

Mark Changizi

Scientist

Dr. Mark Changizi

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Skills

Cognitive sciences, neuroscience, human perception, UX, evolution, mathematics, computer science, empirical data, complex systems, medical technology, start-ups.

Author of books and articles. TEDs, television, and keynotes. Curating exhibitions at art and science museums.

Able to approach complicated systems, find elegant theories to make sense of them, and rigorously empirically test them.

Experience

2ai Labs / Director of Human Cognition ~ <http://2ai.org>

2010 - PRESENT, Columbus, OH

A private think tank and start-up generator founded by myself and colleague Dr. Tim Barber. Our aim is to output novel research in cognitive science and artificial intelligence, but also to spin off start-ups. VINO OPTICS (below) was our first start-up, based on patents emanating from my color research. The [Emotion Chip](#) is our second, still in development. And there are others on the conveyer belt.

VINO OPTICS / Founder and CEO ~ <http://vino.vi>

2012 - PRESENT, Columbus, OH

The company emanates from a major 2006 discovery of mine while at Caltech on the [origins of color vision](#). Namely, I provided evidence that primate red-green vision evolved for detecting oxygenation modulations of blood under the skin, so that primates could see emotions, health and state.

Out of that discovery, a colleague and I were able to [patent](#) the first (and only) optical filter technology that passively enhances visibility of these oxygenation modulations, as well as related technology.

VINO OPTICS serves two main markets.

- (1) Medical personnel wear our vein glasses, protective eyewear that enhances visibility of veins and health signs. We also sell distinct technology that enhances visibility of bruising and blood pooling under the skin. Our vein glasses technology has been shown to work in the *Journal of Emergency Medical Services*.
- (2) Colorblind people wear one of our technologies, which enhances the signal that red-green vision is for, and that color deficient are deficient at. Unlike our competitors, our tech has been shown to aid colorblindness in *Invest Ophth Vis Sci*.

VINO OPTICS has sold many thousands of items, acquired hundreds of testimonials, and appeared in more than a hundred magazines and news stories, including the *New York Times*.

Yamaha Motors / UX Consultant

2017 - 2019, Pasadena, CA

Consultant developing and testing novel technology for enhanced perception of a motorist's surrounding, for safety and a richer experience. It involved devising new theoretical technologies often based around my earlier discoveries in visual and auditory perception, and directing experiments to test the efficacy of those technologies.

MONA Museum / Guest Curator

2014 - 2017, Hobart, Tasmania, Australia

Invited by MONA founder, David Walsh, to be one of four external guest curators for a [six month exhibition](#), On the Origin of Art, at his famous art museum in Hobart, Australia. The show had [international press](#), and highlighted my research on the origins of writing, speech, music, and the arts. It led to a [joint book](#) with the same title with the other invited guest curators, Steven Pinker, Geoffrey Miller, and Brian Boyd.

Department of Cognitive Science, RPI / Assistant Professor

2007 - 2010, Troy, NY

Researcher in cognitive science, as well as two courses per semester teaching. Many publications while here, as well as my first trade (i.e., non-academic-monograph) book, *VISION rEVOLUTION*, about the function and design of vision, covering many of my own discoveries in the area of visual perception, including why we evolved color vision, why we see illusions, why some animals (like us) have forward-facing eyes, how we came to have writing.

Caltech / Sloan-Swartz Fellow in Theoretical Neurobiology

2002 - 2006, Pasadena, CA

As a mathematician with research in the neurosciences, I was awarded two years of money from the Sloan-Swartz foundation to research at Caltech. I then extended it to two more years via winning an NIH fellowship. Although independently funded, I collaborated with well known Japanese vision research Shinsuke Shimojo. With great independence, and inspiration from those around me, a wide variety of my discoveries came to fruition while here.

Department of Neuroscience, Duke / Postdoctoral Fellow

1999 - 2002, Durham, NC

Researcher in the brain sciences, worked in the lab of Dale Purves, and then in the lab of Ted Hall. Studied the ontogeny of thirst and hunger behavior, and had tremendous freedom to work on a variety of other research areas, leading for example to my "perceiving the present" work on why we see illusions.

Schafer Corporation / Computational Neuroscience Consultant

1998 - 1999, Fairfax, VA

Researcher in computational neuroscience. Developed novel computational and statistical methods and software for detecting the presence of correlated activity in neuronal populations.

Department of Computer Science, University College Cork /

Assistant Professor

1997 - 1998, Cork, Ireland

Researcher in cognitive and computer science, as well as one introductory computer algorithms course per semester teaching. Worked here on my first book, *The Brain from 25000 Feet*.

Miscellaneous Teaching and Research Positions while undergrad and grad

1989 - 1997,

- 1989. Undergrad researcher in physics lab, Prof. Deaner, UVA.
- 1990. Undergrad researcher at Fermi Lab, Experiment 771.
- 1990-91. Undergrad researcher for SLAC.
- 1991. Post-grad researcher, Fly's Eye, University of Utah.
- 1992-1995. Lab teacher, physics and astronomy, George Mason.
- 1993-1997. Theoretical neurobiology research, Prof Chris Cherniak, University of Maryland
- 1994-1997. Lecturer for logic, and also education-major math.
- 1996-1997. Teaching assistant for calculus.

Education

University of Maryland / PhD, Applied Mathematics

1992 - 1997, College Park, MD

PhD was in applied mathematics, more specifically on complexity theory, algorithms, theory of computation, and mathematical logic. In addition to being the usual teaching assistant -- often the primary lecturer -- in a variety of math classes, and teaching physics and astronomy at nearby George Mason University, I worked in the laboratory of theoretical neuroscientist and philosopher Chris Cherniak, thereby also acquiring a background in the cognitive and brain sciences, allowing me to later postdoc in those fields, and eventually become a theorist in the field.

University of Virginia / Bachelor of Science, Physics and Math

1987 - 1991, Charlottesville, VA

Double majored in physics and math, and chose the more difficult B.S. rather than B.A. route. Worked as an undergrad researcher during those undergrad years at a variety of physics labs, including FermiLab, Fly's Eye and SLAC.

Thomas Jefferson High School for Science and Technology / Diploma

1986 - 1987, Alexandria,, VA

Applied and was accepted to the new magnet school in northern Virginia the year it opened. Was a great experience, preparing me well for my next step at UVA physics and math.

Books

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1. **BRAIN FROM 25000 FEET: High Level Explorations of Brain Complexity, Perception, Induction, and Vagueness.** Kluwer, 2003.
 - "This is a very rich and exceedingly well-written book. I learned a lot." Dan Ryder, University of Connecticut, U.S.A., *Synthese* 141:2
 2. **VISION rEVOLUTION: How the Latest Research Overthrews Everything We Thought We Knew.** Benbella, 2009.
 - "...one of the best works of theoretical vision science since Gibson," Dan Simons, author of *The Invisible Gorilla*.
 - "...a book full of invention and originality..." -- Peter Lucas, Professor of Anthropology.
 - Glowing review in [Wall Street Journal](#).
 - Translated into German, Russian, Japanese, Korean and Chinese.
 3. **HARNESSED: How Language and Music Mimicked Nature and Transformed Ape to Man.** Benbella, 2011.
 - "...this book might hold the key to one of humanity's longstanding mysteries..." Stanislas Dehaene, author of *Reading in the Brain*
 - "I'd be amazed if everything he says is right; but at this point I'd be even more surprised if his main ideas, which crack open riddles that have annoyed me for years, aren't on the right track." Frank Wilczek, Recipient, Nobel Prize in Physics, 2004
 - "Top 10 Books of 2011" *New Scientist*.
 - Translated into Japanese and Korean.
 4. **HUMAN 3.0.** Self-published, 2012.
 - A hybrid novel and essays on what's next, after humans.
 5. **ON THE ORIGIN OF ART, MONA,** 2016. Co-authors, Steven Pinker, Geoffrey Miller and Brian Boyd.
 - The book associated with the [2016 exhibition at MONA](#) on the origin of art, where I curated my own exhibition based on my research.
 6. **THE POKER ORIGINS OF EMOTIONAL EXPRESSIONS: How We Know When to Hold, Fight, or Fold.** Benbella, 2021. Co-author Tim Barber.
 - The theory underpinning our [VICTOR Emotion Chip](#) technology.

Research

I have several dozen journal articles, and six books, on my research. As a theorist, I always move on to new areas in hopes of a good idea. My journal articles can be perused at either of the following links:

- [Google Scholar](#)
- [My own web page](#), with links for each paper

Here is a sample of the sorts of research I am known for, and for which I have been covered extensively in the media.

- (1) [Color vision](#) evolved and is well optimized for sensing oxygenation modulations under bare skin, so as to see emotions, health and state.
- (2) [Forward facing eyes](#) evolved not because of stereoscopy or for the needs of predators, but, rather, for seeing the most in cluttered, forested environments.
- (3) We see geometrical and other [illusions](#) because the brain is trying to correct for neural delays, and generates a perception of the next moment (100 msec into the future), so that by the time the perception is generated, it's a perception of the *present*.
- (4) We came to be able to [read](#) because the shape of writing culturally evolved to look like nature, thereby harnessing our visual object recognition system for the new task of reading.
- (5) Our fingers get [pruney](#) when wet because the resulting morphology is well designed as rain treads, near optimally channeling out water upon a grip and thereby avoiding hydroplaning.
- (6) The time-course of [liking a visual stimulus](#), and then later getting bored of it, can be explained from first principles emanating from utility calculus.
- (7) The repertoire, structure and function of [emotional expressions](#) can be explained from first principles, emanating from the demands of social animals without language who must "play a Poker Game of Life", a natural generalization of poker.
- (8) The hierarchical organization of [dictionaries](#) is consistent with minimizing the overall size of the dictionary.
- (9) [Neuron and artery morphologies](#) shape themselves such that they utilize the least amount of volume to reach out to their various "leaf" points.
- (10) Why [brains scale](#) in the ways they do, from mouse to whale, including convolutedness, white matter volume, neuron soma size, and many other micro- and macro-neuroanatomical measures.

**TEDs, TV, keynotes,
appearances, media etc..**

I have done a lot of [TEDs, TV and keynotes](#), as well as writing for many magazines including the Telegraph, WIRED, Forbes, Psychology Today, and Discover Magazine. (I also was on the board for the development of the Franklin Institute BRAIN exhibition.) I have included just some of the more fun ones below.

The Science Moment series, YouTube

2019 – [My own video series](#) covering a wide variety of science topics related to my research.

Mind Field, YouTube Premium / Color and VINO OPTICS tech

2017 – [My appearance](#) on the Emmy nominated science show Mind Field.

Head Games, Discovery Channel / Head Games on MSNBC

2016 – My appearance on the [Dylan Ratigan show](#) talking about the first (and only) season of Head Games, for which I was the regularly appearing science guy.

TEDxSaintThomas / Colorblindness and Health-Blindness

2015 – Covers my discovery on the origins of color vision, and how it led to technology that helps the colorblind. Concentrates on medical

personnel who are colorblind, and who are [thereby “health blind.”](#) an underappreciated handicap and danger in medicine.

TED / Why We See Illusions

2013 – Covers my discovery on how illusions are due to your brain trying to correct for neural delays by anticipating the next moment, so as to [perceive the present.](#)

TED / Pruney Fingers: A Gripping Story

2013 – Covers my discovery on how [pruney fingers](#) are primate rain treads.

Brain Games, National Geographic / Illusions

2013 – Covers my discovery on [why we see illusions.](#)