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Elimination of the Hindsight Bias in Individual Versus Group Decision Making

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ELIMINATION OF THE HINDSIGHT BIAS IN INDIVIDUAL
VERSUS GROUP DECISION MAKING

BY

HOLLY ANNE SINDELAR

A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
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IN
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2000

Abstract

The *hindsight bias* refers to the tendency of people, after an event, to overestimate how accurately they would have predicted the outcome had they been asked in advance. The consequences of the hindsight bias on clinical decision making are significant. The bias is believed to impede one's ability to learn from experience and to lead to an undue level of confidence in future decision making. Research has shown that, under some conditions, groups have been shown to be less susceptible to bias than individual decision makers. The hindsight bias also has been found to be attenuated under certain conditions involving an increase in cognitive effort. The current investigation sought to answer the following questions: (a) Will groups demonstrate less hindsight bias in their decision-making efforts than individuals?, and (b) Can the hindsight bias be reduced in groups similar to previous results among individual decision makers? Undergraduate students ($N = 180$) read two case vignettes, either as individuals or in groups and predicted outcome probabilities, either with the benefit of outcome information or without. Half of the participants provided with outcome information were also asked to complete a counterfactual reasoning task. Data were analyzed using the binomial sign test and with multivariate analyses of covariance statistics (MANCOVA) with deliberation time included as a potential covariate. Nonparametric analyses indicated that groups were just as susceptible to the hindsight bias as individuals. The hindsight bias could not be eliminated using a counterfactual reasoning task. Implications of the results are discussed along with suggestions for future research.

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Hindsight Bias

Hindsight is the means by which we are all able to see, after an event, what should have been done. It is not difficult to evaluate a situation or circumstance once it has come to pass, hence, the adage "hindsight is 20/20." In the present, however, we are continually making decisions under conditions of uncertainty. We cannot know ahead of time how the future will play out. So, in the moment, we weigh the pros and cons of deciding one way or the other, we make our choice, and we wait to see whether the outcome will be positive or negative. In advance, we can only predict what the outcome might be.

The *hindsight bias*, or the "knew-it-all-along" effect, refers to the tendency of people, after an event, to overestimate the likelihood that they correctly would have predicted the outcome's occurrence had they been asked in advance (Arkes, Faust, Guilmette, & Hart, 1988). In other words, once an event has occurred, we are generally unable to return to our "foresightful" state of mind. We cannot ignore what we know has already happened. Thus, hindsight appears to be somewhat myopic, rather than 20/20.

The consequences of the hindsight bias on subsequent decision making are significant. The bias is believed to impede one's ability to learn from experience and to lead to an undue level of confidence in future decision making. That is, if we remember being more correct than we actually were, then we will not only fail to learn from our inaccuracies, but we will be lulled into a false sense of confidence in our ability to predict the outcome of events. Overconfidence is, in fact, another biasing factor in human decision making in its own right. The hindsight bias is just one expression of the overconfidence that has been demonstrated across a broad range of

judges and decision tasks (Arkes et al., 1988). Research has demonstrated, for example, that confidence in judgment increases as more information is reviewed, although judgment accuracy is not likewise improved (Oskamp, 1965).

Overconfidence has also been found to lead to insufficient consideration of alternative possibilities and to premature closure in the decision process, thus further decreasing judgment accuracy (see Fischhoff, 1982, for an overview).

The hindsight bias was first empirically documented by Fischhoff (1975), and a steady stream of research has been conducted on the hindsight bias in the over 20 years since his work was first published. A meta-analysis of the hindsight bias effect was conducted by Christensen-Szalanski and Willham (1991). They analyzed 122 empirical studies with calculable effect sizes and found the average weighted effect size to be small, but statistically significant (corrected $r = .21$ to $.29$). To date, the hindsight bias has been documented in a variety of contexts and with an array of participants from many walks of life. The following is a review of the empirical research currently available on the hindsight bias effect.

Research Findings

As noted, numerous laboratory studies investigating the hindsight bias have shown that there is a significant, reliable effect of outcome information on subsequent probability judgments (Hawkins & Hastie, 1990). The hindsight bias effect has been investigated in a variety of sample populations. As with much laboratory research, the vast majority of empirical studies (more than 40) have been conducted with college and university undergraduate students (for examples see Fischhoff, 1975; Hasher, Attig, & Alba, 1981; Kamin & Rachlinski, 1995; Ofir & Mazursky, 1997). Other sample populations that have been studied include: graduate students, primarily in

business fields (Brown & Solomon, 1987; Buchman, 1985; Bukszar & Connolly, 1988; Connolly & Bukszar, 1990; Hoch & Loewenstein, 1989; Mitchell & Kalb, 1981); judges and jurors (Anderson, Lowe, & Reckers, 1993; Casper, Benedict, & Perry, 1989); nurses, physicians and surgeons (Arkes et al., 1981; Detmer, Fryback, & Gassner, 1978; Jones, 1995); neuropsychologists (Arkes et al., 1988); cognitive psychologists (Pohl & Hell, 1996); community residents (LaBine & LaBine, 1996; Mark & Mellor, 1991; Verplanken & Pieters, 1988); university football fans (Leary, 1981; Roese & Maniar, 1997); and high school students (Stahlberg et al., 1995).

The main effect found in studies of hindsight bias is that of outcome information. If participants are asked to predict the outcome of an event prior to its occurrence, they generally give moderate estimates that are consistent with base rates, or the general odds, for the event. If people are asked after an event's occurrence to remember their original prediction (i.e., memory design) or to make predictions as if they did not know the outcome (i.e., hypothetical design), however, they consistently skew their predictions toward the actual outcome, demonstrating that their responses are affected by the outcome information they have received. In addition, these individuals routinely report having more confidence in their ratings and claim to have had more information to make their decision than their foresight counterparts, even when the same people are making both sets of predictions (Bodenhausen, 1990; Powell, 1988). Other factors also have been found to mediate, or interact with, the biasing effect of outcome information.

Outcome occurrence versus nonoccurrence. It generally has been found that the magnitude of the hindsight bias is higher for events that did happen than for events that did not happen (Fischhoff & Beyth, 1975; LaBine & LaBine, 1996). In a meta-

analysis of the hindsight bias effect, Christensen-Szalanski and Willham (1991) found a significant correlation between the size of the biasing effect and whether the outcome information stated that the event occurred. For example, in one of the original publications on hindsight bias by Fischhoff and Beyth (1975), individuals estimated higher probabilities in hindsight than they originally had estimated for events which they believed to have occurred. Seventy-five percent of the hindsight participants assigned higher probabilities to events they believed had happened, versus only 57% of hindsight participants who reported lower probabilities to events they believed had not happened, a difference that was statistically reliable. In another study by LaBine and LaBine (1996), individuals made determinations of negligence in Tarasoff-type cases, referring to a California court decision stating that when a therapist determines that a patient may be dangerous, the therapist has a duty to take steps to protect any potential victim. In this study, community members (i.e., potential jurors) demonstrated a higher degree of hindsight bias when the event had occurred (e.g., the patient became violent) than when the event had not occurred. Essentially, patient violence was seen as having been more foreseeable when participants were told that violence had occurred than when they were told that it had not occurred. In addition, when participants were told that the patient had become violent, the therapist's actions were seen as more negligent and less reasonable than when subjects were told that violence had not occurred.

Outcome valence. Another factor that appears to influence the degree of hindsight bias is the valence (i.e., positive or negative) of the outcome presented to participants. In general, negative outcomes lead to a hindsight bias effect of greater magnitude than when positive outcomes are reported (Schkade & Kilbourne, 1991).

The person who made the decision that led to the negative outcome is viewed as more responsible for the outcome and more internal attributions are made of that person regarding the reason for the outcome (compared to when a positive outcome is reported) (Mitchell & Kalb, 1981). In two studies of court cases, when the defendant was found guilty (i.e., negative outcome), the jurors reported, in hindsight, that the defendant was less likely to be innocent and that police were justified in their warrantless search of the defendant's home (Bodenhausen, 1990; Kagehiro, et al., 1991). When a technological disaster was portrayed (versus no disaster), the company was held increasingly responsible, more anger was reported toward the company, and more sympathy was reported for the community residents (Brown, Williams, & Lees-Haley, 1994). In contrast, when a favorable outcome is reported, the decision maker is generally evaluated, in hindsight, as a better thinker and as more competent (Baron & Hershey, 1988).

Task difficulty. The difficulty of the task participants are required to engage in during these studies also appears to moderate the hindsight-bias effect to some degree. In general, research has demonstrated that the hindsight bias is more pronounced on easy decision tasks, whereas the bias is not as prevalent given a more difficult decision task (Hudson & Campion, 1994). Level of training, however, may interact with task difficulty to create this effect. For example, Dawson et al. (1988) examined the effect of the hindsight-bias phenomenon in clinicopathologic case conferences attended by physicians and medical students. They found that the medical students demonstrated hindsight bias on cases that were both easy and difficult to diagnose. In contrast, the attending physicians showed hindsight bias on the easier cases but not on difficult

cases, indicating a more thorough decision process or at least an appreciation of the difficulty involved in the diagnosis of more complicated cases.

Familiarity. It might be inferred from the previous discussion regarding task difficulty that an increased level of training would ensure less bias and more accurate decision making. For example, Dawson et al. (1988) concluded that the more experienced physicians demonstrated less hindsight bias than did the medical student trainees. In their meta-analytical study of the hindsight bias, Christensen-Szalanski and Willham (1991) also found a significant correlation between the size of the hindsight effect and the participants' familiarity with the task. That is, the more familiar a person is with the task, the smaller the hindsight bias effect. This finding, however, contrasts with a large body of research in other areas of clinical decision making demonstrating that more experienced clinicians are more confident and more susceptible to certain decision errors than those less experienced (for example, see Arkes, Dawes, & Christensen, 1986). Contradictory examples can be found in other hindsight bias research as well. For example, a study by Arkes et al. (1981) revealed that medical-college faculty physicians with a great deal of knowledge regarding disease and diagnosis were still susceptible to the hindsight bias.

Time elapsed. Studies on the hindsight bias phenomenon also indicate that time (between foresight and hindsight estimates) influences the degree of the effect. It appears that the hindsight bias may take some time to emerge and that the effect may grow stronger with time. In one study by Bryant and Brockway (1997), a hindsight bias effect for the more likely outcome was present within 48 hours, whereas a significant effect for the less likely outcome took one week to emerge. In a similar paradigm, Fischhoff and Beyth (1975) reported that 67% of participants demonstrated

a significant hindsight bias effect (in the expected direction) after two weeks, whereas 84% of the participants demonstrated an effect after three to six months.

Unlikelihood of event. A final factor that has been found to mediate the hindsight bias effect is the likelihood of the event. It appears that the less likely an event is, the greater its influence on decision-making errors. That is, the biasing effect of outcome information has been demonstrated to be strongest for events that were initially judged to be the least plausible (Arkes et al., 1981; Fischhoff, 1975; Fischhoff, 1977; Wood, 1978).

In summary, the hindsight bias effect has been demonstrated with individuals in various contexts to be a consistent and robust impediment to human decision processes. In addition, the effect appears to be mediated by or to interact with various other factors, including task and event variables as well as characteristics of those making the foresight and hindsight predictions. The research available on whether groups are as susceptible to decision making bias has revealed mixed, although somewhat promising, results.

Group Decision Making

Research regarding group versus individual decision making has addressed four biases aside from the hindsight bias, namely fundamental attribution error, consensus underutilization, the base-rate fallacy, and illusory correlation with mixed results. A study by Wright and Wells (1985) found that group discussion attenuates the dispositional bias (or fundamental attribution error). This bias involves a lack of consideration of situational contributions to the behavior of others, while simultaneously failing to consider the contribution of dispositional forces on one's own behavior. In a similar vein, Wright, Luus, and Christie (1990) investigated the use of

consensus information in group versus individual decision making. Consensus information comprises beliefs about how other people have or would have behaved in a similar situation. To date, individual decision makers have tended to underutilize consensus information in their decision making. Wright, Luus, and Christie found that groups were significantly more likely to include consensus information into their decision process than were individual decision makers.

Three studies have investigated individual versus group utilization of base-rate and individuating information. An initial study by Argote, Seabright, and Dyer (1986) revealed that groups relied more on individuating information and less on the base-rate information than individual decision makers. The authors concluded that the biases of individual decision makers are systematic, rather than random, and that the subsequent pooling of individual responses through group discussion may thus potentiate the biases instead of ameliorating them. The authors also discussed the influence of persuasive arguments theory (PA theory) (Vinokur & Burnstein, 1974), which would predict that group discussion exposes members to additional arguments in favor of using the individuating information. In a follow-up study by Argote, Davadas, and Melone (1990), however, groups relied on individuating information and underutilized base-rate information only when the individuating information was seen as informative. When the individuating information was seen as uninformative, groups were less prone to use this information and were more likely than individual decision makers to rely on base-rate information. These results are consistent with the PA theory when individuating information is informative, but are inconsistent with the theory when individuating information is believed to be uninformative.

In a similar study of individual versus group decision making, Aspel (1994) found that teams of psychoeducational decision makers were no more likely than individuals to integrate base-rate information into their decision-making processes. The teams did, however, tend to select a more restrictive educational placement based on irrelevant information than did individual decision makers. The groups were also found to be just as likely as individuals to incorporate irrelevant case information consistent with an illusory correlation effect. In other words, neither teams nor individuals were influenced by information that should have influenced their decisions, but both were influenced by information that should not have influenced their decisions.

In summary, groups tend to perform better than individuals when faced with some decision making biases (i.e., fundamental attribution error and consensus underutilization), and to perform similarly or worse than individuals on other decision tasks. Specifically, groups tend to use relevant base-rate information less often than individual decision makers.

Hindsight Bias in Groups

There have been two studies, to date, examining the existence of a hindsight bias effect in group decision making. The two studies use divergent methodologies and research designs and reveal equivocal preliminary evidence. In one study, Bukszar and Connolly (1988) addressed the question of whether individuals with formal training in strategic decision making would be susceptible to the hindsight-bias effect. They demonstrated a significant hindsight bias effect among M.B.A. students with experience in case analysis and formal training in strategic decision making. They also found that this effect was not attenuated in groups. The groups of decision

makers were just as susceptible to hindsight bias as the individuals. Bukszar and Connolly concluded that their study provides evidence in support of Fischhoff's (1975) theory of "creeping determinism" in which individuals automatically assimilate outcome information, permanently altering their memory for any foresight judgments.

The second study, conducted by Stahlberg, Eller, Frey, and Maass (1995) sought to establish the existence of a hindsight bias effect in groups while simultaneously attempting to determine the probable underlying process responsible for the effect. In the first of two experiments, a strong hindsight bias effect was revealed among a large sample of German high school students, although the bias was of equal magnitude between individuals and randomly assigned groups of three to five individuals. The groups were just as susceptible as individuals to the biasing effect of outcome information. In the second experiment, undergraduate psychology students at a German university were asked to bring two good friends to class, creating groups of three well-acquainted members with some common history. In this study, a significant hindsight bias effect again was demonstrated. The groups and individuals were similarly biased in their decisions, but the groups had better recall of their initial predictions (i.e., better hit rates) than individuals, an effect that was found to be mediated by the increased amount of time that the groups spent in their decision process.

Stahlberg et al. (1995), however, concluded that their results disconfirmed Fischhoff's (1975) theory that hindsight bias is the result of an immediate assimilation of outcome information (i.e., "creeping determinism"), thereby permanently altering the individual's memory for foresight judgments. They reported groups to be somewhat less biased than individuals, although not at a conventional alpha level.

According to Stahlberg et al., if Fischhoff's theory were true, individuals and groups would demonstrate equal degrees of hindsight bias, which they did, according to more conventional statistical standards. Rather, the authors concluded that the results of their second experiment provided support for a response bias theory in explaining hindsight bias differences between individual and group decision makers. According to the response bias theory, when decision makers have received outcome information and are then asked to recall their original predictions, they either remember their original judgment or not. For those decision makers who cannot remember their foresight predictions, they will use the outcome information as an anchor in guessing what their original judgment was. The outcome information itself does not erase or otherwise alter memory for the foresight predictions. Thus, because groups have more than one member and spend more time in deliberation, the likelihood of the original judgment being recalled is higher in groups than in the individual decision maker, leaving the groups less susceptible to hindsight bias. Essentially, groups will be less likely to have to guess what their original judgments were than individuals.

Stahlberg et al. (1995) attempted to suggest that groups are somewhat less susceptible to hindsight bias, due to the increased amount of time they take to make decisions, which then mediates recall of their original (foresight) judgments. These results are equivocal, however, primarily because the results of the two experiments were not consistent, and the results that were believed to support the response-bias explanation were insignificant at conventional alpha levels. More rigorous research will need to be conducted that consistently demonstrates an attenuation of the hindsight bias in groups before any conclusions can be made regarding the underlying process or processes that mediate the effect.

Elimination of the hindsight bias

Attempts to eliminate the hindsight bias effect in decision making have yielded mixed results. Providing participants with instructions to "work harder," as well as informing them of the bias and asking them to avoid it, all have proven ineffective in reducing or eliminating the biasing effect of outcome information (Davies, 1993; Fischhoff, 1975; Fischhoff, 1977; Hennessey & Edgell, 1991; Kamin & Rachlinski, 1995; Pohl & Hell, 1996; Sharpe & Adair, 1993; Wood, 1978). For example, in a study by Pohl and Hell (1996), participants were told, in advance of the experiment, about the hindsight bias phenomenon and that the point of the experiment was to test whether knowing about the bias would reduce or eliminate it. In a follow-up experiment, participants also were provided with individual feedback about their recall performance before being tested again. Neither manipulation reduced the biasing effect of the outcome information. Therefore, it appears that attempts to increase awareness of the bias and to increase motivation for accuracy are ineffective in reducing hindsight bias.

One method that has demonstrated some success (although inconsistently) in reducing hindsight bias is that of formally discrediting the feedback information given to participants. Hasher, Attig, and Alba (1981), for example, conducted the most widely cited example of this methodology. Their participants completed a simple within-subjects hindsight bias paradigm in which predictions were made and feedback was given. Then, prior to having subjects restate their prior probabilities, as is usually done, the subjects were told that the feedback they had just received was incorrect. This manipulation was associated with a reduction in hindsight bias. Other attempts to manipulate outcome feedback, however, have found no significant reduction in

hindsight bias (Connolly & Bukszar, 1990; Tversky & Kahneman, 1974). Also, such a counterfactual reasoning technique cannot readily be applied by the clinical decision maker to maximize their decision accuracy. Rarely are we provided with feedback that a diagnosis we considered accurate, for example, is completely incorrect.

The only reliable and consistent method that has been reported to reduce or to eliminate the hindsight bias has been the use of *counterfactual reasoning* strategies (Arkes et al., 1988; Davies, 1992; Koriat, Lichtenstein, & Fischhoff, 1980; Pohl & Hell, 1996; Slovic & Fischhoff, 1977). For example, Arkes et al. (1988) conducted a between-subjects hindsight bias study with neuropsychologists in which participants were asked to read a case report and assign probabilities to four possible diagnoses. Some participants also were asked to provide one reason why each of the possible diagnoses might be correct. This act alone significantly reduced the degree of hindsight bias. Similar studies have been conducted that have been effective in decreasing the bias as well. A study conducted by Creyer and Ross (1993) demonstrated that the harder participants were made to work during the foresight phase (i.e., increased cognitive effort), the lower the degree of hindsight bias. By leaving some aspects of the task materials ambiguous, participants were forced to put forth more effort to complete the task, and this apparently mediated the expected biasing effects. Thus, rather than simply instructing participants to work harder -- a debiasing technique that has been proven ineffective -- if individuals are forced to work harder via increased task demands, their degree of bias is minimized. In a study by Pennington (1981), rather than providing pre-established outcomes to participants and asking them to rate the probabilities of each, the participants were asked to generate their own outcomes of the events and to rate the probabilities of each.

Although the participants who generated their own outcomes developed fewer outcome choices than were provided to the other groups, these individuals demonstrated little or no hindsight bias. Thus, it appears that engaging individuals in more rigorous cognitive-decision processes, such as considering all of the alternatives thoroughly, is the most consistently effective means of reducing the hindsight bias.

Theoretical basis for the hindsight bias

As with attempts to reduce or eliminate the hindsight bias, the theoretical stances that have been taken in explaining how the hindsight bias arises primarily have been motivational or cognitive in nature, with the cognitive explanations being more consistently validated than the motivational explanations.

Theories of a motivational interpretation of the hindsight bias primarily have centered around the concepts of self-esteem and self-presentation (i.e., a desire to maintain public or private self-evaluation). For example, Campbell and Tesser (1983) found a need for predictability and a self-presentation motive to be positively correlated with the hindsight bias. Verplanken and Pieters (1988), however, challenged this conclusion by pointing out that the significant self-presentation effect reported is relatively small in comparison to the magnitude of the hindsight bias demonstrated. Verplanken and Pieters (1988), in their own investigation, examined the effect of a "need for cognition" on the hindsight bias. The need for cognition is defined as "the tendency to engage in and enjoy effortful cognitive endeavors" (p. 136), and was found to significantly influence the degree of hindsight bias demonstrated by participants -- those high in the need for cognition demonstrated nonsignificant levels of hindsight bias whereas those low or medium in their need for cognition demonstrated a significant degree of hindsight bias. The authors concluded

that "need for cognition" is a motivational factor that influences cognition (i.e., information processing).

There is a substantive body of research also available that disputes these motivational interpretations of the hindsight bias. Leary (1981, 1982) conducted two studies examining motivational explanations and found in both instances that self-presentation and self-esteem (or ego-involvement) did not influence the degree of hindsight bias demonstrated. Synodinos (1986), in addition, found no effect of political involvement or of self-esteem with regard to hindsight bias.

Fischhoff (1975), in his foundational work on the hindsight bias, offered a theoretical explanation for the existence of the bias, which he termed the "immediate assimilation hypothesis." His theory, among other more recent cognitive explanations, has been found to be the most reliable and robust means of explaining why the hindsight bias exists in human decision making. The immediate assimilation hypothesis assumes that, on receipt of outcome information, judges immediately assimilate it with what they already know about the event being considered and subsequently are unable to regain their foresightful state of mind. Fischhoff further concluded, based on his research, that judges largely are unaware of the effect that outcome knowledge has on their perceptions. In fact, when participants were explicitly asked to ignore the outcome information, they were not able to, still demonstrating the hindsight bias. Pohl and Gawlik (1995) described a similar cognitive interpretation of the hindsight-bias phenomenon involving recall from memory. Here, hindsight bias occurs as the result of "blended recollections," that is, probabilities given after outcome information is known consist of a combination of the foresight prediction and the outcome information.

Other studies agree with Fischhoff's (1975) interpretation of the hindsight bias as arising from the fallible nature of cognitive processing, although they disagree with the assimilation mechanism he proposes. As previously discussed, Hasher et al. (1981) designed an experiment in an attempt to eliminate the hindsight bias. Foresight predictions were elicited from participants; outcome feedback then was followed by a manipulation in which the feedback was discredited. Participants were told that the feedback they had just received was, in fact, false and to recall their original predictions, ignoring the incorrect feedback. Under these conditions, participants were able to regain their foresightful state of mind, demonstrating no significant level of hindsight bias. These authors concluded that, in contrast to Fischhoff's theory, outcome information is likely not immediately assimilated into what was previously known. If it were, participants in this study would not have been able to ignore the feedback they were given, regardless of its accuracy. Further, the fact that the hindsight bias has been consistently eliminated using increased cognitive effort calls into question whether outcome information is immediately assimilated into what was previously known. Perhaps a less extreme explanation is more feasible, such as Pohl and Gawlik's (1995) theory of blended recollections, which does not necessitate immediate assimilation.

Another theory of the nature of hindsight bias deserves mention as an alternative explanation for its emergence. The availability heuristic describes the tendency for people to overestimate the frequency of salient events due to their ease of recall. This heuristic has been discussed as a naturally occurring information-processing strategy that may influence the presence of the hindsight bias. Essentially, once outcome information has been presented, the actual outcome becomes more

salient (i.e., more available) leading to information-processing difficulty in simulating or considering alternatives (Agans & Shaffer, 1994; Detmer, Fryback, & Gassner, 1978; Powell, 1988). This theory explains the hindsight bias phenomenon as well as Fischhoff's (1975) theory without excluding the possibility that, under certain conditions such as an increased demand in cognitive effort, the hindsight bias could be reduced or eliminated.

Clinical Implications

The consequences of the hindsight bias for clinical decision making are substantial. The tendency of people, without realizing it, to remember being more accurate than they really were (or thinking they would be more accurate than they probably would be) leads to overconfidence in future decision making endeavors. Conclusions are reached prematurely, and alternative possibilities are not sufficiently considered, which ultimately results in decreased judgment accuracy (Arkes et al., 1988). Overconfidence has thus been found to lead unduly to reliance on clinical judgment (versus statistical evidence) in decision making, which significantly increases the likelihood of decision error. Overconfidence has been demonstrated to be, it seems, even more stubbornly unalterable than the hindsight bias itself (Fischhoff, 1982).

In addition to overconfidence, the hindsight bias similarly impedes one's ability to learn from the past. If, after the fact, we remember being more accurate than we actually were, we will likely see no reason to improve our decision making. As Fischhoff (1975) stated:

If, in hindsight, we systematically underestimate the surprises which the past held and holds for us, we are subjecting those hypotheses to inordinately weak tests and, presumably, finding little reason to change them. Thus, the very outcome knowledge which gives us the feeling that we understand what the past was all about may prevent us from learning anything from it (pp. 298-299).

Within the field of psychology, there has been a paucity of research on the probable effects of the hindsight bias phenomenon. For example, no study has been reported, to date, examining the impact of the hindsight bias among multidisciplinary team (MDT) functioning, despite the prevalence of such group decision making within psychology as well as the significance of the decisions made by these professionals in the lives of children and families. The purpose of this investigation is to identify whether the hindsight bias influences the decision making of groups and, if it does, whether the bias can be effectively eliminated by minimally increasing cognitive effort.

Hypotheses

Previous research has yielded mixed results regarding the accuracy of group decision making over individual decision making. Therefore, this study addresses two broad research questions: (a) Do groups demonstrate less hindsight bias in their decision making efforts than individual decision makers?, and (b) Can the hindsight bias be reduced in groups similar to previous results among individual decision makers? Based on these two general research questions, the following predictions are made:

1. The outcome probabilities of hindsight participants will differ from those given by foresight participants, with those receiving outcome information giving

probabilities much closer to the actual outcome than those not receiving outcome information.

2. Group decision makers provided with outcome information will demonstrate the same degree of hindsight bias as individual decision makers provided with outcome information, when compared to group and individual decision makers not provided with outcome information.

3. Hindsight participants completing a counterfactual reasoning task will demonstrate less hindsight bias than those hindsight participants not completing the counterfactual reasoning task, regardless of whether the decision is made individually or in groups.

4. Groups will take more time than individuals to make their decisions, and those completing the counterfactual reasoning task will take more time in their decision making than those not completing a counterfactual reasoning task.

Method

Participants

Permission to conduct the study was granted by the Institutional Review Board at the University of Rhode Island. Participants were undergraduate students enrolled in psychology courses at the University of Rhode Island. Students were recruited as voluntary participants for course credit and were all at least 18 years of age, in order to secure informed consent. A total of 180 individuals were recruited for participation in the study, with all participants completing both individual and group decision making tasks. The mean age of the sample was 19.77, with a standard deviation of 4.18 years. The age distribution was similar across conditions. Participants' race was distributed as follows: 88.9% White, 3.3% Hispanic, 2.8% Black, 2.2% Asian/Pacific Islander,

and 2.8% Other/Mixed. Sixty percent of participants were in their first year of college, 18.3% were in their second year, 8.9% were in their third year, and 12.8 % were in their fourth year of college. Most participants (80.0%) received credit for an introductory psychology course, 2.2% received credit in a sophomore-level class, 16.7% received credit in a junior-level class, and 1.1% received credit in a senior-level class. Groups consisted of three members. Prior investigations in group decision making have used groups ranging from three to five members (Argote, Devadas, & Melone, 1990; Argote, Seabright, & Dyer, 1986; Stahlberg, et al., 1995; Wright, Luus, & Christie, 1990). The greater number of groups created by using the three-person format, however, was seen as more statistically beneficial for this study than the increase in generalizability attained by using four- or five-person groups.

Case Materials

The vignettes were created by the investigator to provide adequate information for making outcome predictions and also to maximize generalizability of the results obtained from undergraduate students. Rather than using the almanac-type questions often employed in hindsight bias research, case vignettes were developed as potentially having more relevance for undergraduate students (see Hawkins & Hastie, 1990 for a review). Also, the vignettes were created to reflect a topic area in which undergraduate students already have some experience. Both vignettes were of approximately equal length (i.e., between 190 and 200 words). They were also equal in number of sentences (i.e., 12) and average word length (i.e., 4 characters), and were nearly equal in the number of words per sentence (i.e., 16 and 15). Both were written at an eighth grade reading level (Flesch Grade Level, as calculated using the grammar check program in Microsoft Word Version 5.1a). Each vignette provided a description

of an individual in the process of applying for admission to college. The vignettes were designed to represent either a generally positive or neutral outcome without eliciting extreme predictions (i.e., > 90% likelihood in either direction). Both vignettes were informally piloted with 15 undergraduate student volunteers from an introductory psychology course and were found to elicit significantly different outcome predictions [$t(14) = 2.39, p < .05$]. Table 1 provides a summary of the results of this pilot study.

Both of the vignettes described a high-school senior applying for admission to college. The vignettes were designed to include information that generally is included in college application materials, as well as minimal descriptive information about the individuals (see Appendix A). Both of the vignettes presented the case of an individual who is likely to be accepted to an ivy league college. Participants in the hindsight condition also were provided with an outcome statement, indicating whether the individual was in fact admitted to their college of choice. Research participants then were asked to rate, based on the information provided, the likelihood that the student would be accepted to college as well as the likelihood that the applicant would not be accepted.

Design and Procedure

The investigation assessed the influence of three independent variables and three dependent variables. The independent variables assessed were: (a) outcome (foresight, hindsight, or hindsight plus the counterfactual reasoning task), (b) process (group or individual), and (c) case (positive or neutral outcome valence). This resulted in a 3 (outcome) by 2 (process) by 2 (case) design, with outcome as a randomly-assigned between-groups measure (with 60 participants in each of three conditions)

and process and case as within-groups measures. The dependent variables were: (a) prediction of the likelihood of college admission, ranging from 0 to 100%, (b) adequacy of the case information available, ranging from 0 to 100 (completely inadequate = 0, completely adequate = 100), and (c) confidence ratings of predictions made, ranging from 0 to 100 (not at all confident = 0 and completely confident = 100).

Participants were provided with a demographic sheet (see Appendix B), the case vignettes, and a response sheet (see Appendix C) including a list of two possible outcomes. First, participants completed the demographic information. They were asked to read the case vignettes in full. Participants then were asked to record the time that they began completing their response sheets. Participants then provided probabilities for each of the two possible outcomes, with the predictions summing to 100. Although only one probability rating was needed for parametric statistical procedures, it was hypothesized that asking participants to record both the positive and negative probabilities would increase the likelihood that they would consider both possibilities more thoroughly. Participants in the hindsight bias condition including the counterfactual reasoning task (both individuals and groups) additionally were asked to state, in writing, one piece of evidence to support each of the two outcomes as the primary one. Participants then provided a rating from 0 to 100 as to the adequacy of the information provided to them in making their outcome predictions. Participants were also asked to rate from 0 to 100 how confident they were in the accuracy of the predictions they had made. The time at which participants completed each decision making task was recorded to calculate total decision time. The instructions given to the participants varied depending on whether decisions were made individually or as members of the three-person groups. All responses, however, were written in order to

maximize the degree of internal validity associated with consistent task completion. Appendix D presents a description of the specific procedural guidelines and oral instructions.

Each participant made decisions on each of two case vignettes (i.e., Case A and Case B); one of these decisions was made individually, whereas the other one was made within the three-person groups. Decision order (i.e., group--individual vs. individual--group) and task order (i.e., Case A--Case B vs. Case B--Case A) were counterbalanced and recorded by the investigator. Upon completion of both decision making tasks, participants were debriefed and dismissed. Total completion time was estimated at forty five minutes, with participants allowed approximately twenty minutes for each decision task. Actual decision time was recorded in order to be analyzed as a potential covariate. It was hypothesized that groups would require more time than individuals and that participants completing the counterfactual reasoning task may require more time than those not completing the counterfactual reasoning task. As noted above, this factor alone may be a significant source of variance between subjects.

Results

Two different statistical methods were used to analyze the data. Because the probabilities for each outcome in the study were ipsative for each participant (i.e., $\Sigma p = 100$), these dependent measures are related and binomial, making the use of parametric statistical procedures problematic. Thus, nonparametric analyses were used in assessing the relationship across all three dependent variables because nonparametric procedures make few assumptions about the nature of population distributions (i.e., distribution-free) (Jaccard & Becker, 1990). Such procedures have

also been employed in previous hindsight bias research (Arkes et al., 1981; Fischhoff, 1975). Parametric analyses (i.e., multivariate analysis of covariance) also were conducted to assess the overall magnitude of the relationships between the independent and dependent variables. The probability ratings were included in the parametric analyses, as well, by isolating one level of the dependent variable for inclusion in the analyses (i.e., p values assigned to the likelihood of acceptance into college).

Nonparametric Analyses

The binomial sign test was used to compare the number of participants who assigned higher probabilities, confidence ratings, and adequacy ratings in hindsight than were given in foresight. This test also was used to compare the number of participants in the hindsight condition who assigned attenuated probabilities, confidence ratings, and adequacy ratings after completing a counterfactual reasoning task than those who did not complete this task. Separate sign test comparisons were made for individual and group decisions. The sign test is a procedure that computes the direction of the difference between two treatments for all cases and then determines the number of increases and decreases in scores. In this way, the direction of the effect is assessed, rather than the magnitude of the effect, as is assessed using parametric statistical procedures. If the two treatments are distributed similarly, or have a similar effect, then the number of positive and negative differences will not differ significantly (Gravetter & Wallnau, 1996). The sign test is often used in a pairwise fashion, but in this case the foresight means were used as centering points, or anchors, and distributions around these means were assumed to be approximately normal.

In this sample, over all participants in the individual decision conditions, 39 of 60 (65%) assigned higher probabilities to the known-to-have-occurred outcome than the corresponding estimate obtained from foresight participants ($z = 2.32$; $p = .01$). Similarly, over all groups in the group decision making conditions, 15 of 20 (75%) also assigned higher probabilities to the known-to-have-occurred outcome ($z = 2.24$; $p = .01$). Neither the individual nor the group participants, however, demonstrated a significant attenuation of the hindsight bias when asked to complete a counterfactual reasoning task, when compared to corresponding estimates obtained from hindsight participants not completing the task. Here, 21 of 60 (35%) individual participants demonstrated an attenuation of the bias, whereas 12 of 20 (60%) group participants demonstrated an attenuation of the bias, both of which were not significant in eliminating the bias ($ps = .19$ and $.50$, respectively).

With regard to the confidence participants had in their predictions, 42 of 60 (70%) individuals provided a higher confidence rating in hindsight than the corresponding ratings obtained from foresight participants ($z = 3.10$; $p = .001$). In the same manner, 15 of 20 (75%) groups provided a higher confidence rating in hindsight than the corresponding foresight groups ($z = 2.24$; $p = .01$). Again, neither the individual nor the group participants demonstrated a significant change in confidence ratings when asked to complete a counterfactual reasoning task, when compared to the corresponding ratings obtained from hindsight participants not completing the task. Here, 32 of 60 (53%) individual participants demonstrated an attenuation of the bias, whereas 13 of 20 (65%) group participants demonstrated an attenuation of the bias, both of which were not significant in eliminating the bias ($ps = .09$ and $.30$).

When asked to rate the adequacy of the information provided to them, 40 of 60 (67%) individuals provided a higher adequacy rating in hindsight than the corresponding ratings obtained from foresight participants ($z = 2.58$; $p = .005$). Similarly, 15 of 20 (75%) groups provided a higher adequacy rating in hindsight than the corresponding foresight groups ($z = 2.24$; $p = .01$). And again, neither the individual nor the group participants demonstrated a significant change in adequacy ratings when asked to complete the counterfactual reasoning task, when compared to the corresponding ratings obtained from hindsight participants not completing the task. Here, 18 of 60 (30%) individual participants demonstrated an attenuation of the bias, whereas 10 of 20 (50%) group participants demonstrated an attenuation of the bias, both of which were not significant in eliminating the bias ($ps > .50$).

When separate sign tests were conducted for each of the two different cases, results varied. Tables 2-7 summarize these data. Due to small sample sizes ($n = 10$), group results were assessed using the binomial distribution, rather than using the z -distribution. Case A (i.e., Jamie) was positively valenced in foresight, with a 72% mean probability of being admitted. In hindsight, participants were told that the individual portrayed in Case A had, in fact, been admitted to the college of his choice. Under these conditions, the hindsight bias was not demonstrated among individual participants with regard to probability ratings obtained. Only 15 of 30 (50%) individual hindsight participants assigned a higher probability of admittance than that obtained from the foresight participants ($z = 0.00$; $p = .50$). In comparison, 7 of 10 (70%) of hindsight participant groups assigned a higher probability of admittance than that obtained from the foresight participant groups ($p = .12$). A significant number of those hindsight participants asked to complete the counterfactual reasoning task tended

to assign a *higher* probability of admittance than hindsight subjects not completing the task. Only 8 of 30 (27%) of those individual participants completing the extra task gave attenuated probability ratings ($z = -2.56$; $p = .005$). In comparison, 7 of 10 (70%) of the participant groups completing the extra task gave attenuated probability ratings ($p = .12$). The confidence ratings of individual hindsight participants, however, did increase significantly. Here, 20 of 30 (67%) participants assigned higher confidence ratings than that obtained from the foresight participants ($z = 1.85$; $p = .03$). This effect was not shown in hindsight participant groups. Seven of 10 (70%) hindsight groups assigned higher confidence ratings than those obtained from the foresight participant groups ($p = .12$). The confidence ratings of hindsight participants were, again, not attenuated for hindsight participants completing the counterfactual reasoning task, either among individual or group participants. Only 18 of 30 (60%) individual participants in this condition gave lower confidence ratings than those obtained from the hindsight participants not completing the task ($z = 1.11$; $p = .13$). Only 6 of 10 (60%) group participants gave attenuated confidence ratings ($p = .21$). No significant hindsight effect was found with regard to adequacy ratings for Case A. Of the 30 individual hindsight participants, 19 (63%) provided higher adequacy ratings than those obtained from the foresight participants ($z = 1.48$; $p = .07$). Of the 10 group hindsight participants, 7 (70%) provided higher adequacy ratings than those obtained from the foresight group participants ($p = .12$). A significant number of those individual hindsight participants asked to complete the counterfactual reasoning task tended to assign a *higher* adequacy rating than hindsight participants not completing the task. Only 10 of 30 (33%) of those completing the extra task gave attenuated

adequacy ratings ($z = -1.85$; $p = .03$). Only 4 of 10 (40%) participant groups provided attenuated adequacy ratings after completing the extra task ($p = .21$).

In comparison, Case B (i.e., Kelli) was neutrally valenced in foresight, with a 47% mean probability of being admitted. In hindsight, participants were told that the individual portrayed in Case B had, in fact, been rejected from the college of her choice. Under these conditions, 24 of 30 (80%) individual hindsight participants assigned a higher probability of rejection than that obtained from the foresight participants ($z = 3.33$; $p = .0005$). Of the 10 hindsight participant groups, 8 (80%) assigned a higher probability of rejection than that obtained from the foresight participant groups ($p = .04$). Only 13 of 30 (43%) of those individual participants completing the extra task gave attenuated probability ratings ($z = -0.74$; $p = .23$). Only 5 of 10 (50%) of the participant groups completing the extra task assigned attenuated probabilities ($p = .25$). A significant number of individual hindsight participants also assigned higher confidence ratings. Here, 22 of 30 (73%) individual participants assigned higher confidence ratings than that obtained from the foresight participants ($z = 2.59$; $p = .005$). Eight of 10 (80%) hindsight participant groups assigned higher confidence ratings than that obtained from foresight participant groups ($p = .04$). The number of higher confidence ratings of hindsight participants was not attenuated for participants completing the counterfactual reasoning task. Only 14 of 30 (47%) individual participants in this condition gave lower confidence ratings than those obtained from the hindsight participants not completing the task ($z = -.37$; $p = .36$). Only 7 of 10 (70%) participant groups in this condition gave lower confidence ratings than those obtained from hindsight participant groups not completing the task ($p = .12$). A significant hindsight effect also was found with regard to adequacy ratings for

Case B. Of the 30 individual hindsight participants, 21 (70%) provided higher adequacy ratings than those obtained from the foresight participants ($z = 2.22$; $p = .01$). Of the 10 hindsight participant groups, 8 (80%) provided higher adequacy ratings than those obtained from the foresight participant groups ($p = .04$). A significant number of those hindsight participants asked to complete the counterfactual reasoning task, however, tended to assign a *higher* adequacy rating than hindsight participants not completing the task. Only 8 of 30 (27%) of those completing the extra task gave attenuated adequacy ratings ($z = -2.69$; $p = .004$). The hindsight effect regarding adequacy ratings was also not attenuated in the participant groups. Of the 10 hindsight participant groups completing the extra task, 6 (60%) provided attenuated adequacy ratings when compared to the adequacy ratings of hindsight groups not completing the task ($p = .21$).

Parametric Analyses

In comparing individual to group decisions, statistical problems can arise. Because there were three times as many individual decisions as group decisions, there is likely to be more variance among the individual responses. Therefore, significant differences between individuals and groups may arise solely as statistical artifact. In order to address this problem, triads of individual responses were pooled (i.e., averaged) to reflect the same number of individual and group responses. One disadvantage of this pooling procedure, however, is that obtaining a mean of three individual responses may closely resemble the group decision-making process. Thus, an additional analysis also was conducted in which one of the three individual scores was chosen randomly and compared to the group response.

Two 3 by 2 by 2 between-subjects multivariate analyses of covariance (MANCOVA) were conducted in order to test for differences among treatment groups. The first MANCOVA compared triads of individual responses (i.e., pooled data) to the group responses. The second MANCOVA compared randomly selected individual responses (i.e., unpooled data) to the group responses. The independent variables included were: outcome (foresight, hindsight, or hindsight plus counterfactual reasoning task), process (individual or group), and case (positively or neutrally valenced). These analyses were conducted to determine whether a hindsight bias effect existed in this sample, whether groups demonstrated more or less hindsight bias than individual decision makers, whether results depended on case valence, or a combination of these factors. Three dependent variables were included in the analyses: (a) probability of a positive outcome, (b) information adequacy rating, and (c) decision confidence rating. Total decision time was analyzed as a covariate. Significant multivariate results were followed up with univariate analyses of covariance (ANCOVAs) to determine which of the dependent variables contributed to the significant differences.

Pooled analysis. For the first MANCOVA, in which group-generated responses were compared against mean triads of individual responses (i.e., the pooled procedure), the only significant finding was a main effect for Case, $F(3,105) = 42.36$, $p < .001$. No other sources of variation were significant at conventional alpha levels ($ps = .10$ to $.93$). Table 8 presents the F and p values for all sources of variation in this analysis. Three follow-up ANCOVAs then were conducted, one for each of the dependent variables. Results showed that only probability ratings accounted for the significant main effect, $F(1,107) = 121.01$, $p < .001$. F -values for all other sources of

variation in these analyses were not significant at conventional alpha levels ($ps = .10$ to $.89$). The positively valenced case (i.e., Jamie) was assigned a significantly higher mean probability of acceptance ($\underline{M} = 71.08$, $\underline{SEM} = 2.04$) than the neutrally valenced case (i.e., Kelli) ($\underline{M} = 39.17$, $\underline{SEM} = 2.04$). The means and standard errors for adequacy and confidence were: $\underline{M} = 77.60$, $\underline{SEM} = 1.28$ and $\underline{M} = 75.08$, $\underline{SEM} = 1.37$, respectively.

Unpooled analysis. For the second MANCOVA, in which group-generated responses were compared against randomly selected individual responses (i.e., the unpooled procedure), again there was a main effect for Case, $\underline{F}(3,105) = 25.34$, $p < .001$; but there also was an interaction effect for Case by Outcome, $\underline{F}(6,212) = 2.21$, $p < .05$. No other sources of variation were significant at conventional alpha levels ($ps = .16$ to $.79$). Table 9 presents the $\underline{F}$ and p values for all sources of variation in this analysis.

Similar to the pooled analysis, three follow-up ANCOVAs then were conducted, one for each of the dependent variables. For these analyses, the Case by Outcome interaction was not significant for either probability [$\underline{F}(2,107) = 2.12$, $p = .13$], adequacy [$\underline{F} < 1$], or confidence [$\underline{F}(2,107) = 2.08$, $p = .13$]. The only significant finding was a main effect for Case for the probability dependent variable, $\underline{F}(1,107) = 62.61$, $p < .001$. Again, similar to the pooled analysis, the positively valenced case (i.e., Jamie) was assigned a significantly higher mean probability of acceptance ($\underline{M} = 69.09$, $\underline{SEM} = 2.66$) than the neutrally valenced case (i.e., Kelli) ($\underline{M} = 39.24$, $\underline{SEM} = 2.66$). The means and standard errors for adequacy and confidence were: $\underline{M} = 78.25$, $\underline{SEM} = 1.50$ and $\underline{M} = 75.53$, $\underline{SEM} = 1.72$, respectively.

Completion Time. An analysis of variance (ANOVA) was used to assess differences in the amount of time taken to complete the decision task by Process (i.e., between individuals and groups) as well as by Outcome (i.e., between participants in the foresight, hindsight, and hindsight plus counterfactual reasoning task outcome conditions). These results are summarized in Table 10. There was a main effect for Process and for Outcome. The interaction effect between Process and Outcome was not significant at a conventional alpha level ($F < 1$). Overall, groups ($M = 2.53$, $SEM = 1.52$) took longer to make decisions than individuals ($M = 1.88$, $SEM = 1.08$) ($p = .005$). All pairwise comparisons were computed for Outcome using Tukey's Honestly Significant Difference test, revealing that foresight and hindsight participants took the same amount of time to decide ($p = .201$), whereas those hindsight participants completing the counterfactual reasoning task took longer to respond than both foresight participants ($p < .05$) and those hindsight participants not completing the extra task ($p < .001$) (see Table 11).

Characteristics of the Covariate. In covariance analysis, the effect of the covariate on the dependent variables is factored out of the total variance such that independent variables are then compared to adjusted dependent variable means. In this way, the error term is adjusted for (i.e., reduced) by the relationship between the dependent variables and the covariate (Tabachnick & Fidell, 1996). There are two criteria that a variable must meet in order to be considered an appropriate covariate: (a) a statistically significant linear relationship must exist between the covariate and all dependent variables and (b) homogeneity of the regression hyperplanes must be satisfied (i.e., there must be equal regression slopes between the covariate and each of the dependent variables).

Pearson correlations were computed in the current study to assess the relationship of the covariate (i.e., task completion time) to the three dependent variables (i.e., probability of acceptance, adequacy rating, and confidence rating) for each case. Table 12 summarizes these data. For the positively valenced case (Jamie), significant correlations were found across the three dependent variables. Time was negatively correlated with the probability, adequacy and confidence ratings. That is, as task completion time increased, probability of admittance, adequacy, and confidence ratings all tended to decrease. No significant correlations, however, were found between the covariate and any of the three dependent variables for the neutrally valenced case (Kelli). Thus, task completion time does not appear to have met the necessary criteria for inclusion as a covariate with regard to the neutrally valenced case in this study.

Supplementary Group Process Analysis. In order to maximize the internal validity of individual and group processes, participants were instructed to form their individual responses (in the same way they had in the individual condition) prior to engaging in the group decision process. Multiple paired sample t-tests were conducted in order to analyze the subsequent group decision process. Across all dependent variables, the average of the three participants' individual responses was compared to their respective group response. Including all 60 groups and all three dependent variables, this analysis yielded 180 pairwise t-test comparisons. Only two of the 180 t-test comparisons reached conventional levels of significance, fewer than would be expected by chance alone. These results indicate that each group consensus response, regardless of outcome condition, essentially consisted of the pooled average of the individual responses generated by the participants comprising that group.

Qualitative Analysis

The forms of evidence provided by hindsight participants completing the counterfactual reasoning task were reviewed for differences. These data are summarized in Table 13. Many participants provided more than one piece of evidence to support either outcome, despite being required to provide only one. With regard to the positively valenced case (i.e., Jamie), however, nearly twice as many pieces of evidence were stated for the known-to-have-occurred outcome than for the outcome that did not occur ($\Sigma = 111$ vs. 63, respectively). For both cases, purely academic evidence (i.e., GPA and SAT scores), which is assumed to be the most highly weighted information in college admission decisions, was most commonly cited in support of the known-to-have-occurred outcome (62% of evidence for the positively valenced case and 98% of evidence for the neutrally valenced case). This was not the case with regard to the outcome that was known to have not occurred (39% of evidence for both cases). Thus, overall, the evidence that is presumed to carry the most weight in college admission decisions was that most frequently cited for the known-to-have-occurred outcome, but not for the outcome that did not occur.

Discussion

Hindsight Bias

The first hypothesis in the present investigation stated that the hindsight bias would be demonstrated. That is, those participants receiving outcome information (i.e., hindsight participants) would assign probabilities much closer to the actual outcome than those not receiving outcome information (i.e., foresight participants), despite being instructed to ignore the outcome information. These results supported this hypothesis. As noted, many different methods have been used to measure the

hindsight bias. Both parametric and non-parametric statistics have been used.

Consistent with Arkes et al. (1981) and Fischhoff (1975), this study demonstrated the hindsight bias using the binomial sign test. Participants who were provided with outcome information tended to provide outcome predictions consistent with the known-to-have-occurred outcome, despite being instructed to respond as they would have *before* knowing the outcome. Participants, thus, could not ignore the outcome information provided to them, and they subsequently saw the outcome as inevitable. Similarly, participants' confidence in their predictions and their rating of the adequacy of the information provided also increased in hindsight, when compared to foresight ratings. Thus, when the outcome was known, participants were more confident in their predictions and felt more secure in the amount of information they had in their decision making. In contrast, however, the magnitude of the hindsight bias for predictions, confidence ratings, and adequacy ratings in this sample population was not sufficient to yield significant results using parametric statistical procedures.

Results of the analyses in the current study also differed according to case valence. A strong hindsight effect regarding probability of admittance, confidence ratings, and adequacy ratings was found for the neutrally valenced case (i.e., Kelli) ($\geq 70\%$ of hindsight participants providing biased responses). The greatest biasing effect was found for probabilities of admittance, with 80% of hindsight participants providing outcome predictions biased toward the known-to-have-occurred outcome. Only a hindsight effect regarding confidence was demonstrated among participants responding to the positively valenced case (i.e., Jamie). It is possible, however, that a ceiling effect was evidenced with regard to the probabilities in this case. A positive valence in foresight (approximately 70% likelihood of acceptance), together with a

positive outcome provided in hindsight may have precluded a significant change in the number of participants increasing their predictions beyond the foresight level. The restriction in probability range caused by such a ceiling effect may also provide an explanation for the non-significant magnitude of the hindsight bias effect yielded in the parametric analyses. Alternatively, the results of the present study may simply reflect cognitive issues associated with the two cases used. The neutrally valenced case may have created more ambivalence in the individual and group decision makers and may have ultimately proven more interesting to the participants. In this way, the results of the present study may provide support for greater effects of the hindsight bias with more ambiguous cases. This interpretation explains the way in which a smaller effect size, such as that found in the meta-analysis of Christensen-Szalanski and Willham (1991), may have yielded significant differences with regard to the neutrally valenced, ambiguous case but not the positively valenced case.

Group Versus Individual Decision Making

The second hypothesis questioned whether groups of decision makers would demonstrate more or less hindsight bias than individual decision makers. This study demonstrated that groups of decision makers were just as prone to the hindsight bias as individual decision makers, consistent with Bukszar and Connolly (1988) and Stahlberg et al. (1995). Similar to individual participants, a significant number of participant groups provided with outcome information subsequently assigned outcome predictions consistent with the known-to-have-occurred outcome, despite being instructed to respond as they would have *before* knowing the outcome. Groups were no more able to ignore outcome information provided to them, and they subsequently also saw the outcome as inevitable. Participant groups also provided higher

confidence and adequacy ratings in hindsight when compared to foresight participant groups. Thus, in hindsight, individuals and groups alike tended to see the known outcome as inevitable, to be more confident in their predictions, and to feel more strongly that they had enough information to make such predictions. Decision groups appear as equally prone to the hindsight bias as individual decision makers. Again, however, the magnitude of the hindsight effect was not sufficient in this sample population to yield significant results using parametric statistical procedures.

Prior to engaging in the group decision process, participants first were asked to formulate their responses as individuals. This was done to maximize the internal validity of the study by ensuring consistency in task completion parameters. A similar procedure was employed in the group versus individual decision-making research of Bukszar and Connolly (1988), who similarly found no attenuation of the hindsight bias via the group decision process. Such a procedure, however, may not reflect the way group decisions tend to be made in the general population. Without further clarification of the true parameters of group decision-making, population generalizations related to the current findings remain tenuous.

Further analysis of the group decision process also revealed that participants tended, in large part, to average their individual responses when developing their group consensus response. This alone may account for the lack of differences between group and individual responses in the current investigation. In asking participants to predict outcomes using percentages (e.g., versus a dichotomous yes/no format), participants may have been encouraged to employ the logical and time-efficient strategy of simply averaging their individual responses. Based on an average group decision time of under 3 minutes, there appears to have been minimal motivation for

debate within the group decision format. Isolating one individual response from each group for additional comparison may not have been sufficient to overcome the overwhelming degree to which participants averaged their responses when in the group decision making format.

Elimination of the Hindsight Bias

The third hypothesis in the present investigation stated that hindsight participants completing a counterfactual reasoning task would demonstrate less hindsight bias than those hindsight participants not completing the task. Results from this study did not provide support for this hypothesis. Despite being required to examine both outcomes more thoroughly as possibilities, a significant number of individual and group responses remained biased to the known-to-have-occurred outcome. Hindsight participants completing the extra task were also no less confident in their predictions and felt that the information they were provided with was just as adequate, if not more, when compared to those hindsight participants not completing the task. Analyses were non-significant using both the non-parametric and the parametric procedures. Qualitative analysis of the evidence generated by participants completing the counterfactual reasoning task revealed a differential pattern of case data cited in support of the known outcome than for the non-reported outcome. In college admission decisions, it is presumed that academic factors (i.e., GPA and SAT scores) are weighted more heavily than other relevant factors (e.g., volunteer work, sports participation, work experience). In this study, purely academic factors were cited most commonly in support of the known outcome, and less frequently for the non-reported outcome. If participants did, in fact, assign higher decision weights to academic than nonacademic evidence, then the counterfactual reasoning task must be

interpreted as insufficient, by nature, for attenuating bias toward the known outcome. The known outcome was supported by more influential data that was likely to overpower any beneficial effects of citing evidence in support of the non-reported outcome. Previous research has demonstrated a significant attenuation of the hindsight bias using a similar procedure with clinical neuropsychologists (Arkes et al., 1988), in which evidence was requested for each of three possible outcomes. The individual pieces of case information provided to participants in that study, however, may have been more equally weighted across outcome diagnoses than in the present study. Similar research also has demonstrated a robust attenuation of the hindsight bias when reasons were generated for the non-occurring outcome only (Davies, 1992; Koriatic, Lichtenstein, & Fischhoff, 1980; Pohl & Hell, 1996). It may be hypothesized that generating *counterfactual reasons* alone (i.e., evidence to support only the non-reported outcome) would have been necessary to eliminate bias toward the known outcome in the present study. It is likely that asking participants to provide evidence for the known outcome as well may have cancelled out any beneficial effects of the counterfactual reasoning task. Thus, the beneficial effect of considering all possible outcomes within the decision making process may vary according to the differential weights assigned to contributing decision data. The hindsight bias may be reduced most effectively by generating evidence only for alternative outcomes, presuming that the chosen outcome is inherently provided sufficient support by the decision maker.

Decision Time

The fourth hypothesis in this investigation stated that groups would take more time to make their decisions, and those completing the counterfactual reasoning task would take more time in their decision making than those not completing the task.

These results provide support for this hypothesis. Groups, as predicted, took significantly more time to reach consensus than did individual decision makers. In addition, those hindsight participants completing the counterfactual reasoning task, whether working as individuals or in groups, also took significantly more time to respond than did individual and group participants who did not complete the extra task.

It does not appear, however, that the amount of time taken by different treatment groups was a significant source of confounding variance in the present study. Overall, time was negatively correlated with probability, confidence, and adequacy ratings for the positively valenced case but no significant correlations were produced with regard to the neutrally valenced case. Therefore, completion time did not meet the statistical criteria necessary for appropriate inclusion as a covariate in parametric analyses. In this study, however, completion time was recorded in minutes, and the range in amount of time taken was restricted, which may have precluded findings of reliably significant correlations between it and the other dependent variables. The low overall mean in response time (<3 minutes) in the current investigation may be a result of lower-than-expected task difficulty or it may be a reflection of low participant motivation. Low participant motivation also may explain the overwhelming tendency (described above) of group participants simply to derive an average of their individual responses when asked to reach group consensus.

Alternatively, task completion time may not, in fact, be a mediating factor in the hindsight bias within hypothetical research designs such as the one employed in the current investigation. In previous research, group and individual differences were found to be mediated by the increased amount of time groups spent in their decision-

making (Stahlberg et al., 1995). This research, however, employed a memory design, in which participants were asked to recall previously formulated predictions after having subsequently received outcome information. Within this design format, groups were just as likely as individuals to provide biased responses in hindsight. Initial predictions, however, were recalled more accurately in groups (i.e., better hit rates), presumably as a result of spending more time in the decision process. In contrast, using a hypothetical design, participants are not actually required to make foresight predictions – only to respond in hindsight *as they would have before knowing the outcome*. As such, recall (or hit rate) is irrelevant in hypothetical designs, essentially nullifying the effect of increased decision time according to this hypothesis. And, as Stahlberg et al. (1995) found, hindsight distortions did, in fact, emerge to an approximately equal extent among individual and group respondents using the hypothetical design format.

Limitations and Future Directions

Four limitations were identified with regard to the current investigation. First, varying the foresight valence of the cases employed (i.e., positive and neutral) was of limited scientific utility because it precluded direct case-to-case comparisons. The positively valenced case, because it subsequently was assigned a positive outcome in hindsight, additionally may have elicited a ceiling effect in participant responding. Future research could employ a completely crossed design, where all participants respond to both cases under all conditions, which would allow for more direct comparison. Alternatively, future investigations could employ two different cases that are both neutral in foresight predictions and then vary the outcome assigned in hindsight to allow for more valid comparisons across cases.

Secondly, the steps taken to maximize internal validity between individual and group decision processes in the current study may have limited both the nature of group outcomes and the extent to which group decision data can be generalized to typical group decision processes in the population at large. For example, it is unclear if group members processed information in ways consistent with generally recognized social psychological principles of group processing (e.g., conformity, group polarization) (for further examples see Baron & Graziano, 1991). Previous research examining group versus individual decision making without controlling for process factors have yielded mixed results (Aspel, 1994; Wright, Luus & Christie, 1990; Wright & Wells, 1985), with some studies supporting less biased outcomes when decisions were made in groups. Future research should seek to isolate the group decision-making process more specifically. One way to accomplish this would be to replicate the design of the current study, adding a third process group composed of individuals who had not delineated their individual responses prior to engaging in the group decision task. This would provide for a comparison group whose decision-making processes may be a more accurate reflection of true population decision processes. Adding such a comparison group, in turn, may yield differences from the other two decision groups that would provide support for the group process itself as a significant source of variance in attenuating the hindsight bias.

Third, the counterfactual reasoning task employed in the current investigation may have been inherently limited in significantly reducing the hindsight bias by inadvertently bolstering support for the known outcome. This is likely to have increased the salience of the inherently dominant, known outcome more so than for the non-reported outcome. An alternative explanation for the lack of effectiveness of the

counterfactual reasoning task relates to participant compliance with experimental instructions. Individual and group participants were instructed to provide only one piece of evidence for each of the two possible outcomes. In fact, many participants, especially with regard to the positively valenced case, provided more than one piece of evidence for the known outcome. This may have invalidated the counterfactual reasoning task as a means of making the alternative outcome more salient in the decision-making process. Future research focused on successful techniques for eliminating the hindsight bias should revert to classic paradigms (see Koriatic, Lichtenstein & Fischhoff, 1980; Slovic & Fischhoff, 1977) in which reasons and support are only generated for the non-reported outcome. If the current methodology is replicated, participants should be implored to comply with task instructions as given. Alternatively, future investigations could seek to provide more equally weighted evidence in support of all possible outcomes. Designing case materials in this way would serve to isolate the debiasing effect of considering all possibilities more equally within the decision-making process. In the current investigation, academic data may have been presumed to carry more weight in admission decisions and were, therefore, more frequently cited in support of the known outcome.

Finally, completion time did not meet criteria for inclusion as a covariate in the current study. Response time was correlated with the three dependent variables for the positively valenced case only. It is likely that the restricted range of decision time ($M < 3$ minutes) in the present study precluded reliable correlations between it and the dependent variables. Future research should use decision tasks requiring more extensive deliberation time in order to determine the nature of the effects of decision time on the group decision process. It also is likely that decision time may be

irrelevant with regard to the hindsight bias, especially within hypothetical research designs. Prior research yielding significant results for decision time within group processes employed a memory design, in which previously made judgments had to be recalled after receiving outcome information (Stahlberg et al., 1995). Hit rates improved in the group process (presumably as a function of increased time in deliberation), but groups were equally biased in hindsight when compared to the individual decision makers. Thus, the hindsight bias itself, in fact, may not be mediated by the increased time spent in deliberation among groups. Further investigation will be necessary to delineate the confounding effect of increased decision time more clearly in groups versus individual decision makers. Increased decision time may simply be inherent in a task involving the integration of ideas from $n+1$ group members versus one individual decision maker and have no differential effect on the resulting outcome data.

Conclusions

In summary, the present investigation provided support for the presence of the hindsight bias in human decision making processes. This bias has been demonstrated consistently in multiple contexts and across a wide variety of disciplines and continues to influence decision making today. Decisions made in a three-person group format were just as likely to be biased in hindsight as individual decisions. Differential results for the two case vignettes, however, do not provide support for Fischhoff's (1975) "immediate assimilation hypothesis." The bias was present for the neutrally valenced case but not for the positively valenced case. If outcome information were immediately assimilated into what was already known, effectively replacing prior considerations, a bias would have been demonstrated for the positive case as well.

Results indicated, in fact, that outcome probabilities did not significantly shift toward the known outcome in hindsight for participants responding to the positively valenced case. Results do, in contrast, provide support for the social psychological theory of the hindsight bias, namely that of the availability heuristic. Such a theory does not eliminate the possibility of differential case effects and provides an explanation for the lack of significance with regard to the counterfactual reasoning task. As stated above, participants tended to provide more than one piece of evidence for the known outcome, especially with regard to the positively valenced case, and tended to provide academic evidence in support of the known outcome. If more heavily weighted evidence was provided for the known outcome, it can be concluded that the known outcome remained salient in the decision makers minds, thus rendering the counterfactual reasoning task ineffective in increasing the salience of the alternative outcome.

With the rising use of decision “teams” across multiple medical, educational, and legal settings, further consideration is warranted with regard to the assumption that two or more “heads” are better than one. The burden of proof remains with the proponents of group decision formats to demonstrate improvements in decision accuracy and/or resilience to the negative effects of known decision errors on judgment. The hindsight bias was also not successfully eliminated in the current investigation through use of a previously documented counterfactual reasoning procedure. The nature of the beneficial effects of such a procedure remains to be determined before its widespread utility in eliminating the hindsight bias can be assumed.

Table 1

Pilot Study Results

Correlated Groups T-Test

N = 15

	Positive Vignette (Jamie)	Neutral Vignette (Kelli)	
Mean probability of positive outcome	66.67	54.33	p < .05
S.D.	20.50	24.85	

Table 2Mean Probability Assigned to Outcome: Positive Case/Positive Outcome (Jamie)

Condition	N	Decision	
		Admit	Reject
Individual			
Foresight	30	72	28
Hindsight	30	67 (15)	33
Hindsight with Task	30	73	27 (8)
Group			
Foresight	10	69	31
Hindsight	10	78 (7)	22
Hindsight with Task	10	69	31 (7)

Note. The numbers in parentheses indicate the number of participants whose probability estimate for that particular outcome exceeds the corresponding foresight estimate (for hindsight participants) or the corresponding hindsight estimate (for hindsight participants with an extra task).

Table 3Mean Probability Assigned to Outcome: Neutral Case/Negative Outcome (Kelli)

		Decision	
Condition	N	Admit	Reject
Individual			
Foresight	30	47	53
Hindsight	30	31	69 (24)
Hindsight with Task	30	34 (13)	66
Group			
Foresight	10	45	55
Hindsight	10	37	63 (8)
Hindsight with Task	10	37 (5)	63

Note. The numbers in parentheses indicate the number of participants whose probability estimate for that particular outcome exceeds the corresponding foresight estimate (for hindsight participants) or the corresponding hindsight estimate (for hindsight participants with an extra task).

Table 4

Mean Confidence Rating Assigned to Prediction: Positive Case/Positive Outcome(Jamie)

Condition	N	Rating	
		Confident	Not Confident
Individual			
Foresight	30	73	27
Hindsight	30	79 (20)	21
Hindsight with Task	30	71	29 (18)
Group			
Foresight	10	73	27
Hindsight	10	80 (7)	20
Hindsight with Task	10	65	35 (6)

Note. The numbers in parentheses indicate the number of participants whose confidence rating of their prediction exceeds the corresponding foresight rating (for hindsight participants) or the corresponding hindsight rating (for hindsight participants with an extra task).

Table 5Mean Confidence Rating Assigned to Prediction: Neutral Case/Negative Outcome(Kelli)

Condition	N	Rating	
		Confident	Not Confident
Individual			
Foresight	30	73	27
Hindsight	30	79 (22)	21
Hindsight with Task	30	73	27 (14)
Group			
Foresight	10	72	28
Hindsight	10	84 (8)	16
Hindsight with Task	10	78	22 (7)

Note. The numbers in parentheses indicate the number of participants whose confidence rating of their prediction exceeds the corresponding foresight rating (for hindsight participants) or the corresponding hindsight rating (for hindsight participants with an extra task).

Table 6

Mean Adequacy Rating Assigned to Information: Positive Case/Positive Outcome
(Jamie)

Condition	N	Rating	
		Adequate	Not Adequate
Individual			
Foresight	30	78	22
Hindsight	30	80 (19)	20
Hindsight with Task	30	79	21 (10)
Group			
Foresight	10	74	26
Hindsight	10	78 (7)	22
Hindsight with Task	10	71	29 (4)

Note. The numbers in parentheses indicate the number of participants whose adequacy rating of the information provided exceeds the corresponding foresight rating (for hindsight participants) or the corresponding hindsight rating (for hindsight participants with an extra task).

Table 7

Mean Adequacy Rating Assigned to Information: Neutral Case/Negative Outcome
(Kelli)

Condition	N	Rating	
		Adequate	Not Adequate
Individual			
Foresight	30	73	27
Hindsight	30	80 (21)	20
Hindsight with Task	30	78	22 (8)
Group			
Foresight	10	77	23
Hindsight	10	82 (8)	28
Hindsight with Task	10	80	20 (6)

Note. The numbers in parentheses indicate the number of participants whose adequacy rating of the information provided exceeds the corresponding foresight rating (for hindsight participants) or the corresponding hindsight rating (for hindsight participants with an extra task).

Table 8Pooled Multivariate Analysis of Covariance

Source	<u>F</u>	<u>p</u>
Completion Time (covariate)	1.12	.344
Outcome	1.80	.100
Case	42.36	.000
Process	.62	.603
Outcome x Case	1.06	.390
Outcome x Process	.51	.797
Case x Process	.78	.509
Outcome x Case x Process	.32	.928

Table 9Unpooled Multivariate Analysis of Covariance

Source	<u>F</u>	<u>p</u>
Completion Time (covariate)	1.74	.164
Outcome	1.54	.168
Case	25.34	.000
Process	1.08	.360
Outcome x Case	2.20	.045
Outcome x Process	.52	.790
Case x Process	.55	.648
Outcome x Case x Process	.62	.711

Table 10

Analysis of Variance Assessing Differences in Completion Time

Source	F	p
Process	8.33	.005
Outcome	9.60	.000
Process x Outcome	.80	.450

Table 11

Pairwise Comparisons of Completion Time by Outcome Condition

Comparisons	p
Foresight vs. Hindsight	.201
Hindsight vs. Hindsight + Task	.000
Foresight vs. Hindsight + Task	.026

Table 12

Intercorrelations Between Time and Dependent Variables for Group Responses by Case

Variable	1	2	3	4
Positive Case ($\underline{n} = 90$)				
1. Time	--	-.338*	-.420**	-.460**
2. Probability		--	.428**	.442**
3. Adequacy			--	.663**
4. Confidence				--
Neutral Case ($\underline{n} = 90$)				
1. Time	--	-.067	.135	-.020
2. Probability		--	-.196	-.059
3. Adequacy			--	.757**
4. Confidence				--

Note. Values in bold type indicate intercorrelations between dependent variables and the covariate.

* $p < .01$

** $p < .001$

Table 13

Summary of Evidence Provided by Hindsight Participants Completing Counterfactual Reasoning Task

Evidence for			Evidence for		
Admission	Frequency	%	Rejection	Frequency	%
Positively Valenced Case (Jamie)					
GPA	38	34	No Academic Clubs	36	57
SATs	31	28	GPA	16	25
Sports	18	16	SATs	9	14
Class Rank	13	12	Class Rank	1	2
Work Experience	8	7	Parents Didn't Attend	1	2
Ranked in Who's Who	3	3			
Neutrally Valenced Case (Kelli)					
GPA	29	39	SATs	50	70
Academic Clubs	17	23	GPA	20	28
Volunteer Work	15	20	Class Rank	1	1
Class Rank	8	11			
Violin	5	7			

Appendix A

Case A

Current Time: _____

Jamie is a senior in high school. He lives with his parents who never attended college but strongly encourage him to apply. Jamie's older sister is currently a sophomore in college. Jamie's goal is to attend an ivy league college in another state. The public high school he attends is in a large, urban school district, and he is currently ranked in the top 20% of his class. His cumulative grade point average (GPA) after his junior year in high school is a 3.7, or 90%. He is taking college preparatory classes and is currently earning a "B" average in those courses. Jamie has taken the Scholastic Aptitude Test (SAT) twice. His highest combined score is a 1050, with a score of 500 in the Verbal section and a score of 550 in the Math section. Jamie plays varsity football and is in the Letterman's Club at his high school, but he is not being considered for any college football scholarships. He is not in any academic clubs or organizations, although he is listed in the publication, "Who's Who Among American High School Students." He has had a summer job for two years working for a landscaping business.

Hindsight condition: Jamie was recently accepted for admission by the ivy league college that he was most interested in, and he will be enrolling as an incoming first-year student there in August, 1999.

Case B

Current Time: _____

Kelli is a senior in high school. She lives with her parents and has two younger brothers. Her father is a college graduate and manages a retail store, and her mother is a full-time homemaker. Kelli's goal is to attend an ivy league college in her home state. The public high school she attends is in a relatively small, suburban school district, and Kelli is currently ranked in the top 30% of her class. Her cumulative grade point average (GPA) after her junior year was a 3.5 or 88%. She is taking college preparatory classes and is currently earning a "B" average in those courses. Kelli has taken the Scholastic Aptitude Test (SAT) three times. Her highest combined score is a 900, with a score of 500 in the Verbal section and a score of 400 in the Math section. Kelli has volunteered for one year in the local city hospital as a "candy striper." She hopes to major in PreMed in college and eventually apply to medical school. Kelli is in the Math and Science Club at her high school, and she plays the violin in the school orchestra.

Hindsight bias: Kelli recently found out that she was not accepted by the ivy league college that she hoped to attend.

Appendix B
Demographic Sheet

Please complete the following questions anonymously:

Age _____

Number of semesters of college completed (for example, a current second-semester freshman will have completed 1 semester of college):

Name of the course that you are receiving credit for by participating in this experiment
(for example, PSY 113 -- Introduction to Psychology):

Appendix C
Participant Response Sheet

Current Time: _____

[Instructions adapted from Arkes et al., 1988]

Based on your consideration of the information provided, what is the probability you would assign to each of the outcomes as the *most likely* one?

Hindsight condition: Please respond as you would have **before** knowing the actual outcome.

[Counterfactual Reasoning task instructions: After each of the following outcomes, please jot down one piece of evidence from the case description that would support that particular outcome as the primary one.]

Assign a probability to both outcomes, making sure that the probabilities add to 100%.

Jamie will be accepted to the college of his choice. _____%

[Evidence]

Jamie will not be accepted to the college of his choice. _____%

[Evidence]

TOTAL = 100%

[Adapted from Bukszar & Connolly, 1988 and Aspel, 1994]

On a scale from 0 to 100, how adequate was the information you were given for making the above predictions (0 = completely inadequate/information not at all helpful; 100 = completely adequate/needed no more information than was provided)?

On a scale from 0 to 100, how confident do you feel making these predictions based on the information provided to you (0 = not at all confident; 100 = completely confident)?

Please indicate the time that you completed the above information:

Current Time: _____

Appendix D

Procedural Guidelines and Instructions

Prior to the participants' arrival, the administration set is randomly assigned a decision process order (i.e., individual -- group or group -- individual) and to one of three possible outcome/intervention groups (i.e., foresight outcome, hindsight outcome, or hindsight outcome with a Counterfactual Reasoning task). Thus, the entire administration set will receive the same instructions and will complete the same task in the same order. For example, administration set 1 may be assigned to the foresight outcome condition, where all participants make decisions first as individuals and then as members of three-person decision groups. Upon arrival, participants randomly are to be assigned to read either Case A first or to read Case B first.

Foresight Outcome Condition

1. Upon arrival, participants are to be given an individual packet containing: (a) two copies of the consent form, (b) a demographic sheet, (c) smaller envelope 1, containing written instructions, either Case A or Case B, and a response sheet, and (d) smaller envelope 2, containing written instructions, the other case, and a second response sheet.
2. When all participants are seated, they are to be instructed to remove the contents of their envelopes and to read and sign one copy of the consent form, which should then be collected by the examiner.

3. Participants are then to complete the demographic sheet included in their packets.
4. Participants will next be asked to open smaller envelope 1 and read only the case description.

The following instructions are to be read to the participants in addition to the written instructions already provided. Instructions will vary depending on whether the decisions are made as individuals or in groups:

Individual Administration

5. Now I will give you the instructions for filling out the response sheet. You will have 20 minutes to complete this task. Based on your consideration of the information provided, what is the probability you would assign to each of the outcomes as the *most likely one*? By probability, I mean: what are the "odds" that this person will or will not get into college. For example, if you thought it was very likely (or that the odds were good) that President Clinton would be impeached, you might say that it is 80% likely that he will be impeached and 20% likely that he won't be. If you thought, instead, that he wouldn't be impeached, you might say that it is 20% likely that he will be impeached and 80% likely that he won't be. Keep in mind that your two probabilities MUST add up to 100%.

[*Hindsight condition*: Please respond as you would have *before* knowing the actual outcome.]

[*Counterfactual Reasoning task instructions:* After *each* of the following outcomes, please write down one piece of evidence from the case description to support why that particular outcome *could* be the real one. For example, under your probability rating for why President Clinton will be impeached, you could state, "Counsel Kenneth Starr's report states that the president lied under oath." And, under your probability rating for why President Clinton will not be impeached, you could state, "There will not be enough of a majority vote in the Senate to impeach the president."]

6. Then, rate on a scale from 0 to 100, how adequate the information was that you were given for making these predictions?
7. And finally, rate on a scale from 0 to 100, how confident you feel making these predictions based on the information provided to you.
8. Also, please write down the time that you start filling out the form at the top of the page and the time you finish filling out the form at the bottom of the page.

Group Administration

5. Now I will give you the instructions for filling out the response sheet. You will have 20 minutes to complete this task. You will be filling out the response sheet as a three-person group. Starting with the first item, you must each use the scrap paper to write down your individual responses. Then each person is to read their responses and the group must come to a consensus and respond to each question with one group answer. Each group member must participate in this way.

Based on your consideration of the information provided, what is the probability you would assign to each of the outcomes as the *most likely one*? By probability, I mean: what are the "odds" that this person will or will not get into college. For example, if you thought it was very likely (or that the odds were good) that President Clinton would be impeached, you might say that it is 80% likely that he will be impeached and 20% likely that he won't be. If you thought, instead, that he wouldn't be impeached, you might say that it is 20% likely that he will be impeached and 80% likely that he won't be. Keep in mind that your two probabilities MUST add up to 100%.

[*Hindsight condition*: Please respond as you would have *before* knowing the actual outcome.]

[*Counterfactual Reasoning task instructions*: After *each* of the following outcomes, please write down one piece of evidence from the case description to support why that particular outcome *could* be the real one. For example, under your probability rating for why President Clinton will be impeached, you could state, "Counsel Kenneth Starr's report states that the president lied under oath." And, under your probability rating for why President Clinton will not be impeached, you could state, "There will not be enough of a majority vote in the Senate to impeach the president." Again, each person is to write down a reason and then the group is to come to a consensus and respond with one group answer.]

6. Then, rate on a scale from 0 to 100, how adequate the information was that you were given for making these predictions? Again, each group member writes down their individual response and the group then must come to a consensus and respond with one group answer.

7. And finally, rate on a scale from 0 to 100, how confident you feel making these predictions based on the information provided to you. Again, each group member writes down their individual responses and the group then must come to a consensus and respond with one group answer.

8. Also, please write down the time that you start filling out the form at the top of the page and the time you finish filling out the form at the bottom of the page.

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