

# Visual illusions: brain and consciousness

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Visual illusions represent ideal means for testing empirical questions on the neurobiology of vision and underlying cognitive processes. Even though we are aware of being tricked by these patterns, we most often cannot overcome the illusory effects. Thus, what is the role of consciousness in the perception of visual illusions?

## 1 What are illusions and why study them?

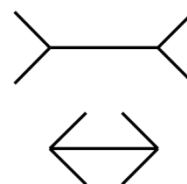
In his review on illusions David Eagleman assumed that *“The complex structure of the visual system is sometimes exposed by its illusions”* and further *“The act of ‘seeing’ seems so effortless that it is difficult to appreciate the vastly sophisticated – and poorly understood – machinery that underlies the process”* (p920)[1]. But, what are illusions and why should we study them? According to Bachmann and colleagues [2] illusions are *“In general terms, [...] generated by physiological and/or psychological processes yielding in awareness phenomenal properties of an object or scene which are noticeably discrepant from their physical or factual properties.”* (p54). Visual illusions are not just entertaining phenomena but represent a powerful window into the neurobiology of vision [1]. In more detail, they are not just entertaining misperceptions [3], no subjective perversions of the contents of objective perceptions [4], they rather represent guesses or predictive hypotheses by the visual system of what may be out there in the visual scene [5], and resemble good adaptations of the visual system to standard viewing situations [6]. Gestaltists argue that mismatches between stimulus and percept, as described in the definition above, serve as evidence of how the brain processes visual information [overview in 7]. In this sense visual illusions serve as noninvasive tools for studying the neural mechanisms underlying visual perception and may therefore reveal the limitations *and* creative abilities of the visual system [7]. As a consequence, using illusions we are able to study the brain in healthy participants without the need of neurological patients. Finally, (visual) illusions have led to new experimental techniques [3]. However, it is easy to formulate a theory that is consistent with correct perception, but it is rather challenging to have a theory at hand that is capable of predicting the failures *and* successes of the visual system [8]. Nonetheless, Robinson also stated that the practical importance should not be overestimated, since most perceptual environments are too rich to give rise to an illusory percept

[8]. *“Thus, visual illusions occur as the extremes of visual perception.”* (p2)[3]. A comprehensive collection of illusory phenomena within the visual domain and possible explanations thereof will soon be available [9].

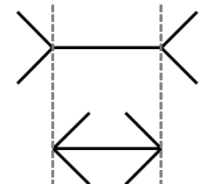
## 2 The human brain and consciousness

When we try to investigate the human brain with visual illusions, we need to go beyond the information given. Gestalt psychologists would say in other words, that the whole is more than just the sum of its parts [10]. This is what makes illusions so fascinating, since they seem to contain more information than is physically present (e.g., in ambiguous figures). Even more impressive is that we might be tricked by such phenomena even though we are aware of the fact that we *are* perceptually tricked, but cannot interpret the scene/object as it physically is (Fig. 1 and Fig. 2).

Mueller-Lyer illusion



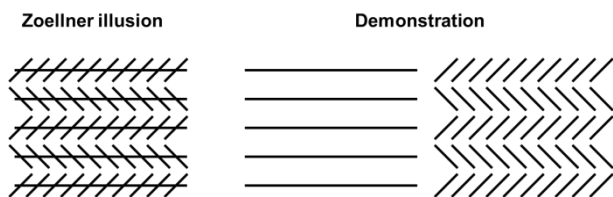
Demonstration



**Fig. 1** Even though the observer might be aware of the illusory effect and that the two horizontal lines in the Mueller-Lyer illusion are physically equal in length (right), the perception is still that the upper line is longer than the lower one (left).

Hamburger and colleagues for example stated in an empirical work on geometric-optical illusions that *“the results show that our conscious percept is affected similarly for both isoluminance and luminance conditions, suggesting that the joint processing for chromatic and luminance defined contours extends well beyond early visual areas.”* (p3284)[11]. Such findings also might have conse-

quences for our understanding of consciousness and reality.



**Fig. 2** In the Zoellner illusion the five horizontal lines are straight and parallel, but are perceived as being tilted either in clockwise or counter-clockwise direction (left). This is not the case when the horizontal lines (center) and the physically tilted lines are presented in isolation (right).

What is real? What I perceive, or what is physically out there in the world? The definition on illusions and consciousness provided above states that illusions lead to phenomenal properties in awareness that differ from the physical or factual content given [2]. This, however, does not mean that the true or real content of a scene/object is any better (more real or more valuable) than the subjective impression of the perceiver. Thus, visual illusions need to be discussed even more within the context of consciousness research. On a more philosophical than empirical side it is currently also heavily discussed whether consciousness is an illusion or not [12]. From a perceptual view the term illusion is inappropriate in such a discussion, since an illusion is characterized by a physical content that is misinterpreted or misrepresented. But, if consciousness is nothing special, just a function or an epi-phenomenon created by the human brain, it should rather be treated as a hallucination instead of as an illusion, since the physical or factual properties outside the human body are then absent.

### 3 A cautious look into the future

Based on the findings of recent research with and on visual illusions it might be important to establish a new classification system for visual illusions. Classical works on categorizing illusions were thus far mainly based on phenomena (e.g., lightness illusions, geometric-optical illusions, ambiguous figures, impossible figures and perspective illusions, color illusions, motion illusions)[13-17]. The task has become a different one now: we are in need of a classification system based on the underlying neural processes. Such a classification system may for example be valuable for diagnostics of lesions (from retina to striate and extrastriate cortex)[3]. Therefore, illusions should not only be presented for entertainment or investigated (to find out how the visual system processes them and how and why it fails), but we also need to create new illusory phenomena based on our knowledge about the visual system and the brain

in order to fully understand its functions and its malfunctions. To conclude, illusions might not only serve as a powerful tool for the investigation of the neurobiology of the brain (vision), but might also represent valuable tools for the investigation and a better understanding of human "consciousness".

### 4 Acknowledgement

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