New Ideas in Psychology 36 (2015) 1–9

Contents lists available at ScienceDirect

New Ideas in Psychology

journal homepage: www.elsevier.com/locate/newideapsych

# Visual illusions and direct perception: Elaborating on Gibson's insights

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*Keywords:*
Visual illusions
Ecological psychology
Individual differences
Visual perception
Perceptual information

A B S T R A C T

Gibson argued that illusory pictorial displays contain “inadequate” information (1966, p. 288) but also that a “very special kind of selective attention” (p. 313) can dispel the illusion—suggesting that adequate perceptual information could in fact be potentially available to observers. The present paper describes Gibson's treatment of geometrical illusions and reviews pertinent empirical evidence. Interestingly, Gibson's insights have been corroborated by recent findings of inter- and intra-observer variability in susceptibility to visual illusions as a function of culture, learning and task. It is argued that these findings require a modification of the general Gibsonian principle of perception as the detection of specifying information. Withagen and Chemero's (2009) evolutionary motivated reconceptualization of perception predicts observers' use of both specifying *and* non-specifying information and inter- and intra-observer variability therein. Based on this reconceptualization we develop an ecological approach to visual illusions that explains differential illusion effects in terms of the optical variable(s) detected.



## 1. Introduction

Geometrical illusions can produce striking alterations of perceived size, shape, orientation or position. In the Müller–Lyer illusion, for example, two equally long lines surrounded by pairs of acute and obtuse angles appear unequal in length, while a ruler reveals that they are not (see Fig. 1a). Indirect perceptionists have often claimed that illusions refute Gibson's (1966, 1979/1986) theory of direct perception (e.g., Fodor & Pylyshyn, 1981; Gregory, 1997; Rock, 1997; Ullman, 1980). However, Gibson did provide an account of illusions, particularly in the context of his extensive analysis of picture perception (see Gibson, 1966, 1971, 1978, 1979/1986; Gombrich, Arnheim, & Gibson, 1971; see also, Gibson, 1970). This paper describes Gibson's treatment of illusions in detail and reviews pertinent recent empirical evidence. It will be argued that although the evidence is in keeping with Gibson's treatment of illusions, it does not accord well with the more general Gibsonian conceptualization of perception as the detection of specifying information. Withagen and Chemero (Chemero, 2009; Withagen, 2004; Withagen & Chemero, 2009) have recently developed an evolutionary motivated reconceptualization of information and perception that lets go of a strict specificity principle but maintains the premise of observers' direct access to optical variables. In contrast

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http://dx.doi.org/10.1016/j.newideapsych.2014.07.001
0732-118X/

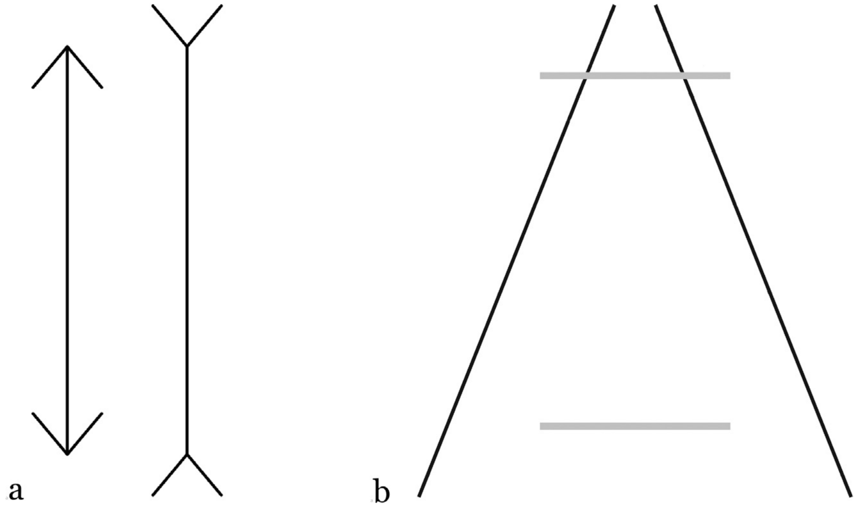


**Fig. 1.** The Müller–Lyer (a) and Ponzo (b) illusions.

with Gibson, these authors argue that perception typically relies on the detection of both specifying variables and variables that merely correlate with the to-be-perceived property. Moreover, their approach explicitly predicts variability between and within observers in what optical variables are picked up. Based on this work, we develop an ecological approach to visual illusions that explains differential effects of illusions in terms of the optical variable(s) detected by the observer. Our discussion will start with a comparison of indirect approaches to perception and Gibson's theory of direct perception.

## 2. Direct and indirect approaches to visual perception

Most theories of perception (e.g., Brunswik, 1956; Fodor & Pylyshyn, 1981; Helmholtz, 1878/1971; Knill & Richards, 1996; Koffka, 1935; Neisser, 1967; Purves, Wojtach, & Beau Lotto, 2011; Rock, 1997; Ullman, 1980) assume that the energy patterns impinging on the senses underspecify the environment and therefore cannot form the sole source of information about the environment. The retinal image of objects, for example, varies with the shape and orientation of the object and the observer's distance to it. Thus, one and the same environmental situation can cause different retinal images. Conversely, one retinal image can be caused by more than one environmental situation. Indirect approaches to perception address the problem of ambiguity in the relationship between the stimulus information available from the retina and its cause in the environment by proposing that the visual system actively constructs a meaningful percept of the environment by inferring the environmental cause of the stimulus information. In this process, the impoverished stimulus information that arrives at the senses is enriched with knowledge from biases, expectations, and assumptions based on prior visual experience. Thus, in the indirect view perception is not of the environment itself but of a mental representation of the environment, fabricated by- and residing in the brain. Taking the indirect position to its extreme, Gregory (1998) claimed that we “[...] carry in our heads predictive hypotheses of the external world of objects and of ourselves. These brain-based hypotheses of perception are our most immediate reality” (p. 1693).

The assertion that perception requires inference runs the risk of having to introduce a homunculus inside the brain—someone or something to infer the cause of the stimulus information—which would lead to an infinite regress; inside the brain of the homunculus another homunculus would be required to attribute meaning to the stimulus information, and so on. Furthermore, perception based on inference seems possible only when one already knows what there is to be perceived, which begs the question of how this knowledge was attained in the first place (Gibson, 1979/1986; Shaw, Turvey, & Mace, 1982; Warren, 2005).

In developing an alternative to the theory of indirect perception that avoids these conceptual problems, Gibson (1950, 1966, 1979/1986) asserted that humans do have direct access to the environment. To this end, he introduced the concept of information as specification, which holds that there is a lawful one-to-one relation between optical variables in the ambient energy array (i.e., the pattern of light that is reflected by the environment) and the properties of the environment or the “organism–environment relation” (see also Turvey, Shaw, Reed, & Mace, 1981). Typically, but not necessarily, optical variables become available as a result of movement of the organism or of the environment. For example, the direction in which a moving observer is heading is specified by the locus of the global expansion pattern in the ambient energy array (Gibson, 1958), and approaching objects bring about local expansion patterns of which the relative rate of change specifies the time-to-contact between the object and the perceiver (Lee, 1976). As an example of optical variables present in static ambient energy arrays, texture gradients specify the relative size of objects (Gibson, 1966).

Thus, unlike the stimulus information available from the retinal image, optical variables do not relate ambiguously