

SLEIGHTS OF MIND

WHAT THE NEUROSCIENCE *of* MAGIC
REVEALS ABOUT OUR EVERYDAY DECEPTIONS



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INTRODUCTION

CLARKE'S THIRD LAW: *"Any sufficiently advanced technology is indistinguishable from magic."*

NIVEN'S LAW: *"Any sufficiently advanced magic is indistinguishable from technology."*

AGATHA HETERODYNE ("GIRL GENIUS") PARAPHRASE
OF NIVEN'S LAW: *"Any sufficiently analyzed magic is indistinguishable from science!"*

Have you ever wondered how magic effects work? Coins materialize out of thin air. Cards move through a deck as if pulled by an invisible force. Beautiful women are cut in half. Spoons bend. Fish, elephants, even the Statue of Liberty disappear before your eyes. How does a mentalist actually read your mind? How can you not see the gorilla in the room? Really, how can someone catch a bullet in his teeth? *How do they do it?*

Don't bother to ask a conjurer. When joining an organization of professional magicians, the initiate may be asked to take an oath: "As

a magician I promise never to reveal the secret of any illusion to a nonmagician, unless that person also swears to uphold the magicians' oath. I promise never to perform any illusion for any nonmagician without first practicing the effect until I can do it well enough to maintain the illusion of magic." It is a code. A brotherhood. The magician who breaks this code risks being blackballed by his fellow magicians.

So what are we, a couple of muggles, doing writing a book on magic? Zipped lips aside, hasn't most everything about magic been revealed? Enter "magic" in the Amazon Books search box and 75,000 results pop up. Log in to YouTube and you can see just about every magic trick ever devised—often demonstrated by darling seven-year-olds in their bedrooms with Mom or Dad wielding the videocam. Visit Craigslist and choose from myriad charming descriptions of local amateur magicians. What's left to say?

Actually, plenty. This is the first book ever written on the neuroscience of magic, or, if you will, *neuromagic*, a term we coined as we began our travels in the world of magic.* Much has been said about the history of magic, tricks of the trade, the latest props, and psychological responses to magical effects. But neuroscience probes more deeply. We want to pop the hood on your brain as you are suckered in by sleights of hand. We want to explain at a fundamental level why you are so thoroughly vulnerable to sleights of mind. We want you to see how deception is part and parcel of being human. That we deceive each other all the time. And that we survive better and use fewer brain resources while doing so because of the way our brains produce attention.

Like so much that happens in science, we fell into magic by accident. We are neuroscientists at the Barrow Neurological Institute in Phoenix, Arizona. The BNI is the oldest stand-alone neurological institute in the United States and currently the largest neurosurgical service in North America, performing more than six thousand crani-

*Devin Powell, a writer for the popular science magazine *New Scientist*, described our early studies in a 2008 article that introduced the term "magicology" (the scientific study of magic) as an alternative to "neuromagic" (the neuroscientific study of magic). Although "neuromagic" is somewhat narrower than "magicology," both terms are roughly equivalent and usually interchangeable.

otomies per year. Each of us runs a research laboratory in the institute. Stephen is director of the laboratory of behavioral neurophysiology. Susana is director of the laboratory of visual neuroscience. Incidentally, we are married. Both of us are primarily interested in how the brain, as a device that is made up of individual cells called neurons, can produce awareness, the feeling of our first-person experience.* Somehow, when neurons are hooked up to each other in specific circuits, awareness is achieved. It's the ultimate scientific question, and neuroscience is on the verge of answering it.

Our foray into illusions began a decade ago when, as young scientists seeking to make a name for ourselves, we tried to rustle up some public enthusiasm for our specialty of visual neuroscience. In 2005, after accepting faculty appointments at BNI, we organized the annual meeting of the European Conference on Visual Perception, which was held in Susana's hometown of A Coruña, Spain. We wanted to showcase visual science in a new way that would intrigue the public and the media. We were fascinated with how science can explain something about the visual arts—for example, Margaret Livingstone's work on why the Mona Lisa's smile is so ineffably enigmatic. We also knew that visual illusions are fundamentally important to understanding how the brain turns raw visual information into perception.

The idea we came up with was simple: we would create the Best Illusion of the Year contest. We asked the scientific and artistic communities to contribute new visual illusions and received more than seventy entries. The audience (a mixture of scientists, artists, and the public) viewed the ten best illusions and then chose the top three. The contest, now in its seventh year, has been a huge success. Our Internet audience doubles every year, and our Web site (<http://illusionoftheyear.com>) currently has about 5 million page views each year.

Because of our success with the illusion contest, the Association for the Scientific Study of Consciousness asked us to chair its 2007 annual conference. The ASSC is a society of neuroscientists,

*Throughout this book we use the terms "awareness" and "consciousness" as synonyms.

psychologists, and philosophers united in the aim to understand how conscious experience emerges from the interactions of mindless, individually nonconscious brain cells.

As our opening move, we proposed holding the conference in our hometown of Phoenix, but the association's board nixed that right away because the city is an inferno midyear. Instead, they suggested . . . Las Vegas. Hmmm. Las Vegas is every bit as blisteringly hot in June as Phoenix, and if you take the lap dancing, gambling, and showgirls into account it is probably several degrees hotter due to friction. So apparently our colleagues in consciousness studies were looking for a bit of real excitement to spice up their thought experiments.

So Vegas it was. We flew there in October 2005 to do some scouting. On the flight over we asked ourselves: How could we raise the visibility of consciousness research to the public? We didn't want to do another contest. The answer began to germinate the moment our plane dipped its wings on approach to the Las Vegas airport. Out the window we could see, all at once, the Statue of Liberty, the Eiffel Tower, an erupting volcano, the Space Needle, the Sphinx, Camelot, and the Great Pyramid. Soon we were driving up and down the Strip, checking out hotels for our meeting space. We passed Aladdin's castle, the Grand Canal of Venice, and Treasure Island. It seemed too strange to be real. Then, bingo: the theme for our conference appeared. Festooned on billboards, taxicabs, and buses were huge images of magicians: Penn & Teller, Criss Angel, Mac King, Lance Burton, David Copperfield. They stared out at us with mischievous eyes and beguiling smiles. And then it hit us that these tricksters were like scientists from Bizarro World—*doppelgängers* who had outpaced us real scientists in their understanding of attention and awareness and had flippantly applied it to the arts of entertainment, pickpocketing, mentalism, and bamboozlement (as well as to unique and unsettling patterns of facial hair).

We knew as vision scientists that artists have made important discoveries about the visual system for hundreds of years, and visual neuroscience has gained a great deal of knowledge about the brain by studying their techniques and ideas about perception. It was painters rather than scientists who first worked out the rules of visual

perspective and occlusion, in order to make pigments on a flat canvas seem like a beautiful landscape rich in depth. We realized now that magicians were just a different kind of artist: instead of form and color, they manipulated attention and cognition.

Magicians basically do cognitive science experiments for audiences all night long, and they may be even more effective than we scientists are in the lab. Now, before our in-boxes fill up with flames from angry colleagues, let us explain. Cognitive neuroscience experiments are strongly susceptible to the state of the observer. If the experimental subject knows what the experiment is about, or is able to guess it, or sometimes even if she incorrectly thinks she has figured it out, the data are often corrupted or impossible to analyze. Such experiments are fragile and clunky. Extraordinary control measures must be put in place to keep the experimental data pure.

Now compare this with magic shows. Magic tricks test many of the same cognitive processes we study, but they are incredibly robust. It doesn't matter in the slightest that the entire audience knows it is being tricked; it falls for each trick every time it is performed, show after show, night after night, generation after generation. We thought, if only we could be that deft and clever in the lab! If only we were half so skilled at manipulating attention and awareness, what advances we could make!

The idea rapidly took shape: we would bring scientists and magicians together so scientists could learn the magicians' techniques and harness their powers.

But there was just one problem: we were clueless about magic. We didn't know any magicians. Neither of us had ever even seen a real magic show. Fortunately, our colleague Daniel Dennett got us our big break. Dennett is a fellow scientist and philosopher who also happens to be a good friend of James the Amazing Randi, a famous magician and skeptic who has spent decades debunking claims of the paranormal. Randi wrote back, enthusiastically endorsing our idea. He told us that he knew three more magicians who would be perfect for our purposes: Teller (from the magic duo Penn & Teller), Mac King, and Johnny Thompson. All of them lived in Las Vegas and all were personally interested in cognitive science. Apollo Robbins,

“the Gentleman Thief,” a friend of Teller, joined our group a few months later. Much of this book is based on our interactions with these talented magicians.

Thus began our journey of discovery about the neural underpinnings of magic. We have spent the last few years traveling the world, meeting magicians, learning tricks, and inventing the science of neuromagic. We developed our own magic show and decided to audition at the world’s most prestigious magic club, the Magic Castle in Hollywood, California, as bona fide magicians. (For how we did, see chapter 11.)

Magic tricks work because humans have a hardwired process of attention and awareness that is hackable. By understanding how magicians hack our brains, we can better understand how the same cognitive tricks are at work in advertising strategy, business negotiations, and all varieties of interpersonal relations. When we understand how magic works in the mind of the spectator, we will have unveiled the neural bases of consciousness itself.*

So pull up a seat, because *Sleights of Mind* is the story of the greatest magic show on earth: the one that is happening right now in your brain.

*Readers can find relevant citations of the original research studies discussed throughout this book in each chapter’s note section.