What Can Magicians Teach Us about the Brain?

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Neuroscience can learn a lot by tapping the intuitive knowledge of magicians as new sources for inspiration and study.

A magician tosses a ball into the air once, twice, three times. Suddenly, the ball vanishes in mid-flight. What happened?

Don't worry, the laws of physics haven't been broken. Magicians do not have supernatural powers; rather, they are masters of exploiting nuances of human perception, attention, and awareness. In light of this, a recent *Nature Reviews Neuroscience* paper, coauthored by a combination of neuroscientists (Stephen L. Macknik, Susana Martinez-Conde, both at the Barrows Neurological Institute) and magicians (Mac King, James Randi, Apollo Robbins, Teller, John Thompson), describes various ways magicians manipulate our perceptions, and proposes that these methods should inform and aid the neuroscientific study of attention and awareness.

Magicians Secrets Revealed

The underlying concept of using quirks in human perception to learn about how the mind works is an old one. Visual, auditory and multisensory illusions, in which people's perceptions contradict the physical properties of the stimuli, have long been used by psychologists to study the mechanisms of sensory processing. Magicians use such sensory illusions in their tricks, but they also heavily use cognitive illusions, manipulating people's attention, trains of logic and even memory. Although magicians probably haven't studied these phenomena with the scientific method - they don't do controlled experiments - their techniques have been tested over time, perfected by practice and performed under conditions of high scrutiny by skeptical audiences looking to spot the trick.

An example of a visual illusion used by magicians is spoon bending, in which a rigid horizontal spoon appears flexible when shaken up and down at a certain rate. This effect occurs because of how different parts of objects (in this case, the spoon) are represented in the brain. Certain neurons are responsive to the ends/corners of the object, whereas others respond to the bars/edges; the end-responsive neurons respond differently to motion than do the bar-responsive neurons, such that the ends and the center of the spoon seem misaligned when in motion.

Attention can greatly affect what we see - this fact has been demonstrated in psychological studies of inattentional blindness. To misdirect people's attention and create this effect, magicians have an arsenal of methods ranging from grand gestures (such as releasing a dove in the theater to distract attention), to more subtle techniques (for instance, using social miscues). An example of the latter can be found in the Vanishing Ball Illusion described at the start of this column. At the last toss, the magician does not actually release the ball from his or her hand. Crucially, however, the magician's gaze follows the trajectory the ball would have made had it been tossed. The magician's eye and head movement serves as a subtle social cue that (falsely) suggests a trajectory the audience then also expects. A recent study examining what factors produced this effect suggests that the miscuing of the attentional spotlight is the primary factor, and not the motion of the eyes. In fact, the eyes aren't fooled by this trick - they don't follow the illusory trajectory! Interestingly, comedy is also an important tool used by magicians to manipulate attention in time. In addition to adding to the entertainment value of the show, bouts of laughter can diffuse attention at critical time points.

Magicians can also manipulate the audience's memory, thus making it difficult to mentally reconstruct what happened. In the cognitive science literature, it is now established that providing misinformation about past events can reduce memory accuracy and create false memories, a fact magicians have intuitively known for centuries. Consider this trick: a person is shown pairs of photographs and asked to choose the more attractive face. After he makes a choice, the magician slyly switches several of the chosen faces for the rejected faces. Then, the subject is asked to explain his preferences. According to a recent experiment, even when people are shown faces they rejected, they still tend to invent explanations for why that face was more attractive. In other words, they make up a false narrative to explain away the sleight of hand they couldn't detect.

Magic's Role in Neuroscience

Cognitive neuroscience can explain many magic techniques; this article proposes, however, that neuroscientists should use magicians' knowledge to inform their research. For example, perhaps cognitive scientists could have learned about important false memory effects earlier if they had considered magicians' intuitions on the topic.

More concretely, the use of cognitive illusions - for example, during brain imaging - could serve to identify neural circuits underlying specific cognitive processes. They could also be used to map neural correlates of consciousness (the areas of the brain that are active when we are processing a given aspect of consciousness) by dissociating activity corresponding to processing of actual physical events from the activity corresponding to the conscious processing.

Indeed, scientists too often become too entrenched in their own circumscribed area of expertise; they do need reminding that a wealth of insight can be found in unexpected places. Recently, there has been an increasing acknowledgment by the scientific community of the insights that artists have had throughout the history about human perceptual mechanisms. For example, painters intuitively knew about pictorial depth cues and opponent processes in color perception long before these notions were established in vision science.

We wonder though, how practical this idea of using magic in research will turn out to be. Magicians spend years perfecting their skills. Will researchers be able to perform such tricks adequately? And most crucially, other than this paper's magician coauthors, will magicians give their secrets away to researchers?