New Perspectives on Vision

Here is a summary of my lecture about some remarkable aspects of vision.

The minimum resolvable acuity (MRA) represents the fundamental limit of spatial vision, being the subtended angle at which a visual system can still discern two points. Since three consecutive cones must be involved, the lower limit is one arc minute (0.017 degrees). Resolution diminishes dramatically with eccentricity from the fovea. If this were not so, we would need eyes and associated brain regions larger than our heads. However, humans have a fantastic ability to discriminate a tiny misalignment of two lines that far surpasses the MRA, such as, according to one report, a displacement of only 6 mm at a distance of 1.6 km. This fascinating phenomenon is called vernier acuity. Vernier acuity is a type of hyperacuity, and is applied when using calipers. Hyperacuity refers to the ability of the visual system to recognize the relative location and offset of stimuli. Human vision is excellent compared with most animals, the exception being birds of prey, whose visual acuity is about 20/4 due to many more cones, a second fovea, and an accommodative cornea.

Normal visual acuity relies on continuous unnoticeable microsaccades. These eye movements allow people to read at least two more lines on the Snellen chart compared with an immobilized gaze—remarkably, brief periods of saccadic suppression amount to 90 minutes of blindness daily in awake individuals. The pattern of eye movements is inheritable and so unique to individuals that tracking them can be used to identify people.

Humans can differentiate 2–10 million chromaticities. Some females are tetrachromatic, and have a fourth photoreceptor allowing them to discriminate up to 100 million colors. In addition, our perception of color differs because of chromatic adaption and how the brain recognizes colors (**Figure 1**). It may depend on our first impressions as neonates, the blood supply to the eye, the season, our moods, earlier memories, and even language and culture. Amazingly, our familiar sense of a colorful, detailed peripheral vision is, for the most part, a delusive sensation created by the brain's perceptual filling-in.

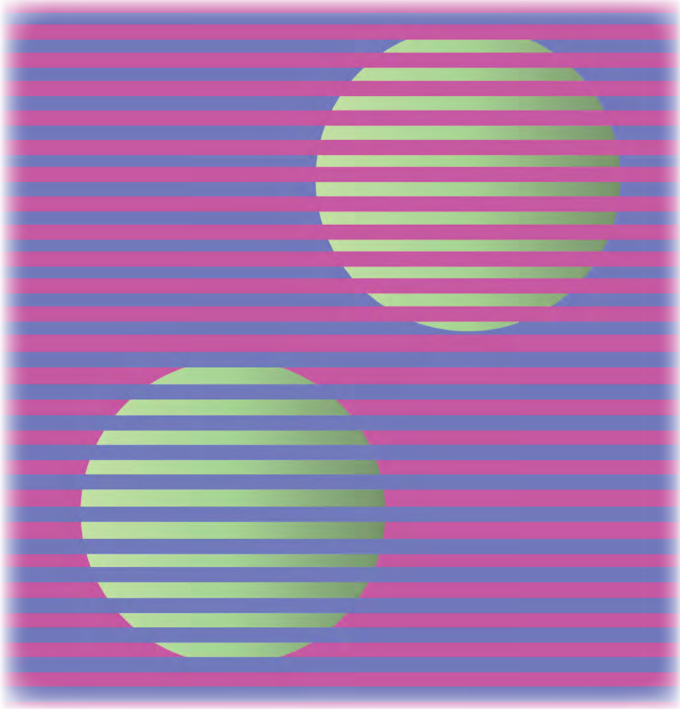

Figure 1. The colors of the spheres may appear different but are, in fact, the same—our perception of color changes depending on the surrounding hues (the Munker–White illusion). Illustration: Atle Østern

Our ability to correctly assess other people by observing their faces is essential for us to interact socially. Face recognition differs from all other visual tasks, with an occipital face area that selectively reacts to facial details and a temporal fusiform face area that reassembles defragmented signals. The human attention to facial images is so strong that we detect facial patterns even where none exist (pareidolia). Meanwhile, a congenital impairment of facial recognition (prosopagnosia or face agnosia) affects up to 2% of the population.

Our experience of observing our surroundings in the present is an illusion. For example, the awareness of moving objects is delayed by approximately 400 ms, which can have serious consequences for vehicle drivers. Signals pass through the slower ventral pathway to the frontal lobe and the faster dorsal stream to the parietal lobe, where unconscious action responses are planned and executed. Astonishingly, our brain dates our perceptions back in time to when the first visual stimulus reached the brain. Further, we see an average of what we perceived in the past 15 seconds. This begs the question: Do we then have free will?

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Oslo Society of Ophthalmology Honorary Lecture Series

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