



**PROFESSIONAL** pickpocket Apollo Robbins has an uncanny ability to control minds. He can manipulate people to an extraordinary degree, drawing their attention away from his thieving hands as he purloins watches and wallets in plain sight. These days, Robbins gives his ill-gotten gains back – he has given up a life of crime to become an entertainer – but most of his victims still have no idea they’ve been robbed until it’s too late.

Watching Robbins at work is like watching somebody with supernatural powers. Yet, like his fellow conjurors, Robbins deceives his targets using nothing more than a finely honed understanding of human psychology. “I think of myself as a folk psychologist,” he says. “It’s all about developing an instinct for how the human mind works.”

After years of ignoring magic, researchers are starting to realise that the methods magicians use to manipulate the human mind might hold important insights into how it works. “We’re all thinking about the same questions,” says Christof Koch, a neuroscientist at the California Institute of Technology in Pasadena. “We just come at the problems from different angles.”

Magic is all about appearing to break the laws of nature – making solid objects appear or disappear, sawing human beings in half, reading people’s minds, and so on. The laws of nature, of course, are inviolable, which is why magicians target the human brain instead, packed as it is with glitches and weaknesses that can be exploited to create the illusion of doing the impossible. And they’re brilliant at it: magic tricks only work if you fool all of the people all of the time.

Cognitive neuroscientists also have a long-standing interest in tricks of the mind, as these are a useful source of insight into how the brain works. Visual illusions, for example, have taught them a huge amount about how the brain processes visual information. Now they’re dipping into the treasure chest of cognitive illusions provided by magic.

Over the past couple of years, neuroscientists and magicians have been getting together to create a science that might



# Magicology

**If you really want to know how the human brain works, ask somebody who knows how to tie it in knots**

be called “magicology”. If successful, both sides stand to benefit. By plundering the magicians’ book of tricks, researchers hope to develop powerful new tools for probing perception and cognition. And if they find any tricks they can’t explain, that could lead to new knowledge about how the brain works. Similarly, magicians hope that the collaboration will lead to new magic tricks by alerting them to perceptual or cognitive weaknesses that they didn’t already know about. “The real proof that a science of magic has come of age will be when we can use science to build a better magic trick,” says Richard Wiseman, a psychologist at the University of Hertfordshire in Hatfield, UK.

According to his fellow psychologist Gustav Kuhn at the University of Durham in the UK, a good starting point for the science

of magic is the magicians’ own classification of their art into three broad types of trick: misdirection, illusion and forcing.

Misdirection lies at the heart of magic. It is the art of diverting the audience’s attention away from what magicians call the “method” – the act of deception itself (see diagram, page 44).

In neuroscience terms, misdirection relies on the fact that the brain has a very limited supply of attention. Over the past decade or so it has become clear just how scarce attention is: focusing on one thing can make you oblivious to other things that would otherwise be obvious. This bizarre phenomenon is called inattention blindness, and it was famously demonstrated in 1999 by psychologists Daniel Simons and Christopher Chabris of the University of Illinois at Urbana-Champaign. They made a video of six people in a circle ▶

**"Magic is all about appearing to break the laws of nature"**

bouncing two basketballs around. When asked to count the number of bounces, around half of the people who watch the video fail to notice a man in gorilla suit walking through the middle of the game and beating his chest (*New Scientist*, 18 November 2000, p 28).

Not surprisingly, magicians use this powerful effect all the time to pull off blatant deceptions right under our noses. Kuhn recently demonstrated this using a trick where he makes a cigarette and lighter "disappear". In truth he simply drops them into his lap when your narrow spotlight of attention is pointing elsewhere.

### Right before your eyes

By tracking eye movements as people watched a video of the trick, Kuhn showed that people miss the deception even when they're looking directly at it. It works because, at the crucial moments, he makes attention-grabbing gestures and eye movements that divert attention (but not gaze) away from the action. If you watch the video a few times it's hard to believe that you could ever fall for it.

Magicians are so adept at manipulating attention that cognitive scientists have started bringing them into their labs to learn more. Susana Martinez-Conde of the Barrow Neurological Institute in Phoenix, Arizona, is one. "My hope is that the cognitive illusions of magicians can help scientists understand awareness, just as visual illusions have helped us to understand sight," she says. To that end she recently started working with Robbins.

During his training as a professional thief, Robbins was taught to use two types of hand

motion to control his victims' attention. Slow, circular hand motions are good at engaging and keeping attention, while fast, straight ones are useful for quickly diverting it from one spot to another. The scientific basis of this difference is unknown, says Martinez-Conde. But she plans to find out.

Another mysterious way of manipulating attention is with humour. "When people laugh, time stands still," says magician John Thompson, aka The Great Tomsoni. He frequently uses jokes to conceal large movements that are particularly difficult to hide. Exactly why laughter disengages attention so efficiently is unknown.

A second key tool in the magic repertoire is illusions, particularly cognitive illusions. These rely on the fact that much of what you think you see is actually invented by your brain. Perception is not about capturing a full picture of reality, but taking snapshots of the world and making the rest up.

In the vanishing ball illusion, for example, a magician tosses a small ball up and down while following it with his eyes. He fakes a third toss, keeping the ball in his hand but still moving his eyes as if watching it. This reliably creates the illusion of the ball being thrown upwards – then disappearing into thin air.

Kuhn recently brought this trick into his lab to examine how it works. By tracking people's eyes as they watched it being done, he found something unexpected. On real throws, the eye movement of subjects followed the ball's trajectory. But on the trick toss, their eyes remain firmly glued on the eyes of the magician. This, says Kuhn, shows that the brain overrules the eyes and creates an image



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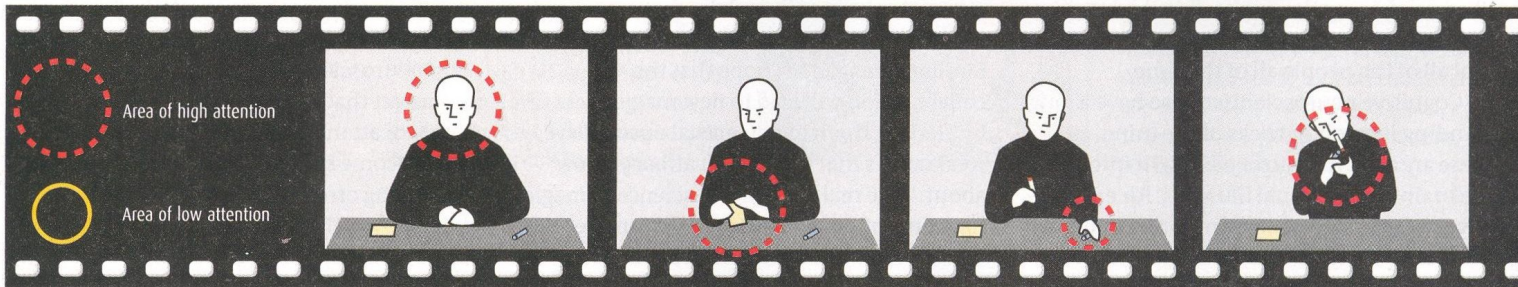
of an object that doesn't actually exist.

Why would it do that? Part of the answer lies in the power of social cues – in this case the magician's eyes – to set up expectations in the brain. Kuhn showed that the trick worked less well if he kept his eyes fixed on the throwing hand rather than tracking the arc of the nonexistent ball.

The trick also relies on another glitch in the visual system. Information captured by the retina takes about 100 milliseconds to reach the brain. To compensate for this lag, the brain predicts what the world will look like in the near future and acts on this prediction rather than the real information at its disposal. This is useful in real-world situations such as driving

### VANISHED!

Psychologist Gustav Kuhn demonstrates the oldest magic technique in the book, called misdirection



The magician sits at a table with a pack of cigarettes and a lighter in front of him

He looks down at the cigarettes and takes one from the pack

He looks at the lighter and picks it up

He puts the cigarette in his mouth and starts to light it, but realises it is the wrong way round



Despite appearing to do the impossible, the rabbit merely confirms that your mind is weak

a car, but it also gives magicians an opening to exploit (*Current Biology*, vol 16, p R950).

A third tool up the magicians' sleeve is forcing. This is any technique that gives the target the illusion of free will when in fact they have none. The classic example is the "pick a card, any card" trick where the magician uncannily knows what you picked.

Ron Rensink, a psychologist at the University of British Columbia in Vancouver, Canada, says that forcing is one of the great mysteries of magic, as yet unexplained by cognitive neuroscience. "The degree to which a magician can control someone's mind tends to be far greater than anything we come up with in the lab," he says.

To find out more, Rensink has teamed up with professional magician Aym Amlani to test forcing scientifically. Amlani devised a trick of the "pick a card, any card" variety in which participants watch Amlani flick through a deck of cards, briefly exposing the face of each. The flip-through lasts only a few seconds, after which subjects are asked to name a card of their choice.

"We can get 70 to 80 per cent of our subjects to pick a specific card," says Rensink. That's because the deck is loaded; 10 out of the 52 cards are the same. Even though the cards fly by in an instant, this moderate bias has a powerful unconscious effect.

Rensink does not know why this trick works.

But he hopes to strip it down to see how strong the principle of exposure is. "If you remove the magician and just show cards on a computer screen, would it still work?" asks Rensink. "How about if you use something other than cards?"

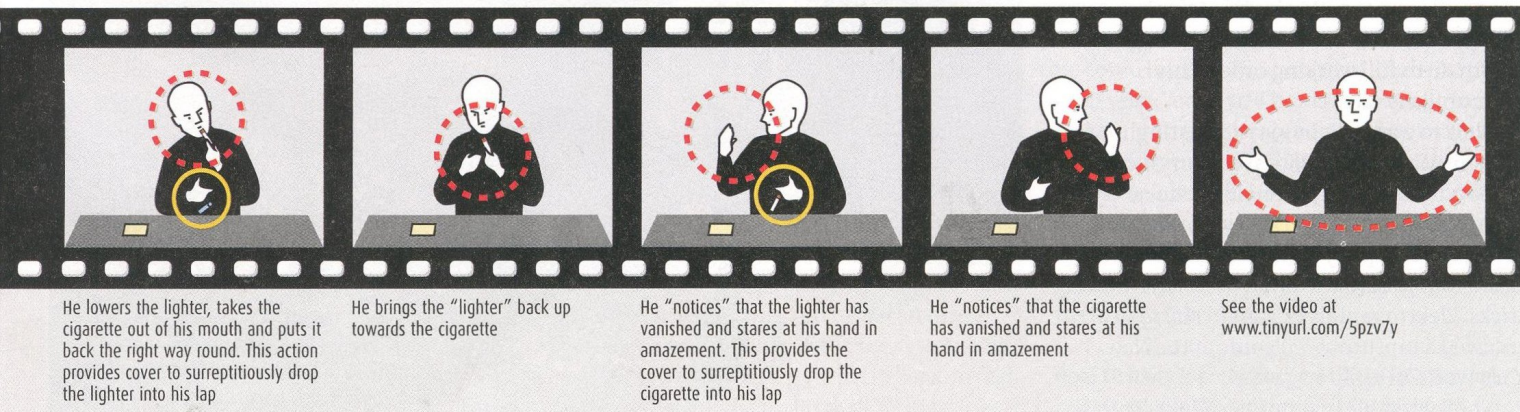
Forcing can also be achieved by another brain glitch that magicians learned about long before neuroscientists – false memory. During a trick, a magician will often describe what he has just done in a way that manipulates people's recollection of it.

Researchers have only scratched the surface of what magic has to offer. Already, though, they've been surprised by how much of "their" knowledge magicians have already discovered. "For years, scientists have been reinventing wheels that magicians have known about for ages," says Martinez-Conde.

As yet, science hasn't led to the creation of new tricks. Yet even if it doesn't there could be practical spin-offs, says Kuhn. Many of the techniques advertisers and politicians use to persuade us are straight out of the magician's book of tricks, so a better knowledge of them could arm us all against manipulation.

The danger, of course, is that scientists become the ultimate killjoys, stripping away the, er, magic of it all. But with so much trickery on their side, the magicians ought to be able to stay one step ahead. If not, they could always send Robbins in to steal wallets and watches until the scientists agree not to spill the beans. **Devin Powell** ●

Further reading: "Towards a science of magic", *Trends in Cognitive Sciences*, vol 12, p 349, and "Attention and awareness in stage magic: turning tricks into research", *Nature Reviews Neuroscience*, vol 9, p 871



He lowers the lighter, takes the cigarette out of his mouth and puts it back the right way round. This action provides cover to surreptitiously drop the lighter into his lap

He brings the "lighter" back up towards the cigarette

He "notices" that the lighter has vanished and stares at his hand in amazement. This provides the cover to surreptitiously drop the cigarette into his lap

He "notices" that the cigarette has vanished and stares at his hand in amazement

See the video at [www.tinyurl.com/5pzv7y](http://www.tinyurl.com/5pzv7y)