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1.
IDENTITY ELEMENTS

Who in the world am I? Ah, that's the great puzzle.
—Lewis Carroll

On a late September day in 1956, a skinny 18-year-old left home with a trunk on his back. John Conway wore his hair long and unkempt like a proto-hippie, and although he generally preferred to go barefoot, on this occasion he wore strappy Jesus sandals. He traveled by steam train from Liverpool southeast to Cambridge. As he passed the 5-hour journey, via Crewe with a connection in Bletchley, the not particularly scenic landscape rolling by in a blur of canals and countryside, something dawned on him: here lay a chance for some much-needed self-invention.

In junior school, one of John's teachers had nicknamed him "Mary," since he was such a delicate creature, a bit effeminate. Being Mary made John's life absolute hell until he moved on to secondary school, at the Holt High School for Boys. When the headmaster, A. G. Russell, called each boy into his office and asked what he planned to do with his life, John said he wanted to "read" mathematics at Cambridge. Mathematics has been studied at Cambridge for a long time, according to the website, which also says that its first notable mathematician was the sixteenth century's Robert Recorde, credited with the invention of the equal sign. After loitering for a while with the reprobates at the back of the classroom, John did well enough on the Cambridge entrance exams to receive a minor scholarship and get his name published in the *Liverpool Daily Post*. So instead of Mary, he became known as "the Prof." These nicknames resulted in a terribly introverted teenager, painfully aware of himself and his own suffering. Hence, on the train, he did some meta-thinking. None of his classmates would be joining him at Cambridge. No one would know him. This gave him the audacious idea of transforming himself into a new person: an extrovert! He wondered if he could pull it off. He worried his introversion was too entrenched, but he decided to give it a go. He would be boisterous and witty, he would tell funny stories at parties, he would laugh at himself—that was key.

> Roughly speaking, I was going to become the kind of person you see now. It was a free decision.

Right then, telling me that story, Conway was holding forth in the edifying alcove at the math department, toggling between telling tales and fretting about a big lecture he was due to deliver that night on his latest brainchild, the Free Will Theorem. Conceived in collaboration with his Princeton colleague and friend Simon Kochen, the theorem came about through a casual kicking around of ideas over more than a decade. On August 19, 2004, a Thursday, all of a sudden they realized what they'd achieved. Using a motley combination of quantum mechanics, philosophy, and geometry, they had proven a theorem, almost inadvertently. The simplest statement of their Free Will Theorem is as follows: If physicists have free will while performing experiments, then elementary particles possess free will as well. And this, they reckon, probably explains why and how humans have free will in the first place. It isn't a circular argument so much as it's a spiral argument, a self-subsuming argument, spiraling outward bigger and bigger.

Kochen was the expert in this subject; in his youth he'd done some serious dabbling in the realm of quantum mechanics. Conway's job was not to understand.

> My contribution was *not* understanding all the quantum mechanics stuff. And that was an important contribution. It freed us to think about things in very simple terms.

Obviously, Conway brought a certain brainpower to bear. "He's sui generis," says Kochen. Meaning he's reliably unusual in his approach. And as far as Conway's brain proper is concerned, "It's big," Kochen says. "A lot of people dig deeper and deeper and deeper, use very technical modern machinery. That's not the way John works. He doesn't use too many technical things, not too much apparatus. He works at ground level, the level that he could explain to anyone, using intuition."

> In a fundamental way my job is thinking. You can't see it from the outside. What does the thinking consist of? I think about how to explain whatever I am thinking about to someone. Then I explain it to someone and it doesn't work. So I think about it some more. I tinker with it, with thinking, until I've simplified it. I personally can only understand things after I've thought about them for ages and made them very, very simple.
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> Most people just understand enough to work. For example, a mechanic doesn't necessarily understand the physics or engineering of how a car works. I'm not putting down a car mechanic. We need practical people. I'm not sure we need theoretical people. Though I'm not going to campaign for my own abolishment.

Conway and Kochen spent a couple of years refining their theorem, readying it for publication in the journal *Foundations of Physics*. With Conway as front man, they also began planning a series of public lectures for fall 2006. They booked the McCosh 50 lecture hall, Princeton's largest classroom, with 446 wooden seats—a creaky 105-year-old venue where Einstein delivered a lecture series on relativity in 1921. Princeton University Press signed the book rights and printed posters to advertise the lectures around campus.

But then things went awry. Conway's wife, Diana, left him. Without her, he floundered. He neglected to take his medication. He suffered his first stroke. The lectures were postponed for more than 2 years. Finally, by March 2009, things were for the most part back on track.

The night before the inaugural lecture, Conway kept himself awake coughing till all hours. I came to this knowledge firsthand. Stealing a page from Margaret Mead's playbook, I'd proposed that I set up camp in Conway's guest room as a full-immersion participant observer. He had no problem with my tailing him 24-7. "My amanuensis," he called me—from the Latin phrase *servus a manu*, a slave at hand. One could let Conway believe what he wanted to believe. Then again, I fetched cough drops and water in attempts to quell his coughing fits, and I carried around his plastic shopping bag full of lecture props, including a book on the Roman poet and philosopher Titus Lucretius and a new braided brown leather belt, a handmade example of knot theory, recently mailed by a friend. He planned to press the belt into service that very evening lest his too-big trousers descend before his audience.

Assuming his position at the lectern that evening, with his coconspirator Kochen sitting in the front row, Conway opened by barking a greeting cum query at his audience:

> WHY ARE YOU HERE TONIGHT?!

He presented 2 answers, with considerable fumbling via PowerPoint (creating the slide presentation had been considerably more challenging for him, intellectually, than constructing the theorem).

> 1) It was predetermined
> 2) You chose to come
>
> That really is the problem that faces us.

There was, however, a bigger question: Why was Conway himself there? What business of his was free will? A survey of friends and colleagues on this issue brought rejoinders like "As far as I'm concerned, it's a lot of nonsense." Or "I'm sorry, but I don't understand what John is talking about." The consensus being that he was wandering rather far afield, even for his impressively philandering ken.

Conway, of course, had an answer to the question, by way of a story. Some 65 years earlier, his father had gone to considerable trouble to prove to little John that a radio did not get its information, its sound, from the cord that plugged it into the wall, nor from the wall or the floor by any route, as his son was convinced it did.

> My dad borrowed a battery-operated radio set—at that time they didn't basically exist, this was Liverpool in wartime—and he suspended the radio by string from a light fitting. . . . Then he said, "Now watch." He snipped

the string. And the radio went on playing music as it fell onto some cushions on the floor—it was in midair and it was still playing music. Well, I didn't understand how that could happen. I still don't understand it, in a sense. We still don't understand how the sun pulls the earth. We don't need an understanding of it. We just accept that it does. The only thing to do is get on with your life. Believe it. Accept it. We don't have to have an explanation for how things happen. They just do.

The radio story was Conway's way of reassuring people that they needn't worry about what they might not understand about the Free Will Theorem. And, he added, almost apologetically:

By the way, we didn't want to prove our theorem. We just wanted to understand what goes on, how the world works. We proved the theorem by accident.

Three axioms make up the guts of the Free Will Theorem. The axioms come from quantum mechanics, which describes the world of the very small, such as elementary particles, and from general relativity, which describes large-scale properties of the universe, such as gravity. But again, the caveat Conway offered, often with throat-clearing asides, was not to worry if you don't understand. He recalled what he once heard the physicist Richard Feynman say about the utter incomprehensibility of quantum mechanics: "If you meet somebody who tells you they understand quantum mechanics, what have you learned? What you've learned is that you've met a liar." Conway has met a few liars. And although he of course doesn't understand quantum mechanics, during the lecture he mentioned the axioms here and there for some ambient scientifica—mood axioms—the postulates in question being "Twin," "Spin," and "Fin." That they rhyme makes them seem at least potentially understandable, in a Lewis Carroll rational nonsense kind of way. From these axioms, and Conway and Kochen's conjuring imaginations, emerged the Free Will Theorem.

And what does "free will" mean? I'm just using this term, "free will"—and many people have said it is a tendentious use of words—to mean that our behavior is not a function of the past.

Precisely how elementary particles demonstrate free will Conway only touched upon in the first lecture. It has to do with an experiment measuring the spin of 2 "Twin" particles, questioning, if you will, the twinned particles about what their spins are. Conway compared this inquisition of the particles to the game Twenty Questions, which he played as a child with his 2 older sisters. John, at the age of about 7, would think of an object and declare it animal, vegetable, or mineral. His sisters would ask questions about the object, and if they succeeded in guessing what it was in 20 questions or fewer, they won. But being a bumptious boy, John displayed no scruples whatsoever when playing this game.

> If I sensed my sisters were getting too close to the object I'd selected, I would change the object. You had to be quite clever to do that. Because you have to select a new object which answers, say, the 7 questions you've already been asked in the same way as the old object did—and is also unlikely to be the kind of object your sisters will think about.

That, he explained, is kind of what the particles do.

> If you ask them this type of "Spin" question, they don't have an answer in mind.
>
> Let's think of that. Let's think of an even cleverer little boy than I was. Very hard to think of a cleverer little boy than I. But think of a cleverer little boy than I was, who never bothers to select an object or an answer in the first place. He just gives the first of so many answers at random and then starts thinking what the object is. Well, that's what the particles do. They don't have answers in mind for each of 33 "Spin" questions that can be asked of them or measured by the experimenters.
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> Now, a clever enough little boy can answer questions like that on the fly, so to speak, and not be caught out by his sisters. I may say, occasionally I was caught out by my sisters, and there were punishments which I won't bother to describe. But suppose I had a twin brother. In fact, there was a long history of twins in our family. My father was a twin. He had a brother and sister who were twins. I always wished I had a twin brother. And if I had, my sisters would have had a much better chance, because they could insist that my twin and I choose our object together, but then interrogate us separately. If that were the case, we couldn't change the

> object. If they chose which one of us they're going to ask about the object, and my twin and I had no chance to transmit information to one another and say, "Hey, quick, I'm changing the object to such and such," well, then we couldn't win. The same happens with the twinned particles. They are tested separately but somehow on the fly they always come up with the same answers.

With that, the Free Will Theorem was essentially QED. Well, not quite. That's an easily digestible analog of the proof, a scientific soupçon. We'll get to the heart of the matter in the not too distant future—we'll revisit the Free Will Theorem intermittently throughout our tortuous journey, treating it like a temporal benchmark, the prevailing present. Most memorable for me during the first lecture was that while Conway took care to avoid getting into any technicalities about the scientific forces at play, he confessed how remarkable he found it that anything could be proven at a mathematical level of precision and exactitude about the nebulous concept of free will.

> But, you know, that's what we've done. Our proof is unassailable.

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