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Subconsciously, Athletes May Play Like Statisticians

By DAVID LEONHARDT

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When Justine Henin-Hardenne rips a cross-court forehand at the Australian Open or Tom Brady, the New England Patriots quarterback, dodges an onrushing defender, each looks like the very definition of living in the moment. Like other great athletes, they often appear to rely on speed, strength and lightning-fast reactions.

There seems to be little time for highly advanced quantitative analysis that weighs current observations against past experiences to suggest a plan of attack.

But this kind of analysis is precisely what the human brain does when facing a physical challenge, according to a study by two European scientists published in the current issue of *Nature*. The more uncertainty that people face — be it caused by wind on a tennis court, snow on a football field or darkness on a country highway — the more they make decisions based on their subconscious memory and the less they depend on what they see.

Among researchers, the combining of new information with conventional wisdom is known as Bayesian analysis, and it has become increasingly popular in recent years. Once controversial, because it muddies supposedly pure scientific data with subjective opinion about which prior research is relevant to a particular study, it has gained adherents as the explosion of computing power has allowed the method's complex formulas to be performed on a basic laptop computer.

With the encouragement of the Food and Drug Administration, medical-device makers use the method to test new devices that are only slightly different from their predecessors. Computer companies use Bayesian methods to build spam filters for e-mail, said Dr. Michael Lynch, the chief



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A new study suggests that under some conditions, athletes like Cédric Pioline. \A new study suggests that under some conditions, athletes like Cédric Pioline draw on their subconscious memories more than on what they see, an example of Bayesian analysis.

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executive of Autonomy, a British software company, and governments use it to try to prevent terrorism, combining data from security cameras and X-ray machines with criminal profiles.

"In academia, the Bayesian revolution is on the verge of becoming the majority viewpoint, which would have been unthinkable 10 years ago," said Bradley P. Carlin, a professor of public health at the University of Minnesota and a Bayesian specialist.

Stephen M. Stigler, a professor of statistics at the University of Chicago who considers himself to be roughly in the middle of the spectrum in the Bayesian debate, added: "It's not a controversial subject. Twenty years ago, it was."

In everyday life, of course, people have been using the ideas underlying Bayesian analysis since well before it became the vogue in science labs, or even before Thomas Bayes, an 18th-century British minister and mathematician, formalized the method in a paper that was published two years after he died. When crossing a street, people rely on both what they see and what they remember about the speed of cars on similar roads. When deciding whether to take a sick child to a doctor, parents consider the current symptoms as well as the child's history and their general knowledge of illness.

"The human brain knows about Bayes's rule," said Konrad P. Körding, a postdoctoral researcher at the Institute of Neurology in London, who conducted the study published in Nature along with Daniel M. Wolpert, a professor at the institute.

The new research stands out because it offers a detailed window into how the Bayesian thought process works, showing the point when uncertainty becomes great enough to give past experience an edge over current observation.

Each participant in the experiment sat down and placed a hand on a tabletop. A projection of a computer screen blocked their view of the hand. The goal was to guide a cursor, which followed the movement of the hand, from one side of the screen to a target on the other side.

Adding to the uncertainty, the cursor usually appeared slightly to the right of the hand, and the participants caught at most a quick glimpse of it when it was halfway across the screen. Sometimes, the cursor appeared as a discrete point; other times, it was an ill-defined cloud.

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The researchers found that when no cursor flashed, people relied on what they had learned during 1,000 practice runs before the experiment: namely that the cursor was, on average, one centimeter to the right of the hand. When a cloud flashed, they considered it, but only somewhat, in a pattern that followed what Bayes's formula predicted. When a distinct cursor flashed, they relied on it and not past experience.

"Most decisions in our lives are done in the presence of uncertainty," Dr. Körding said. "In all these cases, the prior knowledge we have can be very helpful. If the brain works in the Bayesian way, it would optimally use the prior knowledge."

The researchers drew the analogy to tennis in their paper, and it is not the first study to suggest that athletes have a more sophisticated understanding of mathematics than even they may realize.

Mark A. Walker and John C. Wooders, economists at the University of Arizona, recently studied old videotapes of tennis matches involving stars like Bjorn Borg, Ivan Lendl and Pete Sampras. The economists looked at the serves in each match to see how well players randomly altered playing the ball to an opponent's forehand or backhand.

Many people do poorly on similar tests when they are conducted in a laboratory. Ask somebody to write down a list of hypothetical coin-flip outcomes, for example, and the result will probably contain too few streaks of heads or tails. Because people know that the overall odds are 50-50, they underestimate how often three straight tails or four straight heads turn up.



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But professional tennis players realize, on some level, that their opponent will have an advantage if he knows that a serve to the forehand is likely to be followed by one to the backhand. They do a relatively good job of mixing serves, though still not as randomly as a computer program would, Professors Walker and Wooders reported in a 2001 paper.

Some researchers remain skeptical that the human mind works like the coldly rational Bayesian machine suggested by the Nature paper. Consider the self-destructive mistakes drivers make in their behavior, from turning a steering wheel the wrong way on a patch of ice to buying sport-utility vehicles that are less safe than their owners believe.

"I'm quite comfortable with the idea that people use probability," said Dr. Stigler, the Chicago statistician. "The idea that it's associated with a Bayesian approach is not quite clear."

The most likely explanation may be that some people are quite good at subconsciously using statistical techniques and others are far less so. As the Super Bowl and Australian Open play out over the next two weeks, the athletes holding trophies at the end might be the Bayesians.

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