# The Generality of the Ratio-Bias Phenomenon

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*A well-substantiated, surprising finding is that people judge the occurrence of an event of low probability as less likely when its probability is represented by a ratio of smaller (e.g., 1 in 20) than of larger (e.g., 10 in 200) numbers. The results of three experiments demonstrated that the phenomenon is broadly general and occurs as readily in pre- as in postoutcome judgments. These results support an interpretation in terms of subjective probability, as suggested by the principles of cognitive-experiential self theory, but not an interpretation in terms of imagining counterfactual alternatives, as proposed by norm theory.*

A well-substantiated, surprising finding is that people judge an unlikely event as less likely or more surprising when its probability is presented in the form of equivalent ratios of smaller (e.g., 1 in 20) than of larger (e.g., 10 in 200) numbers. We conducted three experiments to examine the generality of this finding, which we will refer to as the *ratio-bias* phenomenon. In addition to its generality, we were concerned with whether the phenomenon occurs more readily in situations requiring postoutcome than preoutcome processing, as suggested by Miller and his associates (Miller, Turnbull, & McFarland, 1989). This variable is of special importance because of its relevance for alternative explanations that have been offered for the phenomenon. Accordingly, each of the scenarios was presented in matched pre- and postoutcome versions.

Before proceeding further, it will be helpful for the reader to consider how he or she would respond to the following two versions of a vignette introduced by Miller and his associates (Miller et al., 1989, p. 583) that differ in one minor detail: whether the probability of the unlikely event is presented in the form of an equivalent ratio of smaller (e.g., 1 in 20) or of larger (e.g., 10 in 200) numbers. As you read the vignette, consider how, if at all, this difference would affect your judgment about whether the outcome was a chance occurrence or provides grounds for suspicion about the child protagonist's behavior. Next, consider how you think most people would respond to this question. Following is the vignette, with the information from the alternative version in parentheses:

> Imagine that you have a young child who loves chocolate chip cookies. Imagine further that you buy cookies in packages that include oatmeal as well as chocolate chip cookies. Your child's practice is to go to the cookie jar and select the chocolate chip cookies, leaving the oatmeal ones to go stale. One day you think of a strategy to cope with the situation. 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. The jar contains 1 (10) chocolate chip cookie(s) and 19 (190) oatmeal cookies. Shortly, he comes back, exclaiming that he did just what you said and he selected a chocolate chip cookie.

From a rational perspective, the absolute number of chocolate chip cookies should, of course, make no difference. All that should matter is the ratios, which are identical. Yet, Miller and his associates (1989) found that people were more suspicious that cheating had occurred when the child obtained the only chocolate chip cookie that was available, and they verified this finding in four other studies using different vignettes that represented

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variations on the same theme (Miller et al., 1989). The experimental design employed by Miller and his associates was an indirect, or between-subjects, one, in which different subjects reported their suspiciousness in the two versions of each vignette. We found we could reproduce the phenomenon with a within-subjects design, in which subjects judge the relative likelihood of two events, one represented by a probability ratio in the form of smaller, and the other in the form of larger, numbers (Denes-Raj & Epstein, in press; Kirkpatrick & Epstein, 1992).

## EXPLANATIONS OF THE RATIO-BIAS PHENOMENON

Why should many individuals feel (subjectively believe) that the occurrence of 1 event out of 20 is less likely than the occurrence of 10 events out of 200, particularly when they know that the objective probabilities are identical? We consider two explanations, one proposed by norm theory (NT) and the other by cognitive-experiential self theory (CEST).

*The norm-theory explanation.* Miller and his associates (Miller et al., 1989) explained their findings by the principles of norm theory (NT), according to which individuals engage in postoutcome *counterfactual thinking*—that is, the imagining of alternatives following unfavorable outcomes (Kahneman & Miller, 1986). In a theoretical article in which they introduced NT, Kahneman and Miller (1986) stated that "the central idea is that norms are computed after the event rather than in advance" (p. 136). For Miller and his associates, this assumption is a basic premise in their explanation of the ratio-bias phenomenon, leading them to conclude that the phenomenon cannot be demonstrated with preoutcome processing.

Kirkpatrick and Epstein (1992) noted several problems with the NT explanation. For present purposes, we need consider only one—namely, that Miller and his associates had not effectively ruled out a subjective-probability interpretation of their results, as the control condition they employed in their experiments was better suited for evaluating subjects' objective than their subjective probability estimates. According to CEST, and verified by research (Denes-Raj & Epstein, in press; Kirkpatrick & Epstein, 1992), it is possible to entertain two different estimates of probability at the same time, an objective estimate in the rational system and a subjective estimate in the experiential system. Epstein and his associates (Denes-Raj & Epstein, in press; Kirkpatrick & Epstein, 1992) demonstrated that, in at least one condition, the ratio-bias phenomenon can be demonstrated with preoutcome assessments of subjective probability, despite its absence in assessments of objective probability.

*The cognitive-experiential self theory explanation.* CEST assumes the existence of two systems for processing information, rational and experiential, each operating by its own principles. It is beyond the scope of this article to provide a thorough description of the distinguishing features of the two systems, which can be found elsewhere (e.g., Epstein, 1991; Epstein, Lipson, Holstein, & Huh, 1992). For present purposes, we need concern ourselves with only two of the principles of the experiential system, the concretive and the experiential principle.

According to the concretive principle, the experiential system encodes events in the form of concrete representations and is, accordingly, particularly responsive to such representations. As a consequence, it is more responsive to frequencies as than to ratios, as the former are more concrete. The experiential system also comprehends smaller numbers better than larger numbers because smaller numbers are more concrete in the sense that they are easier to visualize, a conventional test of concreteness (Paivio, 1986). For the same reason, it is able to comprehend ratios between smaller numbers better than ratios between larger numbers. It follows from these considerations that the subjective probability of an infrequent event should be judged greater when the same probability ratio is presented in the form of larger, as contrasted with smaller, numbers. For example, the likelihood of drawing a desired red bean when there are 10 red beans among 90 white beans should be judged to be greater by the experiential system than when there are 1 red bean and 9 white beans. The reason is that the former condition offers more red beans, which makes it seem more probable that one can be obtained, and because an unfavorable probability ratio of 1 in 10 is more comprehensible and therefore more compelling with respect to the improbability of drawing a red bean than a probability ratio of 10 in 100. Support for these assumptions was obtained in previous research in which subjects reported that they responded to the numerators and ignored the denominators (Denes-Raj & Epstein, in press; Kirkpatrick & Epstein, 1992) and in preliminary research in which subjects reported they could visualize small ratios better than larger ones.

It may be objected that, according to the concretive principle, subjects could just as well attend to the denominator as to the numerator, as it is no less concrete. There are two problems with this argument. One is that the larger numbers in the denominator are, in fact, more abstract than the smaller numbers in the numerator. The other is that the items in the numerator are the object of greater concern than those in the denominator. They are the figure against which the denominator is the ground. Directing attention to the denominator requires a step back from the immediate focus on the numerator. In the sense that the denominator is more

removed from immediate attention, it is less concrete (less clearly represented in memory) than the numerator.

Although the concretive principle is sufficient to account for the ratio-bias phenomenon, there is reason to suspect that it is supplemented by the experiential principle. According to the experiential principle, the schemata in the experiential system represent, to a considerable extent, 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 some large number (e.g., 1 in 20) is highly unlikely to occur. Moreover, their experience with odds in betting situations is that odds are normally represented by a comparison of the figure 1 with a larger figure, such as "1 in 2" or "1 in 10," rather than "2 in 3" or "5 in 19." Thus, the experiential principle supplements the concretive principle in the prediction that an unusual event with a given objective probability will have a smaller subjective probability when it is represented by an equivalent probability ratio with a 1, rather than with a larger number, in the numerator.

## THE RELATIVE INFLUENCE OF POST- AND PREOUTCOME PROCESSING ON THE RATIO-BIAS PHENOMENON

In two experiments, one involving simulated situations in vignettes and the other real behavior in the laboratory, Kirkpatrick and Epstein (1992) demonstrated the ratio-bias phenomenon with preoutcome probability judgments. These findings clearly disconfirmed the NT position that the phenomenon can be obtained only with postoutcome processing and supported the alternative interpretation that the phenomenon is attributable to subjective probability estimates that are as relevant for pre- as for postoutcome assessments.

Although it has been established that there is at least one condition in which the ratio-bias phenomenon can be demonstrated with preoutcome estimates, it remains to be determined whether it is, nevertheless, more generally and/or more strongly exhibited in postoutcome processing across a variety of situations. Such a result would suggest that neither the NT nor the CEST position is sufficient and that a combination of the two may be necessary to account for the phenomenon in all situations.

To examine this issue, we conducted three experiments with matched pre- and postoutcome vignettes describing a variety of situations. Miller and his associates investigated the generality of the ratio-bias phenomenon only in postoutcome judgments (with the exception of a questionable control condition), and Kirkpatrick and Epstein examined the phenomenon only in preoutcome judgments with another kind of situation. It remained for a direct comparison to be made between the influence of pre- and postoutcome processing on the ratio-bias effect within a single investigation of matched situations, which was the major purpose of the present series of experiments.

Our investigation of three scenarios paralleled the strategy used by Miller et al. (1989) for establishing the generality of the ratio-bias phenomenon with respect to postoutcome processing by demonstrating its occurrence in vignettes with varying content. However, as already noted, in contrast to their procedure, in which different subjects received the alternative versions of each of the scenarios, we used a within-subjects design, in which subjects indicated in which of two versions of the same event they considered the subjective probability of the occurrence of a particular outcome to be greater (or to provide less reason for suspicion).

Another variable of interest in the present series of experiments was the difference between self- and other-ratings. In previous research, we found that the ratio-bias phenomenon is more readily demonstrated in ratings of others' behavior than in ratings of one's own behavior (Kirkpatrick & Epstein, 1992). Presumably, judging others' behavior is more revealing because it circumvents subjects' desire to present themselves as rational people. To replicate this observation, we had subjects in all three experiments rate how both they themselves and most people would behave if they were in the position of the protagonist in each of the scenarios.

## STUDY 1

The vignette used in this study described an impersonal, mechanical event. Subjects in the preoutcome condition were informed that a machine randomly selects a ball from a basket that contains many colored balls, and they were asked to judge the likelihood that a red ball would be selected. In the postoutcome version, they rated their suspiciousness, after the ball had been selected, that the selection had not been random.

### *Method*

*Subjects.* Subjects were 96 university students who agreed to participate when approached by one of five experimenters who inquired whether they would be willing to spend a few minutes responding to scenarios about unlikely events. Virtually everyone agreed to participate.

*Procedure.* Subjects were given one of four booklets, each presenting a pre- or a postoutcome version of the same scenario. In half the booklets in each condition, the ratio represented by the larger numbers was presented first; in the other half, the order was reversed. The booklets were systematically rotated among successive

subjects. The vignette for the preoutcome condition and the instructions for responding to it were as follows:

> Imagine two scenarios, which we shall call X and Y, in which there are colored balls in a round wire basket. A machine rotates the basket and randomly draws a single ball. In one scenario, there is one red ball among a total of a thousand balls (including the red ball). In the other, there are ten red balls among a total of ten-thousand balls (including the ten red balls). Although the proportions are identical, you might feel that the chance of a red ball being selected is less in one scenario than in the other.
>
> In which scenario would you feel there is less of a chance of the red ball being selected? (If you cannot make a choice, skip this item, and check "not at all" in the next item.)
>
> ——— in situation X (1 red ball in 1,000)
>
> ——— in situation Y (10 red balls in 10,000)
>
> To what extent would you feel that the chance of a red ball being selected is less in one condition than in the other?

Response options ranged from 0 (*not at all*) to 4 (*a great deal*).

Subjects next responded to the same questions from the perspective of how they thought "most people" would respond. A final question asked them to write the reasons for their responses. The vignette for the postoutcome condition was identical except that subjects were informed that the machine had already selected a red ball, and they were asked to indicate in which scenario, if either, they would be "more suspicious that the selection of the red ball had not been random."

Several features of the procedure warrant comment. First, although we counterbalanced for the order in which the larger and smaller numbers were presented, we elected not to counterbalance for self- and other-ratings, because previous research (Kirkpatrick & Epstein, 1992) suggested that the order we used was preferable. In the previous research, which investigated self-ratings and other-ratings in separate studies, self-ratings did not show even a tendency toward exhibiting a ratio-bias effect, whereas other-ratings produced a highly significant ratio-bias effect ($p < .001$). Therefore, as presenting other-ratings first could be expected to bias self-ratings more than the other way around, we decided against it. It should be noted that to the extent that order could influence the results, the procedure we followed was a conservative one.

Second, we provided subjects with the option of indicating that they had no preference, which has usually not been done in previous research in judgments under uncertainty that has examined comparative judgments. The advantage of including the response option "not at all" in the rating scale is that it more accurately captures subjects' judgments than forcing them to endorse a choice they do not believe in. Moreover, it made it possible to examine "objective," unbiased responses, which is not possible when subjects are forced to make a biased response in one direction or the other.

Third, as previously noted, our experimental paradigm differs from that of Miller et al. (1989) in that we used a within-subjects design and informed our subjects that the objective probabilities were identical in the two conditions. We made this fact explicit because we did not wish to confound arithmetic ability with the ratio-bias phenomenon. Having noted that the ratios were the same, we needed to give subjects a reason for making a choice. We therefore indicated that they may have a preference even though they know it is not necessarily reasonable. This simply gave them permission to acknowledge that people can have reactions that they recognize are irrational. The important point is that such rating instructions could not bias the direction of the decisions. Moreover, as already noted, subjects had the option of reporting no preference. Miller and his associates avoid this problem by using a between-subjects design, which we decided not to use because, in preliminary work, we found it to be a much weaker design for demonstrating the ratio-bias phenomenon. We found in the present study, as in previous ones (e.g., Epstein et al., 1992; Kirkpatrick & Epstein, 1992), that our subjects found the instructions reasonable and were comfortable with the idea that they and others might have irrational preferences.

Our procedure also differs from that of Miller and his associates in that they do not inform their subjects about the probabilities but simply present them with numbers (e.g., 1 vs. 19; 10 vs 190). In preliminary work, we have found that many subjects are unable to correctly convert such numbers into probability ratios. Their subjects apparently had the same difficulty, for in their cookie-jar experiment, the subjects, on average, estimated the probability of the unlikely outcome (1 vs. 19), which was actually 5%, as slightly more than 20%. Assuming that at least 50% of Princeton students can compute the correct percentage for 1 versus 19, the other 50% must have made estimates that were mathematically bizarre, which makes arithmetic ability a serious complicating factor when subjects have to estimate probabilities from the constituent numbers in the form in which Miller and his associates presented them.

The ratio-bias phenomenon was assessed by two measures in the present study. The first was an unweighted score of directional bias. This measure indicated whether subjects judged the ratio represented by the larger numbers or the equivalent one represented by the smaller numbers as lower in subjective probability before the fact (or as a source of greater suspicion after the fact)

**TABLE 1: Number of Subjects Responding in the Expected Biased Direction (EXB), in the Unexpected Biased Direction (UEB), and Objectively (OBJ), Study 1 (Mechanical Scenario)**

| | *Estimates for Self* | | | | *Estimates for Others* | | | |
|---|---|---|---|---|---|---|---|---|
| | *EXB* | *UEB* | *OBJ* | n | *EXB* | *UEB* | *OBJ* | n |
| Preoutcome condition | 13 | 10 | 25 | 48 | 30 | 10 | 7 | 47 |
| | (27%) | (21%) | (52%) | (100%) | (64%) | (21%) | (15%) | (100%) |
| Postoutcome condition | 18 | 5 | 25 | 48 | 25 | 12 | 11 | 48 |
| | (38%) | (10%) | (52%) | (100%) | (52%) | (25%) | (23%) | (100%) |
| All subjects | 31 | 15 | 50 | 96 | 55 | 22 | 18 | 95 |
| | (32%) | (16%) | (52%) | (100%) | (58%) | (23%) | (19%) | (100%) |

NOTE: Difference in number of subjects for self and others is due to missing data.

or whether they believed there was no difference. For convenience, we shall refer to judging the ratios expressed in smaller absolute numbers as lower in subjective probability (or as more suspicion arousing) as the *expected bias* (EXB), making judgments in the opposite direction as the *unexpected bias* (UEB), and judging the two representations as equally likely as an *objective response* (OBJ).

The second measure was a weighted index for degree of bias in the EXB direction. This measure weighted direction of bias by extent of preference. An endorsement of 4 in the UEB direction was assigned a weight of 1 a "not at all" response was assigned a weight of 5, and an endorsement of 4 in the EXB direction was assigned a weight of 9. This procedure transformed the data into a 9-point scale for magnitude of EXB.

It should be noted that the analyses of variance (ANOVAs) of weighted scores provide a more powerful test of the differences between the various conditions (pre- vs. postoutcome, self vs. others, and their interactions) than the analysis of the unweighted frequencies. Why, then, bother with analyzing the data in frequency terms at all? The answer is that the ANOVAs, unlike the frequency data, do not provide information on the occurrence of the basic ratio-bias phenomenon itself.

*Results and Discussion*

*Overall incidence of the ratio-bias phenomenon in self- and other-ratings.* Table 1 presents the numbers and percentages of subjects who made the various choices. It can be seen in Table 1 that 32% of subjects exhibited the ratio-bias phenomenon in their self-ratings and 58% in their ratings of others. Apparently, the ratio-bias phenomenon, though fairly common in both conditions and particularly in ratings of others, is far from ubiquitous.

*Self-ratings, frequency analysis.* Because chi-square comparisons revealed that pre- and postoutcome conditions did not differ significantly in the degree to which they elicited the ratio-bias phenomenon, the data were collapsed over these two conditions. Among the 48% of those in the combined group who exhibited biases (i.e., produced nonobjective responses), significantly more, $\chi^2(1) = 5.56$, $p < .05$, were biased in the EXB direction (67%) than in the UEB direction (33%), thereby providing evidence of the ratio-bias phenomenon.

*Ratings of others, frequency analysis.* When subjects predicted how others would respond, the results for the pre- and postoutcome conditions were again similar, and therefore the data across conditions were combined. For the combined group, 81% of subjects said that others would make biased choices, and of these, significantly more, $\chi^2(1) = 14.14$, $p < .001$, said that others' decisions would be in the EXB direction (71%) than in the UEB direction (29%).

A comparison of self- and other-ratings revealed that significantly more subjects reported that others would make biased decisions and they would not than the other way around, $\chi^2(1) = 29.12$, $p < .001$.

*Magnitude of directional ratings.* A mixed ANOVA with two levels of the between-subjects variable (pre- vs. postoutcome) and two levels of the within-subjects variable (self vs. others) of the weighted EXB variable yielded a significant main effect for self versus others, $F(1, 88) = 4.78$, $p < .05$. Subjects reported that others would exhibit a greater degree of bias ($M = 5.54$) in the EXB direction than they themselves would ($M = 5.12$). Pre- versus postoutcome processing neither produced a significant main effect nor was included in a significant interaction.

*Qualitative responses.* It will be recalled that subjects were asked to report the reasons for their responses. As the results were very similar for self- and other-ratings, only the former are reported.

Of the 17 people who gave reasons for responses in the EXB direction, 16 (94%) referred to the numbers in the numerators of the ratios and ignored the denominators. Typical responses were "Although logic tells me that the chances are the same, it seems to me that if there is only one red ball there are greater odds against it being selected"; "Because there is only one red ball, it would really be weird if that ball was chosen."

*Conclusions.* It may be concluded that biased processing in the EXB direction (the ratio-bias phenomenon) can be demonstrated in a simple, impersonal, mechanical situation, that under such circumstances it is fairly prevalent but far from universal, that it occurs no less in pre- than in postoutcome processing conditions, and that it occurs to a greater extent when subjects report how others would respond than when they report how they would respond.

## STUDY 2

The vignette in Study 2 described a situation in more vivid and personalized detail than the one in Study 1 by referring to a protagonist, "Ralph," who strongly desired a favorable outcome. Under these circumstances, there was a motive for foul play, which could provide a basis for an interpretation of improper behavior before the fact or for suspiciousness after the fact.

### *Method*

Ninety-seven students were tested under identical conditions to those in the first study. The vignette for the preoutcome condition was as follows:

> 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. Ralph asks your advice about which lottery to buy. Although you know the proportions are identical, you may have the feeling that it is less likely that Ralph will get a winning number in one lottery than in the other.

Subjects were asked to indicate how they would advise Ralph about which lottery, if either, they thought was more likely to produce a winning ticket and the degree to which they believed this was true. They were then asked to rate how they believed most people would advise Ralph and to give the reasons for their ratings. Next they rated their degree of preference for one lottery over the other, which included the choice of no preference.

The vignette for the postoutcome condition was identical except that subjects were informed that Ralph had already won the lottery and were asked to judge in which scenario, if either, they and most people would be more suspicious that the lottery had not been completely honest and the degree to which they and most people would be more suspicious.

### *Results and Discussion*

*Overall incidence of the ratio-bias phenomenon in self- and other-ratings.* It can be seen in Table 2 that 36% of subjects exhibited the ratio-bias phenomenon in their self-ratings and 54% in their ratings of others. Again, it was indicated in a relatively simple situation that about a third of the subjects exhibited the ratio-bias phenomenon in their self-ratings and about half in their ratings of others.

*Self-ratings, frequency analysis.* Because chi-square comparisons revealed that pre- and postoutcome conditions did not differ significantly in the degree to which they elicited the ratio-bias phenomenon, the data were collapsed over these two conditions. Of the 57% of subjects who exhibited biased processing in their self-ratings, significantly more (64% vs. 36%) believed that Ralph had a better chance of winning (or were less suspicious) in the case of the lottery that offered 10 winning numbers than in the one that offered a single winning number, $\chi^2(1) = 4.09$, $p < .05$. The data therefore provide evidence of the statistical reliability of the ratio-bias phenomenon.

*Ratings of others, frequency analysis.* Because the difference between pre- and postoutcome processing for other-ratings did not approach significance, the data for the two conditions were combined. Among the 80% of subjects who reported biased processing in their other-ratings, significantly more (67% vs. 33%) reported that others would exhibit bias in the EXB than in the UEB direction, $\chi^2(1) = 8.90$, $p < .01$.

Ratings of others were significantly more biased than ratings of the self, $\chi^2(1) = 15.13$, $p < .001$. More subjects reported that others would make biased decisions and they would not ($n = 27$) than the other way around ($n = 5$).

*Magnitude of directional ratings.* The ANOVA of magnitude of EXB bias responses produced a significant effect for self versus others, $F(1, 91) = 6.42$, $p < .01$, and no other significant effect. Consistent with the frequency data, ratings of others ($M = 5.59$) exhibited greater bias in the EXB direction than self-ratings ($M = 5.12$). Pre- versus postoutcome judgment was significant neither as a main effect nor in interaction with self-versus-others.

*Qualitative responses.* As the results for the self- and other-comments were highly similar, only the former will be reported. Of the 22 people who gave reasons for their responses in the EXB direction, 16 (73%) referred to the numbers in the numerators of the ratios and ignored the denominators. The remaining responses were classified as miscellaneous or unscorable. Two of these referred to the personality characteristics of the protagonist, such as whether he was the kind of person who would cheat under the circumstances.

**TABLE 2: Number of Subjects Responding in the Expected Biased Direction (EXB), in the Unexpected Biased Direction (UEB), and Objectively (OBJ), Study 2 (Lottery Scenario)**

| | *Estimates for Self* | | | | *Estimates for Others* | | | |
|---|---|---|---|---|---|---|---|---|
| | *EXB* | *UEB* | *OBJ* | n | *EXB* | *UEB* | *OBJ* | n |
| Preoutcome condition | 18 | 9 | 20 | 47 | 22 | 14 | 11 | 47 |
| | (38%) | (19%) | (43%) | (100%) | (47%) | (30%) | (23%) | (100%) |
| Postoutcome condition | 17 | 11 | 22 | 50 | 29 | 11 | 8 | 48 |
| | (34%) | (22%) | (44%) | (100%) | (60%) | (23%) | (17%) | (100%) |
| All subjects | 35 | 20 | 42 | 97 | 51 | 25 | 19 | 95 |
| | (36%) | (21%) | (43%) | (100%) | (54%) | (26%) | (20%) | (100%) |

NOTE: Difference in number of subjects for self and others is due to missing data.

Typical responses of those who exhibited the ratio-bias effect were "The idea of just one winner seems less hopeful than when there are more"; "I would find it more believable that the lottery was fixed if the only winner was chosen. With more winners, it seems less likely that it had to be fixed for a winner to get chosen."

*Conclusions.* The findings closely replicate those from the previous study with respect to the overall incidence of the ratio-bias phenomenon, the absence of a significant difference between pre- and postoutcome conditions, and the greater extent to which the phenomenon is exhibited in other- than in self-ratings.

## STUDY 3

In the interest of examining differences in pre- and postoutcome processing over a wide range of conditions, we constructed a scenario in Study 3 that described an intensely emotion-arousing event—the development of AIDS in a loved one.

### *Method*

Ninety-seven students were tested in the identical manner as in the previous studies. The vignette for the preoutcome condition was as follows:

> Imagine a situation in which you are watching TV late one night when you are startled by the telephone ringing. The caller says he is a policeman with unfortunate news to report. You learn that the person you love most in your life has been in an automobile accident and is in critical condition in a hospital. In desperation, you rush to the hospital. When you arrive there, the physician in charge of the case informs you that your loved one is in a coma, and needs an immediate blood transfusion.
>
> You are asked to choose between samples from two blood banks, both of which have a rate of HIV transmission that is barely acceptable, but they are the only samples available at the moment. One has a record of one HIV positive case out of a thousand transfusions and the other has a record of ten HIV positive cases out of ten thousand transfusions. You know that the proportions are identical, but somehow you may feel that the chance of transmission is greater in one sample than in the other.

Subjects were asked to indicate in which sample, if either, they thought there was a greater likelihood of HIV contamination and the degree to which they believed this was true. They were then asked to indicate how they thought most people would rate the situations and to give their reasons for their ratings.

The first paragraph of the vignette for the postoutcome condition was identical to that in the preoutcome condition. The second paragraph read as follows:

> Now imagine two different scenarios. In one, your loved one is given a transfusion from a blood bank with a record of one HIV positive case out of one thousand administrations. In the other, the blood comes from a blood bank that has a record of ten HIV positive cases out of ten thousand administrations. A year later, your loved one tests HIV positive. You are, of course, suspicious that the HIV positive condition was caused by the transfusion. You know that the proportions are identical, but somehow you may feel more suspicious in one case than in the other.

Subjects indicated in which situation, if either, they would be more suspicious and the degree to which that would be the case. They then rated how most people would rate the situations. Next, they reported the reasons for their choices.

### *Results and Discussion*

*Overall incidence of the ratio-bias phenomenon in self- and other-ratings.* It can be seen in Table 3 that 22% of the subjects exhibited the ratio-bias effect in their self-ratings and 51% in their ratings of others. Thus, as in the other studies, about half the subjects exhibited the phenomenon in their ratings of others, and a substantial minority exhibited it in their self-ratings.

**TABLE 3: Number of Subjects Responding in the Expected Biased Direction (EXB), in the Unexpected Biased Direction (UEB), and Objectively (OBJ), Study 3 (HIV Scenario)**

| | *Estimates for Self* | | | | *Estimates for Others* | | | |
|---|---|---|---|---|---|---|---|---|
| | *EXB* | *UEB* | *OBJ* | n | *EXB* | *UEB* | *OBJ* | n |
| Preoutcome condition | 12 | 8 | 28 | 48 | 26 | 11 | 11 | 48 |
| | (25%) | (16%) | (58%) | (100%) | (54%) | (23%) | (23%) | (100%) |
| Postoutcome condition | 9 | 8 | 33 | 50 | 24 | 8 | 18 | 50 |
| | (18%) | (16%) | (66%) | (100%) | (48%) | (16%) | (36%) | (100%) |
| All subjects | 21 | 16 | 61 | 98 | 50 | 19 | 29 | 98 |
| | (22%) | (16%) | (62%) | (100%) | (51%) | (19%) | (30%) | (100%) |

*Self-ratings, frequency analysis.* As the number of subjects who made biased self-ratings in the EXB relative to the UEB direction did not differ significantly in the pre- and postoutcome conditions, the data from the two conditions were merged.

Of the 38% of subjects who made biased decisions, the difference between the number who chose in the EXB direction (57%) and those who chose in the UEB direction (43%) was in the expected direction but not significant, $\chi^2(1) < 1$.

*Ratings of others, frequency analysis.* As the number of subjects who made biased other-ratings in the EXB relative to the UEB direction did not differ significantly in the pre- and postoutcome conditions, the data from the two conditions were merged. The majority of subjects (70%) believed that others would make biased decisions. Among them, significantly more reported that others would choose in the EXB (72%) than in the UEB (28%) direction, $\chi^2(1) = 13.93$, $p < .001$, thereby indicating a strong ratio-bias effect.

Significantly more subjects, $\chi^2(1) = 24.20$, $p < .001$, reported that others would make irrational decisions and they would not ($n = 39$) than the other way around ($n = 6$).

*Magnitude of directional ratings.* The ANOVA of weighted EXB responses produced a significant effect for self versus others, $F(1, 92) = 9.24$, $p < .01$. There was greater bias in the EXB direction for other-ratings ($M = 5.40$) than for self-ratings ($M = 5.02$). Pre- versus postoutcome processing was significant neither as a main effect nor in interaction with self-versus-others.

*Qualitative responses.* As the qualitative results were similar for self- and other-ratings, only results for the former will be reported. Of the 11 people who gave reasons for their responses in the EXB direction, 9 (82%) referred to the numbers in the numerators of the ratios and ignored the denominators. Typical responses were "Ten sounds a whole lot more than one" and "Although the odds are the same, 1 case is much less than 10 cases."

*Conclusions.* The findings supported the ratio-bias phenomenon for the other-ratings and exhibited a nonsignificant tendency in the same direction for the self-ratings. Thus, the overall findings are consistent with those from the previous two studies in providing evidence for the ratio-bias phenomenon. As in the other studies, no significant difference was found for the ratio-bias phenomenon in the pre- and postoutcome conditions, and the prevalence of the phenomenon was greater when subjects reported how others would respond than when they reported how they themselves would.

## GENERAL DISCUSSION

The major purpose of the present series of experiments was to examine the generality of the ratio-bias phenomenon and, more particularly, to determine whether the phenomenon occurs differentially in pre- and postoutcome processing, and occurs more strongly in other- than in self-ratings. We first discuss the generality issue and then consider the implications of our pre- versus postoutcome findings.

### *Generality of the Ratio-Bias Phenomenon*

The overall evidence suggests that the ratio-bias phenomenon is a highly general phenomenon. The basic phenomenon has by now been replicated across a wide variety of conditions, including vignette studies with between- and within-subjects designs and pre- and postoutcome judgments, as well as laboratory studies with real rewards (e.g., Denes-Raj & Epstein, in press; Epstein, Denes-Raj, & Heier, 1994; Kirkpatrick & Epstein, 1992; Miller et al., 1989; the present series of studies).

Although the ratio-bias phenomenon has been demonstrated to be highly general across a variety of situations, this does not mean that it is ubiquitously exhibited across situations and subjects. A variable that has consistently been demonstrated to be important in influencing the ratio-bias phenomenon is self- versus other-ratings (Kirkpatrick & Epstein, 1992; the present three studies). Most people believe they are more ra-

tional than others and, accordingly, assume that others will exhibit a ratio-bias effect more than they will. This finding is consistent with the assumption in CEST that there are two systems, experiential and rational. People assume that others process information mainly in the mode of the experiential system whereas they, as rational people, react more in accordance with the principles of the rational system.

Another parameter that has been demonstrated to exert an important influence on the ratio-bias phenomenon is whether the test of the phenomenon is based on people's reactions to real situations with significant consequences or to simulated situations, as in responses to vignettes. Considerably stronger ratio-bias effects have been observed in the former than in the latter condition (Kirkpatrick & Epstein, 1992). This finding is consistent with the experiential principle of CEST, according to which the experiential system derives its schemata from repetitive or emotionally significant experiences in living and is therefore apt to be particularly strongly engaged in real situations with meaningful consequences.

Turning to individual differences: In the present series of studies, typically about 30% of the subjects exhibited the ratio-bias phenomenon in their self-ratings and about 60% in their ratings of others. A considerable number, therefore, did not exhibit the phenomenon. A fundamental assumption in CEST is that individuals differ in the degree to which they rely on processing in the mode of the experiential relative to the rational system (Epstein et al., 1994). Thus, the observation that some, but not all, subjects responded heuristically is completely in accord with this assumption.

*Pre- Versus Postoutcome Processing*

There was no significant difference between pre- and postoutcome processing in any of the situations examined, which included a simple, impersonal situation that involved a presumably random selection by a mechanical device. It may be concluded that the results of the present series of studies are inconsistent with the NT explanation that the ratio-bias phenomenon is the result of the postoutcome imagining of counterfactual alternatives and, accordingly, cannot be obtained in situations that require preoutcome processing. The results are in accord with the CEST position, which attributes the ratio-bias phenomenon to subjective-probability assessments that are equally applicable to pre- and postoutcome processing. The greater subjective probability of events that are represented by probability ratios in the form of larger numbers than of smaller numbers is explained in CEST by two principles, the concretive principle and the experiential principle, described earlier.

The qualitative data in the present study provide some support for both these principles. People who exhibited the ratio-bias effect said they attended to the frequencies in the numerator and ignored the relations between the numerators and the denominators (the ratios)—a response consistent with the concretive principle. They also reported that they believed it was particularly unlikely that the only item of a particular kind would be selected from a larger number of other kinds of items—a response consistent with the experiential as well as the concretive principle.

*Self-Ratings Versus Ratings of Others*

In the present series of studies as well as in previous studies (Kirkpatrick & Epstein, 1992) in which subjects responded from both a self- and an other-perspective, the ratio-bias phenomenon was considerably stronger when subjects responded from an other-perspective. In order to attribute ratio-bias responses to others, subjects, of course, have to know somehow that such responses are intrinsically appealing. They could readily become aware of this by detecting such tendencies in themselves, which some, in fact, acknowledged they did. As further evidence in support of the assumption that subjects have impulses to respond in the direction of the ratio-bias phenomenon, that is how most of them responded in a real situation with money at stake (Denes-Raj & Epstein, in press; Kirkpatrick & Epstein, 1992). The motivation to secure the money apparently overrode the demand characteristic to present themselves as rational.

There are some important methodological lessons to be learned from the differences between self- and other-ratings. One is that results can be significantly affected by whether subjects are asked to respond to vignettes from their own or the protagonist's perspective. Moreover, it is important to indicate whom the protagonist should represent (e.g., "most people," "the average person") to reduce extraneous variance that may result when subjects identify the protagonist in different ways.

In past research on heuristic processing, the importance of a distinction between a self- and an other-orientation has generally been overlooked. Some investigators have used one procedure and others the other, and some have used one on one occasion and the other on other occasions. It is unknown whether and how such differences affected the results. In one series of studies, in which we examined a different kind of heuristic processing (the "if only" effect), we obtained similar results when subjects responded from the two orientations (Epstein et al., 1992). However, in other research (Epstein, Pacini, Denes-Raj, & Heier, 1995; Kirkpatrick & Epstein, 1992), including the present series of experiments, we found it does matter. It may be concluded that responding from a self- versus other-orientation is an important parameter that should be taken into account in both the design and the interpretation of research.

## NOTE

1. The reason for having subjects indicate how they would advise the protagonist, rather than having them report how they themselves would react, was to make the pre- and post-outcome conditions as parallel as possible. In the judgments of suspiciousness (the postoutcome condition), subjects judged how suspicious they were of the possible complicity of someone else. To hold this aspect of the rating task constant, subjects in the preoutcome condition were also asked to respond in terms of their reaction to someone else (i.e., advising the protagonist on how to choose).

## REFERENCES

Denes-Raj, V., & Epstein, S. (in press). Conflict between experiential and rational processing: When people behave against their better judgment. *Journal of Personality and Social Psychology.*

Epstein, S. (1991). Cognitive-experiential self-theory: An integrative theory of personality. In R. Curtis (Ed.), *The relational self: Convergences in psychoanalysis and social psychology* (pp. 111-137). New York: Guilford.

Epstein, S., Pacini, R., Denes-Raj, V., & Heier, H. (1995). *Individual differences in heuristic processing.* Manuscript submitted for publication.

Epstein, S., Lipson, A., Holstein, C., & Huh, E. (1992). Irrational reactions to negative outcomes: Evidence for the two conceptual systems. *Journal of Personality and Social Psychology, 62,* 328-339.

Kahneman, D., & Miller, D. T. (1986). Norm theory: Comparing reality to its alternatives. *Psychological Review, 93,* 136-153.

Kirkpatrick, L., & Epstein, S. (1992). Cognitive-experiential self-theory and subjective probability: Further evidence for two conceptual systems. *Journal of Personality and Social Psychology, 63,* 534-544.

Miller, D. T., Turnbull, W., & McFarland, C. (1989). When coincidence is suspicious: The role of mental simulation. *Journal of Personality and Social Psychology, 57,* 581-589.

Paivio, A. (1986). *Mental representations: A dual-coding approach.* New York: Oxford University Press.

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