

The Boston Globe

A pair of juggler-scientists think they've answered a big question

By [Billy Baker](#), Globe Staff

July 25, 2018





Competitors in the group Numbers competed at the International Jugglers' Association's annual convention in Springfield last week.

Barry Chin/Globe Staf

SPRINGFIELD — The competitors are off to the side, warming up, each juggler standing under a waterfall of props flying through the air, trying to get their patterns into something approaching control.

In a few moments, they will each step into a roped-off area in the large convention hall to compete in the International Jugglers' Association's "Numbers Championship," an event that gives each competitor four minutes to prove an answer to the oldest question in the 4,000-year history of juggling: How many objects can you juggle?

The Numbers Championship is held each year during the IJA's annual festival — this year's brought hundreds of jugglers to the MassMutual Center in Springfield — and has been the scene for dozens of world records, as jugglers have slowly pushed the envelope of what's possible. The current records are 8 clubs, 10 rings, and 11 balls.

But alongside the Numbers Championship has long lingered a second question, the one of the absolute limit of human achievement: How many objects can a human juggle?

The question has been the subject of endless debate. But this year, for the first time, there was an answer. Or at least a strong, evidence-based theory, put forth in a new book written by two juggler-scientists.

“Fifteen,” Arthur Lewbel said as he took his seat in the second row of the audience and prepared to watch the competition. “Fifteen is possible. But it’s going to require an incredible amount of skill, plus an incredible amount of luck.”

By day, Lewbel is a professor of economics at Boston College. But for decades, his side passion has been juggling, with a particular interest in the math and science behind it.

At its root, juggling is physics. Acceleration, trajectory, momentum, gravity. So Lewbel and Jack Kalvan, a Los Angeles-based engineer juggler, set about breaking it down to understand the skills, and the limits, of the juggler.



Jugglers competed at the International Jugglers' Association's annual convention in Springfield.

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Lewbel and Kalvan calculated how much more speed, height, and accuracy that jugglers needed for each new object they add to the mix then tested humans limits.

They strapped accelerometers to the wrists of jugglers and quickly found that most jugglers had the hand speed to handle 15 objects. British juggler Alex Barron, who holds the 11-ball world record, has enough hand speed, they found, to juggle 20 balls.

Likewise, the ability to mentally process a large number of objects in a pattern also turned out to be something jugglers — even ordinary people — had plenty of. The only real limiting factor, they discovered, was throwing accuracy.

“For smaller numbers, it’s not a big deal,” Lewbel said. “But as you get up there, the throws must go higher, you need to throw faster, and your throws need to be close to perfect or the objects are going to collide.”

The results of their calculations, listed in their book, “When Balls Collide,” showed how rapidly the margin for error narrows. With three balls, a juggler can be off by nearly 11 degrees. At nine balls, the window is 1.3 degrees. For 15, it’s less than a quarter of a degree.

“Even the best jugglers are only accurate to within 1 degree,” Lewbel said.

So to actually accomplish 15, Lewbel and Kalvan argue,

the juggler will need an incredible amount of luck on top of an incredible amount of skill, because perfection is simply not possible, especially as the throws get higher.

“To double the time, you need to throw four times the height,” Lewbel said. “That’s one of Newton’s laws, and it’s really brutal for a juggler.”

But in many ways, that brutal difficulty of juggling is its chief appeal. All around the convention hall, hundreds of jugglers were failing over and over with balls and clubs and rings and diabolos and spinning plates and unicycles and any other skill toy you can think of, trying to redefine their own limits of what is possible.

And so it was that Lewbel and Kalvan’s new theory, at least at this festival, was treated as just that — a theory.

“We see people do things all the time that were thought to be impossible,” said Wes Peden, a 28-year-old from Rochester, N.Y., who is widely considered the best juggler in the world. (He won the clubs competition with 54 catches of seven clubs.)

“So when they say 15 is all that’s possible, I’m going to be so happy when they do 16,” said Peden, who now lives in Sweden and performs around the world. “Math, in terms of human achievement, can be proven wrong whenever there’s a new baby born.”

The whole argument is, like juggling itself, both

beautiful and largely pointless. But within the chase there is something elegant, like the invisible rails in the sky whose rules govern what is possible in a juggling pattern.



Matan Presberg, 22, of Rochester, N.Y., competed at the convention.

Barry Chin/Globe Staff

“There’s a magic in standing under a huge juggling pattern and feeling it stabilize,” said Matan Presberg, a 22-year-old who juggled nine balls for 43 catches to win his fourth straight gold medal in the balls category.

“After hundreds and hundreds and hundreds of attempts, you finally feel something approaching control, and you kind of go into shock.”

Scott Sorenson, a 48-year-old programmer from Austin who has won 18 gold medals in the numbers

competition, said that locking into a huge pattern is a feeling of graceful athleticism that is hard to define. “You get into this flow state where everything comes together, and the impossible feels possible. It’s the same feeling people experience when they juggle three balls for the first time. That’s what we’re always chasing.”

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