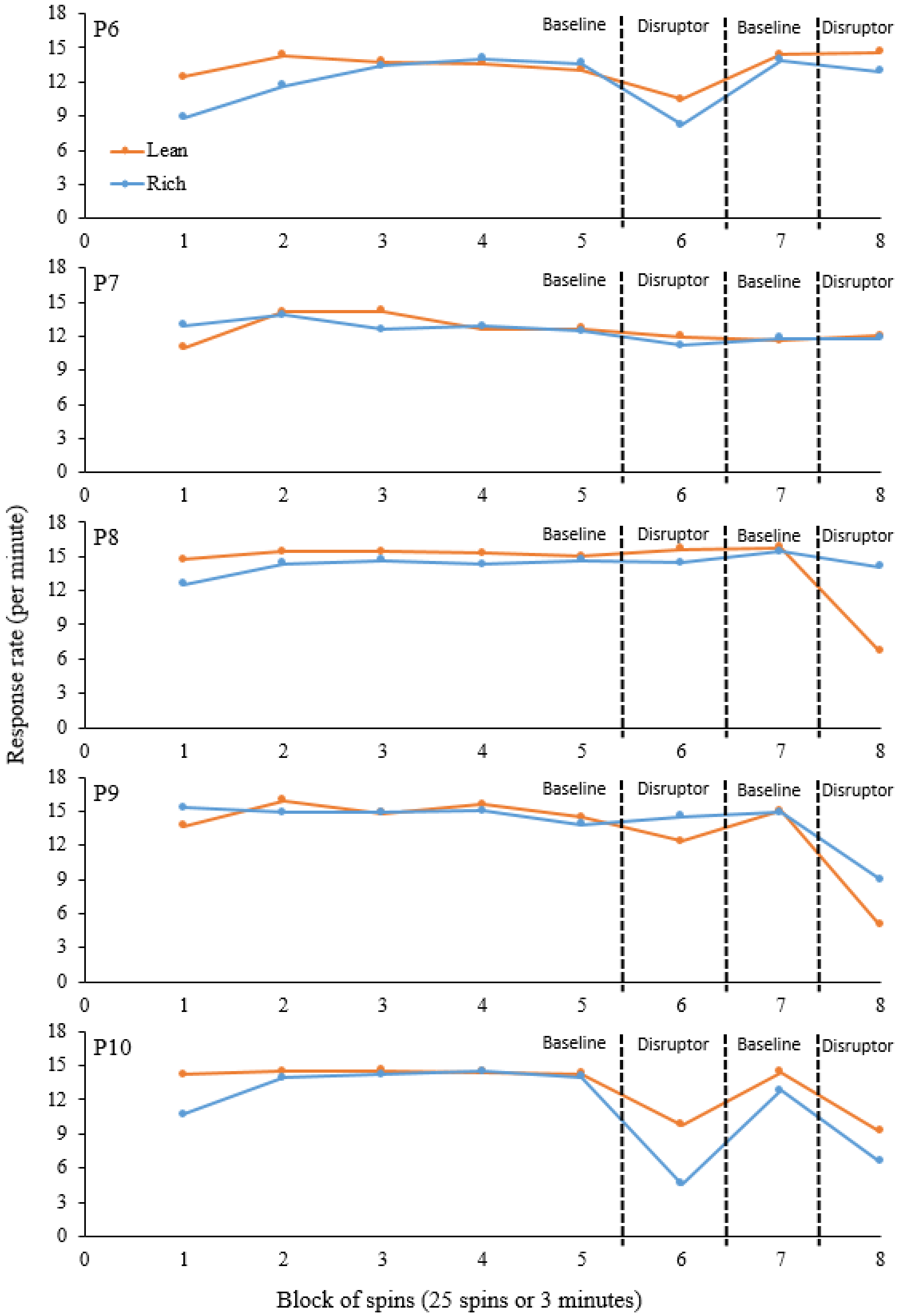


Condition Two participants' response rates per minute across all blocks of the experiment in Persistence Study 1. Blue lines display response rates on the free-spins machine, orange lines display response rates on the machine without free spins. Periods where the disruptor videos were available are marked by vertical reference lines. Even numbered participants were first exposed to the free-spins machine, while odd numbered participants were first exposed to the control machine.

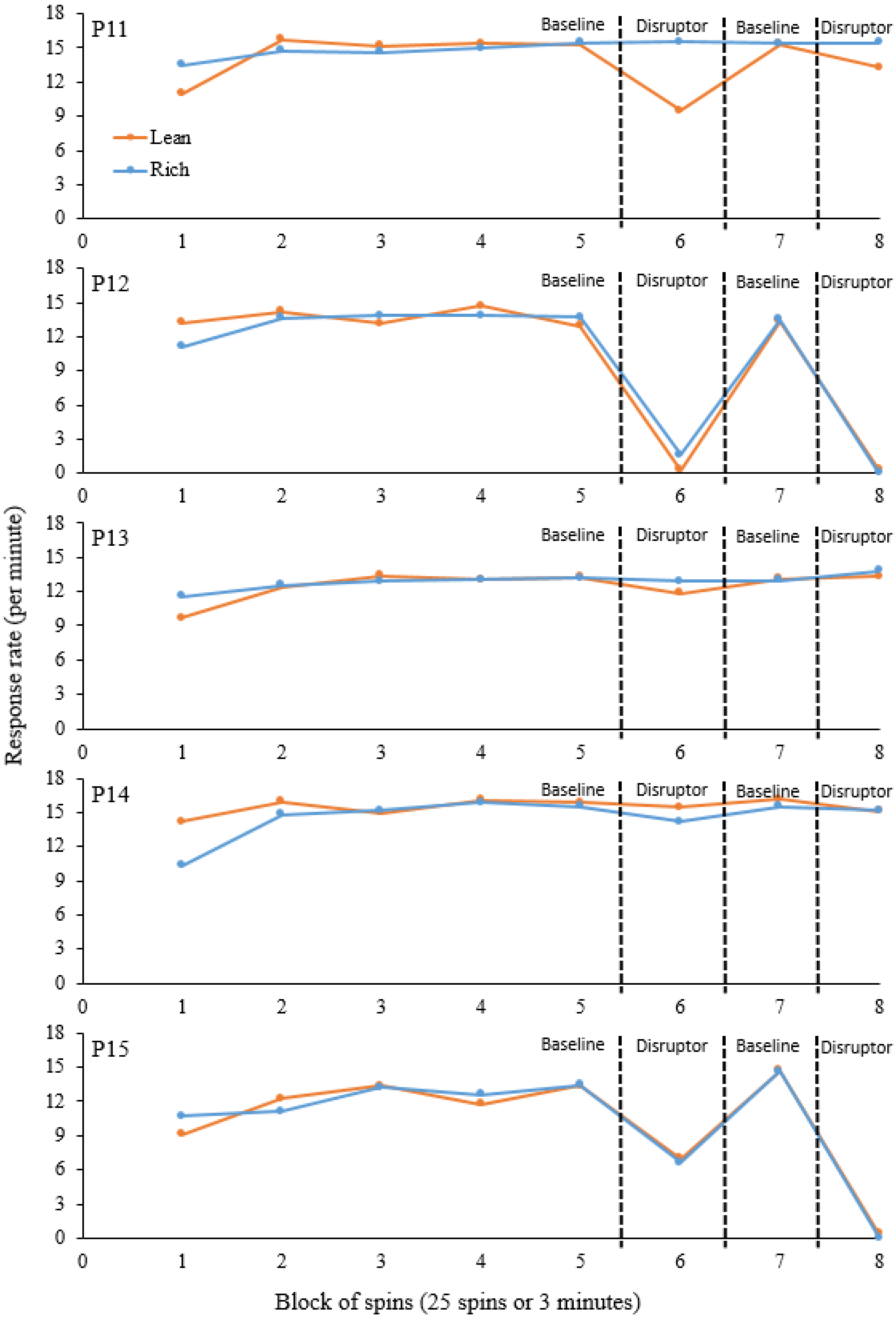
Appendix H

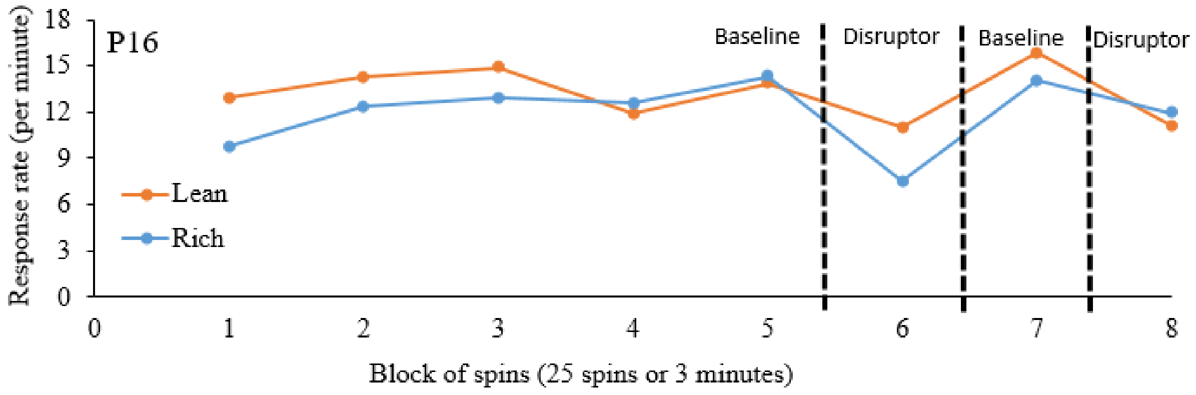


P1
P2
P3
P4
P5
Baseline
Disruptor
Lean
Rich
Response rate (per minute)
Block of spins (25 spins or 3 minutes)



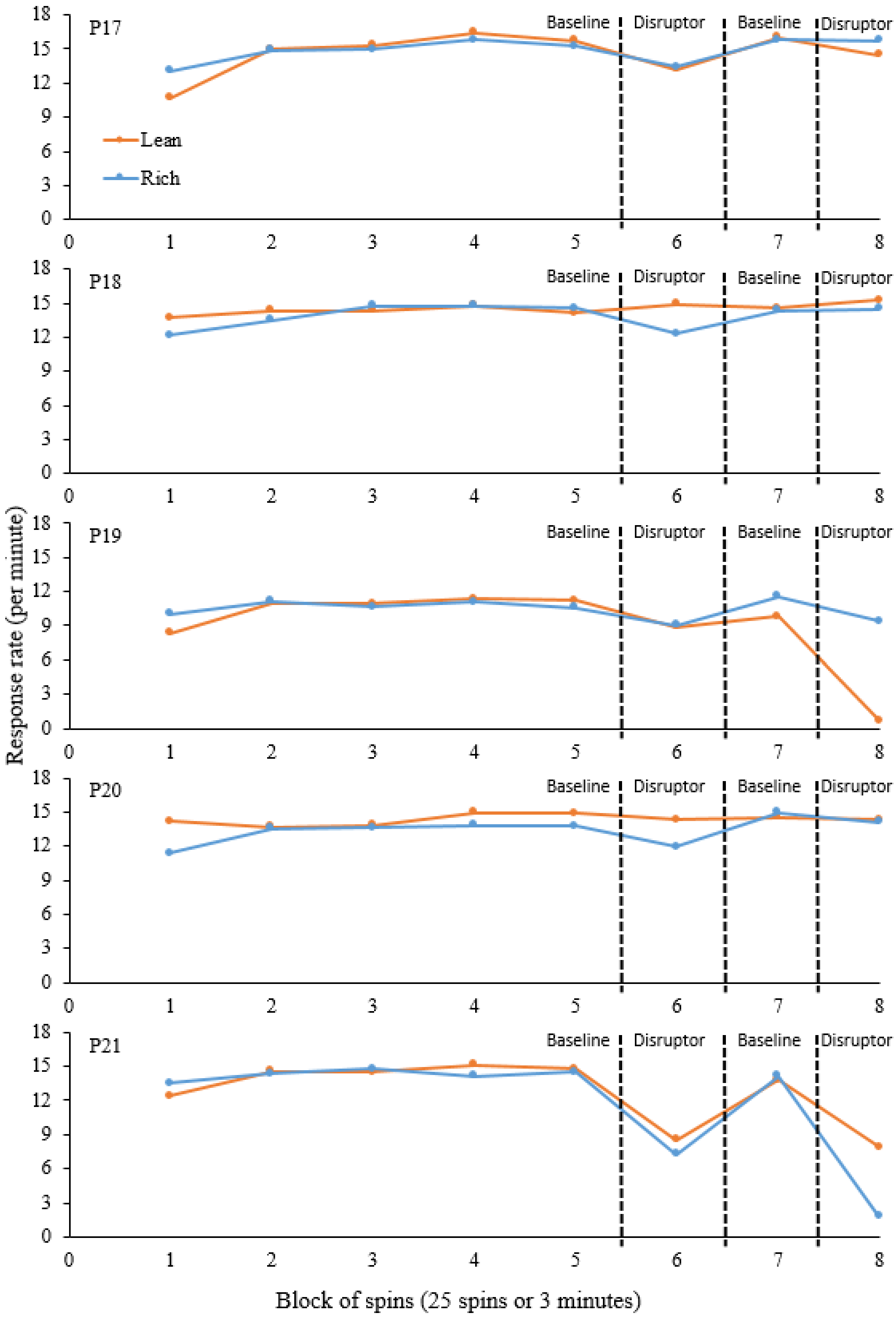
Response rate (per minute)
P6
Baseline
Disruptor
Baseline
Disruptor
Lean
Rich
P7
P8
P9
P10
Block of spins (25 spins or 3 minutes)


P11
P12
P13
P14
P15
Baseline
Disruptor
Baseline
Disruptor
Lean
Rich
Response rate (per minute)
Block of spins (25 spins or 3 minutes)

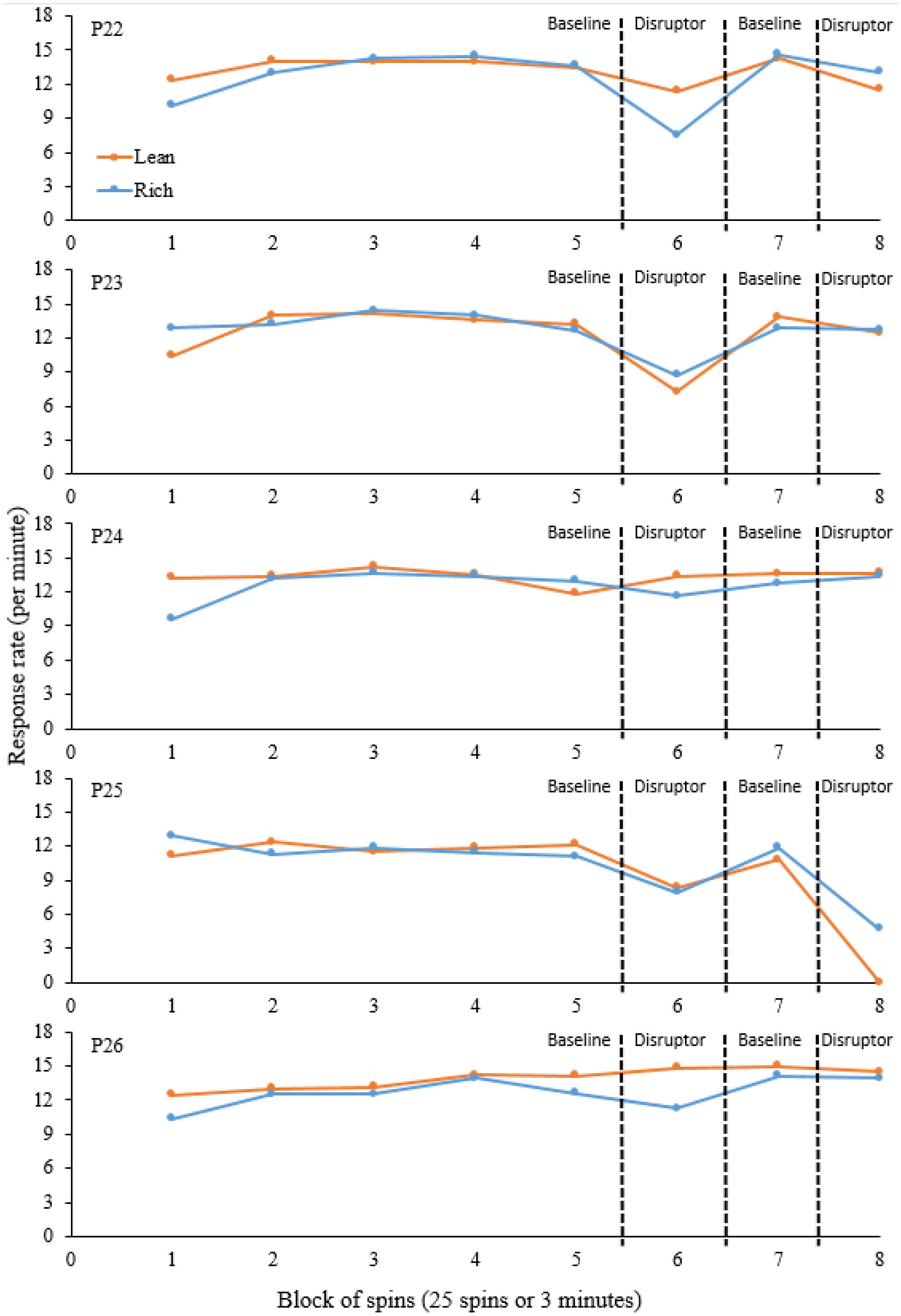


Condition One participants' response rates per minute across all blocks of the experiment in Persistence Study 2. Blue lines display response rates on the rich machine, orange lines display response rates on the lean machine. Periods where the disruptor videos were available are marked by vertical reference lines. Even numbered participants were first exposed to the rich machine, while odd numbered participants were first exposed to the lean machine.

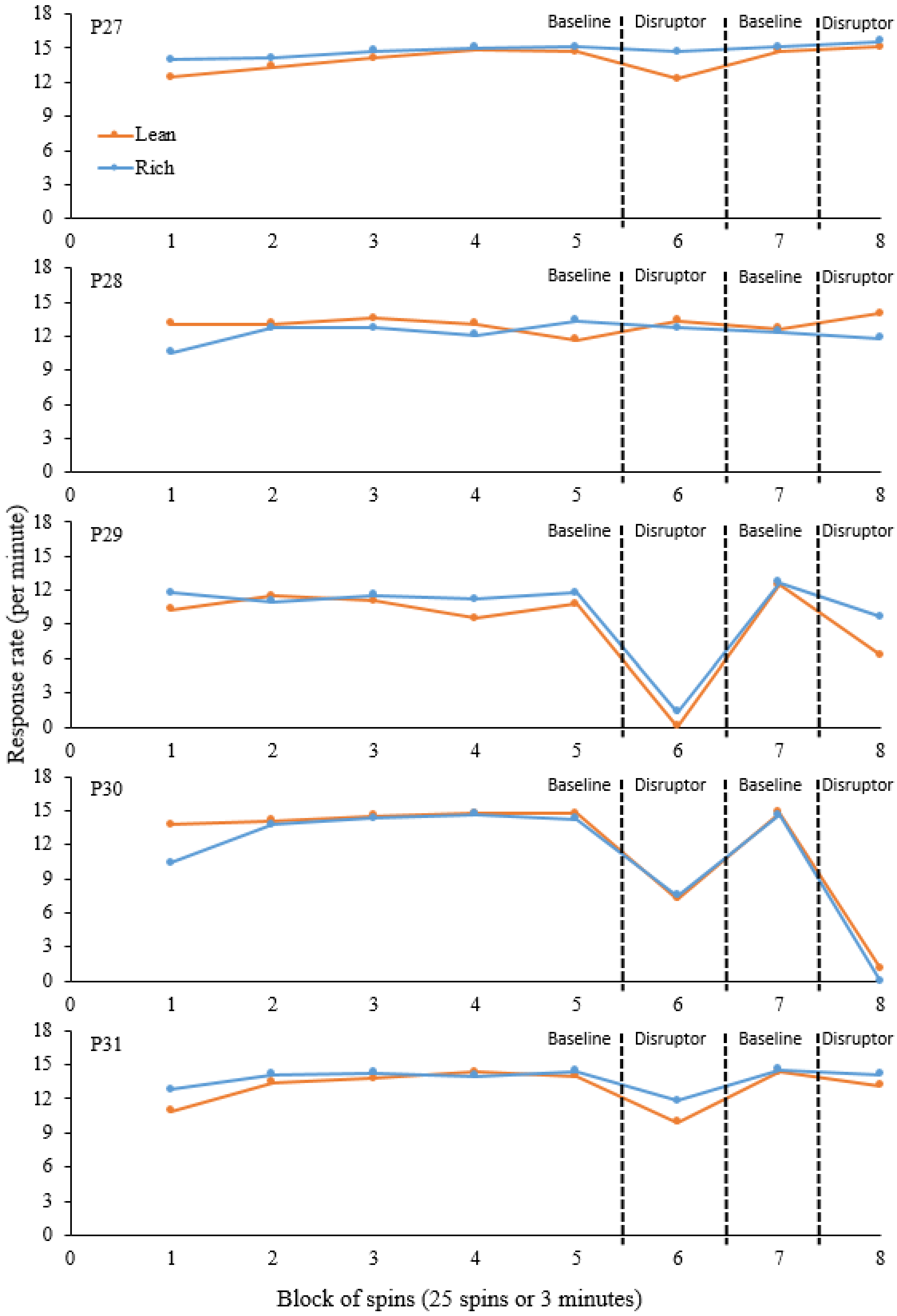
Appendix I



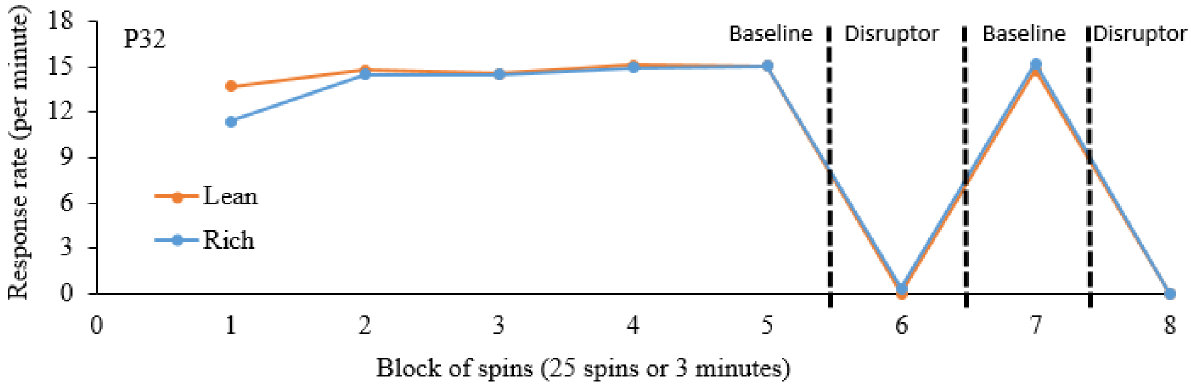
P17
P18
P19
P20
P21
Lean
Rich
Baseline
Disruptor
Baseline
Disruptor
Response rate (per minute)
Block of spins (25 spins or 3 minutes)



P22
P23
P24
P25
P26
Baseline
Disruptor
Baseline
Disruptor
Lean
Rich
Response rate (per minute)
Block of spins (25 spins or 3 minutes)
0
3
6
9
12
15
18
0
1
2
3
4
5
6
7
8



P27
P28
P29
P30
P31
Baseline
Disruptor
Lean
Rich
Response rate (per minute)
Block of spins (25 spins or 3 minutes)



Condition Two participants' response rates per minute across all blocks of the experiment in Persistence Study 2. Blue lines display response rates on the rich machine, orange lines display response rates on the lean machine. Periods where the disruptor videos were available are marked by vertical reference lines. Even numbered participants were first exposed to the rich machine, while odd numbered participants were first exposed to the lean machine.