KidsVUe • Issue One

NOW YOU SEE IT: THE COGNITIVE PSYCHOLOGY BEHIND MAGIC

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Published on: Feb 21, 2021

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ABSTRACT

Magicians provide a sense of wonder through their magic tricks. Magicians manipulate individuals' attention and perception to effectively perform their tricks. In this paper, we will use cognitive psychology to explain and understand common magic tricks such as the following: wave change card trick, cut-and-restored rope trick, and the vanishing ball illusion. These tricks utilize various cognitive concepts such as change blindness, Gestalt's principles of perceptual organization, and covert shifts of attention. Understanding these magic tricks provide a learning opportunity about cognition in terms of attention and perception.

INTRODUCTION

Have you ever wondered how magicians perform their tricks? It is difficult to follow what is actually going on during magicians' performances, which gives them the illusion of magic, but we can explain their tricks through concepts in psychology. Magicians achieve their goal through the manipulation of human attention and perception.

Attention is an individual's ability to focus on specific stimuli or locations in their environment. Magicians manipulate where an individual's attention is focused with various techniques, such as misdirection (Kuhn et al., 2008). Misdirection is a method of deception that lures the attention of individuals to one area to distract from another. Magicians create a high-attention area by presenting certain stimuli to capture the audience's attention, such as a rabbit suddenly popping out of a hat. However, they are completing the actual magic trick in the low-attention area that the audience is not focused on. Another method of misdirection is a psychological misdirection. Magicians lead the audience to believe that they can assume the outcome with various cues; however, their assumption causes them to falsely predict the outcomes.

Perception is an experience resulting from the stimulation of the senses. Errors in perception result in the production of illusions (Kuhn et al., 2008). Magicians create illusions to influence the perception of their audience, giving them the experience of seeing an impossible phenomenon while the methodology remains undetected.

Magicians provide a new opportunity to understand cognition from a new perspective. In this paper, we will use cognitive psychology to explain and understand three common magic tricks: wave change card trick, cut-and-restored rope trick, and vanishing ball illusion.

WAVE CHANGE CARD TRICK

Magicians take advantage of our tendency to pay attention to one thing at a time by misdirecting their audiences. When our attention is misdirected, we easily miss the changes that occur in a given location. If a rabbit suddenly pops out of a hat, it immediately captures the audience's attention, allowing for a sneaky maneuver to occur somewhere else. The audience experiences change blindness, which is when an observer fails to detect relatively large changes in visual scenes (Rensink, 2002). Take for instance, the wave change card trick. One card changes into another, by a flick of a finger, as the cards move up and down like a wave (see **Fig. 1**).

How does a trick that occurs in plain sight cause change blindness? The answer lies in the swift change of direction. Scientists conducted an experiment to investigate if a sudden directional change increases the likelihood of change blindness (Yao et al., 2019). Subjects were asked to detect a directional change of an item in a series of Gabor patches as it traveled in an L-shaped route across a screen (see **Fig. 2**). Gabor patches are a pattern that resemble blurry lines in front of a grey background (see illustration in **Fig. 2**), often used as visual stimuli in experiments because of their ability to produce optical illusions. A randomly chosen patch underwent a 15 degree rotational change and subjects were tasked with determining which patch rotated. Subjects more accurately noticed the change if it occurred as the patches moved in a straight line, but missed it more often if it occurred as the patches changed directions at the corner of the “L.” Likewise, making the card switch as the direction of the wave changes disguises the change to the audience. Motion-induced change blindness is often used in stage magic to distract an audience and change an object right in front of them.

CUT-AND-RESTORED ROPE TRICK

Another magic trick that can be explained by the principles of cognitive psychology is the classic “cut-and-restored rope” trick. Have you ever seen a magician cut a piece of rope, and then somehow restore it to one piece with a simple hand movement? He does this by exploiting people’s assumption that the rope was cut equally in half, when it was really cut just a few inches from the end, resulting in one long

piece and one very short piece, but with the position of his hand preventing the audience from seeing that (see **Fig. 3a**). When he then moves his hand and reveals the “restored” rope, he is still showing them the longer piece of rope together with the shorter piece of rope, just held in a different position (see **Fig. 3b**). Because the audience originally assumed that the rope was cut in two equal pieces, this seemingly impossible feat looks like magic.

Now that you understand how magicians accomplish this trick, it probably seems obvious that the rope was cut into unequal pieces. So why do people automatically assume that it was cut in half? According to Barnhart (2010), their perception of the rope can be explained by Gestalt’s principles of perceptual organization, a set of rules that explain how elements of a display are grouped together. The Gestalt law of *pragnanz*, or the principle of simplicity, states that patterns are typically perceived as having a structure that is as simple as possible (Helson, 1933). In this trick, given the way the magician holds the ropes in his hand, the possibility of two equal-length ropes is simpler than the possibility of two unequal-length ropes held one on top of the other. Therefore, the audience perceives the ropes as equal lengths because it is the simplest interpretation of the situation. Another Gestalt principle that influences the audience’s perception is the principle of continuity, which states that objects that are overlapped by other objects are typically perceived as continuous. In this trick, the overlapping object is the magician’s hand; after “restoring” the rope, the magician’s hand obscures the break between the longer and shorter pieces of rope (see Figure 3b). Therefore, due to the principle of continuity, people perceive the two pieces of rope as continuous, when in reality they are not.

The Gestalt principles of simplicity and continuity are present in a variety of classic magic tricks. They cause people to make assumptions about their perception of objects, which is easily manipulated to create the illusion of magic.

VANISHING BALL ILLUSION

Another trick that plays with our perception is the vanishing ball illusion. The magician begins by tossing a ball into the air a few times then, on the final toss, the observers watch in amazement as the ball appears to disappear midair. In actuality, on the last toss the ball never leaves the performers hand. So, why does the ball appear to rise then disappear? Kuhn and Land (2006) studied this illusion by having subjects watch two videos of the trick. In the first video, after the final “toss”, the performer’s head and eyes follow the path that the ball would have taken had it been released into the air. In the second, the performer’s eyes remain on the hand concealing the ball. They found that with the video where the magician’s eyes followed the expected path of the ball, 68% of observers claimed to see the ball disappear midair, a significantly higher number compared to the video without the head and eye movements. Their results reveal that the key component that works to trick the observer's perception is the social cues (the head and eye movements) exhibited by the magician.

Kuhn and Land (2006) also tracked the participants’ eye movements as they watched the illusion. They found that although participants claim to have seen the ball rise, their eyes were not fooled; when the ball was not released, their eyes remained trained near the hand and did not rise to the place where they believed the ball had disappeared. These results reveal that this illusion functions through a covert shift of attention, which is when the mind’s attention shifts while the eyes remain still

(Goldstein, 2019). In this case, the brain attends to the area where the ball was believed to have disappeared despite the eyes not moving to that area. It's believed that this occurs due to the implied motion created by the magician's social cues, which activates neural pathways similar to the ones active during real motion, tricking the brain into perceiving motion of the ball (Macknik et al, 2008).

CONCLUSION

The wave change card trick, cut-and-restored rope trick, and vanishing ball illusion are just three examples of the many ways magicians creatively use the principles of cognitive psychology to amaze their audiences. From change blindness, to Gestalt's principles of perceptual organization, to covert shifts of attention, cognitive science allows magicians to manipulate people's perception and create incredible illusions. These tricks provide meaningful insights into the inner workings of our minds, and are therefore a great source of ongoing research for cognitive psychologists interested in human perception, attention, and cognition. Next time you see any type of magic performance, take a moment to think about how science is influencing your perception. Maybe you will be able to figure out how the magician is performing his trick based on what you've now learned about the science of magic.

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Caroline Marone is a student at Vanderbilt University studying psychology and business. After graduation, she is planning to pursue a career in business but hopes to use the skills and knowledge learned in her psychology studies throughout both her personal and professional life. Some of her

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