Going, Going, Gone! The Psychology of Baseball

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It's the seventh game of the World Series — bottom of the ninth inning, your team is down 4-3 with runners on second and third — and you're on deck. You watch as your teammate gets the second out. That means you're up with a chance to win a championship for your team…or lose it.

You're known as a clutch hitter, and you've hit safely in 22 straight games — an impressive streak to be sure. But as you step into the batter's box, your hands are sweating and your mind is racing. You think about the last time you faced this pitcher and the curveball he threw to strike you out. You look at him standing on the mound and he looks tired. You try to pick up clues from his body language. How fast is his fastball today? Will he tempt you with that curveball again?

Psychologists are asking different questions: Does your recent hitting streak really matter? Is there even such a thing as a clutch hitter? Will the pitcher's curveball fool you? And then there are the more basic questions: How is it possible to hit a 100 m.p.h. fastball without being able to see it for more than a split second? How is it that even sandlot players — mere children — can intuitively do the complex geometry needed to get to precisely the right spot to catch a fly ball?

University of Missouri psychologist Mike Stadler uses research from dozens of behavioral scientists, plus some of his own, to try answering these complicated questions in his new book, *The Psychology of Baseball*. "Baseball turns out to be a good laboratory for studying psychological phenomena," Stadler says, "because you're pushing the human system to its limits. And that's a good way to see how the system works."

Psychologists have been studying baseball players almost as long as the Red Sox had been disappointing fans in Boston, and much of the attention has naturally focused on the most heroic part of the game: hitting. Baseball's great sluggers, such as Babe Ruth, Ted Williams, and Albert Pujols, make it seem so effortless, which makes it hard to accept the scientific consensus that hitting is basically impossible. That's right, impossible. Why? A ball thrown by a major league pitcher reaches speeds of 100 m.p.h. and an angular velocity (the speed in degrees at which the ball travels through your field of vision) of more than 500 degrees per second. A typical human can only track moving objects up to about 70 degrees per second. Add to this the fact that it takes longer to swing a bat than it does for a pitch to go from the pitcher's hand to the catcher's mitt, which means a hitter must start his swing before the ball is released and has less than a half a second to change his mind. All that equals impossible.

Not surprisingly, professional baseball players are able to keep their eye on the ball longer (up to 120 degrees per second) than the average human being. In one study, pro players who were asked to keep their eyes on the ball did one of two things. They either watched the pitch until it reached speeds too fast to keep track of — the farthest a player could track a pitch was 5.5 feet in front of the plate — or, less commonly, they watched for the first few feet and then quickly moved their line of vision to where they thought the ball would end up and watched it as it crossed the plate.

So it turns out that your little league coach's advice — watch the ball until it meets the bat — is actually physically impossible. But even the worst Major League hitters succeed two out of every 10 trips to the plate. Are the hits they get just pure luck? Not exactly.

"I guess what interests me most in some ways is that even though we have the perceptual limitations and even though we have the reaction time limitations, there's still enough mental machinery there to help us solve the problem," Stadler says.

Hitters must make some assumptions and guess where the ball is going to be and when it is going to be there in order to make contact. Because the barrel of the bat is long enough to cover the entire plate but is only a few inches thick, predicting where the ball will end up horizontally across the plate is much less important than predicting where it will be vertically. And a large portion of predicting at what height it will cross the plate has to do with predicting the speed of the ball.

Arizona State's Rob Gray has used a virtual hitting simulation — something he describes as a "purposefully simplified" video game — to help determine what cues help hitters make contact with the ball. In a 2002 study, he varied the speeds of the virtual ball randomly from about 70 to 80 m.p.h., and hitters failed miserably, with batting averages of about 0.030. That'll get you cut from a T-ball team.

But in the same simulation, hitters fared much better — with batting averages of 0.120 — when pitches were thrown at just two different speeds: slow (75 m.p.h.) or fast (85 m.p.h.). It's the randomness, not an overpowering fastball, that fools hitters. Gray's conclusion: "It is clear that successful batting is nearly impossible in the situation in which pitch speed is random and in which no auxiliary cues (e.g., pitcher's arm motion or pitch count) are available to the batter."

So, back to you now in the batter's box. You can at least take comfort in knowing that the pitcher you're facing only has a few pitches: a fastball, a changeup, and maybe a slider or a curveball. You've practiced hitting each of those pitches thousands of times during your career, and can draw on your knowledge of those at-bats. There are also cues like the pitcher's arm speed and the rotation of the ball that help you make an educated guess about what pitch is coming. You may need to get used to a pitcher's speed, but you have a decent idea of where the ball is going — at least enough of a good idea to succeed at your job 30 percent of the time.

Now the question is: Are you going to perform in this clutch situation, with the game and the championship on the line, or will you choke? Research dating back to a 1984 study by Florida State's Roy Baumeister (an APS Fellow) and including work by Michigan State's Sian Beilock suggests that if you put a player in a pressure situation, he develops a greater than normal self-focus — what we colloquially call trying too hard. When you learn a process like a baseball swing, it is important to practice it step-by-step, and novice hitters actually think through their actions of shifting their weight, rotating their hips, and so forth. But experts do this naturally. Indeed, Gray used his hitting simulation to show that when expert hitters were asked to focus on a particular part of their swing, it adversely affected their performance.

"If we force you to go back and think about each stage of what you're doing, you actually start interfering with this procedural knowledge, this motor memory, and you start messing it up," Gray says. "It's like tinkering with a machine that's running really efficiently. You start trying to control

everything yourself and it messes it up and it hurts your performance."
It's hard to imagine a more pressure-filled situation than the World Series, so it wouldn't be a stretch to think the hitter might overthink his swing. But what if he's a clutch hitter? What if he's been on a hot streak the last few weeks? The scientific consensus is that there is no such thing as a streaky hitter; though try telling that to anyone who's been on the losing end of one of David Ortiz's 15 walk-off hits with the Red Sox or Derek Jeter's 14 consecutive World Series games with a hit. Still, the statistical analysis seems to show that streaks and clutch hitting could just be a result of simple probability.

Physicist Ed Purcell of Harvard did a statistical analysis and concluded that all streaks and slumps except for Joe DiMaggio's remarkable 56-game hit streak fall within what could be expected by chance. Think of it this way: If you flip a fair coin a couple million times, it's not hard to imagine that there might be times when it comes up heads 20 times in a row.

There is additional support for this view. Dick Cramer, baseball statistician and founder of STATS, Inc., hypothesized that if baseball did have clutch players, they would be consistent from year to year — much like the league's best home-run hitters are consistent across years. What he found in fact is that a player might be one of baseball's best clutch hitters one year, then plummet to the bottom the very next year.

Not everyone is ready to discount clutch hitting. Gray, for example, thinks clutch hitters might know how to relax and not try too hard in situations where there is a lot on the line. So maybe it's not so much being a clutch hitter as it is being a nonchoker. A study of bowlers lends support to this idea. Professional bowlers, the study showed, are much more likely to bowl a strike after a series of strikes than they are to bowl a strike after a series of nonstrikes. That was true for weekend sports, like horseshoes, as well.

It could be that too much of baseball is decided by factors other than the hitter — the pitcher and the fielders certainly have some influence — to be able to accurately determine whether hitters are clutch or streaky. What happens when a "streaky" hitter comes up against a pitcher who's also on the top of his game? Or what if the hitter makes good contact during two of his at-bats but is robbed by spectacular fielding plays both times?

"Everything ultimately comes down to the hitter succeeded or he didn't," Stadler says. "But there's a lot more behind that number in the box score that the box score just doesn't capture."

So, let's say you're back at the plate, and you've fallen behind in the count 2-2. The next pitch comes and, like you predicted, it's another curve ball. You're ready. You give a good swing. The ball sails deep into the outfield. The centerfielder takes off to his right immediately, tracking the ball with ease. He's not actually computing any complicated formula in his neurons while sprinting, but he seems completely sure about where the ball is going to land. Then, whack! He runs straight into the outfield wall, and the ball flies over his head for a game-winning home run.

Like hitting, fielding also seems like it should be a mental and physical impossibility — which makes it fascinating to psychology researchers. If you put a player in the outfield and make him stay put, he is actually quite bad at predicting where a ball is going to land, yet he will run effortlessly to that spot when allowed to do so. How?

One of the first theories developed to explain fly-ball catching was developed by physicist Seville Chapman, who hypothesized that fielders used the acceleration of the ball to help them determine where the ball will land. To simplify the problem for experimental purposes, balls were only hit directly at the fielders, who then moved either forward or backward in order to keep the ball moving at a constant speed through their field of vision — so, they started with their eyes on home plate and then moved in a way that kept their eyes moving straight up at a constant speed until they made the catch. If they moved too far forward, the ball would move more quickly through their field of vision and go over their head. If they moved too far backwards, the ball would appear to die in front of them.

This theory seemed too simple to Mike McBeath, a psychologist at Arizona State. For one thing, Chapman's model predicted that fielders would use the same process for balls hit to their left or right, simply making a sideways calculation along with the basic speed calculation. But that would mean balls hit to the side should be harder to catch, and McBeath (and every sandlot outfielder) knows that's simply not the case. Any outfielder will tell you that a ball hit directly at him is the most difficult to catch, so McBeath reasoned instead that, when a ball is hit directly at a fielder, the fielder lacks some crucial bit of information for making the catch.

He came up with a method that was similar to Chapman's but included an extra piece: He hypothesized that fielders kept the ball moving through their field of vision in a straight but diagonal line. So if the outfielder is looking at home plate when the ball is hit, he then keeps his eyes on the ball and runs so his head moves along a constant angle until the ball is directly above him, which is when he snags it. To test this, McBeath had fielders put video cameras on their shoulders, and the cameras moved in this manner.

Yet ask any Major Leaguers about this, and you'll get blank stares. McBeath did talk to pro outfielders, and responses ranged from "Beats me" to "You're full of it." That's because there's no conscious processing involved; it's all taking place at the level of instinct, even though the geometry is sophisticated.

It turns out that outfielders aren't the only ones who operate according to McBeath's strategy. Dogs use it to catch Frisbees, bats and insects use it to catch prey, infielders use the model — only upside-down — to field ground balls, and now robots use it, too. Because the algorithm for catching fly balls is actually so simple, McBeath has been able to work with robotics experts to program robots to catch fly balls. (Or at least to get to the right spot; catching is a different problem for a robot with no hands.)

"It's neat," says McBeath, an expert on perception. "It's not always true that the way humans and animals do things is the best way. The geometry of a moving fielder from the perspective of the fielder seems like it would be a nightmare of a formula. But what we've shown is that we can reduce it down to this really simple geometric solution."

Chapman's model is still used to describe the special case of catching balls hit directly at the fielder. Both fly-ball catching theories require that the fielders make adjustments on the go, which explains why we're so bad at predicting where a ball will go if we stand in one place.

It also explains why our World Series outfielder ran straight into the wall when tracking the game-winning home run. Using McBeath's method, players tracking a fly ball only know that they are capable of getting to the spot where the ball will land. This intuitive geometry offers no insight into whether that ball is going, going … gone.

Are good players born or made?

It's tempting to assume that there is some innate ability involved in becoming an elite ball player. Baseball playing does seem to run in families — think Ripken or Bell or Bonds. Plus, studies have shown that baseball players are a select group of athletes with amazing skills such as being able to track objects moving at extremely high speeds of angular velocity.

Back in 1921, psychologists at Columbia convinced Babe Ruth to take a series of tests and found that he reacted faster to sound and visual signals than the average human being. His hand-eye coordination was better than most of the population, and he could perceive information significantly better than the average person.

"The secret of Babe Ruth's ability to hit is clearly revealed in these tests," wrote Hugh Fullerton, the author of the *Popular Science Monthly* article that described the tests. "His eye, his ear, his brain, his nerves all function more rapidly than do those of the average person."

Similar tests were recently done on St. Louis slugger Albert Pujols and, not surprisingly, he also ranked near the top of the human population. But psychologists haven't been able to determine a causal link between this superior physiological functioning and succeeding at baseball. These characteristics might make people better at baseball, but it could be that baseball players with these abilities are better because they practice hitting baseballs all the time.

Mike Stadler, University of Missouri, subscribes to a set-point theory, meaning that players are born with a certain range of talent, but they get to the top of their range through hard work and practice. For most of us, no matter how hard we practice, we won't make the Major Leagues. Others have the talent to make it, but need to develop their skills to become superstars.

Certainly speed, reflexes, and hand-eye coordination are important, but there are other factors as well. All fielders seem to follow Mike McBeath's theory to help them catch fly balls. But McBeath, Arizona State University, found that some are naturally more aggressive, trying to stay ahead of the curve, so to speak, and these fielders tend to be more successful getting to balls that are difficult to catch. Others lag behind, wait for the ball to move off the straight line and then must make adjustments, which slows them down.

Baseball teams use personality tests — the most famous of which are William Winslow's Athletic Motivation Inventory and the Athletic Success Inventory, which is based off AMI — to help them weed out the great players from the good players when it becomes draft time. Instead of looking at players' heights and speeds, these tests distinguish between their levels of ambition, coachability, and leadership. Baseball teams don't like to give away their secret formulas, but University of Washington's Ronald Smith and others have looked at the correlation between these tests and success in professional baseball. Smith's studies found a few characteristics — achievement motivation, coping with adversity, and peaking under pressure —correlated well to a long career in the Majors, but, in particular, hitters with higher self-confidence are more successful Major League players. This characteristic doesn't seem to be as important in football or basketball, probably because the whole team is more responsible for a successful outcome in those sports. In baseball, it’s just the pitcher against the hitter.

“For hitters, failure is such a commonplace experience that you have to have people who maintain confidence through even a long string of failure,” Stadler says.

Does a fastball rise and a curveball curve?

The terms “rising fastball” and “off-the-table” curveball have become part of the baseball lexicon. But most psychologists and physicists agree that neither really exists.

Because of gravity and because a pitcher throws from a mound a few inches above where the batter stands, it is impossible for a fastball to rise — even for a sidearmed pitcher.

Still, many hitters swear they’ve seen — and even been struck out by — these tricky pitches. As a graduate student working on his PhD dissertation at Stanford, Mike McBeath, now at Arizona State, was intrigued by this contradiction and took a month off from his research to write a paper on the illusion of the rising fastball. What he came up with is a model that explains how a fastball could be perceived to have risen even if it had in fact dropped a few feet from the time it was released.

If a batter misjudges the speed of a pitch and is expecting the ball to be slower than it actually is, he expects that it will fall farther by the time it crosses the plate. So he swings where he thinks the ball should be crossing the plate, but that swing is actually a few inches under the ball. Because it is impossible for him to follow the ball from the time of release to the time of contact, the result is a ball that appears to have been so fast that it jumped up over the bat.

The opposite is true for the curveball. The batter assumes the ball is coming faster than it actually is, so by the time it gets to the plate, it’s lower than the batter expected, giving the impression that it fell a few inches.

“The curveball definitely does curve some,” McBeath says. “There’s been high-speed photography verifying that. It’s just that it appears to curve in funnier ways than it’s verified to do.”

Side-to-side curvature has very little impact on the batter because the bat is big enough to cover the entire plate. Misjudging the speed, however, can cause the batter to swing over or under the ball So, maybe players should really be talking about “rising” and “off-the table” swings rather than pitches.