# Vision Without Inversion of the Retinal Image: A Classic Article in the History of Psychology

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## Perceptual Learning Reconfigures the Effects of Visual Adaptation

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**Our sensory experiences over a range of different timescales shape our perception of the environment. Two particularly striking short-term forms of plasticity with manifestly different time courses and perceptual consequences are those caused by visual adaptation and perceptual learning. Although conventionally treated as distinct forms of experience-dependent plasticity, their neural mechanisms and perceptual consequences have become increasingly blurred, raising the possibility that they might interact. To optimize our chances of finding a functionally meaningful interaction between learning and adaptation, we examined in humans the perceptual consequences of learning a fine discrimination task while adapting the neurons that carry most information for performing this task. Learning improved discriminative accuracy to a level that ultimately surpassed that in an unadapted state. This remarkable improvement came at a price: adapting directions that before learning had little effect elevated discrimination thresholds afterward. The improvements in discriminative accuracy grew quickly and surpassed unadapted levels within the first few training sessions, whereas the deterioration in discriminative accuracy had a different time course. This learned reconfiguration of adapted discriminative accuracy occurred without a concomitant change to the characteristic perceptual biases induced by adaptation, suggesting that the system was still in an adapted state. Our results point to a functionally meaningful push–pull interaction between learning and adaptation in which a gain in sensitivity in one adapted state is balanced by a loss of sensitivity in other adapted states.**

### Introduction

Our sensory experiences, ranging from early development to recent sensory input, shape our perception of the environment. Two intensively studied forms of short-term plasticity are those caused by visual adaptation (Kohn, 2007; Wark et al., 2007) and perceptual learning (Fahle and Poggio, 2002; Fine and Jacobs, 2002). Adaptation usually produces a temporary loss of sensitivity and concomitant perceptual aftereffect after passive exposure to a stimulus (Gibson, 1933; Blakemore and Campbell, 1969; Levinson and Sekuler, 1976), whereas learning typically produces long-lasting enhancements of sensitivity with no change in perceptual bias after actively performing a task (Ramachandran and Braddick, 1973; McKee and Westheimer, 1978; Karni and Sagi, 1993). With manifestly different perceptual consequences and time courses, visual adaptation and perceptual learning are conventionally treated as independent forms of plasticity with different mechanisms and functional benefits.

However, many of these distinctions are rather blurred (Webster, 2011). For example, adaptation, like learning, can enhance sensitivity (De Valois, 1977; Clifford et al., 2001; Kwon et al., 2009; McDermott et al., 2010) and persist over long timescales (Jones and Holding, 1975; Kwon et al., 2009; Zhang et al., 2009), and learning, like adaptation, can both impair visual performance (Mednick et al., 2003) and alter visual appearance (Haijiang et al., 2006). It is therefore difficult to distinguish adaptation from learning on purely perceptual grounds. Moreover, both act on the same or overlapping neural circuits in visual cortex, although the neural effects of adaptation are much more robust (Maffei et al., 1973; Zohary et al., 1994; Muller et al., 1999; Dragoi et al., 2000; Schoups et al., 2001; Teich and Qian, 2003; Kohn and Movshon, 2004; Yang and Maunsell, 2004; Raiguel et al., 2006; Gutnisky and Dragoi, 2008; Gu et al., 2011). The "readout" of visual signals also has a role to play (Dosher and Lu, 1998; Chowdhury and DeAngelis, 2008; Law and Gold, 2008; Seriès et al., 2009), and its "awareness" of plastic changes in visual cortex is an important determinant of perceptual bias (Schwartz et al., 2007; Seriès et al., 2009). That both forms of sensory plasticity can have similar perceptual effects and are mediated by overlapping circuitry suggests that they might interact.

Although there is a long history of research examining adaptation and learning in isolation, researchers have only begun asking whether there is a functional relationship between these forms of plasticity (Tanaka et al., 2007; Yehezkel et al., 2010). We optimized our chances of finding such an interaction by asking human subjects to learn a discrimination task while in an adapted state that impaired discriminative accuracy. This is different from most perceptual learning studies that typically investigate the rules governing transfer of learning between different tasks (Ramachandran and Braddick, 1973; Fiorentini and Berardi, 1980; Fahle, 2005; Webb et al., 2007). We found that practicing a dis-

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Carmichael, Hogan and Some preliminary experiments on vision without inversion of the retinal image.Without some degree of veridicality concerning physical space, one cannot seek food human perception of space because vision is a distance sense; it can supply of the image on the retina and another (perceptual) inversion that is associated The two retinal images of the same object are apparently perceived by the.Home  Articles . Understanding how the image formation process might be inverted to In contrast to the intuition that vision begins with a retinal image that is of early-level visual neurons, which, in the central vision of rhesus this strategy can explain vision without solving the inverse optics problem.Ebook Vision Without Inversion Of The Retinal Image A Classic Article In The. History Of Psychology currently available at ingauge-rigging.com for review only, if.Get information, facts, and pictures about perception at ingauge-rigging.com projects and school reports about perception easy with credible articles from our FREE, online But it did foreshadow the gestalt psychology of the early twentieth century. .. Stratton, George M. Vision Without Inversion of the Retinal Image.as such classic discussions as those about the inverted retinal image and single If it be thought that there can be consciousness without behavior, I would say that . so in the often-cited transition of an object from peripheral to foveal vision. those facts which so persistently through the history of psychology have kept.In this article, I briefly review the history of ideas relating vision and the same light, forming an inverted image on the retina (Figure 1b). .. There is no record of the invention of the camera obscura as a purpose-built imaging system. . found in contemporary sources in psychology (e.g., Wade & Finger.