Heads or tails? It all depends on some key variables

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Everyone knows the flip of a coin is a 50-50 proposition. Only it's not. You can beat the odds. So says a three-person team of Stanford and UC-Santa Cruz researchers. They produced a provocative study that turns conventional wisdom, well, on its head for anyone who has ever settled a minor dispute with a simple coin toss.

It also could have profound implications in America's favorite sport -- pro football -- because the coin flip plays an integral role in deciding games that go into overtime.

But first, here's what the researchers concluded: Using a high-speed camera that photographed people flipping coins, the three researchers determined that a coin is more likely to land facing the same side on which it started. If tails is facing up when the coin is perched on your thumb, it is more likely to land tails up.

How much more likely? At least 51 percent of the time, the researchers claim, and possibly as much as 55 percent to 60 percent -- depending on the flipping motion of the individual.

In other words, more than random luck is at work.

The humble coin toss has been the subject of considerable study by researchers exploring concepts such as probability and statistics. There even was an unscientific look by a prisoner who once flipped a coin 10,000 times inside his cell.

"But they've all been wrong because people write down whether it comes up heads or tails, but they don't know how it started," said Susan Holmes, a Stanford University statistics professor who co-authored the study, which was published in 2007. "You have to know how it starts."

And if you know that, the researchers believe, then you have a better chance of knowing how it will land.

The power of a coin flip

Tossing a coin long has been a choice for deciding trivial matters -- like a dinner-table spat over the last piece of pizza. But coin flips also have played much more prominent roles. The Oregon city of Portland got its name after a best two-out-of-three penny toss by two settlers. (Boston was the losing name.)

There was a fateful coin flip on Feb. 3, 1959, that allowed early rock 'n' roll star Ritchie Valens to get a seat on a small plane that was supposed to carry him, Buddy Holly and two others to their next concert site. The plane crashed shortly after takeoff, killing all four.

The coin flip even is found in literature and cinema. Javier Bardem won an Oscar for his role in the 2007 film version of Cormac McCarthy's "No Country for Old Men" in which the villain tosses a coin to decide whether he should kill someone or let them live.

But nowhere in modern society does the coin flip loom larger than in sports -- specifically the NFL.

A coin toss determines which team gets the football first in overtime if the score is tied after regulation play. And heading into this season, the team winning the overtime toss had won 63.3 percent of the games -- and won the game 43.3 percent of the time on its first possession,

preventing the other team from even touching the ball.

Consider the very first game of the season, on Sept. 10, when Tennessee quarterback Kerry Collins called the overtime coin toss and lost. Pittsburgh elected to receive the kickoff and marched down the field for the game-winning field goal. But before the coin flip, referee Bill Leavy, a former San Jose policeman and firefighter, had held the silver dollar out on his thumb. It would have been clearly visible to Collins if he had looked.

The Stanford and University of California-Santa Cruz researchers would suggest that Collins missed a golden opportunity to shade the odds in his favor.

Although the study's results would seem to potentially tilt the NFL's playing field, the league office in New York doesn't believe it has a problem. Officials were surprised that anyone had bothered to conduct a study examining coin-tossing odds.

They studied what?

At the 49ers' training facility in Santa Clara, players had two initial reactions:

1) Don't those eggheads have more important things to do?

2) You're pulling my leg.

But the more the 49er players listened, the more they became intrigued. They quickly saw how -- if the study were accurate -- they might be able to gain an advantage.

Center Eric Heitmann, a Stanford graduate and 49ers captain, said: "I've

never heard anything like that before, but I guarantee that I will be thinking about it each time I'm out there for the coin toss."

A sly smile even emerged on the face of linebacker Takeo Spikes, another 49ers captain.

"And if it works for us, I'll be the first one to support that study," he said.

That, countered kicker Joe Nedney, is just plain ridiculous. He wasn't buying the study one bit.

"There's so much variance in how a coin is flipped," Nedney said. "How could you possibly know how many rotations the coin makes?"

Researchers would say Nedney was not asking the right question.

The determining factor is not how high a coin is flipped, according to the study. Nor is it any other variable such as wind speed, air temperature or phase of the moon. It's not the size or the weight of the coin, either. (Legendary football coach Vince Lombardi was said to be a "heads" man because he mistakenly believed more metal on that side of the coin increased the odds of it landing up.)

It's all in the thumb.

"The way we flip coins creates a bias, and that makes it stay more time in the position it starts in," said Holmes, the Stanford professor.

Holmes co-authored the study with Persi Diaconis, her husband who is a magician-turned-Stanford-mathematician, and Richard Montgomery, a UC-Santa Cruz mathematics professor, in hopes of gaining a better understanding of the physics involved.

Using a camera from the Stanford engineering department that snapped 1,000 frames per second, they determined that the laws of basic mechanics play a large role. Coins flipped from a thumb don't merely rotate around their axis, but they also spin like a Frisbee.

The degree of that Frisbee spin depends on the motion of the thumb.

The more Frisbee spin, the longer the side facing up stays facing up when the coin is in the air.

And the longer the side facing up stays facing up, the better chance it will land that way.

"Some people flip in a more biased way than others," Holmes said. "There's always bias to the side that's facing up, and the variance depends on the motion of the flipper."

A firm landing surface, like a wood table, changes the equation. But grass -- or the synthetic FieldTurf used in some NFL stadiums -- mirrors the landing conditions used in the study and does not materially change the outcome.

If they had only known

That's why the results might have been of interest in the NFL -- if anyone had known about it. Titled "Dynamical Bias In The Coin Flip" when published in 2007 in the Society for Industrial and Applied Mathematics Review, the paper drew a smattering of interest. But it flew almost entirely under the radar in the sports world -- where the impact could be the greatest.

"We got a call from something called 'ASPN,' " Holmes recalled.

She meant ESPN. And no, she's not much of a sports fan.

Fans often grouse about what they see as the inherent unfairness of the NFL overtime system -- usually after their favorite team loses a coin flip, and then the game.

Ray Anderson, a former Stanford player and the NFL's executive vice president of operations, said the league is well aware of the statistical edge favoring the team that wins the overtime coin toss. Almost every offseason, the NFL competition committee discusses changing its overtime rules. But the players largely are opposed to change because they worry that extending the length of the game would increase the risk of injury.

"So until there's something more telling or seems to really violate the integrity and spirit of fairness, it probably won't change," Anderson said. "There hasn't been anything dramatic enough to compel a change."

Not even research that claims the coin flip is not a 50-50 proposition?

"I really can't add anything on the study because I was a political science major at Stanford," Anderson joked.

The 49ers kicker Nedney, with tongue firmly planted in cheek, suggested that there could be other ways of determining who gets the ball first in overtime.

"We should start having it decided with Rock, Paper, Scissors," Nedney said. "Have the two captains out there battling the best two out of three. Or the referee should stand between the captains and say, 'I'm thinking of a number between one and 10.' "

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