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The near-miss effect has been repeated documented in the published literature as a variable that impacts gambling behavior. The effect, however, has been almost exclusively studied using slot machines. The present investigation sought to explore the effect of almost winning while playing roulette. When 28 participants were given the opportunity to play roulette and rate the closeness to wins after every trial, ratings varied as a function of numerical value between number bet and number won for most players. These results extend the findings that almost winning (e.g., a near-miss effect) is present for the game of roulette and defines the parameters of such an effect. Implications for the treatment of pathological gamblers are presented.

Keywords: Near-miss, Roulette, Gambling, Addiction, Risk-taking

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When partaking in a game of chance, many players will find themselves becoming quite pleased upon producing a winning outcome. The unexpected, probabilistic, reinforcement schedule maintains behavior for great periods of time. However, when that same player loses, yet his/her loss looks "close" to a win, a paradox appears to occur. Close-win outcomes are often rated by players as being somehow closer to wins than other types of losses (Dixon, Nastally, Jackson, & Habib, 2009; Dixon & Schreiber, 2004). What is interesting is that all losses are just that - losses, and none are more predictive of a win right around the corner. This tendency to categorize certain losses as more valuable or predictive of a win has been termed the near-miss effect (Reid, 1986). Previous research has noted the potential for these types of outcomes to promote problem gambling (Griffiths, 1991), produce preferences for such outcomes over total losses (MacLin, Dixon, Daugherty, & Small, 2007), as well as generate specific neurological activity usually only occurring during wins for pathological gamblers (Habib & Dixon, 2010).

While there has been considerable growth in the exploration of the near-miss effect by persons who gamble, what has not been seen is much extension beyond a simple slot-machine preparation. With slot machines, the near miss is clearly defined as 2 winning symbols on the payoff line, and the remaining 1 winning symbol somewhere right above or below the payoff line. A notable exception to the exclusive study of near misses via slot machines was conducted by Dixon, Nastally, Hahs, Horner-King, and Jackson (2009) using the casino game of Blackjack. Using a single-deck game, participants rated how close 50 consecutive hands of blackjack were to a win. Losses were latter categorized as either "busts" or "non-busts" with the former being defined as a loss to the dealer where the player did obtain card values of over 21, and the latter being card values of less than 21. A near-miss effect was shown only for the non-bust losses and it decreased in strength as the difference between dealer and player hand

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card values increased (Dixon et al., 2009). Near misses thus appear to be present on more than just slot machines, and their presence is not simply a factor of formal similarity to a win. In the above blackjack study, the additional feature of "bust" or "non-bust" modulated the effect, suggesting a role for psychological function to impact participant outcomes (i.e., ratings). Additional research has demonstrated the flexibility of the near-miss effect based on conditioning history of the participants (Dixon et al., 2009).

To date, the published gambling literature has yet to aggressively explore the presence of near misses in other casino games. Such losses might be present at the craps table when rolling dice "close" to those that are designated as winning combinations or at the video-poker machine where a royal flush is missed by just one card. Expanding the scope of the investigation of the near miss to other casino games is critical to determine if the effect is a feature of actual slot machine or as a psychological process that leads to faulty decision making. Behavior analytically, one might consider this an issue of a structural characteristic of one game or a frequently occurring discriminative stimulus present across many casino-type games that sets the occasion for players to respond by wagering even when a win is not reliability predictable. Others might also consider the near miss to be a contextual stimulus, setting event, or motivational operation that participates in a field of interaction to increase the probability of a gambler responding (gambling), under a certain set of stimulus conditions. However, regardless of definition, as researchers we must continue to explore the robustness of the near miss across games, and determine the conditions under which it is demonstrated. As a result, the present investigation attempted to explore the potential for the game of roulette to produce near-miss outcomes from gamblers. Using self-reports of "closeness to a win" this study examined a series of wins and losses from individuals gambling at roulette.

METHOD

Participants

Twenty-eight college students with no self-reported history of gambling disorders participated in the present study for course extra-credit and a chance to win a $50 gift card to a local retail establishment. Additional contingencies were imposed such that the first 5 students that selected a winning number were given 10 extra-credit points towards their final course grade, the next 5 students to select a winning number received 5 extra-points, and the remainder of the students received 1 extra-credit point. While not available during the current study, additional opportunities for course extra-credit were afforded to the students that may have wanted more. Participants recruited for this study were informed that, if they had a gambling problem, they would be allowed to obtain identical compensation for a non-gambling study.

Setting / Apparatus

The experimental procedure took place in a single-room stadium style classroom following the completion of an undergrad-graduate class lecture. The room cpntained a large number of chairs, desks, and speak-er's podium with two large screens for presentation displays which faced the class attendees. A computerized roulette interface was presented on one of the large screens and can be seen in Figure 1.

Figure 1. Display of the experimental interface.

All programmed contingencies were at fair odds. In other words, each location on the roulette reel had an equal probability of being displayed on the board ($p = 1/38$). Participants were also provided with a data sheet which included space to write trial number, number on the board which they wished to wager upon, and the number on the board which was eventually displayed as the winning number. They were also provided with a Likert-type scale from 1 to 10 in which they were to circle the number that they believed was "how close their outcome was to a win."

Procedure

At the onset of the experiment, all participants completed an informed-consent document, and were instructed that they were able to win additional course extra credit, and an opportunity for a cash prize for completion of the study. Course credit was administered as described above, and the potential cash prize consisted of their name being entered into a lottery for the drawing of a single 50 USD gift card to a local retail establishment.

Participants were instructed the following verbally by the experimenter:

> *"You will be asked tonight to wager on a single number that you see displayed on this computerized roulette board. You will complete a data sheet whereby you will indicate the number of trial that you are on, the wager you make, and the resulting outcome of each spin. After you select a number you think will win, place your pen on the desk, and your hands in your lap. Once everyone's hands are down, I will*

click on the spin button and we will all watch the wheel spin. If the winning number that is displayed on the board is the number you bet on, please raise your hand for me and let me know that you won. If you did not win, please keep your hands down until we have checked all 'winners.' At that time you will be allowed to rate how close your wager was to the winning wager. At this time you can also bet on the next game. We will be watching you to ensure you are performing this task correctly, and if not, you will be dismissed from the study."

To ensure that participants did not "cheat" and wait until the winning number on the roulette board was displayed to write down their own wagered number, each participant was instructed to put their pen on the table, and their hands in their lap until the spin of the wheel occurred, and the winning number revealed. Any participant that had wagered on that winning number was instructed to raise their hand to allow one of three researchers in the room to check their data sheet for correspondence between numbers. If correspondence was observed, contingencies as previously specified were delivered. This procedure produced 100% correspondence between self-reported wins and observed data sheets. No participant was ever observed attempting to alter a data sheet mid or post spin of the reel. Correspondence between all participants' recording of the obtained winning number and the experimenter's recording of the number matched 100% of the trials conducted.

Once the participant wagered on the winning number, they were dismissed from the remainder of the study. This resulted in varying lengths of exposure to the experimental procedure, which increased based on repeated losses. For example, one participant may have won after 3 trials and another after 34 trials, thus the procedure would have resulted in more obtained data from the second participant. The procedures continued until all participants had wagered on a winning number (85 trials).

RESULTS

All recruited participants completed the experimental procedures. Wins were obtained by participants on as few trials as 3 and as many trials as 85. Figure 2 displays the average subjective rating for all participants on losing trials.

Figure 2. Average rating of closeness to a win as a function of numerical value difference between number bet upon by the participant and the obtain winning number displayed on the roulette board.

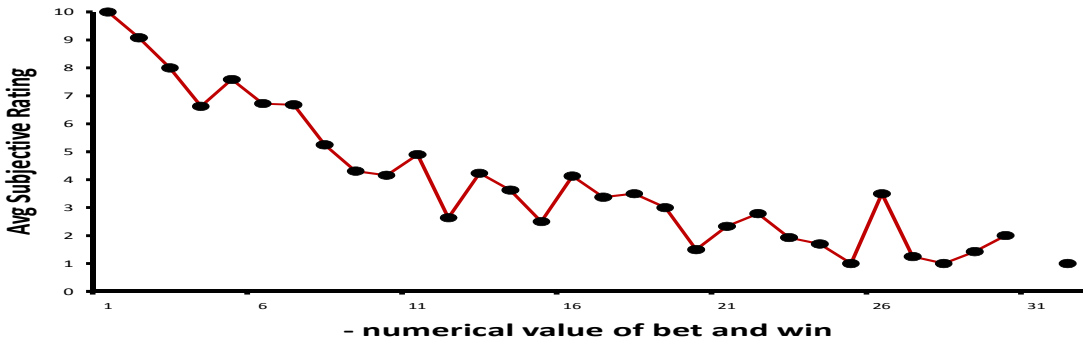
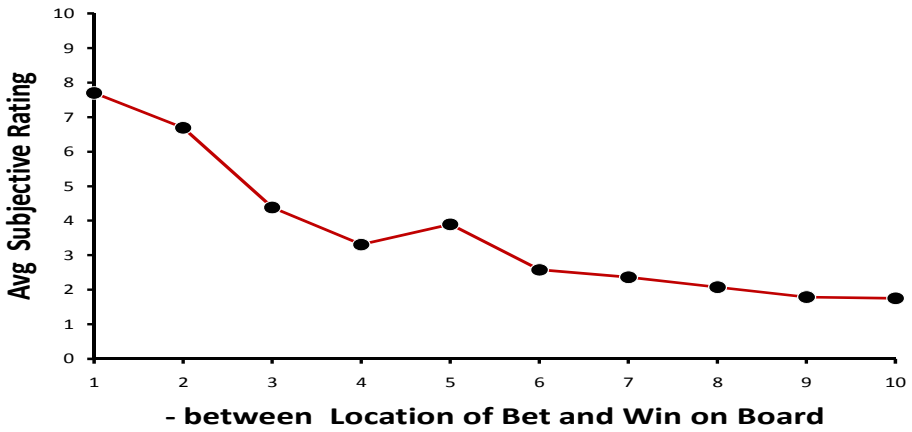


Figure 3. Average rating of closeness to a win as a function of spatial difference between number bet upon by the participant and the obtained winning number displayed on the roulette board.



Data are plotted as a function of the numerical value difference between the wagered and the winning number. Subjective ratings were extremely high (close to a win) when the difference in value was small, and decreased considerably as the differences in value increased. A Pearson Product-Moment Correlation was calculated to support the visual analysis of the data. This analysis revealed a significant correlation between the difference in numerical value of wager and win and subjective rating, $r(30) = -.90$, $p < .05$). Figure 3 displays a similar trend when the subjective ratings are plotted against the difference between location on the roulette board between the wagered and the winning number. Here, however, the negative data trend is less pronounced. A Pearson Product-Moment Correlation was also calculated to support the visual analysis of the data. This analysis also revealed a significant correlation between the proximal distance on the roulette board between wagered and winning number and subjective rating, $r(8) = -.88$, $p < .05$).

DISCUSSION

The near-miss effect occurs when a gambler believes that certain losing outcomes are closer to wins than other losing outcomes. In an objective reality, all losses are just that - losses. None are more predictive of a win that is bound to occur. Furthermore, no loss, no matter how much it might "look like a win", is indicative of being close to a win. Each outcome from typical casino games such as slot machines, craps, or roulette is independent of the next. The game knows no history of prior outcomes. Instead, the gambler incorrectly assumes history or certain losses reveal information about the future. The present findings extend the published research that has documented a near-miss effect in slot-machine players (Dixon & Schreiber, 2004), and blackjack players (Dixon et al., 2009) to the game of roulette, as well as support the conceptualizations that near misses do in

fact occur when people are gambling (Reid, 1986). In the present study, twenty eight roulette players rated losing outcomes closer to winning when that losing outcome was a) close in numerical value to the winning number, and b) close in proximity on the actual roulette table to the winning number. The two factors noted here are to a fair degree autocorrelated with each other, and future research is warranted which could determine if one of these factors is more responsible for producing inflated subjective ratings than the other.

With hopes of maintaining a fair degree of external validity, the present study utilized a roulette simulation that closely resembled those found in casinos as well as mirrored that found in online gaming environments. The makeup of the roulette game, and the board specifically, grouped numbers close together proximally that were close together numerically. As a result, it is possible that the current participants' rating behavior was a product of one or a combination of both of these factors. A future study might consider altering the roulette board display to examine if non-numerically close numbers, if grouped together proximally on the board, would alter the correlational relationship that was observed in Figure 3. A similar examination could be made by examining the distance on the actual roulette wheel between winning number and wagered number. The reel itself does not have numerical numbers placed proximal. In this study, it was not possible, given the setting configuration. Additional data capturing along these lines would thus allow for more sophisticated data analyses to be conducted such as a regression model which contained distance on board, distance on reel, and distance in numerical value.

The obtaining of a near-miss effect by roulette players was not entirely surprising given that an increasing body of literature is emerging on the presence of this effect by gamblers. What remains to be answered at this time however, is what this "effect" really is. From a behavioral perspective, such an "effect" beckons notions of internal casual states of the organism, that are somehow flaws of rationality or decision making abilities. Behavior analysts are not content with such an explanation, and need to examine the factors in the environment that may be producing the near-miss response. In the present study's case, the inflated self-reported ratings of certain losses compared to other losses. With respect to slot machines, the near miss might be defined as a result of stimulus generalization, given that two winning symbols on the payoff line and a third right above or below the payoff line looks physically similar to an actual win. The data of the current study tend to weaken this explanation. The numerical value of a 7 is not typographically similar to an 8, nor is a 9 to a 10. However, an 8 is very similar to an 18, and a 1 to an 11. Yet, it is the numerical value that was correlated to the near miss, not the physical similarity of the stimuli. Previous research by Dixon et al. (2009) has suggested that the near-miss effect is a product of verbal behavior, or a verbal construction, rather than a product of stimulus generalization. The current data support this assertion, given that a participant's pre-experimental history is probably very rich for relating the number 8 as being a little less than 9, and 1 being far from 11. Such a history comes to bear in an experimental, or gambling, experience and alters responding accordingly.

Working on the assumption that the near-miss is verbally constructed, therapists have a fair amount of resources by which they may be able to minimize or reverse the effect in their patients. Behavioral techniques such as deliteralization, transformation of stimulus functions, and/or altering relational networks may have

promise. These techniques have been successful at altering response allocations of gamblers to game alternatives when contingencies have remained in tack (e.g., Zlomke & Dixon, 2006), and it is thus possible that they may be able to alter near-miss ratings and control by near-miss stimuli as well. Preliminary findings support this notion (Nastally & Dixon, this issue).

In summary, the near-miss effect occurs in multiple casino games. The present data add the game of roulette to the list made up previously of only slot machines and blackjack. The means by which the "effect" is produced has yet to be comprehensively explained but the current data weaken the notion that physical characteristics of the stimuli are solely responsible for the exhibiting of a near-miss response. If pathological gamblers have developed deep rooted notions of what are considered wins and almost wins, and those gamblers alter subsequent gambling because of such near-miss outcomes, the present data suggest that care providers need to be very careful in treatment. Near misses are not just a part of a slot machine, and they are not just part of the internal workings of an illogical gambler. Instead the near-miss effect appears to be the outcome of certain environmental arrangements, and given that position, altering such arrangements either via differential reinforcement or through verbally constructed means, should be able to produce change in the pathological gambler. With the lives of thousands of pathological gamblers in need of treatment, researchers should extend investigations of the near-miss forward with the hope being that caregivers will not need to do rely on unfounded treatment approaches that may at best lead to "almost" a success in therapy.

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Concurrent Validity of the Gambling Functional Assessment (GFA): Correlations with the South Oaks Gambling Screen (SOGS) and Indicators of Diagnostic Efficiency

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Concurrent validity of the recently introduced Gambling Functional Assessment (GFA) was assessed by comparison with the long-used South Oaks Gambling Screen (SOGS) in two nonclinical adult samples (N = 201, 49% female; N=101, 74% female). Correlations between GFA total scores and its four content scores with SOGS scores were promising (r = .04 to .61), with the content score relating to Escape yielding the highest correlations (.45, .61) and the score relating to Attention yielding the lowest. Performance in the second sample, where the SOGS-defined base rate of pathological gambling (28.7%) was high, was best for Escape scores, which efficiently categorized SOGS-defined cases. The present data suggest that the GFA content area of Escape shows promise at classifying pathological versus nonpathological gambling, while the GFA as a whole may be a useful treatment tool, allowing clinicians to identify the mechanisms that may be maintaining gambling in their patients seeking treatment for pathological gambling.

Keywords: Concurrent validity, Gambling Functional Assessment, Escape, South Oaks Gambling Screen, Adults

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The current Diagnostic and Statistical Manual (DSM-IV; American Psychiatric Association, 1994) defines pathological gambling as "persistent and recurrent maladaptive gambling behavior" (p. 618). As with most DSM-defined disorders, the diagnostic criteria are *a la carte*, with the individual needing to display at least five of 10 potential symptoms to be given the diagnosis. Not all symptoms are directly linked to the behavior itself, however. For example, the first criterion, preoccupation with gambling, refers to planning and mental rehearsal for future gambling and rumination about past gambling experiences. Several subsequent criteria refer to the negative life consequences of the behavior, its practical maintenance, or concealment. Apart from apparent "withdrawal" symptoms reflected in the criterion "is restless or irritable when attempting to cut down or stop gambling," only one criterion, "gambles as a way of escaping from problems or of relieving a dysphoric mood," refers to maintenance mechanisms—in this case, negative reinforcement. Thus, the current diagnostic criteria emphasize pathological outcomes and deemphasize the means of behavioral maintenance.

In contrast, the Gambling Functional Assessment (GFA; Dixon & Johnson, 2007) was designed to determine the consequences that might be maintaining the individual's gambling. It was designed around the as-

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sumption that different individuals may gamble for different reasons, and thus need different styles of treatment to successfully overcome excessive gambling. For example, one person may gamble to try and avoid the pain of a dysfunctional marriage, while another may gamble for the physiological rush or sensory experience it gives him/her. While the severity of the disorder for these two individuals could be very similar, the cause, and thus the required treatment, could be much different. This type of "function-based" assessment approach has been utilized for a number of clinical disorders from self-injury and aggression (e.g., Iwata, Dorsey, Slifer, Bauman, & Richman (1994) to eating disorders (e.g., Piazza et al., 2003). The reasons for gambling assessed by the GFA are not *necessarily* pathological in and of themselves, though there are theoretical reasons to suspect that different maintenance mechanisms may be more or less likely to result in pathological gambling in some individuals (e.g., see Weatherly & Dixon, 2007).

The GFA is a 20-item, Likert-type, self-report instrument designed to identify four possible maintaining functional consequences of gambling (i.e., reinforcement contingencies): Sensory, Attention, Tangible, and Escape (see also Durand & Crimmins, 1988). Sensory functions might include the lights, sounds, or physical bodily sensations associate with gambling. Attention functions may include the social enjoyment of being with friends while gambling, or the emotional embraces of a loved one who provides compassion to the gambler upon returning from the casino. Tangible functions might include gambling to acquire casino "points" or "comps," as well as the possibility of gaining sums of money. Finally, the escape functions might include gambling to numb oneself from certain life pains or stressors, or to replace dealing with difficult psychological issues.

Five of the 20 total items are dedicated to each of the four functional consequences. Scores for each item range from 0 to 6, resulting in a possible maximum score of 30 in each content area (i.e., type of consequence) and a maximum raw score of 120 for the entire instrument. Reliability of the GFA has been measured in a large (N = 949) non-clinical college sample (Miller, Meier, & Weatherly, 2009). Internal consistency (Crombach's α) was quite good for the total GFA score (.92) and for the four content scores (.80 to .84). Test-retest reliability for the total GFA score was adequate (.75) after 12 weeks. Temporal stability for three of the four content areas was likewise adequate (.69 to .71). The consequence of Escape, however, evidenced lower test-retest reliability (.40) than the other consequences, which is indicative of variability over time.

The Escape content area also proved unique with respect to construct validity (Miller, Meier, Muehlenkamp, & Weatherly, 2009). Factor analysis (N=308) suggested that the GFA measured two broad constructs, interpreted as *positive reinforcement* and *negative reinforcement*, in a young-adult non-clinical sample. While strong positive correlations were observed between the positive reinforcement factor and the GFA scores for Attention (r = .84), Sensory (r = .79), and Tangible (r = .85), only the Escape scores correlated highly (r = .95) with the negative reinforcement factor. It was further observed that Escape scores were highly positively skewed; only a small minority of respondents in the upper 50th percentile of total GFA scores endorsed any items related to Escape. Miller et al. posited that the Escape score might thus be a better indicator of pathogenic, *per se*, behavioral maintenance function for gambling than the other three GFA content areas, as scores in these other areas were relatively normally distributed in the non-clinical sample. However, there is to date, no independent empirical evidence to

support this assertion. Likewise, there is no empirical support for the external validity of the GFA as a measure of pathological gambling. One means of establishing this *criterion* validity (Groth-Marnat, 2003) is direct comparison with other established measures of the same construct(s), applied at the same point in time (i.e., concurrent validity; e.g., Anastasi & Urbina, 1997; Sattler, 2001).

One Criterion Measure of Pathological Gambling

The South Oaks gambling Screen (SOGS; Lesieur & Blume, 1987) is a brief instrument intended to measure probable pathological gambling by sampling clinically relevant outcomes (e.g., difficulty controlling the amount of gambling, guilt about gambling, lying about or hiding gambling behavior, low efficacy for quitting despite a desire, negative interpersonal and occupational consequences, and means used or sources tapped for securing the money necessary to continue gambling). Thus, the SOGS, having been developed using prior DSM criteria (Lesieur & Blume, 1987), is similar to the DSM-IV clinical criteria, in that pathological outcomes are emphasized. The SOGS' authors recommend a raw score of five or more as an indicator of potential pathological gambling. Reliability statistics for the measure are uniformly adequate. For internal consistency, Stinchfield (2003) found $\alpha = .81$ for a large non-clinical Midwestern sample ($N = 803$). While Lesiuer and Blume (1987) reported $\alpha = .97$ for the original norming sample, Stinchfield (2002) pointed out that this coefficient was derived using a large mixed clinical/non-clinical sample. In actual use, where reference is made to a single population, testing of a more homogeneous sample should result in less score variance and lower internal consistency, such as that reported by Stinchfield (2003). Test-retest reliability for the SOGS with a mixed clinical/non-clinical sample ($N = 112$) was $r_{tt} = .71$ with test administrations "30 or more days apart" (Lesiuer & Blume , 1987; p. 1186). The SOGS is a thoroughly researched instrument and its validity is well-accepted, despite some critiques (see Gambino & Lesieur, 2006). Thus, with respect to the identification of likely pathological gamblers, the SOGS is a legitimate criterion measure for assessment of the GFA's validity as a screen for probable pathological gambling.

Diagnostic Efficiency Relative to SOGS-Defined Populations

Using the SOGS' cutoff score as criterion, it should be possible to estimate the diagnostic efficiency of various GFA cutoff scores. In other words, probable pathological gamblers and non-pathological respondents may be identified by their SOGS raw score (pathological ≥ 5); various GFA cutoff scores could be used to identify these same cases, and the accuracy of categorization by the GFA assessed. Indicators of diagnostic accuracy derived from this analysis would not represent the GFA's diagnostic accuracy or efficiency *per se* (i.e., no diagnoses are rendered, and there is no independent confirmation of the categories defined by the SOGS cutoff score). However, classification of cases similar to that accomplished by SOGS scores would support *concurrent validity* of the GFA, by supporting its convergence with the SOGS categorization of cases.

Hypotheses

The current study used scores from the SOGS as a means of assessing the concurrent validity of the GFA scores as indicators of probable pathological gambling in two ways. First, we determined the degree of correlation between scores from the two tests—the more traditional method of demonstrating this form of criterion validity (Anastasi & Urbina, 1997; Groth-Marnat, 2003' Nunnally & Bernstein, 1994). We hy-

pothesized that GFA scores would correlate highly and significantly with SOGS scores. Because the statistical significance of a correlation is relative to sample size, the magnitude of the correlation is more salient. Anastasi and Urbina (1997) suggest that such convergent correlations should be "moderately high, but not too high" (p. 127), as very high correlations may suggest that the new measure is redundant. Groth-Marnat points out that there is no universally accepted minimal correlation sufficient to support convergent validity; rather, a criterion should be set logically, following the purpose and assumptions of the tests involved, and, where possible, comparison with known correlations among tests of the same construct.

Stinchfield (2002) found high correlations between SOGS scores and DSM-IV diagnostic criteria in a large Minnesota community sample, surveyed by telephone (r = .77; N = 803), and a large sample of clients seeking treatment for gambling problems at state clinics (r = .83; N = 400). Recently, four pathological gambling measures were intercorrelated in a large study of university students (N = 197) in Singapore (Arthur, Tong, Chen, Hing, Sagara-Rosemeyer, Kua, & Ignacio, 2008). Correlations between the SOGS and the Gamblers Anonymous 20, the Canadian Problem Gambling Index, and the DSM-IV diagnostic criteria for pathological gambling ranged from .60 to .79. Jimenez-Murcia et al. (2009) considered correlations with SOGS of $\geq$ .30 evidence of convergent validity in their evaluation of a Spanish translation of a DSM-IV based pathological gambling measure. Based on these precedents, we anticipated that correlations between SOGS and GFA scores would exceed .30. Correlations in the range of .60 or above would be considered more satisfactory, since the correlation between SOGS and the current "gold standard" DSM-IV criteria falls at or above .60 (Arthur et al., 2008; Stinchfield, 2002).

Second, we explored the GFA's accuracy and efficiency in predicting categories (i.e., pathological versus non-pathological) as defined by the SOGS cutoff score for probable gambling pathology. This methodology is less traditional, but has several advantages. Correlational analyses reveal little about the relative diagnostic efficiency of a test, and tests that correlate may not necessarily distinguish groups with similar accuracy. Some researchers have suggested that a test's ability to classify relevant cases is a better indicator of its validity than its correlations with related measures, since such classification more closely matches real-world application. The notion of validity is tied to the application of the testing method (Cronbach, 1988). Thus, because the GFA was originally designed for clinical applications, a diagnostic approach that more closely parallels its eventual application, rather than a correlational method, would seem warranted. Moreover, the second approach allows for the identification of optimal cutoff scores for such applications, which are not produced by the correlational analysis. Sensitivity, specificity, and other indicators of diagnostic accuracy may be evaluated in the context of diagnostic efficiency relative to the base rate of pathology as indicated by the criterion measure. We therefore hypothesized that, as a valid measure of gambling pathology, the GFA would be diagnostically efficient (Meehl & Rosen, 1955) relative to the "base rate" established empirically by SOGS $\geq$ 5. Based on the unusual performance of the GFA Escape score seen previously (Miller et al., 2009), we further hypothesized that GFA Escape scores would evidence the greatest diagnostic accuracy relative to the SOGS-defined categories (i.e., these previous data suggest that negative reinforcement contingencies are the most

pathogenic in the context of gambling; cf., Weatherly & Dixon, 2007).

METHOD

Participants

Data were collected from two locations in the United States: One in Nevada and one in Illinois. Demographic data are displayed in Table 1 for each sample, including gender distribution, median, and mean age (and SD) of participants, self-identified race, annual income, and history of treatment for drug abuse, alcohol abuse, or gambling problems. Data were collected from 204 participants (49% female) in Las Vegas and Wendover, Nevada. Three of these cases were removed due to missing data. One hundred-one participants (74% female) were sampled in Rockford, Illinois.

Table 1.
Demographic Variables for Participants in the Nevada and Illinois Samples.

	Nevada	Illinois
***N* (% Female)**	201 (49%)	101 (74%)
Age, in Years		
Median	45	32
Mean	45.7	35.8
SD	14.3	12.0
Race		
White	171	85
Asian	6	3
African American	11	8
Hispanic	9	1
Native American	1	1
Other	3	3
Income		
$0-5,000	2	0
$5,000-10,000	4	1
$10,000-20,000	13	14
$20,000-30,000	20	24
$30,000-50,000	34	44
$50,000-70,000	50	15
>$70,000	74	3
Education		
High School / GED	93	45
Associates Degree	34	26
Bachelors Degree	43	26
Graduate Degree	31	4
History of Treatment		
None	195	84
Drugs	4	3
Gambling	4	2
Alcohol	5	15

Materials and Procedure

Human subjects approval was obtained from Southern Illinois University's Human Subjects Committee prior to the sampling of participants. All participants were given a copy of an informed consent page which described the research and its purpose, the risk to the participant, as well as information on the human subjects committee's approval and contact information if the participant had any questions regarding the research.

The materials were stapled packets containing the informed consent (described above), a demographics questionnaire, and two surveys/assessments on gambling behavior- the SOGS (Lesieur & Blume, 1987) and the GFA (Dixon & Johnson, 2007).

People above the age of 18 were approached by one of three researchers and asked if they would participate in a research study on gambling behavior. Individuals who agreed to participate were given the packet or the packet was read to them (depending upon their reading ability or request). Participants responded to the survey, which took an estimated 5 - 10 min to complete. Once the participant was finished, the researcher collected the survey. Participants were not given anything of material value for their participation.

All participants in the Nevada sample were approached by one of three researchers in locations including, but not limited to, restaurants, outside streets, public transportation systems (e.g., the airport, trolley, and

bus), Laundromats, grocery stores, private transportation service (i.e., hotel van transportation), parking lots, convenience stores, pawn shops, and liquor stores—all of which were within 100 yards of a gambling establishment. Data from the Illinois sample were collected in two sports bars in Rockford.

Scores for the SOGS and GFA were calculated for each participant, according to the appropriate scoring guidelines (Dixon & Johnson, 2007; Lesieur & Blume, 1987).

Indicators of diagnostic accuracy.

Overall accuracy of GFA categorization was tabulated, along with sensitivity, specificity, positive predictive power, and negative predictive power for a range of GFA Overall and content cutoff scores (see Results). The method and rationale follow. All calculations are predicated on the SOGS score of ≥ 5 being a valid positive indicator of probable pathological gambling. The ability of various GFA cutoff scores to accurately reproduce the SOGS-based categories was assessed.

Four outcomes are possible when predicting dichotomous group membership (e.g., identifying likely pathological versus likely non-pathological respondents): true positive, false positive, true negative, and false negative. If we identify cases as probably pathological (i.e., a "positive" prediction), based on some GFA cutoff score (e.g., Escape ≥ 10), then we are correct for people who scored ≥ 5 on the SOGS (true positives) and incorrect (false positives) for those who scored < 5 on the SOGS. If the GFA cutoff score identifies pathology as being *absent* (a "negative" prediction, e.g., Escape < 10), then we are correct (true negatives) for cases where SOGS < 5 and incorrect (false negatives) where SOGS ≥ 5. Only two of these outcomes are correct: true positives and true negatives. Together, cases with these frequencies are used to calculate the *overall accuracy* of classification (Kamphuis & Finn, 2002) using Equation 1:

$$\%\ \text{Correct Classification} = \frac{\text{True Positives} + \text{True Negatives}}{N}$$

(Equation 1)

It should be noted that accurate prediction of a low base-rate phenomena is notoriously difficult (Meehl & Rosen, 1955). For example, the prevalence of pathological gambling in the general population has been estimated at 1-3%, a low base rate occurrence (e.g., see Petry, 2005). By simply predicting that no one in a random sample of the general population gambles pathologically, we would be correct in 97%-99% of cases, despite having made no true positive predictions. Meehl and Rosen (1955) derived Equation 2 as a criterion to determine when a cutoff score is *efficient* (i.e., when the predictions based on the cutoff yield greater overall accuracy than use of the base rate alone):

$$\frac{\text{Base Rate of Event}}{\text{Base Rate of No Event}} > \frac{\text{False Positives, using the Procedure}}{\text{True Positives, using the Procedure}}$$

(Equation 2)

Using SOGS-defined groups, the Base Rate of Event is the percentage of respondents with SOGS ≥ 5, the Base Rate of No Event is 1- (Base Rate of Event), and "the Procedure" is the identification of likely pathological and non-pathological respondents using the GFA cutoff score of interest.

Efficiency, as defined by Meehl and Rosen (1955), is one important criterion used to identify optimal cutoff scores for a test. However, in clinical use, "optimal" is variously defined (Groth-Marnat, 2003; Kamphuis & Finn, 2002), depending mostly on the importance assigned to avoiding false positives versus false negatives. For example, false positives might be more acceptable

than false negatives for a test of suicidality, because failing to detect suicidal intent may have far more dire consequences than mislabeling an individual as potentially suicidal. A practitioner might retain an inefficient test, because it produces few false negatives and identifies all or nearly all of the suicidal respondents (true positives). Therefore, other indicators of diagnostic accuracy, such as sensitivity, specificity, positive predictive power, and negative predictive power, are often of interest.

Sensitivity is the proportion of cases in which a trait (present) is identified by the test (true positives) relative to the total number of cases where the trait is present. Sensitivity is calculated using Equation 3. In the current case, the trait is probable pathological gambling (operationalized as SOGS ≥ 5), true positives would be those likely pathological gamblers identified as such by GFA data, false negatives would be likely pathological gamblers not identified by GFA data, and the sensitivity of the GFA score would be equal to the number of SOGS-defined probable pathological gamblers identified by GFA (true positives) divided by the total number of SOGS-identified probable pathological gamblers (true positives + false negatives).

$$\text{Sensitivity} = \frac{\text{True Positives}}{\text{True Positives} + \text{False Negatives}}$$

(Equation 3)

Specificity is the proportion of cases without the trait correctly identified by the test as lacking the trait. Specificity is calculated using Equation 4. In the current study, Specificity is defined as the number of identified likely non-pathological gamblers, as determined by the SOGS (true negatives), divided by the total number of likely non-pathological gamblers (true negatives + false positives). Specificity reflects how well the test discounts cases that are likely not pathological.

$$\text{Specificity} = \frac{\text{True Negatives}}{\text{True Negatives} + \text{False Positives}}$$

(Equation 4)

Positive predictive power (PPP) is the proportion of cases predicted to have the trait that indeed have the trait. PPP can be calculated using Equation 5. PPP is, in the current case, the proportion of respondents identified as likely pathological by GFA data who earned a SOGS score of five or more.

$$\text{PPP} = \frac{\text{True Positives}}{\text{True Positives} + \text{False Positives}}$$

(Equation 5)

Negative predictive power (NPP) is the proportion of cases predicted to lack the target trait that indeed lack it. NPP can be calculated using Equation 6. Here, NPP is the proportion of respondents identified by the GFA as probably non-pathological who score less than five on the SOGS.

$$\text{NPP} = \frac{\text{True Negatives}}{\text{True Negatives} + \text{False Negatives}}$$

(Equation 6)

Table 2.
Correlations with SOGS Total Score for Two Samples.

	Attention	Escape	Tangible	Sensory	GFA Total
Nevada Sample (*N*=201; BR=7.5%)	.24	.45	.44	.42	.49
Illinois Sample (*N*=101; BR=28.7%)	.04	.61	.24	.38	.44

BR = Base Rate (SOGS≥5)

RESULTS

Correlations

Table 2 displays correlations between the SOGS score and the total GFA score and each of the four GFA content scores for both the Nevada and Illinois samples.

Nevada sample (N = 201).

The correlation between the SOGS and total GFA score was significant at the = .01 level, though the correlation was modest (r = .49). Similarly, significant correlations were found between the SOGS and GFA scores for Escape (r = .45), Sensory (r = .42), and Tangible (r = .44). The correlation between SOGS and GFA Attention scores appeared smaller than for the other GFA content areas (r = .243; p < .01).

Illinois sample (N = 101).

Correlations were more variable for the Illinois respondents, with coefficients for GFA scores on Attention (r = .04) and Tangible (r = .24) failing even to meet the significance criterion of α = .01. GFA Total (r = .44) and Sensory (r = .38) score correlations with the SOGS were both significant (p < .01). Correlations between the SOGS and GFA Escape scores yielded the largest coefficient (r = .61; p < .01) for either sample.

Diagnostic Efficiency with Respect to SOGS-Defined Categories

Tables 3, 4, and 5 display the sensitivity, specificity, positive predictive power (PPP), and negative predictive power (NPP) across a range of cutoffs for the four content and the total GFA scores in the Illinois and Nevada samples. Data are bolded where the cutoff score yielded efficient overall prediction (using criterion in Eq. 2) relative to the base rate, which was 7.5% for the Nevada sample, and 28.7% for the Illinois sample. Due to its unique factor loadings and distribution (Miller, Meier, Muehlenkamp, & Weatherly, 2009), and its moderate to high correlations with SOGS (Table 2), the Escape score is of particular interest.

Illinois Sample.

The Escape scores performed best in the Illinois sample, consistent with the pattern of correlations displayed in Table 2. The efficiency criterion was met when Escape ≥ 11. At this cutoff, sensitivity was 38% and specificity was 94%, reflecting the relative importance of minimizing false positives when base rates are less then 50%. This cutoff score correctly classified 78% of the sample.

Nevada sample.

Both sensitivity and specificity were uniformly lower over the same range of Escape cutting scores in this sample. The maximum Escape sensitivity was 80%, versus 90% in the Illinois sample.

DISCUSSION

In terms of convergence with the SOGS, the GFA appeared to perform somewhat differently in the two samples, and across content scores. One reason may be the differences in the two samples. In the Nevada sample, 7.5% of respondents scored ≥5 on the SOGS—the instrument's criterion for probable pathological gambling (Lesieur & Blume, 1987). The frequency of scoring 5 or more on the SOGS for the Illinois sample (28.7%) was nearly four times as high. The Nevada sample appeared to be somewhat wealthier and better educated overall. Only bar goers were sampled in Illinois, while Nevada respondents came from a variety of locations near gambling establishments. It should also be remembered that the GFA and SOGS are intended to measure two different, though related, constructs. The SOGS measures range and frequency of gambling behaviors, as well as behaviors—legal or illegal—serving to facilitate or obfuscate the

Table 3.

Diagnostic Accuracy of GFA Total Score Cutoffs for the Illinois & Nevada Samples). SOGS≥5 is the criterion.

	Illinois Sample *N* = 101; *BR* = 28.7%					Nevada Sample *N* = 201; *BR* = 7.5%				
Cut	Sens	Spec	PPP	NPP	%C	Sens	Spec	PPP	NPP	%C
≥50	0.52	0.75	0.46	0.79	0.68	0.47	0.96	0.50	0.96	0.93
≥48	0.52	0.67	0.39	0.77	0.62	0.53	0.95	0.44	0.96	0.92
≥46	0.69	0.65	0.44	0.84	0.66	0.67	0.94	0.48	0.97	0.92
≥44	0.76	0.64	0.46	0.87	0.67	0.67	0.93	0.42	0.97	0.91
≥42	0.76	0.60	0.43	0.86	0.64	0.67	0.89	0.32	0.97	0.87
≥40	0.79	0.57	0.43	0.87	0.63	0.67	0.86	0.27	0.97	0.84
≥38	0.79	0.44	0.37	0.84	0.55	0.73	0.81	0.24	0.97	0.81
≥36	0.83	0.38	0.35	0.84	0.51	0.80	0.78	0.23	0.98	0.78
≥34	0.86	0.32	0.34	0.85	0.48	0.80	0.72	0.19	0.98	0.72
≥32	0.86	0.26	0.32	0.83	0.44	0.80	0.69	0.17	0.98	0.70
≥30	0.93	0.19	0.32	0.88	0.41	0.80	0.67	0.16	0.98	0.68
≥28	0.97	0.13	0.31	0.90	0.37	0.80	0.62	0.15	0.98	0.63

BR = Base Rate, i.e., % of *N* for whom SOGS≥5
Sens = Sensitivity = True Positives / (True Positives +False Negatives)
Spec = Specificity = True Negatives / (True Negatives + False Positives)
PPP = Positive Predictive Power = True Positives / (True Positives + False Positives)
NPP = Negative Predictive Power = True Negatives / (True Negatives + False Negatives)
%C = Percent Correct Overall = (True Positives +True Negatives) / *N*

gambling (i.e., the quantity of gambling and maladaptive outcomes). In contrast, the GFA assesses reasons for gambling in general, with no reference to maladaptive consequences; the only consequences assessed are those that maintain the behavior. The distributions of scores may reflect the differences between the tests. SOGS scores are highly positively skewed, with 92.5% of the Nevada respondents and 71.3% of the Illinois respondents falling below the cutoff score of five. GFA Total scores are more normally distributed, reflecting a range of functions maintaining gambling behavior among those who gamble, though, not necessarily, pathologically. Given that the two instruments measure different constructs, the more modest of the correlations might be expected. However, for the GFA to be useful (valid) as a *diagnostic* instrument, it should be able to discriminate the same populations as the SOGS. That is, it should be able to discriminate between pathological and nonpathological respondents.

The current clinical definition of pathological gambling (i.e., "persistent and recurrent maladaptive gambling behavior") suggests many possible assessment approaches. One, a purely clinical and empirical approach, focuses on the maladaptive outcomes of the problem behavior. Such an approach, exemplified by the SOGS (Lesieur & Blume, 1987), catalogs negative consequences in close relationships, financial problems, time investment, etc. but does not address the reasons for the behavior's persistence and recurrence. This emphasis ties the test closely to DSM diagnostic criteria, which often avoid defining disorders using any single theoretical model (i.e., the SOGS is *atheoretical*, consistent with its

Table 4.

Diagnostic Accuracy of GFA Subscale Score Cutoffs for the Illinois sample. N=101; Base Rate (SOGS=5) =28.7%.

	Escape					Sensory					Attention					Tangible				
Cut	Sens	Spec	PPP	NPP	%C	Sens	Spec	PPP	NPP	%C	Sens	Spec	PPP	NPP	%C	Sens	Spec	PPP	NPP	%C
=21																0.21	0.89	0.43	0.74	0.69
=20																0.24	0.85	0.39	0.74	0.67
=19						0.07	0.99	0.67	0.72	0.72						0.31	0.81	0.39	0.74	0.66
=18						0.07	0.93	0.29	0.71	0.68						0.35	0.72	0.33	0.73	0.61
=17						0.14	0.92	0.40	0.73	0.69	0.31	0.72	0.31	0.72	0.60	0.35	0.67	0.29	0.72	0.57
=16						0.21	0.90	0.46	0.74	0.70	0.52	0.64	0.37	0.77	0.60	0.59	0.61	0.40	0.79	0.62
=15						0.31	0.88	0.50	0.76	0.71	0.52	0.57	0.33	0.75	0.55	0.72	0.60	0.42	0.84	0.63
=14	**0.35**	**0.99**	**0.91**	**0.79**	**0.80**	0.38	0.83	0.48	0.77	0.70	0.62	0.54	0.35	0.78	0.56	0.86	0.53	0.42	0.91	0.62
=13	**0.35**	**0.97**	**0.83**	**0.79**	**0.79**	0.41	0.75	0.40	0.76	0.65	0.66	0.49	0.34	0.78	0.54	0.90	0.47	0.41	0.92	0.59
=12	**0.35**	**0.96**	**0.77**	**0.78**	**0.78**	0.62	0.68	0.44	0.82	0.66	0.76	0.38	0.33	0.79	0.49	0.97	0.36	0.38	0.96	0.54
=11	**0.38**	**0.94**	**0.73**	**0.79**	**0.78**	0.69	0.54	0.34	0.81	0.58	0.76	0.29	0.30	0.75	0.43	0.97	0.31	0.36	0.96	0.50
=10	0.41	0.93	0.71	0.80	0.78	0.76	0.43	0.35	0.82	0.55	0.79	0.22	0.29	0.73	0.39	1.00	0.18	0.33	1.00	0.42
=9	0.45	0.89	0.62	0.80	0.76	0.79	0.25	0.30	0.75	0.41	0.86	0.14	0.29	0.71	0.35	1.00	0.15	0.32	1.00	0.40
=8	0.55	0.79	0.52	0.81	0.72	0.83	0.15	0.28	0.69	0.35	0.90	0.04	0.27	0.50	0.29					
=7	0.55	0.78	0.50	0.81	0.71	0.86	0.13	0.28	0.69	0.34	0.97	0.01	0.28	0.50	0.29					
=6	0.59	0.71	0.45	0.81	0.67	0.90	0.06	0.28	0.57	0.30	0.97	0.00	0.28	0.00	0.28					
=5	0.69	0.58	0.40	0.82	0.61	0.93	0.00	0.27	0.00	0.27										
=4	0.83	0.54	0.42	0.89	0.62	0.97	0.00	0.28	0.00	0.28										
=3	0.86	0.46	0.39	0.89	0.57	1.00	0.00	0.29		0.29										
=2	0.90	0.32	0.35	0.89	0.49															
=1	0.90	0.15	0.30	0.79	0.37															

Sens = Sensitivity = True Positives / (True Positives +False Negatives)
Spec = Specificity = True Negatives / (True Negatives + False Positives)
PPP = Positive Predictive Power = True Positives / (True Positives + False Positives)
NPP = Negative Predictive Power = True Negatives / (True Negatives + False Negatives)
%C = Percent Correct Overall = (True Positives +True Negatives) / *N*

Bolded items are "efficient" with respect to the base rate, as defined by Meehl & Rosen (1955): $\frac{\text{Base Rate of Event}}{\text{Base Rate of No Event}} > \frac{\text{False Positives, using the Procedure}}{\text{True Positives, using the Procedure}}$

Table 5.

Diagnostic Accuracy of GFA Subscale Score Cutoffs for the Nevada Sample. N=201; Base Rate (SOGS=5) =7.5%.

	Escape					Sensory					Attention					Tangible				
Cut	Sens	Spec	PPP	NPP	%C	Sens	Spec	PPP	NPP	%C	Sens	Spec	PPP	NPP	%C	Sens	Spec	PPP	NPP	%C
=21																0.07	0.98	0.20	0.93	0.91
=20																0.07	0.96	0.11	0.93	0.89
=19						0.27	0.99	0.67	0.94	0.94						0.13	0.95	0.18	0.93	0.89
=18						0.27	0.99	0.67	0.94	0.94						0.20	0.91	0.15	0.93	0.86
=17						0.27	0.98	0.50	0.94	0.93	0.33	0.91	0.24	0.94	0.87	0.20	0.88	0.12	0.93	0.83
=16						0.33	0.96	0.42	0.95	0.92	0.33	0.89	0.20	0.94	0.85	0.20	0.82	0.08	0.93	0.77
=15						0.33	0.94	0.31	0.95	0.90	0.33	0.85	0.15	0.94	0.81	0.27	0.77	0.09	0.93	0.74
=14	0.07	0.99	0.50	0.93	0.93	0.40	0.91	0.27	0.95	0.88	0.40	0.79	0.13	0.94	0.76	0.33	0.72	0.09	0.93	0.69
=13	0.07	0.99	0.50	0.93	0.93	0.47	0.89	0.26	0.95	0.86	0.40	0.76	0.12	0.94	0.74	0.33	0.68	0.08	0.93	0.66
=12	0.07	0.99	0.33	0.93	0.92	0.60	0.87	0.27	0.96	0.85	0.53	0.70	0.13	0.95	0.69	0.47	0.65	0.10	0.94	0.63
=11	0.07	0.99	0.33	0.93	0.92	0.60	0.83	0.23	0.96	0.82	0.67	0.67	0.14	0.96	0.67	0.53	0.59	0.10	0.94	0.59
=10	0.07	0.99	0.33	0.93	0.92	0.60	0.76	0.17	0.96	0.75	0.67	0.62	0.13	0.96	0.63	0.60	0.58	0.10	0.95	0.58
=9	0.13	0.99	0.50	0.93	0.93	0.67	0.70	0.15	0.96	0.70	0.67	0.57	0.11	0.96	0.58	0.67	0.53	0.10	0.95	0.54
=8	0.20	0.97	0.38	0.94	0.92	0.73	0.61	0.13	0.97	0.62	0.87	0.52	0.13	0.98	0.54					
=7	0.20	0.96	0.30	0.94	0.91	0.80	0.57	0.13	0.97	0.58	0.87	0.47	0.12	0.98	0.50					
=6	0.20	0.94	0.21	0.94	0.89	0.87	0.52	0.13	0.98	0.55	0.93	0.38	0.11	0.99	0.42					
=5	0.40	0.87	0.20	0.95	0.84	0.87	0.44	0.11	0.98	0.47										
=4	0.53	0.84	0.22	0.96	0.82	0.87	0.39	0.10	0.97	0.42										
=3	0.60	0.80	0.19	0.96	0.78	0.87	0.31	0.09	0.97	0.35										
=2	0.80	0.76	0.21	0.98	0.77															
= 1	0.80	0.67	0.16	0.99	0.68															

Sens = Sensitivity = True Positives / (True Positives +False Negatives)
Spec = Specificity = True Negatives / (True Negatives + False Positives)
PPP = Positive Predictive Power = True Positives / (True Positives + False Positives)
NPP = Negative Predictive Power = True Negatives / (True Negatives + False Negatives)
%C = Percent Correct Overall = (True Positives +True Negatives) / *N*

origin in the pointedly atheoretical criteria of the DSM). Another, theoretically based, approach emphasizes the proposed underlying causes of the behavior and the mechanisms of maintenance. Use of the GFA (Dixon & Johnson, 2007), and its underlying behavior-analytic theoretical perspective, emphasizes reinforcing consequences. This theory-based approach has added value for clinicians, as the diagnostic indicators suggest theoretically relevant and practical targets for intervention. In other words, identification of the mechanisms maintaining a behavior is also, by definition, identification of the means for changing it. By drawing distinctions between the descriptive and theoretically driven assessment approaches, we do not mean to suggest that the two are somehow contrary or incompatible. Any such suggestion would be moot, given the need for diagnostic schemes that may be applied irrespective of theoretical orientation, and the universal acceptance of the DSM system for classifying pathology. Theoretically-based methods, such as the GFA, may serve as a means of bridging the gap between diagnosis and treatment, clarifying the intervention targets by exposing the means of maintenance. Further research will be needed to explore the utility of the GFA as a treatment-planning tool. A useful first step would be to correlate GFA scores with various outcomes in treatment for gambling addictions, such as indicators of treatment compliance, symptom reduction or remission, and post-treatment relapse.

Data from the current study support the concurrent validity of only one GFA component, Escape, relative to the SOGS, i.e., as a diagnostic indicator. Performance differences across the two samples are enlightening. In the Illinois sample, the base rate of gambling pathology, as measured by the SOGS, was much higher than in the Nevada sample, and much higher than estimates for the general population (APA, 1994; Petry, 2005). In this way, the Illinois sample was the closer of the two to a 'clinical" sample, where the base rate of pathology would be expected to be higher than in a general, non-clinical group. In this sample, the GFA Escape score performed better than other GFA content scores. SOGS and GFA Escape scores shared about 37% of variance (r = .61, the highest overall). Correlations of this magnitude are not uncommon for measures of similar, though distinct, constructs like those measured by the SOGS and GFA. For example, Verbal and Performance IQ scores of the Wechsler Adult intelligence Scales, 3rd Edition, correlate at .68 to .80, depending on the age of the subject (Tulsky, Zhu, & Ledbetter, 2002). Indicators of substance abuse from the Minnesota Multiphasic Personality Inventory, 2nd Edition (Butcher, Dahlstrom, Graham, Tellegen, & Kaemmer, 1989), the MacAndrew Alcoholism Scale—Revised and the Addiction Admission Scale, correlate at r = .48 (Greene, 1999).

GFA Escape and SOGS scores were distributed similarly, with most respondents in the ostensibly non-clinical sample endorsing few items, if any, on either. This similarity in distribution contributed to the comparatively good sensitivity and specificity (in the Nevada sample) of the Escape cutoffs scores. While the higher base rate in the Illinois sample, relative to the Nevada sample, would be expected to contribute as well, performance did not improve for *all* of the GFA content scores.

Analysis of GFA diagnostic efficiency using SOGS ≥ 5 as criterion (Tables 3, 4, 5) indicated that the Escape subscale most accurately replicated SOGS-based classification. Escape was the only GFA score to meet Meehl and Rosen's (1955) criterion for *efficiency* (Table 4). That is, it was the only score to predict SOGS-based categories better than prediction by the base rate alone.

This occurred in the Illinois sample, where, as stated earlier, the base rate was much higher than typically observed in nonclinical settings (Petry, 2005). "Efficiency" does not necessarily equal clinical utility, however. Clinicians may use test scores for different purposes (e.g., to "rule out" or "rule in" a diagnosis) for which different types of errors are more or less tolerable. Depending on the intended use, other accuracy indicators may be of greater interest to clinicians. In the Illinois sample, PPP at Escape≥14 was .91, meaning that, in this sample, there was a 91% chance that a positive result on GFA Escape would be confirmed by SOGS ≥ 5. At this same cutoff, there was a 79% chance that a negative finding (Escape < 14), or rule-out, would be confirmed by SOGS < 5 (NPP = .79). Specificity was excellent at this same cutoff (.99), while sensitivity was poor (.35). These data suggest that, with base rates similar to those found in clinical settings, Escape ≥ 14 is a highly *conservative* (resulting in an acceptably low probability of false positive results) threshold for identifying probable gambling pathology, as defined by the SOGS. These findings must be considered tentative because of the nonclinical nature of the sample and its limited size. In the Nevada sample, where the base rate was much closer to that of the general population, a curoff as low as Escape≥2 yielded acceptable sensitivity (.80) and specificity (.76) and excellent NPP (.98). PPP, however, was poor (.21), owing to the low base rate and the test's specificity. No Escape cutoff score met efficiency criteria at this lower base rate.

As mentioned above, factor analysis supports Escape as the only GFA measure of *negative reinforcement*, and it is quite possible that negative versus positive reinforcement contingencies may be critical to the etiology of pathological gambling (Miller et al., 2009). Morasco, Weinstock, Ledgerwood, and Petry. (2007) reported that pathological gamblers in treatment indicate negative reinforcement as an important contributor to maintenance of their gambling behavior. The Illinois data, though not a clinical sample, suggest that the GFA Escape score may be useful in identifying pathology in a clinical setting (e.g., among patients referred for gambling problems or who report distress or impairment related to their gambling behavior). A study of diagnostic efficiency within a true clinical population, where independent confirmation of diagnoses is available, will be needed to verify this possibility.

In the Nevada sample, with roughly one quarter of the Illinois sample's base rate of potential pathological gambling, performance of the GFA relative to SOGS was poorer than in the Illinois sample. While convergent correlations were less variable than in the Illinois sample, none of the coefficients matched the magnitude of the GFA Escape score. As the SOGS is a "screen," these results may not be surprising. The SOGS has been used in large research studies to establish prevalence rates among sectors of the general population, where base rates are low (e.g., Gill, Dal Grande, & Taylor, 2006; Philippe & Vallerand, 2007), and has demonstrated its effectiveness in these contexts. The current data suggest that the GFA may not be as useful as the SOGS in this capacity.

Further validation will be necessary to establish the GFA Escape score as a reliable indicator of pathology, though the data collected to date are mixed. The Escape score performed better where the base rate of SOGS-defined pathology was highest, suggesting it may not perform well as a screening for pathology in community samples. While the Sensory, Attention, and Tangible scores do not appear to measure SOGS-identified probable pathology to the extent that the Escape score does, these components of the GFA may still have some clini-

cal, if not diagnostic, utility. If the GFA Escape score proves to discriminate well between *real* pathological and non-pathological cases in future studies involving clinical populations, other GFA content scores may be useful in treatment planning by assisting in the identification of salient maintenance functions for persons whose gambling behavior has already been deemed pathological. At present, however, evidence for the *diagnostic* utility of the positive reinforcement functions assessed by the GFA is very limited.

As with the majority of clinical disorders, the diagnosis is only a first step towards successful treatment and recovery for the person suffering from the affliction. For over 20 years, the SOGS has provided researchers and treatment providers with a means of easily assessing the severity of gambling for a given individual. However, syndromal classification is only the beginning. Afterwards, the clinician needs ways to understand, assess, and eventually treat reasons for why individuals continue to gamble when the odds of winning are surely against them. A function-based approach has yielded an effective means by which to discover the heterogeneity of specific clinical populations, and it appears promising that such an approach will yield great benefits for the field of pathological gambling treatment. The GFA is a promising assessment device, and with it, perhaps the odds of effective treatment will become just a bit more favorable.

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