There’s more to magic than meets the eye

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Our perception of an event is often modulated by our past experience and expectations [1,2]. Here we used a magic trick [3] to demonstrate how magicians can distort our subjective perception and we investigate the mechanisms behind this deception. We found that when a magician performed an illusion in which a ball was seen to vanish in the air, 63% of observers perceived the ball leave his hand, move upwards, and disappear even though the ball did not leave the magician’s hand. Moreover, observers’ illusory perception of the ball was determined by cues that indicated the ball’s location, namely the magician’s head direction, rather than the percept itself. Furthermore, eye movement records revealed participants’ strategic use of social cues prior to looking at the ball. Surprisingly, however, when the ball was not physically present, observers did not look at the area where they claimed to have seen the ball vanish, suggesting that the oculomotor system was not fooled by the illusion. These results show that although people’s subjective percept is determined by expectations, the oculomotor system is largely driven by accurate bottom-up information, which is consistent with the suggestion that there are separate mechanisms for perception and visuomotor control [4].

A striking example of magicians’ deception is the vanishing ball illusion, in which a ball apparently disappears in mid air. This illusion is created by pretending to throw a ball up in the air, when in fact it remains secretly palmed in the magician’s hand [3]. If done convincingly, the observer should perceive the ball as moving up in the air even though it is no longer physically present. Similarly, when observers view a moving object that suddenly disappears, the final position of the object is usually perceived as being further along the path of motion than its actual final position [5], a phenomenon known as representational momentum [6]. Much of the magician’s deception relies on social cuing, in terms of his head and gaze direction, and we therefore predicted that the effectiveness of the vanishing ball illusion would be influenced by the magician’s social cuing.

Two different versions of the trick were created that addressed the extent to which the magician’s social cues are responsible for the illusion. In the social cues pro-illusion condition, on the final ‘fake’ throw, the magician’s eyes and head followed an imaginary ball moving upwards (Figure 1 and Supplemental data available on-line with this issue). In the social cues anti-illusion condition, the magic trick was identical except that on the final ‘fake’ throw, the magician looked at the hand concealing the ball, rather than following the imaginary ball (see Figure 2F). We also measured people’s eye movements while they watched the video of the trick, to gain an online measure of the information obtained by the visual system. Immediately after having seen the magic trick, participants were questioned as to whether they perceived the ‘illusory ball’ moving towards the top of the screen on the final throw.

Participants who perceived the illusory ball had a vivid recollection of seeing the ball leave the screen at the top, and typically claimed
that the illusion was created by someone catching it beyond the top of the screen. 68% of the participants in the social cues pro-illusion condition experienced the illusion, significantly more than in the social cues anti-illusion condition (32%, χ² = 5.16, p = 0.025), thus demonstrating that the illusion was mediated by the social cuing.

Most of the participants claimed that they spent their entire time looking at the ball. However, these reports deviated strongly from where they were actually looking. Figure 1 shows a timeline indicating where participants were looking during the magic trick. We found a very high consistency in the eye movement patterns between the participants, suggesting that people employed similar eye movement strategies. On throws where the ball was visible, participants generally looked at the ball once it reached the apex. But rather than merely tracking the ball, most of the participants glanced at the magician’s face before looking at the ball, indicating that the visual system uses information about where the magician is looking as a way of predicting the location of the ball.

Our results show that an observer’s percept was driven by the magician’s social cuing, and that participants utilized the magician’s social cues. However, there was a surprising difference in the susceptibility of these two systems to the illusion. On the final illusory throw, most participants claimed to have seen the ball at the top of the screen. The oculomotor system on the other hand was not fooled by the illusion. Figure 2 shows that participants only looked at the top of the screen when the ball was physically present. These results illustrate a remarkable dissociation between what participants claimed to have seen and the way in which their eyes behaved. Whilst their percept was predominantly based on expectations, their eyes were largely driven by the actual visual input. Our results offer a striking example of how the dissociation between vision for perception and action, well documented in neurological patients [4,7,8] and neurologically intact subjects [9], also translates to more real world situations.

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Supplemental data
Supplemental data including experimental procedures and video clips are available at http://www.current-biology.com/cgi/content/full/16/22/R950/DC1

References