Third-eye Rivalry

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Abstract

We showcase an optical phenomenon that we call “Third-eye Rivalry”. The effect is most easily induced by viewing one’s own reflection in a mirror. Using the pupil of the opposing eye as a fixation target, people can easily cross their eyes in free-fusion to experience vivid rivalry. The resulting percept is of a prominent central “third” eye and two peripheral faces rivaling for perceptual dominance. We illustrate the process of achieving third-eye rivalry and discuss historical connotations of the third eye in scientific and mystical contexts.

Key words: third eye; cyclopean eye; binocular rivalry; conscious perception

Changing the vergence angle of the two eyes results in normally-fused percepts becoming decoupled. With effort, it is possible to “free-fuse” different objects in the environment that offer stable vergence cues. However, free-fusion strains eye muscles, making it difficult for many untrained observers to maintain fixation at unnatural vergence depths. Here, we report a condition in which sustained and vivid rivalry is easily inducible in an untrained population, making it an ideal everyday visual illusion.

To experience vivid binocular rivalry outside of lab settings typically requires a salient and stable target for fixation. We found that it is rather easy to use one's own pupil as such a fixation target. If you look in the mirror and cross (or uncross) your eyes, the usually singular percept of your own face staring back at you will be doubled, resulting in two adjacent faces with four eyes distributed horizontally. If you then free-fuse two of the reflected eyes, three will remain— two eyes will be perceived peripherally with a third eye seen between them. The pupil of this “middle eye” offers a strong enough vergence cue to help maintain stable fixation. The effect and procedure are depicted in Figure 1.

Figure 1. A “third eye” results from free-fusing reflections of the left and right eyes in a mirror (top). Normal fixation in a mirror involves binocularly viewing one pupil at a time (bottom left), whereas third-eye rivalry involves simultaneous fixation of opposing pupils, either through binocular convergence (as shown in bottom right) or divergence (not shown).

As has long been known in the binocular rivalry literature, discrepant monocular images will intermittently disappear or dominate in awareness (see Wheatstone, 1838; or Alais & Blake, 2005, for a review). Rivalry typically happens when the optical information presented to the two eyes is sufficiently different that perceptual convergence is impossible. Consistent with the known laws of rivalry (Brascamp, Klink, & Levelt, 2015), the temporal effects of third-eye fixation are intermittent alternation of face dominance (and suppression), with periods of percepts in which only a singular eye is visible, reminiscent of the one-eyed cyclops from Greek mythology. From Figure 2 below you can get a sense of the effect of third-eye fixation, assuming you have the ability to free-fuse discordant signals after crossing your own eyes (for best results, find a mirror, or colleague, and stand as close as feasible, ~20-50cm).

Figure 2. Maintaining free-fusion of opposing pupils in the mirror. The multistable phenomenology includes two distinct faces and a third form with a prominent central eye, as though of a cyclops.

Binocular rivalry has been utilized as a potent tool to study the neural correlates of conscious perception (Blake 2002; Tong, 2006; Maier et al., 2012). Such studies often use a novel face as stimuli (e.g., Alais & Parker, 2006; Klink et al., 2017). In third-eye rivalry, free fusion in the mirror produces a strong fixation point in the midline of the stimulus, and the reflection of self in the mirror becomes subject to perceptual suppression through rivalry. The ability to use one's own face as a rivaling stimulus is a novel contribution to the field of binocular rivalry and to the neuroscience of conscious perception.

A more subtle aspect of third-eye rivalry can be observed without a mirror or crossing the eyes by simply recognising the presence of two transparent noses on the edges of the visual field (depicted in Figure 3). Over time, the visual system suppresses the monocular occlusion signals from the nose in favour of signals from the environment, in which case the first-person perspective rivals between 1) a singular vantage point that sits above the shoulders, and 2) a three-panel perspective with a central, unobstructed viewpoint situated between two semi-transparent noses. In the history of vision science, the singular vantage point has been called the cyclopean eye (Julesz, 1972) and has been discussed primarily in relation to the geometry of binocular disparity and the implied reference point of the observer's "self" (Enright, 1988; Ono, Mapp, & Howard, 2002). From a phenomenological point of view, however, the cyclopean (i.e., "single eye") terminology neglects the nose as an ever-present occlusion signal. The "third-eye" terminology highlights that the two lateralised monocular vantage points induce an *additional*, not solitary, percept of a central vantage point. Looking from between the noses (i.e., from the third eye of the illusion described above) is equivalent to seeing from the cyclopean eye without suppression of occlusion signals.

Figure 3. Discrepant monocular images are ever present at the periphery, but third eye sight is unobstructed. Seeing from the third (cyclopean) eye implies recognising the perception of having two noses (image adapted from D. E. Harding's "On having no head: Zen and the rediscovery of the obvious", 1998).

Recognising that the third eye and the cyclopean eye are equivalent, bistable interpretations of the first-person point of view connects the study of visual perception to a storied history. While vision scientists have conferred utility to the third (cyclopean) eye as a reference point for visual perspective, the third eye has long been a central concept in the human understanding of anatomy, perception, consciousness, and spirituality. For example, anatomists have detailed retinal projections from a vestigial third “parietal” eye in some reptiles and amphibians (Sapède & Cau, 2013); neuroscientists and medical doctors have identified the human pineal gland (the evolutionary homologue of the parietal eye) as light sensitive (Su & Luo et al., 2006) and involved in consciousness-altering psychedelic experiences (Strassman, 2000); the polymath Rene Descartes pondered whether the pineal gland (also called the third eye; Mano & Fukada, 2007) allows the soul to enter the body (Lokhorst, 2005); modern philosophers refer to the third eye as the “mind’s eye” (or the mind’s “I”; Dennett & Hostadter, 1981); and Eastern mystics have long recognised that the self is an illusion, a developing awareness of which is associated with the opening of the third eye (*ajna*) chakra (Mookerjee, 1984; Grimes, 1996). What we have described is an illusion with a salient third eye that evokes the perceptual dissolution of the self. Whether or not the present phenomenon bears relation to any of the varied historical depictions and their surrounding mythology is, like any rivalling phenomenon, open to multiple interpretations.

In summary, third-eye rivalry results in the familiar aspects of binocular rivalry: wholesale and piecemeal suppression of monocularly conflicting images across time. The effect is easily achieved by crossing the eyes in front of a mirror, or one can experience seeing *from* the third eye (the percept in which you have two noses). Rivalries of various kinds are used as to study consciousness and its neural correlates. In terms of its utility, this illusion invokes rivalry of one’s own face, which might have novel impacts on neural and perceptual dynamics. In the scientific literature today, a persistent debate exists: when, if ever, does binocular rivalry occur in ecological contexts (Arnold, 2011; O’Shea, 2011; Shimojo & Nakayama, 1990)? To this point the present paper might be informative. As with enlightenment, binocular rivalry can happen when you are brushing your teeth, bleary-eyed, at about seven in the morning.

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