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Leading neuroscientist reveals the evolutionary basis of modern vision

Scientist have long known much of our how human vision functions, from the detailed structure of the eye to the visual processing functions of the brain.

But until recently scientists have known very little about *why* we see the way we do, and what they did know was wrong. Neuroscientist Mark Changizi has broken new ground in presenting surprising insights into why we see the way we do, all meticulously demonstrated through careful research.

In *The Vision Revolution: How the Latest Research Overturns Everything We Thought We Knew About Human Vision*, Mark Changizi, prominent neuroscientist and vision expert, addresses four areas of human vision and provides explanations for why we have those particular abilities, complete with a number of full-color illustrations to demonstrate his conclusions and to engage the reader. Written for both the casual reader and the science buff hungry for new information, *The Vision Revolution* is a resource that dispels commonly believed perceptions about sight and offers answers drawn from the field's most recent research.

Changizi focuses on four "why" questions:

1. Why do we see in color?
2. Why do our eyes face forward?
3. Why do we see illusions?
4. Why does reading come so naturally to us?

Why Do We See in Color?

It was commonly believed that color vision evolved to help our primitive ancestors identify ripe fruit. Changizi says we should look closer to home: ourselves. Human color vision evolved to give us greater insights into the mental states and health of other people. People who can see color changes in skin have an advantage over their color-blind counterparts; they can see when people are blushing with embarrassment, purple-faced with exertion or the reddening of rashes. Changizi's research reveals that the cones in our eyes that allow us to see color are exquisitely designed exactly for seeing color changes in the skin. And it's no coincidence that the primates with color vision are the ones with bare spots on their faces and other body parts; Changizi shows that the development of color vision in higher primates closely parallels the loss of facial hair, culminating in the near hairlessness and highly developed color vision of humans.

Why Do Our Eyes Face Forward?

Forward-facing eyes set us apart from most mammals, and there is much dispute as to why we have them. While some speculate that we evolved this feature to give us depth perception available through stereo vision, this type of vision only allows us to see short distances, and we already have other mechanisms that help us to estimate distance. Changizi's research shows that with two forward-facing eyes, primates and humans have an x-ray ability. Specifically, we're able to see through the cluttered leaves of the forest environment in which we evolved. This feature helps primates see their targets in a crowded, encroached environment. To see how this works, hold a finger in front of your eyes. You'll find that you're able to look "through" it, at what is beyond your finger. One of the most amazing feats of two forward-facing eyes? Our views aren't blocked by our noses, beaks, etc.

Why Do We See Illusions?

We evolved to see moving objects, not where they are, but where they are going to be. Without this ability, we couldn't catch a ball because the brain's ability to process visual information isn't fast enough to allow us to put our hands in the right place to intersect for a rapidly approaching baseball. "If our brains simply created a perception of the way the world was at the time light hit the eye, then by the time that perception was elicited—which takes about a tenth of a second for the brain to do—time would have marched on, and the perception would be of the recent past," Changizi explains. Simply put, illusions occur when our brain is tricked into thinking that a stationary two-dimensional picture has an element that is moving. Our brains project the "moving" element into the future and, as a result, we don't see what's on the page, but what our brain thinks will be the case a fraction of a second into the future.

Why Does Reading Come So Naturally to Us?

We can read faster than we can hear, which is odd, considering that reading is relatively recent, and we've evolved to process speech for millions of years. Changizi's research reveals that language has been carefully designed to tap in to elements of the visual processing center that have evolved for tens of millions of years. Visual signs of all languages are shaped like objects in nature, Changizi says, because we have evolved to see nature easily. "People have noticed letters in nature for some time, and there are artists who have a spent a lot of time photographing Latin letters in natural scenes or on butterfly wings," Changizi says. "For example, if you look at an upper corner of the room you are in, you will see three contours meeting at a point, making a shape close to that of a 'Y.'" *The Vision Revolution* expands upon

how our ancestors found the shapes of Latin letters and delves into how visual signs can have similar shapes even though their inspirations come from very different environments.

In addition to these four areas, *The Vision Revolution* explores other phenomena such as cyclopses, peeking and many more you hadn't even thought to wonder about. Changizi shows how deeply involved these evolutionary aspects of our vision are in why we see the way we do—and what the future holds for us.

"…to understand how culture interacts with vision, one must understand not just the eye's design, but the actual mechanisms we have evolved," Changizi says, "for culture can tap in to both the designed responses of our brains and the unintended responses."

The Vision Revolution is a book that finally gives attention to what before has been largely neglected by other works on human vision—a book that looks at the "why."

ABOUT THE AUTHOR

Mark Changizi is an assistant professor of cognitive science at Rensselaer Polytechnic Institute. His research areas tend to concern the evolutionary function and design principles governing complex behaviors, perceptions and organisms. His first book appeared in 2003 and is called *The Brain from 25,000 Feet*: *High Level Explorations of Brain Complexity*, *Perception*, *Induction and Vagueness* (Kluwer Academic, Dordrecht). Dr. Changizi is the first author on 25 journal articles in diverse topics, and his research has been in more than 75 media outlets worldwide, including Time, Newsweek, USA Today, Discover, New Scientist, Financial Times, Daily Telegraph, Scientific American, The Times of London, Natural History, Reuters, ABC News, MSNBC, Fox News, Gehirn & Geist Magazine, Bild der Wissenschaft, Der Standard, Rhein Zeitung, Die Presse, Die Welt, De Morgen, Suddeutsche Zeitung, NRC Handelsblad, Internet Haber, Spiegel and Arzte Zeitung. He has also appeared as a guest on the CBC News' "As It Happens" radio show.

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AUTHOR INTERVIEWS

Please contact **Adrienne Lang** at (214) 750-3600 or adrienne@benbellabooks.com to arrange author interviews or to request additional copies.

We hope you enjoy the enclosed review copy.

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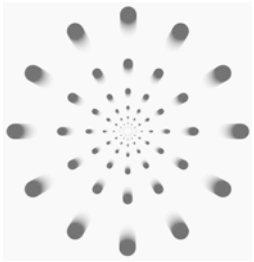
The Vision Revolution Images

Images in the book illustrate the conclusions and information discussed

Illustration of how the directions from us to the sides of a doorway change as you approach, from one moment to the next. (**1**) When you approach the doorway, the sides flow outward, but do so more at eye level (the middle here) than above or below. The photo on the right is of a door as seen through a fish-eye lens, which exaggerates the distortions that occur as you get closer for the sake of illustration. (**2**) On the left are the sides of a doorway as seen in the left-hand image in Figure 1. The same two vertical lines are shown on the right, but with the addition of radial lines, which are interpreted by the brain as optic blur due to forward motion. One can see that the vertical lines seem to bow out the same way they do as you approach a doorway, as in the right-hand image in Figure 1.

(**1**) Imagine having eye stalks so that your eyes could be suspended behind you and on either side of you. Or instead, imagine rigging cameras to your back and feeding the images to your eyes with goggles. (**1**) and (**2**) are what your left and right eyes would see, respectively.: Your left eye sees your body to the right of its visual field, and your right eye sees your body to the left. (**3**) An illustration of what is perceived with single, unified perception. It consists of two views of yourself, each perceived to be transparent. Your vantage point appears to be situated well behind your body.



Another illusion invented by Dave Widders. If you loom toward the center point (short, quick movement works best), the blobs flow outward faster than they should.

About the Author

"Although many neuroscientists are trying to figure out how the brain works, Mark Changizi is bent on determining why it works that way."
— Scientific American

Mark Changizi is a 39 year-old scientist with expertise in cognitive science, theoretical neuroscience and theoretical biology. His research areas tend to concern the evolutionary function and design principles governing complex behaviors, perceptions and organisms. He is the first author on more than 30 journal articles in diverse topics.

His first book appeared in 2003, an academic monograph called *THE BRAIN FROM 25,000 FEET: High Level Explorations of Brain Complexity, Perception, Induction and Vagueness* (Kluwer Academic, Dordrecht).

Dr. Changizi's research has been featured in more than a hundred media outlets, including The New York Times, Time, Newsweek, USA Today, Discover, New Scientist, Financial Times, Daily Telegraph, Scientific American, The Times of London, Natural History, Live Science, Reuters, ABC News, MSNBC, Fox News, Gehirn & Geist, Cahiers de Science et Vie, Newsweek (Russia), Bild der Wissenschaft, Der Standard, Rhein Zeitung, Die Presse, Die Welt, De Morgen, Suddeutsche Zeitung, NRC Handelsblad, Internet Haber, Spiegel and Arzte Zeitung. He has also appeared as a guest on the CBC News's "As It Happens" radio show.

He received his bachelor's degree in physics and mathematics from the University of Virginia in 1991 and his doctorate in applied mathematics from the University of Maryland in 1997, where, in addition to studying mathematics, he carried out research in theoretical neuroanatomy with Professor Christopher Cherniak. After graduating, he became a visiting assistant professor in the Department of Computer Science at University College Cork in Ireland for one year, after which, he worked as a neuroscience consultant for a neuro-engineering group at Schafer Biotechnology. Since then, he moved more formally into the mind/brain academic community by taking a postdoc at Duke University's Department of Psychological and Brain Sciences. After this, he won a prestigious fellowship position in the Sloan-Swartz Center for Theoretical Neurobiology at Caltech. In 2007, he joined the Department of Cognitive Science at Rensselaer Polytechnic Institute as an assistant professor.