Departures From Sensible Play in Computer Blackjack

ALBERT W. L. CHAU
Department of Psychology
The University of Hong Kong

JAMES G. PHILLIPS
KAROLA L. VON BAGGO
Department of Psychology
Monash University, Australia

ABSTRACT. Gambling has been viewed as irrational, and even though blackjack offers rational strategies (i.e., Basic [E. Thorp, 1966] and card counting), people exhibit departures from rationality (e.g., "Never Bust" strategies). To determine whether departures from rational behavior reflect ignorance or fatigue, university students were provided with on-line Basic advice while playing a simplified computer blackjack. Although the on-line advice initially affected the totals these players sat on, it was eventually discarded for higher risk strategies. Irrational play did not reflect ignorance or fatigue and was not necessarily conservative. Real fluctuations of odds in blackjack may lead to situations in which Basic is not perceived by players as effective. Because Basic is not a personalized strategy, it seems less likely to be maintained in the face of losses. Players were more optimistic that they might win when utilizing their personalized strategies.

Key words: blackjack, gambling, risky decision making

ALTHOUGH GAMBLERS BELIEVE that, with persistence and skill they can overcome the odds (Walker, 1992), most games of chance have a negative long-term expectation (i.e., a loss). This situation leads researchers to suggest that gamblers' behaviors are irrational (e.g., Langer, 1975). Although mathematicians indicate that long-term gain is not possible for most forms of gambling, there is an exception. Blackjack is of unique interest to students of gambling because player decisions have an impact on the outcome of the game, thus allowing for the possibility of rational play not afforded in other games of chance. In blackjack, unlike other games of chance, the fact that cards are drawn without replacement

Address correspondence to Albert W. L. Chau, Department of Psychology, The University of Hong Kong, Pokfulam Road, Hong Kong; awlchau@hkucc.hku.hk (e-mail).

makes it possible to calculate, and take advantage of, real changes in the odds. Therefore, rational strategies are possible for this game (Thorp, 1966).

One type of simple decision strategy that can be used to reduce a player's losses in blackjack is Basic (Thorp, 1966). The Basic strategy involves recommendations to sit or hit depending on the player's and dealer's totals (see Table 1) and provides a rational model of blackjack play. Determining the odds actually requires lengthy simulation; however, Wagenaar (1988) suggested that the proportion of winning hands produced by Basic is 0.492. Even though this is a losing outcome, it is still better than "Mimicking the Dealer," which produces a proportion of winning hands of 0.47, and "Never Busting," which produces a proportion of 0.46. Interestingly, despite the opportunity for more rational play in blackjack, Griffin (1987) and Wagenaar (1988) both reported that players tend to behave irrationally when playing this game.

Wagenaar (1988) unobtrusively observed people playing blackjack in Dutch casinos. He found that the majority of deviations from sensible play were failures to hit when indicated by the Basic strategy. Wagenaar suggested that players were employing a simpler "Never Bust" strategy. The "Never Bust" strategy has the advantage of saving face—better to be beaten by the dealer than to bust—whether the odds are in the dealer's favor or not. The motivation for this strategy may arise from people's belief that their successes are related to their own skill, and their failures are attributable to external factors (Weiner, 1986). In making a decision to hit, players place the responsibility of loss (caused by a bust) on themselves, but, if they sit, any losses they experience can be attributed to factors beyond their control (i.e., chance). This explanation is consistent with research into the psy-

TABLE 1
Hitting (H)[a] and Standing (S)[b] According to Basic Strategy (Modified From Wagenaar, 1998)

	Dealer's upcard									
Player's total	2	3	4	5	6	7	8	9	10[c]	Ace
8	H	H	H	H	H	H	H	H	H	H
9	H	H	H	H	H	H	H	H	H	H
10	H	H	H	H	H	H	H	H	H	H
11	H	H	H	H	H	H	H	H	H	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

[a]Draw another card. [b]Not draw another card. [c]Face cards (jack, queen, king) also equal 10.

chology of regret. Gilovich and Medvec (1995) found that incorrect action (in the case of blackjack, calling for a hit and going bust) causes more short-term regret than an inaction (i.e., sitting and being beaten by the dealer).

However, there may be simpler explanations for failures of rationality. For example, if players are unaware of rational strategies such as Basic, their failure to use the strategy could simply be a product of ignorance. Alternatively, poor play could be a function of fatigue. The Basic strategy is complicated, and determining the best play option using it may involve a considerable cognitive load. It is possible that players eventually abandon rational strategies purely because of the work involved in maintaining them.

These issues were investigated using a computerized version of a simplified blackjack game that could provide players with on-line advice. This advice consisted of the correct action to take (i.e., hit or sit) as a function of the player's total and the dealer's face card, according to the Basic strategy. We addressed the contributions of ignorance and fatigue to departures from sensible play in blackjack by manipulating the presence or absence of on-line advice regarding the appropriate action as determined by the Basic strategy. We thought that the presence of Basic advice could eliminate the role of ignorance and reduce the effects of fatigue in the decision making of the players. Thus, if the failure to follow the Basic strategy was attributable to ignorance or fatigue, the provision of the Basic advice would definitely influence the performance of the players receiving this advice relative to those who did not.

Method

Participants

The participants were 16 undergraduate students at The University of Hong Kong. The age range was 19 to 22 years with a mean age of 20.3. All of the participants knew the game of blackjack, but none had experience in playing blackjack at casinos. Thirteen participants had engaged in recreational gambling occasionally. The players received a monetary reward for their participation, the size of which was determined according to the number of points they had at the end of the session. The mean reward was HK$20.6 (US$2.64), with a standard deviation of HK$1.63.

Apparatus and Task

The game of blackjack was simulated on an IBM compatible 486 personal computer with a custom designed program. The program followed the game of blackjack as played in casinos but with some simplifications (there was no provision for splitting, doubling, or insurance, nor were standoffs possible when the player drew blackjack). Otherwise, card totals were calculated as in casino blackjack (e.g., ace counted as 1 or 11, and the picture cards, jack, queen, and king counted as 10), and blackjack paid 1.5 times more than a usual win. In this case, however, the "Dealer" was a computer algorithm, which had to stand on 17 or above and draw on 16 or lower (see Phillips & Amrhein, 1989).

During each hand, players saw a green screen on the computer monitor. At the center of the screen were two lines of instructions: "Blackjack pays 3/2" and "Dealer must stand on 17 and draw on 16." Minimum and maximum bets (1 and 9) were displayed in the upper right corner. Cards and totals for the dealer appeared in the top left part of the screen; the player's cards, the bet size, the amount won and lost on the current hand, and the cumulative points from the start of the experiment appeared at the bottom.

The play followed casino blackjack. A blank screen signified that a hand was about to commence. A complete screen was then followed with a "Place your bets" prompt and an auditory tone to convey to the player that a bet should be placed. The player entered a number from 1 to 9 to indicate a bet. If a bet was not placed within 1.5 s of the prompt, the computer assigned the minimum bet of 1 when time expired. Then two cards were dealt to the player and one was dealt to the dealer. "Another card?" was displayed at the center when the player could draw another card. To receive another card, the player pressed any key on the keyboard, again within a time limit of 1.5 s after the last card was dealt. If the player was in the advice group, a piece of advice based on the Basic strategy was displayed right above the "Another card" prompt. The advice was either "Advised to hit" or "Advised to stand." The player and then the dealer subsequently drew cards, sat, or went bust.

The actual odds in blackjack vary with the proportion of 10 and face cards remaining, and this process made experimental comparisons difficult. Therefore, we controlled the probability of the player winning at approximately 47%. Routines were built into the program in order to manipulate the number of winning and losing hands in a block by biasing some of the cards dealt to the player and dealer. The first two cards for the player and the first card for the dealer were not rigged. The probability of the player drawing blackjack was fair and not manipulated. However, the possible totals of the subsequent cards dealt were fixed by the computer program. If the player had blackjack, and the dealer had an ace or a 10, then the computer could not draw a 10 or an ace for the second card.

Individual hands in a block were designated randomly as winning or losing. In the actual dealing of cards, a simple algorithm was followed to produce the desired outcome. If the player's hand was to be a loser, the cards dealt to the player were random, and the cards to the dealer would give the dealer a total equal to or greater than (without busting) that of the player. If the player's hand was to be a winner, the cards were dealt so that the total could not exceed 21 (i.e., the player could not bust), and the cards to the dealer would either produce a smaller total than the player or bust. The proportions of winning and losing hands were manipulated in each block of trials so that the blocks were fair (i.e., players were to receive randomly 10 winning and 10 losing hands in each block). However, for this computer program the proportions of blackjacks and standoffs were random, and this arrangement affected the observed proportions of winning hands.

Design

Eight participants were randomly assigned to the advice group and another 8 to the no-advice group. The advice group received on-line Basic advice, whereas the no-advice group did not. Participants were tested over eight blocks of 20 hands of blackjack to produce a 2 × 8 design (Advice/No-Advice × Block).

Procedure

The rules of blackjack were explained, and the player was shown how to play the version of blackjack on the computer. It was emphasized that the player should try to win as many points as possible. The advice group was told the advice that appeared in the center of the screen was an optimal strategy that should maximize the winning total. However, the player was to decide freely whether to follow this advice.

Each player was given HK$20 (approximately US$2.5) to start. The number of points they won or lost on each hand was twice their bet size, and the monetary value of each point was HK$0.10. The players were allowed to continue even if they had lost all HK$20 (equivalent to a loss of 200 points). The players who had 200 or more points at the end of the session were rewarded with money associated with their point total. Those who had less than 200 points were rewarded HK$20 for their participation. However, all players were led to believe at the beginning of the experiment that the amount of money they could keep would be determined by their final point total and that they could leave the experiment empty handed.

The player was given 10 fair hands for practice. After practice, the eight blocks of 20 hands were administered. After each block of 20 hands, the message "shuffling cards" was displayed on the screen. During this interval, the players were required to give ratings on a 7-point scale on how much of the outcome in the previous set of hands was caused by luck (1 = *no luck*, 7 = *luck*), how much was a result of their ability (1 = *no ability*, 7 = *ability*), and how well they thought they would do in the next block of hands (1 = *very poorly*, 7 = *very well*). Participants in the advice group were also asked how useful the advice suggested by the computer was (1 = *not useful*, 7 = *useful*), and to what extent they would follow the advice in the next block of hands (1 = *not all*, 7 = *follow exactly*).

The computer program collected data on play outcomes (i.e., the total number of wins, losses, and ties per block for each participant). It also recorded the bet size, the total number of points sat on (total sat on), the number of points when the last card was drawn (total drawn on), and the number of play decisions that violated the Basic strategy (i.e., failure to hit and failure to stand errors). A score of zero on failure to hit and failure to stand measures would indicate perfect correspondence with Basic.

Results

The dependent variables were analyzed using two way mixed-model analyses of variance (ANOVA, Advice/No-Advice × Block) unless otherwise indicated. Table 2 shows the data collected on play outcomes (i.e., number of wins, number of losses, and number of ties), as a function of advice group and block.

The number of winning and losing hands was constrained to reduce the likelihood that one group would receive a greater "reward" for their strategy than the other, a situation that could complicate comparisons between the two advice groups. As such, there was no significant difference in the total number of wins for the advice and no-advice groups, $F < 1$. There was also no significant difference between the advice groups in either number of losses, $F(1, 14) = 3.54$, $p > .05$, or number of ties, $F < 1$. There was no effect of block on wins, losses, or ties, all $F < 1$, and no significant interactions between advice group and block: wins, $F < 1$; losses, $F(7, 98) = 1.47$, $p > .05$; and ties, $F(7, 98) = 1.72$, $p > .05$. From this it can be concluded that the two advice groups did not experience appreciably different play outcomes, and that any differences between the two groups cannot be attributed to differential reinforcement of their play.

TABLE 2
Mean Frequency of Each Play Outcome as a Function of Advice/No-Advice and Block

	Block								
Outcome	1	2	3	4	5	6	7	8	*M*
Advice									
Total wins	8.62	8.00	8.25	8.50	8.24	8.62	9.63	8.24	8.51
Losses	10.00	9.62	9.87	9.25	9.88	9.75	9.62	9.38	9.67
Ties	1.38	2.38	1.88	2.25	1.88	1.63	0.75	2.38	1.82
No-Advice									
Total wins	8.25	8.76	8.25	8.62	8.62	8.38	8.75	8.50	8.52
Losses	9.50	9.62	9.38	9.88	9.50	9.62	9.12	9.50	9.52
Ties	2.25	1.62	2.37	1.50	1.88	2.00	2.13	2.00	1.97
M									
Total wins	8.44	8.38	8.25	8.56	8.43	8.50	9.19	8.37	8.51
Losses	9.75	9.62	9.63	9.57	9.69	9.69	9.37	9.44	9.59
Ties	1.82	2.00	2.13	1.88	1.88	1.82	1.44	2.19	1.89

Table 3 shows the data relating to actions by the player: the size of the bet placed, the number of points the player had before drawing his or her last card, and the total number of points sat on. Table 3 also shows violations of the Basic strategy in the form of failure to hit and failure to stand errors.

There was neither an effect of advice on mean bet size, $F < 1$, nor an interaction between advice and block, $F < 1$, but mean bet size increased significantly across the eight blocks of trials, $F(7, 98) = 2.83$, $p < .05$. Players were more willing to take risks in their betting strategy over time despite the fact that they were not winning any more games. Similar effects have been reported in horse racing, where people take greater risks later in the day in an effort to win back their losses (Johnson & Bruce, 1993; Kopelman & Minkin, 1991).

Previous research has indicated that Basic may be perceived as a high-risk strategy because it recommends that players sit on higher totals than they might otherwise feel comfortable with (Wagenaar, 1988). Therefore, if the advice players were following the Basic strategy, they should have been drawing cards and sitting on

TABLE 3
The Effect of Advice/No-Advice and Block on Player Decisions

	Block								
Decision	1	2	3	4	5	6	7	8	*M*
Advice									
Bet size	4.23	4.69	5.22	5.56	5.76	4.98	5.56	5.49	5.19
Total drawn on	12.40	12.54	12.93	12.75	13.28	13.33	12.86	12.73	12.85
Total sat on	18.63	18.58	19.18	19.51	18.89	19.08	19.05	18.95	18.98
Fail to hit	1.13	1.00	0.25	0.00	0.50	0.50	0.38	0.38	0.52
Fail to stand	5.00	5.13	6.13	5.88	7.00	7.63	5.75	5.38	5.99
No-Advice									
Bet size	4.38	4.72	5.22	5.39	5.02	4.99	5.12	5.43	5.03
Total drawn on	13.00	12.56	12.70	13.10	12.58	13.25	13.09	12.90	12.90
Total sat on	19.11	18.96	18.90	18.94	19.21	19.26	19.25	19.15	19.10
Fail to hit	0.75	0.63	0.88	0.75	0.50	0.63	0.25	0.50	0.61
Fail to stand	6.25	5.38	5.13	6.88	4.38	5.88	7.00	5.38	5.79
M									
Bet size	4.31	4.71	5.22	5.48	5.39	4.99	5.34	5.46	5.11
Total drawn on	12.70	12.55	12.82	12.93	12.93	13.29	12.98	12.82	12.88
Total sat on	18.87	18.77	19.04	19.23	19.05	19.17	19.15	19.05	19.04
Fail to hit	0.94	0.82	0.57	0.38	0.50	0.57	0.32	0.44	0.56
Fail to stand	5.63	5.26	5.63	6.38	5.69	6.76	6.38	5.38	5.89

higher totals than the no-advice group. Although there were no effects involving the totals drawn on, all *F*s < 1, there were some differences in the totals that players sat on. There was a significant Advice × Block interaction on the total number of points sat on, $F(7, 98) = 2.30, p < .05$. The total sat on by the advice group increased from Block 1 to Block 4, then dropped and remained steady for the final four blocks (see Table 3). In contrast, the no-advice players showed no obvious trend except that they sat on higher totals in the last four blocks than in the first four blocks.

Basic dictates sitting on higher totals, and the increasing total sat on by the players receiving advice in the first four blocks was reflected by a decreasing number of failure to hit errors. Although the Advice/No-Advice × Block interaction was not significant in failure to hit errors, $F(7, 98) = 1.27, p > .05$, this may be a floor effect due to the overall low number of this type of error, $M = 0.56$. Indeed, by the fourth block the advice group made no failure to hit errors (see Table 3). This suggests that on-line Basic advice had an impact on play, but that the Basic strategy was subsequently discarded after Block 4. Because the appropriate strategy was right in front of participants' noses, it would appear that irrational behavior is not simply a product of fatigue or ignorance.

Failures of rationality in blackjack have been previously linked to increased failure to hit errors (Wagenaar, 1988). However, in this study, the overall mean frequency of failure to stand errors, $M = 5.88$, was much greater than failure to hit errors, $M = 0.56$. This finding suggests that our Hong Kong players were using a "Go for Broke" strategy rather than the "Never Bust" strategy used by Wagenaar's Dutch players and indicates that irrational behavior need not reflect conservatism. As going bust shortens the game somewhat, the impatient Hong Kong participants may have used this as a strategy to reduce the length of the experiment. However, if this were the case, the number of failure to stand errors should have increased as the experiment progressed. This was apparently not the case as there was no effect of block on failure to stand errors, $F < 1$.

Players' Attitudes

To better understand people's play, we examined the rating data (see Table 4) to determine whether the provision of advice influenced the attitudes of the players toward the game. If players believed that the strategies they employed were working for them, then this belief should have resulted in a decrease in their attribution of luck to the result of the game. However, in general it was found that as the blocks progressed, there was an increase in the luck rating rather than a decrease, $F(7, 98) = 2.31, p < .05$, meaning that the participants attributed the game outcomes to luck as the trials wore on. A significant Advice × Block interaction indicated that this trend differed somewhat between the two advice groups, $F(7, 98) = 2.36, p < .05$. The advice group began with a *lower* belief that outcomes were due to luck, which increased substantially as the experiment progressed, whereas there were fewer changes in the belief in luck for the no-advice group.

TABLE 4
Mean Self-Ratings of Attitude as a Function of Advice/No-Advice and Block

Attitude	Block 1	2	3	4	5	6	7	8	*M*
Advice									
Outcome due to luck	5.00	5.13	5.50	5.50	5.50	5.63	5.88	6.25	5.55
Outcome due to ability	2.75	3.38	3.13	3.38	3.13	3.00	3.38	3.13	3.16
How well in upcoming block	3.63	3.63	3.25	3.25	3.00	3.13	3.25	3.50	3.33
Usefulness of advice in the past block	2.50	2.75	3.00	2.63	2.63	2.25	2.25	2.13	2.52
Usefulness of advice in the upcoming block	2.88	2.88	3.13	2.38	2.25	2.38	2.13	2.13	2.52
No-Advice									
Outcome due to luck	5.38	5.25	4.75	4.75	4.88	5.13	5.00	5.38	5.07
Outcome due to ability	3.13	3.63	3.50	4.00	3.75	3.88	4.00	4.13	3.75
How well in upcoming block	4.38	4.38	4.38	4.38	4.75	4.88	4.88	5.13	4.65
M									
Outcome due to luck	5.19	5.19	5.13	5.13	5.19	5.38	5.44	5.82	5.31
Outcome due to ability	2.94	3.51	3.32	3.69	3.44	3.44	3.69	3.63	3.46
How well in upcoming block	4.01	4.01	3.82	3.82	3.88	4.01	4.07	4.32	3.99

In particular, when asked how well they thought they would do in upcoming blocks, the advice group, $M = 3.33$, was less optimistic than the no-advice group, $M = 4.64$, $F(1, 14) = 11.95$, $p < .05$. In other words, players were more optimistic that they might win when left to their own personalized strategies, and they tended to maintain the belief that outcomes were less related to luck. Such findings might be in keeping with suggestions that illusions of control play a role in gambling behavior (Langer, 1975). However, we note there was no significant effect of Advice/No-Advice, $F(1, 14) = 1.20$, $p > .05$, or Block, $F(1, 7) = 1.82$, $p < .05$, on ratings of the degree to which play outcome was due to their ability, nor was there an Advice/No-Advice × Block interaction, $F < 1$. In other words, there was more of an illusion that wins were possible, rather than a belief that ability (or control) influenced outcomes.

Certain questions were applicable only to the advice group. The advice group was asked to rate how useful they felt the advice was. They were asked whether they thought the advice had helped them in the past block and whether they thought it would help in future blocks. Participant ratings of past usefulness did not change across the blocks ($F < 1$). However, when asked about their attitude toward the future usefulness of the advice, an interesting pattern emerged. They began believing that the advice would help them, with the future usefulness rating increasing steadily from Blocks 1 to 3. But from Block 3, the future usefulness rating gradually declined. This block effect was significant, $F(7, 49) = 2.41$, $p < .05$. It would appear that the advice group may have begun the experiment with high hopes for the effectiveness of the Basic advice, but that this was followed by disillusionment and, ultimately, the abandonment of the strategy. These findings are in keeping with changes in the totals sat on and the failure to hit errors, which indicated that participants started using the strategy in the first three or four blocks and then stopped.

Discussion

Departures from rational (Basic) behavior occur in blackjack but may simply reflect ignorance or fatigue. The provision of on-line Basic advice over an extended period of play allowed us to address these issues. Because the computer made appropriate strategies effortlessly available, departures from Basic could not reflect ignorance or fatigue. Also, as participants were led to believe that their payment for the experiment would be contingent on their playing performance, they were encouraged to play well. Nevertheless, players adopted Basic and then discarded it. The question is: Why did they stop?

Personalized Strategies

We have previously noted the strength of one's own personal strategies over other strategies in the face of losing streaks. Chau and Phillips (1995) and

Phillips and Amrhein (1989) found that players would reduce the size of their bet in response to a losing streak less if they were placing bets on another player (i.e., a computer algorithm that sat on 15) than if they were placing bets on their own play. Basic may have been perceived as another person's system of play and therefore was not protected in the face of losses because of its lack of personal involvement.

Strategy Shifts

The odds in blackjack are known to vary as a function of the proportions of 10 cards in the shoe. This situation means that the odds in favor of the dealer will vary over time depending on the cards played. Basic does not take such changes in the odds into account. Indeed, if players can keep track of previous play, then Basic may not be the most optimal strategy. In addition, the occasional sub-optimalities in Basic (i.e., losing streaks) may push people to other, more personal and less rational, strategies. Nevertheless, this is not a sufficient explanation, because we controlled the odds in this study such that players would not experience serious losing streaks. However, the control placed on the number of wins also meant that players would not experience the type of winning streaks that might serve to reinforce the response strategy being used.

Instead, any losses that occur will lead players to question Basic. This loss of confidence is evident in the lower ratings of the usefulness of the Basic strategy and the higher ratings of the importance of luck toward the end of the experiment in the condition where players were provided with on-line Basic advice. Given a choice between reinforced and non-reinforced alternatives, organisms learn to discriminate (Nevin, 1973) and choose the reinforced alternative (in this case Basic), and they learn not to respond to the unreinforced alternative (in this case non-Basic strategies). After reinforcement is withdrawn (losses), there is a tendency for responding to shift not only away from the non-reinforced alternatives but also away from the previously reinforced optimal response (in this case Basic; Hanson, 1959). This effect (the peak-shift effect), which occurs in both humans and animals (Nevin, 1973), implies that mechanisms exist to create shifts from optimal responding in transitory instances of non-reinforcement. An irregular reinforcement history might be sufficient to lead to a shift away from, and then a cessation of the utilization of, optimal/rational response and work to prevent its resumption.

Previous reports of irrational behavior in blackjack favor conservatism in the form of "Never Bust" strategies (Wagenaar, 1988). In the present study we observed a "Go for Broke" strategy, indicating that irrational behavior need not be conservative in this game. The most likely explanation for this observation is that Wagenaar made his observations in real casinos with real players. Play was often made late into the night, and, most importantly, Wagenaar's players were playing with money that they had brought to the table. In this study, players had an incentive to win (because they could increase their reward), however, they had no disincentive to lose as they were not playing with their own money. Therefore, our players could afford to use a reckless play strategy such as "Go for Broke," whereas the real players could not. Nevertheless, we note that people exhibited systematic changes toward larger wagers, suggesting that people were attempting to chase their losses. This type of effect has been observed in situations in which there is only a fixed period of time to gamble (i.e., horse-racing; Johnson & Bruce, 1993; Kopelman & Minkin, 1991).

Conclusion

Even when players are given explicit advice on rational play in blackjack, they prefer to follow some other strategy of their own. The results of this experiment suggest that past observations of deviations from optimal strategies (e.g., Wagenaar, 1988) are not attributable to player ignorance and are unlikely to be attributable to fatigue or even conservatism. Authors such as Rosecrance (1987) and Walker (1992) have suggested that problem gambling reflects a loss of control, with Walker considering the possibility that the encouragement of sensible play might control problem gambling. The present data imply that educating people about more intelligent forms of play is likely to be unsuccessful in the control of problem gambling (Blaszczynski, McConaghy, & Frankova, 1991). Although the provision of strategies such as Basic seems to give players a more realistic appreciation of the likelihood of winning and seems to potentially reduce their losses, our data suggest that, in the face of losses, sensible play is less likely to be maintained and personalized strategies are more likely to be preferred.

REFERENCES

Blaszczynski, A., McConaghy, N., & Frankova, A. (1991). Control versus abstinence in the treatment of pathological gambling: A two to nine year follow-up. *British Journal of Addiction, 86*, 299–306.

Chau, A. W., & Phillips, J. G. (1995). Effects of perceived control upon wagering and attributions in computer Blackjack. *The Journal of General Psychology, 122*, 253–269.

Gilovich, T., & Medvec, V. H. (1995). The experience of regret: What, when, and why. *Psychological Review, 102*, 379–395.

Griffin, P. (1987). *Mathematical expectation for the public's play in casino blackjack.* Paper presented at the 7th International Conference on Gambling and Risk Taking, Reno, Nevada.

Hanson, H. M. (1959). Effects of discrimination training on stimulus generalization. *Journal of Experimental Psychology, 58*, 321–334.

Johnson, J. E. V., & Bruce, A. C. (1993). Gluck's second law: An empirical investigation of horserace betting in early and late races. *Psychological Reports, 72*, 1251–1258.

Kopelman, R. E., & Minkin, B. L. (1991). Toward a psychology of parimutuel behavior: Test of Gluck's laws. *Psychological Reports, 68*, 701–702.

Langer, E. J. (1975). The illusion of control. *Journal of Personality and Social Psychology, 32*, 311–328.

Nevin, J. A. (1973). Stimulus control. In J. A. Nevin (Ed.), *The study of behavior* (pp. 114–152). Glenview, IL: Scott, Foresman.
Phillips, J. G., & Amrhein, P. C. (1989). Factors influencing wagers in simulated blackjack. *Journal of Gambling Behavior, 5,* 99–111.
Rosecrance, J. (1987). Attribution and the origins of problem gambling. In M. B. Walker (Ed.), *Faces of gambling* (pp. 247–261). Sydney, Australia: National Association for Gambling Studies.
Thorp, E. (1966). *Beat the dealer.* New York: Vintage.
Wagenaar, W. A. (1988). *Paradoxes of gambling behavior.* Hillsdale, NJ: Erlbaum.
Walker, M. B. (1992). *The psychology of gambling.* Oxford, UK: Pergamon Press.
Weiner, B. (1986). *An attributional theory of motivation and emotion.* New York: Springer-Verlag.

Manuscript received June 1, 1999
Revision accepted for publication February 15, 2000