Manifest Illusions

A Reply to Axel Kohler

Heiko Hecht

The notion of illusion as a discrepancy between physical stimulus and percept (here referred to as illusion$_d$, as long as merely this "error" is meant) is unable to capture the four very different cases in which illusions can arise. The observer may or may not be aware of the discrepancy, and its magnitude may be large or small. I argue that the special case of small error paired with awareness deserves special attention. Only in this case does the observer readily see the illusion, since it becomes manifest (referred to as illusion$_m$). Illusion$_m$ is a meaningful category even in cases where illusion$_d$ cannot be determined. Illusions$_m$ of apparent motion and illusions of intuitive physics are solicited.

Keywords
Apparent motion | Illusion | Illusion$_m$ | Intuitive physics | Manifest illusions | Relational properties | Underspecification problem

Author

Heiko Hecht
hecht@uni-mainz.de
Johannes Gutenberg-Universität
Mainz, Germany

Commentator

Axel Kohler
axelkohler@web.de
Universität Osnabrück
Osnabrück, Germany

Editors

Thomas Metzinger
metzinger@uni-mainz.de
Johannes Gutenberg-Universität
Mainz, Germany

Jennifer M. Windt
jennifer.windt@monash.edu
Monash University
Melbourne, Australia

1 The concept of illusion

Axel Kohler points out that illusions understood as discrepancy between physical stimulus and percept (illusion$_d$) have inspired progress in the history of experimental psychology. At first glance, this seems to be rather obvious. However, to define a discrepancy, one must have two comparable measures of the same thing. But this is often not the case. Take a given lamp that looks very dim to us during the day but blindingly bright at night. How bright is the stimulus really? We are unable to determine which of the two cases is more illusory$_d$. The perceiver does not normally notice the illusion$_d$. Apparent motion, in contrast, which has been a very influential paradigm, is more than mere illusion$_d$. By differentiating illusions into illusion$_d$ and illusion$_m$, I am able to point out a strange inconsistency between the amount of error contained in an illusion and the perceptual conspicuity of this error. I argue that there are four varieties of discrepancy between physical stimulus and the related percept (illusion$_d$). They can be grouped by the size of the discrepancy and the degree of awareness (see Figure 1). First, there are more or less subtle discrepancies that are ubiquitous and go unnoticed most of the time. In rare occasions, and usually triggered by a revealing piece of contradiction, they are noticed (illusion$_m$). The second variety consists of very large discrepancies, such as found in many intuitive physics examples. For instance, a water surface may look fine even if it extends impossibly at a large angle from the horizontal. For instance, when asked to draw the surface level that water assumes in a tilted beaker, observers err as if they did not know that water remains parallel to the ground. And the more expert they become at avoiding spills, the larger the error becomes. Experienced bartenders produce the largest errors (see Hecht & Proffitt 1995). The perception of relational properties discussed in the target article falls into this category. Here the perceptual error can be enormous and still go unnoticed. Typically, we need to consult physics books and learn about a physical stimulus before we are convinced that our perception is erroneous. When conceiving of illusion as mere illusion$_d$, we fail to honor the special case of illusion$_m$. Illusions$_d$ are ubiquitous. As a matter of fact, the core discipline of sensory psychology—psychophysics—can be thought of as the formal description of how a physical stimulus differs from its percept. It does so all the time. Illusions$_m$ are a special case. They may warn the organism about where adjustments to the perceptual system are necessary in order to avoid potentially dangerous misjudgments. Or they may just be occasions where the perceptual system fails to suppress the perceptual process that has lost out in the competition to resolve the underspecification problem.

2 Apparent motion (AM)

I thank Axel Kohler for bringing up AM (apparent motion) as an example of how seminal an illusion can be for research. I do concur that it continues to be a fascinating phenomenon. However, I believe that AM did not fascinate Wertheimer (1912) because it is an illusion$_d$, but rather because it is predominantly an illusion$_m$. Note that the timing has to be just so (i.e., a particular combination of on-times and ISI, inter-stimuli-intervals) in order to perceive what he called phi-motion: perfectly smooth motion practically indistinguishable from real motion. Most of his experiments and demonstrations have in fact worked with suboptimal cases in which the perceived motion is bumpy or faint. In all these other cases of AM, the illusory nature of the percept becomes manifest. The bistable quartet is another beautiful case of an illusion$_m$. The mere fact that the percept can flip at will shows the illusion$_m$ to be manifest.

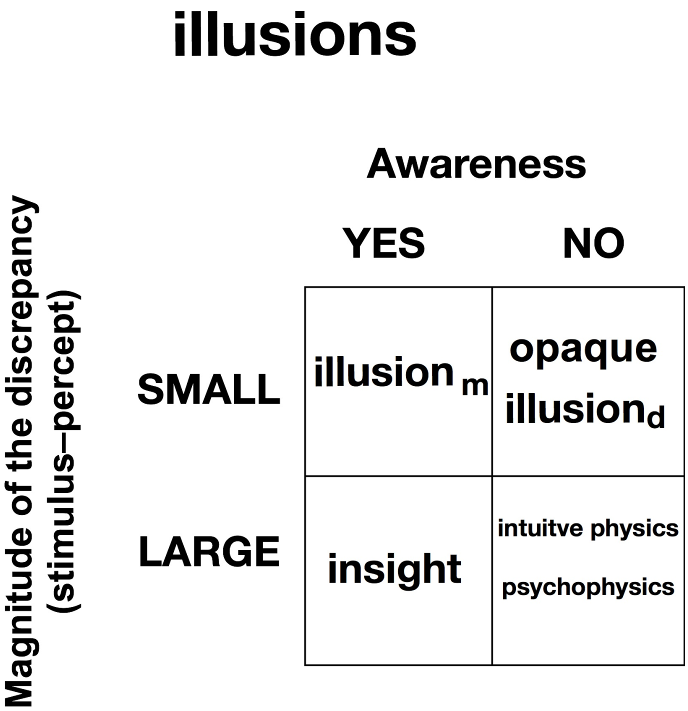

Figure 1: Varieties of illusions.

As an aside, the Gestalt laws can be understood as an attempt to describe how the percept emerges from the given physical stimulus. But note that while the percept is always different from the physical stimulus, it should not be thought of as illusory just because it is the outcome of a Gestalt process. When I said that Gestalt psychologists have "avoided the term illusion" I was not expecting anyone to count the occurrences of the term in Wertheimer's 1912 paper. He did use the term. I stand corrected. Note, however, that he put the term "Täuschung" in quotation marks the first time he used it, well aware that the phenomenal experience of motion is what makes the Gestalt, regardless of how it relates to the physical stimulus.

Another revealing aspect of AM is its power to reveal the extent to which world-knowledge is factored into our perception, unconsciously and the more so the less well-defined the stimulus. Let us consider a classic AM-display in which two rectangles at two locations and at different orientations are shown in alternation. Whenever the ISI is short (say 100ms), we see one rectangle moving on a straight path and changing its orientation concurrently. If, however, the ISI is lengthened (to, say, 500ms), then the AM-path curves (see McBeath & Shepard 1989; Hecht & Proffitt 1991). The phenomenal quality of this motion is rather ephemeral. We immediately see that the motion is not distinct but fraught with uncertainty. When choosing intermediate ISI, and forcing observers to make up their minds, some observers will see the rectangle curve and others will see it move along a straight path. And when the display remains unchanged but the area between the rectangles is shaded, then the rectangle appears to move along the shaded path. Thus, one can direct the motion of the rectangle along almost arbitrary paths (e.g., Shepard & Zare 1983). Such demonstrations reveal that the very notion of error or discrepancy between physical stimulus and percept becomes shaky. It seems rather arbitrary whether the researcher considers only the rectangles to be the relevant stimulus or also considers the background to be part of the stimulus. In these AM displays, the visual system appears to make sense of the entire display, not just the two moving rectangles.

3 The case for illusion$_{\mathrm{m}}$

Such resolution of the underspecification problem can even annihilate an existing illusion$_{\mathrm{d}}$. Consider the sophisticated AM display we encounter when going to the movies. And let us take the old-fashioned kind, where the projection screen is black most of the time, only interrupted 24 times a second by a very brief flash of a stationary picture. Smooth motion is perceived. Here, the observer is typically unaware of the illusion$_{\mathrm{d}}$, but what is perceived is actually closer to the original scene than to the movie that was made from it. We might even entertain the idea that there is no illusion$_{\mathrm{d}}$, since the percept is very close to the original scene that was filmed. Now, calling apparent motion illusory$_{\mathrm{d}}$ when dealing with artificial or computer-generated stimuli, but veridical when dealing with a movie, does not seem to make much sense. This is because, in a very deep sense, the visual system has no way of distinguishing between actual motion and snapshot motion. The hardware we use to detect motion is built such that it is unable to differentiate between the two. Basically, the detector for motion is designed such that successive excitations of the receptive fields of two motion-sensitive neurons lead to the impression of motion. These Reichardt/Hassenstein detectors (Hassenstein & Reichardt 1956) are discrete; they cannot tell the difference between continuous and stroboscopic motion (see e.g., Hecht 2006). Note that this holds for phi-motion but falls apart when ISI or duty cycle are changed.

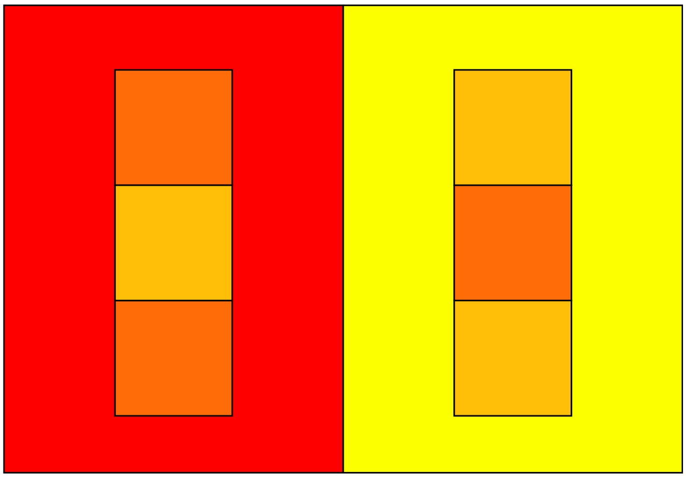

Figure 2: Simultaneous color contrast: The orange and the yellow squares are of the same respective color in the panel on the left and on the right.

Let us now look at an example from the color domain to further challenge the notion of illusion$_{\mathrm{d}}$. The phenomenon of color constancy lets us perceive the same color even if the ambient lighting changes dramatically. We see an object as blue regardless of whether the room is lit by a neon light or by sunlight. It would not make sense to call the percept of “blue” an illusion$_{\mathrm{d}}$ under neon light when the ambient lighting is such that the object mainly reflects wave lengths of say 500 nm and to call it veridical when it is lit by sunlight such that the dominant wavelength is 450 nm. In both cases, the object appears blue. We cannot determine in principle which of the two cases deserves the name illusion$_d$, if any, or if both deserve to be called illusion$_d$. In contrast, when the two cases are juxtaposed, an illusion$_m$ becomes manifest. In Figure 2, the center inner square surrounded by red on the left and the outer squares surrounded by yellow on the right are of an identical color, as becomes manifest when occluding the surrounds. Thus, illusion$_m$ becomes apparent, but illusion$_d$ cannot be defined in any meaningful way.

4 Conclusion

In sum, the role of illusions in vision research has historically been very important. The beginnings of experimental psychology have attempted to measure illusions$_d$ in terms of the discrepancy or error between physical stimulus and percept. I have attempted to show that this error is neither substantial enough to serve as a definition of illusion, nor particularly fascinating. Instead, illusions$_d$ are as ubiquitous as they are typically unnoticed or indeterminate. In contrast, the cases that engage our imagination usually are manifest illusions$_m$. The latter can be defined even in cases where it is not meaningful to speak of illusion$_d$.

References

Hassenstein, B. & Reichardt, W. E. (1956). Systemtheoretische Analyse der Zeit-, Reihenfolgen- und Vorzeichenauswertung bei der Bewegungsperzeption des Rüsselkäfers Chlorophanus. *Zeitschrift für Naturforschung*, *11b*, 513-524.

Hecht, H. (2006). Zeitwahrnehmung als Bewegungswahrnehmung. In N. Mewis & S. Schlag (Eds.) *Zeit* (pp. 61-78). Mainz, GER: Leo-Druck.

Hecht, H. & Proffitt, D. R. (1991). Apparent extended body motions in depth. *Journal of Experimental Psychology: Human Perception and Performance*, *17* (4), 1090-1103. 10.1037/0096-1523.17.4.1090

——— (1995). The price of expertise: Effects of experience on the water-level task. *Psychological Science*, *6* (2), 90-95.

McBeath, M. K. & Shepard, R. N. (1989). Apparent motion between shapes differing in location and orientation: A window technique for estimating path curvature. *Perception & Psychophysics*, *46* (4), 333-337.

Shepard, R. N. & Zare, S. L. (1983). Path-guided apparent motion. *Science*, *220* (4597), 632-634.

Wertheimer, M. (1912). Experimentelle Studien über das Sehen von Bewegung. *Zeitschrift für Psychologie*, *61* (1), 161-265.