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Free-Operant Research in the Experimental Analysis of Human Slot Machine Gambling

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Since the pioneering days of the experimental analysis of behavior, free-operant methods have been the hallmark of a behavioral science because they permit investigators to track moment to moment changes in behavior rate. Behavior rate as a dependent variable is more sensitive to momentary changes than statistical analysis, discrete-trial arrangements, and between-subject examinations of aggregate data. In reviewing the gambling literature on slot machine studies, we found that none has focused on free-operant preparations. This lack of free-operant use is likely because of the limitations in designing a practical apparatus to study slot machine gambling through free-operant means. We provide a rationale for free-operant analyses in slot machine gambling as well as proposed methods to bring free-operant preparations to slot machine research. While non-free-operant arrangements have many merits, free-operant preparations will give additional insight into the development of problem gambling while making use of the behavior analyst's metric of choice: behavior rate.

Keywords: Free-operant, Behavior rate, Gambling, Slot machine

A behavioral approach to slot machine gambling research is an idiographic approach that appreciates environmental and contextual influences over the player's behavior. In free-operant preparations, behavior rate, and change with respect to that rate, are the primary metrics for assessment (see Ferster, 1953; Lindsley, 1996; Perone, 1991). Behavior rate in free-operant responding always refers to an operant response, so defined by a common environmental effect, and is measured in frequency as a function of time. Research using discrete-trial preparations impose limitations on responding that might mask or prevent moment-to-moment changes in responding. To best identify and demonstrate control over responding, behavioral researchers interested in gambling must ultimately work toward developing free-operant methods in their research. Free-operant research is informed by, and thus informs, other methods of slot machine investigation, making it a complementary analysis.

After a review of slot machine research in *Analysis of Gambling Behavior* (see below), we find no behavioral research in slot machine gambling that makes full use of free-operant research methods. Instead, most work centers on discrete-trial assessment methods. This paper presents a review of articles in the first eight volumes of *Analysis of Gambling Behavior* and proposes that rate of play in slot machine gambling has not been addressed. Instead, experimental designs used by researchers have mostly focused on behavior change across discrete trials, and thus behavior rate is not the typical dependent variable. The implications of experimental design, a proposed free-

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operant apparatus, and future studies are discussed.

Gambling Research and the Experimental Analysis of Human Behavior

Nearly 50 years have passed since Strickland and Grote (1967) conducted the first behavioral investigation into slot machine gambling. Since then, much research has been conducted in the behavioral vein that addresses slot machine gambling (Dixon, Whiting, Gunnarsson, Daar, & Rowsey, 2015; Witts, 2013). For example, behavior analysts have asked questions pertaining to win size influence (e.g., Dillen & Dixon, 2008), win rate influence (e.g., Brandt & Pietras, 2008), money's role in gambling experimentation (Peterson & Weatherly, 2011; Weatherly & Meier, 2007), how near-miss presentations alter play (e.g., Ghezzi, Wilson, & Porter, 2006), and many others.

We see three questions that drive this research: 1) under what conditions does the player select this machine? 2) under what conditions does the player remain at this machine? and 3) under what conditions does the player return to this machine on a subsequent visit? Inherent in these three questions are their opposites: 1a) under what conditions does the player not select this machine? 2a) under what conditions does the player leave this machine? and 3a) under what conditions does the player not come back to this machine? As far as we can tell, all slot machine research hinges on these three questions, or at least will help answer them (e.g., the role of money, verbal behavior). Play styles are at least ancillary to time spent gambling on machine (e.g., credit wager variations).

Investigating the conditions under which behavior is produced keeps the behavioral scientist oriented to his or her subject matter: the interaction between the whole organism and its environment with respect to current and historical events (Bijou, Peterson, & Ault, 1968). Thus, to study slot machine gambling, we either need actual casino slot machines or slot machine simulations and analogues. However, what is gained in external validity by using casino slot machines is lost in experimental control. For example, an experimenter might be interested in the relation between slot machine gambling and casino-offered free beverages. The experimenter might look at this question through an adjunctive behavior lens (i.e., escape prevention), and in this case, the ability to alter win and loss outcomes with respect to beverage delivery timing would lead to greater experimental control. A casino slot machine with its random number generator would lead only to descriptive outcomes that lack programmed control measures. While any translational (see Dube, 2014) or applied endeavor is ultimately concerned with external validity, well-controlled research requires isolating the independent and dependent variables of interest, and nothing else. Isolating variables of interest might prove difficult without the aid of specially-programmed simulations or analogues.

In terms of experimental control, animal models hold the greatest advantages. Consider that animal models permit complete control over ontogenetic factors and motivational concerns like water and food restriction as well as allowing researchers to subject the animal to repeated sessions over weeks, months, or even years. While animal models for gambling are growing in use (e.g., Kearns & Gomez-Serrano, 2011; Madden, Ewan, & Lagorio, 2007; Peters, Hunt, & Harper, 2010; Weatherly & Derenne, 2007), the fact that our ultimate goal is to understand human gambling necessitates that we continue to keep—at least partially—focused on the experimental analysis of human behavior (see Kantor, 1970).

Thus, we are left with the question of how best to heighten experimental control in slot machine research with humans. Historically, the greatest experimental control in behavioral research is had through the free-operant analysis (e.g., Ferster, 1953). Here we will compare free-operant and discrete-trials methods, and after we will return again to the issue of developing greater experimental control in slot machine research.

Free-Operant and Discrete Trial Responding

Demonstrating control in a free-operant analysis requires stable responding within and across sessions. What qualifies as "stable" is subject to alteration across species, responses, and contexts (Perone, 1991). However, determining stable responding requires one central component: an analysis of within-session change in behavior rate (Ferster, 1953; Lindsley, 1996; Perone, 1991). Behavior rate necessitates that the analysis be based on time, and not number of trials. With behavior rate as the dependent variable, other variables such as response distribution, latencies, magnitude, speed, and so forth are not of primary interest as they are discrete measures. The within-session change in behavior rate is then compared to other sessions in which some independent variable is introduced, removed, or varied. Between-session change is further assessed with replications of each session.

Stable responding is assessed on some functional response free from topographical limitations (Ferster, 1996; Perone, 1991). For example, a depressed lever sets the occasion for advancement on a reinforcement schedule, regardless of response topography. Topographically restricted responses might interfere with behavior rate through fatigue or other organismic factors, thus limiting stability assessments. For example, in slot machine gambling we are not concerned with which hand presses a spin button, how much force is generated in doing so, and how the hand is oriented during the press (e.g., a fist, open hand, a finger). Therefore, a definition for free-operant analyses can be derived that reads: *free-operant analyses focus on alterations to the stability of functionally-defined behavior rates between two or more conditions within an individual organism*.

Omitting or altering one or more aspects of free-operant arrangements or introducing additional components results in a preparation more consistent with its counterpart, *discrete-trial* responding. In discrete-trial preparations, an organism's responses are limited to only once per trial, and different metrics, like latency and percentage, are favored over behavior rate (Ghezzi, 2007; Lindsley, 1996; Perone, 1991). For example, comparing *average* baseline behavior rates to behavior rates in a subsequent condition eliminates within-session changes and makes the analysis discrete trial. Additionally, by adding a delay between responses, either through experimental parameters (i.e., intertrial interval) or the manipulandum (e.g., a response lever that is difficult to depress), the arrangement becomes discrete trial.

The Slot Machine as a Discrete Trial Apparatus

Common discrete-trial arrangement definitions include presenting a discriminative stimulus (S^D) that sets the occasion for a response to be reinforced, the response leading to some outcome, a period following the outcome in which the response is no longer capable of producing reinforcement (an S-delta [S^Δ]), and if appropriate repeating the sequence or presenting an alternative trial (e.g., Malott, 2008). Slot machines contain all these elements and, depending on one's view, in the same order outlined in common definitions. In the simplest sense, the lit "spin" button (so lit after enough credits have been deposited) is the S^D for pressing said button. The button produces an outcome within the machine's computer system, though this outcome is not observed by the player until later. Following this computer-generated outcome is a period free from response-produced reinforcement with respect to wins (i.e., the reels spin). Thus, from the perspective of the apparatus, the sequence consists of S^D, outcome, and S^Δ. However, from the player's perspective, the sequence consists of S^D, S^Δ, and outcome. The variation between procedure and what the player experiences might be important, though the arrangement still permits discrete trial analyses of play.

Advantages of Free-Operant Preparations

It is difficult to speak of advantages of free-operant over discrete-trial preparations without first clarifying the word "advantage." By advantage, we simply mean that the free-operant preparation permits greater orientation to a particular organism's interaction with its world, and the orientation achieved varies with the particular question asked. Furthermore, some questions can be addressed with both discrete-trial and free-operant preparations, and advantages are perhaps more difficult to identify in these circumstances. For example, conditioned reinforcement can be assessed with preference (discrete trial) or the observing response (free-operant; cf. Witts, Ghezzi, & Manson, 2015). The former does not guarantee conditioned reinforcement, as the organism might be forced to choose between two aversive or low-preference stimuli. The latter can only be produced at high rates if it is maintained by some relative reinforcement.

An additional concern of discrete-trial arrangements—and by no means is this concern limited to those arrangements—is the general reliance on group designs and statistical analyses (see Cohen, 1994; Michael, 2004, Chapter 11). Of course, discrete-trial arrangements do not *necessitate* the use of statistical analyses and control (see Hoon & Dymond, 2013, particularly Experiments 2 and 3). However, consider that problem gamblers might contribute disproportionately to casino revenues compared to their recreational counterparts (e.g., Meier, 2014). Given that a relatively small sample size might be used in research, having just one problem or probable problem gambler in one of two test groups might be enough to create statistically significant differences where none would otherwise exist.

Greater statistical control can be had through larger samples (though at the cost of effect sizes), while experimental control in single-subject methodology requires a better-designed study. The point is that designs that invite statistical analyses based on between-groups designs and collapsing individual data will always stand at a disadvantage to within-session changes for idiographic pursuits. This does not imply that statistical analyses and group designs are not without merit, but that they simply do not directly add enough to the prediction and control of individual behavior.

General advantages of free-operant preparations center on the experimental control afforded to the scientist. Ferster (1953) noted that the advantages of the free-operant in experimental design are in identifying the likelihood and tendency of a particular behavior occurring under particular conditions, and relative to other conditions. Without the imposition of an S^D and intertrial intervals, there are no restrictions on the frequency with which the organism can engage in the behavior (Ferster, 1953). Discrete trials limit the organism's opportunities to engage in behavior, and impose a structure within which the response must occur. Conversely, free-operant design allows for the observation of moment-to-moment changes in the rate of behavior (Ferster, 1953).

Additionally, behavior rate as a dependent variable can accommodate wide ranges of behavior (Ferster, 1953). The dependent variables used to measure discrete-trial responding (i.e., percentage correct, latency to response, trials to extinction) are only measures of the opportunities to respond. Discrete-trial designs cannot take into account response variability outside of the opportunities presented.

With respect to our three questions, we find the free-operant techniques readily amenable to their study. For example, controlled manipulations of machine characteristics and payout schedules and magnitudes using single or concurrent operant designs with features like changeover delays can help us understand why the gambler selects a particular machine. Answering why a gambler remains at a machine might require convergent data from free-operant and discrete-trial work. Here different free-operant investigational tools are needed (e.g., matching law analyses, behavioral momentum theory), which might simply identify the appropriate variables for discrete-trial investigations. Returning to the machine on a subsequent visit is likely answerable with either a free-operant or discrete-trial approach, and again we see that the difference of dependent variable is one of scale and preparation (i.e., in situ versus analogue).

Note that we are not arguing for the exclusive use of free-operant preparations; indeed, discrete-trial analyses might be needed in answering our three questions as they pertain to the individual gambler. Specifically, answering why a participant remains at a machine might require resistance-to-extinction preparations (a discrete-trial analysis), though the appropriate variables of interest might be better isolated in preliminary free-operant work. Further, we must recognize that free-operant and discrete-trial preparations lay on a continuum, separated largely by scale. As we will explore in further detail later, a discrete-trial preparation might become free-operant when session length is increased.

Thus, while the typical casino-style slot machine appears to produce discrete-trial arrangements, it does not mean that free-operant methods could not be applied. To help better understand how behavioral researchers study slot machine gambling, we set out to assess the extent to which discrete-trial and free-operant techniques have been employed. As *Analysis of Gambling Behavior* carries the majority of behavioral research in gambling (Dixon et al., 2015; Witts, 2013), it stands to reason that it is the best place to begin an investigation in free-operant and discrete-trial preparations in slot machine gambling research.

METHOD

Article and Variable Selection

We conducted independent reviews of every slot-machine-based study published in *Analysis of Gambling Behavior* from Volume 1, Number 1 through Volume 8, Number 2, which spans 2007 to 2014. Articles were coded on several variables, and the following variables are reported here; use of within-subjects analysis, use of between-subjects analyses, baseline data collected, stability assessed, discrete-trial arrangement used, free-operant arrangement used, number of minimum trials, maximum allowed time, and number of participants. These variables were selected as they all related in some manner to either discrete-trial or free-operant arrangements, save for participant number. Several dependent variables were assessed, and these included response allocation, persistence (i.e., resistance to extinction [or change]), behavior rate, latency to responding, and inter-response time. The variable set was coded for each experiment within an article. For example, Hoon, Dymond, Jackson, and Dixon (2007) contains three experiments, and each experiment was treated separately.

RESULTS AND DISCUSSION

Twenty-six experiments were identified across 17 slot-machine-based articles in *Analysis of Gambling Behavior*. While both coders recorded data separately, they met to resolve disagreements until 100% agreement was met for each variable reported.

Tables 1 and 2 present summary data from all variables assessed. While there were near-equivalent frequencies of within- and between-subject analyses, none was free-operant. Though four articles investigated behavior rate as the dependent variable, these data did not provide information on within-session changes. And while minimum trials and maximum durations are reported, this in no way indicates that these were the actual values achieved for each participant in the studies (the specific data were often lacking), and thus these are at best conservative estimates.

Two articles contained experiments that approached free-operant analyses (i.e., behavior rate as the dependent variable), but ultimately were not. Dixon, Miller, Whiting, Wilson, and Hensel (2012) reported rate of gambling (number of reel spins per unit time) across 1- and 5-line slot machines. However, rather than analyze within-session changes in behavior rate, as required in a free-operant analysis, data were collapsed across the entire session. While results were obtained from three 10-minute sessions (one forced-choice on 1-line, one forced-choice on 5-line, and one free choice session), it was unclear if behavior rate was assessed across forced-choice only or forced-choice plus free-choice. Thus, derived behavior rate was not possible to calculate.

Though it lacked any stability criteria and conclusions were drawn from between-group analyses, Armour and Bizo (2014) most closely approximated a free-operant analysis. In their article, Armour and Bizo conducted three experiments investigating the applicability of the Mathematical Principles of Reinforcement—a formula that predicts and describes behavior on reinforcement schedules—in human simulated slot machine gambling. In each experiment, participants interacted with a simulated slot machine that altered its random ratio (RR) schedule of reinforcement in an ascending or descending fashion, with (Experiment 2) or without (Experiments 1 and 3) a large win or loss early in the sequence. Experiments 1 and 3 investigated the formula with respect to differing RRs. While Armour and Bizo's work incorporated between-subject analyses with no stability measures, the work focused on changes in behavior rates as a function of different conditions (e.g., ascending vs. descending RR schedules).

Given the prominent status of free-operant procedures in the experimental analysis of behavior, it is perhaps surprising that so little has been applied to experimentation in human gambling on slot machines. However, when one considers the limitations imposed by the inherent characteristics in casino-style slot machines, the current findings are not unexpected. More modern options, like reel-stopping devices, might make for faster-rate responding which could align with a free-operant analysis, and it is to these features that we know turn.

Reel-Stopping Devices and Free-Operant Responding

Slot machines often include the ability for players to stop the spinning reels before their programmed spin time has been met (see Nastally, Dixon, & Jackson, 2009). These reel-stopping devices add concern regarding the discrete-trial nature of slot machines. Specifically, the ability for the player to reduce the intertrial interval renders the analysis more free-operant than if the spin was forced to complete its full

Table 1. Factors assessed and frequency of occurrence in Volumes 1-8 of AGB

		n	Out of
Analysis	Within	17	26
	Between	20	26
	Baseline Recorded	16	26
	Stability Criteria	2	16
Design	Free-Operant	0	26
	Discrete Trial	23	26
Dependent Variable	Response Allocation	15	26
	Persistence	7	26
	Behavior Rate	4	26
	Latency	2	26
	Inter-Response Time	1	26

cycle. However, an alternative analysis sees the manual reel-stopping option as being a separate discrete trial in which the spinning reels is the S^D to which pressing the spin button (or an appropriate alternative, depending on machine design) produces the outcome (i.e., stopped reels), which is subjected to an S^Δ that is the start of the discrete trial for the next spin. Thus, while button pressing rates increase when stopping devices are used, up to half of the spin-button presses belong to a separate discrete-trial arrangement. The fact that a different discrete trial is interspersed between the spin-based trials leads to the obvious conclusion that the slot machine has not been altered to a free-operant device.

Reel-Stopping Devices and Hybrid Discrete-Trial/Free-Operant Responding.

We must recall that science is a verbal, and thus social, enterprise. As such, our taxonomical practices do not reflect reality as it exists independent of the scientific worker. In this light, we are not surprised to learn that the boundaries between free-operant and discrete-trial preparations are artificial and overlapping, given rise to what some have referred to as *hybrid discrete-trial/free-operant* (HDF) preparations (Malott, 2008).

Table 2. Number of trials, maximum time possible, and number of participants in articles that reported these data in Volumes 1-8 of AGB.

	Number of Articles Reporting	*M*	*SD*	Range
Minimum Number of Trials	11	90.73	42.32	28-160
Maximum Time in Minutes	9	43.89	31.70	15-120
Number of Participants	26	18.27	20.51	2-108

HDF preparations produce both discrete-trial and free-operant responding. In his example, Malott (2008) discussed puzzle assembly as being HDF. In the free-operant sense, completing the puzzle is the response, and this consists of placing puzzle pieces in their correct placements. As a series of discrete responses, each puzzle piece has its own S^D, response, outcome, and S^Δ which also signals to select the next puzzle piece.

Given Malott's (2008) assessment, it seems that the difference between free-operant and discrete-trial arrangements is one of scale. In the puzzle example, placing each piece—a more molecular analysis—renders the procedure discrete trial. Moving to a more molar analysis brings free-operant analyses to bear on the data. Reconsider the rat pressing a lever for food reinforcement. Here each lever press could be HDF in the sense that no S^D is necessarily present (see Malott, 2008) and an intertrial interval is present between the time the lever is maximally depressed to when the lever is in a position that will register a new response. Note here that the intertrial interval is shorter than the time it takes for the rat to produce the next response, so the interval is of no concern on the molar scale. However, the existence of an intertrial interval necessitates that each instance of lever pressing be considered, at least partially, discrete trial.

HDF preparations might help address the slot machine arrangement typical of most slot machines found in casinos. On a more molar scale, the introduction of manual reel-stopping permits fast-paced responding, conducive to free-operant analyses, while the stopping of each reel serves as feedback and the S^D for the next trial to begin. Alternatively, one could compare responding under shorter time scales (e.g., 30 minutes) for discrete trial dependent variables (e.g., latency) versus larger time scales (e.g., 100 1-hour sessions) for the free-operant dependent variable (i.e., behavior rate). In this latter approach, the option for reel-stopping might not be necessary to achieve differences in behavior rate. Furthermore, this latter approach is amenable to research in the university settings. For example, our lab is working with our IRB to create research-based courses that permit repeat testing throughout the semester. In our pilot work, we have recruited three undergraduate participants to play a simulated slot machine once per week for 45 minutes each session (450 minutes total during the semester). In this one-credit experiential research course, students operate a simulated slot machine whose reinforcement schedule changes session-by-session dependent upon stability requirements (not announced to the student). Thus, we are seeking to answer if larger time scales can render the discrete-trial slot machine to a free-operant one by looking at changes in behavior rate. Alternatively, participation in research could be presented as part-time work with contractual obligations (e.g., Galizio, 1979), though this could become prohibitively expensive without adequate funding. Nevertheless, it becomes clear that the researcher's dependent variable choice might have more to say about whether the study is free-operant or discrete trial, and this in turn might be influenced by session length.

Conducting Free-Operant Research on Slot Machines

We are left with a difficult question to answer: how can we take a discrete-trial, or at least semi-discrete-trial apparatus, and make it free-operant? Recall that free-operant research requires a functional response and no period in which the organism is restricted from responding. No slot machine to date would permit such an experimental analysis. Two alternative approaches are proposed here.

The first alternative approach is to remove the reel spins and post-spin programmed pause and have any reinforcement schedule requirement met advance the slot machine's reels to the next outcome. In a study on the effects of punishment on the free-operant behavior of human subjects, Bradshaw, Szabadi, and Bevan (1979) used an apparatus with a counter that displayed either a loss or a win after a subject pushed a button (see also Baron, Kaufman, & Stauber, 1969). A slot machine could be programmed on a fixed-ratio 1 (FR 1) in which each button press (or any other functional response) would present a new reel presentation to the player, free from animations. Under an FR 1 schedule, screen presentations would occur as quickly as the player could press the spin button. Alternative schedules could be used and meeting these schedules would then advance the reels with the same immediacy described. Under this configuration immediate outcomes are presented to the participant with no intertrial interval before the next opportunity to respond.

The second alternative is more complicated, though arguably permits more sophisticated research. Here a slot machine runs constantly without player input. Reels spin for a pre-determined period, stop, and start again. This sequence repeats itself with the exact same timing regardless of user activity. In this way all timings are constant, and the same interval is placed between the end of one spin and the start of the next. The player responds on either the spin button on the slot machine or some external input device. Responding on this manipulandum does not alter the machine in any observable way, except to change the various random ratio schedules at work. For example, we can conceive of a three-reel slot machine that spins for five seconds before stopping for three seconds. During the three-second pause the machine either plays celebratory music for any player wins or remains silent or continues with some background noise or song in the win's absence. Thus, every eight seconds a new spin starts. During this time the experimental arrangement can include automatically deducted credits, and thus the player's responding can only serve to slow or reverse the continual credit loss. For simplicity, we will say that this machine presents one of two outcomes: a) small wins or b) complete losses. If the player fails to respond or meet some schedule requirement, the machine produces small wins on an RR 20. Meeting some schedule requirement would alter the win production to, say, an RR 5. With time, stable responding to the schedule requirement would emerge if small wins were reinforcing. This arrangement, the eight-second spin sequence that produces small wins on an RR 20 or RR 5 schedule on the slot machine, is what we will use for our illustrations here.

Meeting schedule requirements under the arrangement just described will take some elaboration to fully explore, and we will undoubtedly fail to address all variations. In its simplest form, a schedule requirement is considered met any time requirements are executed, and this then changes the RR schedule on the next spin. For example, on an FR 25 a player might produce seven responses on the first eight-second spin sequence, 10 responses on the next sequence, and 12 on the third (for 29 responses). The program would read that the 25 spin requirement was met on the third eight-second spin sequence and set the fourth sequence to produce small wins on an RR 5. The experimenter must then decide for that study if the additional four spins from the third sequence begin the next run of 25 responses or if the FR 25 starts anew with the start of the fourth, or even fifth, sequence. Alternatively, responding on a variable-interval five-second (VI 5 s) schedule could alter the RR schedule on reel outcomes. Here we find that it is possible for some eight-second spin sequences to see multiple VI schedules met, and the experimenter must decide if the first or last schedule requirement in the eight-second spin sequence sets the occasion for the next outcome to produce the RR 5. Other arrangements can easily incorporate differential reinforcement of low (either spaced or whole-session) or high rates for each sequence.

Our review of *AGB* reveals no such research that approximates our methods proposed here. Specifically, players' responding that meets some reinforcement schedule's requirements produces changes to the reinforcement schedule of a continually-progressing slot machine. Galizio (1979) used a similar apparatus to demonstrate that instructions can control responding in a multiple reinforcement schedule, and do not control responding in a monetary loss contingency. Doing so might require separate analyses of completing schedule requirements and when the putative reinforcement was contacted. Such analyses are not typical in cumulative records, though adjustments would be easy enough. We should note that the slot machine's reinforcement schedules need not be randomly produced on the fly, but could be pre-determined in large spin-sequence batches a priori. Doing so would help give all players a more comparable experience.

CONCLUSION

It is clear that group designs, discrete-trial arrangements, and statistical analyses are useful tools in the pursuit of understanding human gambling behavior. However, the questions often asked of behavior analysts pertain to the individual gambler. As an idiographic science that works toward prediction and influence, such averages or aggregate accounts of behavior are at best orientational endeavors that help to refine a topic of analysis for studies employing greater control. It is in this light that we suggest behavior analysts working in gambling behavior complement the work done by incorporating more free-operant methods. Specifically, experimenters are urged to make greater use of within-subject analyses, behavior rate as the primary dependent variable, and stability criteria as a requirement for independent variable alteration. We will undoubtedly have to sacrifice external validity in many of these pursuits, but by carefully controlling and manipulating variables of interest, our studies focusing on external validity will only stand to be enhanced from our greater understanding of the interaction between the gambler and the slot machine. With respect to slot machine gambling, greater experimental control will help us answer: 1) why did the player select this machine? 2) why did the player remain at this machine? and 3) why did the player return to this machine on a subsequent visit?

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