In his book on probability theory and the perception of luck, Warren Weaver (1982) tells the story of a rather unusual business trip taken by his next door neighbor, George D. Bryson. According to Weaver, Bryson traveled by train from St. Louis to New York. After boarding the train, Bryson asked a conductor whether it would be possible to stop over for a few days in Louisville, Kentucky—a city he had never seen before. The conductor replied affirmatively, and Bryson got off in Louisville. At the train station, Bryson inquired about hotel accommodations and was directed to the Brown Hotel, where he registered and was assigned Room 307. Then, on a whim, Bryson asked whether there was any mail waiting for him. The clerk calmly handed him a letter addressed to "Mr. George D. Bryson, Room 307." As it turned out, the previous resident of the room had been another George D. Bryson!

What are the chances of a coincidence like this? The natural reaction many people have is to say that the odds are less than one in a million. After all, it's not every day that successive occupants of a particular room at a particular hotel in a particular city share a name as uncommon as "George D. Bryson."

But thinking about the coincidence this way is misleading. The question is not whether this particular episode is likely to happen. The question is whether it is likely that successive occupants of some room in some hotel in some city at some point in time will share the same name. As with the birthday problem discussed in Chapter 13, the probability of an unspecified match is much greater than the probability of a particular match.

Indeed, coincidences based on duplicate names are more common than many people suspect (see Figure 14.1). Here are two further examples:

On October 5, 1990, the San Francisco Examiner reported that Intel Corporation, a leading computer chip manufacturer, was suing another chip maker for infringing on Intel's 386 microprocessor trademark (Sullivan, 1990, October 5). Intel had learned that the rival company was planning to release a chip called the "Am386." What is remarkable
Mixup in Cars Proves Startling Coincidence

MILWAUKEE, April 2 (AP) — The police estimated the odds as “a million to one.”

Two men with the same surname, each owning a car of the same model and make and each having an identical key, wound up at a Sheboygan shopping center at the same time on April Fool’s Day.

Richard Baker had taken his wife in their 1978 maroon Concord model of an American Motors Corporation automobile to shop at the Northgate Shopping Center in Sheboygan.

He came out before she did, put his groceries in the trunk and drove around the lot to pick her up.

The two were coming back from another errand when, “My wife said, ‘Whose sunglasses are these,’” Mr. Baker said. “I noticed I had a heck of a time getting the seat up and it was way back when I got in,” he said. “My wife said: ‘Something’s wrong. Look at all this stuff in here. This isn’t our car.’”

A check of the license plates confirmed it: The Bakers had the wrong car.

Meanwhile, Thomas J. Baker, no relation to Richard Baker, had reported his car stolen.

Thomas Baker and the police were waiting for Richard Baker and his wife when they drove back into the shopping center parking lot.

The police tried the keys on the cars and both keys operated and unlocked both cars.

Sgt. William Peloquin said estimated the odds of such an incident as “a million to one.”

AN UNLIKELY DEVELOPMENT

Can you think of a coincidence so unlikely that you would be forced to assume it was not simply a random occurrence? Consider a story told by Richard Blodgett (1983, November, p. 17):

A German mother . . . photographed her infant son in 1914 and left the film at a store in Strasbourg to be developed. In those days, film plates were sold individually. World War I broke out and, unable to return to Strasbourg, the woman gave up the picture for lost. Two years later she bought a film plate in Frankfurt, nearly 200 miles away, to take a picture of her newborn daughter. When developed, the film turned out to be a double exposure, with the picture of her daughter superimposed over the earlier picture of her son. Through some incredible twist of fate, her original film had apparently never been developed, had been mislabeled as unused, and had eventually been resold to her.

This coincidence is quite famous because it is one of the stories that led Swiss psychiatrist Carl Jung to propose his theory of “synchronicity”. According to Jung, coincidences occur much more frequently than one would expect by chance and are actually the work of an unknown force seeking to impose universal order.

In many ways, Jung’s theory is similar to religious interpretations that characterize coincidences as acts of God. One coincidence that was about this story is how Intel discovered the infringement. As fate would have it, both companies employed someone named Mike Webb, and both Mike Webbs had checked into the same hotel in Sunnyvale, California, at the same time. Then, after both men had checked out, the hotel received a package addressed to one of the Mike Webbs. The package—which contained documents referring to an Am386 chip—was then misdelivered to the Mike Webb at Intel, who in turn forwarded it to Intel’s attorney!

The second coincidence took place in the summer of 1990, when Frank William Bouma and his wife, Trudy, sent their fiftieth wedding anniversary picture to the Grand Rapids Press (a Michigan newspaper). At roughly the same time, the newspaper received a fifty-fifth anniversary announcement from another Frank William Bouma and his wife, Nella. Amazingly enough, both couples were celebrating their anniversary on July 9. Thinking the coincidence would make an interesting story, the Grand Rapids Press ran an article that detailed other similarities between the two Frank Boumas, such as the fact that both men had a daughter named Marcia (Malone, 1990, September 9). The story was then picked up by the Associated Press wire service and ultimately appeared in the National Enquirer (Carden, 1990, September 25).
widely interpreted this way appeared in *Life* magazine in 1950 (Edel, 1950, March 27). On March 1 of that year, 15 members of the West Side Baptist Church choir in Beatrice, Nebraska, were due to practice at 7:15 PM, but for one reason or another, all 15 members were late that particular night. The minister's family was late because his wife ironed their daughter's dress at the last minute; a couple of choir members were late because their cars wouldn't start; the pianist had intended to get to church half an hour early but had fallen asleep after dinner; and so on. In all, there were at least 10 rather ordinary and seemingly unconnected reasons why people were late that night.

As things turned out, though, it was fortunate that everyone was late. According to the report in *Life*: "At 7:25, with a roar heard in almost every corner of Beatrice, the West Side Baptist Church blew up. The walls fell outward, the heavy wooden roof crashed straight down like the weight in a deadfall. . . . Firemen thought the explosion had been caused by natural gas [but] the Beatrice choir members . . . began . . . wondering at exactly what point it is that one can say, 'This is an act of God.'" Of course, this "coincidence" may well have been an act of God, and Jung's theory of synchronicity may well be true. Such explanations are not subject to empirical confirmation or disconfirmation. Even the most improbable events are unlikely to turn skeptics into believers, because skeptics can always explain improbable events as a function of the astronomical number of opportunities for coincidences to arise (e.g., Alvarez, 1965). Likewise, most believers would probably be unmoved by the skeptic's explanation, because they base their beliefs on more than probabilities alone.

What can be empirically investigated, however, are the answers to two interrelated questions: (1) Do people tend to see meaningful patterns in random arrangements of stimuli? (2) Can people behave randomly?

An answer to the first question was given partially in Chapter 10, when the discussion focused on the illusion of streak shooting in basketball. The next section reviews other research on the perception of randomness.

**LUCK AND SUPERSTITION**

An estimated 40 percent of Americans believe that some numbers are especially lucky for some people ("Harper's Index," 1986, October). Does such a belief make sense?

As Robert Hooke (1983, p. 51) wrote in *How to Tell the Liars from the Statisticians*:

A person claiming to be "lucky" is making perfectly good sense if by this it is meant that he or she has had good luck up until now. If the claim extends to the future by implying a greater chance of winning a lottery than the rest of us have, then it becomes a superstitious claim, and this is the kind of luck that many are speaking of when they say they don't believe in luck.

One of the earliest experiments on the creation of superstitious beliefs was published by Harold Hake and Ray Hyman (1953). On each of 240 trials, Hake and Hyman presented subjects with one of two stimuli—either a horizontal row of lighted neon bulbs or a vertical column of lighted bulbs. Before each trial, subjects were asked to predict whether the stimulus would be horizontal or vertical. Hake and Hyman presented subjects with one of four different orderings of the stimuli, but the most interesting series was random—half of the trials were horizontal and half were vertical, in no detectable pattern (there is some question as to whether a series can ever be completely random, so the word random will simply be used here to indicate a series with no discernible pattern).

Hake and Hyman found that subjects who viewed a random series predicted a horizontal stimulus roughly half the time, regardless of whether they had predicted a horizontal stimulus on the previous trial. In this respect, their guesses resembled the random series they observed.

Subjects did not choose entirely at random, however; they were strongly influenced by whether their previous prediction had been correct. After correctly guessing horizontal on the previous trial, they guessed horizontal again 64 percent of the time, and after correctly guessing horizontal on the previous two trials, they repeated this guess 72 percent of the time. In other words, subjects superstitiously based their predictions on previous correct identifications, even though the series was random. As Hake and Hyman (1953, p. 73) concluded: "If our subjects are typical, [this means that people] will always perceive an ambiguous series of events as being more structured than it really is. This must follow whenever subjects allow their own past behavior to influence their predictions of the future occurrence of series of events which are, in fact, completely independent of the behavior of subjects."

A similar experiment was published by John Wright (1962). Wright presented subjects with a panel that had 16 regularly-spaced pushbuttons arranged in a circle around a seventeenth pushbutton. Subjects were told that by pressing the correct sequence of outside buttons, followed by the center button, they could sound a buzzer and score a point on a counter. If the sequence they chose was incorrect, pressing the center button would simply advance them to the next trial. In reality, there were no correct or incorrect sequences; the rewards were distributed randomly. In one condition of the experiment, subjects were randomly rewarded on 20 percent of the trials; in another, on 50 percent of the trials; and in another, on 80 percent of the trials. Wright found much the
same result as Hake and Hyman—subjects tended to see patterns in the random feedback. They tended to develop superstitious behaviors, or preferences for certain patterns of buttons, and this tendency was most pronounced when the probability of reward was highest (80 percent).

RECOGNIZING RANDOMNESS

In the studies by Hake and Hyman (1953) and Wright (1962), subjects were presented with random feedback after each trial in a long series of trials, and in both cases subjects tended to see patterns in the random feedback. There is a problem with this research, though; the very nature of the tasks may have led subjects to expect to see a pattern. After all, if psychologists are interested in topics such as perception and learning, why would they present people with random feedback? To give subjects a reasonable chance of recognizing that the feedback they are getting is random, subjects should at least be forewarned that random feedback is a possibility.

In 1980, Christopher Peterson published a study that used the same general procedure used by Hake and Hyman, except that subjects in some conditions were asked not only to predict which stimulus would be shown on the next trial, but to indicate whether the sequence “has been generated randomly or in accordance with some rule.” Half the subjects were presented with a random sequence, and half were presented with a patterned sequence. Peterson found that when randomness was explicitly included as a legitimate possibility, subjects were usually able to recognize the series as random or close to random.

Of course, the recognition of randomness does not necessarily eliminate superstitious choices if similar choices have been correct on previous trials. Peterson did not find that superstitious behaviors went away if people were warned that a series might be random. He simply found that by including randomness as an explicit possibility, many people did in fact label a random series as random. As the next section shows, however, perceptions of what “randomness” means are not always accurate.

SEEING PATTERNS IN RANDOMNESS

In 1970, Dutch researcher Willem Wagenaar published an intriguing study on the perception of randomness. Wagenaar (1970a) presented subjects with a large set of slides that each contained seven series of white and black dots on a neutral grey background. For each slide, subjects were asked to indicate which of the seven series looked most random (i.e., most like it was produced by flipping a coin). On every slide, one series had a .20 probability of repetition (the probability of a black dot following a black dot, or a white dot following a white dot), one series had a .30 probability of repetition, one series had a .40 probability of repetition and so on up to .80. In a random series with two equally likely alternatives, the probability of repetition is .50 (just like the probability of tossing Heads after already tossing Heads), so if subjects were able to detect which of the seven series on each slide was random, they should have chosen the one with a .50 probability of repetition.

Instead, Wagenaar found that subjects judged series with a .40 probability of repetition as most random. That is, people thought that the most random-looking series was the one in which there was a 40 percent chance of one kind of dot occurring right after it had already occurred.* People expected a random series to alternate between the two kinds of dots more often than a truly random series would. Wagenaar found that subjects were particularly biased against long runs of the same outcome—for example, strings of six or more dots of the same kind. Thus, people saw randomness when there was actually a pattern, and saw patterns when the sequence was actually random. As mentioned earlier, Thomas Gilovich et al. (1985) found similar results in their study of streak shooting. People judged a series as most random when its probability of alternation was about .70 (equivalent to a .30 probability of repetition).

CAN PEOPLE BEHAVE RANDOMLY?

The difficulty people have in judging randomness implies that they should also have difficulty generating random sequences—and indeed they do. The earliest discussion of this issue was published by Hans Reichenbach (1949), who claimed that people are simply unable to produce a random series of responses, even when motivated to do their best.

This inability was clearly illustrated in an experiment published by Paul Bakan (1960). Bakan asked 70 college students to “produce a series of ‘heads’ (H) and ‘tails’ (T) such as [would] occur if an unbiased coin were tossed in an unbiased manner for a total of 300 independent tosses.” Random 300-trial sequences should have an average of 150 alternations between Heads and Tails, but Bakan found that nearly 90 percent of the students produced a sequence with too many alternations (the average was 175). These findings are consistent with what Wage-

*Peter Ayton, Anne Hunt, and George Wright (1989) have criticized this line of research for leading subjects to equate randomness with how “random looking” a sequence is. Randomly generated sequences of sufficient length always contain sections that do not seem random; hence, asking subjects to choose the sequence that looks most random may induce a bias against repetition. Other studies have found, however, that subjects underestimate the amount of repetition in random sequences even when they are merely asked to detect whether the sequences were randomly generated—with no mention of how the sequences look (Diener & Thompson, 1985; Lopes & Oden, 1987).
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naar (1970a) found—people expect more alternations between two outcomes than would actually occur in a random sequence.

This tendency is even more pronounced when people are asked to alternate randomly among more than two choices (Wagenaar, 1970b, 1972). For example, when people are presented with panels of six or eight pushbuttons and asked to generate a random pattern of button pressing, the amount of excessive alternation is even greater than in the case when they are presented with only two pushbuttons. The implication here is that in daily life, when there are often more than two available outcomes (such as Heads and Tails, or Horizontal and Vertical), the repetition of any one outcome will often be viewed as a nonrandom sequence. People expect a random sequence to alternate much more than the sequence would by chance alone.

LEARNING TO ACT RANDOMLY

In 1986, Allen Neuringer published a study that showed how people can be trained to behave "randomly" over an extended time period. Neuringer devised a computer program that gave subjects feedback on 5 or 10 statistical measures of randomness, such as the number of runs, the percentage of trials in which a certain choice was made, and so on. Subjects were simply asked to press one of two keys on a computer keyboard at any speed they wished, and as they went along, the computer gave them feedback on how they were doing.

Neuringer observed that subjects began by generating nonrandom sequences, just as Wagenaar and other researchers had found. But after receiving feedback over the course of several thousand responses, subjects were able to generate long strings (of 6000 keystrokes) that were indistinguishable from random sequences according to all the statistical indices that Neuringer had used to give subjects feedback. So it appears that people can behave in a random-like way, but only when they are explicitly trained to do so. Although few of us will ever enroll in a training procedure designed to teach us how to behave randomly—and few of us would want to behave randomly even if we could—Neuringer's experiment is important because it underscores the fact that misperceptions of randomness are not immutable. With enough training, they can be unlearned.

CONCLUSION

What are the practical implications of research on perceived randomness? The outcomes most common in daily life are not Heads and Tails or Horizontal and Vertical; they are hirings and firings in the workplace, wins and losses on the playing field, gains and losses in stock prices, and so forth. Although it certainly makes sense to seek patterns in these outcomes, research on perceived randomness suggests that decision makers have a tendency to overinterpret chance events.

For example, despite evidence that stock market fluctuations approximate a "random walk" down Wall Street (Fama, 1965; Malkiel, 1985), thousands of people labor each day to predict the direction stock prices will go. Indeed, Baruch Fischhoff and Paul Slovic (1980) found that subjects who were given stock prices and trend information were roughly 65 percent sure they could predict the direction stocks would change, even though they were correct only 49 percent of the time and would have done about as well tossing a coin.

As the studies in this chapter show, it is easy to see patterns in random outcomes. After witnessing three or four similar outcomes, most people conclude that a pattern is present. Of course, if a certain outcome does not usually occur, then three or four occurrences of that outcome may indeed be informative (for example, three closely spaced job turnovers in a company that rarely has turnovers). If the situation involves independent events with equally likely outcomes, however, it is not unusual to see three or four occurrences of the same outcome. In such circumstances, decision makers should resist the temptation to view short runs of the same outcome as meaningful.