

who have tried to merely discuss foundational issues away and may thus compel at least some to face up to them,” he says.

Wigner’s thought experiment has seen renewed attention in recent years. In 2015, Časlav Brukner of the University of Vienna tested the most intuitive way around the paradox: that the friend inside the lab has in fact seen the particle in one place or another, and Wigner just doesn’t know where it is yet. In the jargon of quantum theory, the friend’s result is a hidden variable.

Brukner sought to rule out that conclusion in a thought experiment of his own, using a trick—based on quantum entanglement—to bring the hidden variable out into the open. He imagined setting up two friend-Wigner pairs and giving each a particle, entangled with its partner in such a way that their attributes, upon measurement, are correlated. Each friend measures the particle, each Wigner measures the friend measuring the particle, and the two Wigners compare notes. The process repeats. If the friends saw definite results—as you might suspect—the Wigners’ own findings would show only weak correlations. But instead they find a pattern of strong correlations. “You run into contradictions,” Brukner says.

In 2018, Richard Healey, a philosopher of physics at the University of Arizona, pointed out a loophole in Brukner’s argument, which Tischler and her colleagues have now closed. In their new scenario they make four assumptions. One is that the results the friends obtain are real: They can be combined with other measurements to form a shared body of knowledge. The researchers also assume quantum mechanics is universal, as valid for observers as for particles; that the choices the observers make are free of peculiar biases induced by a godlike superdeterminism; and that physics is local, so that one observer’s choices do not affect another’s results.

Yet the analysis shows the contradictions of Wigner’s paradox persist. The team’s table-

top experiment, in which it made pairs of entangled photons, also backs up the paradox. Optical elements steered each photon onto a path that depended on its polarization: the equivalent of the friends’ observations. The photon then entered a second set of elements and detectors that played the role of the Wigners. The team found, again, a mismatch between the observations of the friends and the Wigners. What is more, when they varied exactly how entangled the photons were, they found that the mismatch occurs for different conditions than in Brukner’s scenario. “That shows that we really have something new here,” Tischler says.

It also indicates that one of the four assumptions has to give. Few physicists believe superdeterminism could be to blame. Locality is already under fire in quantum theory, but a failure in this case would imply an especially potent form of nonlocality. So some are questioning the tenet that observers can pool their measurements empirically. “It could be that there are facts for one observer, and facts for another; they need not mesh,” says study co-author and Griffith physicist Howard Wiseman. It is a radical relativism, still jarring to many. “From a classical perspective, what everyone sees is considered objective, independent of what anyone else sees,” says Olimpia Lombardi, a philosopher of physics at the University of Buenos Aires.

And then there is Wigner’s verdict: that quantum mechanics itself breaks down. Of all the assumptions, it is the most testable, by efforts to probe quantum mechanics on ever larger scales. But the one position that doesn’t survive the analysis is having no position, says Eric Cavalcanti, a co-author at Griffith. “Most physicists, they think: ‘That’s just philosophical mumbo-jumbo.’” Now, he says, “They will have a hard time.” ■

George Musser is a journalist based in New Jersey and author of *Spooky Action at a Distance*.

## COVID-19

# Coronavirus creates a flu season guessing game

## SARS-CoV-2’s interactions with other pathogens remain unknown as winter looms

By Kelly Servick

In March, as the Southern Hemisphere braced for winter flu season while fighting COVID-19, epidemiologist Cheryl Cohen and colleagues at South Africa’s National Institute for Communicable Diseases (NICD) set up a plan to learn from the double whammy. They hoped to study interactions between seasonal respiratory viruses and SARS-CoV-2, which causes COVID-19. Does infection with one change a person’s risk of catching the other? How do people fare when they have both?

But the flu season—and the answers—never came. NICD’s Centre for Respiratory Disease and Meningitis, which Cohen leads, has logged only a single flu case since the end of March. In previous years, the country’s surveillance platforms, which capture a sampling of flu cases from doctors offices, hospitals, and clinics, have documented, on average, about 700 cases during that period, Cohen says. “We’ve been doing flu surveillance since 1984, and it’s unprecedented.”

Some cases probably got overlooked as clinics temporarily closed and people with mild symptoms avoided medical care, Cohen says. “But I don’t believe it possible that we’ve entirely missed the flu season with all of our [surveillance] programs.” Apparently, travel restrictions, school closures, social distancing, and mask wearing have all but stopped flu from spreading in South Africa. Similar stories have emerged from Australia, New Zealand, and parts of South America.

The Northern Hemisphere hopes to be so lucky. Few cases in the south might mean little infection spreading north, says Pasi Penttinen, head of the influenza and respiratory illness program at the European Centre for Disease Prevention and Control

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When observers observe observers, a quantum paradox persists, suggesting measurements are relative.



Australia stepped up flu vaccination efforts to reduce strain on hospitals during its winter.

(ECDC). But if lockdowns and social distancing measures aren't in place in October, November, and December, flu will spread much more readily than it has in the south, warns virologist John McCauley, director of the Worldwide Influenza Centre at the Francis Crick Institute.

The prospect of a flu season during the coronavirus pandemic is chilling to health experts. Hospitals and clinics already under strain dread a pileup of new respiratory infections, including influenza and respiratory syncytial virus (RSV), another seasonal pathogen that can cause serious illness in young children and the elderly. In the United States, where some areas already face long waits for COVID-19 test results, the delays could grow as flu symptoms boost demand. "The need to try to rule out SARS-CoV-2 will be intense," says Marc Lipsitch of the Harvard T.H. Chan School of Public Health.

Because flu has largely spared the Southern Hemisphere, researchers have little evidence about how COVID-19 might influence the course of a flu outbreak. One big concern is coinfection—people getting COVID-19 and flu at once, says Ian Barr, deputy director of the World Health Organization Collaborating Centre for Reference and Research on Influenza in Melbourne, Australia. "Two or three viruses infecting you are normally worse than one," he says.

But the consequences of coinfections with SARS-CoV-2 haven't been thoroughly studied. In April, a team at Stanford University found that among 116 people in Northern California who tested positive for the coronavirus in March, 24 also tested positive for at least one other respiratory

pathogen, most often rhinoviruses and enteroviruses that cause cold symptoms, as well as RSV. Only one of the patients had influenza, although there likely wasn't much flu circulating so late in the season, says Stanford pathologist Benjamin Pinsky, a co-author. The study didn't find a difference in outcomes between COVID-19 patients with and without other infections. But it was too small to draw broad conclusions.

To make things more complicated, having one virus can change a person's chance of getting infected with another. Epidemiologist Sema Nickbakhsh and her team at the University of Glasgow have studied interactions between different pairs of respiratory viruses, adjusting for confounding factors that would cause two viruses to show up concurrently or at separate times, such as tendencies to wax and wane with the seasons.

Coinfections with flu and other respiratory viruses are relatively rare, Nickbakhsh says, and the interactions her group has documented suggest some protective effects. For example, being infected with influenza A seemed to reduce the chance of also having a rhinovirus, the researchers reported in 2019. (The mechanism behind this effect isn't yet clear.)

Nickbakhsh is more concerned about RSV, which her team found to have positive interactions with CoV-OC43, a coronavirus species of the same genus as SARS-CoV-2. It's possible, she says, that having COVID-19 could increase a person's susceptibility to RSV, or vice versa. Pinning down interactions between COVID-19 and other infections requires a large number of patient samples tested for SARS-CoV-2 and other respiratory viruses. Rapid, dual diagnostic

## The flu season that wasn't

COVID-19 control measures dramatically reduced transmission of flu in many Southern Hemisphere countries (documented cases, April through mid-August).

COUNTRY	2018	2019	2020
Argentina	1517	4623	53
Chile	2439	5007	12
Australia	925	9933	33
South Africa	711	1094	6

tests will be important for both research and treatment decisions, says Benjamin Singer, a pulmonary and critical care physician at Northwestern University. The U.S. Food and Drug Administration has issued emergency use authorizations for three flu-COVID-19 combination tests, developed by two companies and the U.S. Centers for Disease Control and Prevention (CDC).

Meanwhile, health authorities preparing for the Northern Hemisphere winter are hoping flu vaccines can help keep hospital admissions down as health systems grapple with the pandemic. Flu vaccine manufacturers including GlaxoSmithKline and AstraZeneca have announced production increases for the 2020–21 season. CDC expects to have a record-setting 194 million to 198 million doses—a 20 million-dose increase from last year. Last month, the United Kingdom's National Health Service announced it would expand the age groups eligible for a free flu shot among both children and adults.

But what if the flu season is minor? Pouring resources into an immunization campaign necessarily subtracts from COVID-19 responses, says Penttinen, whose team provides guidance to European member states on flu vaccination. Still, rates of vaccination have long been "suboptimal" in Europe, he adds. (Rates among older adults—the target population for the flu vaccine in many countries—range from 2% to 72.8%, depending on the country, according to the most recent ECDC data, released in 2018.) "I think the tendency is to say, 'We should err on the side of caution—putting efforts into at least maintaining if not increasing the influenza vaccine coverage,'" Penttinen says.

The dearth of flu in the Southern Hemisphere could complicate efforts to develop its next influenza vaccine. Less circulating influenza virus means fewer clues about which genetic variants are most prevalent and likely to contribute to a new season. The current record-low season creates a genetic bottleneck, McCauley says, and the flu variants that survive "will be presumably the fittest ones." It's not clear what variants will dominate when flu, inevitably, rears its head again.

Barr and McCauley, whose institutions are two of the six that collect and analyze flu samples to decide the composition of the annual vaccine, say they've received fewer patient samples than in previous years. Insufficient data could lead to a less effective vaccine for the Southern Hemisphere in 2021. The contents of that cocktail must be decided by the end of September. "It's a little unsettling," Barr says, "but we'll do the best we can with the viruses that we have." ■

## Coronavirus creates a flu season guessing game

Kelly Servick

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