students to think, challenge, and question rather than to memorize a set of "facts" which at this stage in our science are overturned all too soon.

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Paradoxes of Gambling Behavior

By Willem A. Wagenaar. Hove, England: Erlbaum, 1988. 126 pp. Cloth, $24.95.

Like most areas of psychological inquiry, decision-making research has blossomed within the last few decades. Willem Wagenaar has extended the psychological research of decision making to everyday gambling behavior. He managed to be welcomed inside casinos in the Netherlands to systematically observe individuals doing their gambling thing. His theoretical counterpoint involves normative decision theory, which has been beaten into the ground by psychological experiments and heuristic biases—the contribution of psychology to a perspective on decision making. The work is motivated by the question of why people gamble, what Wagenaar and others might view as the greatest paradox of all. As Wagenaar convincingly demonstrates, gambling is a no-win situation. Players refuse to improve their odds even

in the game of blackjack, which is possible to play in a way that evens the odds or in fact gives the player somewhat better odds. Most players choose to play by suboptimal strategies, providing the house with the monetary advantage it needs to sponsor such games. Even well-entrenched, compulsive gamblers do not choose to use strategies that would give them a better chance at winning.

This engaging research monograph contains an appropriate blend of theoretical discussion, empirical observation (at the level of both actual behavior and questionnaire or subjective reports), and appropriate discussion relating the results of the empirical investigations to existing theory. The theoretical context and the plan of the book are presented in chapter 1. The next two chapters are devoted to the game of blackjack. Roulette and lotteries demand a chapter each, followed by a chapter contrasting games of chance with games of skill. Another chapter addresses the distinction between chance and luck. In the final chapter, the author confronts normative and descriptive theory with the results of his investigation and ends with the gambling paradox.

As with most behaviors, there are multiple influences supporting gambling behavior. These influences include the value of money, the entertainment provided by gambling, and perceived prestige to the gambler. Gambling is almost universal in humans, and it would be of interest to know if some form of it has been observed in nonhuman animals. Viewing gambling as a form of game playing seems reasonable and would lead to the expectation that it may be found in the nonhuman world.

The author presents a cogent discussion of normative decision theory. He points out that one of the weak links in decision theory is that predictions are based on long-run expectancies that do not necessarily make sense, especially in everyday life. The economist Paul Samuelson tells an anecdote in which long-run expectancies are inadequate to describe our gambling behavior. He offered favorable odds on a tempting gamble (in terms of expected value) to a colleague: two-to-one odds on a single coin flip for \$100. The bet was refused because his colleague was not willing to part with \$100 even if he had an equally good chance of winning twice this amount. A counteroffer from Samuelson's colleague was 100 flips for a dollar a flip but with the same two-to-one odds. Expected value is the same in both cases, but the latter case pretty much guarantees a no-loss situation for Samuelson's colleague.

Wagenaar also reveals an additional critical deficit in an axiom of normative utility theory—that there is continuity of the scale of probability and utility. Consider a lottery involving some probability to win one million guilders and a probability to lose everything you own. This axiom states that you can always find a value of p such that the lottery is judged to be equally acceptable as receiving a certain prize with a utility between the utilities of the two extremes. In other words, by making a probability mixture of two extreme utilities, one can always reach every utility in between. This axiom says that a chance of experiencing extreme loss can be compensated for by the prospect of a large benefit no matter how unlikely this prospect is.

However, this assumption is also falsified by Samuelson's colleague, who would supposedly refuse to take good odds on a single gamble, even if the odds were 10 to 1.

Wagenaar describes how the utility curve for profits appears to be concave, whereas the utility curve for losses is convex. He correctly observes that the measurement of utility is a major stumbling block in using *utility theory* to describe behavior. It is possible to measure utility only when people, in fact, follow the assumptions of the theory. However, Wagenaar's research shows that gamblers violate some of the axioms of utility theory. When gamblers violate the axioms of utility theory, we cannot simultaneously measure their utility in that context.

As a counterpoint to normative decision theory, Wagenaar gives an overview of the theoretical framework of heuristics and biases. The central idea behind this framework is that processes involved in everyday problem solving are also used when faced with decision-making events with mathematical solutions. As Wagenaar makes clear, however, heuristics and biases can be viewed as something like Rudyard Kipling's nonfalsifiable *Just So Stories*—one could always construct a sensible story regardless of the behavioral outcome.

Wagenaar lists three advantages for studying decision making in a gambling situation rather than in simple laboratory studies. First, the gambling scenario has quantitative problems that allow exact normative predictions. Second, one can be assured that the participants, the gamblers themselves, are sincere in their decision making. That is, they have a vested interest in the outcomes of their decision. This is particularly important because philosophers and economists have consistently claimed that psychologists' experiments do not resemble motivated real-life decision making. Third, of appeal to psychophysicists, is that the gambling scenario allows the investigator to collect many replications on the same gamble within a given subject. Gamblers play repetitively—without complaining that the task is boring.

Wagenaar describes blackjack as the game that players refuse to win. Although there is an optimal strategy in blackjack, the players observed by Wagenaar refuse to learn to use it. This observation has changed my more positive view of blackjack players relative to players of roulette or the slots. Blackjack players, I believed, had a little more sense because they played a game with somewhat better odds. Given that they play suboptimally, however, they belong in the same class as roulette or slots players. Wagenaar describes the game of blackjack along with some possible strategies. In the *never-bust* strategy, the player takes a card with 11 points and under but not with 12 points or over. In this way, the player will never bust and will win if the dealer busts, but will lose otherwise—clearly, a nonoptimal strategy. A second strategy is *mimic-the-dealer,* in which the player simply does what the dealer is required to do. If the player has 16 or under, the player takes a hit; 17 and above, the player stands. The disadvantage with this strategy is that the player loses if both the dealer and player bust.

The third strategy, called *basic,* and made well known in the classic book by Epstein (1967), is a formal algorithm for playing. This strategy reduces

the negative expected value of playing blackjack from 8% and 6% with the first two strategies to merely 0.4% of the total investment. That is, in the long run, the player loses only 4 cents on every 10 dollars that is gambled, relative to a loss of 80 or 60 cents, respectively, given the other two strategies and a loss of about 27 cents playing roulette. An illustration from Wagenaar's book gives the appropriate behaviors according to the basic strategy (Fig. 1). This requires simply that the players stand (not take a card), or take a card, or double (split their cards), given the value of each player's total and the dealer's up card. Counting, something we all hate to do, is what allows a player to have positive expected value. Players have to count the cards that have been played and formulate the quantity of their bets accordingly. Very few blackjack players use this strategy, perhaps because counting requires intense effort and work. Wagenaar found no one that used this strategy, even in habitual gamblers. In fact, his habitual gamblers did not even use *basic* most of the time.

If blackjack players do not use normatively optimal appropriate algorithms, what do they do? Although players do not behave optimally, they are fairly orderly in the way they behave. If the player has a 13 total and the dealer's up card is a 2, 3, 4, 5, or 6, then the player should stand. However, although people take a hit 50% of the time when the dealer's up card is just a 2, they take a hit only 8% of the time when the dealer's up card is a 6. They thus

PLAYERS TOTAL	DEALERS UPCARD 2	3	4	5	6	7	8	9	10	A
8	H	H	H	H	H	H	H	H	H	H
9	H	D	D	D	D	H	H	H	H	H
10	D	D	D	D	D	D	D	D	H	H
11	D	D	D	D	D	D	D	D	D	H
12	H	H	S	S	S	H	H	H	H	H
13	S	S	S	S	S	H	H	H	H	H
14	S	S	S	S	S	H	H	H	H	H
15	S	S	S	S	S	H	H	H	H	H
16	S	S	S	S	S	H	H	H	H	H
17	S	S	S	S	S	S	S	S	S	S

Figure 1. *Basic* strategy for the game of blackjack: The player simply hits (H), stands (S), or doubles (D) as a function of the player's total and the dealer's upcard. In addition, the player always hits given a total of 7 or less, and always stands given a total of 18 or more.

believe, correctly, that the dealer's chances of busting are greater with a 6 than with a 2, and this guides their behavior. But even so, their optimal behavior requires them to stand in all cases. Gamblers might take a hit when they should not because they see that they are currently beaten even though the dealer has to take a card and therefore has a chance of busting with the player winning. In general, players tend to stand when they should hit. As I say, this implies that they tend to see themselves as winning and are worried about taking a hit and busting; so they are delaying eventual loss.

Wagenaar provides a measure of the consistency of behavior in the gambling situation. With repeated plays, a gambler is confronted many times with exactly the same scenario. Does the gambler behave identically in all of these cases? It turns out that the gambler does not. Faced with the same situation (the same total and the dealer with the same up card), the gambler will stand in one case and take a hit in another. This is good evidence for a probabilistic decision role and evidence against a stable criterion rule of signal detection theory in which the criterion remains constant from moment to moment. This evidence from gambling supports models of decision making that are deterministic up to the stage of decision and with stochastic noise being introduced at the decision stage.

What we have learned is that blackjack gamblers, even habitual ones, are no smarter than other kinds of gamblers. It was also interesting that almost half of his sample of habitual gamblers are female. One does not have the image of habitual gamblers being female. No other sex differences in terms of the amount or forms of gambling behavior were addressed. This omission, along with the neglect of affect and personality variables, reveals a gap in contemporary research on gambling behavior.

Gamblers have a variety of incorrect beliefs about the gambling scenario. In blackjack, one incorrect belief is that other players can influence your luck in the game. This is clearly false, because another player's action does not influence whether you or the dealer will win. Wagenaar gained some insight into the beliefs of gamblers by giving a questionnaire to the habitual gamblers. Based on something comparable to a multidimensional scaling analysis of their answers to these questions, Wagenaar found three principal components of the responses: (a) people are influenced by expected value; (b) they are aware of a rational approach; and (c) they differ from each other with respect to risk taking. These three components contribute to their perception of the game. Most people agree on expected value, but they disagree in terms of rationality and risk taking. That is, some people are more rational than others, and some people value taking risks more than others do.

In the game of roulette, Wagenaar shows that people play incredibly complicated strategies even though the expected value of these strategies is no better than simply betting on the color. Players who want to win large sums of money should make risky bets. Players who want to avoid large losses or stay in the game as long as possible should avoid risky bets. Wagenaar's results show that most players play in order to play for a long time.

That is to say, they are not out to make a lot of money but simply to pass the time.

An interesting sidelight has to do with a potential advantage that might be gained because the outcome of roulette is dependent on the physical device the game is implemented on. If a player knew the location of the ball in flight before it lands, along with some of the physics of the roulette wheel, the outcome could be predicted better than chance. As chronicled in the *The Eudaemonic Pie* (Bass, 1985), graduate students in physics used home-built computers hidden under bulky sweaters or placed in a shoe to measure properties of the ball and the roulette wheel. Determination of some of these properties then allowed them to predict where the ball would land. This information was passed electronically to another player around the roulette table who would then place the appropriate bet. As far as I know, no money was ever made on this venture. ("Golden ten" is a modification of the roulette game that allows players to use physics to help them win. However, people seem to have no interest in playing in this manner.)

Wagenaar's study of lotteries substantiates that their players are not put off by the low expected value of the lottery. The hope and excitement of winning seem to be sufficient to override the poor expected value of the game. However, people who play lotteries seem to know how to combine the information about the number of tickets that are sold, the size of the prizes and the number of the prizes, along with the cost of the tickets. Although people are not optimal because they, in fact, do play lotteries, it is encouraging that they do know how to combine the information in an optimal way. This observation is consistent with recent research showing that people generalize pattern-recognition behavior to more complicated decision-making situations. In addition, although utility is not optimized, they integrate the different sources of information in an optimal manner.

In a separate chapter, games of chance are contrasted with games of skill. Chance is also involved in games of skill, such as soccer. Wagenaar then broaches the legal distinction between the two types of games because only one has been outlawed (although betting on games of skill is another matter). Contrasting games of chance with games of skill extends the fuzzy concept of games made famous by Wittgenstein (1953). These two concepts of chance and skill are also fuzzy, and there is a fuzzy boundary between them. The way legislatures have dealt with this fuzzy distinction is simply to make their difference categorical by requiring the wagering of money as a necessary and sufficient condition for a game to be a gambling one. Thus, although baseball is a game of skill, Pete Rose's betting on the game involves gambling.

The author replicates previous findings that people expect chance events to have many more alternations than they actually do have. He confronts the differences between chance and luck by asking people to rate stories on several properties. The results indicate that chance involves surprise, whereas luck depends on the consequences of an action. A word of caution is that Wagenaar may give these phenomenological reports more weight than deserved. A Skinnerian analysis of gambling behavior might also be of interest. Partial reinforcement is effective for rats and it might be for gamblers.

Wagenaar argues that explanations based on heuristics and biases are to be preferred over those based on utility theory. Even so, he also notes a limitation in the predictive value of heuristics and biases because they cannot predict individual choice behavior. Heuristics and biases cannot predict exactly how a given subject faced with a given set of circumstances will behave. However, heuristics and biases explain how gambling is possible even though such tactics lose money for the gambler in the long run. Gamblers will underestimate the influence of chance if they use heuristic reasoning. Heuristics/biases and normative theory describe gambling in different ways. Normative theory explains gambling without changing the nature of the game. People who gamble might overestimate their probability of winning, or their subjective value of money might differ from its objective value. Heuristics/biases, on the other hand, change the concept of the game from a quantitative problem analyzed by normative theory to one in which the role of chance is minimized and replaced with other "inappropriate" influences, such as an illusion of control. (However, is not an illusion of control simply a misreading of the probability of winning?) Wagenaar then ends with the gambling paradox. He says that the reason for gambling is that it is supported by epistemic reasoning—isolating instances from the family of events to which they belong. Gamblers know and experience long-term negative expected value, but they believe "this is my lucky day," "my luck has to change," or "this number has to win."

I see differences between the two types of theory as quantitative rather than qualitative, once it is accepted that the normative theory must be made descriptive. If the extraneous influences of heuristics/biases are incorporated into the decision algorithm of utility theory, we may have the best of both theories in one. The new theory would have the precise quantitative form of utility theory along with additional terms representing other important influences. When gambling is viewed in this manner it is less of a paradox because the perceived inputs justify the behavior. If gamblers believe that a "seven" is due on the next roll of the dice, it is not unreasonable that they should bet on it. The psychologist/therapist must change the belief—not just the behavior given the belief.

Wagenaar sometimes gives the impression that an adequate theory of gambling should predict behavior exactly. Recent lessons from physics in the form of chaos theory, however, have taught us that this may not necessarily be the case (Gleick, 1987). Chaos in the physical world around us precludes exact predictions of many relatively simple physical events. Because chaos exists in physical phenomena, we might expect that it would also exist in psychological phenomena. Perhaps a predictive theory in gambling situations is not possible—no theory can predict exactly whether the subject will alternate a bet or persist in a given bet after a win or loss.

Finally, the negative expected utility of gambling might not be that negative in the light of our other behaviors. Even if we put aside smoking, drinking, and high-cholesterol diets, what about the sure negative value that can be placed on much of our everyday life. Working (or playing) 70 hours a week, jogging, and cycling might be claimed to have negative expected

utility (placing the likelihood of running-related injuries in the jogging equation or hitting solid objects in the cycling one). Thus, gamblers are probably no less rational than nongamblers. Gamblers simply lose their advantage over life in a more obvious manner.

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