the secretary to the British Treasury, in 1765. Indeed, 90 percent of all Britons—including the wealthy merchants of London—did not enjoy the right to vote. "Although the Americans greeted the theory of virtual representation with scorn," Zuckert writes, "it is in fact an extremely plausible application of the underlying theory of the constitution, as contained in the [1689] Bill of Rights."

To trump that theory of virtual representation and the inconvenient precedents in their own colonial history, Americans drew on the Lockean theory of individual natural rights, combining it with as much of the historical constitution as possible. Our laws, said John Adams, derive "not from parliament, not from common law, but from the law of nature, and the compact made with the King in our charters." In this way, says Zuckert, persuading themselves "that the British were nefariously innovating and that the colonists had every right, as loyal subjects, to resist those innovations," the Americans proceeded on to the Revolution. And the Revolution then cemented their case, giving "the nascent American political culture a fundamentally Lockean orientation."

Science, Technology & Environment

Mr. Wizard at Bat

"Predicting a Baseball's Path" by A. Terry Bahill, David G. Baldwin, and Jayendran Venkateswaran, in *American Scientist* (May–June 2005), P.O. Box 13975, 3106 East N.C. Hwy. 54, Research Triangle Park, N.C. 27709–3975.

When the innings stretch lazily through a warm afternoon and the crowd's murmurings merge into a locustlike drone, baseball seems the perfect summer game. The field itself, however, is an arena of precise violence. Standing 60.5 feet from the batter, the pitcher hurls a ball just under three inches in diameter at a target only 17 inches wide. The ball arrives in less than half a second, sometimes dropping nearly six feet on its way to the plate.

The batter has perhaps one-seventh of a second to determine the ball's speed and spin, another seventh of a second to decide whether—and where and when—to swing, and a fraction more to muscle the bat.

Science has more to offer the beleaguered man at the plate than illegal steroids, according to Bahill, a professor of systems engineering and computer science at the University of Arizona, and his colleagues, Baldwin, a former major-league pitcher, and Venkateswaran, a graduate student.

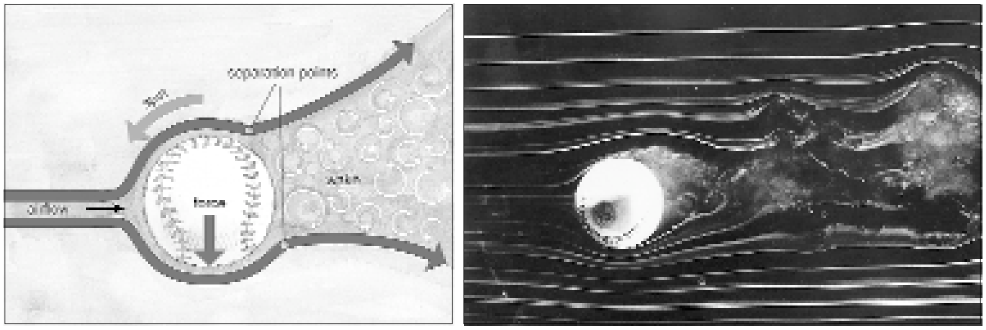
The batter can first pick up a few clues from the pitcher's delivery. "To go through the strike zone, a 95-mile-per-hour fastball must be launched downward at a two-degree angle, whereas a 60-mile-per-hour change-up must be launched upward at a two-degree angle." A major-league batter can often tell the difference.

The batter can also observe the pitcher's hold on the ball as he releases it. "If a pitcher throws a curve ball and a batter has keen eyesight, he might be able to see the index and middle fingers roll across the face of the ball as the pitcher snaps it off."

But the batter's best source of information is the way the ball spins immediately after its release. Each type of pitch has its own spin, and detecting it requires excellent "dynamic visual acuity," that is, the ability to perceive moving objects. For instance, Ted Williams, the great Boston Red Sox slugger, could read the label on a spinning 78-rpm record.

How the pitch appears to the batter depends on the pitcher's grip. If the pitcher clutches the ball across the seams, it appears that four seams pass in front as the ball makes a revolution; if he holds the ball along the seams, it appears that only two seams do. To see what actually happens in flight, the authors skewered some baseballs on an electric drill and spun them at a fastball's typical rate (1,200 rpm). The four-seam fastball was a gray blur with thin vertical red lines a seventh of an inch apart. The two-seam fastball showed two big red stripes, each about three-eighths of an inch wide, which made the spin direction more easily detectable.

The "flicker factor" also plays a role in detection, the authors speculate. The seams on



Spin determines how a baseball moves. In a curveball (above, lateral view), the ball has topspin, turning in a counterclockwise direction. The turbulence in its wake causes the ball to drop faster than normal. It's the drop more than the curve that gives batters problems.

the two-seam fastball appear almost as one, so as the ball rotates, it may flicker like a rapidly blinking light. That flickering could reveal if the ball has topspin (a curve ball) or backspin (a fastball). There's no flicker with a four-seam pitch, though, since the "blinking" of the four individual seams is so rapid.

Unfortunately for batters, most pitching coaches recommend a four-seam grip for the fastball. But pitchers generally use the same grip for the fastball and the slider (a pitch that travels faster than a curve ball but spins less) to avoid tipping off the pitch. On the slider, the four-seam grip works to the batter's advantage because it produces the perception of a red dot on the ball visible from home plate. Eight of 15 former major leaguers Bahill and his colleagues surveyed recalled seeing just such a dot. A smart pitcher could use the two-seam grip to avoid this telltale signal. Now if only future Babe Ruths could keep this scientific knowledge out of the hands of pitchers!

Bug Cops

"Policing Insect Societies" by Francis L. W. Ratnieks and Tom Wenseleers, in *Science* (Jan. 7, 2005), American Assn. for the Advancement of Science, 1200 New York Ave., N.W., Washington, D.C. 20005.

Though it may not provide the basis for yet another *Law and Order* spinoff, police work goes on in insect societies, too. The criminals in these societies are females out to spread their genes around, even though that may not be in the colony's best interest and may upset the division of labor between queen and workers. "In the life of any female bee, wasp, or ant, there are two points at which she may try to reproduce," write Ratnieks, a professor of apiculture at the University of Sheffield, and Wenseleers, a fellow at the Institute of Advanced Study in Berlin.

One is when, as an adult worker—incapable of mating, in most species, yet still possessing ovaries—she can activate those ovaries to lay eggs; if reared, the unfertilized eggs will develop into males. That would mean too many males. A typical honeybee colony, for instance, has tens of thousands of workers (female offspring of the queen), but only a few hundred drones (male offspring of the queen). Enter "worker policing," in which workers (and sometimes even the queen) detect and kill eggs laid by other workers. In the case of the honeybee and the common wasp, this policing eliminates 98 percent of worker-laid eggs. It also appears to have a deterrent effect, discouraging workers from laying eggs.

The other "danger" point in a female insect's life occurs earlier, when she is a larva and can "choose" to develop into a worker or a queen. In most species, queens are specialized structurally for egg laying and frequently are unable to work. "A larva is often better off developing into a queen, yet policing ensures that most are prevented from doing so. Because queens are generally larger than workers and need more food, adult workers can control whether a larva will develop into a queen by controlling her food supply." In a