Conflict Between Intuitive and Rational Processing: When People Behave Against Their Better Judgment

Veronika Denes-Raj and Seymour Epstein

When offered an opportunity to win $1 on every "win" trial in which they drew a red jelly bean, subjects frequently elected to draw from a bowl that contained a greater absolute number, but a smaller proportion, of red beans (e.g., 7 in 100) than from a bowl with fewer red beans but better odds (e.g., 1 in 10). Subjects reported that although they knew the probabilities were against them, they felt they had a better chance when there were more red beans. Similar, but less extreme results were obtained on "lose" trials, where drawing a red bean meant losing $1. These results were predicted from the concretive and experiential principles of cognitive-experiential self-theory. Nonoptimal choices in the laboratory were significantly correlated with heuristic responses to relevant vignettes and with self-reported gambling in real life.

The traditional view of human decisional processes by social scientists has been that people make rational decisions predicated on maximizing pleasure or gains and minimizing pain or losses. Over the past several decades, this rational model has been increasingly challenged from a variety of theoretical perspectives as well as on empirical grounds (e.g., Bruner, 1986; Epstein, 1973; Epstein, Lipson, Holstein, & Huh, 1992; Johnson-Laird, 1983; Kahneman, Slovic, & Tversky, 1982; Kirkpatrick & Epstein, 1992; Nisbett & Ross, 1980; Simon, 1957; Tversky & Kahneman, 1982; for reviews, see Epstein, in press; Fiske & Taylor, 1991; Sherman & Cortsy, 1984). Several of these approaches assume that people process information in two different modes, one identified by terms such as rational, analytical, deliberative, propositional, and extensional and the other by terms such as experiential, automatic, intuitive, narrative, and natural. It is within the framework of one of these approaches, cognitive-experiential self-theory (CEST), that the studies reported in this article were conducted.

According to CEST, individuals apprehend reality by two interactive, parallel processing systems. The rational system, a relative newcomer on the evolutionary scene, is a deliberative, verbally mediated, primarily conscious analytical system that functions by a person’s understanding of conventionally established rules of logic and evidence. The experiential system, which is considered to be shared by all higher order organisms (although more complex in humans), has a much longer evolutionary history, operates in an automatic, holistic, associationistic manner, is intimately associated with the experience of affect, represents events in the form of concrete exemplars and schemas inductively derived from emotionally significant past experiences, and is able to generalize and to construct relatively complex models for organizing experience and directing behavior by the use of prototypes, metaphors, scripts, and narratives. Although the experiential system is generally adaptive in natural situations, it is often maladaptive in unnatural situations that cannot be solved on the basis of generalizations from past experience but require logical analysis and an understanding of abstract relations (Epstein et al., 1992).

According to CEST, behavior is guided by the joint operation of the two systems, with their relative influence being determined by the nature of the situation and the degree of emotional involvement. Certain situations (e.g., solving mathematical problems) are readily identified as requiring analytical processing, whereas others (e.g., interpersonal behaviors) are more likely to be responded to in an automatic, experientially determined manner. Holding such situational features constant, the greater the emotional involvement, the greater the shift in the balance of influence from the rational to the experiential system (for more detailed discussions of the differences between the two systems, see Epstein, 1983; Epstein, 1993; Epstein et al., 1992).

Of particular interest with respect to its broader implications, the experiential system is assumed not only to automatically direct animal and human behavior, but also to automatically influence conscious human thought. To the extent that this is true, humans can respond rationally (in the sense of engaging their deliberative, rational system in an objective, unbiased manner) only to the degree to which they are aware of and can therefore compensate for their experientially influenced thoughts and response tendencies.

From the perspective of CEST, the principles of heuristic responding that have been inductively derived by social-cognitive psychologists such as Tversky and Kahneman (1982) and Nisbett and Ross (1980) represent the normal mode of operation of the experiential system (Epstein et al., 1992). Although experi-
ential processing is highly efficient and adaptive in most circumstances, in other circumstances it is error-prone and a source of maladaptive biases. The limitations of experiential (heuristic, intuitive) processing have been well demonstrated in numerous studies that have examined judgmental processes under uncertainty. For example, it has been found that people often ignore basic statistical concepts, such as base rates, sample size, regression to the mean, and the conjunction principle and rely instead on judgmental heuristics, such as representativeness, availability, anchoring effects, and salience (see reviews in Fiske & Taylor, 1991; Kahneman, Slovic, & Tversky, 1982; Nisbett, Krantz, Jepson, & Kunda, 1983).

Of particular interest with respect to the issues of primary concern in this article is a series of studies conducted by Miller, Turnbull, and McFarland (1989) in which they showed that people judge the same probability of an unlikely event as lower when the probability is presented in the form of a ratio of smaller rather than of larger numbers (an effect we refer to as the "ratio bias effect"). For example, they found that subjects believed that a mother would be more suspicious that her child had cheated (presumably by peeking) if he succeeded in drawing a desired chocolate chip cookie from a jar that contained 1 chocolate chip of 20 cookies, than if he drew the coveted cookie from a jar that contained 10 chocolate chip cookies of 200 cookies.

Kirkpatrick and Epstein (1992) modified the Miller et al. (1989) experimental paradigm to make it more appropriate for college students as well as suitable for study in the laboratory as a real experience. These researchers found that when subjects had an opportunity to win money by drawing a red jelly bean from two bowls, one of which contained 1 red of 10 beans and the other of which contained 10 red of 100 beans, although the bowls were both clearly identified as containing 10% red beans, over two thirds of the subjects elected to draw from the bowl that contained the larger number of beans, thereby demonstrating the ratio-bias phenomenon. Moreover, most subjects willingly paid dimes to guarantee their choices, rather than having their choices made for them randomly. Also, subjects made spontaneous comments indicating that they knew their behavior was irrational, but they nevertheless felt they had a better chance of getting a red bean when there were more of them, even though the ratios were the same.

Kirkpatrick and Epstein (1992) had hypothesized that the results would be based on two fundamental principles derived from CEST: the concretive and the experiential principles. According to the concretive principle, information in the experiential system is encoded primarily in the form of concrete representations. Thus, absolute numbers, which are more concrete than ratios, are more comprehensible to the experiential system. Also, small ratios represented by large numbers are perceived as less extreme than ratios between smaller numbers because large numbers are less concrete than small numbers in the sense that they are less well articulated in memory (Banks, Fujii, & Kayra-Stuart, 1976; Holyoak, 1978; Kirkpatrick & Epstein, 1992). More specifically, people can visualize 1 compared with 9 items more clearly than 10 compared with 90 items.

As for the experiential principle, as already noted, the schemata in the experiential system represent, for the most part, generalizations from emotionally significant past experience. Because life is full of experiences in which people face long odds as one individual among many, individuals are likely to learn that any event with the probability of 1 in any large number (e.g., 1 in 20) is highly unlikely to occur. Thus, the experiential principle supplements the concretive principle in supporting the prediction that an unusual event with a given objective probability of occurrence will have a smaller subjective probability when it is represented by a ratio of 1 in any large number than when it is represented by the same ratio expressed in terms of two larger numbers.

In the Kirkpatrick and Epstein study (1992), subjects elected to draw from one of two bowls that contained different numbers of jelly beans but offered equal probabilities of winning (e.g., 1 in 10 vs. 10 in 100). Although making a choice between identical probabilities can demonstrate the occurrence of the ratio bias, it does not permit an interpretation to be made that one of the choices is more irrational than the other (although, of course, paying a dime to guarantee the choice is).

Study 1

The primary purpose of the first study was to determine whether subjects would make nonoptimal, clearly irrational decisions by electing to draw from a bowl that they recognized offered less favorable objective probabilities than an alternative bowl. If so, how extreme would their irrational behavior be? Would they make only the mildest nonoptimal responses, such as selecting a 9% over a 10% probability of a favorable outcome, or would they make more extreme nonoptimal responses, such as selecting a 5% over a 10% probability? The results could provide a dramatic illustration of the extent to which people, under the prompting of their experiential system, behave against the better judgment of their rational system.

To investigate this issue, we presented subjects with situations in which they had to choose between drawing from a small bowl that always contained 1 red and 9 white jelly beans and was clearly identified as offering a 10% chance of drawing a red jelly bean and a large bowl that contained a total of 100 jelly beans and, depending on the trial, offered a 5%–9% chance (clearly identified) of drawing a red jelly bean. We hypothesized, on the basis of the concretive and experiential principles of CEST, that a substantial number of subjects would make nonoptimal responses by basing their choices on the absolute numbers of red beans, while ignoring the ratios. A second aim of the study was to determine whether subjects process information nonsymmetrically with respect to the prospects of winning and losing money. To accomplish this, subjects were informed that on win trials, they could win but not lose money, and on lose trials they could lose but not win money, by drawing a red jelly bean. As losses influenced net earnings in an exactly equivalent manner as wins, if subjects were completely rational, they would behave completely symmetrically with respect to win and lose trials. It can be inferred from two sources, however, that people are likely to make more nonoptimal choices on win than on lose trials. One is that the experiential system is assumed, in CEST, to be an associationist system that guides future behavior by associations to past experience. Thus, although from an objective perspective, win and lose trials exert equivalent effects on net earnings (i.e., losing $1 on a lose trial contributes to final net
earnings the same as failing to win $1 on a win trial), the asso-
ciations to lose trials, based on past experience, can be assumed
to invoke greater negative and less positive affect than the asso-
ciations to win trials. This should lead subjects to be more cau-
tious on lose trials, which we assumed would promote operating in
a more considered, rational manner. The other is that there is
evidence that positive affect favors spontaneous, intuitive pro-
cessing (Ison, Means, Patrick, & Nowicki, 1982). Accordingly, it
was hypothesized that subjects, following the prompting of their
experimental system, would make more nonoptimal choices in
win than in lose trials.

A third aim of the study was to examine the generality of
individual differences in heuristic processing in different do-
 mains. Could individual differences in heuristic responses to
vignettes be shown to be related to individual differences in heu-
ristic responses in the laboratory? If so, it would provide sup-
port for the existence of individual differences in a broad ten-
dency to process information in the mode of the experiential
relative to the rational system (Epstein, 1990; Epstein et al.,
1992). In a recent study, Epstein, Denes-Raj, and Heier (1993)
obtained evidence of a global factor of heuristic processing
across a wide variety of vignettes. The present study examined
the relation between responses to these vignettes and responses
in the laboratory situation. It was hypothesized that there is a
direct relation between the extent to which individuals make
heuristic, nonrational responses to vignettes and the degree to
which they make nonoptimal choices in the laboratory.

Method

Subjects. Seventy-nine undergraduates (30 men and 49 women) en-
rolled in psychology classes at a large northeastern state university par-
ticipated in the study in exchange for experimental credit and an oppor-
tunity to win up to $7.

Materials. A number of transparent, plastic bowls contained vari-
cious mixtures of red and white jelly beans. The bowls were arranged in
pairs consisting of a large bowl and a small bowl. The small bowl always
contained 10 beans, one of which was red. The large bowl always con-
tained 100 beans, and anywhere between 5 to 9 of them, depending on
the trial, were red. The bowls (more accurately, the rectangular platters)
were of a size such that the jelly beans were spread out in a single layer,
with no bean hidden from view. To eliminate concern about arithmetic
ability, each bowl was clearly labeled with an index card indicating the
percentage of red jelly beans it contained.

Play money consisted of photocopies of dollar bills. These were ex-
changed at the end of the experiment for real money.

A measure of heuristic responding to vignettes (Epstein et al., 1993)
consisted of responses to 11 vignettes adapted from a variety of studies
on heuristic processing, predominantly by Tversky, Kahneman, Miller,
and their associates (e.g., Kahneman & Miller, 1986; Kahneman &
Tversky, 1982a) and by Nisbett and his associates (e.g., Nisbett et al.,
1983). The vignettes required judgments about near versus far misses,
usual versus unusual behaviors, acts of commission versus omission,
and acts associated with cost-benefit considerations, such as whether
one would pay more of an expensive than of an inexpensive unsavory
pastry. Subjects indicated in which of two alternative versions of each
vignette, if either, they believed the protagonist (identified as an average
person), they themselves, and a completely logical person would have
a stronger emotional reaction (feel more foolish, angry, or upset). For
example, one of the vignettes, which examined reactions to near versus
far misses, described two women, who, because their limousine was
caught in a traffic jam, arrived at the airport 30 min after the scheduled
departure of their flights. One learned that her flight left on schedule.
The other learned that her flight was delayed and just left a few minutes
ago. Subjects were asked to indicate (a) in which version they believed
the protagonist, assuming she reacted as an average person would,
would feel more foolish about having dawdled for 10 min before leaving
for the airport; (b) in which version they, themselves, would feel more
foolish; and (c) in which version a completely rational person would feel
more foolish. In each version, they had three response options: that the
first person would feel more foolish, that the second would feel more
foolish, or that neither would feel more foolish. In a previous study, it
was established that for each orientation (protagonist, self, and ra-
tional), there was a general factor of degree of heuristic processing.

Other materials consisted of standard and specially constructed self-
report personality scales selected because of their possible relevance to
individual differences in heuristic relative to analytical processing. The
results relating to these personality measures will be presented together
with findings from other studies using the same measures in a separate
publication.

Procedure. At the time of recruitment, participants received a pack-
age containing the booklet of vignettes and the personality inventories,
which they completed at home and returned when they came for their
laboratory session.

When subjects came to the laboratory, the experimenter explained to
them that they would participate in a game of chance in which they
would have the option of drawing from one of two bowls that contained
different numbers of jelly beans. On seven of the trials, designated as
win trials, they would win $1 if they drew a red bean and would win
nothing if they drew a white bean; on the other five trials, designated as
lose trials, they would lose $1 if they drew a red bean and not lose any-
thing if they drew a white bean.

The small bowl offered a 10% chance of drawing a red bean on all
standard trials. The probabilities (5%–9%) in the large bowl on standard
trials were varied according to a Latin Square design. To sustain morale,
we increased the chances of subjects winning something by including
two additional win trials that offered a 50% versus a 45% chance of
winning. On these two trials, the small bowl contained 5 red of 10 jelly
beans, and the large bowl contained 45 red of 100 jelly beans.

Subjects were given $10 in play money to begin with and told that at
the end of the experiment, any earnings they had beyond the $10 would
be exchanged for real money. They were informed that they could keep
their winnings above the amount loaned but would not be held account-
able for any net losses. The experimenter emphasized that the concern
of the study was in understanding people's preferences with respect to
drawing from the two bowls under various conditions. Subjects were
assured that there was no deception and that the amount of money they
won or lost would be truly in accordance with the stated probabilities.

On each trial, the experimenter presented subjects with the two
bowls, announced whether the trial was a win or a lose trial, and called
attention to the respective probabilities in the bowls. The experimenter
then shielded the bowls from view with a cardboard screen, scrambled
the jelly beans, and told the subject to draw a single bean from the bowl
of his or her choice. If subjects selected a red bean on a $1 win trial, they
were immediately given $1 in play money. If they picked a red bean on
a lose trial, they immediately paid $1 in play money to the experimenter.
After the last trial, any play money they had beyond $10 was exchanged
for real money. Subjects were then informed that the next part of the
experiment was concerned with how well the subject could estimate the
kinds of choices that "most people make" in the experiment, which,
they were told, "can be different from or similar to the way you made
your choices." The 12 trials were then repeated, with subjects estimat-
ing on each trial the choice they believed most people make.

Results and Discussion

Subjects' bowl choices were assessed by two measures. The first was an unweighted score of the number of nonoptimal
choices. This measure indicated how many times subjects selected from the bowl that offered the lower probability of a favorable outcome. The second measure was a weighted index of degree of nonoptimal choice. On win trials, an optimal choice was assigned a score of 0, a nonoptimal choice of 9% a score of 1, a nonoptimal choice of 8% a score of 2, and so forth. Corresponding scores of degree of nonoptimal responding were assigned to lose trials.

Nonoptimal choices. An examination of nonoptimal responses on the 5 regular win trials revealed that, consistent with the ratio-bias phenomenon, a considerable majority (82%) of subjects made one or more nonoptimal choices. The mean number of nonoptimal choices on win trials was 2.18, and the mode was 2, made by 24% of the subjects. Eight percent of the subjects made nonoptimal responses on all five win trials.

On lose trials, similar, but not as extreme results were obtained, with 61% of subjects making one or more nonoptimal responses. The mean number of nonoptimal responses for lose trials was 1.34, and the mode was zero, made by 39% of subjects. Four percent of subjects made nonoptimal responses on all five lose trials.

Figure 1 presents the percentage of subjects who made nonoptimal choices of various magnitudes. Not surprisingly, for both win and lose trials, the greater the magnitude of a nonoptimal response, the less frequently it was made. It is evident in Figure 1 that nonoptimal responses of all magnitudes occurred more often on win than on lose trials and that the greatest discrepancies between win and lose trials occurred at the more modest levels of nonoptimal responses. A majority (61%) preferred the large bowl that offered a 9% probability of winning over the small bowl, with its constant offering of a 10% chance of winning. A substantial number of subjects (23%) selected the large over the small bowl when it offered only half the chance (5% vs. 10%) of winning. The results are similar but less extreme on lose trials.

A repeated measures analysis of variance (ANOVA) of the unweighted scores (number of nonoptimal choices) as a function of gender, valence (win vs. lose trials), and mild (9% and 8%) versus more extreme (7%-5%) nonoptimal choices yielded a significant main effect for valence, $F(1, 72) = 13.59, p < .001$. Subjects were significantly more likely to make nonoptimal choices on win ($M = 2.18$) than on lose trials ($M = 1.34$). No other effects were significant. An analysis of weighted scores, necessarily excluding the variable of mild versus more extreme magnitudes of nonoptimal responses, produced the same results.

The considerably lower incidence of nonoptimal choices on lose than on win trials should be interpreted with reference to the consideration that the contributions of win and lose trials to net earnings are identical. Thus, it had to be the subjective meaning assigned to losing and to winning and not the objective consequences of the outcomes that determined subjects' reactions.

Estimates of others' choices. Subjects' judgments about how others behave closely paralleled their own choices. On the five win trials, a majority of subjects (73%) said that others would make one or more nonoptimal responses. The mean number of estimated nonoptimal responses on win trials for others was 2.22 and the mode was 0, made by 27% of the subjects. Nineteen percent of the subjects said that others would make nonoptimal responses on all five win trials, and 27% said that others would make optimal responses on all five win trials.

On the five lose trials, the majority of subjects (54%) said that others would make one or more nonoptimal responses. The mean number of nonoptimal responses for others was 1.55 on the lose trials. The modal nonoptimal response for others on the lose trials was 0, made by 46% of subjects. Twelve percent said that others would make nonoptimal responses on all five lose trials, and 46% said they would make optimal responses on all five lose trials.

A repeated measures analysis of variance (ANOVA) examining the unweighted scores (number of nonoptimal choices) as a function of gender, perspective (self vs. other), valence (win vs. lose trials), and mild (9% and 8%) versus more extreme (7%-5%) nonoptimal choices produced no significant difference between subjects' choices for themselves and for others, $F(1, 65) = .19, ns$. However, it yielded a highly significant main effect for valence, $F(1, 65) = 22.27, p < .001$. Across self- and other responses, subjects were more likely to make more nonoptimal responses on win ($M = 4.39$) than on lose trials ($M = 2.90$). The effect of valence did not differ significantly for self and others, as indicated by an absence of a significant interaction between valence and self versus others. The means for win and lose trials
for self were, respectively, 2.18 and 1.34. For others, the corresponding means were 2.22 and 1.55. No other effects were significant. An analysis of weighted scores produced the same results.

**Introspective self-reports.** Subjects commonly commented that in spite of the stated odds, they felt that they had a better chance of winning by picking from the bowl with the more winning (red) beans. They made statements such as, "I picked the ones with the more red jelly beans because it looked like there were more ways to get a winner, even though I knew there were also more whites, and that the percents were against me." Other subjects endorsed the gambler's fallacy, stating that they were influenced in their choices by the outcomes of previous trials and that they had confidence that their luck was bound to change if they kept choosing from the same bowl: "Once I started playing the large bowl, I kept playing it, because sooner or later the odds will balance out if you stick with the same choice." Subjects who made uniform optimal choices often commented that it was self-evident to them that the right choice was to go with the better odds, and they expressed astonishment that anyone would think otherwise. A few acknowledged that, despite knowing this, the large bowl looked more inviting, and they had to fight the temptation to make nonoptimal choices.

**Correspondence between laboratory performance and vignette responses.** Responses to the vignettes were scored as heuristic if they demonstrated bias in the expected direction, for example, reporting that people would be more prone to attribute causality to an arbitrary near miss than to an arbitrary far miss, or that people would eat more of a tasteless pastry if one paid a lot for it than if one had paid little. There were two other scores. If the subjects reported "no difference" between the two versions of the vignette, the response was scored as "objective," and if the response was in the opposite direction of a heuristic response, it was scored as "opposite-heuristic." Because opposite-heuristic responses were few in number and reciprocally reflected the information from the other two kinds of responses, they were not analyzed.

The first question of interest is whether the reliability of the vignette scale, as established in previous research, is replicable. This issue is important for theoretical as well as methodological reasons, because it tests a fundamental assumption of CEST that there is a broad factor of heuristic processing across a wide variety of situations. Because responses are available from a rational as well as an experiential orientation, it also permits the hypothesis to be tested that the experiential system operates in a less general, more context-specific manner than the rational system. This follows from the assumption in CEST that, unlike the rational system, which represents events largely in the form of verbal abstractions, the experiential system represents events primarily in the form of concrete exemplars and prototypes. The internal consistency reliability coefficients (coefficients alpha) for heuristic responses in the previous study, in which the 11-item vignette scale was constructed, were .47 and .53, respectively, for the self- and other orientation (how oneself and others actually react) and .84 for the rational orientation (how a completely logical person would react). It was concluded that there is a modest degree of generality in the experiential system and considerably greater generality in the rational system. In the present study, the internal consistency reliability of heuristic responses to the same vignettes from the self-, other, and rational orientation were, respectively, .44, .57, and .83. These figures closely replicate those from the previous study. Correlations between subjects' nonoptimal bowl choices in the laboratory and their responses to the vignettes revealed no significant relations. This was true for subjects' responses to the vignettes from all three orientations: protagonist, self, and rational. Thus, the hypothesis that heuristic responding in the laboratory is related to heuristic responding to the vignettes was not confirmed.

**Conclusions.** The results of this experiment are consistent with the following generalizations derived from CEST: There are two fundamentally different ways of processing information, rational and experiential, which at times may be in conflict with one another, the experiential system can override the rational system even when people are aware of the normative rules; the experiential system is particularly responsive to concrete representations (e.g., absolute numbers of items) and to associations derived from past experience.

There are several viable explanations for the lack of correspondence between subjects' tendency to respond heuristically to the vignettes and to the laboratory. One is that people's decision-making strategies differ when they respond to simulated and real situations (Kirkpatrick & Epstein, 1992). Another possibility is that, despite the finding of a global factor of heuristic processing in response to vignettes, there are important differences among different kinds of vignettes. That is, there may be both generality and specificity in heuristic processing just as there is in intellectual processing. If such is the case, vignettes that describe situations conceptually more similar to the laboratory situation might produce positive findings. As will be seen shortly, support for this hypothesis was provided in the second study.

**Study 2**

Study 1 demonstrated the dominance of the experiential system over the rational system in a simple probability estimation task in which the two systems were placed in conflict with each other. Under these circumstances, the majority of subjects found their intuitive (experiential) judgments to be more compelling than their awareness of the objective probabilities and acted accordingly, despite their explicit recognition that their behavior was irrational. Some went so far as to prefer to draw from a bowl that offered only half the probability of a favorable outcome as an equally available alternative. Given such astonishing findings, it seemed important to establish their replicability.

The second study had two aims in addition to replicating the first study: to investigate the influence of motivation on nonoptimal responding and to demonstrate that the phenomenon of making nonoptimal choices in the jelly bean experiment has general implications that extend beyond the laboratory.

Motivation was manipulated by varying incentive level. For one group of subjects, the stakes for picking a red jelly bean were winning or losing 10¢ per trial. The most money that subjects in this group could win was 70¢. For another group, the stakes were $5 per trial, and subjects could win $35. We saw no basis for hypothesizing whether an increase in motivation would
drive the balance of influence of the two systems in the direction of the experiential or the rational system, and we decided to simply investigate this issue empirically. On the one hand, it could be argued that an increase in motivation would result in a greater increase in the engagement of the rational than of the experiential system, as occurs in studies on impression formation (e.g., Chaiken, Liberman, & Eagly, 1989; Freund, Kruglaniski, & Shpitzaizen, 1985; Harkness, DeBono, & Borgida, 1985; Petty & Cacioppo, 1986; Tetlock & Kim, 1987; see review in Fiske & Taylor, 1991). If such is the case, then the higher incentive condition can be expected to elicit fewer nonoptimal responses than the lower incentive condition. On the other hand, if responses to the experimental situation in question are governed by the same principles as in gambling situations and in certain kinds of judgmental heuristics (e.g., Grether & Plott, 1979; Lichtenstein & Slovic, 1971, 1973; Tversky & Kahne man, 1982), then experiential dominance might well prevail at all levels of motivation. In that case, an increase in motivation might have no effect or could, conceivably, drive the reaction in the experiential direction. From the perspective of CEST, increasing motivation should increase engagement of both the experiential and rational systems. Which system is apt to become dominant with increasing motivation in any particular situation would depend on stimulus parameters and perhaps on individual differences, about neither of which enough is known to provide a basis for prediction.

Two approaches were taken to examining the generality of individual differences in the production of nonoptimal responses in the jelly bean experiment to situations outside of the laboratory. One was to determine whether heuristic, nonoptimal responding in the laboratory situation was related to heuristic irrational responses to vignettes with relevant content. As previously noted, one possibility for the negative results with respect to such a relation in Study 1 is that the content of the vignettes used in that study was too remote from the nature of the laboratory situation for the two to be related at a conceptually meaningful level. Accordingly, in Study 2, we selected vignettes with more relevant content. The second approach was to obtain information on gambling to determine whether people’s performance in the laboratory is related to relevant behavior in real life.

Method

Subjects. Subjects were 96 undergraduate students (24 men and 72 women) enrolled in psychology classes at a large northeastern state university who volunteered to participate in the study in exchange for experimental credit and an opportunity to win money.

Procedure. Subjects were tested in the laboratory in an identical manner as in the previous study, except that half of the subjects (11 men and 37 women) were randomly assigned to a low-incentive condition in which they could win or lose $5 per trial and half of the subjects (13 men and 35 women) were assigned to a high-incentive condition in which they could win or lose $5 per trial. Because in Study 1 there were no differences between subjects’ own choices and their estimates of others’ choices, subjects were asked only about their own choices.

After responding to the laboratory task, subjects took a battery of personality tests, the results of which will be reported together with data from other studies in an article on individual differences. They then responded to three vignettes. Finally, subjects were asked to report whether they had engaged in formal gambling (playing the lottery, playing a slot machine, or betting on horses) and in informal gambling (playing cards or dice for money) within the last 6 months.

Materials. The three vignettes each included alternative outcomes that presented equal likelihoods of occurrence that were represented, in one case, in the form of a ratio of smaller and in the other of a ratio of larger absolute numbers. The vignettes were taken directly or adapted from previous studies (Denes-Raj, Epstein, & Cole, 1993; Miller, Turnbull, & McFarland, 1989). In response to each vignette, subjects reported whether they would be more suspicious after either outcome, or whether it would make no difference. They also rated the degree of their greater suspicion in one situation than in the other on a 5-point scale from not at all to a great deal. Subjects next responded to the same questions from the perspective of how they thought most people would respond. The exact wording of the vignettes was as follows:

Vignette A. Imagine two scenarios involving lotteries. In both cases, a winning number pays ten thousand dollars. Now imagine that Ralph Jones, a friend of yours, thinks of all the things he could buy with the money, like a new car, and all he can do with the money, such as take his dream vacation. These thoughts and images make Ralph desperately want to win the lottery.

In one of the lotteries, a single winning number is selected from a thousand numbers. In the other, ten winning numbers are selected from ten thousand numbers. In both scenarios, Ralph wins the lottery. Rumor has it that Ralph won because of insider influence. Although the proportions are identical, you may nevertheless have the feeling that in order to have won, Ralph was more likely to have cheated in one lottery than in the other. [From Denes-Raj et al., 1993]

Vignette B. Imagine two scenarios involving your child, who loves chocolate chip cookies. You tell your child to close his eyes before he reaches into the cookie jar, taking whichever cookie he grabs. He agrees to this and heads to the kitchen and the cookie jar.

In one of the scenarios the cookie jar contains 1 chocolate chip cookie and 19 oatmeal cookies. In the other, the cookie jar contains 10 chocolate chip cookies and 190 oatmeal cookies. In both scenarios your child comes back, exclaiming that he did just what you said and he selected a chocolate chip cookie. Although the proportions are identical, you may nevertheless have the feeling that the child peeked into the cookie jar before selecting the cookie. [Adapted from Miller et al., 1989]

Vignette C. Imagine that several weeks ago you lost a very dear friend in a car accident. Your friend was thrown through the windshield in a head-on crash after the taxi he was in veered off into the opposite lane. The police report noted that he and the taxi driver were dead on arrival at the hospital.

Now imagine two alternative scenarios. In one scenario you check into the records of the cab company and learn that during the last month, the company has had one conviction driving while intoxicated (DWI) in a thousand pick-ups. In the other scenario, you learn that during the last month the cab company, a much larger one, has had ten DWI convictions in ten-thousand pick-ups.

Although you know that the proportions are identical, you might nevertheless feel more suspicious about drunken driving being involved in one case than in the other. [From Denes-Raj et al., 1993]
Results and Discussion

Bowl choices. As in Study 1, the results provided strong evidence for the ratio-bias phenomenon. On the five win trials, the great majority of subjects (85%) made nonoptimal choices. The valence effect was also replicated: Subjects made more nonoptimal responses on win trials (81%) than on lose trials (64%). On the five regular win trials, the mean number of nonoptimal choices was 2.13, and the mode was 1, which was made by 26% of the subjects. Nineteen percent of the subjects made optimal responses on all five win trials, and 7% made nonoptimal responses on all five win trials.

On the five lose trials, the mean number of nonoptimal responses was 1.53 and the mode was zero. Thirty-four percent of subjects made optimal responses on all five lose trials, and 8% made nonoptimal responses on all five lose trials.

As in Study 1, the greater the magnitude of a nonoptimal response, the less frequently it was made. This was equally true for win and lose trials. On win trials, 54% of the subjects preferred to draw from the large bowl, when it offered a 9% chance of winning, than from the small bowl, which always offered a 10% chance of winning. An astonishing 34% of the subjects preferred to draw from the large bowl even when it offered only half the chance (5%) of winning as the small bowl (10%).

On the lose trials, 41% of the subjects preferred to draw from the small bowl, with its constant 10% chance of losing, than from the large bowl when it offered a more favorable, 9% chance of losing. Close to a quarter of the subjects (23%) preferred to draw from the small bowl when it offered twice the chance of losing (10%) as the large bowl (5%).

Subjects' nonoptimal responses were further assessed by a repeated measures ANOVA in the same manner as in Study 1, except that the variable of incentive was added. As the results were the same for weighted and unweighted scores, only the latter are reported. As before, there was a highly significant effect for valence, $F(1, 92) = 9.26, p < .01$. Subjects made more nonoptimal choices on win trials ($M = 2.13$) than on lose trials ($M = 1.53$). There were no significant main effects for gender, incentive, and magnitude of nonoptimal response (mild vs. extreme), but there was a significant interaction of Gender X Incentive, $F(1, 92) = 4.56, p < .05$. Women made fewer nonoptimal responses in the high-incentive ($M = 3.06$) than in the low-incentive ($M = 4.08$) condition, whereas men exhibited the reverse pattern, with respective means of 4.69 and 2.91. In summary, the effect of incentive was complicated by its interaction with gender. As the effect was unanticipated and the number of men was small, the results require verification with a more adequate sample of men. Such a study is currently in progress.

Correspondence between laboratory performance and vignette responses. As in Study 1, two scores were analyzed with respect to responses to the vignettes, an objective score that indicated number of unbiased responses and a heuristic score that indicated the number of biased responses in the expected direction, for example, judging odds expressed in smaller numbers.

Table 1 presents the correlations between the laboratory responses and the responses to the vignettes from the self-orientation.
measures were significantly correlated ($r = .40, p < .01$), they were combined into a single index. As can be seen in Table 1, the relation of gambling in real life and responses in the laboratory is stronger for lose than for win trials. For lose trials, the correlation, corrected for attenuation, is .34 (the uncorrected correlation of .22 is significant at the .05 level). For win trials, the uncorrected correlation is .13, which is not significant, and the corrected correlation is .21. For the combined win and lose trials, the corrected correlation is .30, and the uncorrected correlation is .20, which is significant at the .05 level. It may be concluded that performance in the laboratory situation, particularly for lose trials, is significantly associated with self-reported behavior in real life.

Summary and Conclusions

The second study replicated the findings on bowl choices in the first study. In accord with the ratio-bias phenomenon, subjects frequently made nonoptimal responses as a result of being unduly influenced by absolute numbers and ignoring ratios. In further support of hypothesis, subjects made fewer nonoptimal responses on lose than on win trials.

The effect of variations in incentive levels was more complicated than had been anticipated. The results suggested that there may be important individual differences with respect to the influence of motivation on nonoptimal responses. With an increase in incentive, men made more, and women made fewer, nonoptimal responses. It was concluded that the results were interesting but require verification.

There was evidence attesting to the generality of the phenomenon beyond the laboratory. First, nonoptimal responses in the laboratory were significantly associated with nonrational, heuristic responses to relevant vignettes. Second, performance in the laboratory was significantly related to self-reported gambling in real life. It may be concluded that the astonishing degree of nonoptimal responding observed in the laboratory, in which subjects readily acknowledged the irrationality of their behavior, is not an isolated, laboratory-specific finding.

General Discussion

Interaction Between the Two Processing Modes

The results in both studies are consistent with the view in CEST that there are two modes of processing information, an intuitive-experiential mode that is more responsive to absolute numbers than to ratios, and an analytical-rational mode that exhibits the opposite pattern. When the two modes were put into conflict with each other, most subjects, although fully aware that such behavior was irrational, elected to behave in accordance with the intuitive mode. These effects were not subtle. A considerable minority behaved irrationally to the extent that they preferred probabilities that were only half as favorable as those provided by an equally available alternative. These results were replicated in the second study, and they verify previous findings obtained with a different version of the same problem (Kirkpatrick & Epstein, 1992). They therefore contribute to accumulating evidence in support of the assumption in CEST that there are two independent, interactive systems, experiential and rational, and that the experiential system can override the rational system, even when people are fully aware that their resultant behavior is irrational (Epstein et al., 1992; Kirkpatrick & Epstein, 1992). These observations are all the more compelling when it is considered that they were obtained in the laboratory, where there is an implicit demand to present oneself as rational.

Not surprisingly, as the nonoptimal alternatives became more extreme, a decreasing number of subjects selected them. This suggests that most people are content to follow the irrational promptings of their experiential systems only up to a point, thereby limiting maladaptive consequences. In addition to providing evidence of the interactive nature of the two systems, this observation raises the intriguing possibility that, in view of its apparent prevalence in normal individuals, there may be an advantage, with respect to spontaneity and efficiency, in trusting the automatic promptings of the experiential system in everyday life, but only within limits, after which the costs outweigh the gains. Such thinking is consistent with the assumptions in CEST that the experiential system is under most circumstances adaptive, that behavior is normally determined by the combined influence of both systems, and that, depending on circumstances and individual differences, one or the other system may exert a greater influence on behavior in any particular situation, and that one or the other may be more effective.

Positive and Negative Incentives

In support of hypothesis, subjects made fewer nonoptimal responses on lose than on win trials. This is of interest because, from a completely rational, objective perspective, there was absolutely no difference in the effect on net earnings of win and lose trials. Thus, the effect must be attributed to the subjective meaning of winning and losing to the subjects. It will be recalled that the hypothesized difference was based on two considerations. One was that associations to losing are more highly motivating than associations to winning, which is consistent with a wide variety of previous research and theorizing (e.g., Anderson, 1965; Birnbaum, 1972; Fiske, 1980; Kahneman & Tversky, 1982b, 1984; Kanouse & Hanson, 1972; Meyerowitz & Chaiken, 1987). The second reason, which may not be independent of the first, was that research has demonstrated that positive affect favors spontaneous, intuitive processing (see review in Isen et al., 1982).

In any event, whatever the explanation, the findings suggest an interesting generalization with respect to the interaction of the experiential and rational systems that can be tested in future research. Namely, when subjects are carefree and happy or confronted with positive outcomes, they are more apt to process information in the mode of the experiential system, and when they are distressed or preoccupied with avoiding negative outcomes, they are more apt to process information in the mode of the rational system. This has implications for individual differences as well as for situational effects, for it suggests that depression may be associated with a reduction of processing in the mode of the experiential relative to the rational system, which should be manifested in a diminution in the ratio-bias effect as well as in other kinds of nonrational, heuristic processing.
Magnitude of Incentive

The influence of the magnitude of the incentive on the balance between the rational and experiential systems was more complicated than anticipated. Rather than a common effect across subjects, a significant interaction was found between gender and incentive on nonoptimal responses. Women made fewer nonoptimal responses in the high- than in low-incentive condition, whereas men exhibited an opposite effect. This suggests that there are important individual differences in the effect of incentive on the relative influence of the experiential and rational systems. Until the interaction is replicated, however, it is idle to speculate on its significance. We are currently conducting a replication study with a larger group of men than the small sample investigated in the second study.

Generality of Heuristic Processing

Generality of heuristic processing is of importance to CEST because it is relevant to the operation of the experiential system. CEST assumes that generality exists in both rational and experiential modes of processing, but that processing in the mode of the experiential system is more context-specific. Evidence in support of these two hypotheses was provided by the internal consistency reliability coefficients of responses to the 11 vignettes that constitute a general scale of heuristic processing. Internal consistency reliability coefficients reflect the degree of generality, or homogeneity, of responding across the items in a scale. For heuristic responses from a self-orientation and from an other orientation (both assumed to be in the domain of the experiential system), the internal consistency reliability coefficients were moderate, whereas from a rational orientation they were high. These findings are consistent with hypothesis and replicate the findings from a previous study (Epstein et al., 1993).

A significant direct relation was found between ratio-bias responses to a laboratory task and ratio-bias responses to the vignettes. There was also a significant correlation of responses to the ratio-bias vignettes and reports of gambling in everyday life, suggesting some degree of generality in the ratio-bias phenomenon beyond the specific domain of the phenomenon itself. However, responses to the ratio-bias vignettes were unrelated to responses to the broader domain of heuristic responses to other kinds of vignettes, which suggests that their generality is highly limited. Ratio-bias vignettes are apparently unique with respect to a more general factor of heuristic processing. It remains for future research to more extensively map out the degree of generality of heuristic processing within and across different domains.

To What Extent Can the Findings Be Said to Support CEST?

The fact that the various findings in the two studies reported here were consistent with hypotheses derived from CEST does not, of course, rule out the possibility that alternative explanations can account for the observations, particularly single ones, as well as CEST. Rather than assuming two modes of processing, for example, it might be argued that subjects were trying to come to grips with two simultaneous mental representations derived from a single processing mode, namely that one bowl has a higher absolute number, and the other a higher percentage, of winners. However, assuming this is true, there remains the problem of explaining why many subjects experienced a conflict between choosing between the two kinds of judgment and did not simply select the response they knew was more reasonable.

Another criticism that might be leveled against the explanation we offered of the ratio-bias phenomenon follows from our assumption that the main reason for the phenomenon is that subjects, under the influence of the concretive principle, attend to the absolute number of winning beans and ignore the ratios (as they themselves report). The argument might be made that it is no less concrete to attend to the jelly beans in the denominator than to those in the numerator of the probability ratio. There are three reasons why we believe this argument is incorrect. One is that the red jelly beans are attended to more than the white ones because they are more salient, standing out as figure against ground. The second is that the red beans are the object of immediate motivational interest, whether the concern is with selecting them or avoiding them. Both of these effects are mediated by attention. If subjects do not attend as much to the white beans, they cannot be as significant a factor in their responses; that is, they exist as objective, but not as effective, stimuli. The third is that larger numbers, as in the denominator, in that they are less articulated in memory, are in fact more abstract than smaller numbers (for more extensive discussions of this issue, see Denes-Raj et al., 1993, and Kirkpatrick & Epstein, 1992). Undoubtedly, other criticisms of our position are possible, and other explanations can be provided. So far, the only other explanation that has been offered for the ratio-bias phenomenon is the one by norm theory (Miller et al., 1989), which assumes that the phenomenon is demonstrable only with postoutcome processing. However, two series of studies have demonstrated that this does not appear to be true (Denes-Raj et al., 1993; Kirkpatrick & Epstein, 1992). It remains to be seen whether other more viable explanations will be forthcoming.

More specifically, the challenge for alternative accounts is to provide a more comprehensive and compelling explanation for the following findings:

1. People judge the likelihood of the occurrence of an unlikely event as greater when the probability ratio is presented in the form of larger than of smaller numbers (Denes-Raj et al., 1993; Kirkpatrick & Epstein, 1992; this study). They do this to the extent that they are willing to pay to choose between equal probabilities represented by different numbers, and a considerable number even prefer a ratio that is only half as favorable as another when the former is presented in the form of larger numbers.

2. Not only do people do this in indirect tests in which different subjects judge the two ratios (Miller et al., 1989), but they also do it in direct comparisons of the ratios and exhibit the ratio-bias phenomenon despite having the option of reporting that there is no difference between the two ratios, and despite recognizing that their responses are irrational (Denes-Raj et al., 1993; Kirkpatrick & Epstein, 1992).

3. The phenomenon is exhibited more strongly in laboratory situations with significant consequences at stake than in simu-
lated situations with nothing at stake (Epstein, 1993; Kirkpatrick & Epstein, 1992).

4. The phenomenon is more strongly exhibited in response to vignettes when subjects report how they believe others would respond than when they report how they, themselves, would respond, or than how they actually do respond in some laboratory situations (Denes-Raj et al., 1993; Kirkpatrick & Epstein, 1992).

5. The phenomenon is more strongly exhibited on "win" than on "lose" trials. Despite win and lose trials contributing identically to the amount of money that is won, subjects make fewer nonoptimal responses on lose than on win trials (this study).

6. People commonly report a conflict between two beliefs, one that they identify as rational or objective, and that reflects their understanding of objective probabilities, and another that they identify as irrational (about which they are often apologetic), but which most find more compelling (Denes-Raj et al., 1993; Kirkpatrick & Epstein, 1992; this study).

7. There are reliable individual differences in the degree to which people engage in intuitive-experiential relative to analytical-rational processing of information as indicated in self-report questionnaires and in responses to a wide variety of vignettes (Donovan & Epstein, 1993; Epstein, 1993; Epstein et al., 1993).

8. Although processing in both modes is somewhat general, processing in the mode of the experiential system (i.e., intuitive-heuristic processing) is more context specific than processing in the mode of the rational system (Donovan & Epstein, 1993; Epstein et al., 1993).

The above findings, we believe, are of considerable interest in their own right. Attempts to explain them and to improve the explanations through investigation will hopefully lead to refinements in theory and method that will enhance our understanding of human irrationality.

References


Lichtenstein, S., & Slovic, P. (1973). Response-induced reversals of pref-


Received May 24, 1993

Revision received November 15, 1993

Accepted November 22, 1993