While a Magician Works, the Mind Does the Tricks

By Benedict Carey
The New York Times
August 12, 2008; Section F, Pg. 1

A decent backyard magic show is often an exercise in deliberate chaos. Cards whipped through the air. Glasses crashing to the ground. Gasps, hand-waving, loud abracadabras. Something's bound to catch fire, too, if the performer is ambitious enough—or needs cover.

"Back in the early days, I always had a little smoke and fire, not only for misdirection but to emphasize that something magic had just happened," said The Great Raguzi, a magician based in Southern California who has performed professionally for more than 35 years, in venues around the world. "But as the magic and magician mature, you see that you don't need the bigger props."

Eye-grabbing distractions—to mask a palmed card or coin, say—are only the crudest ways to exploit brain processes that allow for more subtle manipulations, good magicians learn.

In a paper published last week in the journal Nature Reviews Neuroscience, a team of brain scientists and prominent magicians described how magic tricks, both simple and spectacular, take advantage of glitches in how the brain constructs a model of the outside world from moment to moment, or what we think of as objective reality.

For the magicians, including The Great Tomsoni (John Thompson), Mac King, James Randi, and Teller of Penn and Teller, the collaboration provided scientific validation, as well as a few new ideas.

For the scientists, Susana Martinez-Conde and Stephen Macknik of the Barrow Neurological Institute in Phoenix, it raised hope that magic could accelerate research into perception. "Here's this art form going back perhaps to ancient Egypt, and basically the neuroscience community had been unaware" of its direct application to the study of perception, Martinez-Conde said.

"It's a marvelous paper," Michael Bach, a vision scientist at Freiburg University in Germany who was not involved in the work, said in an e-mail message. Magicians alter what the brain perceives by manipulating how it interprets scenes, Bach said, "and a distant goal of cognitive psychology would be to numerically predict this."

One theory of perception, for instance, holds that the brain builds representations of the world, moment to moment, using the senses to provide clues that are fleshed out into a mental picture based on experience and context. The brain uses neural tricks to do this: approximating, cutting corners, instantaneously and subconsciously choosing what to "see" and what to let pass, neuroscientists say. Magic exposes the inseams, the neural stitching in the perceptual curtain.

Some simple magical illusions are due to relatively straightforward biological limitations. Consider spoon bending. Any 7-year-old can fool her younger brother by holding the neck of a spoon and rapidly tilting it back and forth, like a mini teeter-totter gone haywire. The spoon appears curved, because of cells in the visual cortex called end-stopped neurons, which perceive both motion and the boundaries of objects, the authors write. The end-stopped neurons respond differently from other motion-sensing cells, and this slight differential warps the estimation of where the edges of the spoon are.

PHILADELPHIA MUSEUM OF ART PURCHASED WITH THE W. P. WILSTACH FUND, 1914

A painting from the 16th century, entitled "The Conjurer."

The visual cortex is attentive to sudden changes in the environment, both when something new appears and when something disappears, Martinez-Conde said. A sudden disappearance causes what neuroscientists call an after-discharge: a ghostly image of the object lingers for a moment.

This illusion is behind a spectacular trick by the Great Tomsoni. The magician has an assistant appear on stage in a white dress and tells the audience he will magically change the color of her dress to red. He first does this by shining a red light on her, an obvious ploy that he turns into a joke. Then the red light flicks off, the house lights go on and the now the woman is unmistakably dressed in red. The secret: In the split-second after the red light goes off, the red image lingers in the audience's brains for about 100 milliseconds, covering the image of the woman. It's just enough time for the woman's white dress to be stripped away, revealing a red one underneath.

Magicians alter what the brain perceives by manipulating how it interprets scenes, "and a distant goal of cognitive psychology would be to numerically predict this."

—Michael Bach, vision scientist, Freiburg University

In a conference last summer, hosted by Martinez and Macknik, a Las Vegas pickpocket performer and co-author named Apollo Robbins took advantage of a similar effect on the sensory nerves on the wrist. He had a man in the audience come up on stage and, while bantering with him, swiped the man's wallet, watch and several other things. Just before slipping off the timepiece, Robbins clutched the man's wrist while doing a coin trick—thereby lowering the sensory threshold on the wrist. The paper, with links to video of Robbins' performance, is at **http://www.nature.com/nrn/journal/vaop/ncurrent/full/nrn2473.html**.

"That was really neat, and new to me," said Bach, who was in the audience. The grasp, he said, left "a sort of somatosensory afterimage, so that the loss of the watch stays subthreshold" in the victim. The visual cortex resolves clearly only what is at the center of vision; the periphery is blurred, and this is likely one reason that the eyes are always in motion, to gather snapshots to construct a wider, coherent picture.

A similar process holds for cognition. The brain focuses conscious attention on one thing at a time, at the expense of others, regardless of where the eyes are pointing. In imaging studies, neuroscientists have found evidence that the brain suppresses activity in surrounding visual areas when concentrating on a specific task. Thus preoccupied, the brain may not consciously register actions witnessed by the eyes.

Magicians exploit this property in a variety of ways. Jokes, stagecraft and drama can hold and direct thoughts and attention away from sleights of hand and other moves, performers say.

But small, apparently trivial movements can also mask maneuvers that produce breathtaking effects. In a telephone interview, Teller explained how a magician might get rid of a card palmed in his right hand, by quickly searching his pockets for a pencil. "I pat both pockets, find a pencil, reach out and hand it to someone, and the whole act becomes incidental; if the audience is made to read intention—getting the pencil, in this case—then that action disappears, and no one remembers you put your hand in your pocket," the magician said. "You don't really see it, because it's not a figure anymore, it has become part of the background."

The magician's skill is in framing relevant maneuvers as trivial. When it's done poorly, Teller said, "the actions immediately become suspicious, and you instantly click that something's wrong."

David Blaine, a New York magician and performance artist, said he started doing magic at age 4 and quickly learned that he did not need any drama or special effects. "A strong and effective way to distract somebody is to directly engage the person," with eye contact or other interaction, Blaine said. "That can act on the subconscious like a subtle form of hypnosis."

Not that there's anything wrong with a dove, a plume of smoke or a burst of fire. As long as it doesn't break magic's unwritten code: First, do no harm. Frightening neighborhood parents, however, is allowed.