The Analysis of Gambling Behavior (AGB) is a peer-reviewed publication that contains original general interest and discipline specific articles related to the scientific study of gambling.

**EDITOR**
Mark R. Dixon  
*Southern Illinois University*

**ASSOCIATE EDITOR**
Jeffrey N. Weatherly  
*University of North Dakota*

**EDITORIAL BOARD MEMBERS**

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jennifer Austin</td>
<td>University of Glamorgan</td>
</tr>
<tr>
<td>Andrew Brandt</td>
<td>Albion College</td>
</tr>
<tr>
<td>Edmund Fantino</td>
<td>University of California, San Diego</td>
</tr>
<tr>
<td>James W. Jackson</td>
<td>Southern Illinois University</td>
</tr>
<tr>
<td>Charles A. Lyons</td>
<td>Eastern Oregon University</td>
</tr>
<tr>
<td>Richard Malott</td>
<td>Western Michigan University</td>
</tr>
<tr>
<td>Cynthia J. Pietras</td>
<td>Western Michigan University</td>
</tr>
<tr>
<td>Lewis Bizo</td>
<td>Southern Cross University</td>
</tr>
<tr>
<td>Andrew Cooper</td>
<td>University of Wales, Swansea</td>
</tr>
<tr>
<td>Patrick M. Ghezzi</td>
<td>University of Nevada</td>
</tr>
<tr>
<td>Eric A. Jacobs</td>
<td>Southern Illinois University</td>
</tr>
<tr>
<td>Otto H. MacLin</td>
<td>University of Northern Iowa</td>
</tr>
<tr>
<td>Nancy Petry</td>
<td>University of Connecticut</td>
</tr>
<tr>
<td>Bryan Roche</td>
<td>National University of Ireland, Maynooth</td>
</tr>
</tbody>
</table>

**Content of the Analysis of Gambling Behavior**

The Analysis of Gambling Behavior (AGB) contains general interest and discipline specific articles related to the scientific study of gambling. Articles appropriate for the journal include a) full-length research articles, b) research reports, c) clinical demonstrations, d) technical articles, and e) book reviews. Each category is detailed below along with submission guidelines:

**Research Articles** – a manuscript of full length (20-30 double-spaced pages), which may contain multiple experiments, and are original contributions to the published literature on gambling.

**Research Reports** – a manuscript of reduced length (no more than 10 double-spaced pages and a single figure or table page), which may be less experimentally rigorous than a Research Article, a replication of or failure to replicate a prior published article, or pilot data that demonstrates a clear relationship between independent and dependent variable(s). The Results and Discussion sections of Reports should be combined.

**Clinical Demonstrations** – a manuscript of reduced length (no more than 8 double-spaced pages and a single figure or table page) which lack the rigor of a true experimental design, yet do demonstrate behavior change of persons with gambling disorders under clinical care. This manuscript should contain an Introduction, Methods/Treatments, Results, and Discussion sections. The Results and Discussion sections of Clinical Demonstrations should be combined.

**Technical Article** – a manuscript of either full or reduced length, depending on necessity, that describes either a new technology available that would be of interest to researchers or a task-analysis style description of how to utilize existing technology for the conducting of research. Examples of appropriate topics may include, but are not limited to, the rewiring of a slot machine for the collection of data or controlling of win/losses, how to use computer software to simulate a casino game, or the way in which neuroimaging devices may interfaced with an experimental apparatus.

**Book Review** – a review of a contemporary book related to gambling not more than three years after the publication data of the book to be reviewed. The review should be no more than 15 double-spaced pages in length.
## Contents

Dixon, M.R.  Delay discounting and pathological gambling  

### Discussion Article

Fantino, E. and Stolarz-Fantino, S.  Gambling: Sometimes unseemly; Not what it seems  

### Commentaries

Catania, A. C.  Gambling, shaping and ratio contingencies  
Potenza, M. N.  Understanding gambling, impulsivity, and decision-making: Self-report and behavioral considerations  
Dymond, S.  Approaching gambling as a verbal event: A commentary on Fantino & Stolarz-Fantino (2008)  
Weatherly, J. N.  Gambling: not what it may seem to be  
Derevensky, J. L.  Simple solutions to complex phenomena: Not in the cards  
DeLeon, I. G.  What else might we ask?: Commentary on Fantino and Stolarz-Fantino’s “Gambling: Sometimes unseemly; Not what it seems”  
Madden, G. J.  Discounting within the gambling context  
Hantula, D. and Puvathingal, B.  The important contingencies in gambling are seldom clear: Avoiding the rational choice trap  
Lyons, C. A.  Seeming to gamble: Commentary on Fantino and Stolarz-Fantino’s “Gambling: Sometimes unseemly; Not what it seems”  
Hayes, L. J.  Classes and instances: Commentary on Fantino & Stolarz-Fantino  
Ghezzi, P. M.  Further directions for gambling research  
Borrero, J. C.  Gambling and risky choice  
Arntzen, E.  On the role of verbal behavior in understanding gambling behavior  
Ninness, C. and Ninness, S.  Gambling, problem-solving, and the contingencies of superstition: A response to Fantino & Stolarz-Fantino  

### In Response

Fantino, E. and Stolarz-Fantino, S.  Response to commentaries  

### Research Article

Dillen, J. and Dixon, M. R.  The impact of jackpot and near-miss magnitude on rate and subjective probability of slot machine gamblers  

### Research Reports

Meier, E. and Weatherly, J. N.  The effects of nicotine on gambling behavior of smoking and nonsmoking undergraduate students  
Bordieri, M., Bordieri, J., and Dixon, M. R.  Video golf and gambling: The impact of monetary wagers on performance  

1A
DELAY DISCOUNTING AND PATHOLOGICAL GAMBLING

Mark R. Dixon
Southern Illinois University

Over the past decade behavior analysts have paid increasing attention to the clinical phenomena of pathological gambling. Explorations have varied from animal models to therapeutic interventions. Perhaps no topic has received greater attention in the behavioral gambling literature than the discounting of delayed consequences. Delay discounting has been noted as both a conceptual framework to understand problem gambling as well as a dependent variable by which to deduce level of pathology. Regardless of hypothesized process, discounting appears to be a topic of great interest to those within the behavioral community. This special section of the Analysis of Gambling Behavior brings together a theoretical account of problem gambling from Fantino and Stolarz-Fantino as well as fourteen commentaries from an impressive list of authors within and beyond the traditional bounds of behavior analysis. Together these articles highlight the wide range of perspectives on the causes of pathological gambling, as well as how delay discounting fits within such causal mechanisms.

Keywords: Pathological gambling, discounting, addiction, choice making

OVERVIEW OF DELAY DISCOUNTING

When given the opportunity to select between two alternatives of equal value yet delivered at different intervals in time, the choices made by most of us appear rational. Everything else being equal, we would rather have the same outcome delivered sooner rather than later. Take for example 1000 dollars. If offered either today or next week, it is safe to assume that most of us would rather have it now than later. If the week was delayed even further in time, to say, 1 year, odds are still good that most of us would continue to prefer the immediate alternative. However, when both the amount of the alternative varies as well as the delay to delivery, our behavior tends to not be so predictable. If we are faced with 500 dollars now or 1000 in a week, all bets are off. Perhaps we need to get our car fixed, pay rent, or buy groceries today. Even though we know that 1000 dollars are more than 500 dollars, time and the activities found within may dictate which outcome is critical for us to choose.

For the past 20 years, many researchers have explored the choices we make under similar conditions to those described above. Varying amounts of money are posed against each other, often at varying delays. Interestingly, what appears to remain clear across the myriad of studies that have been published on delay discounting is that as time to gain access to an outcome/reward increases, we appear to prefer smaller sooner rewards. While disadvantageous to select smaller immediate rewards, increased delays produce increased “discounting.” Populations that have been investigated range from children with brain injuries (Dixon et al., 2005), smokers (Reynolds, Richards, Horn, & Karraker, 2003), drug users (Heal, Johnson, Higgins, & Bickel, 2005), over-eaters (Weller, Cook, Avsar, & Cox, 2008), and pathological gamblers (Dixon, Marley, & Jacobs, 2003).

Address Correspondence to:
Mark R. Dixon
Behavior Analysis and Therapy Program
Rehabilitation Institute
Southern Illinois University
Carbondale, IL 62901
E-mail: mdixon@siu.edu
Interestingly, most clinical populations appear to “discount” at greater rates than matched control (i.e. non-clinical) populations.

**DISCOUNTING AS A CONTRIBUTING FACTOR FOR GAMBLING**

It has been noted by some in behavior analysis that individuals who discount delayed rewards, may in fact be more prone to gambling (Weatherly, Derenne, & Chase, 2008; Weatherly & Dixon, 2007; Madden, this issue). Here a relationship is assumed to some degree that if an individual possesses a behavioral repertoire of making choices for smaller immediate reinforcers, then in fact, they may display such impulsive choice making when it comes to gambling. They may gamble longer, may risk more money, or both. Preliminary data attempting to correlate discounting with various risk-factors for pathological gambling have failed to find a relationship (e.g. Weatherly, Derenne, & Chase, 2008). However, direct comparisons of gambling activity between high and low discounting persons have yet to be conducted.

Conceptualizing delay discounting as a participating factor that modulates problem gambling suggests at least a degree of belief that discounting is a static trait of an individual, rather than a transient state. Researchers study various clinical “groups” and compare them to non-clinical comparisons. Such an approach, and assumption of the stable nature of discounting, should be questioned. Recent evidence suggests that discounting of pathological gamblers can be increased or decreased via psychological conditioning (Dixon & Holton, in press) as well as be sensitive to changes in context alone (Dixon, Jacobs, & Sanders, 2006). In short, the debate on the stability of a pattern or degree of discounting within an individual remains open to further exploration.

**DISCOUNTING AS A DEPENDENT MEASURE OF GAMBLING SEVERITY**

In contrast to the position that a person’s history of discounting may in fact be a cause for their problems with gambling, it is also possible that one’s severity of problems with gambling could be measured by their degree of delay discounting. While the difference in perspectives may initially seem trivial, it should not be. Widespread gambling severity and screening assessments are plagued with problems ranging from minimal or no psychometric properties to high levels of social desirability. If asking someone that is not interested in seeking treatment “Have you ever worried that you spend too much money on gambling?” a negative response is sure to emerge. However, ask that same question to someone seeking treatment, and a response “Yes” is quite predictable. When the two people are clearly spending a large proportion of their time and money on gambling, and such activity is yielding no positive financial return, objectively the two people are equal. Yet, they answer differently to a question designed to screen them for pathological gambling. Maybe some of our popular screening tools are more accurately depicting remorse about gambling than actual behavior. Perhaps it would be better to evaluate severity in more discrete ways that do not assume evaluations of the behavior but in fact simply measure the behavior itself. Choice making among financial alternatives, and the rates of discounting that emerge, may be a possible alternative strategy to evaluate gambling severity. To date, initial explorations appear positive (Alessi & Petry, 2003), and more research is clearly warranted.

**WHERE DO WE GO FROM HERE?**

The paper by Fantino and Stolarz-Fantino presents a behavioral conceptualization of the causes of pathological gambling and how the basic processes of gamblers, and the decisions
that they make, can be approached from a functional perspective. The authors review a number of foundational laboratory research investigations that have shaped their view on pathological gambling. They conclude with a position that delay discounting plays an important role in understanding why someone might be prone to gambling more than they should. However, discounting alone is not where they believe we find the answer. Instead a dynamic interaction of direct contingencies, verbal behavior, and social influences participate in the eventual act of gambling according to the authors. It is only in such complexity that the true answer to the mystery of gambling addiction shall emerge.

The fourteen commentaries that follow Fantino and Stolarz-Fantino’s paper are as rich in content as they are diverse. Ranging from enthusiastic support to considerable doubt, these authors present fascinating interpretations of the most critical features for investigating pathological gambling. It is the intention that this special section of the Analysis of Gambling Behavior will serve as a stimulus for future research, hypothesis testing, and collaborative investigations at all levels of inquiry related to pathological gambling. From animal models and neuroscience to basic operant experimentation and clinical intervention, much work needs to be done. Thus, I present to you the special section on Delay Discounting in this issue of the Analysis of Gambling Behavior.

REFERENCES


Madden, (2008). Discounting within the gambling context. Analysis of Gambling Behavior, …


GAMBLING: SOMETIMES UNSEEMLY; NOT WHAT IT SEEMS

Edmund Fantino and Stephanie Stolarz-Fantino
University of California San Diego

Gambling offers opportunities for basic research and theory, and has hugely important applied implications. As Fantino (2008) said recently, “The current view of pathological gambling as an addiction cries out for a functional analysis of the controlling variables and for strategies of behavioral intervention.” This view echoed that of Dixon (2007) who called out for behavior analysts to apply their very relevant skills to discovering the causes of gambling disorders. To understand the behavior of gambling, one must understand the basic processes and variables involved in making the decisions gamblers make. Behavior analysts, those experimental psychologists who approach psychological phenomena from a behavioral (or functional) perspective, have long concentrated on the choices organisms make. Thus, they should be in a strong position to contribute to our appreciation of the factors controlling gambling. In this paper we will examine some of the advances already made, and also propose some directions for future research.

Keywords: Gambling, decision-making, behavior analysis, self-control.

First, we briefly review some contributions behavior analysts have made towards understanding gambling. Then we turn to our main focus, the role of discounting in decision-making with an emphasis on its relevance for gambling. As Fantino, Navarro, and O’Daly (2005) have noted, many basic principles in the learning literature can be applied in a straightforward manner to explain the acquisition, maintenance, and durability of addictive behaviors such as compulsive gambling (including superstitious behavior, the partial-reinforcement effect, and behavioral persistence). They point out the critical role played by accurate discriminative stimuli in encouraging optimal and rational decision-making. In most cases, choices become more optimal under conditions in which the true contingencies and probabilities governing the outcomes are made more transparent. Conversely, when the true contingencies are disguised, as they are in some gambling situations, players may be led to make less-than-optimal decisions. For example, Ladouceur and Sévigny (2005) found that subjects persisted longer in playing a video lottery game when they believed that pressing the screen activated a “stopping device” that made the reels stop spinning. This gave players the illusion of control over outcomes; in reality, the outcomes were pre-programmed and the device had no effect.

SALIENCE OF CONTINGENCIES

Research on well-known failures of rational decision-making such as probability matching and the sunk-cost effect (for probability matching, see Fantino & Esfandiari, 2002; and Benhsain, Taillefer, & Ladouceur, 2004; for the sunk-cost effect, see Navarro & Fantino, 2005) show that providing transparent cues to the prevailing contingencies makes behavior more optimal. We illustrate with experiments on the sunk-cost effect, a type of behavioral persistence in which the subject persists in a non-optimal course of action. Navarro & Fantino (2005) placed pi-
geons individually in an operant chamber in which they could peck either of two keys: a "reward" key colored white, or an “escape” key displaying a white ‘X’. College students were faced with a corresponding task on a computer console. For a large number of trials, the subjects had to peck (or press) the reward key an unknown number of times until they received a reward. At any time they could respond on the escape key to cancel the current trial and initiate a new one. A new trial began either after a peck to the escape key or after a reward (i.e., food for the pigeon, points for the college student). The reward key modelled a course of action gone awry: it offered a diminishing chance of reward as responses incremented. In other words, as subjects responded without getting a reward, the amount of work remaining for reward became increasingly large. A subject's optimal strategy was to escape after 10 non-rewarded responses to the reward key. Navarro & Fantino made the advantage of escaping more salient in each of two ways with pigeons and in the second of these two ways with the college students. First, they manipulated whether or not discriminative stimuli were present on the reward key that were correlated with the average number of responses remaining to reinforcement. In half of the conditions the same stimulus was always present on the reward key. In the other half of the conditions, discriminative stimuli signalled the pigeon's lack of progress. As expected, when discriminative stimuli were present, pigeons selected optimally. When the key light changed after 10 non-rewarded responses, the pigeon immediately selected the escape key, initiating a new trial. When the discriminative stimuli were absent, however, only one of four pigeons selected optimally. The remaining three pigeons consistently persisted in responding on the food key until food was ultimately (and arduously) obtained. Thus, this finding could be seen as a non-human analogue of the sunk-cost effect. Second, they created a situation in which there were no discriminative stimuli associated with the changing fortunes on the reward key, but in which the difference in conditions were more extreme than they had been in the prior experiment. The assumption was that if the value of escaping were sufficiently greater than the value of persisting, then subjects would learn to escape even without explicit discriminative stimuli. The results for both pigeons and college students supported this assumption (Navarro & Fantino, 2005).

Other examples of the sunk-cost effect may be explained, at least in part, because we have learned (and have been taught) not to be "wasteful". Indeed much non-optimal human decision-making may be traced to the misapplication of rules that under other circumstances promote adaptive behavior (see Fantino, 1998, for a discussion). That our histories affect persistence has been demonstrated by Goltz's research (e.g., Goltz, 1993, 1999). She has shown that people playing an investment game may tenaciously persist in a losing strategy if they have a history of reinforcement for persisting (as most of us have). In one study, Goltz (1992) exposed subjects to a variable reward history and others to a fixed reward history in which gains and losses strictly alternated (e.g., WLWLWL...). When the game changed so that all future investment decisions resulted in losses (a change that was not signalled to the subjects), those with the variable reinforcement histories persisted in placing investment bets far longer than those with the regular (“fixed”) reward histories. Results from other studies are also consistent with this conclusion that humans choosing in mock investment scenarios will more readily abandon a bad investment strategy when the value of persisting versus abandoning that strategy is made more salient. This of course raises the question: How salient are the contingencies in standard gambling situations?
SELF-CONTROL

In many cases gambling settings include precise odds telling the prospective players exactly what the probabilities of success are for each alternative, for example, odds or “betting lines” in most sports (one team favored by x points; a horse with one chance in three to win, etc.). The fact that a small share is taken by the bookmaker (or “the house”), while generally not emphasized, is certainly known to gamblers, especially experienced ones. The fact that the basic contingencies in much everyday gambling are salient suggests that additional factors are involved in the decision to gamble. In particular, there must be factors that help determine why most individuals do not gamble or do so without developing pathology, while others become compulsive gamblers. A key factor may be the way we react to immediate and delayed rewards, the issue of self-control versus impulsiveness. Many of society’s problems stem from a preoccupation with short-term gain. Perhaps this is most evident when considering crime. However, the dearth of self-control is manifest elsewhere. Consider the environment, where the pressures for practical immediate solutions to industrial and political problems may lead to decisions which make good sense in the short-term. For example, there may be more jobs, more housing, or lower taxes, but these may wreak havoc in the longer term, resulting in a poorer quality-of-life, higher rates of cancer, and a legacy of environmental problems.

Stock analysts and investors place tremendous emphasis on short-term earnings prospects, as revealed in a company's quarterly reports. Often there is risk in undertaking long-term restructuring of the corporation or in taking measures that, while costly now, would produce a stronger corporation five years in the future. The specter of a mediocre short-term outlook may trigger "sell" recommendations by analysts, eroding the investment of the shareholders. And the corporate leaders who make the decisions are usually the largest shareholders, in other words, the ones with the most to lose. Do the leaders of corporations fail to realize this? Don't they see that, ultimately, it is in the best interest of the corporation to adopt goals consistent with a longer-term perspective? Generally, they do, in the same way that a dieter knows that there is a greater long-term benefit in passing up an inviting slice of apple pandowdy. They know it in the same way that a smoker knows there is a greater long-term benefit in not lighting up. But the corporate leaders face the same pressures as the dieters and the smokers: The pressure to accept the immediately available short-term gain. Moreover, any given corporate leader may not be part of the same corporation five years later ... so, in economic terms, the benefit of the long-term gain to the corporation may be "discounted" somewhat by the possibility that long-term gains may not benefit the individual making the decisions.

Politicians face a host of comparable problems on a daily basis. For example, consider education. Money spent to better educate our youth should have tangible and dramatic positive effects on our society: With increased education our young will develop into adults who are fit for more skilled work positions which, in turn, will lead to reduction in crime and a more competitive economy. But the catch is that these benefits are many years away, whereas the costs are immediate. Also relatively immediate are the politicians’ re-election concerns. They may perceive—often correctly—that their re-election chances will be damaged by programs that cost the taxpayers’ money. Again, the bias is toward making decisions that increase the likelihood of short-term gains at the expense of greater long-term benefits. If, in confronting major economic, educational, and environmental problems, society—with all of its resources—often opts for small, short-term gains rather than the greater long-term gains, it is not sur-
prising to find that individuals make non-optimal choices when confronted with similar dilemmas.

DISCOUNT FUNCTIONS

If self-control can be viewed as underlying the maintenance of many non-adaptive behaviors, including addictive ones such as gambling, then discounting may be seen as a mechanism whereby impulsive behavior is justified. Consider discounting of rewards in terms of increasing (temporal) delays. For an individual with a very shallow temporal discounting function $100 five years from now is almost as good as $100 now. For an individual with a very steep temporal discounting function $100 five years from now may be of almost no value. In general we admire the individual with the shallow discounting function as someone possessing a good bit of “self-control” (or “will power”). The impulsive individual with the steep discounting function is seen as weak or perhaps neuroanatomically challenged. Of course there are situations where steep discount functions make more sense: that slice of apple pandowdy won’t be much to look at (or taste) several months from now. Likewise, $100 five years down the road may not be of any value to a terminally ill patient. So, immediately the question arises about the conditions under which we get different degrees of discounting. Across conditions, is there stability in the discounting functions of individuals? Is there a single type of mathematical function that can describe discounting across the broad range of possible situations? More generally, what can the facts of temporal and probability discounting tell us about gambling? Equally important, what remains incomplete in any account of gambling based on discounting?

Dealing with fundamental principles first, is there a mathematical function that well describes temporal discounting? There is general agreement that for most situations hyperbolic discounting equations, such as that proposed by Mazur (1987), provide an excellent account of the impact of delay (or probability) on the value of a commodity (e.g., Charlton & Fantino, 2008; Estle, Green, Myerson, & Holt, 2006; Madden, Ewan, & Lagorio, 2007). A more general view was presented by Killeen (2008) in his paper “The Mother of All Discount Functions.” We need not review the supporting data and arguments here, except to note that the hyperbolic form appears to work well. But we will review how discounting is affected by certain characteristics of the commodities being selected and by the nature of the organism doing the selecting. And we will conclude by discussing how external variables may influence the likelihood of gambling and how altered discounting rates may be seen as a mechanism for these influences.

It is perhaps intuitively appealing to attribute problem gambling to steeper discounting characteristics of the subject. And, in fact, pathological gamblers and other addicts have been shown to have steeper discounting functions than control subjects (e.g., Bickel, Odum, & Madden, 1999; Petry, 2001; Dixon, Marley, & Jacobs, 2003). However, upon reflection, this account may be somewhat incomplete or at least oversimplified. For there are several reasons why we might expect that what is known about discounting would inhibit rather than encourage gambling. For one, the commodity generally gambled is money; money supports relatively shallower discount functions, at least where delay is concerned, than other commodities studied. The observation that the characteristics of the delayed commodity affects rate of discounting has been termed the “domain effect” by Baker, Johnson, & Bickel (2003). Charlton & Fantino (2008) referenced studies in which each of the following commodities is discounted more steeply than money: cigarettes for smokers; health gains; crack-cocaine for cocaine-dependent individuals; and consumable commodities such as candy, food, soda,
and alcohol for users of these goods. It has also been shown that commodities that are perishable (such as that piece of apple pandowdy) are discounted more steeply than less perishable commodities. Based on this earlier research and on their own comparison of discount rates for different types of commodities, Charlton & Fantino (2008) concluded that there is a continuum of discount rates based on the nature of the commodity being discounted. This continuum is anchored at the low end with commodities, such as money, that serve an exchange function rather than a direct function, and at the high end by those serving a direct metabolic function (e.g., food, alcohol, other drugs).

WHY WE SHOULDN’T EXPECT PROBLEM GAMBLING

Since most gambling involves monetary payoffs, based on the discounting findings that we have just summarized, we should expect relatively shallow discount functions and relatively little pathological gambling. Second, gambling generally involves variable amounts of monetary rewards, not variable delays. A rich literature with both human and non-human subjects suggests that preference for variable amounts, as found in gambling, is far less likely than preference for variable delays. Third, the literature also suggests that probabilistic discounting may be flatter than delay discounting. Yet many gambling settings involve probabilistic outcomes. Fourth, humans tend to be risk-averse, not risk-prone. All of these factors, which we consider briefly in turn, ostensibly argue that many contingencies should conspire against the tendency to gamble. Yet on closer analysis we will see that these contingencies may not be the ones that are most relevant to our problem gambler.

Fantino et al (2005) have reviewed much of the huge literature on choosing between certain and variable outcomes. Whereas pigeons and other non-human subjects show robust preferences for variable over fixed delays, human data are harder to categorize. And where fixed versus variable amounts of reward are being chosen, the data for non-humans is mixed, dependent on sometimes subtle variables (e.g., O’Daly, Case, & Fantino, 2006), whereas the data from humans tend to support risk-aversion (e.g., Pietras, 2001; Weiner, 1966). In fact risk-aversion under a wide variety of circumstances is thought to be one of the hallmarks of human decision-making (see, for example, Tversky & Kahneman, 1992).

What of the issue of whether discounting functions involving delays or probabilities are steeper? This is a false question since time and probability involve different dimensions. However, there is a rich literature on choice behavior suggesting that, when schedules of reinforcement are degraded by inserting delays between one choice and the following reinforcer, there is a dramatic weakening effect on preference. Not so when the degradation is made by decreasing the probability that the reinforcer will occur (e.g., Fantino, 1967; Spetch & Dunn, 1987).

With respect to risk-aversion, a widely-cited example involves a problem Samuelson (1963) posed to a colleague, asking him whether he would accept a single bet with a 50% chance to win $200 and a 50% chance to lose $100. The colleague turned him down, and there is ample evidence from everyday life that most other people would do the same. Tversky & Bar-Hillel (1983) gave a hypothetical version of the gamble to a sample of 230 Stanford undergraduates; it was rejected by 70% of them.

So, when all is said and done why do we observe problem gambling?

WHY WE SHOULD EXPECT PROBLEM GAMBLING

While each of the four factors discussed above would seem to argue against the likelihood of gambling, there are reasons for fram-
ing the gambling situation in a different way. While the actual wager may not involve temporal discounting, the first three points ignore an aspect of temporal discounting that may be very much a part of the gambling equation. The gambling situation may be viewed as a choice between possible immediate rewards (on successful gambles, which occur in almost any gambling situation) and much more delayed—and less clearly defined—larger rewards in the form of fiscal and familial well being, etc. The steep discounting functions that are inherent in this setting may contribute to an increased propensity to gamble. Holt, Green, and Myerson (2003) argue against the idea that impulsivity is a general trait encompassing both risk-taking and inability to delay gratification. They found that college students with and without gambling experience reacted similarly on a temporal discounting task, but that those who gambled were less sensitive to changes in the probability of rewards, a possible sign of being more likely to take risks. With respect to the fourth factor discussed above, that humans are typically risk-averse, it may be that this aversion is limited to certain situations and to certain (albeit a majority of) individuals. For example, the gambling context may provide cues more conducive to gambling than, say, a questionnaire about hypothetical gambles made in a psychology experiment. Equally important, we should explore whether problem gamblers, non-problem gamblers, and non-gamblers evince the same degree of risk-aversion. We wager that they do not.

Our discussion thus far has emphasized contingencies that should make gambling more or less likely. The implication is that people should act rationally in terms of responding appropriately to the constraints imposed by the prevailing contingencies. But if we know anything about human decision-making we know that it is not necessarily rational, logical, or optimal (e.g., Fantino, 2004). Gambling is also affected by social considerations (e.g., Rockloff & Dyer, 2007) and by verbal behavior (e.g., Dixon & DeLaney, 2006). The present authors (Fantino & Stolarz-Fantino, 2002) have discussed the likelihood that internal events may affect overt behavior. We noted:

> For example, it may well be that the drug addict under treatment is more likely to take drugs after a prolonged period of thinking about them than after a period of thinking about an upcoming basketball game. That these two episodes of thinking can be understood as a function of the addict’s reinforcement history does not necessarily render them irrelevant to a complete account of behavioral causation (Fantino & Stolarz-Fantino, 2002, p. 124.)

The problem gambler may well be more likely to associate cues in his or her environment with past gambling behavior including memorable “wins,” and therefore be more prone to thinking about gambling. A closely related question, deserving of research, is whether problem gamblers are more susceptible to the role of instructions or advertising about gambling than are non-problem gamblers and non-gamblers.

May we affect the propensity to gamble by “getting inside the gambler’s head?” In a first effort to do so, we conducted two studies in which subjects were given $10 and had the opportunity to bet any amount of it on a 50/50 wager based on the throw of a fair die. Subjects were randomly assigned to conditions in which they were instructed to concentrate on a particular thought for several minutes while the experimenter was out of the room getting the materials used in the study. In each case, some of the assigned thoughts were gambling related (e.g., betting and winning; betting and losing), while others were chosen to evoke feelings (e.g., having a dream vacation; doing well or poorly on an exam). Would gambling-related thoughts serve as discriminative stimuli for wagering, thus influencing subjects to bet more of their $10? In fact, as might be predicted, the situation has proven to be more
complicated. First, men wagered a great deal more than women. This may be an effect of differential experience, and we are looking into this possibility. Second, thoughts of a pleasant nature (e.g., having a dream vacation; doing well on an exam) were at least as likely to lead to wagering as were gambling-related thoughts. Further investigation is ongoing.

In summary, there are many reasons to gamble and many reasons not to do so. A more satisfying and complete account awaits after a great deal more research is undertaken. Discounting functions certainly play a central role in helping us appreciate the nature of gambling, but they are only a part of a rather rich tapestry of contingencies, including the social, emotional, and verbal.

REFERENCES


Action Editor: Mark R. Dixon
COMMENTARY

GAMBLING, SHAPING AND RATIO CONTINGENCIES

A. Charles Catania
University of Maryland, Baltimore County (UMBC)

Fantino & Stolarz-Fantino rightly point out that pathological gambling often seems paradoxical, in the sense that the behavior persists despite powerful contingencies operating against it. They also argue that verbal behavior probably plays a major role in pathological gambling. I am strongly inclined to agree with them.

My guess is that the dependence of an individual’s gambling on that individual’s verbal behavior will depend not only on what is said but also on how the verbal behavior was established. To the extent that correspondences between verbal and nonverbal behavior matter, it probably makes a difference whether the gambler says, “I’m on a winning streak” or “I’d better quit while I’m ahead.” Perhaps more important, it probably also makes a difference whether the gambler says it based on recent events in the current gambling environment or because someone else has just said it. Correspondences between verbal and nonverbal behavior are more likely when the verbal behavior has been shaped than when it has been established by instruction (e.g., Catania, Lowe, & Horne, 1990; e.g., Catania, Matthews, & Shimoff, 1982). It may therefore be worthwhile for experimental analyses of verbal behavior in gambling to address the sources of the verbal behavior as well as its topographies.

Fantino & Stolarz-Fantino make it clear that a crucial issue in the analysis of pathological gambling is the range of individual differences. The relevant histories are not easily accessible, so it is not surprising to look to properties of the organism, and for Fantino & Stolarz-Fantino a major candidate is in the relative steepness or shallowness of discount functions. Discount functions, however, are economical ways to describe patterns of behavior; they do not explain those patterns. Fantino & Stolarz-Fantino recognize this, but I am leery of accounts that appeal to something within the organism, even if the account might be regarded mainly as metaphorical (and I must acknowledge having occasionally indulged in such metaphors in my own writings).

The language of choice too easily leads to invented inner entities. If words such as choice and decision are followed, for example, by statements that an organism first chooses or decides and then makes a response based on that choice or decision, a way-station has been created that can distract us from environmental contingencies in their interactions with behavior (Skinner, 1950; 1963). Fantino & Stolarz-Fantino are reasonably careful, but I worry that some who approach the relevant behavior analytic literature from other perspectives may fall into such cognitive traps.

One consequence of such language may be a neglect of basic environmental contingencies. Fantino & Stolarz-Fantino are concerned with delays and other contingencies, but give scant attention to the literature on the effects of schedules of reinforcement (Ferster & Skinner, 1957). Random- or variable-ratio schedules capture the sorts of contingencies that operate in gambling, so it is appropriate

Address Correspondence to:
A. Charles Catania
E-Mail: catania@umbc.edu
to ask why the experimental analysis of behavior does not give them more attention. After all, these contingencies can engender enormous quantities of behavior, and conditioned reinforcers can vastly amplify their effects (Findley & Brady, 1965). These facts about behavior are presumably not lost on those who design the workings of casinos.

Perhaps a major reason for the neglect of such basic contingencies in our analyses of gambling behavior lies with the large variability in gambling behavior. If these contingencies are so powerful and so ubiquitous, how can it be that some become pathological gamblers whereas others seem immune to the lure of the wager? Would we expect such individual differences in the behavior of pigeons or rats or even chimpanzees?

But anyone who has worked with large ratios will tell you that you cannot just drop an organism into a chamber with appropriate contingencies arranged and expect lots of behavior. Instead, the behavior must be shaped. You start with relatively small ratios, and only gradually build them to the point where very long runs of responses as well as some very short ones are followed by reinforcers (I am taking it for granted here that the reader is familiar with the essential properties of random-ratio schedules).

Skinner recognized the necessity of shaping in establishing random-ratio performance in a satirical op-ed piece (Skinner, 1977) in which he proposed that taxation could be eliminated if lottery contingencies were stretched over successive terms of school, so that all adults would eventually become chronic gamblers (Skinner offered many clues that his piece was a take-off on Jonathan Swift’s 1729 satire, “A modest proposal,” but subsequent letters to the editor suggested that too many readers missed the joke).

The key may then lie in the variability of gambling contingencies. At issue are the effects on very large populations of individuals and not just on a very small number of laboratory subjects (furthermore, experiments in the laboratory have only sometimes used true random-ratio contingencies, as opposed to recycling sequences of ratios or other arrangements better suited to the technologies available in the early days of schedules research). Expose thousands or millions of individuals to ratio contingencies and it will be inevitable that some will have the bad luck (or good, depending on one’s perspective) to lose so often in their early exposures to gambling contingencies that their gambling behavior remains weak over extended periods of time. It will similarly be inevitable that some at the other end of these probability distributions will start out with the good luck (or, conversely, the bad, depending on one’s perspective) to win often in early gambling experiences, with the wins gradually tapering off only after having engendered a rate of gambling sufficiently high that it persists over long runs of losses (and so is labeled pathological by those without access to the relevant history).

As already mentioned, I strongly suspect that other variables (verbal behavior for one) may enter into pathological gambling, but we should exhaust the potential effects of environmental contingencies before we invest great effort on research that does not take those contingencies into account. Once we assess the likelihoods of different sorts of histories that can be created by various gambling contingencies, we may be able to make some predictions about the prevalence of pathological gambling to be expected in large populations, and we may also be able to study whether patterns of gambling behavior share properties with random-ratio behavior in the laboratory (e.g., break-and-run patterns of responding in extinction as a function of history).

REFERENCES


COMMENTARY

UNDERSTANDING GAMBLING, IMPULSIVITY, AND DECISION-MAKING: SELF-REPORT AND BEHAVIORAL CONSIDERATIONS

Marc N. Potenza
Yale School of Medicine

The manuscript by Fantino and Stolarz-Fantino raises multiple important points about the study of gambling and how findings from such investigations have both applied (e.g., clinical and societal) and basic implications. A main theme of the manuscript is that behavioral analysts are well suited to provide a structural framework for such studies and to inform future directions.

A focus on behavior is important in understanding many human processes, particularly gambling and excessive patterns of gambling exhibited by individuals with pathological gambling (American Psychiatric Association Committee on Nomenclature and Statistics, 2000). Behavioral assessments, as compared with self-report ones, have benefits. For example, they are often more easily modeled across species, facilitating translational research efforts that can provide significant insight into the biological factors contributing to human behaviors, including gambling and pathological gambling (Williams, Grant, Winstanley, & Potenza, 2008). Furthermore, behavioral assessments may provide unique information that differs from self-report measures, even when assessing the same domain. For example, in a study of adolescents seeking to quit smoking (Krishnan-Sarin et al., 2007), behavioral measures of delay discounting on an Experiential Discounting Task (Reynolds & Schiffbauer, 2004) did not correlate with delay discounting as estimated from a self-reported preference measure (Kirby, Petry, & Bickel, 1999). In this study, the adolescents able to maintain smoking abstinence at the end of the behavioral therapy trial were distinguished from those who relapsed by showing less steep discounting on the behavioral measure, and no significant relationship between self-reported discounting and treatment outcome was observed (Krishnan-Sarin et al.). These results suggest that what people say that they might do and what they actually do in specific situations might differ significantly (consider dieting resolutions and consummatory behaviors when offered a tempting dessert). The findings also echo those from other studies of drug dependence; e.g., performance on the Iowa Gambling Task, a behavioral measure of risk/reward decision-making, has been found to correlate with the ability to hold a job amongst cocaine dependent subjects (Bechara, 2003). Despite the importance of behavioral measures, it is also important to consider internal states not readily captured by behavioral assessments (e.g., feelings of depression, anxiety, or appetitive states like urges or craving). These states appear relevant to gambling behaviors,
particularly clinically important phenomena like treatment outcome in pathological gambling (Grant, Kim, Hollander, & Potenza, 2008; Grant & Potenza, 2006).

When discussing impulsivity, Fantino and Stolarz-Fantino allude to the complexities of impulsivity and theoretically related phenomena like risk-taking. Multiple definitions for impulsivity have been proposed, with some focusing more narrowly on processes like temporal discounting and others covering more broad areas, such as the definition described by Fantino and Stolarz-Fantino that encompasses risk taking. Members of the International Society for Research on Impulsivity (www.impulsivity.org) have forwarded the following definition for impulsivity (Moeller, Barratt, Dougherty, Schmitz, & Swann, 2001; Potenza, 2007): “a predisposition toward rapid, unplanned reactions to internal or external stimuli [with diminished] regard to the negative consequences of these reactions to the impulsive individual or others.” If one accepts this definition, there are several important points that can be noted. First, impulsivity is a complex, multifaceted construct. Consistently, factor analyses have typically identified two or more domains of impulsivity including ones related to risk/reward decision-making and response inhibition, respectively (de Wit, 2008; Reynolds, Ortengren, Richards, & de Wit, 2006; Verdejo-Garcia, Lawrence, & Clark, 2008). Second, aspects of impulsivity overlap with proposed core components of addiction; e.g., continued engagement despite adverse consequences (Potenza, 2006). As pathological gambling has been described as a “behavioral” addiction (Grant, Brewer, & Potenza, 2006; Holden, 2001), an improved understanding of how specific aspects of impulsivity relate to specific patterns and features of gambling is important and clinically relevant. Consistent with this notion, individuals with pathological gambling have been shown to be impulsive on both self-report and behavioral measures of impulsivity in multiple domains (Blaszczynski, Steel, & McConaghy, 1997; Lawrence, Luty, Bogdand, Sahakian, & Clark, in press; Verdejo-Garcia et al., 2008), and certain measures of impulsivity are related to treatment outcome in pathological gambling (Blanco et al., in press). Third, as gambling behaviors, particularly problem and pathological gambling, often co-occur with substance use behaviors and disorders (Desai & Potenza, 2008; Kessler et al., 2008; Petry, Stinson, & Grant, 2005) and as substance use may influence impulsivity in a complex fashion (with impulsivity predisposing to use and use promoting greater impulsivity (de Wit, 2008; Kreek, Nielsen, Butelman, & LaForge, 2005; Perry & Carroll, 2008), including with respect to decision-making in gambling (Kyngdon & Dickerson, 1999)), an improved understanding of the relationship between specific aspects of impulsivity, substance use and gambling is important. Fourth, given the complex nature of impulsivity, a battery of assessments (both behavioral and self-report) will be important in dissecting impulsivity and understanding the relationship of the components to specific aspects of gambling behaviors.

Behavioral tasks also have the benefit of being adaptable for use in neurobiological investigations, including brain imaging studies involving human subjects. Such studies have the promise to understand not only the neural mechanisms underlying gambling processes, but also how brain function is different in people with and without gambling problems. Functional magnetic resonance imaging (fMRI) techniques allow for the investigation of behavioral processes (e.g., tasks assessing aspects of impulsivity) to test hypotheses regarding the neural mechanisms underlying specific aspects of behaviors (e.g., gambling) or emotional or motivational processes (e.g., sadness or gambling urges) relevant to gambling behaviors. Such investigations (reviewed in Potenza, 2008) indicate that individuals with pathological gambling
differ from control subjects in showing relatively diminished activation of ventral cortico-striatal circuitry (involving the ventromedial prefrontal cortex and ventral striatum) during response inhibition, decision-making, simulated gambling, and gambling urge paradigms. These brain regions have been implicated in aspects of impulsivity. For example, consider delay discounting, in which a central element is the selection of small, immediate rewards over larger delayed ones. Among healthy volunteers, the selection of small, immediate rewards recruited ventral striatum and ventromedial prefrontal cortex, whereas the selection of larger, delayed rewards was associated with brain activations in more dorsal cortical regions (McClure, Laibson, Loewenstein, & Cohen, 2004). Moreover, the processing of small immediate monetary awards can be further parsed into anticipation and receipt phases, with the former more closely associated with activation of the ventral striatum and the latter with activation of the ventromedial prefrontal cortex (Knutson, Fong, Adams, Varner, & Hommer, 2001; Knutson, Fong, Bennett, Adams, & Hommer, 2003). Together, these data are beginning to provide an understanding of the brain mechanisms underlying specific aspects of engagement in impulsive behaviors, and what brain function might underlie excessive patterns of gambling. A future goal would be to translate this understanding to improved prevention and treatment strategies.

Towards the goal of advancing prevention and treatment strategies, an understanding of how individual difference measures (e.g., gender and specific genetic and environmental factors contributing to such constructs as emotional regulation and stress responsiveness) might contribute to impulsivity and gambling is important. For example, treatment trials for certain types of medication (e.g., serotonin reuptake inhibitors) in the treatment of pathological gambling have yielded mixed results, and it is likely that individual differences contribute to the variability in results (Brewer, Grant, & Potenza, 2008). Heritable contributions to pathological gambling are substantial, with studies of male twins estimating genetic contributions over 50% (Eisen et al., 1998) and suggesting overlaps in genetic contributions to alcohol dependence, antisocial behaviors and depression (Potenza, Xian, Shah, Scherrer, & Eisen, 2005; Shah, Eisen, Xian, & Potenza, 2005). Similar studies are needed to investigate these relationships in women, particularly as there exist significant gender-related differences in both problematic and recreational gambling behaviors (Potenza, Maciejewski, & Mazure, 2006; Potenza et al., 2001). Genetic and environmental factors have been reported to interact in a complex manner, with significant life experiences (e.g., stressors like childhood trauma) associated with and the development of specific pathologies (e.g., depression) in individuals with specific commonly occurring allelic variants (e.g., of the gene coding for the serotonin transporter) but not in those individuals with the other variant (Caspi et al., 2003). Such commonly occurring allelic variants (including the one coding for the serotonin transporter, the molecular target of serotonin reuptake inhibitors) have also been associated with specific patterns of brain activation (e.g., in the case of the allelic variants of the serotonin transporter gene, in regions associated with emotional reactivity) (Hariri et al., 2002). Together, these data suggest that there are complex interactions between genetic and environmental factors that contribute to brain function and behavior. The data also suggest that the technological advances to which we currently have access should allow for a more complete understanding of internal and behavioral phenomena related to gambling, and that this understanding should lead to improved prevention and treatment strategies for individuals with gambling problems.
REFERENCES


Potenza, M. N. (2007). To do or not to do? The complexities of addiction, motivations, self-control


Fantino and Stolarz-Fantino’s thought provoking and scholarly article grapples with the complexity of understanding the behavior of gambling in direct contingency terms. The basic processes and variables involved in gambling have long been the subject of attention in the operant lab, and the authors do an exemplary job of illustrating how the basic research on choice and delay discounting has relevance for understanding the seemingly perplexing choices that gamblers often make. Yet, Fantino and Stolarz-Fantino’s article makes it clear that more is needed. Something additional is required to elucidate anomalous findings and highlight the applied implications of a functional analytic account of gambling behavior. In this brief commentary, I will directly address the issue of this erstwhile elephant in the room: the role of verbal behavior in initiating and maintaining gambling.

The very nature of verbal stimuli play such a prominent role in gambling behavior that what is now needed is a new way of approaching gambling as a verbal event. The authors state that the salience of contingencies in everyday gambling suggests, “additional factors are involved in the decision to gamble.” Identifying these factors, one of which is a preference for short-term gain, may go some way towards explaining why some people, but not others, go on to develop a gambling problem. An additional factor might be the structural characteristics (Parke & Griffiths, 2006) or physical, nonarbitrary features of the gambling activity and the context in which gambling takes place (Hoon, Dymond, Jackson & Dixon, 2007, 2008). The background color, sounds, and flashing visual displays of slot machines are prime examples of structural features, and it now widely accepted that the gambling context may provide cues conducive to both initiating and maintaining gambling.

This is exactly what the preliminary work conducted in our lab shows (Hoon et al., 2007, 2008). Specifically, we have shown that background color readily exerts nonarbitrary contextual control over choices for concurrently available slot machines of identical payout probability. That is, a background color or that acquires contextual functions of “more than” increases response allocation to the slot machine that shares the same color, despite the matched probabilities. Indeed, Rockloff and Dyer (2007) showed a social facilitation effect over gambling induced by the presence of misleading sight and sound (i.e., nonarbitrary) stimuli, with separate stimuli being shown to be less effective. Such demonstrations of nonarbitrary contextual control have been demonstrated numerous times in the literature on relational responding. Indeed, a nonhuman model of this generalized nonarbitrary performance should be possible, and
may even be desirable, in order to fully inform our understanding of the transition from direct-acting, nonarbitrary discriminative control, readily shown with nonhumans, to emergent or derived, arbitrary control, which is something that nonhumans appear to have great difficulties with, despite heroic research efforts.

The Hoon et al. (2007; 2008) studies on situational factors do not, however, demonstrate derived, verbal control over concurrent slot machine choice. The performance was not derived, in the technical sense that the background colors did not participate in pre-established derived stimulus relations. When a stimulus obtains its functions based, at least in part, on participation in derived relations or relational frames, it is said to be functioning verbally (Dymond & Rehfeldt, 2000; Dymond & Whelan, 2007). It does not take a great leap of imagination to consider how such verbal functions might extend the analysis of situational factors in gambling. Consider, for instance, someone entering a casino. Choice of which slot machine, or of which form of gambling (roulette, craps, poker, etc.) to play is likely to be influenced by derived, verbal functions such as rules and self-rules like “loosest slots in the house” and “I feel lucky”, along with formal features of the context (e.g., lights, colors, sounds, and names of slots machines). In gambling, stimulus functions such as these likely participate in multiple, contextually controlled derived relations. Gamblers’ relational histories with various stimulus functions may come to exert control over choices and override the effects of programmed contingencies. And because not all objects and events in a derived relation need to be directly experienced, the potential for gambling to be controlled by increasingly complex and ever more remote contingencies is tremendous and far-reaching. But this is, importantly, an empirical issue.

There is other evidence that verbal functions play a central role in gambling. As Fantino and Stolarz-Fantino point out, research showing a continuum of discounting rates based on the commodity being discounted, with money anchored at the low end, hints that human choices for money “serve an exchange function rather than a direct function”. It may be useful to conceptualize such exchange functions as based in part on the derived functions that money can buy.

Finally, there are numerous reasons why contingencies “should conspire against the tendency to gamble”, but the fact is they do not, which suggests that gambling is maintained through derived, verbal functions. The role of verbal behavior in gambling behavior or, more technically, the participation of stimulus and response functions in relational frames, must become the focus of study in its own right (Dixon & Delaney, 2006). This endeavor is only just beginning, but its implications for basic and applied research, as well as the potential for forming alliances with other scientific disciplines such as neuroscience offer tremendous opportunities for behavior analysis.

REFERENCES
Parke, J., & Griffiths, M. D. (2007). The role of structural characteristics in gambling. In G. Smith, D. Hodgins, and R. Williams (Eds.), Research and
measurement issues in gambling studies (pp. 211-243). New York: Elsevier.
COMMENTARY

GAMBLING: NOT WHAT IT MAY SEEM TO BE

Jeffrey N. Weatherly
University of North Dakota

Fantino and Stolarz-Fantino (this issue) undertake a very worthy effort; attempting to characterize gambling from a behavioral perspective and outlining some of the complex issues in the study of gambling behavior, as well as offering some future directions for research. As others before them (e.g., Madden, Ewan, & Lagorio, 2006; Petry, 2005; Weatherly & Dixon, 2007), Fantino and Stolarz-Fantino identify connections between research on basic behavioral phenomena and the behavior of gambling. They also note several places where such connections are, well, perplexing.

For instance, Fantino and Stolarz-Fantino point out that gambling may be facilitated by the illusion of control (Langer, 1975; Ladouceur & Sévigny, 2005). This idea has support in the literature. For instance, research in laboratory situations has demonstrated that roulette players may sometimes pay “extra” for the opportunity of picking their own numbers (Dixon, Hayes, & Ebbs, 1998). In contrast, however, Dannewitz and Weatherly (2007) found that participants ultimately risked more money when playing video poker when they had no control over which cards were played than when they had complete control. In short, the variable of “control” has not lead to uniform effects on gambling.

Fantino and Stolarz-Fantino also note that the salience of contingencies controls choice behavior and that the lack of transparency of the contingencies can lead to non-optimal responding. This assertion is reasonable enough. Unfortunately, our research has repeatedly shown that participants have extreme difficulty discerning the contingencies when gambling, at least when playing slot machine (simulations). Weatherly and Brandt (2004, Experiment 1) found that participants’ gambling behavior was similar when playing a slot-machine simulation programmed at a 75%, 83%, or 95% payback percentage. Because this experiment employed a between-groups design, we surmised that the similar play might well have occurred because individual participants were afforded limited experience with different payback percentages. Thus, in Experiment 2, we used a within-subject design that had each participant play the simulation three times at each of the three payback percentages. Gambling behavior still did not differ across the different contingencies. Weatherly, Thompson, Hodny, and Meier (submitted) proposed that the results of Weatherly and Brandt (2004) were the result of participants not having concurrent access to slot machines paying back at different rates. We gave participants, across repeated sessions, free access to two slot machines programmed to pay back at different rates. Preference for the higher-paying slot did not emerge. In fact, the only evidence that participants’ gambling behavior can be controlled by the programmed contingencies comes from Gillis, McDonald, and Weatherly (2008).
this study, participants played a slot-machine simulation in three different sessions in which the percentages were programmed at 85%, 95%, and 105% payback. Consistently with previous finding, no differences in gambling were observed between the 85% and 95% conditions. However, significantly more gambling occurred in the 105% condition than in the other two. The take-home message seems to be that people can discern winning from losing, but not between losing and losing more.

The reason for this lack of discrimination is not immediately clear. It could be that the contingencies are very difficult to discriminate when conditions are suboptimal. It could be that games of chance, such as slot machines, actually program multiple contingencies simultaneously (e.g., bars vs. cherries vs. sevens, etc. on a slot machine) and that behavior is controlled differently by the different contingencies. As with the illusion of control, however, whatever the answer, it promises to be less than simplistic and straightforward.

Fantino and Stolarz-Fantino also draw our attention to discounting functions and their potential relationship to gambling. This connection is a popular one and has been highlighted as important in a bevy of recent papers (e.g., Madden et al., 2006; Petry, 2005; Weatherly & Dixon, 2007). Unlike many, Fantino and Stolarz-Fantino correctly identify that this connection itself is not a straightforward one (e.g., the “domain effect”; Baker, Johnson, & Bickel, 2003). What remains amiss, however, is the process that leads to changes in discounting in the first place. That is, although a relationship between discounting and gambling has been proposed (e.g., Dixon, Marley, & Jacobs, 2003), it is not clear what factors lead to changes in discounting. The discounting function itself is descriptive. So one can identify individuals who discount more steeply than others, but that does not provide an explanation for why they do so. Weatherly and Dixon (2007) proposed that discounting functions change because some of the risk factors for pathological gambling (e.g., ethnic minority status; see Petry, 2005) potentially serve as setting events (Kantor & Smith, 1975) that change how those individuals discount delayed monetary consequences. On the bright side, recent research from our laboratory suggests that steepness of the discounting function is related to how much money people will gamble on a slot machine during an experimental session (Weatherly, Marino, Ferraro, & Slagle, submitted). On the dark side, our research (Weatherly, Derenne, & Chase, in press) has also failed to show a predictive relationship between the risk factors for pathological gambling and rates of discounting or between rates of discounting and scores on the South Oaks Gambling Screen (Lesieur & Blume, 1987), a self-report measure of past gambling history. In short, discounting of future consequences may be related to gambling, but we do not have a good understanding of what experiences or situations lead to changes in discounting. That understanding would appear to be critical to fully understanding the true relationship between discounting and gambling.

In the end, Fantino and Stolarz-Fantino come to the issue that is arguably the crux of the matter. How is it that many individuals can experience the same or similar situation and the majority of those individuals walk away without displaying long-term negative behavioral problems and a small minority comes to display pathological behavior? Their description of the sunk-cost effect is a good example. All gamblers, with continued play, will ultimately face that situation. However, only 1 – 2% of the population will come to display pathology.

I agree with the authors in that the answer likely will be found in differential prior experiences of the gamblers. I also agree that a full understanding of gambling behavior, and especially pathological gambling, will require
WHAT IT MAY SEEM TO BE

a better understanding of the social and verbal contingencies than we have today. If I have learned anything from my efforts to research gambling behavior, it has been that, however straightforward the manipulation may appear, its influence on gambling behavior will not be a simple or even a direct one.

REFERENCES
COMMENTARY

SIMPLE SOLUTIONS TO COMPLEX PHENOMENA:
NOT IN THE CARDS

Jeffrey L. Derevensky
McGill University

Fantino and Stolarz-Fantino suggest that to understand gambling behavior, in particular pathological gambling, a better understanding of human basic decision making processes is paramount. To accomplish this task they suggest that behavior analysts are in a unique position to elucidate the important and critical variables underlying adult gambling behavior and problem gambling. To support their claim, they point to some of the behavioural literature which have been used to explain the acquisition, maintenance and resistance to cessation of other addictive behaviors. The basic premise underlying their arguments is that individuals make educated, rational choices. Thus, if we can better understand these processes and modify the individual’s decision making processes then individuals might continue to indulge in gambling in a relatively safe manner, stopping when they have reached their predetermined time and financial limits. While this may make intuitive sense, and behavioural analysis can certainly help explain the acquisition of this behavior, decision making and more importantly good decision making is lost when individuals are deeply engrossed in the gambling activity itself.

Where else can bright intelligent individuals, capable of making countless good decisions in their daily lives, succumb to multiple erroneous cognitions which ultimately results in ignoring predetermined limits and in some cases excessive gambling. I offer the following two simplistic examples. First, the Bellagio casino in Las Vegas cost 2 billion dollars to build yet everyone gambling in the casino believes they are smarter than the owner. Second, casino operators have long known that by providing visual cues to individuals they are more likely to perceive that they can cognitively predict the outcome. Take for example a roulette wheel which in almost every casino now exhibits the last 12 results of where the ball has landed. Individuals with good decision making principles will study the board and wager on where the ball will land next. If five red numbers appear, the individual knowing that the probability of red vs. black is 50% (excluding green) will likely wager on black. Unfortunately, the roulette ball does not have memory where it landed previously. This illusion of control reinforces the notion that individuals when gambling often endorse the fallacy of the law of independent events such that each spin is independent from the other.

Clearly, behavioural analysts have little difficulty in explaining the acquisition and the maintenance of some specific forms of gambling (e.g., slot machine or electronic gambling machine gambling) as a result of intermittent contingencies. The real question that remains - why do people continue to gamble
in excess of their predetermined limits in spite of their repeated losses?

To help us better understand this complex behavior, Fantino and Stolarz-Fantino turn to an explanation of temporal discounting to help us understand why individuals make non-optimal choices during a gambling episode. In analyzing the arguments they too concur that while there is some empirical evidence to suggest that pathological gamblers and smokers exhibit steeper discounting functions than controls, the explanation for excessive gambling remains incomplete.

Given the discounting functions of individuals does not provide a strong basis for decision making when gambling, Fantino and Stolarz-Fantino try “getting inside the gamblers head”. To do so, they conducted two rather simplistic studies to determine whether or not gambling-related thoughts serve as discriminative stimuli for wagering. Once again, the explanation remains incomplete.

Finally, the authors conclude that while discounting functions play a role in gambling this is a much more complex phenomena. While a number of theoretical models have been proposed to account for pathological gambling a purely behavioural explanation is indeed incomplete (see reviews by Abbott, Volberg, Bellringer, & Reith, 2004; Gupta & Derevensky, 2008). One further point is necessary in understanding pathological gambling. A traditional behavioural view suggests that money is the preeminent reason underlying gambling. There is considerable evidence to suggest that while all individuals want to win money, the pathological gambler will often engage in this behavior to modulate emotional negative affective states or seek to escape from stressors. Dissociation, so very important in understanding pathological gambling, is an important determinant to be considered. For the pathological gambler loses himself/herself in the game. Playing for as long as possible becomes the primary reason for gambling with money being used only to continue gambling. Pathological gamblers report that all their problems (familial, work or school related, interpersonal, psychological or even physiological) disappear when gambling.

Is there a better explanation for understanding pathological gambling? Fantino and Stolarz-Fantino are quite correct in arguing that the behavioural paradigm offers a partial explanation. Others such as Blaszczynski and Nower (2002) have articulated a pathways model suggesting differential pathways toward problem gambling. Different subgroups of individuals may not only have a propensity to engage in different forms of gambling but may have different aetiologies and motivations. While our current thinking is that an integrative bio-psycho-social model provides a more comprehensive explanation (Sharpe, 2002; Derevensky, 2008), considerable more research is necessary before definitive conclusions can be made.

REFERENCES
COMMENTARY

WHAT ELSE MIGHT WE ASK?: COMMENTARY ON FANTINO AND STOLARZ-FANTINO’S “GAMBLING: SOMETIMES UNSEEMLY; NOT WHAT IT SEEMS”

Iser G. DeLeon
The Kennedy Krieger Institute and Johns Hopkins University School of Medicine

Fantino and Stolarz-Fantino have offered a highly informative summary of behavior analytic knowledge regarding problem gambling. As is sometimes the case with this sort of treatment, its greatest value might lie in making clear how much we do not know. Below, I follow their lead in discussing how behavior analytic considerations of problem gambling may be incomplete and suggesting additional, potentially fruitful, avenues of inquiry.

ON THE RELEVANCE OF SUNK COSTS AND THE SALIENCE OF RISK INFORMATION

Fantino and Stolarz-Fantino ask “How salient are the contingencies in standard gambling situations?” The implication is that making the prevailing contingencies more transparent may make behavior more optimal. This has clearly played out well in the authors’ examinations of cost sunk-effects. Sunk-cost effects seem particularly relevant and, I think, cannot be overestimated in the current context. This particular form of irrational behavior pervades the gambling culture and influences problem gambling on both local and extended temporal scales. Individual bets are influenced by sunk costs (see below) and, in the longer run, self-statements such as “one more big bet can help me re-coup all those prior losses” are also a form of sunk-cost effect. The so-called “gambler’s fallacy”, a failure to understand or acknowledge that past failures or successes have no bearing on the probability of winning the next gamble, is almost certainly related to sunk costs.

Navarro and Fantino (2005) clearly succeeded in pointing towards promising directions for curtailing sunk-cost effects. Still, as the current authors note, stimuli indicating risk are already ubiquitous in the gambling environment. Informational strategies aimed at curtailing sunk-cost effects may be further questioned insofar as experienced gamblers have a keen self-awareness of this form of irrational behavior. This is perhaps illustrated by the elaborate vocabulary for such effects that exists in gambling culture. Poker players, for example, acknowledge being “pot committed” to a hand—the poker player’s version of sunk cost. Similarly, being “on tilt,” describes, among other things, an extended period of emotionally infused irrational decision-making. That gamblers can already discern these features of their own behavior makes one question the benefits of supplemental stimuli that confirm its irrationality.

Informational strategies further fail to acknowledge other, possibly self-defeating, effects that such stimuli may have. A potential-
ly relevant extrapolation from recent research is that reward-related stimuli, ironically, may decrease sensitivity to risk information. Ditto, Pizarro, Epstein, Jacobson, and MacDonald (2006) arranged two relative probabilities of winning a pleasant experience (eating an unlimited number of cookies) versus an unpleasant task (completing problems for 30 min). The gamble was made by choosing a card from a deck of 10. For some subjects, 8 cards resulted in cookies and 2 resulted in work (low-risk scenario); for others, 6 cards resulted in cookies and 4 resulted in work (higher-risk scenario). The dependent variable was simply what proportion of the subjects accepted the gamble. When the cookies were simply described to subjects, they showed a rational sensitivity to risk information: 95% took the low-risk gamble, but only 45% accepted the high-risk gamble. When visceral cues were provided (the students could see and smell the fresh-baked cookies), these differences disappeared: over 80% of students in both the low- and higher-risk group accepted the gamble. In essence, the students’ behavior was less sensitive to risk information in the presence of those cues than in the absence of the cues. Furthermore, the visceral cues altered the perceived likelihood of winning. Students rated their chances of winning the cookies to be better when the cues were present than when they were absent.

If we can extrapolate to the current context, stimuli that increase the salience of risk are themselves visceral (at least visual) cues, and/or are often embedded in contexts that provide further related stimulation. Where is the problem gambler likely to encounter risk information on betting on a given horse? For some, the answer is at the race track amidst the sights, sounds, and yes, smells of horse racing. This may help to account for Dixon, Jacobs, and Sanders’ (2006) finding that delayed rewards generally were discounted more steeply in a gambling environment than in a non-gambling environment. Context appears to matter. Individual predispositions, however developed, to various forms of context-driven arousal may also be relevant. For example, sexually aroused college students, not surprisingly, reported a higher likelihood of engaging in risky sexual behavior than when they were not sexually aroused (Ariely & Lowenstein, 2006).

**ON THE RELEVANCE OF SELF-CONTROL AND DISCOUNTING PARADIGMS**

Fantino and Stolarz-Fantino later ask, “What remains incomplete in any account of gambling based on discounting?” Discounting of delayed rewards is certainly relevant and essential differences in discounting patterns between pathological gamblers and others are informative. Still, I agree with Fantino and Stolarz-Fantino that accounts based on differences in discounting functions may be incomplete or oversimplified. How might behavioral discounting preparations, whether inter-temporal or probabilistic, more fully capture important features of the real problem space?

One issue is whether sooner-smaller vs. larger-later choices adequately take into account the actual consequences of poor choices. Larger, delayed outcomes are typically cast as greater magnitudes along the same qualitative dimension, but aren’t delayed aversive consequences more to the point when considering “pathological impulsivity”? The suffering produced by the delayed aversive outcome of risky behavior is qualitatively different from foregoing the delayed potential gain. For example, lighting a cigarette is sometimes cast as a choice between immediate benefits of nicotine self-administration vs. the delayed benefits of a longer, healthier life. But losing out on a long life is not quite equivalent to suffering through lung cancer. Similarly, the delayed gains of larger amounts of money are very different from dealing with bankruptcy. Self-control has, on occasion, been cast in terms of negative consequences
(e.g., Deluty, 1978), but my point is that the positive and negative consequence versions are not necessarily equivalent. As Fantino and Stolarz-Fantino point out, aversion of risk is motivationally more potent than the promise of gain (as exemplified by the 50/50 chance of winning $200 vs. losing $100 experiment).

In dealing with pathology, might we be closer to the point in arranging choices between small, immediate gains vs. large, delayed aversive consequences?

In relation, typical self-control preparations fail to fully take into account dependencies inherent in real-world choices. Repeated impulsive choices do not simply displace the alternative rational options; they lessen the quality of the delayed consequences. The more frequently the impulsive choice is repeated, the greater the probability of the delayed aversive outcome. Thus, more frequent decisions to light up that cigarette actually decreases the probability of a long, healthy life and/or increases the likelihood of lung cancer, heart disease, etc. In dealing with pathology, might we be closer to the point in arranging choices between small, immediate gains vs. delayed alternatives that worsen as a function of impulsive choices?

Yes, many people gamble, but only some develop pathology. Behavior analysts have examined different sensitivities between problem gamblers and others as a basis of addressing the problem. Temporal discounting is certainly a good start, as are observations that gamblers are less sensitive to changes in the probability of rewards (Holt, Green, and Myerson’s, 2003). Fantino and Stolarz-Fantino have proposed a variety of potentially useful avenues for examining further differences: Do problem gamblers evince the same degree of risk aversion? Are gamblers more prone to be thinking about gambling? Are problem gamblers more susceptible to gambling related instructions or advertisement? My hope is that the above is informative in stimulating still others: Are problem gamblers relatively less likely to understand that past failures have no bearing on future odds or are they simply more driven by other factors to ignore these relations? Are problem gamblers relatively less likely to attend to risk information—possibly an observing response issue? Are problem gamblers more sensitive to the effects of gambling-related visceral cues? Do they become relatively more aroused by the outcomes, positive or negative, of their choices? Could there be benefit in casting self-control experiments in terms of small, immediate gains vs. delayed aversive consequences. Are problem gamblers relatively less sensitive to long-term aversive outcomes than casual gamblers or non-gamblers? Most importantly, from a functional behavior analytic perspective, what sort of individual history impacts relative sensitivity to these variables? Onward.

REFERENCES
COMMENTARY

DISCOUNTING WITHIN THE GAMBLING CONTEXT

Gregory J. Madden
University of Kansas

Fantino and Stolarz-Fantino argue that high rate delay discounting may be correlated with pathological gambling not because of factors at work within the gambling context, but because of discounting of the delayed, diffuse benefits of gambling abstinence. Although I agree that the discounting of events outside the gambling context probably affect the probability of gambling, I will argue below that events occurring within the gambling context would also be expected to predispose high-rate discounters toward problem gambling. The authors make four arguments regarding discounting and gambling. I will restrict my comments to the first two.

HUMANS DISCOUNT MONEY LESS THAN OTHER COMMODITIES.

Citing evidence that humans discount delayed monetary rewards at a lower rate than non-monetary rewards, the authors would seem to predict that humans would make more self-control choices in a traditional gambling context, than in other settings where the rewards are not monetary. Thus, gambling should be more likely to occur when the items wagered and won are nonmonetary items such as food, health, or cigarettes (to name a few commodities that have been used in human delay discounting experiments). This is an interesting prediction worthy of empirical investigation. Until those data are collected, a thought experiment will have to suffice.

Consider two casinos. One in which you can wager and win money and another in which you can wager cigarettes on the chance of winning packs, cartons, or cases of your preferred brand of cigarettes. Obviously, the only people interested in gambling in the latter casino will be smokers who tend to discount delayed cigarettes at a higher rate than comparable amounts of delayed money (e.g., Mitchell, 1999). Accordingly, Fantino and Stolarz-Fantino would appear to predict that, all else being equal, smokers would behave more impulsively (i.e., wager more and longer) in the cigarette casino than in the monetary casino. And what if the two casinos were side by side? Which casino would the smokers be more likely to enter and engage in more gambling? Presumably Fantino and Stolarz-Fantino would predict that because of higher rates of discounting delayed cigarettes, the smokers would impulsively choose to gamble cigarettes rather than money. However, given a choice between the two casinos, I would be surprised to see anyone enter the cigarette casino.

A larger point about how discounting rates may interact with factors in the gambling context will be developed below, but for now let us briefly consider why the monetary

Address Correspondence to:
Gregory J. Madden
Department of Applied Behavioral Science
University of Kansas
1000 Sunnyside Ave.
Lawrence, KS 66045
E-mail: gmadden@ku.edu
tel: 785-864-0504
fax: 785-864-5202

Preparation of this manuscript was supported by grants from the National Institutes of Health: DA023564
casino might be favored over the cigarette casino (the answer may have little to do with delay discounting but it is interesting nonetheless). One hypothesis was provided by a recent episode of the television show Family Guy (a program I abhor, but my son enjoys immensely). In the episode, the father character, Peter, wins a lottery and proclaims that he is going to take his family out for the best meal of their lives. In the next scene, Peter and family are in their car at the drive-up window of a fast food restaurant. Peter is ordering vast quantities of the hamburgers they eat on a regular basis. This is humorous because only a fool, like Peter, would waste a windfall of cash on more of the same.

The scene illustrates that an apparent appeal of monetary gambling wins is that there is a chance that you could hit the jackpot and, if this unlikely event were to occur, it would afford you the opportunity to purchase something normally out of reach (e.g., a trip to Europe or a new sports car). The same cannot be said of a jackpot of cigarettes; more cigarettes is more of the same. The relation between large monetary wins and access to previously unattainable luxuries was recently made explicit on an advertising billboard for a casino. The billboard illustrated the transformation of one of their customers from a hamburger-eating commoner to a lobster-eating aristocrat. Perhaps the possibility of this transformation underlies the tendency for pathological gambling to be more prevalent among lower SES populations (see review by Petry, 2005). With so many more luxury items out of their reach, gambling on a low probability of winning a monetary jackpot is the only seemingly open road to aristocracy. Of course these are speculations awaiting empirical findings; findings I hope those taking a functional approach to the study of gambling will pursue.

VARIABLE AMOUNTS VS. VARIABLE DELAYS

Fantino and Stolarz-Fantino correctly note that animals prefer variable delays and response requirements over fixed delays/requirements, but less consistently prefer variable reinforcer amounts over fixed amounts. Thus, variable amounts, which are characteristic of gambling wins, should not increase the appeal of gambling. However, as just noted, for humans, a monetary jackpot provides access to previously unattainable luxury items. Perhaps laboratory animals would prefer variable reinforcer amounts if, when they occasionally hit the jackpot, it provided access to a qualitatively different reinforcer – one that can only be obtained by choosing the variable reinforcer alternative. This may more closely model human gambling wins and may yield more systematic preferences for variable reinforcers.

A second component of the Fantino and Stolarz-Fantino argument is that we might expect gambling to maintain more behavior than predictable sources of income if human gambling was characterized by variable delays, but it is not. When one gambles, there are minimal delays between placing the bet and winning or losing. Thus, strictly speaking, Fantino and Stolarz-Fantino are correct about gambling not involving variable delays. However, if one conceptualizes the time between the initiation of a gambling episode (i.e., a series of wagers) and an eventual win as a delay (e.g., Rachlin, 1990), then the delay to the next win is quite variable. If this conceptualization has merit, then there should be a relation between the rate at which delayed rewards are discounted and the value of gambling wins.

How increased impulsivity may put one at risk of problem gambling due to factors in the gambling context has been outlined in two separate theories. According to string theory (Rachlin, 1990), gamblers take an accounting of the discounted expected value of a string of
Figure 1. Hyperbolic discounting functions obtained by setting the free parameter \((k)\) in Equation 1 to the values shown in each panel. The horizontal dashed line in each panel gives the overall discounted value of a gamble with a 1 in 100 chance of winning (amount constant from win to win). The solid point in each panel shows the discounted value of a comparable win obtained after the 100th “gamble” every time.

gambling events following each win. The delay to this gambling win is the time separating the initiation of the string of gambles and the eventual win. When a win occurs following a single bet, the expected value of the win is not discounted because it is not delayed. When a win follows an extended string of losses, however, the negative expected value is discounted in value because of the delay from the beginning to the end of the string. If an individual discounts delayed losses at a low rate, then the negative expected value of delayed losses retain much of their negative value and outweigh the positive value of gambling wins that occasionally follow short strings of bets (strings with positive expected values). At higher discounting rates (in the range characteristic of pathological gamblers), the negative expected values associated with long strings of losses are more heavily discounted and, therefore, are ineffective in inhibiting the decision to gamble. Thus, according to the string theory of gambling, high-rate discounting should predispose one toward pathological gambling.  

The second theory of the relation between discounting events within the gambling context and pathological gambling is based on quantitative predictions of Mazur’s (1987) hyperbolic discounting equation (Madden, Ewan, & Lagorio, 2007). The hyperbolic shape of the delay discounting function is shown in both panels of Figure 1 and is given by the following equation (Mazur, 1987):

\[
\text{% Present Value} = \frac{1}{1 + k \cdot t}
\]  

\(^1\) According to string theory, very high discounting rates are predictive of decreased gambling. However, for this prediction to hold requires that discounting rates be far higher than what has been reported thus far in the human delay discounting literature.
where $A$ is the objective amount of the reinforcer obtained following delay $D$. The free parameter $k$ is a quantitative index of impulsivity, as it reflects the steepness of the function (i.e., how rapidly the reinforcer loses its value as it becomes increasingly delayed). Extensive empirical evidence shows that discounting of delayed outcomes by humans and nonhumans is well described by Equation 1 (see review by Green & Myerson, 2004).

The upper panel of Figure 1 shows high-rate discounting characteristic of pathological gamblers (Petry, 2001) and the lower panel shows low rate discounting characteristic of humans with no pathology (Kirby, 1997). If the duration of the string of gambles is unpredictable, then so is the delay to a gambling win; indeed, the obtained delay to the next gambling win can occur at any value along the x-axis of Figure 1 (and beyond). This second account of the role of delay discounting in gambling focuses on the discounted value of these unpredictably delayed gambling wins (not gambling losses). To calculate the discounted value of gambling wins ($V_g$), we use the equation proposed by Mazur (1989):

$$
V_g = \sum_{i=1}^{n} P_i \left( \frac{A}{1 + kD_i} \right)
$$

where $P_i$ is the probability of experiencing each delay ($D_i$) and $k$ is the rate of delay discounting. A similar equation has been proposed for unpredictable work requirements, like those arranged by random-ratio schedules of reinforcement (Field, Tonneau, Ahearn, & Hineline, 1996). These equations have been empirically supported in experiments involving nonhuman subjects (e.g., Madden, Dake, Mauel, & Rowe, 2005; Mazur, 1989).

The horizontal dashed lines in Figure 1 show the percent of the present (discounted) value of unpredictably delayed gambling wins ($V_g$) given discounting rates characteristic of pathological gamblers (upper panel) and no-pathology humans (lower panel). These discounted values of the gambling wins were obtained by a computer-simulated series of 200,000 gambling wins where the odds of winning were 1 in 100 and the discounting rate was set equal to that indicated in each panel. Within the simulation, the number of gambles made before each win provided the value of $D_i$, and the probability of winning following $D$ gambles ($P_i$) was empirically obtained for each value of $D$ in the simulation. The solid data point within each panel shows the discounted value of a comparable reward reliably delivered following the 100th “gamble”. This predictable delay to a win is equal to the average obtained delay of the 200,000 gambling wins; thus, any difference in the discounted values of the predictable and unpredictable wins is not due to a difference in obtained delay.

In the upper panel of Figure 1, gambling wins are discounted by approximately 75%, but that is unimportant in the decision to gamble or not. What is important is that gambling wins are worth nearly twice as much as a predictably delayed reward of the same magnitude. At this high rate of delay discounting the unpredictably delayed gambling-like reward retains more value and should be strongly preferred over the predictable outcome which may more closely model the more predictable monetary rewards obtained by humans (e.g., regular paychecks). In the lower panel, the discounted values of gambling and non-gambling outcomes are approximately equivalent because the hyperbolic discounting function is shallow and closely approximates linearity. Thus, at low rates of discounting, gambling-like rewards have no
greater value than predictable rewards and thus gambling should have no untoward appeal.

Equation 2 may be used to predict how much the value of gambling-like wins will increase over predictably delayed non-gambling rewards as a function of increases in the degree of delay discounting (k in Equation 2). This predicted relation is shown in Figure 2. At k-values of 0.001 (typical of humans without a pathology) nothing is to be gained by gambling (% increase = -0.3). However, at k-values of 0.03 and above (the range reported for pathological gamblers by Alessi & Petry, 2003) the individual experiences at least a 50% increase in subjective reward value by choosing to gamble. Thus, Equation 2 predicts that, all else being equal, higher delay discounting rates are predictive of stronger preferences for gambling-like rewards.

If factors occurring in the gambling context combine with high rates of delay discounting to render gambling wins more valuable (Madden et al., 2007) and/or strings of losses less costly (Rachlin, 1990), then when combined with greater discounting of the benefits of delayed gambling abstinence, high-rate delay discounting should be predictive of increased rates of pathological gambling. Although we have learned much by studying correlations between delay discounting and addicted populations, further animal research is needed to determine if we can experimentally manipulate rates of delay discounting (e.g., Mazur & Logue, 1978) and, if so, if this affects the subsequent development of socially relevant behavior such as drug self-administration and preferences for gambling-like outcomes. I, like Fantino and Stolarz-Fantino, look forward to the results of this functional approach to the study of gambling.

REFERENCES
Kirby, K. N. (1997). Bidding on the future: Evidence against normative discounting of delayed re-
wards. *Journal of Experimental Psychology: General, 126, 54-70.*


COMMENTARY

THE IMPORTANT CONTINGENCIES IN GAMBLING ARE Seldom CLEAR: AVOIDING THE RATIONAL CHOICE TRAP

Donald Hantula & Bess Puvathingal
Temple University

Fantino and Stolarz-Fantino ask how clear the contingencies are in a standard gambling situation, and suggest that when contingencies are made clear, both people and pigeons will choose in a “rational” manner appropriate to the constraints imposed by the prevailing contingencies. But, then they note that human decision making is not terribly rational or logical. Gambling regulations specify that parameters such as payout amount and odds of winning be clearly communicated to gamblers; gambling guidebooks, tip sheets and websites are readily available. Yet, gambling abounds, and problem gambling affects 2.3% of the USA adult population. Nearly four out of five US adults report having gambled. Of those, 12.2% of frequent gamblers become problem gamblers while 4.3% become pathological gamblers. Pathological gamblers report annual losses up to $5,000 (Kessler et al., 2008). Clearly, many people are not choosing rationally. Fantino and Stolarz-Fantino suggest that answers may be found in the gambler’s head or in the gambler’s social milieu. Or, in other words, we could be rational, we may indeed want to be rational, but the buzzing in our heads and buzzing by our fellow creatures around us are holding us back. And with that we step right into the jaws of the rational choice trap.

Rational choice theory has dominated economics and discourse about decision making for decades. Herrnstein (1990) points out, rational choice theory may be an excellent prescriptive theory (how we should behave), but fails as a descriptive theory (how we actually behave). We argue that it also fails as a prescriptive theory, largely because rational choice theory ignores our evolved, naturally selected decision processes, and privileges a cognitive calculus as the central decision mechanism. Rational choice theory may be a better prescription for industrial automatons than for evolved biological organisms. As long as it is assumed that humans should or do want to be “rational” in this classical manner, our attempts to understand and ameliorate problem gambling will remain trapped.

Consider first the problem of probability. Although probabilities involved in games of chance are easily accessed, stated probabilities do not seem to exert much control over our behavior. It could be the buzzing in our heads that interferes with calculations. Or, it could be that the rational representation of probabilities in terms of odds is not how our species has come to understand probability. Cosmides and Tooby (1996) have shown that when decision problems are expressed in terms of probabilities, we choose “irrationally.” But when the same problems are expressed as frequencies (occurrences over time) we seem to get it right most of the time. Why should a seemingly simple verbal adjustment make such a difference? Homo sapiens evolved learning about probabilities by

Address Correspondence to:
Donald A. Hantula
Department of Psychology
Temple University
Philadelphia, PA 19122
E-mail: hantual@temple.edu
sitting on a rock, watching prey gambol down different sides of a valley, noting the number that went in each direction, and choosing where to hunt based on these observations. We didn’t perform the calculus of probabilities with sticks in the sand. Taking this analysis a step further, it may be that we are much more sensitive to amount, and count, than we are to probability; but ironically the contingencies of gambling are expressed in terms of probability! Lyons and Ghezzi (1995) provide some excellent field evidence here, showing that wagers in state lotteries are largely insensitive to changes in probability but are very sensitive to changes in amount of payout. The contingencies may be clear to a calculator, but not to most humans.

Consider second the problem of delay. All real gambles are delays; the one-shot stated probability type problems that seem ubiquitous in the literature are minimally informative at best. No real person gambles once, and never before or never hereafter, based on stated probabilities, except in a modern cognitive psychology laboratory. Gambling is either used in the progressive tense (indicates ongoing action) or perfect progressive tense (indicates action that started in the past, continues in the present, and will be completed at some time in the future), implying repeated plays over time. Once time enters the analysis, delay is only seconds behind. It is a good bet that delay discounting may have much more to do with gambling than we suspect. For example, consider the ‘near miss’ effect in video poker (in which cards close to those needed for a win appear in the display). These cards appear on nearly every play, much more immediately than any wins, and are implicated in the especially entrapping nature of this game (Parke & Griffiths, 2004). Does the ‘near miss’ serve as a sufficient fairly immediate conditioned reinforcer to maintain high levels of play despite heavy losses? As another example, the ‘illusion of control’ and other ‘irrational’ thinking found in gambling (e.g., self statements about winning) may also serve as fairly immediate conditioned reinforcers that maintain play. Humans are not very sensitive to the passage of time without the aid of external stimuli (DiClemente & Hantula, 2003); thus it is not surprising that the modern casino is bereft of clocks, and windowless; like a trap.

We wager that answers to the puzzles posed by problem gambling lie somewhere at the intersection of amount, probability, delay, and personal reinforcement history, not trapped inside gamblers’ heads. Indeed, it is only when we stop viewing problem gambling as a costly violation of self-interest and start viewing it as the product of a complex interplay of naturally selected adaptations will we successfully avoid the enticing jaws of the rational choice trap.

REFERENCES


COMMENTARY

SEEMING TO GAMBLE: COMMENTARY ON FANTINO AND STOLARZ-FANTINO’S “GAMBLING: SOMETIMES UNSEEMLY; NOT WHAT IT SEEMS”

Charles A. Lyons
Eastern Oregon University

Those interested in analyzing the field of activities and contexts that comprise gambling will welcome the assessment of Fantino and Stolarz-Fantino. Their recognition that behavior analysts are uniquely prepared to contribute to our understanding of gambling, and by extension to other sorts of “addictive” disorders as well, echoes what the researchers and theorists involved in this journal have been proclaiming for more than a decade. The added voices of Fantino and Stolarz-Fantino will certainly improve on our efforts to disseminate that message.

I suspect that we all agree about the importance of understanding the basic processes and variables involved. As Fantino and Stolarz-Fantino note in their discussion of the sunk-cost effect, the salience of contingencies is central to the initiation and persistence of gambling. By design, gambling teaches players to tolerate loss. A history of intermittent reinforcement undoubtedly contributes to persistence in betting, as does the conditioned reinforcing effect of the “near miss” (in which losing in certain ways actually strengthens rather than weakens play). One task we face is to make our analyses as relevant for the larger scientific community as those of our more physiologically-oriented colleagues. A recent assessment of the neural activity triggered by near-miss stimuli during slot machine play (Clark, Lawrence, Astley-Jones, & Gray, 2009) is only the latest of a series of papers on the brain correlates of gambling that appeal to the wider interest in neurological than environmental variables. As we demonstrate the practical value of our approach, perhaps behavioral explanations will find a more positive reception.

The analysis is also one that, like all self-control issues, concerns discounting of value as a function of time or probability, as well as choice between competing activities. If it is true that the unit of gambling could be defined as the string of losses that culminate in a win (Rachlin, 1990), then gambling involves both variable probabilities and variable delays — and there is some reason to think that these have opposite effects on the discounting of rewards (Green, Myerson, & Ostaszewski, 1999). In their analysis, Fantino and Stolarz-Fantino make an interesting and important observation about the form of discount functions across different commodities: the steepest discounting occurs with perishable commodities that serve a direct metabolic function, with shallower discounting for commodities that serve an exchange function (e.g., money). The analysis of discounting among gamblers remains incomplete, the authors note, partly due to questions about the conditions under which we get different degrees of discounting.
Among the most important of these conditions requiring clarification is debt, which has not yet been adequately modeled in our methods. As an establishing or motivating operation, debt is clearly related to steeper temporal discounting, chasing of losses, and lower risk aversion, but it remains an elusive factor for experimental analysis. We simply cannot allow subjects in our studies to encounter the significant financial consequences that define actual gambling, let alone pathological gambling. As the authors note, humans are widely held to be risk-averse rather than risk-prone in the “real” world. In the analogues of the laboratory, however, subjects cannot (for ethical reasons) incur any net loss or fall into debt, and so there is no meaningful risk to a wager. That is an important problem for any analysis of gambling based on risk aversion and discounted value; what we study in an experiment may only seem like gambling.

Fortunately, we have clever colleagues and powerful techniques, and progress is being made toward a comprehensive behavioral model. Our experimental analyses should eventually be as strong as our conceptual analyses of gambling. Fantino and Stolarz-Fantino suggest several areas for future research: the salience of gambling contingencies, differences between players and non-players, the effects of instructions, and other social, emotional, and verbal influences, all part of the “rich tapestry” of controlling variables. A few more might be specified. Comparisons of different games in terms of “addictive” potential could add to our understanding. And beyond the analysis of individual wagers, we have yet to turn our attention to the other form of gambling, the one that professionals play. For them, gambling is very much a prediction of what other people will do; the behavior called bluffing plays no part in the analysis of slot machines, video poker, or the Powerball lottery. In “real” poker, one can win with the worst hand at the table. We have much to do.

REFERENCES
Fantino & Stolarz-Fantino’s eloquently written, concise, and thought provoking re-
view of research on gambling was a pleasure to read. My comments are addressed more to
those engaged in this line of work than to these authors in particular and are intended
merely as “food for thought.”

As scientific operations, prediction and control apply to classes of events, not to indi-
vidual members of those classes. Hence pursuit of the factors controlling gambling, and
by which it may be predicted, implies that gambling may be conceptualized as an ope-
rant class. Membership in an operant class is defined by common controlling variables
though; and given the varying conditions entailed in different games of chance, and the
fact that the choices made by persons playing these games are influenced by these condi-
tions, the conceptualization of gambling as a single operant seems problematic to this re-
viewer. One solution to this problem might be to overlook the unique features of different
games of chance as to make the collection of their instances into a single class seem justi-
fied. The size of the class formed by this solution would create another problem, however,
as the larger the class the less its utility in practical matters. In the end it might be more
useful, particularly as it pertains to matters of

pathology, to conceptualize gambling as a
number of related operants distinguished by
the unique conditions of their members’ oc-
currences.

Beyond this rather general comment, I
was intrigued by the authors’ explorations as
to the role played by internal events in gam-
bling episodes. While I wouldn’t construe an
act of thinking as an internal event but rather
as a subtle interaction of the responding of a
whole organism with the stimulating of an
environing object, this line of research raises
an interesting issue. As I see it, thinking
about gambling is not a factor that may have
the effect of influencing instrumental gam-
bling activity differentially, as presumably
intended by the authors, but is rather a com-
ponent of gambling. Thinking is substitu-
tional activity, and the products of such activities
are sources of substitute stimulation for sub-
sequent substitutional actions. In this sense,
persons who are thinking about gambling are
already gambling, and the more extensive are
their histories of instrumental activities of
these sorts, the more elaborate will be their
related substitutional interactions. By this log-
ic, thinking about gambling is not an inde-
pendent variable in this line of research: it is
an aspect of the dependent variable.

The value of conceptualizing the induct-
ion of thinking in this way is in the emphasis
it places on the subjects’ histories, and the
fact that they cannot be isolated or differen-
tiated from the current or future instrumental
performances of those subjects. It is not sur-
prising, therefore, that experimental manipu-
lations of these sorts produce mixed results: no two subjects’ histories are sufficiently alike with respect to initial exposures, the frequencies and durations of play, games played, win-loss outcomes and so on as to expect their instrumental gambling performances to be similar – even under current, common sets of experimental conditions.

I am not suggesting that individual differences undermine or should undermine the pursuit of general principles or laws in science. On the contrary, laws and principles are among the most valuable of all scientific products. Rather, my point is simply that laws and principles are descriptive of classes, not their members – be they instances of an operant or individual gamblers. The latter are unique events, operating in the midst of unique sets of more specific conditions. This is not to say that laws and principles developed in investigative circumstances will not contribute to the development of effective interventions for the problems of pathological gamblers. They will provide only general solutions for these problems though and, as has been discovered in every other applied domain, specific solutions will be required for specific problems.

In short, solutions for the problems of pathological gamblers will not be discovered in laboratories – not just because laboratory conditions are analogues of real world circumstances or because the subjects exposed to them are not pathological gamblers – but because the solutions to these problems reside elsewhere, namely in the unique histories and specific circumstances of individual members of the pathological gambler class.
COMMENTARY

FURTHER DIRECTIONS FOR GAMBLING RESEARCH

Patrick M. Ghezzi
University of Nevada, Reno

It is encouraging to see someone of Fantino’s stature call attention to the opportunity that gambling presents for basic and applied behavior analytic research. Indeed, in his 2008 paper on the future of behavior analysis, Fantino predicted that “gambling is an area that will see important and well-publicized advances in the next few years and that behavior analysis may be in the forefront of these advances” (p. 127). Not content to merely make this prediction, Fantino and Stolarz-Fantino take aim at the future by offering a number of concrete suggestions on how gambling research might proceed in the coming years.

Reminiscent of Rachlin’s (1990) earlier insights on why people gamble, Fantino and Stolarz-Fantino emphasize the relevance of self-control, temporal discounting, and the sunk-cost effect. A gambler with a problem controlling his or her level of play is described as someone for whom occasionally winning a small amount of money over the short term trumps the benefits of conserving money over the longer term, for instance, by simply walking away from the game before losing more or perhaps all of their money. Self-control is the culprit, then, which is weakened if not defined by the problem gambler’s tendency to steeply discount the long term advantages of saving or conserving money.

Rachlin (1990) speculated that the tendency to discount the upside of saving money is related to how the problem gambler responds to the distribution of wins and losses over repeated gambles. On this view, a winning bet has two main effects: (1) it sets the occasion for the gambler to take stock of the monetary cost of the win, which in turn (2) sets the occasion for subjectively discounting that cost in relation to that win. In other words, the effect of a win is to minimize the downside of the losses that preceded it. To make matters worse, Rachlin predicts that the longer the string of losses prior to a win, the greater the degree of discounting the cost of the win.

“Chasing losses” aptly describes these effects and seems also to relate to the conditions under which the sunk cost effect is observed. To combat that effect, Fantino and Stolarz-Fantino suggest that it may be beneficial either to increase the magnitude of the monetary difference between losing and winning or to provide cues that inform the problem gambler that continued play amounts to losing play.

If Rachlin’s (1990) analysis is near the mark, then anything less than a dramatic and sustained difference between losing and winning will not inhibit the level or persistence of the problem gambler’s play. How large and how sustained this difference would have to be is a worthy topic that might take as its starting point the uppermost limit of the difference. Who would risk their home, life savings, and job on a single gamble? By the same token, who would take a single puff
from a cigarette if the immediate consequence was terminal lung cancer?

Informative cues might discourage losing play, and yet the reality is that no such cues are available where it matters the most: the natural gaming environment. Casino gaming is by far the most common form of gambling in this country and abroad; it is also a wildly profitable, multi-billion dollar industry that is clearly invested in protecting not only its own revenue stream but also the enormous capital that it adds to the nation’s tax base (cf. Ghezzi, Lyons, & Dixon, 2000). Discouraging losing play, then, is obviously not in the industry’s best interest.

What is instead in the gaming industry’s best interest is to encourage play, and it often does this by capitalizing on so-called “gambler’s fallacies.” Fantino and Stolarz-Fantino mention this in connection with the role that verbal behavior can play, for instance, in the development of the false or illusory belief that one can control the outcome of purely chance events. Dixon and Delaney (2006) are at the forefront of work of this sort, and Fantino and Stolarz-Fantino add to it with the intriguing suggestion that gambling-related thoughts may acquire discriminative control over play.

A fallacy of a different sort is the “near-miss effect.” The effect is seen in slot machine play, for example, where two of three winning symbols appear on the pay line in manner that fosters the false belief that a winning spin is close at hand. With that belief in mind, the gambler will presumably play beyond the point at which they would otherwise stop playing.

A functional analysis of the near miss effect in slot machine play centers on the conditioned reinforcing properties of the symbols and the rate and pattern of responses that produce them (Ghezzi, Wilson, & Porter, 2006). Research to date suggests that the near miss effect may be overstated as a means of prolonging slot machine play, however. In any case, the effect represents yet another opportu

REFERENCES
COMMENTARY

GAMBLING AND RISKY CHOICE

John C. Borrero
University of Maryland, Baltimore County

Fantino and Stolarz-Fantino bring a very rich understanding of basic research with humans and nonhumans to bear on what may be considered a gambling pandemic. As the well-researched random ratio schedule may characterize “gambling” by nonhumans (e.g., Madden, Ewan, & Lagorio, 2007), the slot machine or similar games of chance characterize gambling by humans. By walking the reader through the enormous body of literature that relates to probabilistic and delayed outcomes Fantino and Stolarz-Fantino draw the reader’s attention to several findings that suggest that humans should not be problem gamblers (e.g., experimental evidence that illustrates that money is discounted less steeply than other goods and the essentially human characteristic of risk aversion). The authors then go on to suggest additional environmental circumstances that illustrate why we should expect problem gambling (the authors place considerable and appropriate weight on the gambling context and the potential differential sensitivity of a particular organism’s behavior; a strictly idiographic account and one that should evoke no objections from the most radical of behavior analysts, nor the most logical psychologist, psychiatrist, or economist). Dixon, Jacobs, and Sanders (2006) recently addressed the role played by context (a gambling environment as compared to non-gambling environments) and found that pathological gamblers’ level of discounting was altered by the context in which the discounting tasks were completed. More to the point, the gambling environment appeared to have evoked greater discounting as compared to the non-gambling environment for many of the participants. What this seems to suggest is that the extent to which one discounts delayed (or probabilistic) events is a function of prevailing environmental contingencies, the individual’s specific history with similar environmental contingencies, and very importantly, the commodity under consideration (e.g., money vs. events that have direct metabolic function, as the authors suggest). Again, a suggestion that should evoke no objection.

In reading this exceptional discussion piece I found myself pondering two questions: (a) What is gambling? and (b) How might a behavioral approach to gambling deal with outcomes that are not easily quantifiable? I turn next to some explication of both considerations.

GAMBLING, PROBLEM GAMBLING, AND PATHOLOGICAL GAMBLING

The task of defining gambling should be rather simple, and on the surface it is probably well understood by those who read this journal. Fantino and Stolarz-Fantino frequently used the terms “pathological gambling” and “problem gambling” to describe the topic at hand (i.e., gambling). Pathological gambling is a formal psychological disorder (under the category of “impulse-control disorders not

Address Correspondence to:
John C. Borrero
Department of Psychology
UMBC
1000 Hilltop Circle
Baltimore, MD 21234
Email: jborrero@umbc.edu
John C. Borreiro

elsewhere classified”) and may be diagnosed when a person meets 5 or more of the 10 diagnostic criteria for the disorder (DSM IV, 1994; Petry & Armentano, 1999). Problem gambling falls short of pathological gambling, but is exemplified by behavioral symptoms of pathological gambling (Weatherly & Dixon, 2007). Clearly, these are persons in need of assessment and intervention, and presumably this strengthens our conceptualization of gambling. From my reading, gambling connotes undesirable behavior. Clearly in the case of pathological or problem gambling undesirable behavior is denoted and not connoted. If we simply take the term gambling however, we might conceptualize it as actively choosing to risk losing one reinforcer to obtain a highly preferred reinforcer with a probability less than 1.0 (G. Madden, February 8, 2009, personal communication). If the reader finds this to be an acceptable definition of gambling, then one might ask, is gambling bad? My sense is that gambling (just gambling) is not “bad” and in some situations it may be “good.” For example, in an educational context, a young student may be faced with a situation in which she can earn a lower quality reinforcer for completing mastery level tasks (those that she can complete accurately and fluently) or earn a higher quality reinforcer for completing more challenging material. By choosing the mastery level task we may conclude that the student has not gambled (the probability of reinforcement for completing the “easy” tasks is 1.0). By choosing the challenging task the student must forgo a sure thing (the reinforcers, albeit less preferred reinforcers, available from the mastery level tasks) for the chance to obtain a highly preferred reinforcer with a probability of less than 1.0 (since the task is more difficult and she will likely emit some incorrect responding thereby resulting in less overall reinforcers). From a strictly pragmatic perspective, an educator or parent would likely encourage the “gamble” in this scenario guided by the assumption that bringing the student into contact with such learning opportunities will impact the acquisition of new skills. This example too fits with the framework constructed by Fantino and Stolarz-Fantino regarding why we should expect gambling (e.g., the context in which choices are made) and should not expect gambling (e.g., humans are risk averse), and is also consistent with the authors’ reference to work by Holt, Green, and Myerson (2003) who suggest that impulsivity is not a central trait that defines risk taking and hypersensitivity to delayed events. Like the conditions that do or do not support pathological gambling, the conditions that support risky choice (when the outcome for doing so is the edification of the organism) should also be considered.

QUANTIFYING DIFFICULT TO QUANTIFY OUTCOMES

For behavior analysts to conduct evaluations of (monetary) gambling is by no means an easy endeavor, and one for which behavior analysts have particular skill (e.g., conceptually and methodologically). It is challenging for several reasons, and one particularly complex variable suggested by Weatherly and Dixon (2007) is human verbal behavior. Again, I recognize and agree that monetary problem and pathological gambling are in dire need of sound behavioral research. The discounting (delay or probability) procedures described by Fantino and Stolarz-Fantino have resulted in very useful metrics to characterize the value of delayed monetary events. However, as the authors note, the outcomes of pathological gambling are sometimes difficult to quantify. For example, we can easily point to the financial losses incurred by the problem gambler, but how does one quantify marital dysfunction that contributes to divorce? Without a monetary conversion of the outcome, how does one characterize the (real) costs of pathological gambling? Odum, Baumann, and Rimington (2006) and Bickel, Odum, and
Madden (1999) take us closer to a better understanding of how this might be accomplished. Odum et al. pitted amounts of food against monetary rewards and Bickel et al. pitted delayed cigarettes against delayed money, both in traditional discounting preparations. While both food and cigarettes may also be converted to monetary amounts, the value of cigarettes, for example, is likely more than its simple monetary conversion. The observation here is that gambling (in the broader use of the term) is associated with a number of possible outcomes that may pose challenges for behavioral researchers driven so strongly by a method of quantification. But we should not give up. Sexual promiscuity may be one such example of gambling. The “gamble” in this situation might involve foregoing a “safe” encounter with a long-term partner while actively choosing to engage a stranger. Although the reinforcing value of the interaction with a stranger may be exceedingly high at the 0-s delay marker (immediate reward), the potential outcomes of the choice may be considerable (e.g., a sexually transmitted disease, a disrupted relationship with the long-term partner) but more difficult to tag with a number.

It would be foolish to presume that the two observations put forth in this commentary represent the “next steps” in the evaluation of gambling (broadly defined). It is clear that there are other more pressing matters to address first. However, Fantino and Stolarz-Fantino have reminded me that there are also other complicated matters that behavior analysts will likely need to address to construct a comprehensive approach to risky choice and pathological gambling. By establishing and fostering relationships with colleagues beyond the choir (behavior analysts) we may move closer to a comprehensive treatment of the problem.

REFERENCES


Author Note

I thank my graduate students for their stimulating discussion of the work by Fantino and Stolarz-Fantino and for assisting me in formulating my commentary.
COMMENTARY

ON THE ROLE OF VERBAL BEHAVIOR IN UNDERSTANDING GAMBLING BEHAVIOR

Erik Arntzen
Akershus University College

In their target article, Fantino and Stolarz-Fantino, point to a number of important issues for understanding gambling behavior. Salient amongst these is describing the factors that influence decision-making in gamblers, and the effects these factors have on gambling behavior. Behavior analysis has much to contribute towards the understanding of the disorder labeled pathological gambling (e.g. Dixon, 2007). However, there are quite few basic research studies examining gambling behavior and even fewer detailing behavior analytic treatment. This is the case even though problem gambling is extensive: for example, in Norway the treatment of children with autism is largely based on a behavior analytic approach, yet there are ten times more people who display problem gambling than there are those diagnosed with autism. It seems that treatments for problem gambling using a behavior analytic approach are under-represented. The reasons for this may reflect that it is difficult to secure funding for behavior analytic projects focusing on gambling behavior, and there may be a resistance to acceptance of a behavior analytic understanding of pathological gambling given that most research on gambling has come from domains outside of behavior analysis.

Several researchers have pointed out that a step further in understanding problem gambling behavior could be to investigate the role of verbal behavior (Dixon & Delaney, 2006; Dymond & Whelan, 2007; Rehfeldt & Dixon, 2007) and the importance of self-generated rules (Weatherly & Dixon, 2007). One way to evaluate the effects of self-generated rules on behavior is protocol analysis (Ericsson & Simon, 1984), a method for analyzing the effects of verbal behavior on other behavior using verbal reports from the participants. However, Cabello and O’Hora (2002) have called attention to some troublesome aspects with the methodology, maintaining that the procedure is time consuming and complex, there are no implementation manuals, and there are significant limitations on the interpretation of data. Hence, there is always a question about the correspondence between saying (or thinking) and what a person actually does (Israel, 1978). For example, in a book from early in the last century Holt (1915) writes about what was behind the thinking, i.e., actually how low the correlation between thinking and doing actually could be. In an example, a man purchased a ticket at the railway station. Instead of asking him to describe his reasons the author observed him further to determine what controlled his behavior; and found, amongst other things, that he was meeting people at different offices in the city etc. The author notes that had he been asked at the station what was behind his action of buying a ticket at the railway station and he might have answered:
“Thinking?” he may reply, if he condones our guidelines impertinence. “Why, I am thinking that it’s a plague hot day, and I wish I had made my morning bath five degrees colder, and drunk less of that hot-wash that my wife calls instant coffee.” “Was that all?” “Yes, that was all until I counted my change; and heard the train whistle ...” (Holt, 1915, p. 87).

However, Hayes, White, and Bissett (1998) describe ‘the silent dog’ method, where, in an attempt to increase the validity of verbal self-reports of ongoing behavior, there are three controls introduced to protocol analysis. In Control 1, the talking aloud should not influence the on-task behavior, which means that the on-task behavior should be the same with talk aloud or not. In Control 2, distracters presented, such as reciting letters, counting etc., should not reduce the on-task behavior to the baseline level; it is also important to note that the distracters should not be incompatible with the on-task behavior. In Control 3, self-generated rules recorded in the first condition (Control 1) should be used in training on-task behavior in another participant.

We have done some experiments in our lab to evaluate the role of self-generated rules, participants were told to talk aloud while completing tasks in an experiment similar to that conducted by Zlomke and Dixon (2006). The participants were pretested on responding on two different slot-machines, yellow and blue, followed by a conditional training of arbitrary relations “greater than” and “less than” in the presence of contextual cues (yellow or blue). Then the participants were tested on the slot machines, posttest, to see if the preferences had changed according to the conditional discrimination training. One group of participants was instructed to talk aloud during the experiment. Based on participant’s ongoing self-talk we extracted rules which were then presented to another set of participants. There have been some difficulties with the verbal reports and the correspondence to on-task behavior. Thus, we found that participants who were instructed to talk aloud and say, for example, “The blue slot machine is giving the highest yields”, may still press the yellow slot machine. Also, in the studies we have conducted we have found difficulties in getting other participants to follow the rules created by others (the third control in the silent dog method).

Relevant to this issue, Pelaez and Moreno (1998) have argued for a useful taxonomy of rules and the effects on the listener; that is, sixteen types of rules derived from four dimensions: (a) explicitness, (b) accuracy, (c) complexity, and (d) source. In the first dimension, explicitness, the rules could be categorized as either explicit or implicit; explicit rules are rules where all contingency components are included, while implicit rules would be rules in which some aspect of the contingency are omitted in the description, for instance, the consequences. The second dimension, accuracy, relates to the specification of the contingencies in the rule and the subsequent matching (or correspondence) to what actually occurs when the rule is followed. The third dimension, complexity, is for example related to number of elements of the antecedent stimuli. The last dimension, source, refers to whether rules are either self-generated or produced by others. In our research (Arntzen, Halstadtro, & Halstadtro, in press) we found that both the explicitness and the source dimensions are important in understanding the differences in the participant’s performance (i.e., implicit rules was used and the differences in performance could be related to missing factors because the rules are produced by others). Dixon (2000) has also conducted a study showing that gambling could come under control of rules generated by the experimenter even if the rules are inaccurate.

It is not only different reinforcement schedules alone which control gambling be-
behavior, but a number of other factors, as pointed out by Fantino and Stolarz-Fantino (2008), are involved in this complex set of behaviors. One critical factor amongst these is the role of instructions or rules, either experimenter defined or self-generated. The taxonomy offered by Pelaez and Moreno (1998) could prove a useful tool for categorizing such rules, and provide a fruitful avenue for further behavior analytic research into the controlling variables that maintain problem gambling behavior.

REFERENCES


Author Note

The author thanks Carl Hughes for his comments on a previous version of the manuscript.
COMMENTARY

GAMBLING, PROBLEM-SOLVING, AND THE CONTINGENCIES OF SUPERSTITION: A RESPONSE TO FANTINO & STOLARZ-FANTINO

Chris Ninness and Sharon Ninness
Stephen F. Austin State University

The excellent paper by Fantino and Stolarz-Fantino provides a compelling examination of the behavioral complexities and paradoxes saturating gambling, risk-taking, and superstition. The paper concludes with two Zen-like (ironic but poignant) level headings: “Why We Should Not Expect Problem Gambling” followed by “Why We Should Expect Problem Gambling.” The issues presented in both of these level headings are addressed and presented to the reader with the realization that the topics remain increasingly intricate and experimentally allusive. The authors state:

A more satisfying and complete account awaits after a great deal more research is undertaken. Discounting functions certainly play a central role in helping us appreciate the nature of gambling, but they are only a part of a rather rich tapestry of contingencies, including the social, emotional, and verbal.

We agree unquestionably, that rigorous investigations into the dynamics of gambling must continue. However, within the experimental analysis of human behavior, some of the answers may be found by looking forward and backward in time. We will briefly describe two rather dated studies conducted in the examination of gambling and superstitious behavior with a focus on how these might reflect some of the current issues within the analysis of these interwoven behavioral phenomena.

A fifteen year old study conducted by Ono (1994) provides a fascinating exploration of superstitious behavior among adult humans as experimental contingencies become increasingly transparent across conditions. In fact, this study may be a better simulation of gambling scenarios than superstitious behaviors. College students assigned to experimental or control groups were asked to generate rules regarding the best way to earn points when pulling a lever in an isolated experimental setting. In this study, students were provided points according to a differential reinforcement of high rate responding (DRH) schedule. If a participant performed at least 5 responses in 15 seconds, a reinforcement lamp was illuminated indicating point acquisition. Actual participants were given partners with whom they supposedly exchanged “response tips” while taking turns at the experimental apparatus. After completing each session, participants formulated and wrote bulletin board tips (rules) regarding how to best perform on the apparatus. Ostensibly, their “partners” did the same. The experimental arrangements were cleverly designed so that it would appear that participants would "benefit" from their own experience, as well as the experience of their respective “partners.”

Address Correspondence to:
Chris Ninness
School & Behavioral Psychology Program
P.O. Box 13019
SFA Station, Stephen F. Austin University
Nacogdoches, TX 75962
E-mail: cninness@sfasu.edu
Initially, the confederates’ bulletin board postings tended to exaggerate the optimal response rate needed to acquire maximum points during a given session. During the early stages of the experiment, participants showed a very high level of compliance with these rules. In fact, many participants pulled the lever four to five times faster than necessary. Interestingly, however, as the various experimental conditions unfolded, many of the participants' performances began to drift from the posted bulletin board tips. With increasing exposure to the actual contingencies, the participants appeared to be operating according to a combination of their own self-generated and posted rules (accurate or otherwise) and “some” of the rules provided by the confederates. Unlike a control group unexposed to confederate tips, however, the experimental participants usually failed to maximize their response potential in accordance with the prevailing contingencies within a given condition. Notwithstanding, it is fascinating to note that while the participants gradually drifted away from absolute compliance with posted confederate (counterfeit) tips for maximizing rewards, these participants always performed in absolute compliance with the (accurate or inaccurate) response tips they, themselves, had generated and posted on the bulletin board for the benefit of their respective partners.

Five years later, we (Ninness & Ninness, 1999) published a “math oriented” systematic replication of the now classic Ono study by way of a coin toss graphic computer math game. In this somewhat dated study, fifth-grade students engaged in a form of “mathematical gambling.” Group 1 students were exposed to response-independent reinforcement according to a second-order RR 2 (RT 30-s:S) (fluctuating between 15-s and 45-s) by way of our (primitive by today’s standards) coin toss computer-interactive simulation. As a historical marker, sometimes such higher-order schedules have been referred to as “double-intermittent” schedules (Millenson & Leslie, 1979). Students in Group 2 received standard RT 30-s reinforcement while a control group was simply exposed to the same demand conditions, but received no form of programmed consequences while sitting at the computer. For this control group, accurate responding to math problems simply allowed access to more math problems.

During the final stage of the study, an extinction condition, students receiving RR 2 (RT 30-s:S) continued performing at extremely high rates throughout the duration of a 25-min extinction condition in which the simulated coins continued to flip intermittently but never matched following each correct math response. Unlike control participants or participants in Group 2, debriefing comments made by Group 1 students exposed to this “double-intermittent schedule” suggested that they really wanted to work even longer and would have done so had the program not terminated automatically after 25-min. Paradoxically, these participants earned less than half as much financial reinforcement as Group 2 students, while they performed an average of 287 more responses across experimental conditions. It is particularly remarkable to note that these students performed at their highest level of speed and accuracy during the extended but fruitless extinction session.

We believe that the relentless persistence and robust rates of accurate problem solving in the face of extinction displayed by Group 1 subjects may be at least partially attributable to the rule-governed effects emerging from exposure to the second-order schedules. Interestingly, parallel findings have been demonstrated in nonverbal organisms. As another related classic study, Zimmerman (1957, 1959), shaped a FR 15 lever press to the sound of a buzzer as a s<sup>CD</sup> allowing access to an opportunity to an alleyway and
ultimately receive primary reinforcers. By integrating the FR 15 lever press as a second-order operant, rats executed literally thousands of lever presses and sustained extraordinarily high rates of responding for over 20 hr in the face of experimental extinction. Analogously, astonishingly high rates and long durations of extremely accurate problem solving by Group 1 students may have been attributable to the direct-acting and the self-generated rule-governed effects emerging from contact with our doubly-intermittent coin-toss form of mathematical gambling.

The previous sentence may beg the question, why invoke the influence of self-generated rules when lower organisms appear to respond in similar fashion in the face of similar experimental arrangements? Unlike control participants as well as Group 2 participants exposed to (single-intermittent) RR reinforcement schedules, post-experimental written responses from Group 1 students consistently indicated that they really "believed" there was a very real "cause and effect" relationship between their high rates of accurate responding and their likelihood of accessing increasing levels of monetary reinforcement via the coin toss gambling graphic. We are simply unable to rule-out the influence of self-generated rules, since all participants in Group 1 acted precisely in accordance with the very rules they had generated during extinction.

In total, it appears college students and fifth-graders behaved in accordance with the contingencies described by Fantino and Stolarz-Fantino "when the true contingencies are disguised, as they are in some gambling situations, players may be led to make less-than optimal decisions". In the above Ono (1994) study, the underlying experimental contingencies became increasingly conspicuous and the participants’ self-stated rules gradually reflected these contingencies, as did their behavior. With regard to our fifth-graders, accurate rules were rarely expressed, and very much like the author’s description of the research conducted by Ladouceur and Sévigny (2005), subjects:

"persisted longer in playing a video lottery game when they believed that pressing the screen activated a “stopping device” that made the reels stop spinning. This gave players the illusion of control over outcomes; in reality, the outcomes were pre-programmed and the device had no effect.”

REFERENCES
IN RESPONSE

RESPONSE TO COMMENTARIES

Edmund Fantino and Stephanie Stolarz-Fantino
University of California San Diego

Our emphasis on discounting in the target article was a response to a request to prepare an article with that emphasis. But whereas we agree that discounting research and theory provide a useful framework in which to view gambling, we also agree that there is much more to the gambling story. Indeed we share Catania’s reservation that, while discounting functions are “economical ways to describe patterns of behavior,” they do not explain the behavior described.

We are delighted that our article set the occasion for such a thoughtful and varied set of responses. We agree with nearly all the points brought up by the commentators, including the fact that the effects of the putative controlling variables on gambling “will not be … simple or even direct …” (e.g., Weatherly and also Hantula and Puvathingal).

Some of these controlling variables include: verbal behavior (e.g., Dymond and also Catania) including rule-governed effects (e.g., Ninness and Ninness, and also Arntzen); the effects of context (e.g., DeLeon, and also both Borrero and Dymond); the unique role played by special circumstances such as jackpots (e.g., Madden) or debt (e.g., Lyons); the role of mediating variables such as thinking, which is more properly considered “an aspect of the dependent variable” (e.g., Hayes); the importance of the entertainment and/or escapist value of gambling (e.g., Derevensky); and the role of conditioned reinforcement (e.g., Ghezzi). Moreover, much more should be said about the effects of both environmental (e.g., Catania) and neurobiological (e.g., Potenza) determinants of gambling.

We exercise restraint by addressing three issues only. First, the relevance of Rachlin’s elegant string theory was raised in three of the commentaries (Ghezzi, Lyons, and Madden). We respond by referring to a discussion of string theory in the context of data on sunk cost from our laboratory (Fantino, Navarro, & O’Daly, 2005). These data would appear to pose difficulty for string theory. However as the various commentators have made clear we would not expect any one account of gambling to be applicable for anything approaching all gambling situations.

Second, the points about jackpots and debt are well taken. For someone sufficiently desperate, in the sense of lacking viable alternatives, the long-shot gamble may be the best shot available. In fact, lower-income people may view gambling as one of the rare arenas in which they have an even playing field. For example, Haisley, Mostafa, & Loewenstein (2008) found that participants were more likely to buy lottery tickets after completing a task highlighting situations in which high or low income people had advantages, and thus implicitly calling attention to the fact that all players have an equal chance to win the lottery. And Callan, Ellard, Shead, & Hodgins (2008) found that college students made to feel relatively deprived compared to their peers with respect to the amount of their disposable income were more likely to partici-
participate in a gambling opportunity than those who did not feel deprived. The budget rule of behavioral ecology stresses that organisms sufficiently deprived will become (and critically, should become) risk-prone. A discussion of risk as a function of budget and some relevant data may be found in Goldshmidt & Fantino (2004). There too the situation is complex. As Borrero points out, there are still other situations in which “risky” choice is also a sensible choice.

Madden’s “thought experiment” involving the cigarette and monetary casinos indeed provides food for thought. There are in fact gambling venues where non-monetary rewards are expected and where cartons of cigarettes might be apt inducements (e.g., bingo parlors). Most smokers do not have a history of gambling for cigarettes; thus, it would not be surprising if they chose the monetary casino. However, this outcome may not tell us much. In order to gamble at the cigarette casino that Madden portrays, the gambler would be gambling his own cigarettes. By definition, then, he would not be cigarette-deprived. A different outcome might be evident if a severely-deprived smoking gambler were using money or some other currency to wager for cigarettes. In fact deprived smokers exhibit steeper discount functions than do non-deprived ones (as found, for example, in recent research conducted by Rick Lamb and Paul Romanowich at the University of Texas, San Antonio). We join Madden and the other commentators in hoping that some of the issues raised in these exchanges will further spur a robust functional analysis of gambling.

Gambling behavior, while complex, provides excellent opportunities to study decision-making, self-control and impulsivity, and the roots of addictive-like behavior within the context of everyday settings.

REFERENCES
THE IMPACT OF JACKPOT AND NEAR-MISS MAGNITUDE ON RATE AND SUBJECTIVE PROBABILIT Y OF SLOT MACHINE GAMBLERS

Jeffery Dillen and Mark R. Dixon
Southern Illinois University

The present study examined the degree to which varying amounts of jackpot size would impact the rate and subjective probability of slot machine play in recreational gamblers. Twenty college undergraduates who reported occasional slot machine playing served as participants. Two groups of 10 participants were utilized with each group exposed to one of two monetary contingencies ($0.50 USD versus $2.00 USD). Various behavioral measures (e.g., inter-response times, subjective probabilities) were measured on each individual trial, and resistance to extinction was also examined. A significant difference of trial outcome (following losses and following wins) was found in respect to inter-response time in that inter-response times were significantly greater following winning trials (i.e., spins) than losing trials, and this difference was not mitigated by jackpot size. Jackpot size only altered responding to near-miss jackpots during extinction conditions. Implications for the treatment of pathological gamblers are presented.

Keywords: near miss, slot machine, reinforcer magnitude, extinction

The foundational behavioral account as to why people continue to gamble when the odds of winning are against them was that the maintenance of the behavior occurred via a specific reinforcement history (Skinner, 1953). Most games consist of a delivery of reinforcement on a variable/random-ratio schedule of reinforcement (Knapp, 1997; Skinner). This intermittent schedule of winning is one of the principal elements involved in theoretical accounts of gambling from a behavioral perspective (Petry & Roll, 2001; Rachlin, 1990). However, the complexity of the natural environment where gambling takes place appears to be more multifaceted than a single reinforcement schedule. Various environmental stimuli (lights, free drinks, other

Address Correspondence to:
Mark R. Dixon, Ph.D., BCBA
Behavior Analysis and Therapy Program
Rehabilitation Institute
Southern Illinois University
Carbondale, IL 62901
E-mail: mdixon@siu.edu

gamblers) exist, as well as the resulting psychological functions those stimuli have on the individual gambler of interest (see Weatherly & Dixon, 2007 for a discussion). The additional influence of verbal behavior and rules, both in the environment and within the skin of the person of interest, have also been investigated as potential maintaining influences on gambling behavior (Dixon & Delaney, 2006; Dixon, Hayes, & Aban, 2000).

Controlled explorations as to what variables do in fact impact responding of the gambler are often conducted in analogue or contrived settings. Experimentation in an actual casino is difficult, if not impossible, and attempts would lack the necessary control needed to ensure internal validity. Without tightening control over the various extraneous variables in a casino, scientific research on gambling will be limited to only correlational accounts and not cause-and-effect deductions. Perhaps one of the most common problems in controlled gambling-like research is the delivery of a consequence that mirrors that to ac-
ually winning money in a casino. Players may be given money by the researcher (e.g., Weatherly & Meier, 2007), promised course extra credit if they are college students (e.g., Dixon & Jackson 2008; Zlomke & Dixon, 2006), or some approximation of both. Others may play simply for the “fun” of gambling being an enjoyable activity. The wide variation in consequential outcomes for participation in casino-like studies has led to debates as to if real money outcomes are functionally similar or different to non-money outcomes (see Weatherly & Meier). For example, research by Weatherly and Meier found that video poker players did not differ in trials played when winning game outcomes were paid with money when compared to conditions where winning game outcomes were paid nothing. These findings run contrary to those of Weatherly and Brandt (2004) that did show differences in trials played by slot machine gamblers when comparing money and no money conditions. In short, the value of money in experimental research is still unknown.

Following from the issue of money or no-money outcomes in experimental research on gambling is the effect of such outcomes’ magnitude or size. Conflicting data have been generated with respect to large or small wins sustaining gambling for longer periods of time. For example, Weatherly, Sauter, and King (2004) exposed one group of gamblers to a large win early in their gambling history (within the context of the experiment) followed by an extended period of no wins, and another group of gamblers to equal total valued amounts of small frequent wins, followed by the same extended no win period. These authors found that the participants exposed to the smaller more frequent wins sustained their gambling behavior under extinction conditions much longer than those participants who experienced a single “big win.” Similar reports have been made by Dixon, MacLin, and Daugherty (2006). The opposite findings of the effects of a single large win have been reported by Delfabbro and Thrupp (2003) who claimed that a large win early in a gambling history is highly correlated with significant gambling problems.

Outside of the mainstream behavioral literature, other gambling researchers have investigated how other structural characteristics of the game itself may sustain gambling. The “near-miss”, or almost winning is exemplified on a slot machine when the display presents two of three winning symbols on a payoff line and the required third winning symbol immediately above or below that payoff line. Reid (1986) has claimed that the near-miss itself could be a reinforcer because “almost winning” is almost as good as winning itself. Griffiths (1999) has argued that near-misses could contribute to a “gamblers fallacy” in which a win is sure to ensue after a string of losses or in this case, the near-miss. According to Skinner (1953) the near-miss or “almost hitting the jackpot increases the probability that the individual will play the machine”, thus sustaining play. Contemporary behavioral conceptualizations of the near miss have ranged from stimulus generalization to a verbal discriminative stimulus (Dixon & Schreiber, 2004). Regardless of which theoretical conceptualization that one may take, the near-miss occurs, alters responding of gamblers (Dixon, Nastally, Jackson, & Habib, under review), and it appears logical that a near-miss for a small jackpot may alter responding differently than a near-miss for a large jackpot.

The primary purpose of the following study was to examine the impact of jackpot size and trial type (win, loss, and near-miss) on recreational gamblers playing a simulated slot machine. Unlike previous studies (Weatherly & Brandt, 2004; Weatherly, Sauter, & King, 2004) in which small monetary incentives were used and made possible to participants, this study utilized relatively larger incentives in hopes of expanding the body of
research on jackpot size and near-miss effects on responding.

METHODS

Participants, Recruitment, and Group Assignment

Twenty undergraduate students served as participants in this study. All participants were at least 18 years of age and students of Southern Illinois University Carbondale. There were 14 males and 6 females ranging in age from 18 to 24 years old. Of the participants, 18 were undergraduate students and 2 were graduate students. Participation took between one and two hours to complete.

Participants were recruited through several means. Public postings describing the study and its compensation (i.e., having the chance to win money; described below) were located within the Rehabilitation Institute and across other university buildings located on the campus of Southern Illinois University Carbondale (e.g., Student Center). In addition, the first author made in-class presentations in Rehabilitation and Psychology courses in which the study was briefly described, notification of potential compensation was provided, and process to participate was outlined.

Potential participants were administered the South Oaks Gambling Screen (SOGS; Lesieur & Blume, 1987). This is a 16-item questionnaire devised to assess the participant’s previous gambling activity. Scores of 5 or greater have been demonstrated to be an indicator of potential pathological gambling behavior (Lesieur & Blume). Psychometric properties have indicated the discriminant validity to be excellent in that it correctly identifies problem gamblers 95% of the time in comparison to social gamblers (Friedenberg, Blanchard, Wulfert, & Malta, 2002). No SOGS score exclusion criteria was used in the current study. Obtained SOGS scores were used to ensure group homogeneity. No participants were removed from the study based on SOGS score, and no participants elected to terminate the study prematurely before completion.

Participants were randomly assigned to one of two conditions of the study. If a participant dropped out or failed to attend a scheduled session, participants were added to each of the conditions.

Experimental Setting and Apparatus

All experimental sessions were conducted in a small room (3 x 3.5 m) within the Rehabilitation Institute at Southern Illinois University Carbondale. The room contained gambling equipment (e.g., craps table, four slot machines, roulette wheel) along with a table, two chairs, physiological equipment, personal computer, and a one-way observation mirror.

The experimental apparatuses consisted of two IBM-compatible laptop computers running slot machine simulations. The slot-machine simulation was a custom version of that described by MacLin, Dixon, Robinson, and Daugherty (2006) and was programmed on the first computer (Toshiba Satellite Pro) in Microsoft Visual Basic.Net. Figure 1 displays an image of the slot machine. The other computers were not used in the present study.

The slot machine simulation had three reels, each consisting of six symbols, which spun when the participant hit the “Spin” button, and a “payout line”. Three positions were visible to the participant by means of the payout window. Only when three of the same symbols were aligned on the “payout line” would a spin be considered a WIN. When two of the same symbol were aligned on the “payout line”, that was considered a Near-Miss (NM); however, near-misses were not utilized in this study until the extinction phase (described below). All other combinations were considered a LOSS. Reels stopped sequentially from left to right with the entire reel spin lasting approximately four seconds. When three of the same corresponding
symbols were aligned on the “payout line” (WIN), the dollar amount per WIN corresponding to the experimental group the participant was randomly assigned to was added to the “Amount Won” textbox located directly above the reels. Topography of wins, losses, and near-misses were determined randomly via random number generators that were part of the computer program.

The version used in this study was dissimilar to the MacLin et al. (2007) version in three ways. Initially, each spin (i.e. trial) outcome was pre-determined by the experimenters. Second, a probability bar was added so participants, at the completion of each spin and before the commencement of the next spin, provided an indication of how confident they were the next spin would be a win. The probability bar ranged from ‘1’ (losing hand for sure) to ‘10’ (winning hand for sure). Lastly, the “TOTAL CREDITS” and “AMOUNT BET” textbox’s were removed from the MacLin et al. (2007) version.

Research Design

A between-groups design was utilized in the present study. Participants were assigned to one of two groups that varied in the amount of money earned following a winning trial. A reversal design (i.e., ABAB) was used within each group with experimental phases alternating between monetary contingencies absent and present. Both groups of participants were exposed to the same distribution of wins, losses, and near-miss slot machine outcomes.

Procedure

Prior to the participant arriving, the first author randomly assigned the participant to one of the two experimental conditions. Upon arriving, the participant was asked to show a valid student ID and to subsequently sit at a desk in the room in which the study took place. The participant was subsequently provided with the informed consent form and asked to read and sign it. Upon signing, the participant was given the SOGS as detailed above.

The first author then read, similar in parts to Weatherly and Brandt (2004), the following to the participant:

You will now be given the opportunity to play a computer-simulated slot machine.
This simulation has been designed and is programmed identically to those found in actual casinos. That is, each potential winning result is programmed at a constant odds and each individual play is independent of the previous play. A variety of symbols will appear on the slot machine while you play, however, the same three symbols must be on the middle row to be considered a win.

You will start off with $0.00 dollars won. While playing, you will see two different background colors for the slot machine. When the slot machine background is red, each time three symbols are aligned on the middle row (i.e. WIN), you will win $0.00. When the slot machine background is blue, each time three symbols are aligned on the middle row, you will win ($0.50 or $2.00 depending on experimental condition) cents/dollars. You may quit (i.e., end the session) at any time after the “Exit” button appears by clicking on the “Exit” button at the bottom of the screen. The session will end when (a) you click “Exit,” or (b) two hours in duration have passed. Do you have any questions?

Any questions asked were answered by repeating the instructions above. After the experimenter read the instructions and answered any questions, the participant began the experimental task. The simulation began with the participant reading another set of instructions shown on the computer screen that were very similar to Dixon & Schreiber, 2002):

Before each trial, a probability bar will appear. Use the bar to indicate how confident you are that your next spin will be a winning one. Selecting a ‘1’ indicates that you guess the next spin will be a losing one for sure, while selecting a ‘10’ indicates that you believe your next spin will be a winning spin for sure. Respond on the numbers between 1 and 10 to your varying degree of confidence about the outcome of your next spin.
After hitting an “I Understand” button, the next screen provided more instructions about the computer interface and procedures for each trial.

During the game, once you select a probability number and hit the “Okay” button, the next spin will be available. You will need to click on the “Bet One” button located in the upper left hand corner of the screen. Once you have hit the “Bet One” button, you will then need to hit the “Spin” button to start the reels.

After hitting the second “I Understand” button, participants played the simulation until one of the aforementioned criteria was reached. Figure 2 displays a chronological depiction of each trial completed by the participant, and Figure 3 provides an illustration of the slot machine simulation interface after a “Win”.

As visualized in Figure 2, the participant initially clicked the second “I Understand” button to start the first trial. The participant subsequently chose a subjective probability value and selected the “Okay” button as a confirmatory response. A response was then made on the “Bet One” button, thus simulating a wager of one credit. After clicking the “Bet One” button, the participant clicked the “Spin” button at which time the reels spun. Approximately four seconds later, the reels stopped, the outcome was observed, and if a WIN occurred, the number of dollars won changed (i.e., if a winning trial occurred in the accurate corresponding background condition) along with a message that read “AWESOME…YOU WIN!!!” Correspondingly, no change was observed if a losing trial occurred or if a WIN occurred in a no-money condition. Finally, the participant hit the “Continue” button upon which the subjective probability bar appeared again and a new trial began. The point counter was constantly displayed and cumulative across all experimental conditions.

Upon completion, the participant was verbally debriefed, handed a permanent product of the debriefing, and paid the amount of money (in the form of a gift card) respective to the study condition they were randomly
assigned to. Session length never exceeded 120 minutes.

Experimental Conditions

**Adaptation.** This adaptation phase was 5 min in duration and was implemented to control for any idiosyncratic effects of initial responding to the experimental procedures. Participants played an average of 20 trials and lost on approximately 18 of the 20 trials.

**Monetary Contingency Absent (A1, A2).** During this phase, the background to the simulated slot machine was the color Red. Each participant played a total of 50 trials, which consisted of 5 WINS (10% of trials) and 45 LOSSES (90%). The location of each of the WINS and the topography of each spin was determined randomly via a random numbers generator. Initially, the location of each of the five WINS was determined by taking the first five numbers (moving horizontally from left to right) less than or equal to 50 produced by the generator. Subsequently, the topography of each spin outcome was determined via the ensuing described method. Each reel had 6 symbols and 6 blanks, thus 12 positions were available to land on for each reel during each spin. These 12 positions were each given a number (1 through 12) that associated each position of the reel with a number to be used in a random numbers generator. Each spin consisted of three positions (one for each reel) that fell on the “payout line,” thus three random numbers were used for each spin (one for each of the positions). The three random numbers for each spin were determined using the procedure described above with three caveats: (1) only numbers less than or equal to 12 were utilized, (2) if the same position number was observed in a string of three random numbers (e.g., 6, 4, 6; i.e., a near-miss result would occur), the last of the duplicate numbers was disregarded and the next number, one that failed to match either of the other numbers was used, and (3) on trials in which a WIN occurred, the first number in the generator was used for each of the three positions (e.g., 12, 12, 12) in order for a WIN to occur.

**Monetary Contingency Present (B1, B2).** During this phase, each participant played a total of 50 trials consisting of 5 WINS (10% of trials) and 45 LOSSES (90%), similar to the monetary contingency absent phase. Trial topography and outcomes were determined utilizing the exact protocol described above. However, in this phase, the background color was Blue and each WIN resulted in the specified monetary reinforcer (e.g., $0.50 ($5.00) or $2.00 ($20.00)).

**Extinction.** The Extinction phase commenced on trial 201 as the final WIN (number 20) occurred on trial 200 for each participant. During this phase, no WINS were programmed and only Near Misses (NM’s) and LOSSES resulted from each spin. Each block of 50 extinction trials consisted of 5 NM’s (10%) and 45 LOSSES (90%) with NM location and LOSS trial topography determined as described previously. In regards to trial topography for NM’s, there were three possibilities: (a) winning symbols located on the left and middle positions of the payout line (left), (b) winning symbols located on the left and right positions of the payout line (split), and (c) winning symbols located on the middle and right positions of the payout line (right). The quantity of each was determined by providing each possibility with a number (e.g., 1, 2, and 3) and using a random numbers generator to determine the trial topography for each of the 5 NM’s (e.g., 2 left, 2 split, 1 right). The actual topography within the NM was further determined via a random numbers generator, similar to that already described (e.g., positions 6, 4, and 6). The same trials and within NM topographies were used in each block of extinction trials and across participants.

Despite previous literature demonstrating that the frequency of NM’s is greater than WINS in a non-simulated slot machine
Table 1

<table>
<thead>
<tr>
<th>Participant</th>
<th>Sex</th>
<th>Group</th>
<th>Money Won</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>1</td>
<td>$20</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>1</td>
<td>$20</td>
</tr>
<tr>
<td>3</td>
<td>F</td>
<td>2</td>
<td>$5</td>
</tr>
<tr>
<td>4</td>
<td>M</td>
<td>2</td>
<td>$5</td>
</tr>
<tr>
<td>5</td>
<td>F</td>
<td>1</td>
<td>$20</td>
</tr>
<tr>
<td>6</td>
<td>M</td>
<td>2</td>
<td>$5</td>
</tr>
<tr>
<td>7</td>
<td>F</td>
<td>2</td>
<td>$5</td>
</tr>
<tr>
<td>8</td>
<td>M</td>
<td>1</td>
<td>$20</td>
</tr>
<tr>
<td>9</td>
<td>F</td>
<td>2</td>
<td>$5</td>
</tr>
<tr>
<td>10</td>
<td>F</td>
<td>1</td>
<td>$20</td>
</tr>
<tr>
<td>11</td>
<td>M</td>
<td>1</td>
<td>$20</td>
</tr>
<tr>
<td>12</td>
<td>M</td>
<td>2</td>
<td>$5</td>
</tr>
<tr>
<td>13</td>
<td>M</td>
<td>1</td>
<td>$20</td>
</tr>
<tr>
<td>14</td>
<td>M</td>
<td>2</td>
<td>$5</td>
</tr>
<tr>
<td>15</td>
<td>M</td>
<td>1</td>
<td>$20</td>
</tr>
<tr>
<td>16</td>
<td>M</td>
<td>2</td>
<td>$5</td>
</tr>
<tr>
<td>17</td>
<td>F</td>
<td>1</td>
<td>$20</td>
</tr>
<tr>
<td>18</td>
<td>M</td>
<td>2</td>
<td>$5</td>
</tr>
<tr>
<td>19</td>
<td>M</td>
<td>1</td>
<td>$20</td>
</tr>
<tr>
<td>20</td>
<td>M</td>
<td>2</td>
<td>$5</td>
</tr>
</tbody>
</table>

(Dixon & Schreiber, 2004), the percentage of NM’s remained the same (in comparison to WINS in previous phases; i.e. 5%) in this phase to control for any effects that both fewer LOSSES and an increased percentage of NM’s (compared to WINS) would have had on resistance to extinction. In addition, an “Exit” button was displayed on trial 201 that participants could voluntarily hit at any point subsequent to its availability, at which time the participant was finished.

**Dependent Measures**

This study concentrated on the following dependent measures: (a) total number of trials played during Extinction, (b) inter-response times between trials/spins, and (c) subjective probability following each trial. Total number of trials played during extinction was defined as the number of trials played after the completion of Trial 200. Response latency was defined as the time from the stopping of the reels of the slot machine to the participant hitting the “Continue Button” to start a new trial (see Figure 2). Subjective probability was defined as the Likert-scale number provided prior to the commencement of each trial.

**Data Analysis**

Two 2 x 2 mixed analyses of variance (ANOVA) were conducted to determine whether main effects of monetary incentive value ($5.00, $20.00) and/or trial outcome (following a loss, following a win, following a near-miss) or an interaction between monetary incentive value and trial outcome were present on inter-response times for the ABAB phase (following loss, following win) and EXT phase (following loss, following near-miss) of the study. Further, two additional 2 x 2 Mixed Analyses of Variance (ANOVA)
were conducted to determine whether main effects of monetary incentive value ($5.00, $20.00) and/or trial outcome (following a loss, following a win, following a near-miss) or an interaction between monetary incentive value and trial outcome were present on subjective probabilities for the ABAB phase (following loss, following win) and EXT phase (following loss, following near-miss) of the study. Finally, independent samples t-tests were conducted between monetary incentive value groups for the number of trials played during extinction.

For all statistical tests, and alpha level of 0.05 was utilized with the effect size provided when a statistically significant result was obtained and power provided when no statistically significance was obtained. When pairwise comparisons were calculated with more than one pair-wise comparison, a Bonferroni correction for multiple comparisons was utilized.

RESULTS

Demographics

Table 1 displays the composition of the participants in this study, specifically their sex, group assignment, and corresponding amount of money won. Each group of 10 participants consisted of 7 males and 3 females with Group 1 winning $20 and Group 2 winning $5. Table 2 exemplifies the score for each participant (separated by group) on the South Oaks Gambling Screen (SOGS) along with its ensuing classification. An independent samples t-test was conducted to
determine whether a difference in SOGS scores was present between the mean scores of Group 1 ($M = 2.40, SD = 2.95$) and Group 2 ($M = 1.30, SD = 2.54$) with no significant difference found, $t(18) = .893, p > .05, d = 0.42$. In summary, each group consisted of eight participants classified as having ‘no problem’ with gambling and two participants classified as ‘probable pathological gamblers.’

**Inter-Response Times**

A 2 x 2 mixed analysis of variance was conducted on group by trial outcome (following loss, following win) during the ABAB phase of the study to test for differences between Mean Inter-response Times (MIRT) for Group 1 ($$) vs. Group 2 ($$) across trial outcomes, differences between MIRT following losses vs. following wins for both groups, and for an interaction effect between group and trial outcome during the ABAB phase. The main effect of trial outcome was found to be statistically significant by the Wilks’ Lambda Criterion (Wilks’ $\lambda = 0.612, F (1, 18) = 11.415, p = 0.003, \eta^2 = .388$). Specifically, and as observed in Figure 4, MIRTs were significantly greater following winning trials ($M = 2.81, SD = 1.20$) than losing trials ($M = 1.88, SD = 0.31$). No main effects of group ($p = 0.114, power = 0.304$) or interaction ($p = 0.087, power = 0.403$) were found. Examining the mean inter-response times (MIRT) by group during the ABAB phase of the study, both demonstrated overall greater MIRT following winning trials ($M = 2.37, SD = 1.09$ and $M = 3.25, SD = 1.18$ for Group 1 and 2, respectively) than losing trials ($M = 1.94, SD = 0.39$ for Group 1, $M = 1.82, SD = 0.21$ for Group 2) (see Figure 4).

A 2 x 2 mixed analysis of variance was conducted on group by trial outcome (following loss, following near-miss) during the EXT phase of the study to test for differences
Figure 5. Interaction between mean inter-trial interval by group and trial outcome during EXT phase of study. Error bars represent one standard deviation around the mean.

between MIRT for Group 1 vs. Group 2 across trial outcomes, differences between MIRT following losses vs. following near-misses for both groups, and for an interaction effect between group and trial outcome during the EXT phase. An interaction effect was found to be significant by the Wilks’ Lambda Criterion (Wilks’ $\lambda = 0.719, F(1, 14) = 5.473, p = 0.035, \eta^2 = .281$). This interaction can be observed in Figure 5. The graph demonstrates that MIRTs were nearly identical following losing trials across groups; however, MIRT was significantly greater following near-misses for Group 1, the larger monetary group, than for Group 2, the smaller monetary group. No main effects of slot-machine outcome ($p = 0.463, \text{power} = 0.108$) or group ($p = 0.195, \text{power} = 0.245$) were observed. Investigating the MIRT during the EXT phase in which losing and near-miss trials were present, Group 1 ($20$) demonstrated greater MIRT following near-misses ($M = 1.02, SD = 0.27$) than losses ($M = 0.92, SD = 0.28$) whereas the opposite was true for Group 2 ($M = 0.72, SD = 0.30$ following near-misses; $M = 0.91, SD = 0.19$ following losses).

Subjective Probability

A 2 x 2 mixed analysis of variance was conducted on group by trial outcome (following loss, following win) during the ABAB phase of study to test for differences between subjective probability for Group 1 ($20$) vs. Group 2 ($5$) across trial outcomes, differences between subjective probability following losses vs. following wins for both groups, and for an interaction effect between group and trial outcome during the ABAB phase. The main effects of trial outcome ($p = 0.075, \text{power} = 0.433$) and group ($p = 0.768, \text{power} = 0.059$) along with an interaction ($p = 0.276, \text{power} = 0.186$) were all found to be statistically nonsignificant. Inspecting the mean subjective probabilities across groups (see Figure 6), both demonstrated greater mean subjective probabilities following losses ($M = \ldots$).
JEFFREY DILLEN and MARK R. DIXON

Figure 6. Mean subjective probabilities following losses and wins for each experimental group and overall during the ABAB portion of the study.

$M = 3.62, SD = 1.93$ for Group 1 and $M = 3.55, SD = 2.05$ for Group 2) than following wins ($M = 2.78, SD = 1.39$ for Group 1 and $M = 3.34, SD = 2.24$ for Group 2).

A $2 \times 2$ mixed analysis of variance was conducted on group by trial outcome (following loss, following near-miss) during the EXT phase of the study to test for differences between subjective probability for Group 1 ($\$20$) vs. Group 2 ($\$5$) across trial outcomes, differences between subjective probability following losses vs. following near-misses for both groups, and for an interaction effect between group and trial outcome during the EXT phase. No main effects of trial outcome ($p = 0.887$, power = 0.052), group ($p = 0.808$, power = 0.056), or an interaction were observed ($p = 0.205$, power = 0.236).

**Extinction Trials Played**

An independent samples $t$-test was conducted to determine if a statistical significance was present between the two groups in the number of EXT trials played. No significance was found, $t(18) = 0.343, p = 0.736, d = 0.16$. Group 1 averaged 120.80 ($SD = 90.37$) EXT trials whereas Group 2 averaged 104.00 trials ($SD = 125.89$)

**DISCUSSION**

The purpose of the current study was to determine whether differences exist in behavioral measures such as inter-response time and subjective probability following wins, near-misses, and losses at different monetary incentive magnitudes. No statistically significant difference was found between jackpot size on the inter-response times following winning and losing trials during the reversal (i.e., ABAB) phase of the study. In other words, monetary incentive value had no effect on MIRT within or between participants. However, a statistically significant result was obtained within participants with respect to trial type or trial outcome; specifically MIRTs were significantly greater following winning trials than losing trials, which supports previous research (Dixon & Schreiber, 2004; Schreiber & Dixon, 2001). Behavioral accounts for this finding include the position that increased inter-response times following wins can be viewed as a type of post-
reinforcement pause. An alternative account is that of a negative reinforcement model in which losing trials are considered aversive stimuli and by initiating the following trial in an expedited fashion, the aversive stimulation is subsequently removed and the individual escapes the stimulation (Dixon & Schreiber, 2004).

In contrast, monetary jackpot size did appear to impact MIRT during extinction. Here all trial outcomes were losses, and near-misses were introduced as a type of loss. Under such contingencies, Group 1 responded in a manner in which near-misses resembled more of a win. That is, they showed minimal MIRTs. This was the opposite to the performance of participants in Group 2 in which MIRTs following near-misses were similar to those following total losses. In short, jackpot size impacts near-miss MIRTs. Thus, the most powerful variable that differentiated responding by our participants was the presence or absence of a near-miss during extinction conditions. It is possible that “almost” winning $20 was more of a conditioned reinforcer than almost winning $5. Magnitude effects of the near-miss have not been experimentally investigated and should be parametrically analyzed. It follows that near-misses of large jackpots may in fact result in larger pauses, and if these outcomes contain some conditioned reinforcer properties, these outcomes may reinforce gambling for longer periods of time.

Despite the non-significant findings of group and trial outcome for subjective probabilities during the ABAB portion of the study, the overall group averages for both trial types (i.e., following losses, following wins) fails to support previous behavior research (Dixon & Schreiber, 2004). Specifically, subjective probabilities were greater following losses than following wins, thus supporting the “gambler’s fallacy”. The “gambler’s fallacy” is described as a belief that a particular event or set of events (e.g., losing trial) has an impact on or is predictive of future events. In other words, it is the gambler’s belief that following a losing trial or string of losses, a winning trial is more likely to occur. This same pattern of demonstrating the characteristics of the “gambler’s fallacy” was observed for Group 1 during the EXT phase of the study, however, subjective probabilities following near-misses were greater than following losses for Group 2.

The obtained results in the present study are further relevant to the research literature examining real versus hypothetical rewards (Weatherly & Brandt, 2004; Weatherly & Meier, 2007), and do not provide strong support for the added value of using real money in experiments on gambling behavior. In our study, we found no differences in performance between jackpot size, and hypothetical versus real rewards in our participants. This begs the question of how real money of various magnitudes alters the participant’s performance on gambling tasks. Perhaps there are individual differences across gamblers in these studies with some finding small amounts of money earned via participation a greater source of reinforcement than for other participants. Much more research is needed to establish conclusive evidence of how money interacts with gambling performance. While our study produced some interesting results, a potential limitation is the small sample size and thus further replications are necessary with larger groups of participants and potentially larger amounts of jackpot payouts.

In summary, the present findings add to the growing research literature on jackpot size and its effects on participant performance at slot machine games. We have found that size of a jackpot does not appear to alter performances, but the size of a near-miss jackpot does. The complexity of what a near-miss is does to a slot machine gambler remains unknown. When almost winning costs the casino nothing, it may in fact cost the player
something much more. In the present study we have only shown an impact on time between trials played. However, if the near miss is indeed a type of a conditioned reinforcer, its presence may result in longer periods of time played by a gambler as illustrated by MacLin, Dixon, Daugherty, and Small (2007). When the odds of winning are against the slot machine player, longer periods of exposure only can result in longer periods of financial loss.

REFERENCES


Action Editor: Jeffrey N. Weatherly
TEMPORAL DISCOUNTING PREDICTS HOW PEOPLE GAMBLE ON A SLOT MACHINE

Jeffrey N. Weatherly, Joanna M. Marino, F. Richard Ferraro, & Brendan Slagle
University of North Dakota

The gambling research literature suggests that temporal discounting may be associated with problem gambling, but research has not demonstrated that rates of discounting predict differences in actual gambling behavior. Thirty eight individuals of different ages and backgrounds were recruited to complete several questionnaires, including a delay-discounting task. They were then given $10 in tokens with the opportunity to gamble on a slot machine. How steeply participants discounted the delayed (hypothetical) monetary rewards was a significant predictor of they gambled. Gender, age, and reported annual income were not significant predictors. To our knowledge, these data are the first to demonstrate that temporal discounting may predict differences in actual gambling behavior (vs. self reports). This predictive relationship has implications for both researchers and practitioners.

Keywords: Temporal Discounting, Gambling, Slot Machine

Petry (2005) outlined six risk factors for pathological gambling: substance abuse, sex, age, marital status, socioeconomic status, and ethnicity. Although these factors are known to be associated with pathological gambling, they are not necessarily causal factors. That is, none of the factors are necessary or sufficient for the presence of pathology.

Of the other factors that have been linked to pathological gambling, one of the more popular ones is temporal discounting. A number of studies have suggested that pathological gamblers discount delayed rewards more steeply than non-pathological gamblers (e.g., Dixon, Marley, & Jacobs, 2003; see Madden et al., 2007, or Petry, 2005, for reviews). In other words, when faced with the (hypothetical) decision of getting $900 today or getting $1,000 a week from today, pathological gamblers are more likely than non-pathological gamblers to prefer the $900 today. Delay discounting has also shown to be related to other risky behaviors such as drug use (e.g., Reynolds, 2006) and smoking (e.g., Reynolds, Richards, Horn, & Karraker, 2004).

The research results on gambling and discounting to date represent correlations found in pre-existing populations (i.e., pathological and non-pathological gamblers). Although it is possible that changes in discounting play a role in the emergence of pathological gambling, it is equally possible that the pathology leads to changes in the discounting process. A recent study from our laboratory (Weatherly, Derenne, & Chase, in press) highlights the murkiness of the issue. One hundred seventy eight undergraduate partici-
participants completed a temporal-discounting task after providing information pertaining to the above risk factors (excluding drug use) and completing the South Oaks Gambling Screen (SOGS; Lesieur & Blume, 1987), the most widely used screening instrument for gambling behavior (Petry, 2005). Results showed that none of the risk factors or SOGS score were significant predictors of how individuals discounted delayed (hypothetical) monetary rewards. Given that each of these variables is related to pathological gambling, one might consider this result surprising.

It is unknown whether the risk factors for pathological gambling and/or rates of temporal discounting translate into differences in actual gambling behavior. The present study was designed as an initial step toward this determination. Participants of varying ages and socioeconomic backgrounds were recruited to complete a temporal-discounting task and were then given $10 in tokens to, if they chose, gamble on a slot machine. Given previous findings, we predicted that participants’ gender, age, socioeconomic status, and rate of temporal discounting would be significant predictors of actual gambling behavior.

METHOD

Participants

Participants (N= 38) were recruited from the student body of the University of North Dakota and the surrounding Grand Forks, ND USA community. Participants ranged in age from 21-86 years old (M = 52.3 years old, SD = 26.26). Fifteen of the participants were students; 23 were not. Seventeen were male; 21 were female. Seventeen reported being single while 11, 3, and 7 reported being married, divorced, or widowed, respectively. Ten participants reported earning less than $10,000 (USD) per year while 10 participants reported earning more than $75,000 per year. The median reported income was $15,000 - $24,999 per year. All participants were Caucasian.

Materials

Participants completed several paper-and-pencil measures. The first was an informed-consent sheet as approved by the Institutional Review Board at the University of North Dakota. The second form was a demographic questionnaire that asked the respondent’s sex, age, marital status, annual income, and ethnicity.

As a measure of substance use, the participants completed the Khavari Alcohol Test (KAT; Khavari & Farber, 1978). The KAT is a 12-item questionnaire that asks respondents about their consumption of beer, wine, and liquor. The answers to these categories are then translated into a measure of ounces of alcohol consumed per day. Khavari and Farber (1978) reported that the internal consistency of the KAT was $\alpha = .80$, with a test-retest reliability of $r = .92$. The KAT does not assess drug use other than alcohol.

Participants were asked to complete the SOGS (Lesieur & Blume, 1987). The SOGS is a 20-item survey designed to assess the respondent’s experience gambling. A score of 5 or more is indicative of the potential presence of pathology. Participants scoring 5 or more on the SOGS were not allowed to participate in the gambling session. The internal consistency of the SOGS is good, with Lesieur and Blume (1987) reporting $\alpha = .97$ using the original norming sample. Stinchfield (2003) reported $\alpha = .81$ for a large, non-clinical sample. Test-retest reliability has been reported at $r = .71$ (Lesieur & Blume, 1987).

The temporal-discounting task was a list of 63 choices between two hypothetical options, a certain amount of money available immediately or $1,000 available after a delay. The amount of the money available immediately and the delay of the constant amount varied across choices. There were nine different immediate amounts, ranging from $1 to $1,000, and seven different delays to the constant $1,000, ranging from one week to 10 years. The order in which the options were
presented to the participants was determined randomly prior to the study and all participants received the series of choices in the same random order (on a total of three pages). Participants indicated their choice(s) by circling their preferred option.

**Apparatus**

Participants played a Red, White, and Blue (wild) slot machine (IGT Inc.) that allowed the player to bet between one and three coins per play. Outcomes of individual spins were not preset (i.e., predetermined). The overall payback percentage for the machine was set at 87%, meaning that over an indefinite period of time the machine would return 87 tokens for every 100bet. The machine had an internal counter that measured the number of tokens inserted and the number of tokens dispensed (for wins). The machine had been altered so that all wins were paid in tokens so that the counter would accurately track the number of tokens won. The visual displays on the machine indicated that it took 25-cent coins. However, the machine had been reprogrammed to accept tokens which, in the present study, were assigned the value of 10 cents. Thus, the “25¢” displays were covered with “10¢” displays. The machine was one of three that were located in a windowless room measuring approximately 1.5 m X 5 m. The other two machines were not turned on during the gambling session.

**Procedure**

Participants were run individually. The researcher first checked the participant’s identification to ensure that s/he was at least 21 years of age. This precaution was taken because participants would be gambling money and the laws in North Dakota (and most states in the United States) require an individual to be 21 years of age or older to legally gamble.\

The researcher then obtained informed consent and then administered the paper-and-pencil measures described above. As the participant was completing the temporal-discounting task, the researcher scored the SOGS so as to determine whether the participant had scored 5 or above on this measure. No participant was dismissed because of her or his SOGS score.

Once the participant had completed the pencil-and-paper measures, the researcher guided her or him to the slot machine and read the following instructions:

> You will now be given the opportunity to play on a slot machine. You will be given 100 tokens worth 10 cents each. Thus, you are being given 10 dollars to play with. You may bet as many credits per play as the machine allows. Your goal should be to end the session with as many tokens as you can. You may end the session at anytime by informing the researcher that you would like to end the session. The session will end when a) you quit playing, b) you run out of tokens, or c) 15 minutes has elapsed. At the end of the experiment you will be paid in cash for the number of tokens you have left or have accumulated. Do you have any questions?

If the participant had questions, the researcher answered by repeating the above instructions. The researcher then gave the participant 100 tokens.

The participants played the slot machine until one of the three criteria for terminating the session was met. The researcher then debriefed the participant and paid the participant for the number of tokens that remained or had accumulated. Student participants also received extra-course credit for their participa-

---

1 The state laws of North Dakota, USA allow for researchers to possess modern gambling equipment under certain conditions and to have participants risk actual money. To our knowledge, North Dakota is the only state in the United States that currently allows such a procedure to be legally executed. Researchers attempting to replicate the present procedure (or some variation of it) should contact their local, state, and/or national officials to determine whether they can legally do so before conducting their research.
tion while non-student participants were paid an additional $5 for their participation. The researcher then dismissed the participant.

**Analyses**

The paper-and-pencil measures were scored by hand (according to the published scoring criteria when applicable). The degree to which participants discounted delayed (hypothetical) monetary rewards was determined in the following way. At each delay, the researcher determined the point at which the participant switched from preferring the delayed $1,000 to preferring the immediately available amount of money. The highest immediately available amount prior to the switch was used as the subjective value of the delayed reward at that particular delay. Because participants were asked to make choices about all nine amounts at each delay (in random order), it was possible for participants to display multiple switchover points at a particular delay (i.e., display inconsistencies in their preferences at a particular delay). When such instances occurred, the subjective value of the delayed reward at that particular delay was determined by the first switch point observed using the procedure described above.

A hyperbolic function was then fit to each participant’s discounting data (e.g., Mazur, 1987):

\[ V = \frac{A}{1 + kD} \]  
*(Equation 1)*

In Equation 1, \( V \) is the subjective value of the delayed monetary reward, \( A \) is the amount of the monetary reward, \( k \) is a free parameter that describes the steepness at which discounting occurs, and \( D \) is the delay. The parameter \( k \) was calculated for each participant, with larger values of \( k \) representing steeper rates of delay discounting than smaller values. This equation was used because it is generally consistent with research results on temporal discounting across a variety of procedures, including those that have investigated discounting with gamblers (e.g., Dixon et al., 2003; Dixon, Jacobs, & Sanders, 2006).

The main dependent measure in the present study was the amount participants gambled on the slot machine as measured by the number of tokens participants inserted into the machine during the session. To test the main hypotheses of the study, a stepwise linear regression was conducted with number of tokens gambled as the dependent measure and gender, age, socioeconomic states (measured by annual income endorsed as a categorical variable), and \( k \) as predictor variables. Results from this analysis, and all other analyses, were considered significant at \( p < .05 \).

**RESULTS**

With one exception, all participants gambled the money they were staked. The mean number of tokens played per session across participants was 102.81 (SD = 86.06). The mean number of tokens won per session was 189.25 (SD = 215.71). This latter number was skewed by one participant who won a 1,199-token jackpot (and finished the session with 1,078 tokens). Of the 37 participants who played the slot machine, 19 ended the session with more than 100 tokens (i.e., they won), one broke even, and 17 ended the session with less than 100 tokens (i.e., they lost). None of the gambling sessions ended because participants had lost all 100 tokens they had been staked.

Table 1 presents the data from the linear regression. Only \( k \) was a significant predictor of the number of tokens bet (\( F(1, 37) = 9.403, \ p < .01 \), with \( R^2 = .222 \)). Overall, the more steeply participants discounted the delayed hypothetical monetary reward, the more they gambled when playing the slot machine.

\[ 2 \] The large coefficient value for \( k \) in Table 1 is correct. It represents the change in the dependent variable as a function of one unit of \( k \). Values of \( k \) are extremely small relative to the number of tokens bet in a session, so a large change in \( k \) would be expected to correspond to a very large change in the number of tokens bet.
Table 1
Results from the regression analysis

<table>
<thead>
<tr>
<th>Factor</th>
<th>Coefficient</th>
<th>Beta Weight</th>
<th>t</th>
<th>Significance</th>
<th>Semi-Partial R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>-.062</td>
<td>-.398</td>
<td>.693</td>
<td>-.070</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>.197</td>
<td>1.292</td>
<td>.206</td>
<td>.223</td>
<td></td>
</tr>
<tr>
<td>Income</td>
<td>.194</td>
<td>1.273</td>
<td>.212</td>
<td>.220</td>
<td></td>
</tr>
<tr>
<td>k</td>
<td>10241.563</td>
<td>.471</td>
<td>3.066</td>
<td>.004</td>
<td>.471</td>
</tr>
</tbody>
</table>

Results from the correlation analyses resulted in relatively few significant correlations. Interestingly, number of tokens won during the session was not significantly correlated with income, including number of tokens bet during the session. Gender was significantly correlated with income, \( r = -.383, p = .018 \), indicating that men in the present study tended to report higher incomes than women. Age was significantly related to marital status, \( r = .754, p < .001 \), indicating that older participants were more likely than younger ones to be married, divorced, or widowed. Age was also positively correlated with reported income, \( r = .718, p < .001 \). Participants’ score on the SOGS did not correlate significantly with how they gambled or with their \( k \) value. Participants’ score on the KAT was not significantly with how much they gambled, their score on the SOGS, or with their \( k \) value.

DISCUSSION

The present study was undertaken because several factors have been shown to be associated with problem and/or pathological gambling, but few if any studies have demonstrated a direct link between these factors and actual behavior. The present study attempted to determine whether gender, age, income, and/or how steeply participants temporally discounted hypothetical monetary rewards would predict how they gambled when playing a slot machine for money. Gender, age, and income were not significant predictors of gambling behavior. Delay discounting, on the other hand, was a significant predictor.

To our knowledge, the present study is the first to demonstrate that individuals who differ in how they discount delayed monetary rewards actually gamble differently. Furthermore, the present study demonstrated that this predictive relationship exists in a sample of non-pathological gamblers. As such, the present results may have implications for both gambling researchers and treatment providers. For researchers, they would appear to validate further study of differences in delay discounting in pre-existing populations. The present results should certainly be replicated before one concludes that temporal discounting is a reliable predictor of gambling behavior. For treatment providers, the present results suggest that efforts to decrease gambling behavior may be accomplished by altering how

---

3 Although interesting, finding that how much money people bet was not significantly correlated with how much money they won is not necessarily surprising. Numerous studies from our laboratory have reported that participants’ gambling behavior is largely insensitive to how well or poorly the slot machine pays off (Weatherly & Brandt, 2004; Weatherly, Thompson, Hodny, & Meier, in press; Gillis, McDonald, & Weatherly, 2008).

4 This correlation represents a point-biserial correlation due to the dichotomous nature of gender as a variable (see Howell, 2002).
individuals perceive delayed monetary consequences. For instance, teaching clients to de-
value the consequence, money in this case, should lessen the rate at which they discount
the delayed reward (e.g., Estle, Green, Myer-
son, & Holt, 2006). The importance of
changing how clients temporally discount is
bolstered by the finding that, with drug treat-
ment programs, discounting is predictive of
success in the program (e.g., Bickel & Marsch, 2001). Thus, if discounting is indeed
a part of the process that leads to disordered
gambling, then addressing how the client
frames future events may ultimately be more
successful than addressing the gambling be-
havior directly, especially given that discount-
ing is related to a number of different beha-
vioral disorders.

These implications, however, need to be
couched in the understanding that the present
study had a number of limitations. The sam-
ple size used in the present study, 38 partic-
ipants, was not extremely large. Next, only
one form of gambling (i.e., on a slot machine)
was measured over a single session of rela-
tively brief duration when participants played
with staked money. These factors may have
contributed to why gender, age, and socio-
economic income were not significant pre-
dictors of gambling behavior. It is also the case
that the participants played an actual slot ma-
chine and not a simulation that would have
allowed all the participants to experience the
identical sequence of outcomes when gam-
bling. The present procedure should be repli-
cated under such a controlled situation. It was
also the case the participants’ scores on the
SOGS and KAT were not correlated with
their gambling behavior or with their k values
and it is not immediately clear why such cor-
relations did not exist.

In closing, the fact that the predictive re-
relationship between discounting and gambling
in the present study was found in a non-
pathological sample is worthy of note. This
finding suggests that steeply discounting de-
layed monetary consequences may not be a
sufficient characteristic for the observance of
pathological gambling. Further, the present
data are silent as to whether displaying a steep
discounting curve is predictive of becoming a
pathological gambler. To make this determi-
nation, one would need to conduct a longitu-
dinal study that monitors for pathology (and/or changes in discounting) across time.
If steep discounting was a significant predictor
of gambling in such a procedure, then its
importance to researchers and therapists
would be even further increased.

REFERENCES
Bickel, W. K., & Marsch, L. A. (2001). Toward a be-

avioral economic understanding of drug de-
pendence: Delay discounting processes. Addiction,

96, 73-86.

Contextual control of delay discounting by patho-
logical gamblers. Journal of Applied Behavior
Analysis, 39, 413-422.

lay discounting by pathological gamblers. Journal
of Applied Behavior Analysis, 36, 449-458.

Estle, S. J., Green, L., Myerson, J., & Holt, D. D.
(2006). Differential effects of amount on tempo-
ar and probability discounting of gains and losses.
Memory & Cognition, 34, 914-928.

American Indians and non-Indians playing a slo-
machine simulation: Effects of sensation seeking
and payback percentage. American Indian and
Alaska Native Mental Health Research: The Journal
of the National Center, 15, 18-32.

Howell, D. C. (2002). Statistical Methods for Psychol-

Khavari, K. A. & Farber, P. D. (1978). A profile in-
strument for the quantification and assessment of
alcohol consumption: The Kavari Alcohol Test.
Journal of Studies on Alcohol, 9, 1525–1539.

Gambling Screen (SOGS): A new instrument for
the identification of pathological gamblers. American
Journal of Psychiatry, 144(9), 1184-1188.

Mazur, J. E. (1987). An adjusting procedure for study-
ing delayed reinforcement. In M. L. Commons, J.
E. Mazur, J. A. Nevin, & H. Rachlin (Eds.), Quanti-
tative Analyses of Behavior: Vol. 5. The Effect of Delay and Intervening Events on Rein-
forcement Value (p. 55-73). Hillsdale, NJ: Erl-
baum.


*Action Editor: Mark R. Dixon*
THE EFFECTS OF NICOTINE ON GAMBLING BEHAVIOR OF SMOKING AND NONSMOKING UNDERGRADUATE STUDENTS

Ellen Meier and Jeffrey N. Weatherly
University of North Dakota

Gambling and smoking have been linked in the literature. The present study recruited smokers and nonsmokers to gamble on a slot machine after they chewed nicotine or non-nicotine gum. Results showed that gambling behavior, both in terms of persistence and risk taking, did not differ as a function of either smoking status or type of gum the participants chewed. Although the present study has a number of limitations, the results highlight that factors correlated with gambling do not necessarily lead to differences in gambling behavior when people actually gamble.

Keywords: smoking, nicotine, slot machine, non-pathological gamblers

Gambling and smoking are similar behaviors in that people can develop a dependency for either. The prevalence rate of pathological gamblers is 1-2% (Petry, 2005) and the prevalence rate of smokers is 22% (Petry & Oncken, 2002). Interestingly, Petry, Stinson, and Grant (2005) found 60.4% of pathological gamblers smoke.

Research suggests that smoking may be related to severe gambling problems. For instance, Petry and Oncken (2002) administered the Addiction Severity Index (McLellan et al., 1985) and the Southern Oaks Gambling Screen (SOGS; Lesieur & Blume, 1987) to problem gamblers. Severity of psychosocial problems, such as taking psychiatric medications or displaying symptoms of mental illness, were higher in treatment-seeking gamblers who smoked than in those who did not. Further, 62% of the sample smoked, compared to the 22% prevalence rate in the general population.

Research also suggests that smokers tend to display more impulsive behaviors that nonsmokers (Mitchell, 1999). Other research (Krishnan-Sarin et al., 2007) has shown that smokers who were unable to become smoke free after receiving treatment for smoking cessation displayed more impulsivity than those who were able to become smoke free. Both of these studies, as well as others (e.g., Petry, 2001), supported the idea that smokers show more discounting of delayed rewards than nonsmokers, a finding also seen in problem gamblers (e.g., Dixon, Marley, & Jacobs, 2003).

The present study was an initial test of whether smokers might gamble differently than nonsmokers and whether such a difference could possibly be attributed to nicotine. Smokers and nonsmokers were recruited to

Acknowledgements
Completion of this project was made possible by an Advanced Undergraduate Research Award fellowship granted to the first author and a corresponding mentor award granted to the second author by the National Science Foundation (EPSCOR05-08).
gamble on a slot machine. Half of the participants chewed nicotine gum prior to the gambling session while the other half chewed sugarless, nicotine-free gum. If smoking and problem gambling are influenced by the same underlying causal mechanism, then you would predict greater gambling in smokers than nonsmokers. If this potential difference is related to the presence of nicotine, then you would predict that gambling would be greater when participants received nicotine than when they did not, even among the non-smoking participants.

METHOD

Participants

Participants were 20 undergraduate students, ten (5 female) who were smokers and 10 (5 female) who were nonsmokers. All participants were 21 years of age or older and scored below a 5 on the SOGS (Lesieur & Blume, 1987). Participants ranged from 21 to 41 years old ($M = 24.15$ years old, $SD = 5.01$ years). The range of SOGS scores was 0 to 4 ($M = 1.55$, $SD = 1.43$).

Materials and Apparatus

Participants completed several measures. One was an informed consent form. They also completed a demographic questionnaire that asked about their age, gender, marital status, ethnicity, and annual income. Information on these factors was collected because each factor is related to pathological gambling (Petry, 2005).

The next questionnaire was the SOGS (Lesieur & Blume, 1987). The SOGS is a widely used screening tool utilized to detect the potential presence of pathological gambling (see Petry, 2005). It contains 20 items that pertain to the person’s gambling experience and history. A score of 5 or more on the SOGS is indicative of the potential presence of pathology.

Participants completed the Fagerstrom Test for Nicotine Dependence (FTND; Heatheron, Kozlowski, Frecker, & Fagerstrom, 1991) as a test for nicotine dependence. The FTND consists of six questions on smoking behaviors and their frequency. Participants scoring above seven have a high level of addiction to nicotine. A score between four and six indicates a medium level of addiction while a score of three or less indicates a low level of (or no) addiction to nicotine. The FTND has been shown to have good reliability and validity (Buckley et al., 2005).

The nicotine gum (Nicorette, GlaxoSmithKine) contained 2 mg of nicotine. The level of nicotine in the gum is lower than the level in cigarettes and is released more slowly than cigarettes (GlaxoSmithKline Consumer Healthcare, 2007). The gum is designed to keep nicotine in the nervous system for a total of 30 minutes. The non-nicotine gum was a sugarless gum of similar flavor to the nicotine gum (i.e., Dentyne Ice, Cadbury Adams USA).

Participants completed the surveys and gambling sessions in a windowless room containing three slot machines. Only one machine was used in the present study, which was a Triple Diamond (International Gaming Technology). The machine allowed up to two tokens to be bet at one time and was programmed at an 87% payback rate. The slot machine recorded the total number of coins inserted into the machine and the total number of coins paid out. The number of trials played was recorded by hand.

Procedure

Smokers and nonsmokers were recruited through the psychology department’s subject pool. Individuals who volunteered to participate were run individually. Prior to his/her arrival, the researcher randomly assigned the participant to either the nicotine or non-nicotine gum group. Thus, there were four groups: Smokers – nicotine gum, Nonsmokers – nicotine gum, Smokers – non-nicotine gum, and Nonsmokers, non-nicotine gum.
After completing the informed consent process, the research gave the participant the assigned piece of gum and instructed him/her to chew it (consistent with the instructions on chewing the nicotine gum). Once the participants were chewing the gum, they completed the surveys. The SOGS was the initial measure and the researcher scored it immediately after completion. Participants were excused from the study if they scored 5 or more on the SOGS. However, no participant had to be dismissed. While the researcher was scoring the SOGS, the participant completed the remaining measures. This process took 5 – 10 min to complete.

After completing the surveys, the research gave the participant 100 tokens worth five cents each. The researcher then read the following instructions:

You will now be given the opportunity to play on a slot machine. You will be given 100 tokens worth five cents each. Thus you are being given five dollars to play with. You may bet as many credits per play as the machine allows. Your goal should be to end the session with as many tokens as you can. You may end the session at anytime by informing the researcher that you would like to end the session. The session will end when a) you quit playing, b) you run out of tokens, or c) 30 minutes has elapsed. At the end of the experiment you will be paid in cash for the number of tokens you have left or have accumulated. Do you have any questions?

Questions were answered by repeating the above instructions. The participant then played the slot machine until one of the criteria for ending the session was met. At that time, the researcher debriefed the participant, paid him/her for the credits the participant had won or had remaining, and dismissed the participant.

RESULTS AND DISCUSSION

Data from the FTND indicated that the self-reported smokers did differ from the non-smokers. An independent-samples t test showed that smokers scored significantly higher ($M = 2.60, SD = 2.41$) on the FTND than did nonsmokers ($M = .60, SD = 1.07$; $t(18) = 2.39, p=.028$, two tailed). These results, and those that follow, were considered significant at $p<.05$.

Two measures of gambling behavior were of interest in the present study. The first was the number of trials played, which is a measure of persistence. The number of trials played by individual participants were analyzed by conducting a two-way (Smoking status X Type of gum) ANOVA. The main effect of smoking status was not significant ($F < 1$), indicating that the number of times participants played the slot machine did not differ as a function of whether or not the participant was a smoker. The main effect of type of gum was also not significant ($F < 1$), indicating that the type of gum chewed also did not influence the number of gambles participants made. The interaction between smoking status and type of gum was also not significant ($F < 1$).

The second measure of interest was the total number of credits participants bet across the session, which is a measure of risk. A two-way (Smoking status X Type of gum) ANOVA failed to find a significant main effect of smoking status ($F < 1$), main effect of type of gum ($F(1, 16) = 2.27, p=.152, \eta^2 = .124$), or interaction ($F < 1$). For the main effect of type of gum, participants receiving the nicotine gum bet an average of 105.0 credits ($SD = 50.33$) when gambling whereas those receiving the non-nicotine gum bet an average of 178.8 credits ($SD = 138.75$).

Results of the present study do not support the idea that smokers gamble longer or more money than nonsmokers, at least in a limited laboratory gambling situation. It also failed to support the idea that nicotine influences gambling behavior. In fact, only one effect approached statistical significance, and that result suggested that, if anything, nicotine
inhibited, rather than promoted, gambling behavior. Thus, one could potentially conclude that the link between smoking and gambling reported in the literature (e.g., Mitchell, 1999) may not be a causal one and that both behaviors may be related to some other factor not investigated in the present study. Before accepting such a conclusion, however, one needs to recognize that the present study presents only null results, at least in terms of gambling behavior. It is also the case that the present study had a number of potentially major limitations. The n size, for instance, was quite small and would have needed to be increased tenfold for most of the present effects to reach statistical significance. Although we were successful in recruiting smokers and nonsmokers, we did not explicitly control when the smokers had last smoked. It is possible, for instance, that some of them had smoked immediately prior to the session or, if they had, different results would have been observed. Further, the dose of nicotine provided to the participants who received the nicotine gum was small and the delivery system used in the present study (i.e., gum) is not the ideal method of nicotine administration. With that said, finding that those participants bet fewer credits than did participants who received the non-nicotine gum, albeit the difference was not significant, suggests that the nicotine gum, even at a low dose, may have been aversive.

Despite failing to find that smokers differed in their gambling from nonsmokers or that nicotine influenced gambling behavior, the present study should serve to highlight a weakness in the literature on gambling. Specifically, there are a number of reported links between gambling and other factors (e.g., smoking) that can be found in the literature. The relationship with smoking, for instance, looks quite strong (e.g., finding that 60.4% of pathological gamblers smoke; Petry et al., 2005). However, these links may not, as in the present study, produce different behaviors when these different individuals gamble. Thus, we are left uncertain as to exactly what the relationship might be and how gambling behavior is ultimately affected by these other factors or if it is even directly affected at all. In our opinion, additional studies that employ experimental, rather than correlational, methodology will likely be required to discover the mechanisms underlying these relationships.

REFERENCES


Petry, N. M. (2005). Demographic Correlates. Pathological Gambling: Etiology, Comorbidity, and


*Action Editor:* Mark R. Dixon
VIDEO GOLF AND GAMBLING: THE IMPACT OF MONETARY WAGERS ON PERFORMANCE

Michael Bordieri, James Bordieri, & Mark R. Dixon
Southern Illinois University Carbondale

The present investigation explored how experimental conditions of money gain and money loss impacted performance of golfers playing a video-based golf simulator. Five female participants were initially assessed for skill level and history of golf play. Following assessment, players were orientated to a computerized video golf game that translated participants’ real world putting stroke into in game simulated putts. Players were exposed to conditions in which putt accuracy led to financial rewards, and other conditions in which putt accuracy led to financial punishers. Results suggest that monetary rewards resulted in decreased putt accuracy and increased variability compared to non-monetary baseline performances in the players. Implications for a behavioral understanding of golf performance, wagering at sports, and the "choking" response are presented.

Keywords: golf, video games, sport performance, choking, wagering

An adult over the age of 21 can bet legally on sporting events in the United States through the licensed Nevada Sports Books. Wagers, however, can be placed illegally on professional as well as amateur sports with bookies in virtually every city and town across the nation. In addition to horse and dog racing, betting on team sports such as football, basketball, baseball and hockey represents a multi-billion dollar enterprise (Sugar, 1992). Golf is an example of an individual sport where gambling frequently occurs (Smith & Paley, 2001). Basketball great Michael Jordan is also well known for wagering large amounts of money on the golf course (Leahy, 2004) and golfers of all skill level will often wager during play. This includes betting on their overall final score, sub totals for each nine holes, total score on a single hole, execution of single stroke, or on a multitude of other performance outcomes.

In the sport psychology literature, athletes are often described as “choking” when they demonstrate poor performance when the stakes are high (Lewis & Linder, 1997). The role of the autonomic nervous system and associated physiological responses of anxiety and stress are critical to the success of golfers (Miller, 2005). Typically, golfers will describe muscle tension, poor coordination, trembling hands, accelerated heart rate, racing thoughts, and loss of mental focus as correlates of “choking” (Miller, 2005; Valliante, 2005). Beilock and Carr (2001) demonstrated that the complex, proceduralized, and sensorimotor task of putting was susceptible to the choking effect and that directing attention towards the execution of the task resulted in diminished performance. Research has also demonstrated that golf performance in chipping (Pates & Maynard, 2000), full swing (Brouziyne & Molinaro, 2005) and putting (Taylor & Shaw, 2002) can be enhanced using relaxation and imagery techniques to reduce stress and “choking”.

A recent single case study examined the effect of monetary consequences on the golf performance of a pathological gambler (Bordieri, Jackson & Dixon, 2007). Using an AB
design, the participant made 10 full swings on a computerized golf simulation game. Swing accuracy (distance from the hole) was the primary dependent measure. Following baseline, he was informed that he would receive a $20 gift card if the average of the next 10 swings were closer to the hole than the average of the first 10 swings. The introduction of the monetary reward resulted in a decrease in shot accuracy and an increase in shot variability.

The current investigation builds upon the case study by assessing the effect monetary consequences have on simulated golf-performance using a more robust withdrawal design. Additionally, performance feedback was provided immediately after each swing and the role of the varying presentations of monetary consequence (response cost or positive reinforcement) was evaluated. This design allowed for putt accuracy and variability to be calculated across and between momentary consequences in order to explore under what conditions the “choking” phenomena would emerge. Specifically, performance differences between baseline and monetary phases as well as discrepancies in performance between response cost and positive reinforcement contingencies were assessed.

METHOD
Participants
Twelve participants were recruited from an undergraduate rehabilitation course at a Midwestern university. Seven were excluded from the study because they did not meet the criteria for golf experience which required playing on a regulation golf course, practicing at a driving range, or playing miniature golf. Of the five who met these criteria, two reported playing on a regulation golf course and all five reported playing miniature golf. Given our volunteer golfers were relative beginners, they were presented with a putting task instead of a full swing challenge in the video golf simulation. All participants were female and they ranged in age from 22-54. At the start of the study participants were assessed for potential pathological gambling using the South Oaks Gambling Screen with all scoring below the threshold for potential pathology (range 0 – 3 M=.08).

Experimental Design and Measures
Participants were exposed to three levels of monetary consequences in a multiple-treatment reversal design (ABCA). To mitigate the threat of a sequence effect, participants were exposed to the two intervention conditions, positive reinforcement (B) and response cost (C), in an alternating fashion with three participants assigned to the sequence ABCA and two participants assigned to the sequence ACBA. The independent variable consisted of three levels of monetary consequence contingent upon putting accuracy: A baseline where there was no monetary consequence, an intervention with positive reinforcement (gaining money), and an intervention with response cost (losing money). The dependent variable was the distance the golf ball rested from the hole after the putt as reported by the computerized interface.

Setting and Materials
Sessions took place in a 16’ x 20’ room containing an observation mirror and chairs. The putting stroke was made on a hardware device that contained a golf ball and various micro-sensors that captured club and ball movement across a 1 ft platform which was constructed of artificial turf. The device was interfaced with a Sony Playstation2 video game system running “Tiger Woods PGA Tour 2006” which used the input from the hardware device to simulate the putt on a 32 inch LCD monitor. Participants were presented with an identical virtual 30 foot putt on the 17th hole at Pebble Beach Golf Links. All were right handed and used a Wilson blade putter to make the putting strokes. Data were collected by an observer that was positioned 4
ft from the LCD monitor and away from the participant swinging the club. During monetary feedback conditions ten new one dollar bills of US currency were used to establish financial contingencies.

**Procedures**

After gaining consent and screening for golf experience and potential gambling pathology participants were oriented to the golfing interface and putter. They were informed that their job during the study was to stoke the ball just like they would a regular golf ball and to try to make the putt or get it as close to the hole as possible. Prior to beginning the baseline phase participants were told to make a few practice strokes to get acquainted to the interface. During this acquisition phase and all subsequent phases the distance from the hole in feet reported by the interface was recorded following each simulated putt and the observer then reset the interface and returned the ball to the virtual starting point holding constant simulated environmental conditions such as wind and visibility. Each participant continued to make putts in the acquisition phase until their performance researched the stability criterion of a standard deviation equal to seven or less feet from cup after at least five trials. The phase was terminated after ten trials regardless of standard deviation. This acquisition phase ensured that each participant was familiar with the experimental apparatus and that they acquired a reasonably stable level of performance before beginning baseline recording.

Baseline recording began immediately following the termination of the acquisition phase without participants being informed of the phase change. The covert transition ensured that participants could not deliberately under perform in order to gain an advantage in later conditions. The baseline phase consisted of ten putting opportunities presented in an identical manner as the acquisition phase. At the end of a baseline phase participants were given a one minute break before continuing on to either the positive reinforcement or response cost condition.

In both the response cost and positive reinforcement condition participants were exposed to an identical financial contingency which allowed them to earn up to $20 gift card contingent on their simulated putting performance. In both conditions the participants attempted 10 simulated putts with each worth the potential of one dollar of gift card value. The criterion level for the contingency remained constant across the two conditions for each participant and it was set to each participant’s mean recorded distance from the hole during baseline. The only difference between the two conditions was in the presentation of the contingency. In the positive reinforcement condition participants were told that they had the opportunity to earn $1 towards their gift card for every putt that was closer than or equal to their mean baseline performance. In this condition the experimenter placed a $1 bill on a table in front of the participant for each putt that met criterion. In the response cost condition the experimenter placed ten $1 bills on the table prior to the condition and told each participant that they could be traded in for a $10 gift card but that first they would have to make ten more simulated putts. Participants were informed in the response cost condition that for every simulated putt that was further away than their mean baseline performance they would lose one dollar of gift card value. The experimenter removed a $1 bill from the table for every put that was further away than the participant’s mean baseline performance in this condition.

Following the counterbalanced presentation of the positive reinforcement and response cost conditions participants were informed that they were almost finished with the study and that they would receive a gift card equal to their earnings in the two contingency conditions. They were then asked to
make ten more simulated putts on the golf interface and were explicitly told that their performance would not affect their gift card value. However, they were still reminded that their job was to sink the putts or get them as close to the hole as possible. Following the ten simulated putts in the return to baseline condition participants were given their gift card and then debriefed.

RESULTS & DISCUSSION

Participants’ performance on each putting opportunity were pooled for each of the four experimental conditions. A directional hypothesis was assumed for comparisons between the initial baseline condition and the two contingency conditions ($\mu_{\text{Initial Baseline}} < \mu_{\text{Positive Reinforcement}}$ and $\mu_{\text{Initial Baseline}} < \mu_{\text{Response Cost}}$). A direction hypothesis was also assumed in the comparison of the pooled baseline and contingency conditions ($\mu_{\text{Initial Baseline and Final Baseline}} < \mu_{\text{Positive Reinforcement and Response Cost}}$) with a one-tailed dependent group t-tests used for all directional hypothesis testing. All other tests of significance assumed a non-directional hypothesis and used two-tailed dependent group t-tests. An alpha level of .05 was used for all statistical tests.

Performance across conditions as expressed by mean distance from the hole in feet is presented in Figure 1. Participant performance in the initial baseline ($M = 1.43, SD = 1.45$) did not differ significantly from performance in the final baseline ($M = 1.52, SD = 1.33$) suggesting the absence of a practice
Figure 2. Mean distance from hole in feet for pooled baseline and financial contingency conditions. The error bars represent one standard deviation.

effect, \( t (49) = -0.33, p = 0.74 \). A significant difference was observed between performance in the initial baseline and the positive reinforcement contingency (\( M = 2.58, SD = 3.80 \)) with performance considerably worse in the positive reinforcement contingency, \( t (49) = 1.88, p = 0.03 \). However there was no significant difference in performance between the initial baseline and the response cost contingency (\( M = 1.48, SD = 1.53 \)), \( t (49) = -0.16, p = 0.43 \). It is of note that performance differences between the two contingency conditions approached significance despite the fact that the underlying financial contingency was identical, \( t (49) = 1.88, p = 0.06 \).

A comparison of pooled performance in baseline conditions (No-Money) and contingency conditions (Money) is provided in Figure 2. Performance in the baseline conditions were significantly more accurate (\( M = 1.48, SD = 1.38 \)) than performance in the contingency conditions (\( M = 2.03, SD = 2.94 \)), \( t (99) = -1.72, p = 0.04 \). There was also considerably more performance variability in the contingency conditions as indicated by a greater range of scores (0-24, \( SD = 2.94 \)) as compared to performance variability in the baseline conditions (0-6, \( SD = 1.38 \)).

While the thrust of research into the “choking” effect has been focused on experienced performers (Miller, 2004, Valliante, 2005), this study demonstrated the effect in relatively inexperienced golfers. When participants had the opportunity to earn money in the positive reinforcement contingency the accuracy of their putts decreased. Consistent
with the findings of Lewis and Linder (1997), both mean distance from hole and variability of putts was highest in this condition and suggests the presence of a clear “choking” effect. It is of note that this effect was not observed in the response cost condition despite it sharing an identical financial contingency with the positive reinforcement condition. That is, the response cost and positive reinforcement contingency differed only in how they were presented to the participants (i.e. chance to earn a dollar per putt in positive reinforcement and chance to avoid losing a dollar per putt in response cost) yet responding across the two conditions was markedly different.

Previous research has noted that gambling behavior can be maintained by rule governed behavior and that it is often insensitive to direct contingencies (Dixon, Hayes, & Aban, 2000). A possible explanation for this performance disparity is the role of client generated verbal behavior or “self talk” during the performance task. It could be that participants generated verbal behavior in the positive reinforcement condition which inhibited performance but not during the response cost condition. As a matter of speculation, participants may have approached the positive reinforcement condition with self-talk such as, “I have to make these putts so I can get some money” while approaching the task in the response cost conditions as, “If I miss it’s only a dollar, I have plenty of money already.” Future research should attempt to replicate this effect and use a protocol analysis to identify if verbal behavior serves as mediator of performance.

One limitation of the current investigation was the limited size and nature of the sample. A small number of only female undergraduate students served as participants in this study. However, the discovery of significant findings in such a low powered analysis is promising and replications should be conducted with larger and more representative samples to confirm these findings and extend them to both male and female participants of diverse ages. Another possible limitation was the relatively insensitive measurement employed by the experiential interface which reported distance from the hole only in feet. Future research should incorporate more sensitive measures of performance (e.g. distance in inches from cup). As the current investigation was a laboratory study, the financial contingencies were quite small relative to “real-world” wagering. While a “choking” effect was noted, the effect might have be more robust if more money was at stake and future research should incorporate reinforcers of larger magnitude and more demanding real world golf performance tasks to extend these findings.

This study successfully replicated the performance “choking” effect in novice golfers using a video golf interface. The introduction of a gambling contingency in the form of performance contingent financial rewards lead to significantly less accurate and less consistent performance. This investigation also demonstrated a marked difference between performance conditions that only differed in the verbal presentation of the contingency highlighting the possible influence of rule governed behavior in the “choking” effect. While still a relatively young line of research, the investigation into the behavior processes behind a financial induced “choking” effect in golf performance has proven to be a fruitful area of study.

REFERENCES


Action Editor: Jeffrey N. Weatherly
This journal is Copyright © 2007 by Jeffrey N. Weatherly, publisher, Analysis of Gambling Behavior. All rights are reserved. All information contained within is provided as is. The AGB journal, its publisher, authors, and agents, cannot be held responsible for the way this information is used or applied. The AGB journal is not responsible for typographical errors.

Analysis of Gambling Behavior (AGB) is published twice per year (summer and winter). AGB is a print journal and back issues are available online.

AGB is an independent publication and is in no way affiliated with any other publications. The materials, articles, and information provided in this journal have been prepared by the staff of the AGB journal for informational purposes only. The information contained in this journal is not intended to create any kind of patient-therapist relationship or representation whatsoever.

Make sure to subscribe to the newest and most scientifically advanced journal for understanding gambling behavior.

*Back Issues are Available*

1 year subscription (2 issues published per year)
$40 USD Professionals and Institutions
$20 USD Students (with documented student status)

Send check or money order to:
Analysis of Gambling Behavior
Department of Psychology
University of North Dakota
Grand Forks, ND 58202-8380
Phone: (701) 777-3470
Fax: (701) 777-3454