Illusion Chasers

The Neuroscience of Slydini's Paper Balls-to-Hat Magic Trick

Just as our visual system strains to see the vase and the two faces at once, we struggle to conceive of a motion that has a dual motivation: to put and to fetch.

By Susana Martinez-Conde on April 27, 2015

The magician's hand partially occludes (left) either two long ropes (middle) or one long rope and one short rope (right). Spectators tend to prefer the two-long-ropes interpretation, which is statistically more likely in normal circumstances.

Ambiguous images –like where people see either a vase or two faces in the same picture –show that information arriving to our visual system is not clear-cut, and can be interpreted in many ways. Scientist and magician Anthony Barnhart proposed that many magic tricks rely on perceptual Gestalt principles–like accidental alignments and good continuations. Close-up rope tricks and grand stage illusions such as cutting the

woman in half depend on the audience segregating figure from ground in specific and contrived ways that do not match reality.

A paper by Van de Cruys, Wagemans and Ekroll, just published in i-Perception, applies this idea of perceptual ambiguity to the exploitation of equivocal hand motions by magicians. Master magician Tony Slydini's paperballs-to-hat magic trick is a case example.

In this trick, Slydini makes several paper balls disappear, only to reveal at the end of the performance that they are inside of a hat that was shown to be previously empty. Slydini's technique is superb, but the illusion would not work without a critical element: our visual system's inability to assign two meanings to the same action.

In our 2008 *Nature Reviews Neuroscience* paper about the neuroscience of magic, which Stephen Macknik and I co-authored with magicians Teller, Apollo Robbins, James Randi, Mac King, and Johnny Thompson, we posited that "an action is a motion that has a purpose":

> *During the execution of a magic trick, it is necessary to use unnatural actions. Thus, the magician needs to reduce the audience's suspicion about such actions. One way to do this is to justify unnatural actions so that they*

seem natural. Teller refers to this principle with the aphorism, "An action is a motion with a purpose." In everyday life we categorize the motions made by others by interpreting their intentions. If we see somebody pushing their glasses higher on the bridge of their nose, we assume that the glasses needed adjustment, and no further interpretations is made. A good magician makes use of such innocent actions to hide ulterior motions in a process called 'informing the motion'. For instance, magicians with a mute onstage persona, like Teller, can take advantage of the glasses-pushing action to discreetly hide a small object in their mouth (being mute, they have no lines to garble). A less clever magician might do the same motion (moving the hand over the mouth) without informing it with a purpose (adjusting one's glasses). Such a motion will be subject to suspicion and scrutiny. In that case, even if the spectators have not seen exactly how the trick works, they might feel that something is amiss. The skilled magician informs every motion with a convincing intention.

Van de Cruys and colleagues extend this notion of a "motion with a purpose" to motions that have a *double* purpose. In such cases, if one of the motion's purposes, no matter how outlandish, is apparent to the audience, they will look no further.

SPOILER ALERT! THE SECTION BELOW DESCRIBES A MAGIC SECRET, READ NO FURTHER IF YOU DON'T WANT TO FIND OUT

Slydini deposits the vanished paper balls into the hat when he reaches inside the hat to fetch invisible magic dust. This mock action prevents the audience from assigning an additional, key intent to the move: to unload the paper balls inside the hat, to later reveal them at the trick's finale.

The i-Perception paper authors draw a parallel between Slydini's confusing hand motions and the principles of figure-ground segregation in classical ambiguous figures, such as the famous image containing a vase versus two faces.

Just as our visual system strains to see the

vase and the two faces at once, we struggle to conceive of a motion that has a dual motivation: to put and to fetch. Even when it should be apparent to every member of the audience, and to every YouTube viewer, that Slydini's action of fetching magical powder inside the hat must be a ruse.

The ambiguous contours in (a) can belong to a vase (b), to two faces (c), or to both vase and faces at once (d). Our brain tends to avoid a double-assignment interpretation, however (d). Similarly, Slydini's hand motion in and out of the hat (e) can involve putting something into the hat (f), fetching something from the hat (g), or putting and fetching at once (h). Our brain avoids the double-assignment interpretation of the movement (h) in much the same way as in the figure-ground of static ambiguous images (d).

In other words, even when the ostensible purpose is preposterous, we still can't consider an alternative explanation.

That's how bad our brains are at multitasking.

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