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Trends in Behavior-Analytic Gambling Research and Treatment

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Abstract The purpose of the present review was to analyze research outcomes for all gambling studies reported in the behavior analysis literature. We used the search term "gambling" to identify articles that were published in behaviorally oriented journals between the years 1992 and 2012 and categorized the content of each article as empirical or conceptual. Next, we examined and categorized the empirical articles by inclusion of an experimental manipulation and treatment to alleviate at least some aspect of pathological gambling, participant population used, type of gambling task employed in the research, whether the participants in the study actually gambled, and the behavioral phenomena of interest. The results show that the rate of publication of gambling research has increased in the last 6 years, and a vast majority of articles are empirical. Of the empirical articles, examinations of treatment techniques or methods are scarce; slot machine play is the most represented form of gambling, and slightly greater than half of the research included compensation based on gambling outcomes within experiments. We discuss implications and future directions based on these observations of the published literature.

Keywords Choice · Citation analysis · Gambling · Pathological gambler · Risk

Gambling, defined as behavior involving risk of some commodity of value on the outcome of a game or event with a chance outcome (Whelan et al. 2007), has spread rapidly throughout the USA. Whether it is commercial casinos, lotteries, or charitable wagering, 48 states now have legalized gambling opportunities (American Gaming Association 2014). Approximately 28 %, or almost 62 million adults, visited a

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gambling establishment in 2009 (American Gaming Association 2010), and casinos continue to report increasing amounts of revenue with over $35.6 billion collected in 2011 (American Gaming Association 2012). Just as casinos and other gambling establishments are seeing increasing gains, as technology expands, internet gambling is also likely to proliferate in the near future (Griffiths 1999). Survey data collected from 1356 college students revealed that 10.4 % of this population has engaged in some form of monetary gambling on the Internet (Petry and Weinstock 2007); one no longer needs to leave the house to gamble. Approximately 1.4 % of the US population is affected by pathological gambling, and with the rapid expansion of wagering opportunities, pathological gambling represents a growing problem of social significance.

Despite the emerging concern about the availability of gambling opportunities and the prevalence of pathological gambling, this area of research appears to be underrepresented in the behavior analysis literature. However, we argue that studying this area offers several advantages to researchers and to the field of behavior analysis as a whole. First, gambling is a far-reaching topic with opportunities for basic, translational, and applied investigations (Fantino 2008). Gambling as a behavior itself has significant social ramifications. With rising numbers of pathological gamblers in societies across the world, treatment approaches with demonstrated efficacy could hold great potential for behavior analysts seeking to make meaningful gains in people's lives. Those of us more interested in understanding basic behavioral phenomena might find that the context of gambling allows us to study various dimensions of human behavior, with these studies framed in such a way that the immediate utility of our discoveries is apparent. To gamble is a basic human activity. Whether we study it to impact the world or study it to understand how the world works, for the field of behavior analysis, there is much to gain by studying gambling.

Second, gambling research allows the field of behavior analysis to join with other fields of psychological study in an attempt to solve an applied problem. Gambling is a problem where biological, cognitive, and behavioral perspectives converge (Fantino 2008). To highlight this point, pathological gambling has been identified as an impulse problem: one where an addicted gambler allocates responding to alternatives with probable reinforcers of lower quality or magnitude that are available immediately in lieu of enduring a delay required to save money with less risk (Petry and Casarella 1999). One methodology frequently employed in many fields of psychology to examine impulsive behavior is delay discounting. Because quantitative analyses of this type are often understood and used by professionals with backgrounds in other areas of psychology as a dependent measure of impulsivity, studies of how cognitive variables and behavioral variables influence delay discounting combine to provide a more thorough analysis of determinants of impulsive choice. Research from a variety of perspectives would likely identify a wider database of factors to inform the development of effective treatment for socially significant problems (Reed et al. 2012), including pathological gambling.

Delay discounting may be an interesting framework in which to position gambling, but discounting alone is far from a comprehensive analysis. First, discounting is the description of a phenomenon and nothing more. A retrospective analysis of choice making deserves a place in the gambling discussion, but the act of gambling is dependent on many more factors than a simple binary choice procedure can explain. Behavioral research has demonstrated that the presence of gambling stimuli (Dixon

et al. 2006), a history of gambling behavior (Dixon et al. 2003), and relational stimuli (Dixon and Holton 2009) can alter gamblers' discounting rates, and that a variety of instructions provided to the gambler (Dixon 2000) or self-generated by the gambler (Zlomke and Dixon 2006) can significantly impact binary choices among money, slot machine playing, or roulette betting. In short, gambling is a complex human behavior, and a comprehensive account of gambling requires an analysis of many variables.

In the past two decades, gambling research has increased within the behavioral community. Once a niche interest, gambling research has now been published in several behavioral journals. However, the question remains as to what we really know about the phenomena and whether we are using that knowledge to improve the lives of people affected by pathological gambling. Although a behavioral analysis of pathological gambling is still under development, numerous basic and applied efforts have been made over the last several years to understand and solve this problem. To date, the current state of the behavioral gambling literature has not been evaluated, nor has progress toward solutions to gambling problems in the behavioral literature been examined. We sought to classify relevant existing publications by methodology, populations employed in research, gambling tasks utilized, presence of risk, and the behavioral phenomenon studied to determine the current status of the literature and to suggest future directions.

Method

Selection of Empirical Articles

We searched the following behavioral journals that serve as a potential outlet for gambling research: *The Journal of Applied Behavior Analysis* (*JABA*), *The Journal of the Experimental Analysis of Behavior* (*JEAB*), *The Analysis of Verbal Behavior* (*TAVB*), *The Analysis of Gambling Behavior* (*AGB*), *The Behavior Analyst*, and *The Psychological Record*. Using the keyword "gambling," we identified 143 articles published in these journals. Articles were removed from further inclusion if the content of the article did not consist primarily of examinations of behavior or concepts in accordance to the definition of gambling by Whelan et al. (2007) noted previously. Thus, articles were removed if the content did not analyze risk behavior or processes, either empirically or conceptually, in relation to a probabilistic outcome. The final pool consisted of 108 articles.

Dependent Variables

Methodologies First, the content of each article was examined and sorted into either empirical or conceptual categories. An article was defined as empirical if the authors attempted to manipulate an independent variable to influence behavior within the study, or if data were collected from observations of behavior. Both basic and applied studies were included. A study was classified as conceptual/other if no new data were generated in the study, the article reviewed the current literature without empirical analysis, or no manipulation of variables or observations was reported.

Next, the empirical articles were further divided by methodology. A study was scored as observational if gambling was observed, but the experimenters did not manipulate an independent variable to influence behavior. In contrast, studies were counted as experimental if an intervention was implemented, the environment was manipulated, or participants were divided into distinct groups to examine population differences. Last, articles categorized as experimental were then scored based on whether participants entered treatment or not. An article qualified for inclusion in the treatment category if it included an evaluation of an intervention designed to alleviate or reduce some aspect of pathological gambling, such as high rate of play, suboptimal choice, impulsive decision making, or increased physiological response in the presence of gambling stimuli.

Populations We initially examined the demographics reported in each study to determine whether pathological or problem gamblers were included in the study. For the study to be scored as one including problem or pathological gamblers, the participants must have been required to demonstrate pathological gambling behavior, or to have scored as a pathological gambler based on a standardized survey, such as the South Oaks Gambling Screen (Lesieur and Blume 1987), provided by the experimenters. Studies using a group of pathological gamblers as an experimental group in comparison with another control group also were scored this way. Studies with all other populations were counted as nonpathological. The articles with populations not including pathological gamblers were further divided into smaller categories such as older adults (those who reported retirement status or residence in a nursing home), general population adults (those aged 18 and older who did not qualify as an older adult with no indication of pathological gambling), college students (participants recruited from or enrolled in college courses), children (aged <18), and animals (nonhuman subjects such as rats or insects) based on the demographic descriptions listed in each study. If a study contained a sample of pathological gamblers and a sample of college students, the study would count toward the total of both pathological gambler and college student categories so that all samples used in the study were represented in the totals.

Gambling Task Studies were categorized by the gambling task used in the research, including roulette, lottery, slot machines, poker, blackjack, craps, or horse racing. In addition, a study was scored as "other risk activity" if the task involved some form of gambling related to betting on performance, playing a probabilistic board game, or engaging in other related gambling activities not frequently found in a casino environment. A study using more than one type of gambling activity was counted toward the total of each activity included.

Compensation Empirical studies were classified as gambling or nongambling. Gambling was defined by the provision or possession of credits or chips, hypothetical or real, to place bets in a gambling task or activity involving risk. Nongambling was defined as scenarios involving no risk of loss and no betting, such as choice trials, "free play" scenarios (e.g., the participant played hands of poker without wagering chips), or experiments where participants provided ratings or reported "feelings" about gambling outcomes, such as examinations of subjective ratings of how close a slot machine spin was to winning or how likely they felt they were to win on future trials. These studies

examined variables directly relevant to the gambling context and were thus included in the present analysis, but required no wagering.

Gambling studies were then further divided based on the presence of actual risk. Contingent payout was defined by compensation earned for participation in the study based on gambling performance. This included studies where the potential to earn or lose additional extra credit for courses, money, or any tangible reward was based on gambling outcomes within the experiment, indicating risk. Noncontingent payout was defined by either the absence of compensation or the provision of a fixed reward contingent only on participation in the experiment and that could not be altered by any choices made when completing the procedures, indicating no risk.

Behavioral Phenomena of Interest Using the proposed behavioral model of gambling by Weatherly and Dixon (2007), papers were categorized as investigating contingencies (e.g., reinforcement, punishment, schedule effects, etc.), verbal behavior (e.g., rule-governed behavior, relational responding, etc.), or motivating operations or setting events (e.g., comparisons of pre-existing demographic groups, influence of risk factors of gambling, deprivation or satiation, etc.). Categorical inclusion was determined by the content of the article's title (e.g., "The effect of relational training on the near-miss effect in slot machine players," by Nastally and Dixon (2010) was categorized as a verbal behavior study), abstract, or the study's stated purpose at the end of the introduction section of the paper. Categorization was mutually exclusive; articles were scored only by the primary principle to avoid excessive overlap. Many studies included multiple principles, such as antecedent control in examinations of rule-governed behavior or reinforcement procedures involved in multiple exemplar training of relational training procedures (e.g., Dymond et al. 2010).

Results

General Parameters

A total of 108 articles were identified as meeting the inclusion criteria. Date of publication ranged from 1995 to 2012, the majority of which (87 %) were published after 2007. The cumulative number of gambling articles in each journal is presented in Fig. 1. Representation of articles across journals was expectedly disproportionate toward the *AGB*, which published 75 out of the total 108 articles reviewed. *The Psychological Record* (13 articles) and *JABA* (12 articles) were similarly represented. *TAVB* (one article), *JEAB* (five articles), and *The Behavior Analyst* (two articles) revealed few articles explicitly related to the topic of gambling.

Interobserver Reliability

Interobserver reliability (IOR) was conducted via independent review of articles. An additional researcher examined the entire list of articles using the search term for each journal and replicated the same procedures described above. Both observers' searches yielded the same list of articles, indicating reliability of 100 %. Further, IOR was
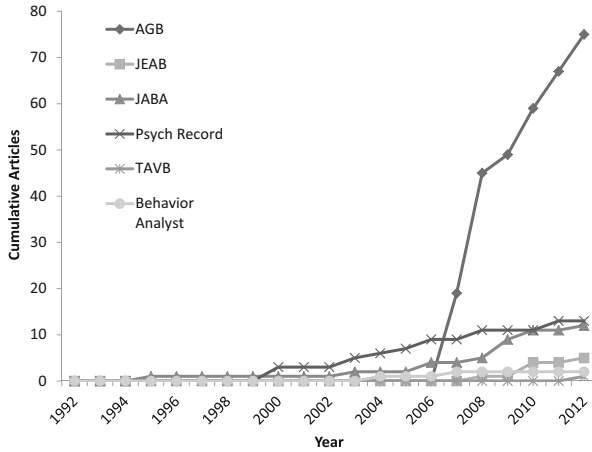
Fig. 1 The cumulative number of gambling articles found in behavioral journals from 1992 to 2012

calculated for content categorization. Agreement was defined as two reviewers independently categorizing every content area of an article similarly. In total, 59 articles (54.6 % of total articles identified in this review) were assessed for reliability. Articles were randomly selected from each journal in proportion to that journal's overall representation. Reviewers agreed on the exact categorization of 56 of 59 (94.9 %) articles.

Methodologies

Thirty-five articles (32.4 %) were determined to be conceptual/other in nature, and 73 (67.6 %) of articles qualified as empirical. Of the empirical articles, most were experimental (64 articles, 87.7 % of empirical articles), and six (8.2 %) were identified as observational (see Fig. 2). Only three articles included any evaluation of an attempt to alleviate some aspect of pathological gambling.
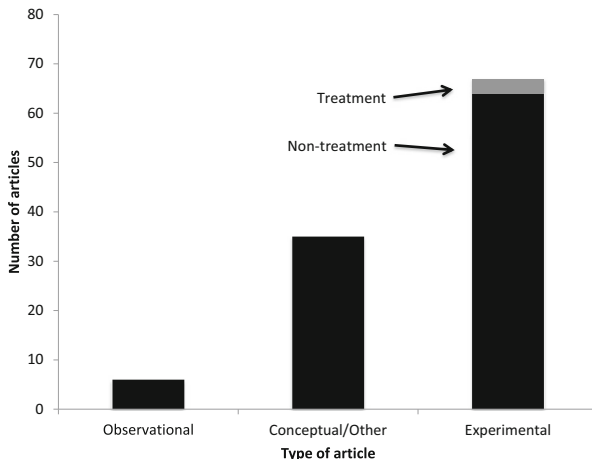

Fig. 2 Number of observational/descriptive, conceptual, and experimental articles (including treatment and nontreatment studies) discovered in the gambling literature

Populations

The various population types represented in empirical studies are displayed in Fig. 3. Of the 73 empirical articles reviewed, college students were represented in more than half of the research articles (45 articles, 61.6 %). General population adults (19 articles, 26 %) and problem/pathological gamblers (9 articles, 12.3 %) were ranked second and third, respectively. Animal (nonhuman) subjects were represented in fewer articles (five articles, 6.8 %), and the remaining empirical studies included children (two articles) and older adults (i.e., nursing home residents; one article). It should be noted that articles containing each type of population sum to 81, although there were only 73 empirical articles, and the percentages sum to a value >100. Several studies included more than one population type, each of which counted toward that population's total representation.

Gambling Task

Various gambling tasks and game-like protocols were represented within the articles reviewed (54 articles, 74 % of empirical articles). A complete breakdown of gambling tasks is presented in Fig. 4. Slot machines (22 articles, 30.1 % of empirical articles) represented the most common gambling task examined. The second most frequently used gambling arrangements included other risk activities not typically found in a casino, such as fabricated dice games or board games (ten articles, 13.7 %). Video poker (12 articles, 16.4 %) and roulette (5 articles, 6.8 %) were identified as the next most common forms of gambling. Blackjack and horse racing were used infrequently (featured in three articles, 4.1 % each), lottery was represented in only two articles (2.7 %), and craps was present in only one article (1.4 %). It must be noted that the sum of articles reporting each type of task exceeds the number of total articles with a gambling task due to the inclusion of multiple gambling tasks in one study (e.g., blackjack, roulette, etc. were all used in Dixon et al. 2010b). The remaining empirical studies that did not include a gambling task included surveys about gambling, delay discounting questionnaires, and evaluations of gambling assessments and diagnostic tools.
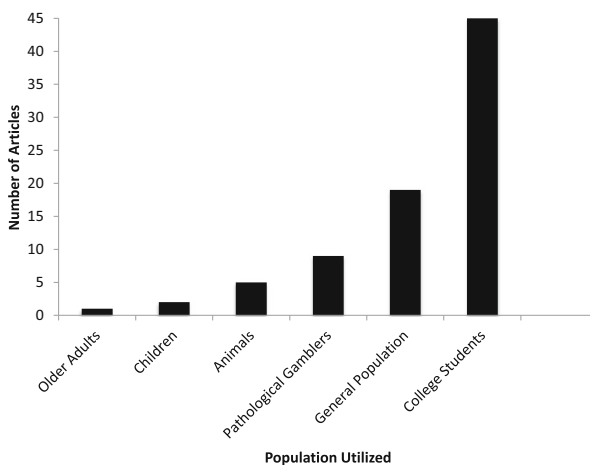

Fig. 3 Number of articles including each type of population in empirical gambling studies
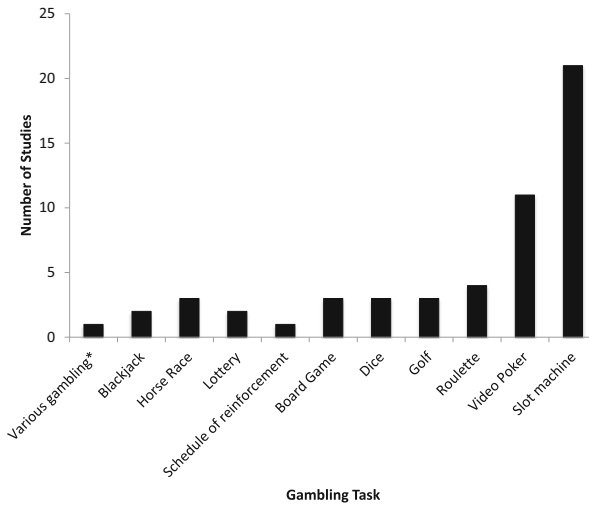
Fig. 4 Number of gambling articles containing various gambling tasks

Compensation

To provide information about the extent to which gambling researchers have observed behavior in a gambling scenario where meaningful risk was involved, we examined the compensation to participants and the risk scenarios in each study. A total of 54 studies used some form of a gambling task, and 44 studies (60.3 % of empirical articles) required participants to engage in betting or wagering of some type. Further analysis revealed that 24 studies (57.1 % of studies involving gambling tasks) provided compensation based on gambling outcomes, and 18 studies (42.9 % of studies involving gambling tasks) provided compensation based on participation only or had no actual risk in compensation during the study.

Behavioral Phenomena of Interest

A summary of the number of articles examining verbal behavior, motivating operations and setting events, and contingencies is presented in Fig. 5. Overall, each type of phenomena was similarly represented in the empirical gambling literature. A total of 20 articles investigated the effects of contingencies on gambling behavior, representing 27.4 % of empirical articles. Next, 24 articles examined the influence of motivating operations and setting events for a total of 32.9 % of empirical studies. The remaining 27 articles examined verbal behavior and its effects on gambling, which represented 37 % of articles.

Discussion

As a whole, the gambling literature across all behavioral journals was scarce until 2007, and thereafter, the rate of published gambling articles increased significantly. However, much of that literature resulted from the introduction of the *AGB* journal in that year,
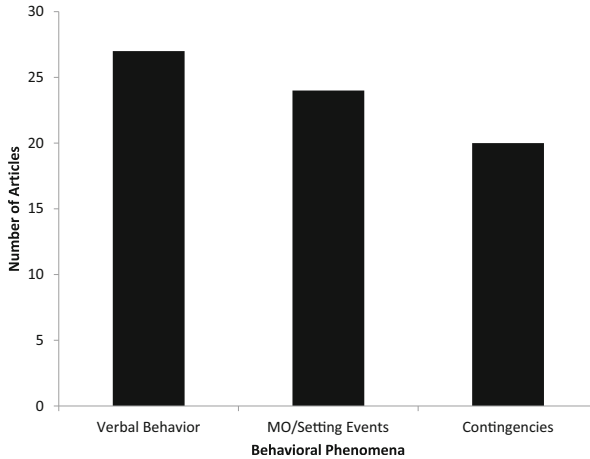
Fig. 5 The total number of gambling articles investigating various behavioral phenomena including contingencies, motivating operations and setting events, and verbal behavior

which published a majority (69.4 %) of the behavioral gambling articles reviewed. Viewed altogether over the last 20 years, a slight increasing trend in gambling papers in other behavioral journals was observed.

Methodologies

With the emergence of gambling as an interest for behavioral researchers, it is encouraging that the ratio of empirical articles to conceptual/theoretical articles remains high (approximately 2:1). Of course, conceptual articles and theoretical examinations continue to represent a fair proportion of published articles and remain valuable to the gambling literature in organizing what is known and providing new direction. Of the empirical articles investigated here, nearly all were experimental, with only a few observational articles present. However, only two studies in the behavioral literature focused on treatment of pathological gambling, leaving a large, crucial gap in the behavioral literature on gambling.

The results of our analysis of methodology in the gambling literature have several implications. First, as noted previously, researchers have not yet captured all of the relevant factors contained in a live casino environment. In a study by Dixon et al. (2006), a group of pathological gamblers responded significantly more impulsively when completing a delay-discounting questionnaire in an off-track betting facility compared to when they completed the same questionnaire in a coffee shop. Many potentially relevant environmental variables such as the ambient noise, smells, sounds, spectators, and other gamblers are often not replicated in basic or translational work, which may impose limitations on the external applicability of the results of experimental studies. The often large number of concurrent gaming options in a casino, the availability and consumption of alcohol, and the sights and sounds of other gamblers winning or losing is rarely represented in experimental studies conducted outside of a casino. A full analysis of gambling behavior must include all relevant factors, and with few observational studies in casinos or other gambling environments, many of these

potentially important factors are left out. However, caution must also be taken to ensure that we do not sacrifice internal validity afforded by the basic laboratory or experimental context in premature efforts to include the full range of variables present in typical gambling contexts.

Researchers must make contact with casinos and conduct investigations in typical gambling environments. Although casino personnel would prohibit manipulations of any sort on the casino floor, newer observational tools, such as small PC devices or smartphones, may afford researchers opportunities for discrete observation and data collection of publically observable behavior in a live environment. Task analyses to create data collection software for Windows Pocket PC devices (Jackson and Dixon 2007) and mobile Apple devices (Whiting and Dixon 2012) have been outlined in behavioral journals and could be directly applied or adapted to suit live observation, or downloadable apps could hold utility for direct observation.

Descriptive observations in gambling environments may prove valuable. For example, observing how patrons in a casino allocate responding to different types of gaming machines could inform an experimental analysis of game features that influence gambling. Observing antecedents and consequences as gamblers wager on roulette may help to identify variables associated with riskier choices. Betting patterns following wins and losses as they occur on slot machines could provide further insight into the effects of a random-ratio schedule in a gambling environment. Results of these naturalistic observations might lead to valuable hypotheses as to the most addictive features that may promote pathological gambling so that these features or corresponding games may be targeted for further well-controlled laboratory experimentation and ultimately intervention to control gambling problems. For example, in a controlled laboratory study involving a 1:1 blackjack game, reinforcing effects may be observed when the player wins, having a higher total than the dealer at the end of the hand. However, in a casino, the presence of three to five other players at the table and their hand outcomes might influence the reinforcing effect such that gambling might increase if the player loses to the dealer but still has the best hand out of any of the players. It is likely that interactions among players also influence gambling on other games, such as roulette and poker. In future gambling research, experimenters could systematically replicate previous research by more closely approximating a live casino environment. With the frequency with which casinos change and upgrade their machines with new features and configurations, maintaining observations in the casino environment will allow researchers to stay abreast of new developments and more closely simulate the environment in controlled investigations.

The results of the methodology analysis also suggest a need to develop behavioral interventions for pathological gambling problems. Only two studies out of 100 administered and evaluated a treatment for pathological gambling, an alarmingly low rate. In one example of a behavioral therapy treatment, Arntzen and Stensvold (2007) administered an intervention that combined restriction of available spending money, instruction about how reinforcement and stimulus control can promote relapse, self-recording of gambling, and differential reinforcement of incompatible and alternative behavior. For the latter component, the experimenters established opportunities for the single participant to exercise in a fitness studio or to engage with an academic study group. After the intervention began, the participant reduced money lost from over $3700/day to no losses after 2 months, and the changes maintained despite removal of

monetary restrictions. In the second treatment study, Guercio et al. (2012) implemented an 8-week program where three pathological gamblers with comorbid brain injuries identified antecedents, consequences, and motivating operations that evoked and maintained gambling, designated alternative behaviors to gambling, underwent assertiveness training to refuse peer pressure to gamble, and completed problem solving training in a multiple baseline design. All of the participants gambled less and reported reduced levels of urge to gamble following the program.

Much of the empirical research examined in the present analysis investigated various cause-and-effect relationships involving gambling stimuli, configurations of risk, and response allocation and choice, but only rarely have these identified relationships been used toward the ultimate goal of treatment or prevention of pathological gambling. The two treatment studies provide promise for behavioral treatments and a potential base from which to proceed, but the confidence with which these technologies may be used is limited, given the pretest–posttest design with only one participant in the former study and the participants' comorbid brain injuries in the latter. Incorporation of techniques conceived from experimental findings, further replications with representative adult pathological gamblers, and use of stronger experimental designs are required to generate robust, widely applicable interventions to combat pathological gambling.

Populations

A majority of gambling research includes a sample of college students. Although college students are typically included in research out of convenience, a sample of these participants are a relevant population for gambling research because young adults (21–35) reported the highest rate of casino attendance (39 %) in the prior year compared to all other age groups, and 90 % of these students reported they planned to return in the next year (American Gaming Association 2013). Although college students are a relevant population for studying gambling, it is unclear whether college students perform similarly to pathological gamblers in laboratory studies.

Several published papers used a sample of nonhuman animals. Such research has demonstrated that animals' choice responses under schedules of reinforcement including delayed and probabilistic consequences typical of casino betting occur in a similar, predictable manner as those of humans (Green et al. 2010), and animals demonstrate characteristic side effects of probabilistic schedules of reinforcement within an animal model such as "pre-ratio pausing" (Weatherly and Derenne 2007). These data suggest generality of behavioral phenomena across species, such that animal models will likely be of value in the controlled study of human gambling. Animal models have the great advantage of increased experimental control, and avoid human ethical considerations in studying gambling behavior. By contrast, young children and elderly adult participants were infrequently reported. Previous research suggests that pathological gambling can begin at age 9 or 10 (Jacobs 2000), and estimates suggest that between 7.7 and 34.9 % of children engage in behavior typical of pathological gamblers, such as lying about winning bets or continuing to gamble to earn back lost money (National Research Council 1999). Investigations of the gambling-like behavior of children might yield an analysis of the development of pathological gambling; experiments involving older adults may be particularly relevant due to the common attendance of this population in

gambling environments: An estimated 28 % of casino visitors are aged 65 or older (American Gaming Association 2013).

The main implication of the population analysis is that future gambling research should recruit participants with demonstrated gambling problems who are most likely to benefit from the findings. Pathological gamblers, or at least people with a history of gambling, would likely serve as the most valuable participant pool. There is certainly no shortage of these participants available in the community. As demonstrated by Dixon et al. (2003), pathological gamblers tend toward more impulsive choices than control participants and thus may respond to risk scenarios, rules, or outcomes differently than those without an extended history of gambling. One study attempted to use a relational training procedure to bias gamblers' responding to one of two concurrently available colored slot machines by training that one color was greater than the other, and found that nonpathological gamblers predictably shifted responding to the machine of the "greater" color while pathological gamblers continued to respond unpredictably (Nastally et al. 2010). These results suggest that the effects observed when studying nonpathological samples may not generalize to pathological gamblers. An analysis of how the behavior and influence of environmental factors differs between pathological gamblers, and control populations may yield further information on how pathological gambling may maintain, how it may develop, and why only certain individuals exhibit pathological tendencies while others do not.

In addition to pathological gamblers, researchers may wish to conduct future investigations with children as participants. Many children's activities such as board games, card games, or various arcade games that involve probabilistic outcomes, inherently involve a sort of pregambling response. Johnson and Dixon (2009) used relational frames of greater than and less than to influence choice behavior of children playing a simulated board game with dice. Children were allowed to select between two different colored die to roll in order to move their game piece across the board as fast as possible. After completing a relational training procedure where reinforcement was earned for selecting the largest stimulus from an array in the presence of a colored contextual cue, and selecting the smallest stimulus in the presence of the other color contextual cue, six out of seven children increased response allocation to the die colored the same as the greater than contextual cue, despite no difference in odds or direct training with the die. Dymond et al. (2010) later extended this study by examining transformation of stimulus functions with children playing a board game. Children were allowed to select between two dice featuring nonsense syllables to roll and move their game piece across the board as fast as possible. Following a similar relational training procedure, equivalence relations emerged between the nonsense syllables on the die and the other die that always rolled high or low. Without direct training, children selected to roll the die with the nonsense syllable in the equivalence network with the "high roll" function. This study illustrates one example of how child participants in simple games of chance may be a valuable outlet with which to examine how faulty rules about gambling develop, how risk tendencies emerge, or how other symptoms of problem gambling originate.

Gambling Task

Among the gambling tasks used, slot machines were most represented. This seems appropriate, as 59 % of survey respondents reported that slot machines were their most

preferred casino game (American Gaming Association 2010). However, games such as blackjack and roulette still represent a significant amount of gambling activity in a casino, representing the favorite game of 19 and 8 % of surveyed casino visitors, respectively (American Gaming Association 2013). Yet, examinations of gambling behavior when playing these types of games are rare in the behavioral literature. Across the various modalities of gambling, there are disparate levels of risk, rates of play and reinforcement, delays, levels of social interaction, response requirements, and sensory stimulation. For example, slot machines pay out randomly regardless of what the gambler does. However, in games such as poker or blackjack, some skill may be involved in winning and losing. Similarly, games such as craps feature much more of a social atmosphere compared to slot machines, which are often played alone. Findings from a study about slot machine gambling may not necessarily apply to a game with a much slower rate of play and reinforcement such as a roulette wheel that spins once every minute, or to a craps game in which behavior may be influenced by social contingencies via other shouting patrons or the bets of other gamblers at the table as well as the tangible contingencies involved in betting on the different dice outcomes. Researchers should address these differences in potential maintaining functions of behavior present in each game and expand to the current focus to target various casino games to determine any differential effects of the environment imposed by each game on gambling behavior. Research along these lines would suggest that pathological gamblers could benefit from the same treatment protocol if no functional differences among games were discovered. However, if different variables are relevant to pathological gamblers who prefer different games, more targeted treatments might be necessary. The factors hypothesized to maintain pathological gambling appear to be present in varying levels across casino games, and the importance of these differences to the analysis of pathological gambling behavior must be addressed.

One variable that has been evaluated across several games is the "near miss," or an outcome that appears "close" to a win. For example, Dixon and Schreiber (2004) discovered that participants playing a slot machine reported that outcomes with two matching symbols on the center line and a third matching symbol one line above or below this line was much closer to a win than other losing outcomes not appearing as such, and 8 out of 12 participants demonstrated increased interresponse latencies following losing trials due to the presence of near misses. The effect was later examined on a roulette table, and participants demonstrated a near-miss effect (or responding to certain "close" losing outcomes in some manner similar to when a win is contacted) and rated losing outcomes higher when the outcomes were closer to the number they bet to win (Dixon 2010). A similar near-miss effect was shown in blackjack; players rated outcomes closer to a win when their card totals more closely matched the dealer's hand (Dixon et al. 2009a, b). These replications across games would suggest that the near-miss effect prevails across many gambling games and may be a necessary target in treatment. Replicating existing findings across games would provide information about important variables to be included in interventions to reduce pathological gambling. While replication across every gambling game would be unnecessary after the influence of variables becomes predictable, the study of behavior when playing slot machines is not sufficient to generate a comprehensive understanding of gambling behavior, and research must include a variety of gambling targets in the future.

Compensation

Compensation is contingent on gambling performance during experimentation in only about six out of every ten of the studies reviewed. Well-controlled gambling simulations can reveal basic processes that operate on behavior in a gambling environment, but the extent to which behavior in a gambling simulation involving no risk reflects gambling behavior when money or other valuable reinforcers are at stake must be considered. Peterson and Weatherly (2011) found that participants bet the fewest credits when playing for real money or competing against other participants for rewards than when they were told to play "as if" they were actually gambling. When contingent compensation is not possible, preparations such as competition, a chance to win bonus gift cards, an opportunity to reduce the duration of participation, or other similar consequences received based on gambling behavior should be explored to more closely approximate gambling. Future basic and translational research conducted in a laboratory setting should attempt to include compensation based on choices made within the gambling experiment to more closely model behavior of real gamblers.

Behavior Phenomena of Interest

The behavioral phenomena examined in empirical studies are well balanced across all key areas proposed in the behavioral model of gambling by Weatherly and Dixon (2007). Examinations of the effects of contingencies, motivating operations and setting events, and verbal behavior all are represented in commensurate proportions. Only the primary phenomenon under study in each article was counted in the present analysis, though several publications investigated the effects of multiple phenomena concurrently or at separate times throughout the study, as they are often difficult to separate in most contexts.

As any behavior analyst would anticipate, contingencies play a major role in gambling behavior. A win on a slot machine will be followed by a pause, and availability of a larger magnitude of reinforcement (jackpot size) appears to function as an antecedent that causes the gambler to respond to a near-miss (i.e., an "almost win" such as when a slot machine's center symbol line has two matching symbols with the third symbol one space above or below the line) more like a win than when smaller magnitude reinforcers are available (Dillen and Dixon 2008). Animals prefer to "gamble" by responding to a probabilistic lever, rather than pressing a lever with a denser fixed requirement (Kearns and Gomez-Serrano 2011). Feedback procedures can improve the performance of poker players (Dixon and Jackson 2008). Research over the last 20 years has covered a variety of behavior phenomena like these across many different contexts.

Despite the advances provided by this mix of well-controlled animal studies and human operant experiments, our understanding of the effects of contingencies on gambling behavior remains incomplete. Every casino game involves a complex set of stimuli including lights and sounds, and newer gaming machines will soon feature tactile feedback via vibration or other similar sensory stimulation capable of developing conditioned reinforcing properties after being presented repeatedly in close temporal proximity to wins. One problem that might emerge due to multimodal stimulus presentation by gaming machines is overshadowing. For example, in a basic

discrimination study, rats were trained to press a lever upon the presentation of one tone, whereas responding was extinguished in the presence of a second tone. When the lever was available at all times, the tones exerted differential control over lever pressing. However, in conditions where the lever was presented at the same time as either tone, response accuracy suffered, and the concurrent presentation of the lever overshadowed the discriminative function of the tones (Hachiya and Ito 1991). In a gambling environment, the presentation of many sights, sounds, and other stimuli might overshadow loss outcomes and gambling behavior could become increasingly resistant to extinction. The topography of near misses, such as slot machine bonus spins, continues to evolve as slot machines show increasing amounts of stimuli to the gambler. Increased stimuli and betting options on a slot machine also now provide the opportunity for partial wins (e.g., betting $1 and winning $0.50), which have been shown to produce a skin conductance response similar to a true winning outcome, and may reinforce behavior despite the loss of money (Dixon et al. 2010a). As casinos continue to develop more intricate gaming devices, researchers must continue to examine how these various stimuli following wins and losses impact play and, more importantly, how to overcome these effects.

Recent advances in studies of motivating operations and setting events have expanded what is known about gambling behavior. Measured by responses to a delay discounting task, pathological gamblers make more impulsive choices in a gambling context than in a nongambling context (Dixon et al. 2006). Further, frequent losses resulting in monetary loss have been demonstrated to temporarily increase impulsive choice when compared to outcomes where the gambler breaks even or wins (Witts et al. 2011), and college students engage in greater impulsive choice making with money they have won compared to money owed to them, suggesting that gambling earnings may be treated as though they are of diminished value (Weatherly et al. 2010a). Several factors previously linked to pathological gambling, such as ethnicity (Weatherly 2011c) and nicotine consumption (Meier and Weatherly 2008), have failed to influence gambling behavior when other factors are controlled. Similarly, age, gender, socioeconomic status, marital status, and ethnicity all failed to significantly predict pathological gambling in a sample of undergraduates (Weatherly et al. 2008a). Given that frequently discussed risk factors do not reliably predict gambling, it may be more productive for researchers to explore environmental antecedents that alter the reinforcing value of outcomes on a temporary or long-term basis. Argument continues on whether impulsivity is a trait (risk tendencies are a static characteristic of a person) or a state (risk tendencies change due to context or consequences) variable (see Odum 2011), or perhaps some combination of both (risk tendencies differ by person and can be influenced by context). Future research should further examine this question and determine how and whether choice behavior can consistently be changed by antecedent manipulations in the environment.

A comprehensive understanding of gambling also requires the study of verbal influences. Although one might expect a gambler to allocate responding in accordance with relative reinforcement (Baum and Rachlin 1969), this is not always the case. Participants provided an inaccurate rule (e.g., "If you have been losing for a while, there is every reason to believe that your luck will change") in a game of roulette wagered larger, riskier bets and persisted more when payoffs were minimal compared to those who were provided accurate rules (e.g., "If you have been losing for a while,

there is no reason to believe that your luck will change"), or no rules at all (Dixon et al. 2000). Studies have demonstrated how greater/less frames can bias responding to a slot machine based only on color (Hoon et al. 2008; Zlomke and Dixon 2006). Similar effects have been noted in children playing pregambling games with risk-based choices (Dymond et al. 2010; Johnson and Dixon 2009). Overall, the research has demonstrated that both directly stated and derived rules may influence behavior, even in opposition to the direct consequences of gambling. When such rules increase the persistence of gambling when resources are lost or increase preference of riskier bet alternatives, the result can be harmful to the gambler. However, in one example of a potential treatment component, Dixon et al. (2009b) demonstrated a decreased rating of near-miss outcomes after participants completed a relational training procedure that equated pictures of near-miss outcomes with the word "loss." Multiple demonstrations of the influence of rules and transformation of function on response allocation have shown that behavior can change without direct contact with gambling consequences (e.g., Dixon et al. 2000; Dymond et al. 2010). More research is needed to understand how rules develop in a gambling context, how problematic rule control can be eliminated or altered, and how to more effectively bring responding under contingency control after rules have been established. Additionally, questions remain about whether rule-governance or relational interventions can be used to stop gambling, divert responding to a nongambling alternative, slow rate of play, or reduce persistence. Once these questions are answered, the literature on verbal influences of gambling behavior could produce effective interventions for pathological gambling.

Although there are many basic demonstrations of phenomena that can impact problem gambling, evaluations of treatments and reported successes are scant. What we do know is that response–cost procedures will suppress wagering on irrelevant game characteristics such as picking a color or spinning the wheel at roulette (Dixon 2000); that gamblers pause between trials more after a win than after a loss (Dillen and Dixon 2008), which might be used as an accounting mechanism to determine if they should walk away (Cloutier et al. 2006); that verbal motivating operations like "imagining" playing before actually playing will suppress the frequency of trials played on a slot machine (Whiting and Dixon 2013); that verbal interventions with components of acceptance and commitment therapy treatments may reduce win-like responses to near-miss outcomes (Nastally and Dixon 2012); and that rules stated by experimenters or generated by the gambler will alter response allocation (Dymond et al. 2010; Zlomke and Dixon 2006). These initial findings provide a framework for treatment that entails contingency manipulations, rule following, and transfer of stimulus functions. Future research must construct treatments combining what we know of these phenomena to improve the lives of pathological gamblers, examine the feasibility of efficacy of such interventions, and continue to refine such treatments to produce a greater effect on meaningful targets, such as reduction in casino visits, monetary losses, or duration of play.

Behavior analysts are not alone in attempting to combat the gambling epidemic in our culture. For example, cognitive psychologists have published hundreds of papers on gambling, many of which have examined variables such as rules, contingencies, and structural game characteristics (see Petry and Armentano 1999 and Toneatto and Ladouceur 2003, for reviews of the literature). Although our cognitive colleagues do not use behavior analytic terms, but rather cognitive constructs such as thoughts and beliefs responsible for behavior, the descriptions of contingencies that bring about such

"thoughts" are clearly defined. For example, in one cognitive treatment, Ladouceur et al. (2001) targeted erroneous beliefs about randomness with a cognitive correction intervention, a component frequently used in cognitive therapies. The intervention included therapy targeting misconceptions about the concept of randomness and control in gambling, correction of any faulty beliefs or statements in regard to gambling outcomes, and an additional component comprised of listing positive consequences of quitting gambling which combined to significantly reduce the participants' number of diagnostic criteria met for pathological gambling. Behavior analysts interested in rule-governed behavior and the influences of accurate and inaccurate rules on behavior may recognize this cognitive treatment as consistent with a behavioral approach. Similarly, within the neuroscience of gambling, researchers frequently attempt to measure the residual effects of gambling at the neurological level and in brain activation, which are essentially nothing more than private dependent variables made accessible through advanced imaging technology (Potenza 2008a; Potenza et al. 2003). In one example, Habib and Dixon (2010) found that pathological gamblers' brains showed similar activation when observing a near-miss outcome and a winning outcome on a slot machine, and control participants did not demonstrate this similarity. As any behavior may be viewed as the activity of the entire organism, this result suggests the importance of near-misses as intervention targets. Other researchers conduct drug efficacy studies examining how performance or "addiction" changes under exposure to psychopharmacological substances (Grant et al. 2010; Grant et al. 2003). In our vocabulary, such experiments are nothing more than examinations of motivating operations. In sum, we have much to gain by consuming the literature outside of behavior analysis, as we could enhance or clarify methods, collaborate with mainstream science, and have increased success at multi-disciplinary grants.

Conclusion

Making any decision entails a certain amount of risk, from setting up a business to eating food from the dive restaurant downtown. Deciding to conduct research on gambling behavior is no different. With greater resources and funding available for research in developmental disabilities or education, a long history of reinforcement and success in applied research in these other areas in the field, and numerous journals available to publish these sorts of works, one may not be surprised that behavior analysts allocate greater responding to those safer, tried, and true outlets (Dixon 2007). This is exemplified by the fact that over one third of the gambling research (38 %) has been authored by just two researchers (Dixon, M. R., and Weatherly, J. N.). However, with the recently introduced *Analysis of Gambling Behavior* journal, researchers now have an outlet dedicated to investigations related to gambling. As the current report indicates, this has allowed for a considerable increase in the amount of gambling research being published. Although *Analysis of Gambling Behavior* accounts for the vast majority of the publications (69.4 % of the total gambling publications) over the last 20 years, the data also indicate an increasing trend in other publication outlets, which is promising for researchers with an interest in gambling.

The findings of the current analysis support those reported by Witts (2013), yet provide a more comprehensive analysis, suggest a research agenda for the future, and

bear on the conceptual underpinnings of the phenomena of pathological gambling. With the increasing availability of live gambling opportunities and the emergence of Internet gambling, the rate of pathological gambling may spike in the years to come, increasing awareness of the issue. Even with the already alarming rates of pathological gambling, research in the area of gambling is likely to be immediately relevant and meaningful to society. Reinforcers for conducting gambling research are readily available, and there is still much to be done to provide a complete account of gambling behavior. The results of the present analysis revealed several key areas for the development of an ongoing research agenda. Investigations set in casino environments, the utilization of pathological gambling samples, compensation based on gambling performance rather than simply participation in laboratory experiments, and continued study of motivating operations, verbal behavior, contingencies, and their interplay across a variety of casino games will provide a strong basis for a comprehensive understanding of gambling behavior.

Perhaps most importantly, the ultimate goal of gambling research is the prevention and treatment of pathological gambling, and a future research agenda must proceed in that direction if behavior analysts are to be of any relevance in this area. Although the current behavioral treatment evidence appears to have little to offer to solutions to pathological gambling, cognitive-behavioral therapy is frequently regarded as "best practice" in the treatment of gambling disorders (Dowling et al. 2006). This approach tends to focus on biological, developmental, and environmental interactions, and empirical evidence has regularly demonstrated positive effects (see Petry 2005b), including reductions in urges to gamble (e.g., McConaghy et al. 1983) and participants no longer meeting diagnostic criteria for pathological gambling following treatment (e.g., Dowling et al. 2006). Treatment packages often rely on a variety of techniques regarding trigger identification (analyzing the antecedents that evoke gambling), avoidance of triggers and contexts where gambling may occur, and the restructuring of erroneous beliefs including the evaluation of faulty rule control among others (see Ladouceur and Lachance 2006 for a detailed treatment guide), and treatment is increasingly orienting toward neurobiological and psychopharmacological intervention and study (see Grant and Potenza 2004).

For behavior analysis to be relevant in treatment efforts, basic laboratory research must be translated and applied to treatment development. Dixon and Wilson (2014) recently described a comprehensive behavioral treatment approach utilizing common behavioral principles such as reinforcement and rule governance within an acceptance and commitment therapy package. In this text, the authors urge clinicians to see gambling as the outcome of deeper-rooted psychological distress that has emerged from functional relationships between behavior and consequences. These authors suggest that gambling is maintained by attention, escape, tangible, or sensory functions—akin to those functions evidenced to maintain problematic behavior of persons with disabilities (e.g., Iwata et al. 1994). An assessment entitled the Gamblers Functional Assessment II is described along with a treatment approach informed by verbal behavior and derived relational responding. Dixon and Wilson's treatment approach follows from much of the conceptual and empirical literature on the various behavioral phenomena we have reviewed, but it will still need evidence of effectiveness from clinical trials with actual pathological gamblers. Further, cognitive treatment plans may benefit from the rigorous methods frequently employed in behavior analytic research,

and the wealth of empirical data produced from functional analyses of variables that maintain gambling could further inform the environmental and behavioral components of treatment, which are frequently passed over in favor of provision of medication (see Hollander et al. 2005). Behavior analysts certainly have a lot to offer to the scientific community, but with only three articles in behavioral journals featuring treatment for pathological gambling, the research, skills, and methods of behavior analysts are likely to be discounted by other professionals. If behavior analysts are to produce changes in the lives of those with gambling problems, the foremost component of a future gambling research agenda must include a functional analysis of problem gambling and demonstrations of the effectiveness and efficiency of behavioral interventions.

Overall, the increased rate of gambling research in the behavioral literature highlights that the field is starting to respond to a problem of social significance. Whether the purpose of the research is to advance toward more effective treatment of pathological gambling or as a means to examine basic behavioral processes, the future outlook of study in this area continues to be promising and will further allow behavior analysts to cooperate with other professionals outside of our field. As gambling continues to spread around the country and into our homes, effective interventions must be developed to counteract pathological gambling. Behavior analysts interested in an analysis of gambling behavior must continue to investigate the controlling variables of gambling, but must also translate their findings into treatment components or packages to contribute to solving real-world applied problems.

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