JUDGMENT IN MANAGERIAL DECISION MAKING

4TH EDITION

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JOHN WILEY & SONS
New York • Chichester • Weinheim
Brisbane • Singapore • Toronto

CHAPTER TWO

Biases

The discussion of heuristics in Chapter 1 suggested that individuals develop rules of thumb to reduce the information-processing demands of decision making. These rules of thumb provide managers with efficient ways of dealing with complex problems that produce good decisions a significant proportion of the time. However, heuristics also lead managers to systematically biased outcomes. Cognitive bias occurs in situations in which a heuristic is inappropriately applied by an individual in reaching a decision.

This chapter is written to provide you with the opportunity to audit your own decision making and identify the biases that affect you. A number of problems are presented that allow you to examine your problem solving and learn how your judgments compare to the judgments of others. The quiz items are then used to illustrate 13 predictable biases to which managers are prone and that frequently lead to judgments that systematically deviate from rationality.

To begin, consider the following two problems:

Problem 1: The following 10 corporations were ranked by *Fortune* magazine to be among the 500 largest United States-based firms according to sales volume for 1995:

Group A: Black and Decker, Dean Foods, McGraw-Hill, Owens-Corning, Pennzoil

Group B: American International Group, Albertson's, McKesson, USX, Pricecostco

Which group of five organizations listed (A or B) had the larger total sales volume?

Problem 2 (Adapted from Kahneman and Tversky, 1973): The best student in my introductory MBA class this past semester writes poetry and is rather shy and small in stature. What was the student's undergraduate major:

(A) Chinese studies or (B) Psychology?

What are your answers? If you answered A for each of the two problems, you may gain comfort in knowing that the majority of respondents choose A. If you answered

B, you are part of the minority. In this case, however, the minority represents the correct response. All corporations in group B were ranked in the Fortune 100, while none of the corporations in group A had sales as large. In fact, the total sales for group B was more than five times the total sales for group A. In the second problem, the student was actually a psychology major, but more important, selecting psychology as the student's major represents a more rational response given the limited information.

Problem 1 illustrates the availability heuristic discussed in Chapter 1. In this problem, group A contains consumer firms, while group B consists of firms less well known to consumers. Most of us are more familiar with consumer firms than conglomerates and can more easily generate information in our minds about their size. If we were aware of our bias resulting from the availability heuristic, we would recognize our differential exposure to this information and adjust, or at least question, our judgments accordingly.

Problem 2 illustrates the representativeness heuristic. The reader who responds "Chinese studies" has probably overlooked relevant base-rate information—namely, the likely ratio of Chinese studies majors to psychology majors within the MBA student population. When asked to reconsider the problem in this context, most people change their response to "psychology," in view of the relative scarcity of Chinese studies majors seeking MBAs. This example emphasizes that logical base-rate reasoning is often overwhelmed by qualitative judgments drawn from available descriptive information.

The purpose of Problems 1 and 2 is to demonstrate how easily faulty conclusions are drawn when we overrely on cognitive heuristics. In the remainder of this chapter, additional problems are presented to further increase your awareness of the impact of heuristics on your decisions and to help you develop an appreciation for the systematic errors that emanate from overdependence on them. The 13 biases examined in this chapter are relevant to virtually all individuals. Each of the biases is related to at least one of the three judgmental heuristics introduced in Chapter 1, and an effort has been made to categorize them accordingly. However, the way our minds work in developing and using the heuristics is not straightforward. Often our heuristics work in tandem in approaching cognitive tasks.

The goal of the chapter is to help you "unfreeze" your decision-making patterns and realize how easily heuristics become biases when improperly applied. By working on numerous problems that demonstrate the failures of these heuristics, you will become more aware of the biases in your decision making. By learning to spot these biases, you can improve the quality of your decisions.

Before reading further, please take a few minutes to respond to the problems outlined in Table 2.1.

BIASES EMANATING FROM THE AVAILABILITY HEURISTIC

Bias 1—Ease of Recall (based on vividness and recency)

Problem 3. Which of the following causes more deaths in the United States each year?

(A) Stomach cancer or (B) Motor vehicle accidents

TABLE 2.1 Chapter Problems

Respond to the following problems before reading the chapter.

Problem 3: Which of the following causes more deaths in the United States each year:
a. Stomach cancer **b.** Motor vehicle accidents

Problem 4a: In four pages of a novel (about 2,000 words), how many words would you expect to find that have the form _ _ _ _ *ing* (seven-letter words that end with *ing*)? Indicate your best estimate by circling one of the values below:

0 1–2 3–4 5–7 8–10 11–15 16+

Problem 4b: In four pages of a novel (about 2,000 words), how many words would you expect to find that have the form _ _ _ _ _ *n* _ (seven-letter words that have the letter *n* in the sixth position)? Indicate your best estimate by circling one of the values below:

0 1–2 3–4 5–7 8–10 11–15 16+

Problem 5: Mark is finishing his MBA at a prestigious university. He is very interested in the arts and at one time considered a career as a musician. Is he more likely to take a job
a. in the management of the arts? **b.** with a management consulting firm?

Problem 6: A certain town is served by two hospitals. In the larger hospital about 45 babies are born each day and in the smaller hospital about 15 babies are born each day. As you know, about 50 percent of all babies are boys. However, the exact percentage varies from day to day. Sometimes it may be higher than 50 percent, sometimes lower.
For a period of one year, each hospital recorded the days in which more than 60 percent of the babies born were boys. Which hospital do you think recorded more such days?
__ The larger hospital? __ The smaller hospital?
__ About the same? (that is, within 5 percent of each other)

Problem 7: You are about to hire a new central-region sales director for the fifth time this year. You predict that the next director should work out reasonably well, since the last four were "lemons," and the odds favor hiring at least one good sales director in five tries. This thinking is
a. correct **b.** incorrect

Problem 8: You are the sales forecaster for a department store chain with nine locations. The chain depends on you for quality projections of future sales in order to make decisions on staffing, advertising, information system developments, purchasing, renovation, and the like. All stores are similar in size and merchandise selection. The main difference in their sales occurs because of location and random fluctuations. Sales for 1997 were as follows:

Store	*1997*	*1999*
1	$12,000,000	
2	11,500,000	
3	11,000,000	
4	10,500,000	
5	10,000,000	
6	9,500,000	
7	9,000,000	
8	8,500,000	
9	8,000,000	
Total	$90,000,000	$99,000,000

TABLE 2.1 *(continued)*

Your economic forecasting service has convinced you that the best estimate of total sales increases between 1997 and 1999 is 10 percent (to $99,000,000). Your task is to predict 1999 sales for each store. Since your manager believes strongly in the economic forecasting service, it is imperative that your total sales equal $99,000,000.

Problem 9: Linda is 31 years old, single, outspoken, and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and she participated in antinuclear demonstrations.

Rank order the following eight descriptions in terms of the probability (likelihood) that they describe Linda:

__ a. Linda is a teacher in an elementary school.

__ b. Linda works in a bookstore and takes yoga classes.

__ c. Linda is active in the feminist movement.

__ d. Linda is a psychiatric social worker.

__ e. Linda is a member of the League of Women Voters.

__ f. Linda is a bank teller.

__ g. Linda is an insurance salesperson.

__ h. Linda is a bank teller who is active in the feminist movement.

Problem 10: A newly hired engineer for a computer firm in the Boston metropolitan area has four years of experience and good all-around qualifications. When asked to estimate the starting salary for this employee, my secretary (knowing very little about the profession or the industry) guessed an annual salary of $23,000. What is your estimate?

$____ per year.

Problem 11: Which of the following appears most likely? Which appears second most likely?

a. Drawing a red marble from a bag containing 50 percent red marbles and 50 percent white marbles.

b. Drawing a red marble seven times in succession, with replacement (a selected marble is put back into the bag before the next marble is selected), from a bag containing 90 percent red marbles and 10 percent white marbles.

c. Drawing at least one red marble in seven tries, with replacement, from a bag containing 10 percent red marbles and 90 percent white marbles.

Problem 12: Listed below are 10 uncertain quantities. Do not look up any information on these items. For each, write down your best estimate of the quantity. Next, put a lower and

(continued)

Russo and Shoemaker (1989) created this problem to demonstrate how we are unaware of the way we are influenced by vivid accounts in the media. Most people believe that motor vehicle accidents cause more deaths. Contrary to this belief, stomach cancer causes more deaths than motor vehicle accidents by a ratio of more than two to one. Russo and Shoemaker went on to document that during a one-year period, two typical newspapers reported 137 stories that involved deaths by motor vehicle accidents and only one as a result of stomach cancer. The availability of instances in the media frequently biases our perception of the frequency of events.

TABLE 2.1 *(continued)*

upper bound around your estimate, such that you are 98 percent confident that your range surrounds the actual quantity.

Estimate	Lower	Upper	
____	____	____	a. Amount of industrial waste generated in the U.S. in 1990 in tons
____	____	____	b. Total households in the U.S., according to a 1994 Bureau of the Census poll
____	____	____	c. Crime rate per 100,000 population in the U.S. in 1993
____	____	____	d. Number of immigrants admitted into the U.S. in 1993
____	____	____	e. Number of species and subspecies of North American mammals extinct since 1600
____	____	____	f. Percentage of paper and cardboard recovery rates in the Netherlands in 1989
____	____	____	g. Annual precipitation in Reno between 1961–1990 (in inches)
____	____	____	h. Live births in the U.S. in 1992
____	____	____	i. Average salary for a secondary school teacher in Illinois in 1994
____	____	____	j. Plastic waste generated in the U.S. in 1993 in tons

Problem 13: (Adapted from Einhorn and Hogarth, 1978) It is claimed that when a particular analyst predicts a rise in the market, the market always rises. You are to check this claim. Examine the information available about the following four events (cards):

Card 1	*Card 2*	*Card 3*	*Card 4*
Prediction: Favorable report	Prediction: Unfavorable report	Outcome: Rise in the market	Outcome: Fall in the market

You currently see the predictions (cards 1 and 2) *or* outcomes (cards 3 and 4) associated with four events. You are seeing one side of a card. On the other side of cards 1 and 2 is the actual outcome, while on the other side of cards 3 and 4 is the prediction that the analyst made. Evidence about the claim is potentially available by turning over the card(s). Which cards would you turn over for the evidence that you need to check the analyst's claim? (Circle the appropriate cards.)

Critical life decisions are also affected by the vividness of information. AIDS has developed into a devastating disease. Yet many individuals ignore all the data that exists about how to avoid contracting AIDS. In the fall of 1991, however, sexual behavior in Dallas was dramatically affected by one vivid piece of data, which may or may not have been true. In a chilling interview, a woman, who used the name C. J. and who was from Dallas, claimed to have AIDS and told how she was trying to spread the disease out of revenge against the man who had infected her. This vivid interview hit the presses, attendance at AIDS seminars increased dramatically, AIDS

became the central concern of Dallas talk shows, and requests for HIV tests surged. Although there is a realistic concern created by C. J.'s possible actions, it is clear that most of the health risks related to AIDS are not a result of one woman's actions. There are many more important reasons to be concerned about AIDS. However, C.J.'s vivid report had a more substantial effect on many people's behavior than the mountains of data that had been available for years.

Tversky and Kahneman (1974) argue that when an individual judges the frequency of an event by the *availability* of its instances, an event whose instances are more easily recalled will appear to be more numerous than an event of equal frequency whose instances are less easily recalled. They cite evidence of this bias in a lab study in which individuals were read lists of names of well-known personalities of both sexes and asked to determine whether the lists contained the names of more men or women. Different lists were presented to two groups. One group received lists bearing the names of women who were relatively more famous than the listed men, but included more men's names overall. The other group received lists bearing the names of men who were relatively more famous than the listed women, but included more women's names overall. In each case, the participants incorrectly guessed that the sex that had the more famous personalities was the more numerous.

Many examples of this bias can be observed in the decisions made by managers in the workplace. The following came from the experience of one of my MBA students: As a purchasing agent, he had to select one of several possible suppliers. He chose the firm whose name was the most familiar to him. He later found out that the salience of the name resulted from recent adverse publicity concerning the firm's extortion of funds from client companies!

Managers conducting performance appraisals often fall victim to the availability heuristic. Working from memory, the vivid instances relating to an employee that are more easily recalled from memory (either pro or con) will appear more numerous and will therefore be weighted more heavily in the performance appraisal. Managers also give more weight to performance during the three months prior to the evaluation than to the previous nine months of the evaluation period.

Many consumers are annoyed by repeated exposure to the same advertising message and often wonder why the advertiser doesn't give more useful information, without repeating it so many times. After all, we are smart enough to understand it the first time! Unfortunately, both the frequency and the vividness of the message have been shown to affect our purchasing. This bombardment of repeated, uninformative messages makes the product more easily recalled from memory and is often the best way to get us to buy a product (Alba and Marmorstein, 1987).

Because of our susceptibility to vividness and recency, Kahneman and Tversky suggest that we are particularly prone to overestimating unlikely events. For instance, if we actually witness a burning house, the impact on our assessment of the probability of such accidents is probably greater than the impact of reading about a fire in the local newspaper. The direct observation of such an event makes it more salient to us. Similarly, Slovic and Fischhoff (1977) discuss the implications of the misuse of the availability heuristic for the perceived risks of nuclear power. They point out

that any discussion of the potential hazards, regardless of likelihood, will increase the memorability of those hazards and increase their perceived risks.

Bias 2—Retrievability (based on memory structures)

Problem 4a. In four pages of a novel (about 2,000 words), how many words would you expect to find that have the form _ _ _ _ *ing* (seven-letter words that end with *ing*)? Indicate your best estimate by circling one of the following values:

0 1–2 3–4 5–7 8–10 11–15 16+

Problem 4b. In four pages of a novel (about 2,000 words), how many words would you expect to find that have the form _ _ _ _ *n* _ (seven-letter words that have the letter *n* in the sixth position)? Indicate your best estimate by circling one of the following values:

0 1–2 3–4 5–7 8–10 11–15 16+

Tversky and Kahneman (1983) found that most people respond with a higher number for Problem 4a than for Problem 4b. However, this response pattern must be incorrect. Since all words with seven letters that end in *ing* also have an *n* as their sixth letter, the frequency of words that end in *ing* cannot be smaller than the number of words with *n* as the sixth letter. Tversky and Kahneman (1983) argue that *ing* words are more retrievable from memory because of the commonality of the *ing* suffix, whereas the search for words that have an *n* as the sixth letter does not easily generate this group of words.

Just as retrievability affects our vocabulary-search behavior, organizational modes affect information-search behavior within our work lives. We structure organizations to provide order, but this same structure can lead to confusion if the presumed order is not exactly as suggested. For example, many organizations have a management information systems (MIS) division that has generalized expertise in computer applications. Assume that you are a manager in a product division and need computer expertise. If that expertise exists within MIS, the organizational hierarchy will lead you to the correct resource. If they lack the expertise in a specific application, but it exists elsewhere in the organization, the hierarchy is likely to bias the effectiveness of your search. I am not arguing for the overthrow of organizational hierarchies; I am merely identifying the dysfunctional role of hierarchies in potentially biasing search behavior. If we are aware of the potential bias, we need not be affected by this limitation.

Retail store location is influenced by the way in which consumers search their minds when seeking a particular commodity. Why are multiple gas stations at the same intersection? Why do "upscale" retailers want to be in the same mall? Why are the best bookstores in a city often all located within a couple blocks of each other? An important reason for this pattern is that consumers learn the "location" for a particular type of product or store and organize their minds accordingly. To maximize

traffic, the retailer needs to be in the location that consumers associate with this type of product or store.

Bias 3—Presumed Associations

People frequently fall victim to the availability bias in their assessment of the likelihood of two events occurring together. For example, consider the following questions: Is marijuana use related to delinquency? Are couples who get married under the age of 25 more likely to have bigger families? How would you respond if asked these questions? In assessing the marijuana question, most people typically remember several delinquent marijuana users and do or do not assume a correlation based on the availability of this mental data. However, proper analysis would include recalling four groups of observations: marijuana users who are delinquents, marijuana users who are not delinquents, delinquents who do not use marijuana, and nondelinquents who do not use marijuana. The same analysis applies to the marriage question. Proper analysis would include four groups: couples who married young and have large families, couples who married young and have small families, couples who married older and have large families, and couples who married older and have small families.

Indeed, there are always at least four separate situations to be considered in assessing the association between two dichotomous events, but our everyday decision making commonly ignores this scientifically valid fact. Chapman and Chapman (1967) have noted that when the probability of two events co-occurring is judged by the availability of perceived co-occurring instances in our minds, we usually assign an inappropriately high probability that the two events will co-occur again. Thus, if we know a lot of marijuana users who are delinquents, we assume that marijuana use is related to delinquency. Similarly, if we know of a lot of couples who married young and have had large families, we assume that this trend is more prevalent than it may actually be. In testing for this bias, Chapman and Chapman provided participants with information about hypothetical psychiatric patients. The information included a written clinical diagnosis of the "patient" and a drawing of a person made by the "patient." The participants were asked to estimate the frequency with which each diagnosis (for example, suspiciousness or paranoia) was accompanied by various facial and body features in the drawings (for example, peculiar eyes). Throughout the study, participants markedly overestimated the frequency of pairs commonly associated together by social lore. For example, diagnoses of suspiciousness were overwhelmingly associated with peculiar eyes. In addition, Chapman and Chapman found that conclusions, such as those just noted, were extremely resistant to change, even in the face of contradictory information. Furthermore, the overwhelming impact of this bias toward presumed associations prevented the participants from detecting other relationships that were, in fact, present.

Summary A lifetime of experience has led us to believe that, in general, more frequent events are recalled in our minds more easily than less frequent ones, and likely events are easier to recall than unlikely events. In response to this learning, we have developed the availability heuristic for estimating the likelihood of events.

In many instances, this simplifying heuristic leads to accurate, efficient judgments. However, as these first three biases (ease of recall, retrievability, and presumed associations) indicate, the misuse of the availability heuristic can lead to systematic errors in managerial judgment. We too easily assume that our available recollections are truly representative of some larger pool of occurrences that exists outside our range of experience.

BIASES EMANATING FROM THE REPRESENTATIVENESS HEURISTIC

Bias 4—Insensitivity to Base Rates

> ***Problem 5.*** Mark is finishing his MBA at a prestigious university. He is very interested in the arts and at one time considered a career as a musician. Is he more likely to take a job
>
> (A) in the management of the arts? or (B) with a management consulting firm?

How did you decide on your answer? How do most people make this assessment? How *should* people make this assessment? Using the representativeness heuristic discussed in Chapter 1, most people approach this problem by analyzing the degree to which Mark is representative of their image of individuals who take jobs in each of the two areas. Consequently, they usually conclude "in the management of the arts." However, as we discussed in the analysis of Problem 2 earlier in this chapter, this response overlooks relevant base-rate information. Reconsider the problem in light of the fact that a much larger number of MBAs take jobs in management consulting than in the management of the arts—relevant information that should enter into any reasonable prediction of Mark's career path. With this base-rate data, it is only reasonable to predict "management consulting."

Judgmental biases of this type frequently occur when individuals cognitively ask the wrong question. If you answered "in the management of the arts," you were probably thinking in terms of the question "How likely is it that a person working in the management of the arts would fit Mark's description?" However, the problem necessitates the question "How likely is it that someone fitting Mark's description will choose arts management?" By itself, the representativeness heuristic incorrectly leads to a similar answer to both questions, since this heuristic leads individuals to compare the resemblance of the personal description and the career path. However, when base-rate data are considered, it is irrelevant to the first question listed, but it is crucial to a reasonable prediction on the second question. While a large percentage of individuals in arts management may fit Mark's description, there are undoubtedly a larger absolute number of management consultants fitting Mark's description because of the relative preponderance of MBAs in management consulting.

An interesting finding emanating from the research done by Kahneman and Tversky (1972, 1973) is that participants do use base-rate data correctly when no other information is provided. For example, in the absence of a personal description

of Mark in Problem 5, people will choose "management consulting" based on the past frequency of this career path for MBAs. Thus, people understand the relevance of base-rate information, but tend to disregard such data when descriptive data are also available.

Ignoring base rates has many unfortunate implications. Prospective entrepreneurs spend far too much time imagining their success and far too little time considering the base rate for business failures. Entrepreneurs think that the base rate for failure is not relevant to their situation, and many individuals lose their life savings as a result. Similarly, unnecessary emotional distress is caused in the divorce process because of the failure of couples to create prenuptial agreements, which specify the peaceful ending of a marriage. The suggestion of a prenuptial agreement is often viewed as a sign of bad faith by the party suggesting this contract. However, the failure to create prenuptial agreements occurs because individuals approaching the marriage decision do not believe that the very high base rate for divorce applies to them.

Bias 5—Insensitivity to Sample Size

Problem 6 (From Tversky and Kahneman, 1974). A certain town is served by two hospitals. In the larger hospital about 45 babies are born each day and in the smaller hospital about 15 babies are born each day. As you know, about 50 percent of all babies are boys. However, the exact percentage varies from day to day. Sometimes it may be higher than 50 percent, sometimes lower.

For a period of one year, each hospital recorded the days in which more than 60 percent of the babies born were boys. Which hospital do you think recorded more such days?

The larger hospital? The smaller hospital?

About the same? (that is, within 5 percent of each other)

Most individuals expect the two hospitals to record a similar number of days with 60 percent or more of the babies born being boys. People seem to have some basic idea of how unusual it is to have 60 percent of a random event occurring in a specific direction. In contrast, simple statistics tell us that it is much more likely to observe 60 percent of male babies in a smaller sample than in a larger sample. The interested reader can verify this fact with the use of an introductory statistics book. However, anecdotally, this effect is easy to understand by thinking about which is more likely—to get 6 heads in 10 flips of a coin or to get 6,000 heads in 10,000 flips of a coin. Our intuition correctly tells us that 6 out of 10 is not that unusual, but 6,000 in 10,000 is very unusual. Sampling theory tells us that the expected number of days in which more than 60 percent of the babies are boys is three times greater in the small hospital, since a large sample is less likely to deviate from the mean. However, most people judge the probability to be the same in each hospital, effectively ignoring sample size.

Although the importance of sample size is fundamental in statistics, Tversky and Kahneman (1974) argue that sample sizes are rarely a part of our intuition. Why is this? When responding to problems dealing with sampling, people often use the representativeness heuristic. People think about how representative it would be for 60 percent of the babies born to be boys in a random event. As a result, people ignore the issue of sample size—which is critical to an accurate assessment of the problem.

Consider the implications of this bias in advertising, where people trained in market research understand the need for a sizable sample but employ this bias to the advantage of their clients. "Four out of five dentists surveyed recommend sugarless gum for their patients who chew gum."

There is no mention of the number of dentists involved in the survey, and without this data the results of the survey are meaningless. If only 5 or 15 dentists were surveyed, the size of the sample would not be generalizable to the overall population of dentists.

Bias 6—Misconceptions of Chance

Problem 7. You are about to hire a new central-region sales director for the fifth time this year. You predict that the next director should work out reasonably well, since the last four were "lemons," and the odds favor hiring at least one good sales director in five tries. This thinking is

(A) correct or (B) incorrect

Most people are comfortable with the foregoing logic, or at least have been guilty of using similar logic in the past. However, the performance of the first four sales directors will not directly affect the performance of the fifth sales director, and the logic in Problem 7 is incorrect. Most individuals frequently rely on their intuition and the representativeness heuristic and incorrectly conclude that a poor performance is unlikely because the probability of getting five "lemons" in a row is extremely low. Unfortunately, this logic ignores the fact that we have already witnessed four "lemons" (an unlikely occurrence), and the performance of the fifth sales director is independent of the performance of the first four.

This question parallels Kahneman and Tversky's (1972) work in which they show that people expect that a sequence of random events will "look" random. They present evidence of this bias in their finding that participants routinely judged the sequence of coin flips H–T–H–T–T–H to be more likely than H–H–H–T–T–T, which does not "appear" random, and more likely than the sequence H–H–H–H–T–H, which does not represent the equal likelihood of heads and tails. Simple statistics, of course, tell us that each of these sequences is equally likely because of the independence of multiple random events.

Problem 7 moves beyond dealing with random events in recognizing our inappropriate tendency to assume that random and nonrandom events will balance out. Will the fifth sales director work out well? Maybe. You might spend more time and

money on selection, and the randomness of the hiring process may favor you this time. But your earlier failures in hiring sales directors will not directly affect the performance of the new sales director.

The logic concerning misconceptions of chance provides a process explanation of the gambler's fallacy. After holding bad cards on ten hands of poker, the poker player believes that he is due for a good hand. After winning $1,000 in the Pennsylvania State Lottery, a woman changes her regular number—because after all, how likely is it that the same number will come up twice? Tversky and Kahneman (1974) note that "Chance is commonly viewed as a self-correcting process in which a deviation in one direction induces a deviation in the opposite direction to restore the equilibrium. In fact, deviations are not corrected as a chance process unfolds, they are merely diluted."

In each of the preceding examples, individuals expected probabilities to even out. In some situations, our minds misconceptualize chance in exactly the opposite way. In sports (basketball specifically), we often think of a particular player as having a "hot hand" or "being on a good streak." If your favorite player has hit his last four shots, is the probability of his making his next shot higher, lower, or the same as the probability of his making a shot without the preceding four hits? Most sports fans, sports commentators, and players believe that the answer is "higher." In fact, there are many biological, emotional, and physical reasons that this answer could be correct. However, it is wrong! Gilovich, Vallone, and Tversky (1985) did an extensive analysis of the shooting of Philadelphia 76ers and Boston Celtics and found that immediately prior shot performance did not change the likelihood of success on the upcoming shot. Out of all of the findings in this book, this is the effect that my managerial students have had the hardest time believing. The reason is that we can all remember sequences of five hits in a row; streaks are part of our conception of chance in athletic competition. However, our minds do not categorize a string of "four in a row" as being a situation in which "he missed his fifth shot." As a result, we have a misconception of connectedness, when, in fact, chance (or the player's normal probability of success) is really in effect.

The belief in the hot hand is especially interesting because of its implication for how players play the game. Passing the ball to the player who is "hot" is commonly endorsed as a good strategy. It can also be expected that the opposing team will concentrate on guarding the hot player. Another player, who is less "hot" but is equally skilled, may have a better chance of scoring. Thus the belief in the "hot hand" is not just erroneous, but could also be costly if you make decisions under this illusion.

The mythical perception of a hot hand is not limited to basketball. Imagine that you receive a free copy of an investor newsletter that recommends that it is a good time to sell stock because the market will fall during the next six months. You ignore this newsletter, and then it happens to be correct. At the end of the six months, you receive another free copy of this newsletter that says the market will rise during the next six months. Again, you ignore this newsletter, and again the newsletter is correct. Again, you receive another free copy of the newsletter, and this time it advises

you to buy stocks for the next six-month period. Once again, you ignore the newsletter, and once again it is correct. After these 18 months, you receive a direct mail solicitation for this newsletter, pointing out that they have been giving you great advice for the last 18 months for free. However, if you want this excellent advice in the future, you need to pay a small subscription fee. Are you intrigued by this publication? Many people are impressed by the consistent past performance of the newsletter and are intrigued. Now, consider what this advice may look like from the other side.

A publisher creates eight financial newsletters, each managed by a different expert. Each of the eight makes a six-month recommendation about the general direction of the market; four predict a rise in the market, and four predict a fall in the market in their initial issues. The four who predicted a fall in the market were correct, and the four who predicted a rise go out of business. Of the remaining four newsletters, two predict a rise for the second six-month period and two predict a fall. The market rises, and the two that predicted a fall in the second six-month period go out of business. Of the two remaining in business after 12 months, one predicts a rise in the market for the third six-month period, and the other predicts a fall. The market rises, and the newsletter that was correct all three times advertises this fact. It seems they have some important insight into financial markets. Yet, we can see that if there are many "experts" making predictions, some will be consistently correct simply by chance. In contrast, our minds tend to provide credit to the one that got lucky. Newspapers constantly provide advertisements for mutual funds that have done very well for the last year, and make people feel guilty for not choosing that fund earlier. Yet, it is easy to see that any large family of mutual funds (e.g., Fidelity, Dreyfus, etc.) will always have some funds that have performed well above the market and some that perform well below the market. However, we see only the advertisements for those above the market. When the above-market fund falls below market, it is no longer advertised.

Tversky and Kahneman's (1971) work also shows that misconceptions of chance are not limited to gamblers, sports fans, or laypersons. Research psychologists also fall victim to the "law of small numbers." They believe that sample events should be far more representative of the population from which they were drawn than simple statistics would dictate. The researchers put too much faith in the results of initial samples and grossly overestimate the replicability of empirical findings. This suggests that the representativeness heuristic may be so well institutionalized in our decision processes that even scientific training and its emphasis on the proper use of statistics may not effectively eliminate its biasing influence.

Bias 7—Regression to the Mean

Problem 8. You are the sales forecaster for a department store chain with nine locations. The chain depends on you for quality projections of future sales in order to make decisions on staffing, advertising, information system developments, purchasing, renovation, and the like. All stores are similar in size and merchan-

dise selection. The main difference in their sales occurs because of location and random fluctuations. Sales for 1997 were as follows:

Store	*1997*	*1999*
1	$12,000,000	
2	11,500,000	
3	11,000,000	
4	10,500,000	
5	10,000,000	
6	9,500,000	
7	9,000,000	
8	8,500.000	
9	8,000,000	
TOTAL	$90,000,000	$99,000,000

Your economic forecasting service has convinced you that the best estimate of total sales increases between 1997 and 1999 is 10 percent (to $99,000,000). Your task is to predict 1999 sales for each store. Since your manager believes strongly in the economic forecasting service, it is imperative that your total sales equal $99,000,000.

Think about the processes used to answer this problem. Consider the following logical pattern of thought: "The overall increase in sales is predicted to be 10 percent ($99,000,000 − $90,000,000/$90,000,000). Lacking any other specific information on the stores, it makes sense simply to add 10 percent to each 1993 sales figure to predict 1995 sales. This means that I predict sales of $13,200,000 for store 1, sales of $12,650,000 for store 2, and so on." This logic, in fact, is the most common approach in responding to this item. Unfortunately, this logic is faulty.

Why was the logic presented faulty? Statistical analysis would dictate that we first assess the predicted relationship between 1997 and 1999 sales. This relationship, formally known as a correlation, can vary from total independence (that is, 1997 sales do not predict 1999 sales) to perfect correlation (1997 sales are a perfect predictor of 1999 sales). In the former case, the lack of a relationship between 1997 and 1999 sales would mean that 1997 sales would provide absolutely no information about 1999 sales, and your best estimates of 1999 sales would be equal to total sales divided by the number of stores ($99,000,000 divided by 9 equals $11,000,000). However, in the latter case of perfect predictability between 1997 and 1999 sales, our initial logic of simply extrapolating from 1997 performance by adding 10 percent to each store's performance would be completely accurate. Obviously, 1997 sales are most likely to be *partially* predictive of 1999 sales—falling somewhere between independence and perfect correlation. Thus, the best prediction for store 1 should lie between $11,000,000 and $13,200,000, depending on how predictive you think 1997 sales will be of 1999 sales. The key point is that in virtually all such predictions, you should expect the naive $13,200,000 estimate to regress toward the overall mean ($11,000,000).

In a study of sales forecasting, Cox and Summers (1987) examined the judgments of professional retail buyers. They examined the sales data from two department stores for six different apparel styles for a total of 12 different sales forecasts over a two-week period. They found that sales between the two weeks regressed to the mean. However, the judgment of all 31 buyers from five different department stores failed to reflect the tendency for regression to the mean. As a result, Cox and Summers argued that a sales-forecasting model that considered regression to the mean could outperform the judgments of all 31 professional buyers.

Many effects regress to the mean. Brilliant students frequently have less successful siblings. Short parents tend to have taller children. Great rookies have mediocre second years (the "sophomore jinx"). Firms that have outstanding profits one year tend to have lesser performances the next year. In each case, individuals are often surprised when made aware of these predictable patterns of regression to the mean.

Why is the regression-to-the-mean concept, while statistically valid, counterintuitive? Kahneman and Tversky (1973) suggest that the representativeness heuristic accounts for this systematic bias in judgment. They argue that individuals typically assume that future outcomes (for example, 1991 sales) will be directly predictable outcomes (1989 sales). Thus, we tend to naively develop predictions that are based on the assumption of perfect correlation with past data.

In some unusual situations, individuals do intuitively expect a regression-to-the-mean effect. In 1980, when George Brett batted .384, most people did not expect him to hit .384 the following year. When Wilt Chamberlain scored 100 points in a single game, most people did not expect him to score 100 points in his next game. When a historically 3.0 student got a 4.0 one semester, her friends did not expect a repeat performance the following semester. When a real estate agent sold five houses in one month (an abnormally high performance), his co-agents did not expect similar performance in the following month. Why is regression to the mean more intuitive in these cases? Because the performance is so extreme that we know it cannot last. Thus, under very unusual circumstances, we expect performance to regress. However, we generally do not recognize the regression effect in less extreme cases.

Consider Kahneman and Tversky's (1973) classic example in which the misconceptions surrounding regression led to overestimation of the effectiveness of punishment and the underestimation of the power of reward. Here, in a discussion about flight training, experienced instructors noted that praise for an exceptionally smooth landing was typically followed by a poorer landing on the next try, while harsh criticism after a rough landing was usually followed by an improvement on the next try. The instructors concluded that verbal rewards were detrimental to learning, while verbal punishments were beneficial. Obviously, the tendency of performance to regress to the mean can account for the results; verbal feedback may have had absolutely no effect. However, to the extent that the instructors were prone to biased decision making, they were prone to reach the false conclusion that punishment is more effective than positive reinforcement in shaping behavior.

How do managers respond when they do not acknowledge the regression principle? Consider an employee with very high performance in one performance period. He (and his boss) may inappropriately expect similar performance in the next period. What happens when his performance regresses toward the mean? He (and

his boss) begin to make excuses for not meeting expectations. Obviously, they are likely to develop false explanations and may inappropriately plan their future efforts.

Bias 8—The Conjunction Fallacy

Problem 9. Linda is 31 years old, single, outspoken, and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and she participated in antinuclear demonstrations.

Rank order the following eight descriptions in terms of the probability (likelihood) that they describe Linda:

a. Linda is a teacher in an elementary school.
b. Linda works in a bookstore and takes yoga classes.
c. Linda is active in the feminist movement.
d. Linda is a psychiatric social worker.
e. Linda is a member of the League of Women Voters.
f. Linda is a bank teller.
g. Linda is an insurance salesperson.
h. Linda is a bank teller who is active in the feminist movement.

Examine your rank orderings of descriptions C, F, and H. Most people rank order C as more likely than H and H as more likely than F. The reason for this ordering is that C–H–F is the order of the degree to which the descriptions are *representative* of the short profile of Linda. The description of Linda was constructed by Tversky and Kahneman to be representative of an active feminist and unrepresentative of a bank teller. Recall from the representativeness heuristic that people make judgments according to the degree to which a specific description corresponds to a broader category within their minds. Linda's description is more representative of a feminist than of a feminist bank teller, and is more representative of a feminist bank teller than of a bank teller. Thus, the representativeness heuristic accurately predicts that most individuals will rank order the items C–H–F.

Although the representativeness heuristic accurately predicts how individuals will respond, it also leads to another common, systematic distortion of human judgment—the conjunction fallacy (Tversky and Kahneman, 1983). This is illustrated by a reexamination of the potential descriptions of Linda. One of the simplest and most fundamental qualitative laws of probability is that a subset (for example, being a bank teller and a feminist) cannot be more likely than a larger set that completely includes the subset (e.g., being a bank teller). Statistically speaking, the broad set "Linda is a bank teller" must be rated at least as likely, if not more so, than the description "Linda is a bank teller and a feminist." After all, there is some chance (although it is small) that Linda is a bank teller but not a feminist. Based on this logic, a rational assessment of the likelihoods of Linda being depicted by the eight descriptions must include a more likely rank for F than H.

While simple statistics can demonstrate that a conjunction (a combination of two or more descriptors) cannot be more probable than any one of its descriptors, the conjunction fallacy predicts and demonstrates that a conjunction will be judged more probable than a single component descriptor when the conjunction appears more representative than the component descriptor. Intuitively, thinking of Linda as a feminist bank teller "feels" more correct than thinking of her as only a bank teller.

The conjunction fallacy can also operate based on greater *availability* of the conjunction than one of the unique descriptors (Yates and Carlson, 1986). That is, if the conjunction creates more intuitive matches with vivid events, acts, or people than a component of the conjunction, the conjunction is likely to be perceived falsely as more probable than the component. For example, Tversky and Kahneman (1983) found experts (in July 1982) to evaluate the probability of a complete suspension of diplomatic relations between the United States and the Soviet Union some time in 1983 as less likely than the probability of a Russian invasion of Poland and a complete suspension of diplomatic relations between the United States and the Soviet Union some time in 1983.

As demonstrated earlier, *suspension* is necessarily more likely than *invasion* and *suspension.* However, a Russian invasion followed by a diplomatic crisis provides a more intuitively viable story than simply a diplomatic crisis. Similarly, in the domain of natural disasters, Kahneman and Tversky's participants rated a massive flood somewhere in North America in 1989, in which 1,000 people drown, as less likely than the probability of an earthquake in California sometime in 1989, causing a flood in which more than 1,000 people drown. It is obvious that the latter possibility is a subset of the former, and many other events could cause the flood in North America.

Tversky and Kahneman (1983) have shown that the conjunction fallacy is likely to lead to deviations from rationality in the judgments of sporting events, criminal behavior, international relations, and medical judgments. Our obvious concern with biased decision making resulting from the conjunction fallacy is that if we make systematic deviations from rationality in the prediction of future outcomes, we will be less prepared for dealing with future events.

Summary This discussion concludes our examination of the five biases (insensitivity to base rates, insensitivity to sample size, misconceptions of chance, regression to the mean, and the conjunction fallacy) that emanate from the use of the representativeness heuristic. Experience has taught us that the likelihood of a specific occurrence is related to the likelihood of a group of occurrences which that specific occurrence represents. Unfortunately, we tend to overuse this information in making decisions. The five biases we have just explored illustrate the systematic irrationalities that can occur in our judgments when we are not aware of this overreliance.

BIASES EMANATING FROM ANCHORING AND ADJUSTMENT

Bias 9—Insufficient Anchor Adjustment

Problem 10. A newly hired engineer for a computer firm in the Boston metropolitan area has four years of experience and good all-around qualifications. When asked to estimate the starting salary for this employee, my secretary (know-

ing very little about the profession or the industry) guessed an annual salary of $23,000. What is your estimate?:

$____ per year

Was your answer affected by my secretary's response? Most people do not think that my secretary's response affected their response. However, individuals are affected by the fairly irrelevant information contained in my secretary's estimate. Reconsider how you would have responded if my secretary had estimated $80,000. On average, individuals give higher salary estimates to the problem when the secretary's estimate is stated as $80,000 than when it is stated as $23,000. Why? Studies have found that people develop estimates by starting from an initial anchor, based on whatever information is provided, and adjusting from there to yield a final answer. Slovic and Lichtenstein (1971) have provided conclusive evidence that adjustments away from anchors are usually not sufficient to negate the effects of the anchor. In all cases, answers are biased toward the initial anchor, even if it is irrelevant. Different starting points yield different answers. Tversky and Kahneman (1973) named this phenomenon **anchoring** and **adjustment.**

Tversky and Kahneman (1974) provide systematic, empirical evidence of the anchoring effect. For example, in one study, participants were asked to estimate the percentage of African countries in the United Nations. For each participant, a *random number* (obtained by an observed spin of a roulette wheel) was given as a starting point. From there, participants were asked to state whether the actual value of the quantity was higher or lower than this random value and then develop their best estimate for the actual quantity. It was found that the *arbitrary* values from the roulette wheel had a substantial impact on estimates. For example, for groups that received 10 countries and 65 countries as starting points, the median estimates were 25 and 45, respectively. Thus, even though the participants were aware that the anchor was random and unrelated to the judgment task, the anchor had a dramatic effect on their judgment. Interestingly, paying participants differentially based on accuracy did not reduce the magnitude of the anchoring effect.

Salary negotiations represent a very common context for observing anchoring in the managerial world. For example, pay increases often come in the form of a percentage increase. A firm may have an average increase of 8 percent, with increases for specific employees varying from 3 percent to 13 percent. While society has led us to accept such systems as equitable, I believe that such a system falls victim to anchoring and leads to substantial inequities. What happens if an employee has been substantially underpaid to begin with? The pay system described does not rectify past inequities, since a pay increase of 11 percent will probably leave that employee still underpaid. Conversely, the system would work in the employee's favor had she been overpaid. It is common for an employer to ask job applicants their current salaries. Why? Employers are searching for a value from which they can anchor an adjustment. If the employee is worth far more than his current salary, the anchoring and adjustment hypothesis predicts that the firm will make an offer below the employee's true value. Does this figure provide fully accurate information about the true worth of the employee? I think not. Thus, the use of such compensation systems accepts

past inequities as an anchor and makes inadequate adjustments from that point. Furthermore, these findings suggest that in deciding what offer to make to a potential employee, any anchor that creeps into the discussion is likely to have an inappropriate effect on the eventual offer, even if the anchor is "ignored" as being ridiculous.

There are numerous examples of the anchoring-and-adjustment phenomenon in everyday life. For example:

- In education, children are tracked by a school system that may categorize them into a certain level of performance at an early age. For example, a child who is anchored in the C group may meet expectations of mediocre performance. Conversely, a child of similar abilities anchored in the A track may be perceived as being better merely because the A track assignment confers high-performer status.
- We have all fallen victim to the first-impression syndrome when meeting someone for the first time. We often place so much emphasis on first impressions that we do not adjust our opinion appropriately at a later date.

Northcraft and Neale (1987) surveyed an association of real estate brokers, who indicated that they believed that they could assess the value of properties to within 5 percent of their true or appraised value. Furthermore, they were unanimous in stating that they did not factor the listing price of the property into their personal estimate of its "true" value. Northcraft and Neale then asked four groups of professional real estate brokers and undergraduate students to estimate the value of a real house. Both brokers and students were randomly assigned to one of four experimental groups. In each group, all participants were given a 10-page packet of information about the house that was being sold. The packet included not only background on the house, but also considerable information about prices and characteristics of other houses in the area that had recently been sold. The only difference in the information given to the four groups was the listing price for the house, which was selected to be + 11 percent, + 4 percent, − 4 percent, and − 11 percent of the actual appraised value of the property. After reading the material, all participants toured the house, as well as the surrounding neighborhood. Participants were then asked for their estimate of the house's price. The final results suggested that *both* brokers and students were *significantly* affected by the listing price (the anchor) in determining the value. While the students readily admitted the role that the listing price played in their decision-making process, the brokers flatly denied their use of the listing price as an anchor for their evaluations of the property—despite the evidence to the contrary. This study provides convincing data to indicate that even experts are susceptible to the anchoring bias. Furthermore, experts are less likely to realize their use of this bias in making decisions.

Joyce and Biddle (1981) have also provided empirical support for the anchoring-and-adjustment effect on practicing auditors of Big Six accounting firms. Specifically, participants in one condition were asked the following:

It is well known that many cases of management fraud go undetected even when competent annual audits are performed. The reason, of course, is that Generally Accepted

Auditing Standards are not designed specifically to detect executive-level management fraud. We are interested in obtaining an estimate from practicing auditors of the prevalence of executive-level management fraud as a first step in ascertaining the scope of the problem.

1. Based on your audit experience, is the incidence of significant executive-level management fraud more than 10 in each 1,000 firms (that is, 1 percent) audited by Big Six accounting firms?
   a. Yes, more than 10 in each 1,000 Big Six clients have significant executive-level management fraud.
   b. No, fewer than 10 in each 1,000 Big Six clients have significant executive-level management fraud.
2. What is your estimate of the number of Big Six clients per 1,000 that have significant executive-level management fraud? (Fill in the blank below with the appropriate number.)

____ in each 1,000 Big Six clients have significant executive-level management fraud.

The second condition differed only in that participants were asked whether the fraud incidence was more or less than 200 in each 1,000 audited, rather than 10 in 1,000. Participants in the former condition estimated a fraud incidence of 16.52 per 1,000 on average, compared with an estimated fraud incidence of 43.11 per 1,000 in the second condition! Here, even professional auditors fell victim to anchoring and adjustment.

The tendency to make insufficient adjustments is a direct result of the anchoring-and-adjustment heuristic described in the first chapter. Interestingly, Nisbett and Ross (1980) present an argument that suggests that the anchoring-and-adjustment bias itself dictates that it will be very difficult to get *you* to change your decision-making strategies as a result of reading this book. They argue that each of the heuristics that we identify are currently serving as your cognitive anchors and are central to your current judgment processes. Thus, any cognitive strategy that I suggest must be presented and understood in a manner that will force you to break your existing cognitive anchors. Based on the evidence in this section, this should be a difficult challenge—but one that is important enough to be worth the effort!

Bias 10—Conjunctive and Disjunctive Events Bias

Problem 11. Which of the following appears most likely? Which appears second most likely?

a. Drawing a red marble from a bag containing 50 percent red marbles and 50 percent white marbles.
b. Drawing a red marble seven times in succession, with replacement (a selected marble is put back into the bag before the next marble is selected), from a bag containing 90 percent red marbles and 10 percent white marbles.

c. Drawing at least one red marble in seven tries, with replacement, from a bag containing 10 percent red marbles and 90 percent white marbles.

The most common answer in ordering the preferences is B–A–C. Interestingly, the correct order of likelihood is C (52 percent), A (50 percent), B (48 percent)—the exact opposite of the most common intuitive pattern! This result illustrates a general bias to overestimate the probability of conjunctive events—events that must occur in conjunction with one another (Bar-Hillel, 1973)—and to underestimate the probability of disjunctive events—events that occur independently (Tversky and Kahneman, 1974). Thus, when multiple events all need to occur (Problem B), we overestimate the true likelihood, while if only one of many events needs to occur (Problem C), we underestimate the true likelihood.

Kahneman and Tversky (1974) explain these effects in terms of the anchoring-and-adjustment heuristic. They argue that the probability of any one event occurring (for example, drawing one red marble) provides a natural anchor for the judgment of the total probability. Since adjustment from an anchor is typically insufficient, the perceived likelihood of choice B stays inappropriately close to 90 percent, while the perceived probability of choice C stays inappropriately close to 10 percent.

How is each of these biases manifested in an applied context? The overestimation of conjunctive events is a powerful explanation of the timing problems in projects that require multistage planning. Individuals, businesses, and governments frequently fall victim to the conjunction–events bias in terms of timing and budgets. Public works projects seldom finish on time or on budget. New product ventures frequently take longer than expected.

Consider the following:

- You are planning a construction project that consists of five distinct components. Your schedule is tight, and every component must be on time in order to meet a contractual deadline. Will you meet this deadline?
- You are managing a consulting project that consists of six teams, each of which is analyzing a different alternative. The alternatives cannot be compared until all teams complete their portion. Will you meet the deadline?
- After three years of study, doctoral students typically dramatically overestimate the likelihood of completing their dissertations within a year. At this stage, they typically can tell you how long each remaining component will take. Why do they not finish in one year?

The underestimation of disjunctive events explains our surprise when an unlikely event occurs. As Tversky and Kahneman (1974) argue, "A complex system, such as a nuclear reactor or the human body, will malfunction if any of its essential components fails. Even when the likelihood of failure in each component is slight, the probability of an overall failure can be high if many components are involved." *In Normal Accidents,* Perrow (1984) argues against the safety of technologies like nuclear reactors and DNA research. He fears that society significantly un-

derestimates the likelihood of system failure because of our judgmental failure to realize the multitude of things that can go wrong in these incredibly complex and interactive systems.

The understanding of our underestimation of disjunctive events also has its positive side. Consider the following:

> It's Monday evening (10:00 P.M.). You get a phone call telling you that you must be at the Chicago office by 9:30 A.M. the next morning. You call all five airlines that have flights that get into Chicago by 9:00 A.M. Each has one flight, and all the flights are booked. When you ask the probability of getting on each of the flights if you show up at the airport in the morning, you are disappointed to hear probabilities of 30 percent, 25 percent, 15 percent, 20 percent, and 25 percent. Consequently, you do not expect to get to Chicago in time.

In this case, the disjunctive bias leads you to expect the worst. In fact, if the probabilities given by the airlines are unbiased and independent, there is a 73 percent chance of getting on one of the flights (assuming that you can arrange to be at the right ticket counter at the right time)!

Bias 11—Overconfidence

Problem 12. Listed below are 10 uncertain quantities. Do not look up any information on these items. For each, write down your best estimate of the quantity. Next, put a lower and upper bound around your estimate, so that you are confident that your 98 percent range surrounds the actual quantity.

Estimate	Lower	Upper	
____	____	____	a. Amount of industrial waste generated in the U.S. in 1990 in tons
____	____	____	b. Total households in the U.S., according to a 1994 Bureau of the Census poll
____	____	____	c. Crime rate per 100,000 population in the U.S. in 1993
____	____	____	d. Number of immigrants admitted into the U.S. in 1993
____	____	____	e. Number of species and subspecies of North American mammals extinct since 1600
____	____	____	f. Percentage of paper and cardboard recovery rates in the Netherlands in 1989
____	____	____	g. Annual precipitation in Reno between 1961 and 1990 (in inches)
____	____	____	h. Live births in the U.S. in 1992
____	____	____	i. Average salary for a secondary school teacher in Illinois in 1994
____	____	____	j. Plastic waste generated in the U.S. in 1993 in tons

How many of your 10 ranges will actually surround the true quantities? If you set your ranges so that you were 98 percent confident, you should expect to correctly bound approximately 9.8, or 9 to 10, of the quantities. Let's look at the correct answers: (a) 7,080,000,000; (b) 97,000,000; (c) 5,483; (d) 904,292; (e) 22; (f) 58.4%; (g) 7.53; (h) 4,065,014; (i) $43,700; (j) 19,300,000.

How many of your ranges actually surrounded the true quantities? If you surround 9-10, we can conclude that you were appropriately confident in your estimation ability. Most people only surround between 3 (30 percent) and 7 (70 percent), despite claiming a 98 percent confidence that each of the ranges will surround the true value. Why? Most of us are *overconfident* in our estimation abilities and do not acknowledge the actual uncertainty that exists.

In Alpert and Raiffa's (1969) initial demonstration of overconfidence based on 1,000 observations (100 participants on 10 items), 42.6 percent of quantities fell outside 90 percent confidence ranges. Since then, overconfidence has been identified as a common judgmental pattern and demonstrated in a wide variety of settings. For example, Fischhoff, Slovic, and Lichtenstein (1977) found that participants who assigned odds of 1,000: 1 of being correct were correct only 81 to 88 percent of the time. For odds of 1,000,000: 1, their answers were correct only 90 to 96 percent of the time! Hazard and Peterson (1973) identified overconfidence among members of the armed forces, while Cambridge and Shreckengost (1980) found extreme overconfidence in CIA agents.

The most well-established finding in the overconfidence literature is the tendency of people to be most overconfident of the correctness of their answers when asked to respond to questions of moderate to extreme difficulty (Fischhoff, Slovic, and Lichtenstein, 1977). That is, as participants' knowledge of a question decreases, they do not correspondingly decrease their level of confidence (Pitz, 1974). However, participants typically demonstrate no overconfidence, and often some underconfidence, to questions with which they are familiar. Thus we should be most alert to overconfidence in areas outside of our expertise.

There is a large degree of controversy over the explanations of why overconfidence exists (see Lichtenstein, Fischhoff, and Phillips [1982] for an extensive discussion). Tversky and Kahneman (1974) explain overconfidence in terms of anchoring. Specifically, they argue that when individuals are asked to set a confidence range around an answer, their initial estimate serves as an anchor which biases their estimation of confidence intervals in both directions. As explained earlier, adjustments from an anchor are usually insufficient, resulting in an overly narrow confidence band.

In their review of the overconfidence literature, Lichtenstein, Fischhoff, and Phillips (1982) suggest two viable strategies for eliminating overconfidence. First, they have found that giving people feedback about their overconfidence based on their judgments has been moderately successful at reducing this bias. Second, Koriat, Lichtenstein, and Fischhoff (1980) found that asking people to explain why their answers might be wrong (or far off the mark) can decrease overconfidence by getting participants to see contradictions in their judgment.

Why should you be concerned about overconfidence? After all, it has probably given you the courage in the past to attempt endeavors that have stretched your abilities. However, consider the following:

- You are a medical doctor and are considering performing a difficult operation. The patient's family needs to know the likelihood of his surviving the opera-

tion. You respond "95 percent." Are you guilty of malpractice if you tend to be overconfident in your projections of survival?

- You work for the Nuclear Regulatory Commission and are 99.9 percent confident that a reactor will not leak. Can we trust your confidence? If not, can we run the enormous risks of overconfidence in this domain?
- Your firm has been threatened with a multimillion dollar lawsuit. If you lose, your firm is out of business. You are 98 percent confident that the firm will not lose in court. Is this degree of certainty sufficient for you to recommend rejecting an out-of-court settlement? Based on what you know now, are you still comfortable with your 98 percent estimate?
- You have developed a market plan for a new product. You are so confident in your plan that you have not developed any contingencies for early market failure. The plan of attack falls apart. Will your overconfidence wipe out any hope of expediting changes in the marketing strategy?

In each of these examples, we have introduced serious problems that can result from the tendency to be overconfident. Thus, while confidence in your abilities is necessary for achievement in life, and perhaps to inspire confidence in others, you may want to monitor your overconfidence to achieve more effective professional decision making.

Summary The need for an initial anchor weighs strongly in our decision-making processes when we try to estimate likelihoods (such as the probability of on-time project completion) or establish values (like what salary to offer). Experience has taught us that starting from somewhere is easier than starting from nowhere in determining such figures. However, as the last three biases (insufficient anchor adjustment, conjunctive and disjunctive events bias, and overconfidence) show, we frequently overrely on these anchors and seldom question their validity or appropriateness in a particular situation. As with the other heuristics, we frequently fail even to realize that this heuristic is impacting our judgment.

TWO MORE GENERAL BIASES

Bias 12—The Confirmation Trap

Problem 13 (Adapted from Einhorn and Hogarth, 1978). It is claimed that when a particular analyst predicts a rise in the market, the market always rises. You are to check this claim. Examine the information available about the following four events (cards):

Card 1	*Card 2*	*Card 3*	*Card 4*
Prediction: Favorable report	Prediction: Unfavorable report	Outcome: Rise in the market	Outcome: Fall in the market

You currently see the predictions (cards 1 and 2) or outcomes (cards 3 and 4) associated with four events. You are seeing one side of a card. On the other side of cards 1 and 2 is the actual outcome, while on the other side of cards 3 and 4 is the prediction that the analyst made. Evidence about the claim is potentially available by turning over the card(s). Which cards would you turn over for the evidence that you need to check the analyst's claim? (Circle the appropriate cards .)

Consider the two most common responses: (1) "Card 1 (only)—that is the only card that I know has a favorable report and thus allows me to see whether a favorable report is actually followed by a rise in the market" and (2) "Cards 1 and 3—card 1 serves as a direct test, while card 3 allows me to see whether they made a favorable report when I know the market rose." Logical? Most people think that at least one of these two common responses is logical. However, both strategies demonstrate the tendency to search for confirming, rather than disconfirming, evidence. Einhorn and Hogarth (1978) argue that 1 and 4 is the correct answer to this quiz item. Why? Consider the following logic:

> Card 1 allows me to test the claim that a rise in the market will add confirming evidence, while a fall in the market will fully disconfirm the claim, since the claim is that the market will always rise following a favorable report. Card 2 has no relevant information, since the claim does not address unfavorable reports by the analyst. While card 3 can add confirming evidence to card 1, it provides no unique information, since it cannot disconfirm the claim. That is, if an unfavorable report was made on card 3, then the event is not addressed by the claim. Finally, card 4 is critical. If it says "favorable report" on the other side, the claim is disconfirmed.

If you chose cards 1 and 3, you may have obtained a wealth of confirmatory information and were likely to inappropriately accept the claim. Only by including card 4 is there potential for disconfirmation of the hypothesis. Why do very few participants select card 4? *Most of us seek confirmatory evidence and exclude the search for disconfirming information from our decision process.* However, it is typically not possible to know something to be true without checking for possible disconfirmation.

The initial demonstration of our tendency to ignore disconfirming information was provided in a series of projects by Wason (1960, 1968a, 1968b). In the first study, Wason (1960) presented participants with the three number sequence 2–4–6. The participant's task was to discover the numeric rule to which the three numbers conformed. To determine the rule, participants were allowed to generate other sets of three numbers that the experimenter would classify as either conforming or not conforming to the rule. At any point, participants could stop when they thought that they had discovered the rule. How would you approach this problem?

Wason's rule was "any three ascending numbers"—a solution that required the accumulation of disconfirming, rather than confirming, evidence. For example, if you thought the rule included "the difference between the first two numbers equaling the difference between the last two numbers" (a common expectation), you must try sequences that do not conform to this rule to find the actual rule. Trying the se-

quences 1–2–3, 10–15–20, 122–126–130, and so on, will only lead you into the confirmation trap. In Wason's (1960) experiment, only 6 out of 29 participants found the correct rule the first time that they thought they knew the answer. Wason concluded that obtaining the correct solution necessitates "a willingness to attempt to falsify hypotheses, and thus to test those intuitive ideas that so often carry the feeling of certitude" (p. 139).

This result was also observed by Einhorn and Hogarth (1978) with a sample of 23 statisticians. When that group responded to a problem very similar to Problem 13, eleven asked for card 1; one asked for card 1 or 3; one asked for any one card; two asked for card 1 or 4; three asked for card 4 alone; and only five trained statisticians asked for cards 1 and 4. Thus, this group tended to realize the worthlessness of card 3 but failed to realize the importance of card 4. This leads to the conclusion that the tendency to exclude disconfirming information in the search process is not eliminated by the formal scientific training that is expected of statisticians.

It is easy to observe the confirmation trap in your decision-making processes. You make a tentative decision (to buy a new car, to hire a particular employee, to start research and development on a new product line). Do you search for data that support your decision before making the final commitment? Most of us do. However, the existence of the confirmation trap implies that the search for challenging, or disconfirming, evidence will provide the most useful insights. For example, in confirming your decision to hire a particular employee, it is probably easy to find supporting positive information on the individual, but in fact the key issue may be the degree to which negative information on this individual, as well as positive information on another potential applicant, also exists.

Bias 13—Hindsight and the Curse of Knowledge

Consider the following scenarios:

- You are an avid football fan, and you are watching a critical game in which your team is behind 35–31. With three seconds left, and the ball on the opponent's three-yard line, the quarterback *unsuccessfully* calls a pass play into the corner of the endzone. You immediately respond, "I knew that he shouldn't have called that play."
- You are riding in an unfamiliar area, and your spouse is driving. You approach an unmarked fork in the road, and your spouse decides to go to the right. Four miles and fifteen minutes later, it is clear that you are lost. You blurt out, "I knew that you should have turned left at the fork."
- A manager who works for you hired a new supervisor last year. You were well aware of the choices he had at the time and allowed him to choose the new employee on his own. You have just received production data on every supervisor. The data on the new supervisor are terrible. You call in the manager and claim, "There was plenty of evidence that he (the supervisor) was not the man for the job."

- As director of marketing in a consumer-goods organization, you have just presented the results of an extensive six-month study on current consumer preferences for the products manufactured by your organization. After the conclusion of your presentation, a senior vice president responds, "I don't know why we spent so much time and money to collect these data. I could have told you what the results were going to be."

Do you recognize yourself? Do you recognize someone else? Each scenario is representative of a phenomenon that has been named "the Monday morning quarterback syndrome" (Fischhoff, 1975b), "the knew-it-all-along effect" (Wood, 1978), "creeping determinism" (Fischhoff, 1980), and "the hindsight bias" (Fischhoff, 1975a, 1975b). This body of research demonstrates that people are typically not very good at recalling or reconstructing the way an uncertain situation appeared to them *before* finding out the results of the decision. What play would you have called? Did you *really* know that your spouse should have turned left? Was there *really* evidence that the selected supervisor was not the man for the job? Could the senior vice president *really* have predicted the results of the survey? Perhaps our intuition is sometimes accurate, but we tend to overestimate what we knew and distort our beliefs about what we knew beforehand based upon what we later found out. The phenomenon occurs when people look back on the judgment of others, as well as of themselves.

Fischhoff has provided substantial evidence on the prevalence of the hindsight effect (1975a, 1977; Fischhoff and Beyth, 1975). For example, Fischhoff (1975a) examined the differences between hindsight and foresight in the context of judging historical events and clinical instances. In one study, participants were divided into five groups and asked to read a passage about the war between the British and Gurka forces in 1814. One group was not told the result of the war. The remaining four groups of participants were told either that (1) the British won; (2) the Gurkas won; (3) a military stalemate was reached with no peace settlement; or (4) a military stalemate was reached with a peace settlement. Obviously, only one group was told the truthful outcome—(1) in this case. Each participant was then asked what his or her subjective assessments of the probability of each of the outcomes would have been without the benefit of knowing the reported outcome. Based on this and other varied examples, the strong, consistent finding was that knowledge of an outcome increases an individual's belief about the degree to which he or she would have predicted that outcome without the benefit of that knowledge.

A number of explanations of the hindsight effect have been offered. One of the most pervasive is to explain hindsight in terms of the heuristics discussed in this book (Tversky and Kahneman, 1974). Anchoring may contribute to this bias when individuals interpret their prior subjective judgments of probabilities of an event's occurring in reference to the anchor of knowing whether or not that outcome actually occurred. Since adjustments to anchors are known to be inadequate, hindsight knowledge can be expected to bias perceptions of what one thinks one knew in foresight. Furthermore, to the extent that the various pieces of data on the event vary in terms of their support for the actual outcome, evidence that is consistent with the known

outcome may become cognitively more salient and thus more *available* in memory (Slovic and Fischhoff, 1977). This will lead an individual to justify a claimed foresight in view of "the facts provided." Finally, the relevance of a particular piece of data may later be judged important to the extent to which it is *representative* of the final observed outcome.

Claiming that what has happened was predictable based on foresight knowledge puts us in a position of using hindsight to criticize another's foresight judgment. In the short run, hindsight has a number of advantages. In particular, it is very flattering to believe that your judgment is far better than it actually is! However, the hindsight bias reduces our ability to learn from the past and to evaluate objectively the decisions of ourselves and others. Leading researchers in performance evaluation (see Feldman, 1981) and decision theory (see Einhorn and Hogarth, 1981) have argued that, where possible, individuals should be rewarded based on the process and logic of their decisions, not on the results. A decision maker who makes a high-quality decision that does not work out should be rewarded, not punished. The rationale for this argument is that the results are affected by a variety of factors outside the direct control of the decision maker. However, to the extent that we rely on results and the hindsight corresponding to them, we will inappropriately evaluate the logic used by the decision maker in terms of the outcomes that occurred, not the methods that were employed.

Closely related to the hindsight bias is the "curse of knowledge," which argues that in predicting others' knowledge, people are unable to ignore knowledge that they have that others do not have (Camerer, Loewenstein, and Weber, 1989). Their sophistication gets in the way. Knowledge that is psychologically available is hard to forget when a person is imagining how much others know (Camerer, 1992). This curse explains the difficulty in teaching because it is hard to imagine how much students know, and the frequency of product designers' overestimating how easy it is for the average person to master high-tech devices.

Although economic models frequently argue that information cannot hurt, a number of empirical investigations show that it can. For example. Hoch (1988) found that marketing experts (who are also consumers) are generally worse at predicting the beliefs, values, and tastes of other consumers than nonexpert consumers are. Similarly, individuals who know the answer to a problem overestimate the percentage of their peers who can solve a problem (Nickerson, Baddeley, and Freeman, 1987).

Have you ever given someone what you believed were very clear directions to your home, only to find that they got lost? Keysar (1992) argues that an individual often assumes that when she sends an ambiguous message (which is clear to her) to another individual, based on information that the receiver does not possess, the communicative intent will be magically understood by the other party. Keysar (1992) had people read scenarios that provided them with privileged information about "David." They read that David followed a friend's recommendation for a particular restaurant and had dinner there. Half the participants in the experiment learned that he really enjoyed the dinner, and the other half learned that he really disliked the dinner. In both cases, they read that David left the following note to his friend: "About the restaurant, it was marvelous, just marvelous." The participants in the study who knew that he enjoyed the dinner had a strong tendency to believe that the friend would take the comment as sincere. In contrast, participants in the study who knew that he disliked the dinner had a strong tendency to believe that the friend would take the comment as sarcastic. This result occurred despite the fact that both groups of participants knew that the friend had access to the same note. Keysar (1992) asserts that this evidence documents our false belief that an ambiguous message will be accurately received if we have the information to unambiguously interpret the message—even if we know that the recipient of the message does not have the information necessary for clear understanding.

INTEGRATION AND COMMENTARY

Heuristics, or rules of thumb, are the cognitive tools we use to simplify decision making. The preceding pages have described 13 of the most common biases that result when we overrely on these judgmental heuristics. These biases are summarized in Table 2.2, along with their associated heuristics. Again, it should be emphasized that

TABLE 2.2 Summary of 13 Biases Presented in Chapter 2

Bias	Description
Biases Emanating From the Availability Heuristic	
1. Ease of recall	Individuals judge events that are more easily recalled from memory, based on vividness or recency, to be more numerous than events of equal frequency whose instances are less easily recalled.
2. Retrievability	Individuals are biased in their assessments of the frequency of events based on how their memory structures affect the search process.
3. Presumed associations	Individuals tend to overestimate the probability of two events co-occurring based on the number of similar associations that are easily recalled, whether from experience or social influence.
Biases Emanating From the Representativeness Heuristic	
4. Insensitivity to base rates	Individuals tend to ignore base rates in assessing the likelihood of events when any other descriptive information is provided—even if it is irrelevant.
5. Insensitivity to sample size	Individuals frequently fail to appreciate the role of sample size in assessing the reliability of sample information.

(continued)

TABLE 2.2 *(continued)*

6. Misconceptions of chance	Individuals expect that a sequence of data generated by a random process will look "random," even when the sequence is too short for those expectations to be statistically valid.
7. Regression to the mean	Individuals tend to ignore the fact that extreme events tend to regress to the mean on subsequent trials.
8. The conjunction fallacy	Individuals falsely judge that conjunctions (two events co-occurring) are more probable than a more global set of occurrences of which the conjunction is a subset.
Biases Emanating From Anchoring and Adjustment	
9. Insufficient anchor adjustment	Individuals make estimates for values based upon an initial value (derived from past events, random assignment, or whatever information is available) and typically make insufficient adjustments from that anchor when establishing a final value.
10. Conjunctive and disjunctive events bias	Individuals exhibit a bias toward overestimating the probability of conjunctive events and underestimating the probability of disjunctive events.
11. Overconfidence	Individuals tend to be overconfident of the infallibility of their judgments when answering moderately to extremely difficult questions.
Two More General Biases	
12. The confirmation trap	Individuals tend to seek confirmatory information for what they think is true and neglect the search for disconfirmatory evidence.
13. Hindsight and the curse of knowledge	After finding out whether or not an event occurred, individuals tend to overestimate the degree to which they would have predicted the correct outcome. Furthermore, individuals fail to ignore information they possess that others do not when predicting others' behavior.

more than one heuristic can be operating on our decision-making processes at any one time. We have attempted to identify only the dominant heuristic affecting each bias. In the last two biases, their effects are so broad that it is difficult even to determine a dominant heuristic.

While the use of quiz items has emphasized the biases that our heuristics create, it should be stressed that, overall, the use of these heuristics results in far more adequate than inadequate decisions. Our minds adopt these heuristics because, on

average, any loss in quality of decisions is outweighed by the time saved. However, we argue against blanket acceptance of heuristics based on this logic. First, as we have demonstrated in this chapter, there are many instances in which the loss in the quality of decisions far outweighs the time saved by the use of the heuristics. Second, the foregoing logic suggests that we have voluntarily accepted tradeoffs associated with the use of heuristics. But in reality, we have not: Most of us are unaware of their existence and their ongoing impact upon our decision making. The difficulty with heuristics is that we typically do not recognize that we are using them, and we consequently fail to distinguish between situations in which their use is more and less appropriate.

To emphasize the distinction between the legitimate and illegitimate uses of heuristics, reconsider Problem 6. In that problem, participants tend to predict that Mark is more likely to take a job in "management of the arts," despite the fact that the contextual data overwhelmingly favor "management consulting." The representativeness heuristic, in this case, prevents us from appropriately incorporating relevant base-rate data. However, if the choice of "management consulting" were replaced with another less common career path for an MBA from a prestigious university (such as management in the steel industry), then the representativeness heuristic is likely to lead to an accurate prediction. That is, when base-rate data are unavailable or irrelevant (that is, the choices have the same base rate), the representativeness heuristic provides a reasonably good cognitive tool for matching Mark to his most likely career path. *The key to improved judgment, therefore, lies in learning to distinguish between appropriate and inappropriate uses of heuristics.* This chapter provides a start in learning to make this distinction.