# I, SCIENCE

THE SCIENCE MAGAZINE OF IMPERIAL COLLEGE

# COINCIDENCE

SUMMER 2020

I, SCIENCE
THE SCIENCE MAGAZINE OF IMPERIAL COLLEGE

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# I, SCIENCE

Dear reader,

The past few months have no doubt been a challenging few. A global pandemic is, to put it gently, not something we expected. Nevertheless, as we step into the summer, we do so with resilience, caution and hope. Best of all, the I, Science team is here with a refreshing dose of literary entertainment.

In this online-only issue, we delve into the science of coincidence. From evolutionary coincidences, to an unbelievable true story of surviving not one, not two, but three massive shipwrecks, we present a crazy continuum of random events.

Our fantastic array of writers has yet again amazed us with their ingenuity and delightful range.

Begin your journey by exploring the relative roles of luck and skill in achieving success. Next, find yourself enthralled by the evolutionary account of the bird that beat extinction. Turn to the next piece to decide for yourself, if the origins of superstitions hold water, then learn more about why humans have a knack for turning into our parents, and mull over the cyclical pattern of pandemics. Next, have you ever wondered if your best friend sharing your birthday is destiny or a mere numbers game? Or have you pondered the unlikely series of events that lead to the formation of life of Earth? Then, if lockdown has you feeling unusually creative, keep going to find out why. When you've got your breath back, read on to hash out some common misconceptions of gambling, before turning to the perplexing stories of the 'Rain God' and the woman who survived three major accidents. Find out the probability of running into your Doppelgänger and, lastly, count your chances of accidently bumping into the love of your life.

We have thoroughly appreciated every moment of leading the I, Science team over this past year. It has been a privilege to work with and learn from such talented writers and fellow editors to put this magazine together. We look forward to seeing the directions in which next year's new editorial team will take it.

So, dive in, and we hope you enjoy reading these articles as much as we relished curating them. ■

Best wishes,
PRIYANKA AND CHARLOTTE
EDITORS-IN-CHIEF

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# news

*Jacob Smith, Sunita Ghosh Dastidar, and Charlotte Hartley cover the latest.*

## COMPOUND OFFERS COMPLETE PAIN RELIEF IN MICE

***Jacob Smith***

Researchers at the University of Copenhagen have developed a new drug for the treatment of chronic pain. This drug, which has been in development for almost a decade, has been recently tested in mice and was found to offer complete relief from pain.

The new drug is a targeted treatment, so it only affects the damaged nerves responsible for causing pain. Unlike current drugs used to treat chronic pain, the new treatment was seen to have no side effects when tested in mice.

"Now, our next step is to work towards testing the treatment on people. The goal, for us, is to develop a drug, therefore the plan is to establish a biotech company as soon as possible so we can focus on this," says Kenneth Lindegaard Madsen, an associate professor in the neuroscience department at the University of Copenhagen and co-author of the study.

Up to 10% of the world's population suffer from chronic pain, which is caused by damage to nerves. Chronic pain can occur in patients following surgeries, living with diabetes or following a blood clot and can be a debilitating condition.

In previous trials, the drug was also shown to reduce addiction in animals. The drug may be used to treat patients who have become addicted to other painkillers, such as opioids. Researchers are now seeking to begin clinical trials in collaboration with Aarhus University.

The work received funding from various organisations, including the Independent Research Fund Denmark

## ARTIFICIAL SKIN MAKES ROBOTS SWEAT

***Sunita Ghosh Dastidar***

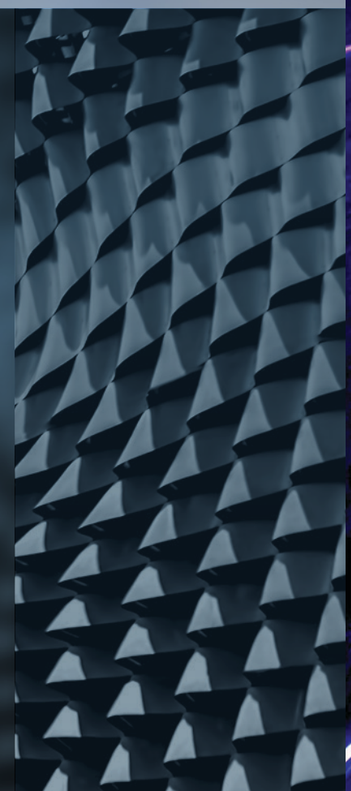
Researchers at Eindhoven University of Technology are developing a smart coating that actively releases and absorbs multiple fluids when stimulated by radio signals.

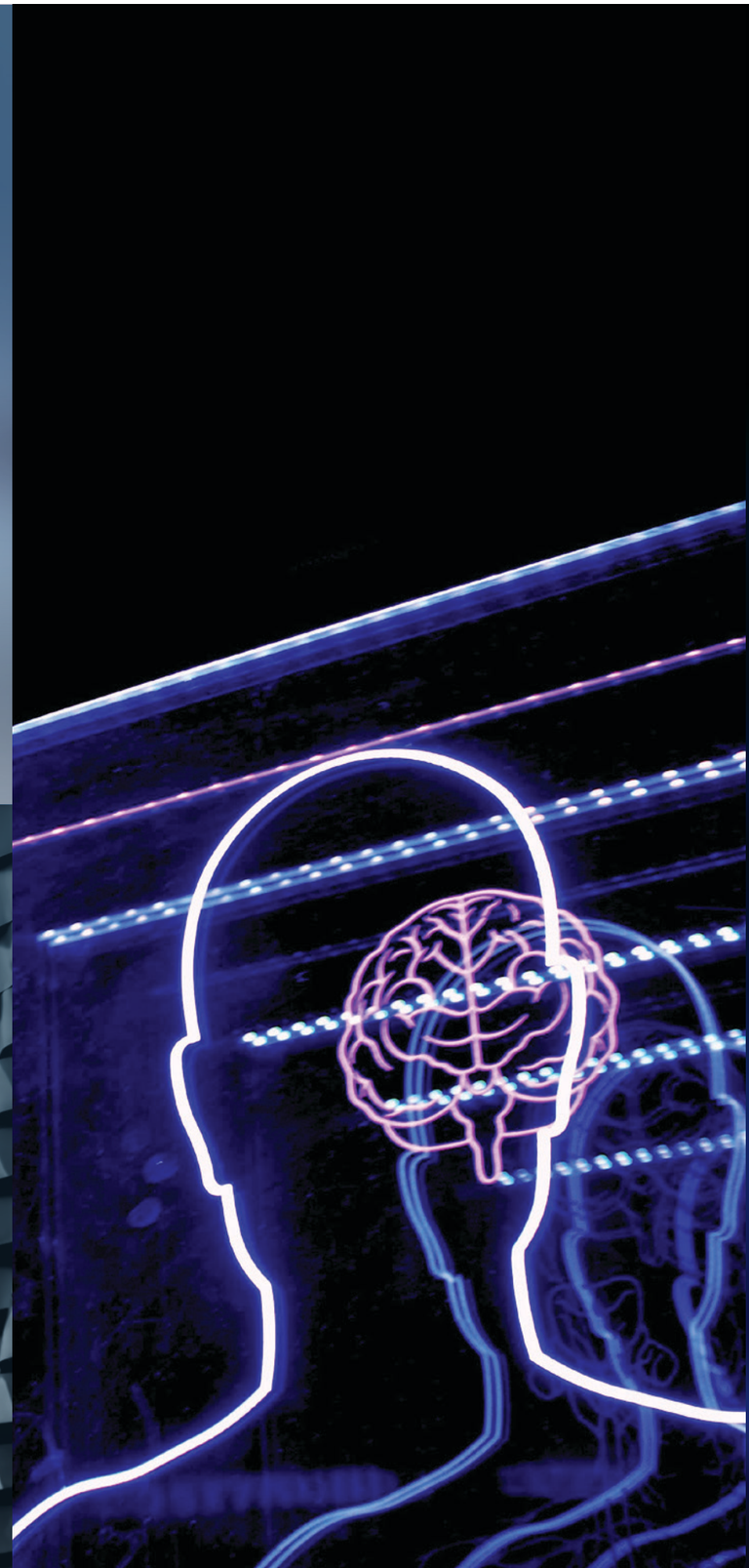
Lead author, Danqing Liu, and her PhD student Yuanyuan Zhan, were inspired by the skins of living creatures. They were particularly interested how human skin secretes sweat to regulate the body temperature. Liu created an artificial skin: a smart coating that could be used to regulate drug delivery, to administer a drug on demand over a longer time then reload with another drug.

The coating is made from liquid-crystal molecules that also used in LCD screens. These molecules have responsive properties. Liu says: "You could imagine this as a communication material. It communicates with its environment and reacts to stimuli."

When the radio waves are turned on, the material acts like a sponge. "When the radio waves are turned on, the liquid-crystal molecules move direction and therefore wring the liquid out of the pores," adds Liu.

In the field of smart materials, most approaches are limited to passive release of fluids. The material is beneficial for the healthcare industry, and promising in the field of robotics. The next step for Liu and her team will be to load the pores with liquids like antibiotics or alcohol. She estimates to have a first model of the dressing by 2025.





## 'SNIFF TEST' PREDICTS RECOVERY FROM SEVERE BRAIN INJURY

***Charlotte Hartley***

A recent study tested brain-injured patients' ability to detect smells to predict their likelihood of recovery. Those who reacted to the 'sniff test' were more likely to regain consciousness and survive in the long-term.

Severe brain injury can make it difficult to determine whether a patient is minimally conscious, where they may have some periods of responsiveness, or in a vegetative state, where they have no awareness whatsoever of their surroundings.

The study, published in *Nature*, involved presenting 43 severely brain-injured patients with three jars, containing either a pleasant odour of shampoo, an unpleasant odour of rotten fish, or no smell. All patients who responded to the sniff test eventually regained consciousness. Three and a half years later, 91% of those who reacted were still alive, compared to just 37% of those who showed no response.

Sense of smell is controlled by basic structures deep in the brain. "When the sniff response is functioning normally it shows that the patient might still have some level of consciousness," said Tristan Bekinschtein, a neuroscientist at the University of Cambridge.

In some cases, the sniff response occurred months before any other indication of future recovery. "The accuracy of the sniff test is remarkable," said Anat Arzi, who led the study. "I hope it will help in the treatment of severely brain injured patients around the world."

A previous study found that state of consciousness is misdiagnosed in up to 40% of cases. The test could help doctors more accurately diagnose patients' state of consciousness, which can inform strategies for treatment or end-of-life care.

# OVERLOOKING LUCK AS THE KEY TO SUCCESS

*Laura Berthoud questions how big a role luck plays in achieving success.*

As humans, we continuously attempt to make sense of the world around us. We look for patterns in our environment in order to make it more predictable and sometimes, we base our patterns on imperfect accounts of events. This is what philosopher Nassim Taleb terms 'the narrative fallacy'. He argues that historians write rationalisations of the past after the facts, when in reality these explanations are rarely more than the tip of a largely submerged iceberg. It addresses our limited ability to look at a sequence of events without seeing a pattern of causal explanations.

> "If you are skilled and you shoot the ball enough times, it becomes **statistically likely** to make (or miss) ten shots at a time."

This is a tendency we all carry within us. We declare certain behaviours or outcomes to be a result of previous actions or experiences retrospectively. Gilovich, Vallone and Tversky wrote an academic paper about the 'hot hand' in basketball — the idea that a player who experiences a successful outcome has a greater chance of success on subsequent attempts. It appears that the player is 'hot' and is therefore more likely to hit their next shot. According to these psychologists, this 'hot hand' is a myth.

The idea is simple: if you are skilled and you shoot the ball enough times, it becomes statistically likely to make (or miss) ten shots at a time. When this happens, observers (such as TV commentators) often explain the event in terms of the character of the player, such as their talent, courage, calmness under stress, or the lack of these qualities in a series of failed attempts. Observers construct a story that apparently explains the event. But according to Gilovich's team, taking ten consecutive shots is actually a statistical probability - something that will eventually happen if enough attempts are made.

The point is not that the player's skill, or character, or talent, or courage, or calmness under stress does not influence these types of events, but rather that statistical possibilities play a greater role than we may think. Yet, when we consider an event of success, we tend to assign a larger role to talent, stupidity, intentions, or a 'hot hand' than to luck.

Luck is a complex concept to understand. It could be explained as something that happens by chance and not as a result of one's own actions or abilities. Like when you roll the exact number you needed on a dice — that's luck. But in more complex situations, we can also use luck to describe a perfect alignment of events that have causes and aren't purely chance events, but are too complex and intertwined to comprehend. Events out of the hands of the agent of luck that could have gone differently.

For example, if a prospective investor of a project was in a good mood because she had just gained a promotion, she may be more willing to part with her money. If, on the other hand, she had just been fired that day, the project leaders might not have managed to convince enough investors and the project would not have gone ahead. Non-events are hard to grasp for the human mind. It is difficult to imagine all the events that could have happened but didn't, like the option of the investor getting fired. This makes us forget about the ways things could have gone differently, and therefore forget about the luck it took for events to line up the way they did.

"A compelling narrative fosters an illusion of inevitability." These are Daniel Kahneman's words in *Thinking Fast and Slow*, a book in which he discusses our human tendency to overlook luck in the reconstruction of events. He uses the example of Google's success story, in which two computer science students came up with the idea to rank search results on the web by their popularity and ended up creating a technology industry giant. A compelling story could give you the sense that you understand what made Google succeed. That there are valuable lessons to be learned from the company's history on what makes businesses succeed.

But unfortunately, according to Kahneman, there is good reason to believe that our tendency to draw lessons and conclusions from the Google story is largely an illusion. In psychological literature, hindsight bias is the term used to describe our tendency to think, after it took place, that an event was predictable even when it wasn't. It's the "I-knew-it-all-along" effect, described by Gordon Wood, a historian. People claim that they would have guessed a higher probability of something happening when they now know it was the outcome. But when they don't know the outcome, they estimate the probability as lower.

> "The question to ask yourself is whether the explanations given would have made the event **completely predictable** in advance."

The question to ask yourself is whether the explanations given would have made the event completely predictable in advance. And no story like Google's unlikely success will pass that test, because no story can contain the countless events that would have caused a different outcome. Did it take skill to reach such success? Yes. But it also took a lot of luck.

Now, the question is what does this research say about scientific success? What is the role of luck in a scientific career? Some of the other articles in this *I, Science* issue detail great accomplishments. Perhaps this research showing our tendency to overlook luck will place those success stories in a new light: Were these low probability breakthroughs in scientific discovery entirely due to the talent and intentions of the researchers? Or was it more coincidental than we might think? ■

# THE BIRD THAT EVOLVED TWICE

*Danny Mello recalls a curious case of iterative evolution .*

If you think about bringing a species back from extinction, it probably conjures up images of the final scenes of Jurassic Park 2; a *Tyrannosaurus rex* rampaging through downtown San Diego. But what are the chances of a once extinct species returning naturally through evolution?

Although once a species has gone extinct it is lost forever, certain traits can re-emerge from the same ancestor at different points in time, through a process called iterative evolution. In some cases, the reappearance of these traits can lead to the evolution of a new species which highly resembles one that has previously gone extinct. This process has been identified in the fossil record, but evidence is relatively scarce.

However, this changed last year when researchers from the Natural History Museum and the University of Portsmouth who were studying fossils of the Aldabra rail—a flightless bird which lives exclusively on a group of four islands that make up the Aldabra Atoll—uncovered an interesting series of events in its past.

> "Although once a species has gone extinct it is lost forever, **certain traits can re-emerge** from the same ancestor at different points in time."

The story starts with the white-throated rail, the surviving ancestor of the Aldabra rail. On their home of Madagascar, the population of these birds often increases so much that many are forced to migrate to new locations overseas. The birds fly in all directions away from their home island, often failing to reach land and drowning in the open sea, and those that do arrive at new islands or mainland Africa are often killed by predators.

However, in the distant past, sometime after the Aldabra Atoll formed around 400,000 years ago, several white-throated rails flew an incredible 250 miles north west to these ring-shaped islands. On their arrival, these rails found themselves in a safe haven, with no predators present.

The birds managed to successfully establish themselves on the islands and soon began to breed. As thousands of years and generations passed, they eventually lost their ability to fly—a waste of energy with no need to flee from danger. These newly flightless birds lived alongside the islands' other inhabitants, such as giant tortoises, for some time.

However, around 136,000 years ago, disaster struck. Flooding caused by sea level rise inundated the Aldabra Atoll. The birds stood little chance of survival as their habitat vanished beneath their feet, and without the ability to fly, they could no longer escape. As the Aldabra Atoll disappeared under water, so did the rail.

Having been wiped out by a flood, it looked as though the story of this flightless subspecies of rail was over. Yet, if you were to visit the Aldabra Atoll today, you would still find a large flightless bird, the Aldabra rail, closely resembling the bird which had gone extinct. Has the rail somehow managed to come back into existence?

In a way, yes. It turns out that history had, almost exactly, repeated itself.

Once the flooding had subsided, due to a drop in sea level around 100,000 years ago, a group of white-throated rails once again made the intrepid journey to the atoll and managed to re-establish themselves on the islands. These birds, discovering the same idyllic conditions as the previous colonists, also lost their ability to fly in only 20,000 years—incredibly quickly in evolutionary time. And with no further catastrophic floods to date, the species has managed to survive on the islands up until the present day. They are now the only known flightless island bird in the Indian ocean.

> "Scientists believe it may be the **most conclusive evidence to date** that the evolutionary phenomenon has taken place in birds."

The fossil record reveals that the Aldabra rail's anatomy highly resembles that of the bird that went extinct around 136,000 years ago in the floods. The scientists who pieced together the history of this species say it clearly demonstrates the process of iterative evolution and believe it may be the most conclusive evidence to date that the evolutionary phenomenon has taken place in birds.

The combination of the same ancestral species and a set of islands with unique predator-free conditions has driven natural selection and led to the evolution of an incredibly similar bird on two separate occasions. So, although the chances of *Tyrannosaurus rex* ever popping back into existence are slim, every now and then, nature does give a species a second chance. ■

# VERY SUPERSTITIOUS

*Daisy Veysey explains why humans are naturally superstitious, and why some rituals may have a kernel of truth to them.*

If I started talking about astrology, most of our readers would probably roll their eyes. But do you cross your fingers when you're hoping for good fortune? Or do you just know that as soon as you go to the toilet, the waiter will come out with your food? The fact is superstitions are just part of human nature. Even walking under ladders has been considered bad luck since the time of the ancient Egyptians.

Superstition can be defined as any belief or practice explained by supernatural forces rather than reason or science. So, if they are so irrational, why do so many of us entertain them?

Perhaps unsurprisingly, many have roots in religion. For example, it is thought that pagans would knock on trees to invoke the protection of good spirits that resided in them and deter evil ones. Today, we 'touch wood' to avoid tempting fate. Some superstitions, meanwhile, have more practical origins. In the Victorian era, opening an umbrella indoors could be seriously hazardous owing to their clumsy spring mechanisms.

Superstitious behaviour can also arise through coincidental associations. The behavioural scientist, B. F. Skinner, with his enduring penchant for pigeons, showed how they could be tricked into superstitious behaviour. Food would be sent to them at regular intervals: in other words, nothing the birds did would affect the food supply. Nonetheless, many of the pigeons began performing strange ritual dances. They associated the arrival of food with whatever they had been doing when it first arrived, as though these rituals had real influence.

> "In the Victorian era, opening an umbrella indoors could be **seriously hazardous** owing to their clumsy spring mechanisms."

Humans are not immune to this either. Perhaps you aced that job interview while wearing a certain tie. From now on, you might associate that tie with bringing you success, so you wear it to every important event. Confirmation bias can cause us to reinforce these superstitions as we are more likely to remember the times when something really lucky, or unlucky, happened.

It is largely accepted that we use two separate systems in making decisions. The first is fast, using emotion or intuition, while the second is slow, using analytical and reasoned thought. The first can obviously be more prone to bias. When we carry out superstitious behaviour, we favour that first system over the second. But why would we do that?

According to tradition, spilling salt invites the devil to do evil to you. To dispel this bad luck, you should throw salt over left shoulder, or into the devil's face, incapacitating him. In this instance, the cost of spilling salt is potentially very high. Meanwhile, the cost of throwing salt over your shoulder is comparatively low. What's a few grains of salt? Chances are, you don't really think the devil is coming to torment you, but you might as well do it because it doesn't really cost you anything.

This kind of cost-benefit comparison could help to explain why superstitious behaviour evolved. Once in a while, a superstition may have actually paid off. Say you knock on a tree believing a spirit dwells there and a fruit falls at your feet. A generous gift from a tree spirit? Maybe. Nourishing food that might boost your health? Certainly. While this example is admittedly contrived, it serves to illustrate the point above. Many superstitions, like knocking on trees, pose little to no fitness cost. Therefore, any benefit, even a small one, could make conserving these behaviours, and any genetic mechanisms underlying them, evolutionarily favourable.

Today, it may be hard to see what benefits most common superstitions still have. However, research suggests that superstitious practices can lead to measurable improvements in performance. They essentially act as placebos; when we believe we might have luck on our side, even if our rational second system rejects the idea, we likely have more confidence in our abilities. One further consideration is that many of us might continue to entertain superstitions simply because they are comforting. Behaviours and rituals can help to ease anxiety and provide us with a sense of control over our lives.

So, keep wearing that lucky tie or crossing your fingers, because it might just bring you luck after all. ■




# TURNING INTO OUR PARENTS

*Samuel Page investigates whether growing up to resemble our mums or dads is a matter of nature, nurture, or simple coincidence.*

Newborn babies are often greeted joyfully with a "She's got her father's smile" or "He has his mother's eyes". However, fast-forward a few years and many teenagers and young adults share a common view: "I really hope I don't end up like my parents".

Nonetheless, it's commonly accepted that at some point, for better or worse, everyone ends up resembling their parents to some extent—be it the clothes they wear, the music they listen to, or the attitudes they hold. Is this a predetermined shift, or is it a result of a lifetime of chance events and life-altering decisions? If we try hard enough, is it possible to beat the odds and avoid turning into our parents?

> "Teenagers and young adults overwhelmingly identify themselves as **distinct from their parents** and reject the idea that they could ever transform into them."

Clearly, genetics plays a huge role. Furthermore, someone's upbringing has a strong influence on their values, interests, and perspectives. Although these factors would appear to dictate that children must share great similarities with their parents, teenagers and young adults overwhelmingly identify themselves as distinct from their parents and reject the idea that they could ever transform into them. Yet, over the years, many identify a change in their behaviours, political views, tastes in music, or hobbies, and see that some of the traits of their parents that they once rejected, they have come to accept, or even desire. There have been a number of studies claiming to pinpoint the exact age at which people consider they have "turned into" their parents. A 2019 study by Dr. Julian de Silva found the average age at 33 for women, and 34 for men.

The nature of our relationships with our parents has a great influence throughout our lives - from work, to our relationships with others. It's important to recognise that we are often operating on a subconscious level, unaware of many of these interactions. Psychologists like Victoria Donahue and David Funder consider that we start inheriting attributes from our parents as infants. Simply being aware of turning into our parents can be considered as the most significant method to avoid doing so. Recognising patterns in our behaviours inherited from our parents, reflecting on these, and choosing to repeat or avoid those in the future, allows us to shape our own path.

Inevitably, consciously intending to deviate from our parents isn't the same as actually doing so, especially in certain situations. For example, stress can indirectly bring out unwanted behaviours, perhaps anger or violence, which we might recognise from our parents but wish to avoid in ourselves. This dilemma between intention and action is heightened if children have had troubled relationships with their parents, who remain their figure of attachment and protection. This leads to a sense of disassociation, or fragmentation, between how their brain is telling them to act and how they want to act. In many cases, people subconsciously end up following in their parents' footsteps by falling into the same traps (anger, cruelty, lack of intimacy), even if they identify these as things to avoid.

Of course, given that in most cases we have two biological parents, we are not identical to either one of them. For most, our parents are our main role-models and source of validation as we grow up. However, other role-models can play just as important a role. Accordingly, the range of experiences and opportunities someone is exposed to in their formative years is likely to affect the extent to which they resemble their parents. Observing a wider number of behaviours or cultures might help someone to forge their own identity. Societal changes too are having an effect. Where women were once expected to stay at home and raise children, or children traditionally continued their parents' profession, it might now be easier to carve out distinct identities and behaviours.

As students at Imperial College, we might consider the effects of our parents on our route towards an education in science. Were our parents particularly interested in science? Did they support our decision or guide our choices at earlier stages? Certainly, in some instances, yes, and in others, no. Therefore, in conscious, explicit decisions, it might be easier to trace the involvement of our parents, and the effect that this will have as our lives progress.

Although it is more difficult to monitor our subconscious behaviours, attitudes, or perspectives, attempting to recognise these is the first step in observing the shifts towards becoming our parents. Whilst we can recognise that there are things which we cannot alter—our DNA or childhood—we can, with attention and effort, take some control over the extent to which we turn into our parents. Maybe it's not time to dust off the Take That CD just yet. ■

# A PATTERN OF PANDEMICS?

*Cristina Coman gets to the bottom of a popular meme which states that pandemics occur in cyclical patterns.*

The first case of the virus SARS-CoV2—a 55-year old resident of Hubei—can be traced back to the 17th of November 2019. But as the coronavirus went viral in the first months of the year 2020, spreading across all continents, so did memes about a certain pattern in pandemics. While structured differently or displaying various, debatably funny backgrounds, they all propose that history simply repeats itself every 100 years. In 1720, it was the Plague; in 1820, it was cholera; in 1920, the Spanish flu. And now, in 2020, Covid-19. While there may be some truth to the idea, it is neither predictive, nor informative, of future events.

In these claims lie gross inaccuracies, either in their dates, or in their scale. These four examples do not all represent the most significant pandemics, with some major ones having been charted long before 1720.

The year 1720 was the year of the outbreak of plague in Marseille, France. Although it did start that year, it was not the first, nor the most severe, instance of this disease. The Plague of Justinian in 541 BC, carried over the Mediterranean Sea from Egypt before spreading to Europe and the Middle East, killed an estimated 30 to 50 million people.

The Black Death, the second occurrence of the plague, is considered to be unparalleled in human history. Between the years 1346 and 1353, it is estimated to have wiped out up to 60% of Europe's population. A bubonic plague, the disease was caused by an infection with the bacterium Yersinia pestis, which usually lies dormant and is passed amongst wild rodents, such as rats. If house rats developed the disease and came into contact with humans, upon their death, the risk of transmission was increased by contact with fleas.

The disease had returned several times by the end of the 19th century, and the Great Plague of Marseille was just one of these outbreaks. Resulting in the death of around 100,000 individuals, it was concentrated in the city and surrounding provinces—thus, did not qualify as a pandemic.

The third plague pandemic, which lasted until 1960, hit China in 1855 before spreading to India, leading to a total of about 25 million deaths. Collectively, infection with *Y. pestis* has resulted in the deaths of approximately 200 million victims.

The aforementioned cholera pandemic, caused by the bacterium *Vibrio cholerae*, spanned from 1817 to 1824, and was the first of seven pandemics that would strike the world by the end of the 20th century. Although it could be considered the deadliest, owing to its estimated death toll of over two million, it was not the most far-reaching: the following six outbreaks spread outside India and Southeast Asia, reaching the Middle East, Europe and Eastern Africa. Affecting mostly impoverished areas, cholera has been largely eradicated in developed countries, and has been responsible for several smaller localised outbreaks in the past thirty years, like South America in the 90s, or as recent as 2018, in Zimbabwe.

> "In these claims lie **gross inaccuracies**, either in their dates, or in their scale."

A common misconception of the 20th century influenza pandemic, called the Spanish flu, is that it originated in Spain—like its name suggests—when there is no such evidence. This pandemic lasted until late 1920, but it began spreading globally, almost everywhere at once, between July and September 1918, coinciding with the end of World War I. Considered the deadliest event in human history, the avian virus H1N1 infected 500 million individuals (a third of the world's population), with an estimated death toll between 50 and 100 million.

> "Considered the **deadliest event in human history**, the avian virus H1N1 infected 500 million individuals."

In a 2018 article published in the American Journal of Public Health, authors Morens and Taubenberger show that while the 1918 virus is considered the "founder agent" of all influenza A-type viruses humans have faced ever since, influenza pandemics have occurred at irregular intervals since at least the Middle Ages.

The 1557 influenza pandemic was the first documented global occurrence and was considered devastating. Although its reach in the Americas remains uncertain due to poor documentation, it did spread westward, from Asia to Europe.

The 'Russian flu' pandemic of 1889 was possibly the most destructive up until that point, and, unlike previous pandemics, lasted a whole five years. Spreading west like wildfire and infecting top European leaders (including the King of Belgium and the Emperor of Germany), its death toll amounted to one million. The pandemic also served as a wake-up call (most notably in the United States) to the increasing sanitary dangers of an interconnected world.

Descendants of the 1918 H1N1 virus led to several other influenza outbreaks throughout the 20th century. Some of the most notable ones include the 'Asian flu', identified in China, which led to between two and four million global deaths between 1957 and 1958. Or, the Hong-Kong flu, which between 1968 and 1969 caused one million deaths.

It is possible to distinguish regular patterns through cherry-picking small data sets and ignoring other bodies of relevant data. However, these disease outbreaks share no common meaningful pattern. Although most spread East to West from Asia, the infecting agents, the geographic areas of spreading and the duration all remain very different.

According to Morens and Taubenberger's 2009 study on influenza pandemics, historical information suggests that pandemics appear in regular cycles; resulting from either a *de novo* emergence of a unique avian-descended virus, like in 1918, or from a modification of an already-circulating human-adapted virus. Nevertheless, influenza expert Edwin Kilbourne states that "there is no predictable periodicity or pattern of major influenza epidemics and [...] all differ from one another".

Pandemics shouldn't only be regarded as events occurring at specific points in time, but rather be considered as pandemic eras. Whenever new technologies, changes to our environment or life habits are established, they are usually accompanied by new health risks. In a way, all these different pandemics do have something in common: They are related to how humans influence their surroundings and challenge nations' medical paradigms. ■

# THE PERPLEXING PSYCHOLOGY OF COINCIDENCES

*Shocking coincidence or simply a numbers game? Nelli Morgulchik analyses whether seemingly unlikely occurrences are really all that rare.*

How many times have you caught yourself wondering what the odds are when you bump into an old acquaintance in a different country, months after your last encounter? More often than not, these moments feel like miracles beyond your comprehension.

A coincidence is not just a surprising and rare event. It may also be perceived as having a related meaning, behind its occurrence, even without any apparent causal link. A firecracker exploding before it is supposed to may be surprising or a lottery win may seem rare. Yet, we don't think of these as coincidences because we don't have any doubt about the nature of their eventual outcome.

So, why do coincidences occur? Some people may want to attribute coincidences to nothing but randomness. Perhaps others would search for patterns in these events which may provide a deeper meaning to it all. Now, thanks to scientists, more substantiated theories behind coincidences have also been put forward. The father of analytical psychology, Carl Jung, believed that coincidences may be mystical and caused by psychic connections between humans that we are not fully aware of.

On the other hand, his contemporary, a biologist named Paul Kammerer, believed in a physical force that attracts bodies and events together. In doing so, the events bring order to the overall chaos of the universe. However, this was almost a hundred years ago, and neither of these proposed theories captures the consensus of the scientific community today.

The scientists of today speculate that what we perceive as coincidences may not be down to chance at all. More statistically-oriented people believe that coincidences can be explained by the Law of Truly Large Numbers. This law states that within a large enough population, any weird event is likely to happen at some point. In other words, all coincidences are in fact, nothing more than random events. However, it is often the case that the majority of us lack the desire for rigorous maths training and may not be able to see the logic—retaining a sense of mystery. And so, we instinctively turn towards a belief in coincidences.

> "Carl Jung believed that coincidences may be mystical and caused by **psychic connections** between humans that we are not fully aware of."

Human brains may be complex beyond our understanding, but at least one thing is clear; we are terrible at intuitively predicting probabilities. Most people—myself included—would be surprised to find out that it only takes having 23 people in a room for any two people to have more than a 50% chance of sharing the same birthday. Although initially shocking to believe, do trust me. Let's brush through the maths of the Birthday Paradox.

The easiest way to go about solving this problem is to actually spend the time calculating the odds that nobody in the room will share a birthday. Let's start small and calculate the probability of two people having different birthdays. With 365 days in the calendar (disregarding leap years for the sake of simplicity) the other person's birthday should fall on any of the 364 remaining days to avoid a match. By adding more people to the group, the number of days on which their birthdays may fall will gradually drop, giving this equation for a group of 23 people:

$$\frac{365}{365} \times \frac{364}{365} \times \frac{363}{365} \times \frac{362}{365} \ldots \times \frac{343}{365} = 0.49$$

**or ~ 49%**

chance that two people in the room **do not** share a birthday

This probability represents the odds of 23 people not sharing a birthday. Therefore, removing 49% from the whole means that the chance two people share a birthday is 51% in a group of 23 people.

I am willing to bet that after grasping the maths behind the paradox, the coincidence of a shared birthday in the next large group of people you encounter won't seem as surprising anymore.

Humans are not only bad at rationally estimating probabilities. We also fail to pay sufficient attention to what happens around us all the time. The renowned British statistician, David Spiegelhalter, stated that "a coincidence itself is in the eye of the beholder". He may even be right. Try to imagine for a second how many coincidences we could have recorded if our brains noticed everything that happens around us each second of our lives.

Yet, you are more likely to pay attention to events and correlations if they confirm your pre-existing beliefs. This is a subconscious phenomenon called "confirmation bias". The theory behind this phenomenon is that if an event is insignificant to us, due to its misalignment with our pre-existing beliefs, we instantly disregard it, assigning its outcome to chance. We would not hypothesise any possible underlying causes which may have instigated the event because, to us, it does not appear to be a coincidence.

> "Humans are not only bad at rationally estimating probabilities. We also **fail to pay sufficient attention** to what happens around us all the time."

Confirmation bias is also hard to remove, because it has been part of our evolution, allowing us to infer causal relationships from coincidences. Magda Osman, an experimental psychologist, believes that our perception of coincidences is an integral part of the brain and an essential way that we make sense of the world around us. She believes that finding meaning behind coincidences, however trivial, gives people seemingly more control over their lives. In this way, looking for coincidences is just another behavioural pattern humans have to retain sanity in this erratic world.

Will we ever cease to look for patterns in our daily lives? My guess is probably not. While I struggle to believe in any mystical force that shapes my life, it would take more courage than I possess to acknowledge that everything that happens to us is utterly governed by the law of probabilities.

Human psychology is far from simple, as is our current understanding of the field. It is unlikely that we will ever confirm the nature of coincidences and put an end to the disputes as to whether a greater force outside of human control really is the ultimate explanation. Yet, as the law of probability suggests, any unlikely event is possible with a large enough sample size. ■

# LIFE ON EARTH: JUST A SERIES OF FORTUNATE EVENTS?

*Vishavjeet Dhaliwal considers the various unlikely events which had to line up for life to evolve on Earth.*

There are at least a billion trillion stars in the observable universe, each orbited by an average of one to two planets. Scientists are continually learning about worlds outside our Solar System (exoplanets). However, these have yet to show any example of life.

Before speculating about the possibility of extra-terrestrial life, we must first investigate how the complexity of intelligent life developed here, on Earth. To determine whether life on Earth is simply a coincidence, I spoke to Dr Subhanjoy Mohanty, an astrophysicist at Imperial College London.

The first reason that our planet can support life is its auspicious position in the 'habitable zone'. This is an area around a star in which vital liquid water can exist on planets. Researchers estimate that there could be up to 40 billion Earth-sized planets orbiting in the habitable zone of their own star across the Milky Way. However, as Dr Mohanty highlighted, being in the habitable zone is no guarantee that a planet will support life, just that it has the potential to. Mars, for example, is also in the Sun's habitable zone but is unlikely to harbour life as it has a much thinner atmosphere than Earth's, meaning it cannot sustain liquid water on its surface.

It's not just Earth's distance from the Sun that is serendipitous. Earth orbits a rarer bright and warm yellow dwarf star instead of a more common small, dim red dwarf. Due to the relative coolness of red dwarfs, their habitable zones are very close to their surface. At this close distance, the strong tidal forces of the star would affect how fast an orbiting planet spins. If these forces are particularly strong, the planet will spin as slowly as it revolves around the star. This is known as 'tidal locking', where one side of the planet perpetually faces the radiating star becoming a hot, radiated surface, while the other side faces away towards freezing darkness. Neither of these extreme conditions are stable environments for life to begin.

> "It is believed that the evolutionary milestone that is the development of multicellular life from single-celled bacteria, **occurred only once**."

The picture may seem bleak, but scientists are still hopeful about life existing on red dwarfs. Around 40% of red dwarfs are thought to have rocky planets in their habitable zones, increasing the statistical likelihood that some of these planets are habitable. Equally, cloud formation in the atmospheres of tidally locked exoplanets may even out the temperature across the extreme climates. "When you have a hot side and a cold side… the laws of thermodynamics kick in to equalise the temperature," Dr Mohanty told me. "The end result is strong winds that circulate round and act to equalise the temperatures."

The precarious balancing act to enable life is difficult to achieve. Water and an atmosphere aren't enough – planets also require nitrogen and oxygen to form organic compounds. The Miller–Urey experiment shows that life could, theoretically, form on other planets by illustrating that when primordial chemicals (such as water, methane, and ammonia) are exposed to conditions present on the early Earth, the building blocks of complex organic molecules called amino acids and nucleotides, quickly form.

Earth demonstrates that once started, life can bloom in the most extraordinary conditions. Bacteria has been found on the ocean floor, thriving under the extreme heat and pressure of hydrothermal vents. Dr Mohanty summarised perfectly, "Given a chance, life finds a way."

However, multicellular, intelligent life as we know it may be unlikely to develop elsewhere in space. It is believed that the evolutionary milestone that is the development of multicellular life from single-celled bacteria, occurred only once. As did other events, such as photosynthesis.

Even with incredibly low odds, life on Earth still managed to beat them. Rather than pure coincidence, these events may have been inevitable when given enough time and under the right conditions.

So, is life on Earth just a coincidence? Well, the short answer is: we don't know. According to Dr Mohanty, however, we should get an answer soon. From 2030 onwards, scientists aim to develop the technology to scan the atmosphere of exoplanets for signs of life. It'll then be up to astrophysicists to interpret the data and determine whether a series of inevitable scientific events or much more coincidental factors enabled complex life to arise on Earth. ■



# CREATIVE COINCIDENCE: WHY YOU CAN'T FABRICATE IT

*Tori Handsley explores whether creative breakthroughs during the COVID-19 lockdown are simply a coincidence, or something more...*

Could it be that during this catastrophic time we might glean creative lessons for our future? Perhaps lockdown could constitute an unexpected opportunity for more space, to step back; a unique, unannounced human experiment, that we might otherwise never have had the chance for.

Amidst all the bad news stories, in my work as a Performance Coach I have seen many individuals make great leaps and bounds and surprising progress at this time. There has been an increased frequency of creative breakthroughs and people are coming out with greater clarity, focus and determination. Many of us have been forced to halt our usual frantic day to day behaviours, inviting us perhaps to reflect and see more clearly. It got me thinking about why this might be. Is it just a coincidence, or is there any evidence behind this to unveil why this could be happening?

John Adair, the world's first Professor of Leadership at Surrey University, studies the habits and behaviours of great leaders. He found that creativity is often a key ingredient. He emphasises the importance of creative thinking, alongside that of a more rational, logical nature, and highlights the role of creativity in great scientific discoveries.

> "It appears that you can't fabricate a creative coincidence. Instead, perhaps it is **leaving space for a little magic** and the unimaginable to occur."

Creative thinking, he claims, involves making jumps between apparently different ideas, and allowing for the unexpected and the magic of the unknown to unfold, as the mind draws connections between seemingly unrelated concepts. To garner this, he suggests finding more objectivity from your work and widening your span of reference from what is directly laid out before you. Allowing space for the imagination to flourish is vital.

Perhaps this could explain why people are having more creative breakthroughs at this time, as we stand back and allow ourselves to see previously unclear, creative connections, away from the usual day to day nose to the grindstone.

"Great ideas don't tend to come when you're narrowly focusing on them," according to Scott Barry Kaufman, Scientific Director of the Imagination Institute in Philadelphia.

But is there any scientific evidence behind this? Delving deeper, current scientific research seems to support such theories and how the brain may indeed make creative connections.

Experiments by scientist Andrew Newberg indicate patterns demonstrating a link between creativity and the ability to make leaps between seemingly unrelated ideas. Newberg examined the brain activity of 36 people, in MRI scans, giving them a task to think of new uses for an everyday object. He found that people displaying greater creativity made more 'intuitive leaps' and exhibited more connections between the left and right hemispheres of the brain. Such behaviour seems to rely on an element of unpredictability and perhaps a lack of formula.

Reflecting on this, it reminded me of a time when I was once struggling with a piece I had been beavering away at. I kept hitting brick walls unable to quite tie everything together. I remember a professor once saying to me that time away from the 'lights' was never wasted. Against all rational thinking and with the deadline looming, I decided to escape to the mountains for a break.

As I drove through the valley of the fells, and the phone reception dwindled away, I began to wonder what I was thinking! The Wi-Fi was patchy, the nights bitter and the elements harsh. One evening I returned from a muscle-aching trek and settled in for the night. As I sat out in the biting open air, with the wind whistling through the trees, I looked up to the black blanket of bleakness and suddenly, out of nowhere, everything clicked. The stars aligned and I felt an overwhelming sense of purpose and all the pieces of the puzzle, that I had been drilling away so hard at before, connected.

It appears that you can't fabricate a creative coincidence. Instead, perhaps it is leaving space for a little magic and the unimaginable to occur.

"Logic will get you from A to B. Imagination will take you everywhere" as Albert Einstein famously stated, " I never made one of my discoveries through the process of rational thinking."

Perhaps these could be lessons to note for the future. They could help us work out solutions in the face of overwhelming global threats, such as climate change, and as mounting pressure builds. There is no clear one set of steps, however, or we would be there already. What we may be sure of is that through nurturing our creativity, allowing the impossible to be possible, and our neurons to fire and connect in ways we never expected, any creative coincidence may be possible. ■

# ARE GAMBLERS BETTER AT PREDICTIONS?

*Priyanka Dasgupta dispels the common misconceptions of predictions and probabilities in gambling.*

"What are the odds?" I said with incredulity, as my friend predicted correctly the outcome for a coin flip, for the third time in a row. That day, this friendly betting game got her out of picking up the check three times. Our circle of friends henceforth crowned her with the moniker 'the woman who beat the odds.'

## Quick References

If **two coins** tossed simultaneously, the set of possible outcomes would be: {HH, HT, TH, TT}

**ODDS:** chances of losing to chances of winning. In this case, odds of getting both heads are 3 to 1

**PROBABILITY:** frequency of an outcome divided by the total number of possible outcomes. In this case, probability of getting both heads is ¼

Practically, however, beating the odds is not a power one can be blessed with. Gamblers often have many misplaced beliefs about luck, chance, and prediction. Scholars studying gambling habits suggest that many people have a problem with the understanding of random events. People sometimes believe they can predict random outcomes, which is aided by the fact that the human brain is wired to find patterns. But random events by definition are ones which can't be predicted.

Many can interpret randomness of events in slightly problematic ways. Some people view random events as having no cause, and thus they find these events inherently mystical. Therefore, they may feel that the chances of getting a seemingly random outcome might be heightened by prayers or other such ways. The second reading is set against the backdrop of 'everything has meaning' philosophy. By that logic, if there is a random event, it must be symbolically significant. Along similar lines, there's the flawed understanding of the concept in the practical world. Drawing from the mechanistic cause-effect functioning of the world, gamblers can create notions that nothing is random and thus these 'random' events can be predicted. Such beliefs are reinforced by assigning meaning to coincidental similarities that the person might have experienced. However, mathematically, random events simply can't be predicted.

Let's take the example of a coin flip. There can be two outcomes—Heads (H) or Tails (T), but both outcomes are random events since the result itself cannot be predicted mathematically. So yes, all random events will have a causative series or combination of events. Like in this case, the event will be affected by how high the coin was flipped, the force applied, the number of in-air flips, point of catching, and more. However, the outcome for either a head or a tail is equally likely. Just because we can describe randomness mathematically, doesn't prove it to be deterministic or non-deterministic.

> "Just because we can describe randomness **mathematically**, doesn't prove it to be deterministic or non-deterministic."

Probability (P) is a term that is often used in this field. It deals with the chance of an event happening out of all possible outcomes. In the coin flip situation, the probability of both outcomes is 1/2. However, the probability need not always be the same for two random events. If two coins are tossed, while it still is a random event, it is less probable to get two heads (there is only one way to get the HH result: P = 1/4), than to get a combination of 1 head and 1 tail (there are 2 ways to get this result, HT or TH: P = 1/2).

The confusion in presuming predictability comes here. Since random events often follow a probability distribution, the possible frequency of outcomes over several trials can be predicted. But in fact, each event in the coin toss scenario is an independent event, i.e. each toss is unaffected by the result of the previous toss. This is the law of independence of events. Say, just because the previous two results of a toss were heads, a coin cannot decide to fall as tails to fit expected frequencies. The gambler's fallacy comes from a misunderstanding of the mathematics, which leads to the erroneous belief that if an event has been occurring more frequently than normal, the chances of it happening in the future keep diminishing. A coin can come up as heads for a thousand times in a row. Granted, its probability is very low $(1/2)^{1000}$, but it's still a possibility by virtue of the independence of each flip.

David Hand, a renowned statistician and senior research investigator at Imperial College London, explains by the Improbability Principle that improbable events are expected to happen from time to time. The same person being struck by lightning twice is an improbable event. But such 'coincidences' can often be explained by the similar conditions of their occurrence, truly large data sets, or in some cases, a selection bias while looking for similarities retrospectively.

> "Gamblers can often get quite good at guessing outcomes based on information about bets. But the outcome itself **remains uncertain**."

There have been studies that show that people can pick up an understanding of probabilities by experience. Gamblers can often get quite good at guessing outcomes based on information about bets, such as the physical ability of horses or the skills of a jockey. But the outcome itself remains uncertain. It's problematic however, if gamblers start believing they can predict the outcomes. Psychologists believe that problematic gambling has less to do with a misunderstanding of mathematics and more with the social environment that dictates their lives. Gambling might be seen as an escape, which might be an accessible option for people who rely on escape mechanisms to deal with stress.

The situation is further complicated by debates about certain betting services being misleading about their functionality. For instance, virtual reel mapping in slot machines or skewing the number of winning symbols in the slots may psychologically deceive people. A Canadian medical article noted that such tactics might even encourage those who weren't pre-disposed to addictions to become addicts. Gambling can be a risky game, not just in terms of the risks involved in the actual bet, but the possibility of addictiveness it poses.

Gambling is a huge industry, manifesting in various forms and degrees. It's largely consumed, perhaps because it is so much fun. It has both positive and negative connotations attached with it, depending on who you speak to. It's even more fascinating because of the mesh of mathematical principles one can find in it. Misconceptions about prediction can be dangerous for a gambler's bet. While the field thrives on principles of randomness and probability, a myriad range of variable understandings of the laws dictating its outcomes can make it one chancy ploy. ■

# TWO IN SEVEN BILLION

*Alana Cullen considers the unlikely possibility of running into your doppelgänger.*

Doppelgänger—German for "double walker"—is a supposed identical version of ourselves. The premise that two people could be so similar they will be mistaken for one another was first recorded over 2000 years ago in *The Epic of Gilgamesh*, one of the oldest known works of literature.

And, statistically, the chances are in favour of doppelgängers existing.

The Infinite Monkey Theorem states that an unlimited number of monkeys randomly typing on a typewriter for an infinite amount of time will eventually produce a text identical to Emily Brontë's *Wuthering Heights*. Or, underwhelmingly, we may see the Twilight Saga reproduced. The reasoning behind this is given infinite time combined with random input, theoretically, all possible outputs should be produced. The human phenotype (the combination of genes that contribute to our outward features) is not exempt from the laws of probability, and so logic dictates that doppelgängers can exist.

Despite the pure numbers premise that they do exist, you would probably never know your double walker existed. The main thing stopping you finding each other is the sheer size of the human population. However, with increasing internet access, using all your efforts you could actually find each other.

Nevertheless, our doppelgängers, like the legend itself, will be scattered throughout time. They could have been alive during the writing of Gilgamesh itself, a jester in Queen Elizabeth I's court, or be born on Mars 1000 years into the future. The probability you will ever hear of them, let alone meet them coincidentally, is lower than the chance of winning the lottery, getting struck by lightning, and winning a Nobel prize combined.

> "Given infinite time combined with random input, theoretically, **all possible outputs** should be produced."

A group of researchers in Australia crunched the numbers and found that the probability of having a doppelgänger is one in a trillion. The team analysed a study of 4,000 faces and deemed that two individuals must have eight distinct identical facial features to be considered true doppelgängers.

Humans have an impressive amount of diversity in their facial features—in fact, we have the most diverse facial features of all animals on the planet. This helps us avoid potential costly mistakes such as trusting someone you do not know, or someone mistaking you as someone else and you being subjected to their punishment.

> "Two individuals would require almost identical upbringings, with similar nutrition and living conditions to grow up and **look the same**."

The Australian study also demonstrated that it isn't just genetics—two individuals would require almost identical upbringings, with similar nutrition and living conditions to grow up and look the same.

## HUMAN PERCEPTION OF DOPPELGÄNGERS

However, just because the science says you are unlikely to bump into your doppelgänger, it doesn't mean you won't think you have. The human brain cannot compute minute details and measurements like computers can. We can convince ourselves that people look identical, even if they only have a few similar features.

And it isn't just facial features that we associate with doppelgänger's, but mannerisms too. Having the same hair style, nose and accent could be enough for your friend to be convinced they look 'just like you.'

Doppelgängers are thus more likely a result of perception as opposed to being identical versions. Moreover, these chances of being 'mistaken' for a look-alike are on the rise, as we are exposed to more faces now via the internet than ever before. Therefore, while statistics and artificial intelligence do not support the chances of double walkers existing, thanks to the evolution of human perception, you could one day meet your pseudo-doppelgänger instead. ■

# THE RAIN GOD OF SAN DIEGO

*Jack Monaghan recounts the mysterious tale of the man who could seemingly control the weather.*

> *"I do not make it rain. That would be an absurd claim.* ***I simply attract clouds, and they do the rest."***
>
> **— Charles Hatfield**

The first raindrop fell sometime in the early afternoon on the 4th of January. It landed on soil thirsty after years of drought. More raindrops followed. By the time they stopped, twenty-five days later, that same soil was submerged under several feet of stinking water. The flood carried automobiles, ruined buildings, and the bloated carcasses of hundreds of drowned cattle out into the San Diego bay. Local papers reported that this was the worst natural disaster in the county's history. But as the unprecedented storm abated, one man was smiling. Charles Mallory Hatfield had been hired by the city council to bring them rain. And rain they had most assuredly received.

Sixteen years earlier, Charles was a salesman, going door-to-door selling sewing machines to local housewives. "He had a nice way," his brother, Paul Hatfield recalled, half a century later. "Everybody liked Charley." But, in the spring of 1903, Charley made a startling discovery: he found the secret to increasing rainfall.

The South Western United States are prone to droughts. Water security has been a priority for every population to have lived there. The Navajo people of neighbouring Arizona have complex rain-dance ceremonies related to *Tó Neinilii*, their God of Rain.

European settlers to the San Diego area found gods of their own. From the 1880s, a new branch of experimental weather manipulation science gained popularity. Its devotees were called 'pluviculturists'—farmers of rain.

> "He built tall wooden towers and from them, evaporated a secret, water-magnetising formula. Within a few hours or days, **heavy rain would fall."**

Through a series of experiments, Charles pioneered a pluviculture method that he called 'moisture acceleration.' He built tall wooden towers and from them, evaporated a secret, water-magnetising formula. Within a few hours or days, heavy rain would fall.

Between the years of 1903 and 1915, Charles travelled the US selling rain to drought-stricken farmers. The deal was always the same: he would only charge for rain above the monthly average. No rain, no fee. The press detailed many of his successes and, with playful incredulity, dubbed him the 'Rain Wizard of California.'

Then came the San Diego contract. The city council had been battling one of the deepest droughts anyone could remember. Their latest solution, Morena Reservoir, had been completed in 1912. But this mammoth water storage facility, covering an area of more than 800 football pitches, had never been more than a third full.

Charles Hatfield made the council a confident offer—he would fill Morena reservoir by the end of 1916. His fee was $10,000, for the ten billion gallons of water it would take. And if it was anything less than full by the end of the year, they wouldn't need to pay him a penny. The city leapt at the offer. "It's heads we win, tails he loses," one of the councillors was heard to say.

Charles and his brother Paul erected their evaporation tower a short distance from Morena on New Year's Day, 1916. Within the month, San Diego had received nearly 30 inches of rain; more than they would expect to fall in two and a half years. Morena was full to overflowing, and it appeared to Charles that they'd fulfilled their contract—with 11 months to spare.

But what he couldn't know from their camp, 50 miles east of the city, was the devastating toll the rains had wrought on the city. Further downstream, two older reservoir dams had burst, overcome by the sheer weight of the water behind them. Newspapers reported at least 50 people had been killed by the resulting flood water, and some 3,000 made homeless by the deluge.

Rather than being received as heroes, Charles and Paul were forced to hide out in a hotel room, checking in under false names, while they awaited their fee. But city hall said they would only pay Charles his $10,000 if he claimed full responsibility for the rains, and thereby take on the legal liability for the millions of dollars of claims for damages due caused by the flood. To accept would have resulted in bankruptcy. In the end Charles Hatfield, God of Rain, was forced to leave the city, without receiving a single dime.

Charles Hatfield's methods were scorned by the scientific establishment of the time. But pluviculture, in its modern guise of cloud seeding, has seen significant government investment in the century that has followed the San Diego flood.

Cloud seeding, like Hatfield's evaporation method, involves introducing chemicals to an atmosphere already laden with water vapour. The most common chemical used is silver iodide, which is sprayed from aircraft into clouds, providing nuclei around which water vapour can condense.

Though scientists have disputed its efficacy, cloud seeding programmes have been conducted by many national governments, including the US, China, and the UK.

One such experiment has an eerie echo of the San Diego incident. Conducted in Devon by the Ministry of Defence, the experiment—codenamed Project Cumulus—has been linked by a BBC investigation to a flash flood that occurred the following day. The flood caused 35 deaths, after the area surrounding the MoD test site experienced 250 times the normal monthly rainfall. The UK government continues to deny any connection.

This year, researchers in the US claim to have demonstrated "unambiguously" that cloud seeding works. The study, published in the journal *Proceedings of the National Academy of Sciences*, boasts "the most comprehensive evidence to date that cloud seeding can generate rain".

Paul Hatfield, when interviewed after his brother's death, said that Charley had taken the secret of his rain-making formula with him to the grave. Without the formula, it is impossible to test if—accidentally or otherwise—Charles Hatfield discovered the secret to rain magnification, a whole century before scientific evidence was discovered. If Charles wasn't responsible, then the worst flood on record beginning the same week a rainmaker arrived in town, was one hell of a meteorological coincidence. ■



# BEATING THE ODDS! THE LIFE OF VIOLET JESSOP

*Cristina Coman returns to tell the fascinating true story of the woman who survived three separate shipping disasters.*

Have you ever survived a maritime disaster? How about two? Three? You would consider it one hell of a lucky coincidence; but maybe three times is the charm! It was in the case of Violet Constance Jessop, a native Argentinian woman who escaped three naval accidents—all on ships belonging to the British shipping company White Star Lines (WSL).

Given the "unwritten law of the sea", women and children first, you might think that a woman's survival is not such a big deal. But Elinder and Erixson's 2012 study on gender, social norms, and survival in maritime disasters might just prove you wrong. The alleged advantage given to women in naval disasters could almost qualify as a myth.

Violet first served the WSL on board the RMS *Olympic*, joining her crew as a stewardess. In September 1911, the *Olympic* collided with the British warship HMS *Hawke* in the North Atlantic Ocean. While the *Hawke's* bow, designed specifically to sink ships, tore two large holes in the *Olympic's* hull, neither ship sank. Nevertheless, you would probably expect such a harrowing experience in open sea to put someone off sailing, but apparently not.

> "The alleged advantage given to women in naval disasters could almost **qualify as a myth."**

Encouraged by friends to partake in a 'wonderful experience,' at the age of 24, she swapped ships and joined the crew of the RMS *Titanic* for her maiden and only voyage. On the night of her second shipwreck in April 1912, Violet was ordered into lifeboat number 16 by a ship's officer who also entrusted her with the life of a stranger's baby.

When you think of a shipwreck, your mind probably goes straight to the most extensively covered events in history. The sinking of the *Titanic* definitely qualifies, as it probably generated the most public and scholarly interest. But she wasn't the biggest in terms of lives lost during peace times. In 1987, the ferry *Doña Paz*'s demise caused three times as many deaths. However, the *Titanic* prompted misconceptions about human behaviour in disasters. While 73.3% of the women survived compared to only 20.7% of the men, Elinder and Erixson's study reveals that, in truth, women's survival rate during maritime disasters is, on average, half that of men (17.9% versus 34.6%, respectively). When maritime disasters specifically involve British ships, women actually fare 10 to 15% worse—something you wouldn't expect in the 19th and early 20th century, when Brits were renowned for their chivalry at sea.

Not only did her sex undermine her chances of survival, but her lower social class, being a farmer's daughter, diminished them further. Violet Jessop beat these odds.

In November 1916, during World War I, Violet was working as a British Red Cross nurse on board the liner-turned hospital ship HMHS *Britannic*, when she struck an underwater mine in the Aegean Sea. Violet jumped out of her lifeboat while struggling not to get sucked in by the boat's propellers. Despite a fracture to her skull on the ship's keel, resulting in numerous headaches years later, she survived the sinking of another British vessel, making this maritime disaster her third and last.

In her memoirs are enclosed details of both her experiences on the *Titanic* and *Britannic* but not on board the *Olympic*—of which she never wished to talk about.

Violet's story of surviving three maritime accidents, with the same shipping company, in the span of six years, is impressive. But, if one were to concentrate solely on the number of accidents, then Arthur John Priest's survivals are nothing short of a miracle. An English fireman and stoker, he not only survived the very same disasters as Violet Jessop, but three more on the HMHS *Asturias*, RMS *Alcantara*, and SS *Donegal*, bringing his total to six near-death experiences. ■

# MEET CUTE OR MERE CHANCE?

*Mariana Kneppers calculates the odds of meeting her one true love on a London bus.*

When moving to London, I was excited for the romanticised idea of city life. An idea that I had garnered from a lifetime (24 years, to be precise) of romantic comedies and love stories. I was almost certain I would fall in love with someone by making eye contact on a big red London bus. I'd rush in, my hair slightly disheveled by the terrible British weather, and clumsily try to close my broken umbrella. I'd glance around subtly to make sure no one had seen my embarrassing display only to meet his perfect eyes.

Well, I can confidently say after six months of living in Notting Hill, I have yet to meet my own Hugh Grant. The most exciting thing to happen to me on a commute has been finding a completely unoccupied front row on the top deck during rush hour. Given the statistics, it's easy to see why.

> "After six months of living in Notting Hill, **I have yet to meet my own Hugh Grant.**"

I'm sure I'm not the only one who's had this fantasy and you'd think the odds would be in a young woman's favour. I spend an average of 12 hours per week on buses. This includes a commute to campus three to four times a week, for an hour each way. Add to that an occasional excursion, or two, over the weekend within London and that creates a total of about 26 weeks (over six months!) on buses. I have spent approximately 312 hours in the setting of my fantasy scenario where it could have come to life. So, why's it not happening?

Now, this is obviously a rough estimation. It's not simply dependent on the number of hours spent on a bus, but also on the time of day, the limited expanse of the route I take round London and its finite passenger number. This makes it incredibly difficult to obtain an exact number. Luckily, statistics can help us get as near to the truth as possible.

According to the Office of National Statistics (ONS), London's 2019 mid-year population was estimated to be just short of nine million people, of which, 50% (4,475,817) were male. My preferred age range for a partner would be somewhere between 24 and 27 years old within the male population, narrowing numbers down to 288,010, just 6.4% of the total male population. After narrowing down the search to the London boroughs I visit most frequently, this leaves a mere 64,271 potential mates—just 1.4% of the possibilities.

> "**It's not simply dependent on the number of hours spent on a bus**, but also on the time of day, the limited expanse of the route I take round London and its finite passenger number."

Up until this point, these statistics came from a single source, the ONS. Applying different statistics from different sources will add various assumptions and the errors associated with that, but let's give it a try.

According to the most recent data from the Department for Transport (DfT) statistics, 14% of Londoners use the bus to commute to work, narrowing the field to 8,998 commuters. This varies depending on whether I am travelling on a bus during the day or the night. According to a Transport for London (TfL) survey, 43% of daytime bus passengers were male whereas, at night, this rises to 64%. Is the answer really to travel at night? Tempting odds, but as a young woman travelling alone, I tend to travel most during the day, making the number of bachelors drop from 8,998 to 3,869, just 43% of the total commuter numbers.

According to the TfL survey, 21% of daytime bus passengers make over £40,000 per annum so, taking into account my travel routes and economic preferences for a partner, this leaves me with about 812 eligible bachelors.

However, my calculations rely on these potential partners also being interested in me. A study from the University of Bath in 2017 found that mutual attraction is as low as 18%. Assuming this is the same in London, statistically, love could happen for me with just 146 men that I find attractive—which is a mere 0.003% of the total male population in London. Yikes!

I'm not the first to try this approach. In 2008, London graduate student, Peter Backus, made an attempt at it in his research paper, 'Why I Don't Have A Girlfriend'. He based his study round the Drake equation, a formula from the field of astronomy used to estimate the probability that humans will find extraterrestrials capable of communicating with Earth. At its core, the Drake equation takes a series of statistics, multiplying them together to produce a probability, as I've done here. Peter found a similarly dismal dating pool of just 26 women. In his case, this was across the entire United Kingdom, though. Thankfully my odds appear better than Peter's.

> "Birth control **may dictate** scent-based preferences for men with compatible immunity-related genetic profiles, to optimise the health of their children."

But these are just numbers. They don't account for the myriad of biological factors operating on the subconscious level that influence our decision in a partner. Many studies have found that women appear most attractive to men during the late follicular phase of their cycle, right before ovulation when fertility is highest.

Even birth control can have an effect. There have been studies dating back from the 1990s showing that its use may dictate scent-based preferences for men with compatible immunity-related genetic profiles, to optimise the health of their children. Ultimately, however, many of these studies don't account for sexual preferences outside of heterosexual relationships.

So, while statistics can give us an idea of how likely events are to occur, they are, after all, no more than an approximation towards the truth, so should never be taken as fact. It's trivial to rely on something logical like maths to determine something as seemingly illogical as love. Even accounting for biology, it may be that humans have evolved to a point where biological demands can be overridden for the sake of love. Rather than relying on numbers, take matters into your own hands and invest in your passions and interests. Regardless of whether you meet your Hugh, or encounter love's massive margin of error, it'll be much more fulfilling than waiting on a bus. ■

# I, SCIENCE