

# Scientists advance the art of magic with a study of Penn and Teller's 'cups and balls' illusion

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Cognitive brain researchers have studied a magic trick filmed in magician duo Penn & Teller's theater in Las Vegas, to illuminate the neuroscience of illusion. Their results advance our understanding of how observers can be misdirected and will aid magicians as they work to improve their art.

The research team was led by Dr. Stephen Macknik, Director of the Laboratory of Behavioral Neurophysiology at Barrow Neurological Institute, in collaboration with fellow Barrow researchers Hector Rieiro and Dr. Susana Martinez-Conde, Director of the Laboratory of Visual Neuroscience. The study, titled "Perceptual elements in Penn and Teller's "Cups and Balls" magic trick" was published today, Feb 12th 2013, as part of the launch of *PeerJ*, a new peer reviewed open access journal in which all articles are freely available to everyone. "Cups and Balls," a magic [illusion](#) in which balls appear and disappear under the cover of cups, is one of the oldest magic tricks in history, with documented descriptions going back to Roman conjurers in 3 B.C. "But we still don't know how it really works in the brain," says Macknik, "because this is the first, long overdue, neuroscientific study of the trick."

The discovery concerns the way magicians manipulate human cognition and perception. The "Cups and Balls" trick has many variations, but the most common one uses three balls and three cups. The magician makes

the balls pass through the bottom of cups, jump from cup to cup, disappear from a cup and turn up elsewhere, turn into other objects, and so on. The cups are usually opaque and the balls brightly colored. Penn & Teller's variant is performed with three opaque and then with three transparent cups. "The transparent cups mean that visual information about the loading of the balls is readily available to the brain, yet still the spectators cannot see how the trick is done!" said Martinez-Conde.

Magicians have performed and systematically developed the art and theory of this illusion for thousands of years, but each new generation of conjurers offers new insights and hypotheses about how and why it works for the audience. Here the scientists turned the power of the scientific method to the illusion. The experiments tracked when and where observers looked during video clips portraying specific element of the performance, filmed by a NOVA scienceNOW TV crew. By quantifying how well observers tracked the loading and unloading of balls with and without transparent cups, the scientists determined that some aspects of the illusion were even more powerful at controlling attention than aspects originally predicted by the magician.

The end result is that cognitive scientists now have an improved understanding of how (and by how much) observers can be misdirected. In addition, this knowledge can help magicians further hone their art.

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