THE 'HOT HAND' AND OTHER ILLUSIONS OF EVERYDAY LIFE

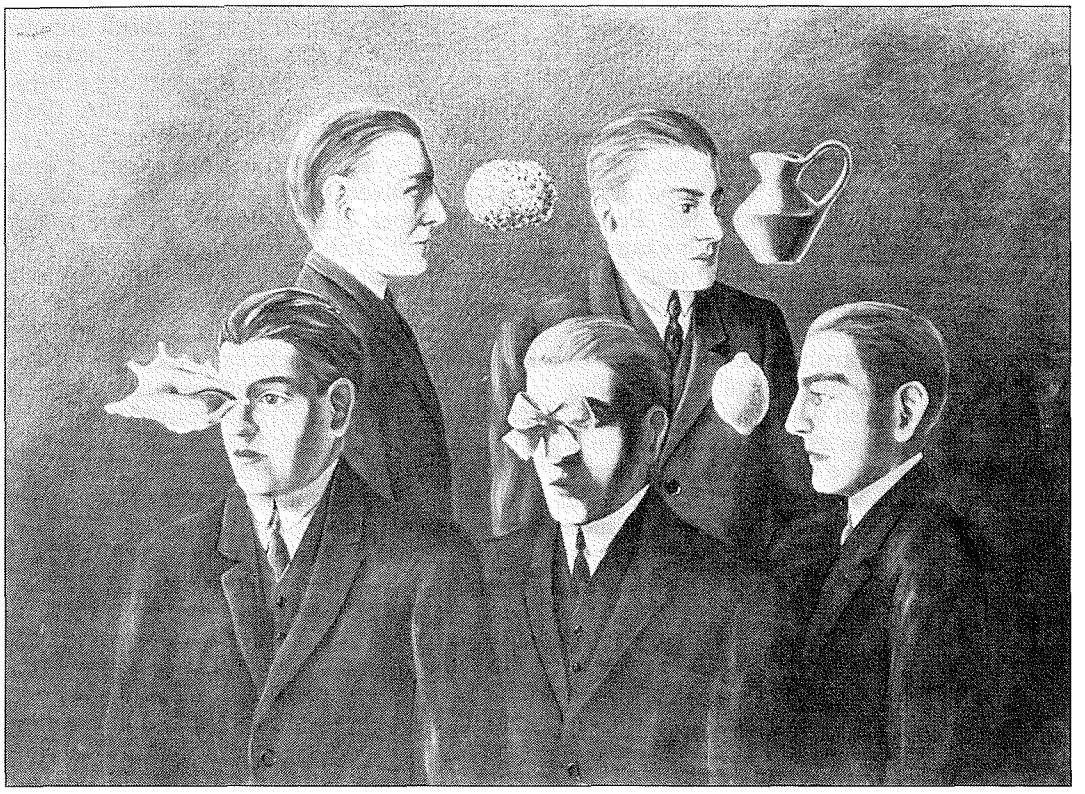
Who among us does not scoff at UFOs, astrology, and ESP? But the fact is that most of us also embrace dozens of other illusions with scarcely a second thought. These illusions, says psychologist Thomas Gilovich, are a product of the human mind's ceaseless quest to find order and meaning in the world—even where there is no order, even if the mind gets the meaning wrong. Many of these erroneous beliefs are harmless; others can lead to bias, prejudice, error, or, in the case of wrongly perceived threats to health or the environment, panic. Here Gilovich explores some commonly held illusions and suggests some antidotes.

by Thomas D. Gilovich

If I'm on, I find that confidence just builds.... You feel nobody can stop you. It's important to hit that first one, especially if it's a swish. Then you hit another, and... you feel like you can do anything. ***—World B. Free***

Known as Lloyd Free before he legally changed his first name, World B. Free was a professional basketball player during the 1970s and '80s. His statement reflects a belief held by nearly everyone who plays or watches the sport, a belief in the "hot hand." After making a couple of shots, players are thought to "get the hot hand" and to be more likely to hit their next few shots. But if a player misses several shots people say that he has "gone cold" and conclude that he is less likely to make his next few attempts.

The belief in the hot hand is really just another version of the common conviction in our daily lives that "success breeds success" and "failure breeds failure." In certain areas this is certainly true. Financial success, for instance, usually promotes more of the same because initial good fortune provides more capital for wheeling and dealing. However, there are other areas—roulette and other forms of gambling immediately come to mind—where the belief is just as strongly held, but where the phenomenon simply does not exist. What



The Familiar Objects *(1928), by Belgian surrealist René Magritte (1898–1967).*

about basketball?

My colleagues Amos Tversky, Bob Vallone, and I have conducted a series of studies to answer this question. First we translated the idea of the hot hand into a testable hypothesis. If a player is subject to periods of hot and cold shooting, then he should be more likely to make a shot after making his previous shot (or previous several shots) than after missing it. This implies, in turn, that a player's hits (and misses) should cluster together more than one would expect by chance.

To find out whether this is so, we obtained the shooting records of the Philadelphia 76ers during the 1980–81 season. (The 76ers are the only team that keeps records of the order in which a player's hits and misses occurred.) Contrary to the hot hand hypothesis, players were *not* more likely to make a basket after making their last shot. In fact, there was a slight tendency for players to shoot better after *missing* their last shot. They made 51 percent of their shots after making their previous shot, compared to 54 percent after missing it. They also had a better chance of making a basket if they missed their previous two or three shots. These and other more detailed analyses flatly contradict the notion that basketball players shoot in streaks.

But when we interviewed that year's team, Julius "Dr. J" Erving and other 76ers were firmly convinced that they shot in streaks. (When confronted with our findings, in fact, most people continue to insist that the hot hand exists.) Dr. J and his colleagues suggested that perhaps a hot player cools off because opponents begin guarding him more closely, or because he becomes overconfident and takes harder shots. The easiest way to test this idea is to look at players' "free throw" records—penalty shots taken from the same distance and without defensive pressure. Our analysis of two seasons of free throw statistics from the Boston Celtics showed that, on average, the players made 75 percent of their second

free throws after making their first, and 75 percent after missing their first.

Why do people continue to believe in the hot hand? The best explanation involves a very basic psychological phenomenon. Research psychologists have discovered that people have faulty intuitions about what chance sequences look like. People expect sequences of coin flips, for example, to alternate between heads and tails more than they actually do. Because chance produces less alternation than our intuition leads us to expect, truly random sequences look too ordered. Streaks of four or five heads in a row clash with our expectations, even though in a series of 20 tosses there is a 50 percent chance of getting four heads in a row, and a 25 percent chance of a streak of five. The law of averages (in fact, statisticians call it the "law of large numbers") ensures the expected even split only after a large number of tosses.

It is not uncommon for a player to make 50 percent of his shots and to take nearly 20 shots per game, so he stands a decent chance of making four or five shots in a row, and thus looking like he has a hot hand. With this in mind, we showed basketball fans a sequence of X's and O's—OXXXOXXXOXXOOOXOOXXOO—that we told them represented a player's hits and misses in a basketball game. We also asked them to indicate whether this sequence constituted an example of streak shooting. Even though the order of hits and misses in this sequence is perfectly random, 62 percent of our subjects thought that it constituted streak shooting.

It is easy to see why they thought this. The sequence above does *look* like streak shooting. Six of the first eight shots were hits, as were eight of the first 11! Basketball players do shoot in streaks, but the streaks do not exceed the laws of chance. They have nothing to do with "hot hands." The mistake made by players and fans lies in how they interpret what they see.

Red Auerbach, the brains behind what is arguably the most successful franchise in American sports history, the Boston Celtics, had this to say upon hearing about our results: "Who is this guy? So he makes a study. I couldn't care less." Another prominent coach, Bobby Knight of the 1987 NCAA champion Indiana Hoosiers, responded by saying "there are so many variables involved in shooting the basketball that a paper like this really doesn't mean anything." Disheartening reactions, perhaps, but not surprising. We would expect the belief in the hot hand to be held most strongly by those closest to the game. Because random sequences of hits and misses *look* like streak shooting, a gargantuan effort would be required to convince players, coaches, or fans that it is an illusion.

In the grand scheme of things, of course, whether or not basketball players shoot in streaks is not particularly important. What is important is that people chronically misconstrue random events, and that there may be other cases in which truly random phenomena are erroneously thought to be ordered and "real." However, the story of our research on the hot hand is only partly about the misperception of random events. It is also about how tenaciously people cling to their beliefs even in the face of hostile evidence. Our research—and the reaction to it—has implications for phenomena that affect our lives far from the parquet floors of the Boston Garden. Most broadly conceived, it touches on processes that have to do with the persistence of racial prejudice, with the assumptions of workers that their workplace is safe, with the blind adherence some people have to dangerous cults.

It ain't so much the things we don't know that get us into trouble. It's the things we know that just ain't so.
—Artemus Ward

It is an article of faith for some people that infertile couples who adopt a child will later be more likely to conceive. The usual explanation is that the couple stops trying so hard and their new-found peace of

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mind boosts their chances of success. On closer inspection, however, it becomes clear that the question is not why adoption increases a couple's fertility; clinical research has shown that it does not. What needs explanation is why so many people hold this belief when it is not true.

The officials who oversee admissions to distinguished undergraduate institutions, prestigious graduate schools, and select executive training programs all think they can make more effective admissions decisions if each candidate is seen in a personal interview. They cannot. Research shows that decisions based solely on objective criteria—such as academic credentials—are at least as effective in predicting future performance as those aided by subjective impressions formed during an interview. Why then do these people believe that interviews are so important?

Maternity ward nurses swear that the number of deliveries jumps during a full moon. They are mistaken. Again, why do they believe it if it "just ain't so?"

Today, more people believe in ESP than in evolution; there are 20 times as many astrologers as astronomers. Opinion polls reveal widespread acceptance of astral projection, "channeling," and the spiritual and psychic value of crystals.

How can such dubious beliefs be so widely and passionately held? Several things are clear at the outset. First, people do not hold these beliefs simply because they have not been exposed to the relevant evidence. Erroneous beliefs are found among experienced professionals and laypeople alike. The admissions officials and maternity ward nurses should "know better," since they are in regular contact with the pertinent data. Nor do people hold dubious beliefs simply because they are stupid or gullible. Quite the contrary. Humans possess powerful intellectual tools for processing information with accuracy and dispatch; the problem is that we sometimes misapply or misuse these tools in characteristic ways. Just as the extraordinary perceptual capacities of human beings occasionally give rise to optical illusions, so can our powerful intellectual abilities sometimes lead to erroneous beliefs.

People cling to many dubious beliefs, in other words, not because they satisfy some important psychological need, but because they seem to be the most sensible conclusions consistent with the evidence before them. They are the products, not of irrationality, but of flawed rationality. Such flawed thinking might never surface under ideal conditions, but the world does not play fair. Instead of providing us with the clear information that would enable us to "know" better, life presents us with messy data that are random, incomplete, unrepresentative, ambiguous, inconsistent, or secondhand. It is our imperfect attempts to deal with precisely these difficulties that cause us to believe things that just ain't so.

So it is with the notion that infertile couples who adopt are more likely to conceive. We've all heard about couples who conceive after adopting, because their good luck grabs our attention. The fate of couples who adopt but do not conceive, or those who conceive without adopting does not jump out from the backdrop of everyday life. Thus, the fertility of couples who adopt a child becomes a "fact" that follows naturally and inexorably from the available information. As we shall see, however, there are inherent biases in the way people absorb and interpret data, biases that must be recognized and overcome if we are to arrive at sound judgments and valid beliefs.

People seem compelled to see order, pattern, and meaning in the world, and they find randomness, chaos, and meaninglessness unsatisfying. We tend to "detect" order where there is none, and to spot meaningful patterns where only the vagaries of chance are operating. This tendency to organize the things we see may have been bred into us through evolution: Noting patterns and making connections is what leads to discovery and advance. The problem, however, is that the tendency is so strong and so automatic that coherence is sometimes detected even when it does not exist. So it is with the example of the hot hand. And even in instances where some statistical regularity exists, we may still read too much meaning into what we observe.

One of the most telling examples of this concerns what statisticians call the "regression effect." When any two variables are related, but imperfectly so, extreme values of one tend to be matched by somewhat less

extreme values of the other. As a result, very tall parents tend to have tall children, but not as tall (on average) as they are themselves; a company's disastrous years tend to be followed by more profitable ones. The heights of parents and children are related, but the relationship is not perfect—it is subject to variability and fluctuation. The same is true of a student's grades in high school and in college, a company's profits in consecutive years, a musician's performance from concert to concert, etc.

Most students in a statistics course can learn to answer correctly questions about the heights of fathers and sons, the IQ's of mothers and daughters, and the SAT scores of college students. People encounter two problems, however, when they venture out in the world and deal with less familiar instances of regression.

First, they tend to be insufficiently conservative or "regressive" when making predictions. Parents expect a child who excels in school one year to do as well or better the following year; shareholders expect a company that has had a banner year to earn as much or more the next. Some management specialists have suggested that this tendency to ignore regression effects may contribute to the high rate of business failures, as optimistic executives, thinking that good times will continue, expand too fast and overextend their companies.

A second difficulty, known as the regression fallacy, occurs when people fail to recognize statistical regression, and instead concoct superfluous theories to explain what they are seeing. An illuminating example is the famous "*Sports Illustrated* jinx." Many pro and amateur athletes firmly believe that it is bad luck to be on the cover of *Sports Illustrated*; they view an invitation to appear with a mixture of eagerness and dread. Olympic swimmer Shirley Babashoff, for example, reportedly balked at getting her picture taken for *Sports Illustrated* before the 1976 Olympics because of the jinx. (She was eventually persuaded to pose when reminded that a cover story on Mark Spitz did not prevent him from winning seven gold medals in 1972. Babashoff went on to win a gold medal as part of a relay team, as well as silver medals in four other events.)

It is easy to see how regression effects may be responsible for the so-called jinx. Athletes appear on the cover of *Sports Illustrated* when their performance has been extraordinary. But due to regression alone, we would expect an athlete's stellar performance to be followed by somewhat poorer performances. Those who believe in the jinx, therefore, like those who believe in the hot hand, are not mistaken in what they observe, but in how they interpret what they see. [See box, p. 57.]

With characteristic insight, John Stuart Mill once remarked that "every erroneous inference involves the intellectual operation of admitting insufficient evidence as sufficient." One pervasive example of this is that people tend to be more impressed by evidence that seems to confirm some relationship than by that which is contrary to it. Thus many people are convinced that their dreams are prophetic because a few have come true; they fail to notice or disregard the many that have not.

"Confirmatory events" often seem sufficient to establish a relationship in part because we tend to explain away any exceptions: A dream that did not come true never felt like a "real" premonition. But quite apart from these mental sanitizing operations, supporting evidence may have disproportionate impact because it is generally easier for the human mind to grasp than disconfirmatory information. Disconfirmations are often expressed negatively, and negatives simply are harder for the human brain to process. We have less trouble with "All Greeks are mortal" than "All nonmortals are non-Greeks." This tendency to focus on the positive is more pronounced, of course, when someone prefers or expects the belief to be true. Theists justify their faith by pointing to the number of times people have prayed for things that later came true; atheists cite the number of prayers that have gone unanswered.

It would make no sense, of course, to go through life weighing all facts equally and reconsidering one's beliefs anew each time an opposing fact was encountered. If a belief has received a lifetime of support, one is justified in being skeptical of an observation or report that calls the belief into question. It made sense for scientists to be

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The regression fallacy plays a role in shaping parents' and teachers' beliefs about the value of reward and punishment in childrearing. All adults like to hand out rewards for good behavior, courtesy, and promptness. However, regression guarantees that on average, such extraordinary performances will be followed by deterioration. The reward will thus appear ineffective or counter-productive. In contrast, regression also tends to ensure that bad performances will be followed by improvement, so any punishment meted out after a disappointing performance will appear to have been beneficial. As psychologists Amos Tversky and Daniel Kahneman put it, regression effects serve "to punish the administration of reward and reward the administration of punishment."

This phenomenon was demonstrated by an experiment in which the subjects played the role of a teacher trying to encourage a student to arrive for school on time. A computer displayed the hypothetical student's arrival time, which varied from 8:20 to 8:40, for each of 15 consecutive days, one at a time. School was supposed to start at 8:30. On each day, the participants were allowed to praise, reprimand, or issue no comment to the student. Predictably, the participants elected to praise the student whenever he was early or on time and to reprimand him when he was late. The student's arrival time, however, was pre-programmed and thus was not connected to the subject's response. Nevertheless, due to regression alone the student's arrival time tended to improve after he was punished for being late, and to deteriorate after being praised for arriving early. As a result, 70 percent of the subjects incorrectly concluded that reprimands were more effective than praise.

—T. D. G.

skeptical of the reports of cold fusion at the University of Utah in 1989 because they possessed a theoretical knowledge that suggested the reports were unlikely. Each of us is equally justified in looking askance at claims about UFOs, levitations, and miracle cancer cures.

But how do we distinguish between the legitimate skepticism of those who scoffed at cold fusion and the stifling dogma of the 17th-century clergymen who, doubting Galileo's claim that the Earth was not the center of the solar system, put him under house arrest for the last eight years of his life? In part, the answer lies in the distinction between skepticism and closed-mindedness. Many scientists who were skeptical about cold fusion nevertheless tried to replicate the experiment in their own labs; Galileo's critics refused to examine the evidence. Equally important, however, is the foundation upon which a person's pre-existing beliefs and theories rests. Well-supported beliefs and theories have earned a bit of inertia, and should not quickly be modified or abandoned because of a few hostile "facts." But ethnic and gender stereotypes rest on flimsy or non-existent information, and should quickly be cast off.

Scientists, of course, are not always innocent of groundless biases. The French craniologist Paul Broca (1824–1880) could not accept that the German brains he examined were on average 100 grams heavier than his sample of French brains. So he adjusted the weights of the two brain samples to take account of extraneous factors that are known to influence brain weight, such as body size. However, Broca never made the same adjustment in his much-discussed comparison of the brain sizes of men and women.

Scientists' most serious biases tend to be overcome by the discipline's insistence on replicability and the public presentation of results. Findings that rest on shaky ground do not usually survive in the intellectual marketplace. To a lesser extent, the same is true with regard to beliefs formed in everyday life: Our wackiest beliefs are probably weeded out on the playground or, as we get older, by the corrective influence of society at large. The biggest difference between science and everyday life is that scientists use formal procedures to guard against bias and error—a set of procedures of which the average person is little aware. They use statistical tools to guard against

the misperception of random sequences; control groups and random sampling avoid the dangers of drawing inferences from incomplete and unrepresentative data. And they use "blind" observers to eliminate the biasing effects of their preferences or expectations.

But perhaps the most fundamental safeguard of scientific inquiry is the requirement that the meaning of various outcomes be precisely specified and objectively determined. This is something we rarely do in everyday life. Instead, we often allow our expectations to be confirmed by any of a set of "multiple endpoints" after the fact.* When a psychic predicts that "a famous politician will die this year," it is important to specify then and there the range of events that will constitute a success. Otherwise, we may be overly impressed by tenuous connections between the prediction and a "confirming" event. Is a Supreme Court justice a politician? Should an unsuccessful assassination attempt count as a successful prediction? This is the stuff that sustains belief in horoscopes, fortune cookies, and the prophesies of Nostradamus.

We tend to believe what we want to believe. That old saw, at least, is true, and considerable evidence has been gathered to support it. Much of the evidence comes from research on people's assessments of their own abilities. For example, a majority of Americans think that they are more intelligent, more fair-minded, less prejudiced, and more skilled behind the wheel of an automobile than the average man in the street. This phenomenon is so reliable and ubiquitous that it has come to be known as the "Lake Wobegon effect," after Garrison Keillor's fictional community, where "the women are strong, the men are good-looking, and all the children are above average." Part of the reason we view ourselves so favorably is that each of us uses different criteria to evaluate our standing on a given trait—criteria that work to our own advantage. As economist Thomas Schelling explains, "Everybody ranks himself high in qualities he values: careful drivers give weight to care, skillful drivers give weight to skill, and those who think that, whatever else they are not, at least they are polite, give weight to courtesy, and come out high on their own scale. This is the way that every child has the best dog on the block."

Another reason we hold such favorable views of ourselves is that we are prone to self-serving assessments when it comes to apportioning responsibility for our successes and failures. Athletes attribute their victories to themselves, but blame their losses on bad officiating and bad luck. Students who perform well on an examination generally think of the test as a valid measure of their knowledge; those who fail tend to think of it as arbitrary and unfair.

But our desire to believe comforting things about ourselves and about the world does not mean that we willy-nilly believe what we want to believe; such flights of fantasy are reined in by the existence of a real world and the need to perceive it accurately. Rather, our motivations have their effects more subtly, through the way we process information. What evidence do we consider? How much of it do we consider? What criteria do we use as sufficient evidence for a belief? For things we want to believe, we ask only that the evidence not force us to believe otherwise—a rather easy standard to meet given the equivocal nature of much information. For propositions we want to resist, however, we ask whether the evidence *compels* such a distasteful conclusion—a much more difficult standard to achieve. For desired conclusions, in other words, it is as if we ask "*Can* I believe this?" but for unpalatable conclusions we ask "*Must* I believe this?" The evidence required for affirmative answers to these two questions are enormously different. By framing the question in such ways, we can often believe what we prefer to believe and satisfy ourselves that we have an objective basis for doing so.

There are times when our mistaken beliefs about ourselves or about the world

*An interesting analogue of the problem of multiple endpoints is seen in the common belief that things like plane crashes, serial-killing sprees, or birth announcements "happen in threes." Such beliefs stem from the tendency for people to allow the occurrence of the third event in the triplet to *define* the period of time that constitutes their "happening together." If three plane crashes occur in a month, then the period of time that counts as their happening together is one month. If three plane crashes occur in a year, then the relevant period of time is stretched. By allowing the window of opportunity to be sufficiently flexible, such beliefs can *only* be confirmed.

around us cost us little or nothing. For most people, a belief in the curse of the Bermuda Triangle has no immediate consequences. It is not so much that they hold such a belief, but that they entertain it—and are entertained by it. Other, more serious beliefs can also be without negative repercussions. Some people believe in one god, some in many, and others in none; all of them can't be right, yet many derive comfort from their beliefs. But these isolated examples aside, there are often real costs of failing to perceive the world accurately. One hears from time to time of cases in which someone dies because an effective medical treatment was ignored in favor of some quack therapy. Can there be anything more pitiful than a life lost in the service of some unsound belief?

Tolerating the occasional eccentric notion is harmless enough, but by attempting to turn our critical intelligence off and on at will, we risk losing it altogether. "When people learn no tools of judgment and merely follow their hopes," observes Harvard paleontologist Stephen Jay Gould, "the seeds of political manipulation are sown."

The complexity of modern life does not yield clearcut answers to many of our most pressing problems. In a world which bombards us daily with conflicting reports about a variety of issues—the destructive effects of acid rain, the cancer risk from inhaling "secondary" cigarette smoke, the threat of AIDS to the heterosexual population—we must increasingly grapple with probabilities rather than certainties. Clear thinking about issues with "messy" evidence becomes more important even as it becomes more difficult.

We are battling against the tendency of the human brain to impute structure and coherence to random patterns, to be more impressed by confirming evidence than by contradiction, and to be overly influenced by our preferences and preconceptions. There may be strategies we can develop to compensate for these tendencies, strategies not to be found in the "deterministic" sciences such as chemistry, but rather in the more "probabilistic" sciences such as economics, psychology, and statistics. Wider education in these fields surely can help check the worst excesses of wrong thinking. But the mind's quest for order does seem to condemn us, ironically, to a certain degree of folly.