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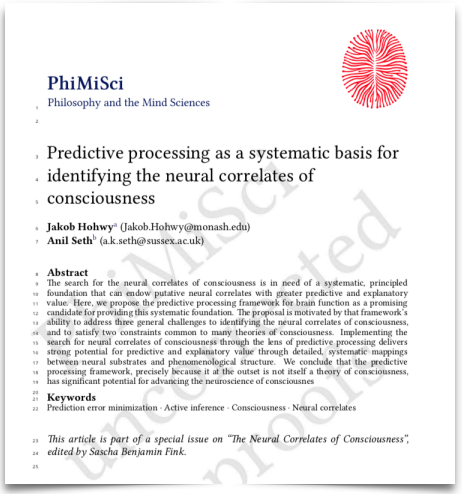
Being You: A New Science of Consciousness
coming September 2021, Faber/Penguin

philosophy



PhiMiSci
Philosophy and the Mind Sciences

Predictive processing as a systematic basis for identifying the neural correlates of consciousness

Jakob Hohwy* (Jakob.Hohwy@monash.edu)
Anil Seth* (a.k.seth@sussex.ac.uk)

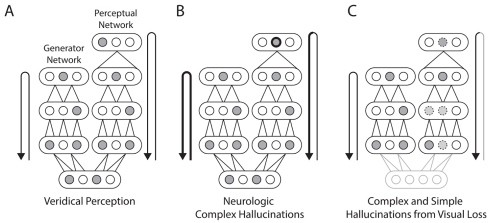
Abstract
The search for the neural correlates of consciousness is in need of a systematic, principled foundation that can endow putative neural correlates with greater predictive and explanatory value. Here, we propose the predictive processing framework for brain function as a promising candidate for providing this systematic foundation. The proposal is motivated by that framework's ability to address three general challenges to identifying the neural correlates of consciousness, and to satisfy two constraints common to many theories of consciousness. Implementing the search for neural correlates of consciousness through the lens of predictive processing delivers strong potential for predictive and explanatory value through detailed, systematic mappings between neural substrates and phenomenological structure. We conclude that the predictive processing framework, precisely because it at the outset is not itself a theory of consciousness, has significant potential for advancing the neuroscience of consciousnes

Keywords
Prediction error minimization · Active inference · Consciousness · Neural correlates

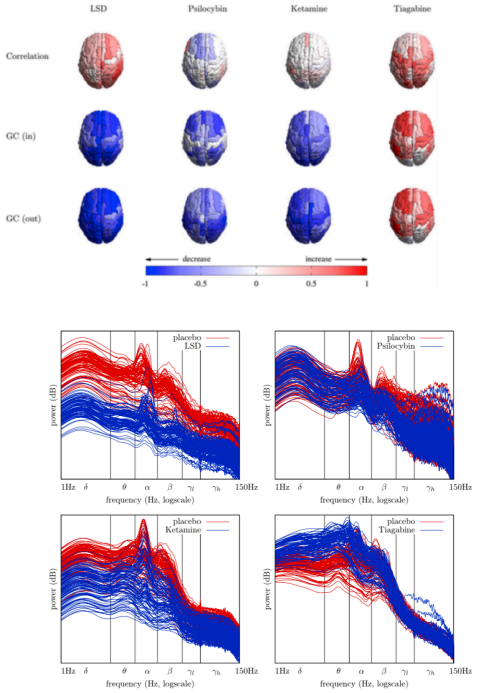
This article is part of a special issue on "The Neural Correlates of Consciousness", edited by Sascha Benjamin Fink.

uncorrected proof

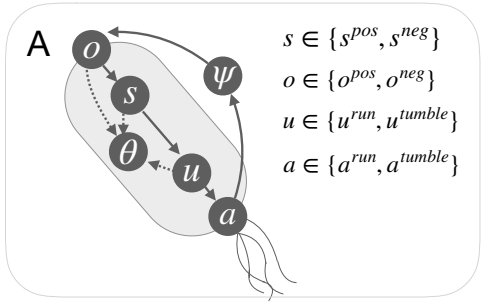
perception

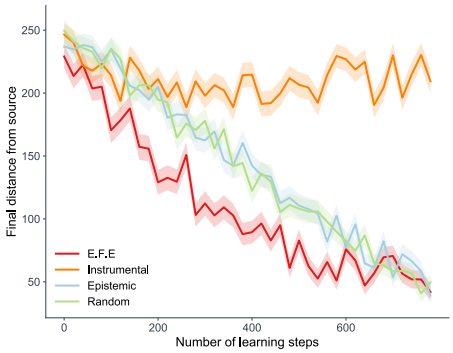


brain imaging



machine learning



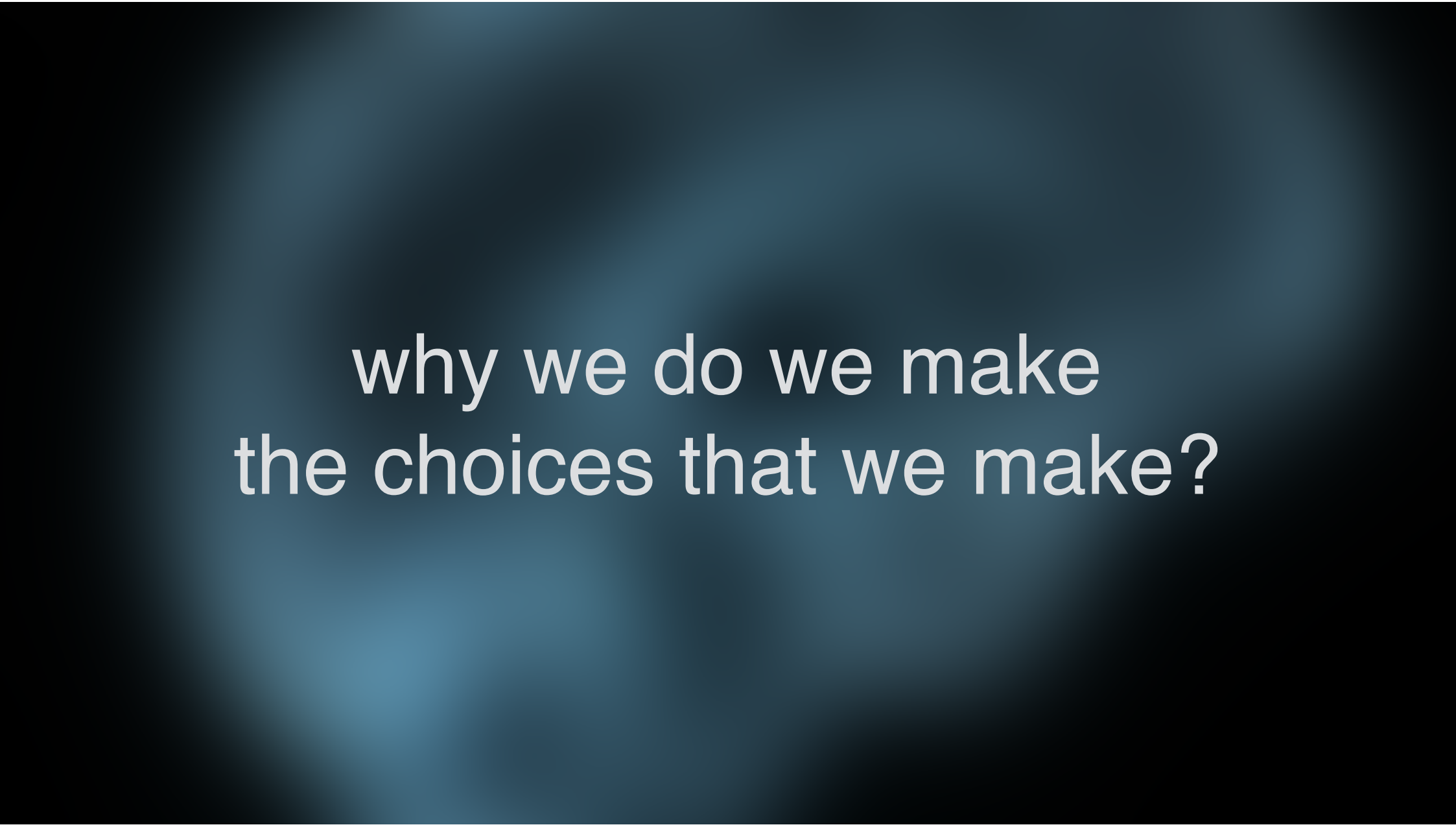


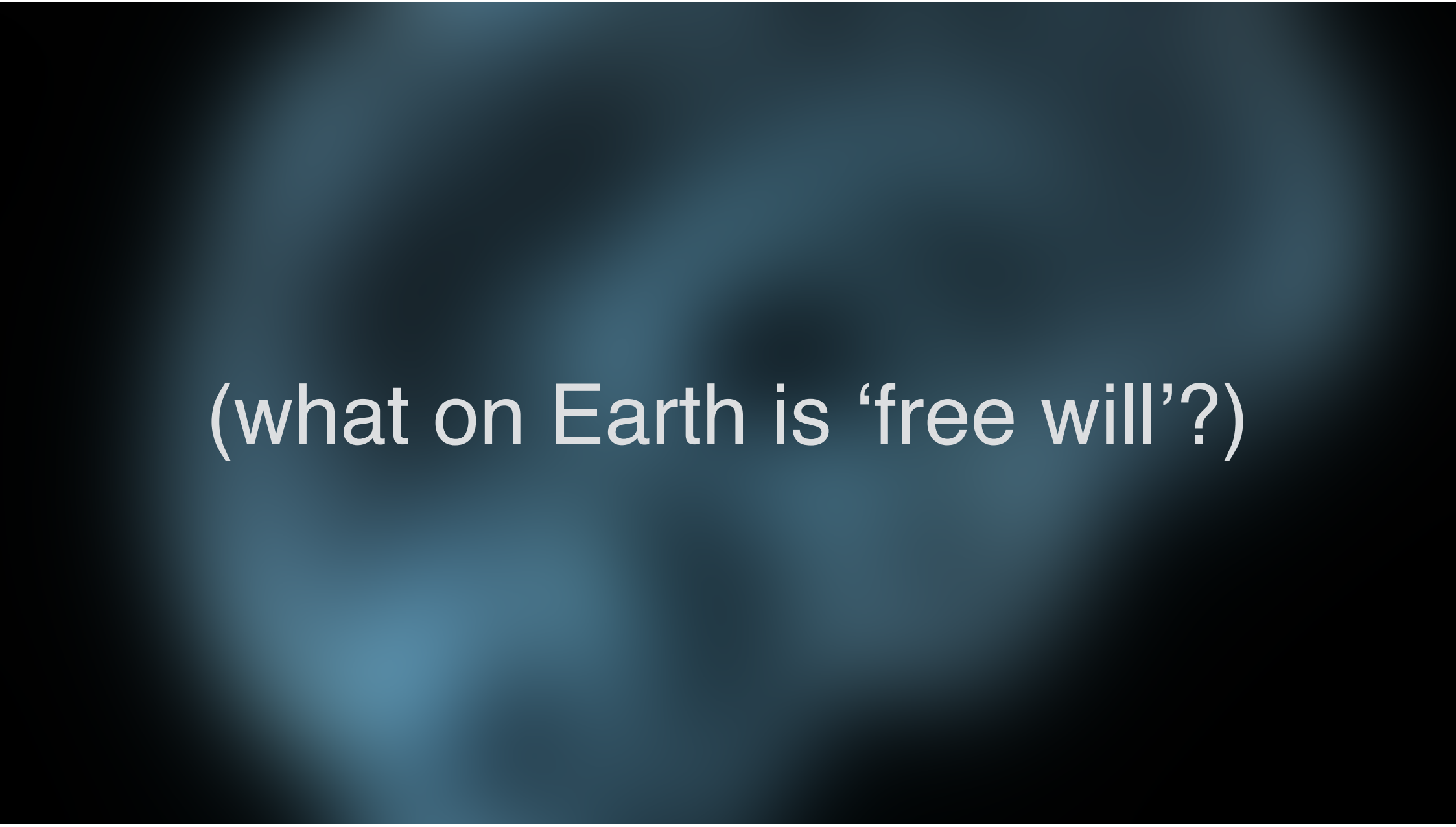
Tschantz et al (2020) PLoS Computational Biology

Barnett et al (2020) Neuroimage

Suzuki et al (2017) Scientific Reports

Hohwy & Seth (2020) Philosophy and the Mind Sciences


why we do we make
the choices that we make?


(what on Earth is ‘free will’?)

predictably irrational

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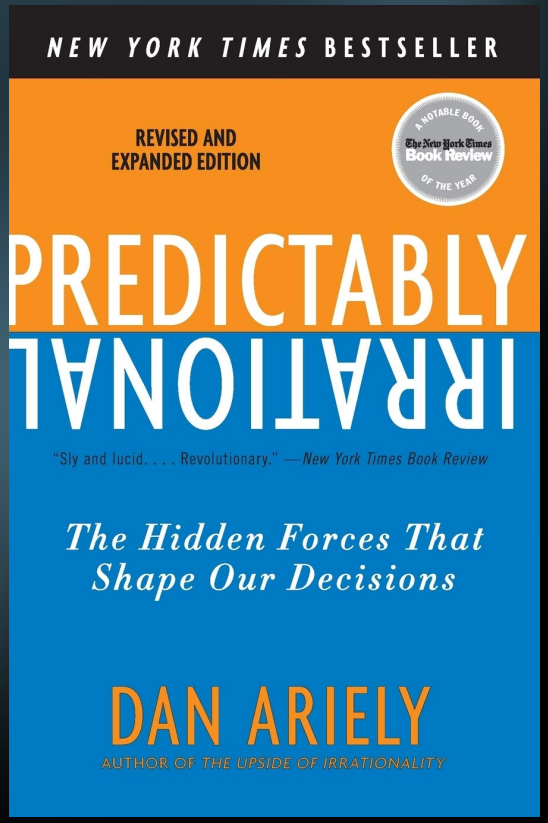

Ariely (2008)

predictably irrational

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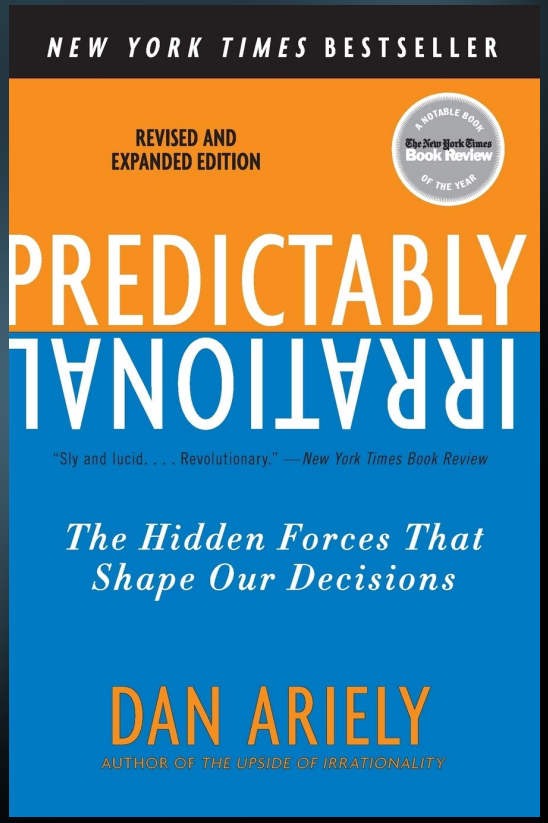

Ariely (2008)

predictably irrational

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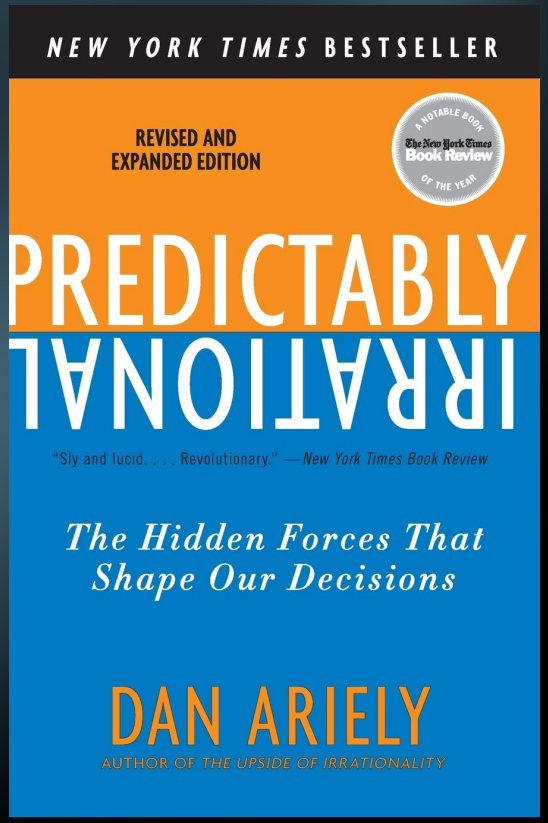
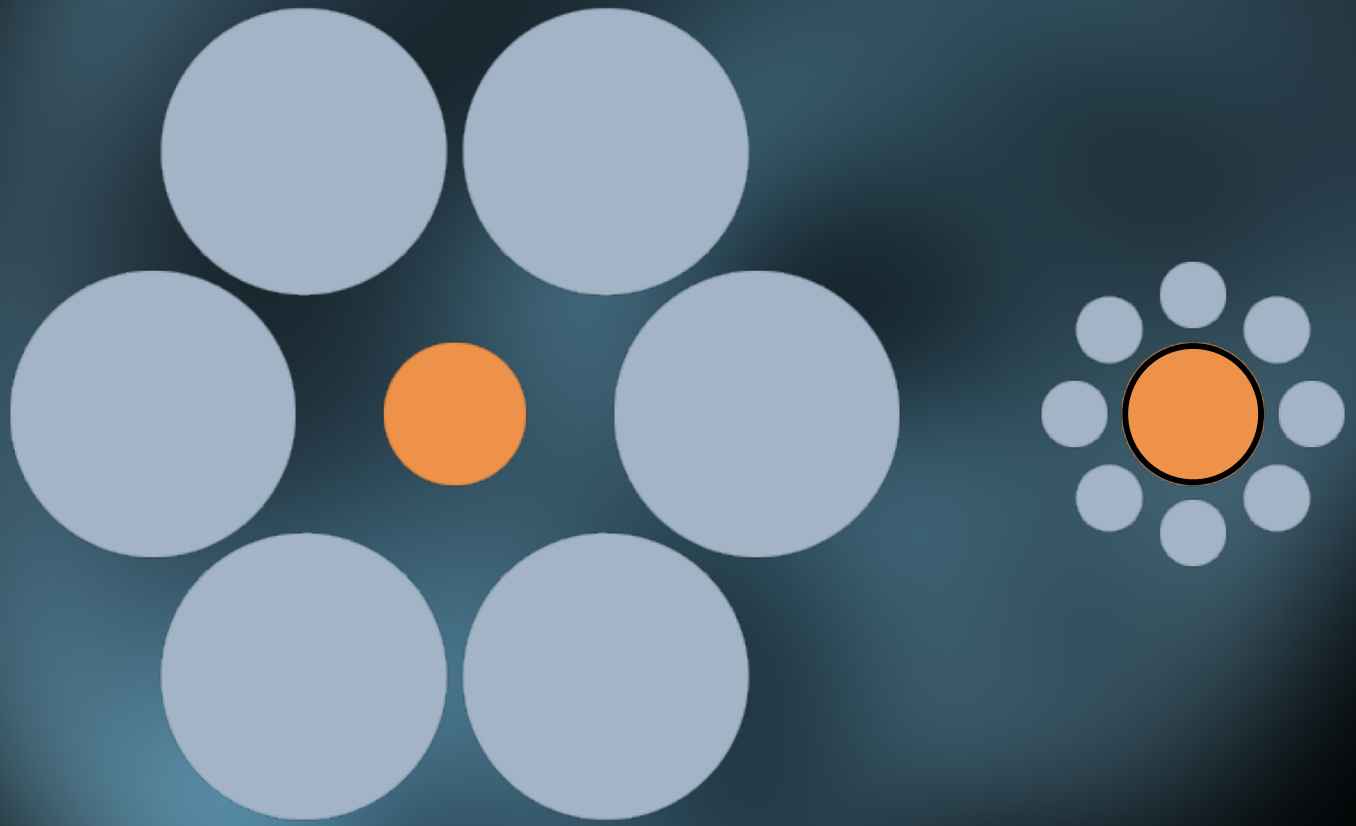


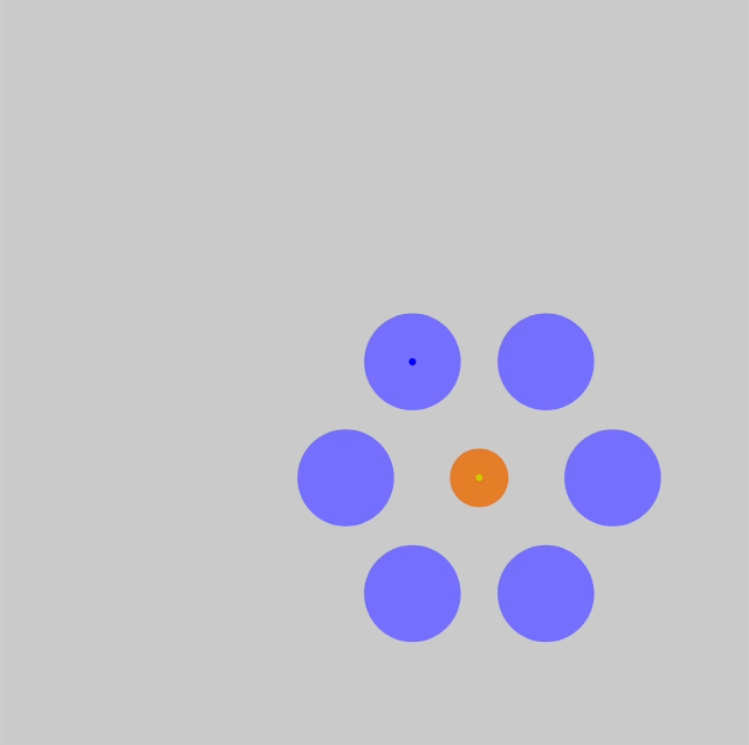
Ariely (2008)

perceptual relativity

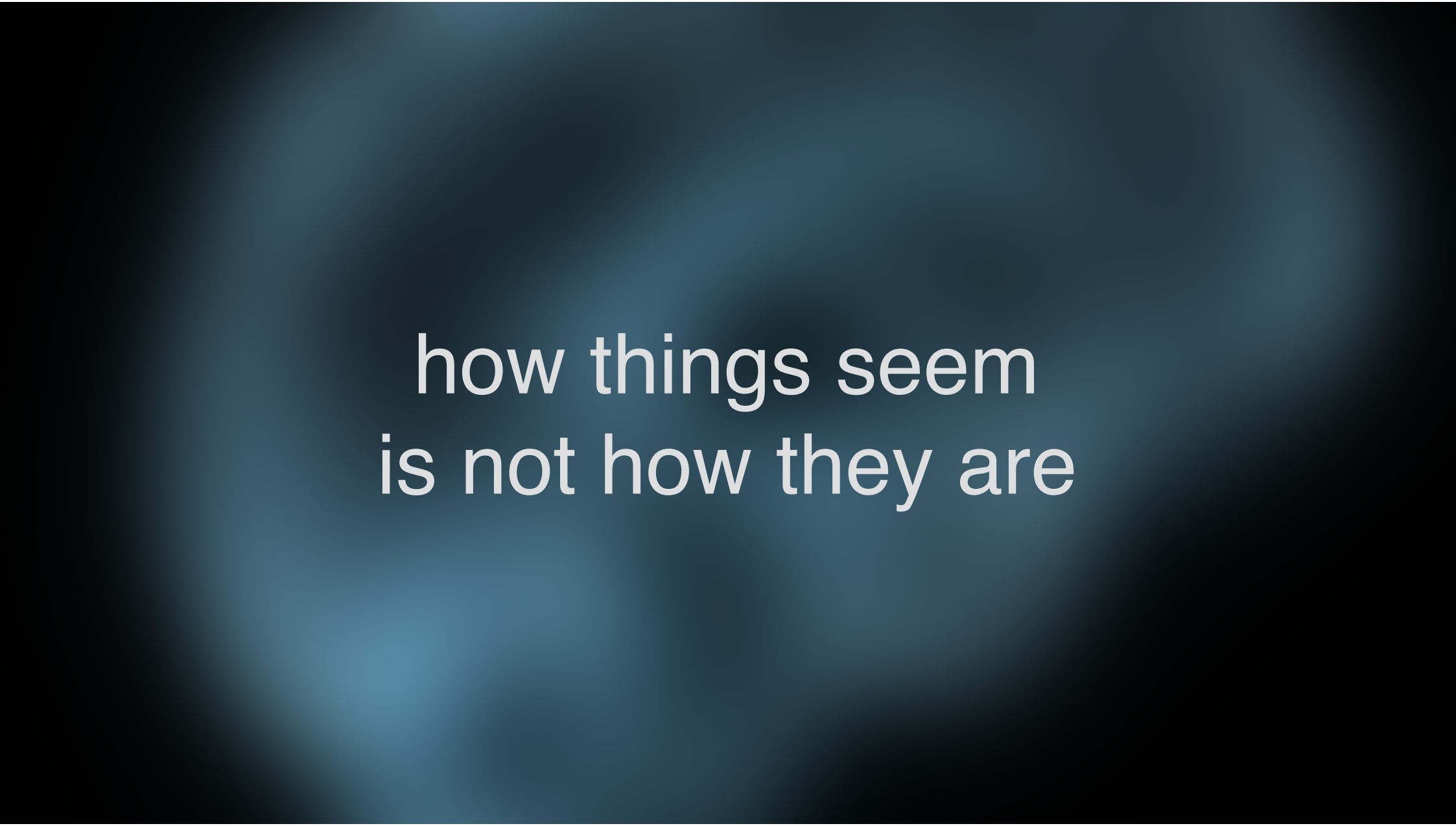


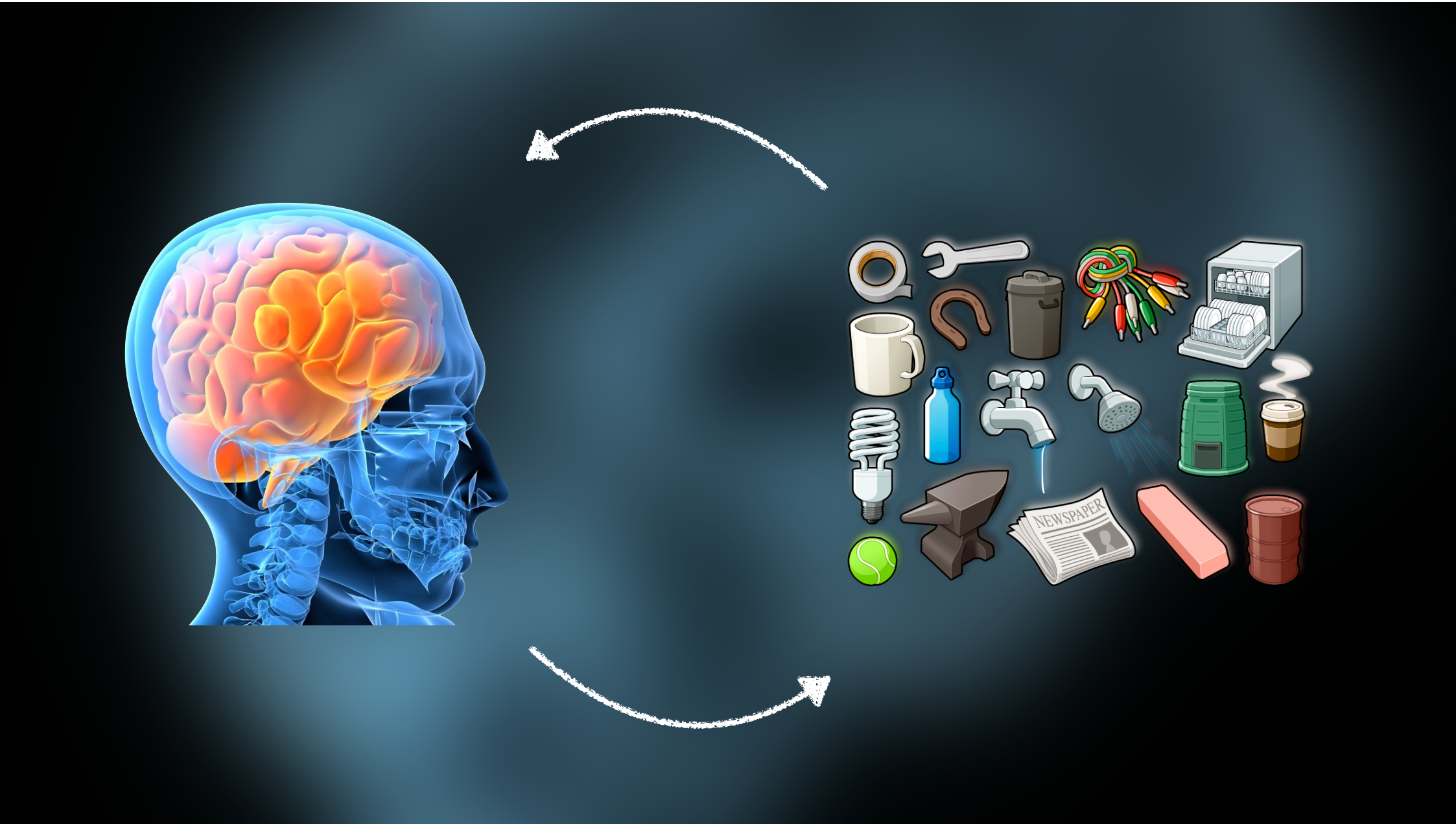
Ebbinghaus Illusion

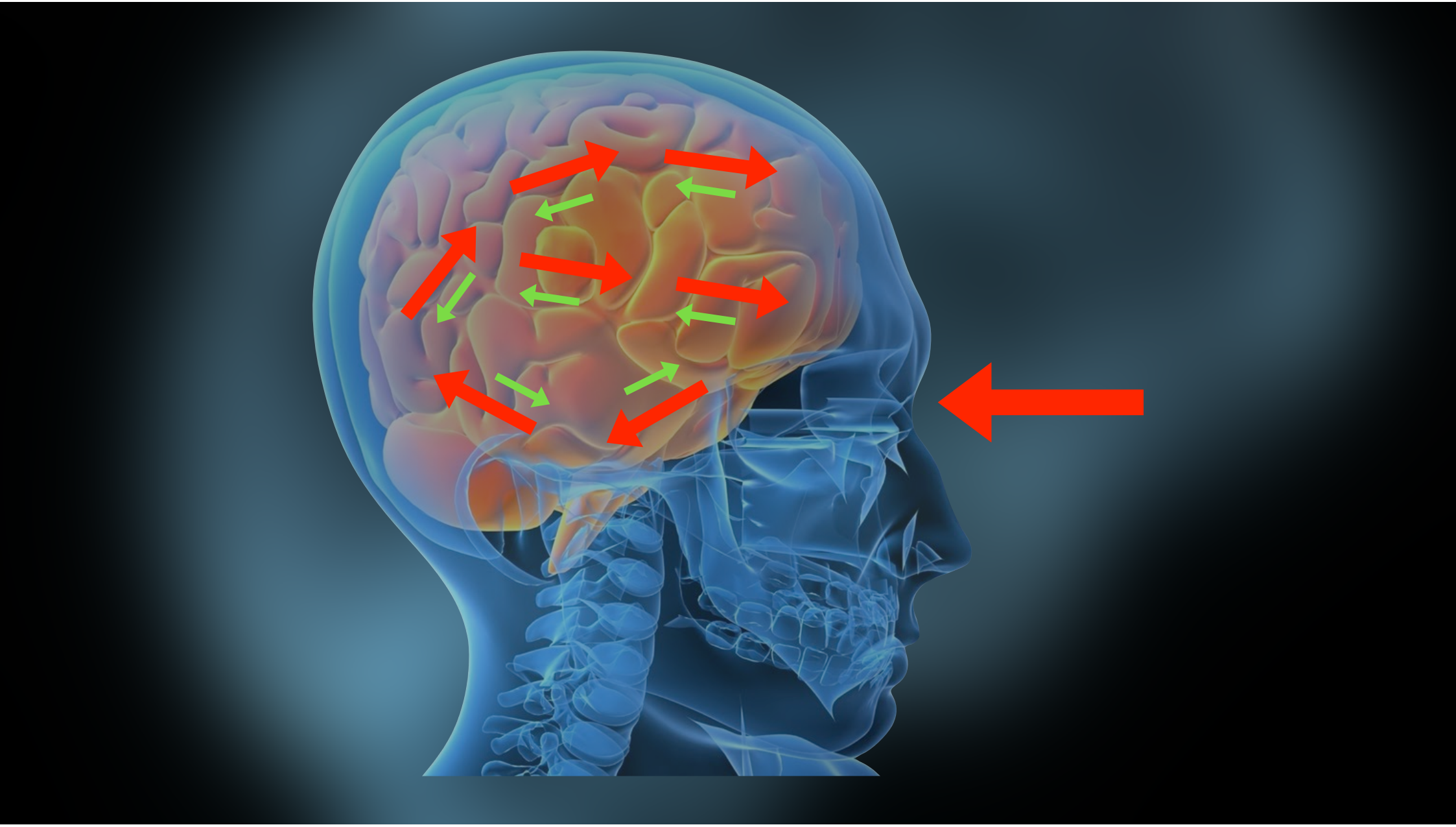
perceptual relativity

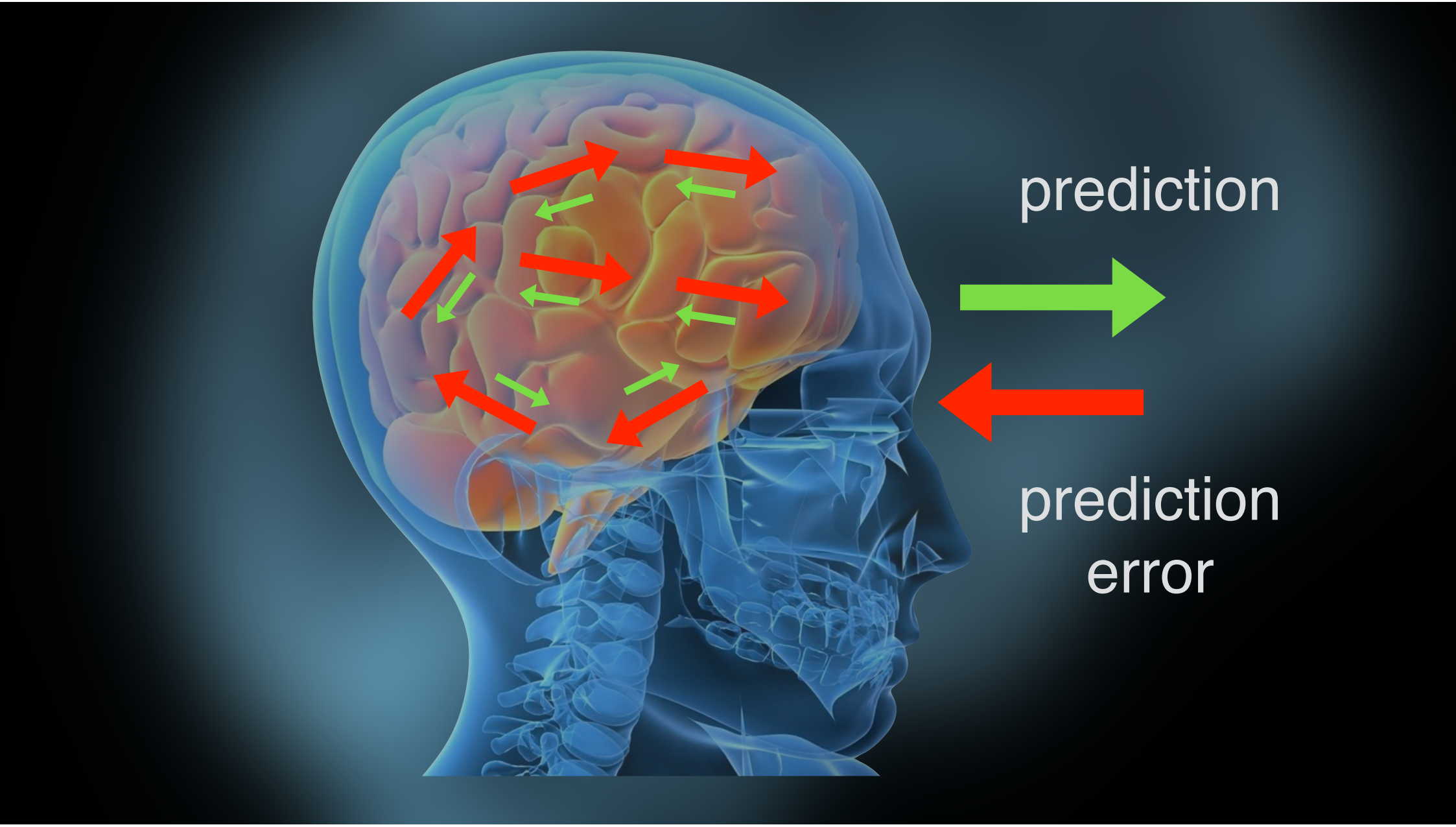


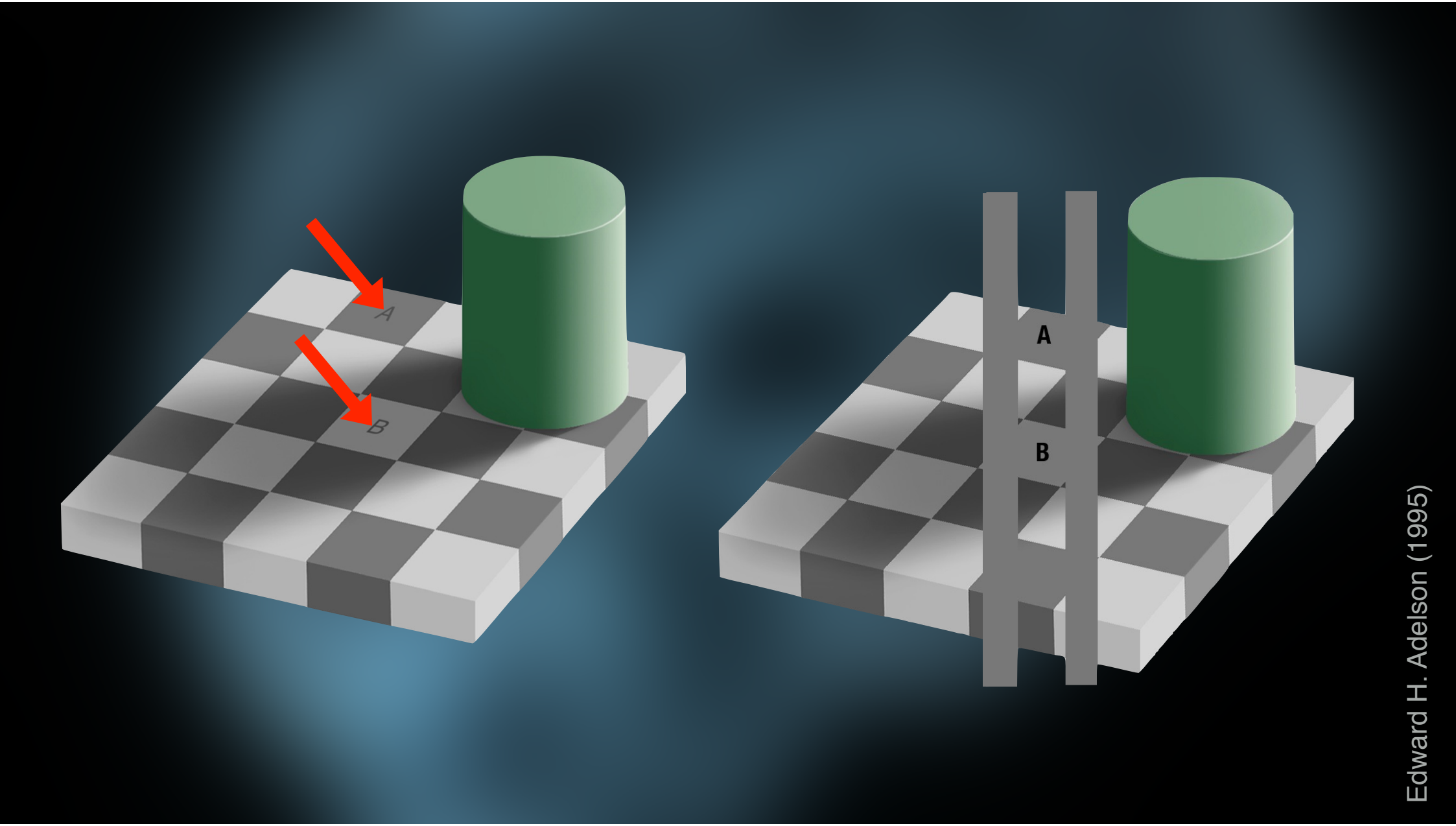
Michael Bach (2018)


how things seem
is not how they are


NEWSPAPER

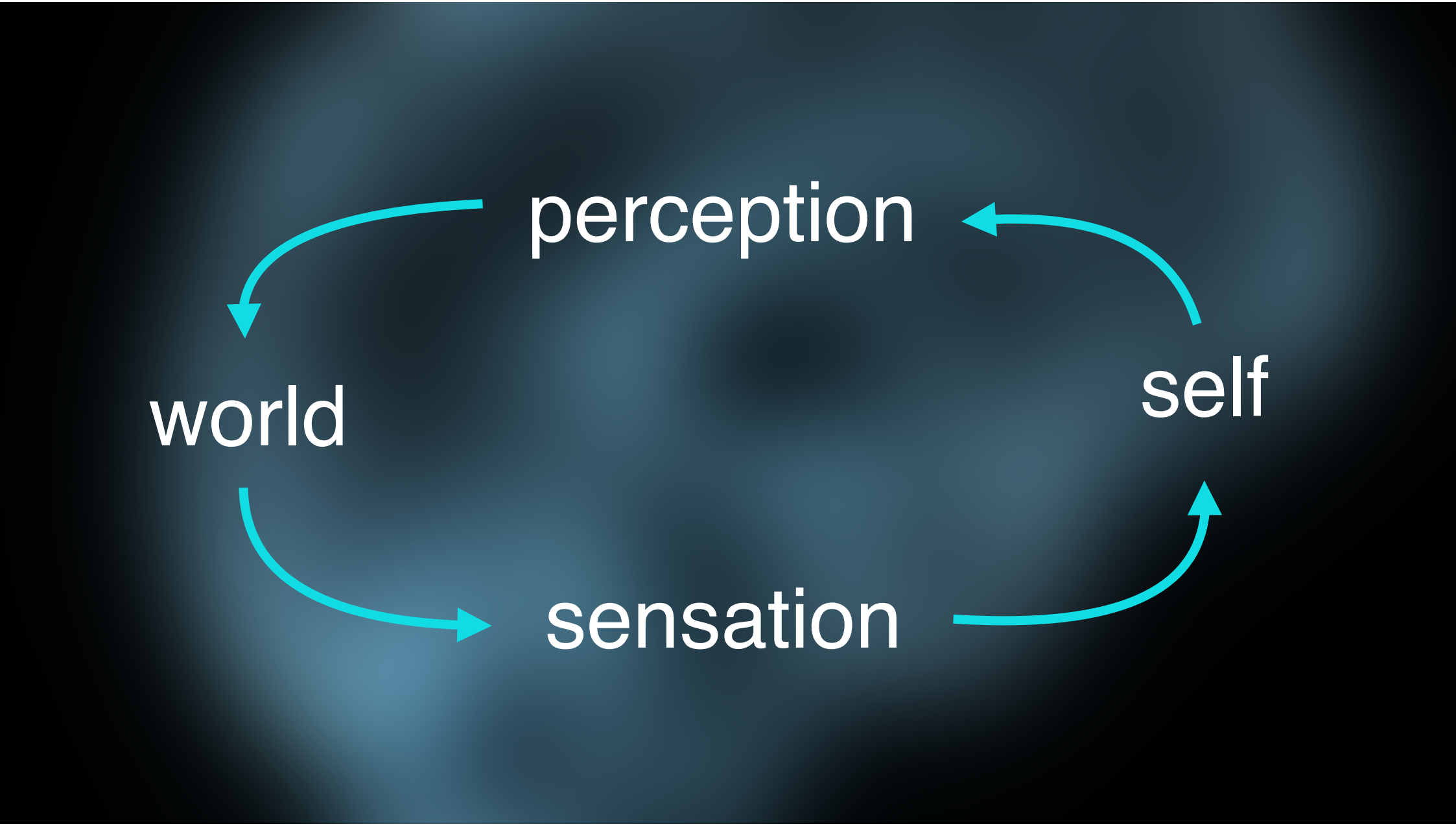


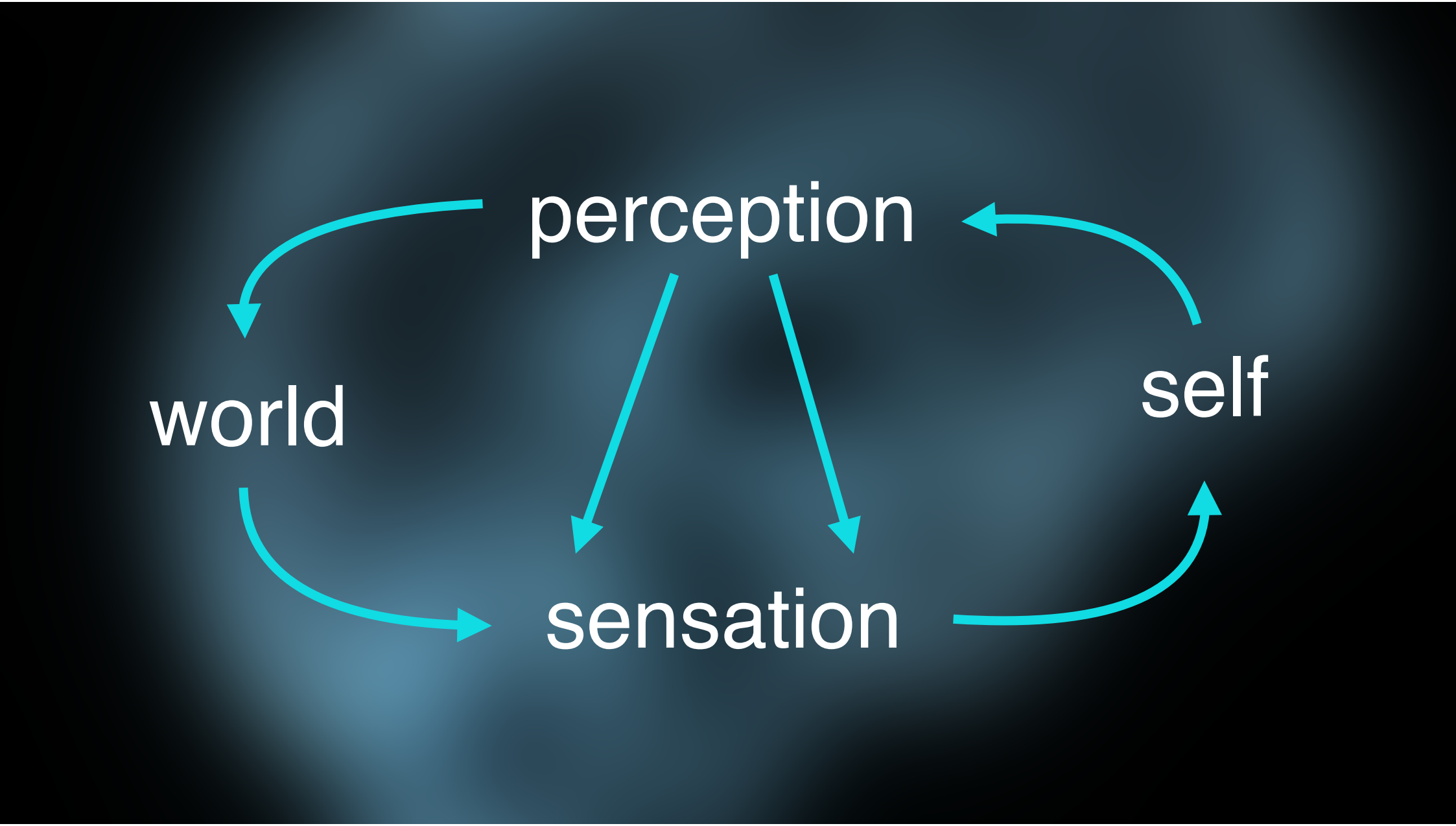

prediction
prediction
error


A
B
A
B
Edward H. Adelson (1995)

not:
I’ll believe it when I see it

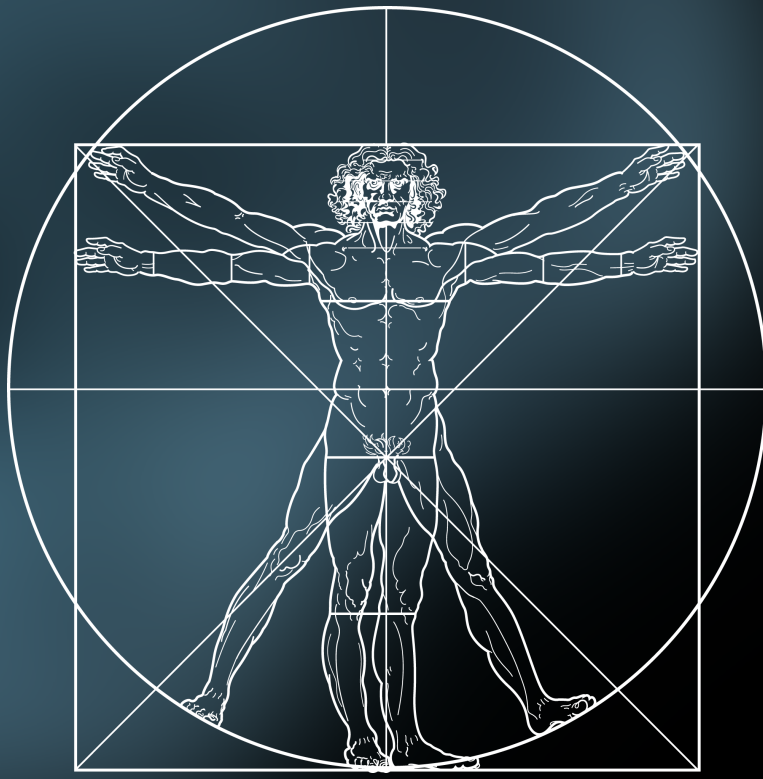
but:
I’ll see it when I believe it


perception
world
self
sensation


perception
world
self
sensation

prediction error

prediction



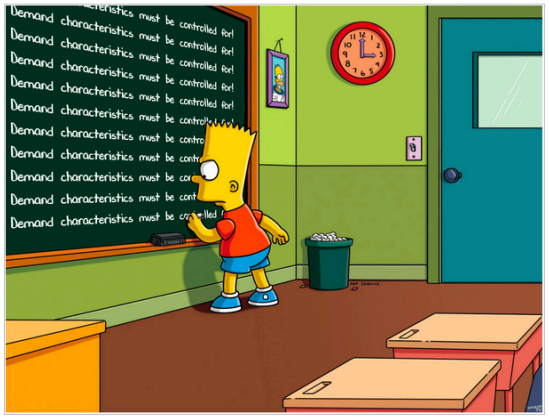
Botvinick & Cohen (1998) Nature

Movie (c) Mehring lab, University of Freiburg, 2009

What's up with the rubber hand illusion?

POSTED ON NOVEMBER 9, 2020 BY AKSETH

Anil Seth, Warrick Roseboom, Zoltán Dienes, and Peter Lush
University of Sussex, Brighton, UK



The rubber hand illusion (RHI) is a cornerstone of the scientific literature on embodiment. We have recently published a series of studies investigating the RHI, in particular its relationship to hypnotic (imaginative) suggestibility, and the validity of commonly used control conditions. These studies have generated substantial discussion regarding our claims, how they should be interpreted, and what all this means for past and future experimental studies of embodiment experiences. To clarify these issues, here we first summarise our main points (there is of course much more in the papers) and then provide responses to some frequently asked questions.

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https://neurobanter.com/2020/11/09/whats-up-with-the-rubber-hand-illusion/

nature COMMUNICATIONS

ARTICLE

https://doi.org/10.1038/s41467-020-18591-6 OPEN

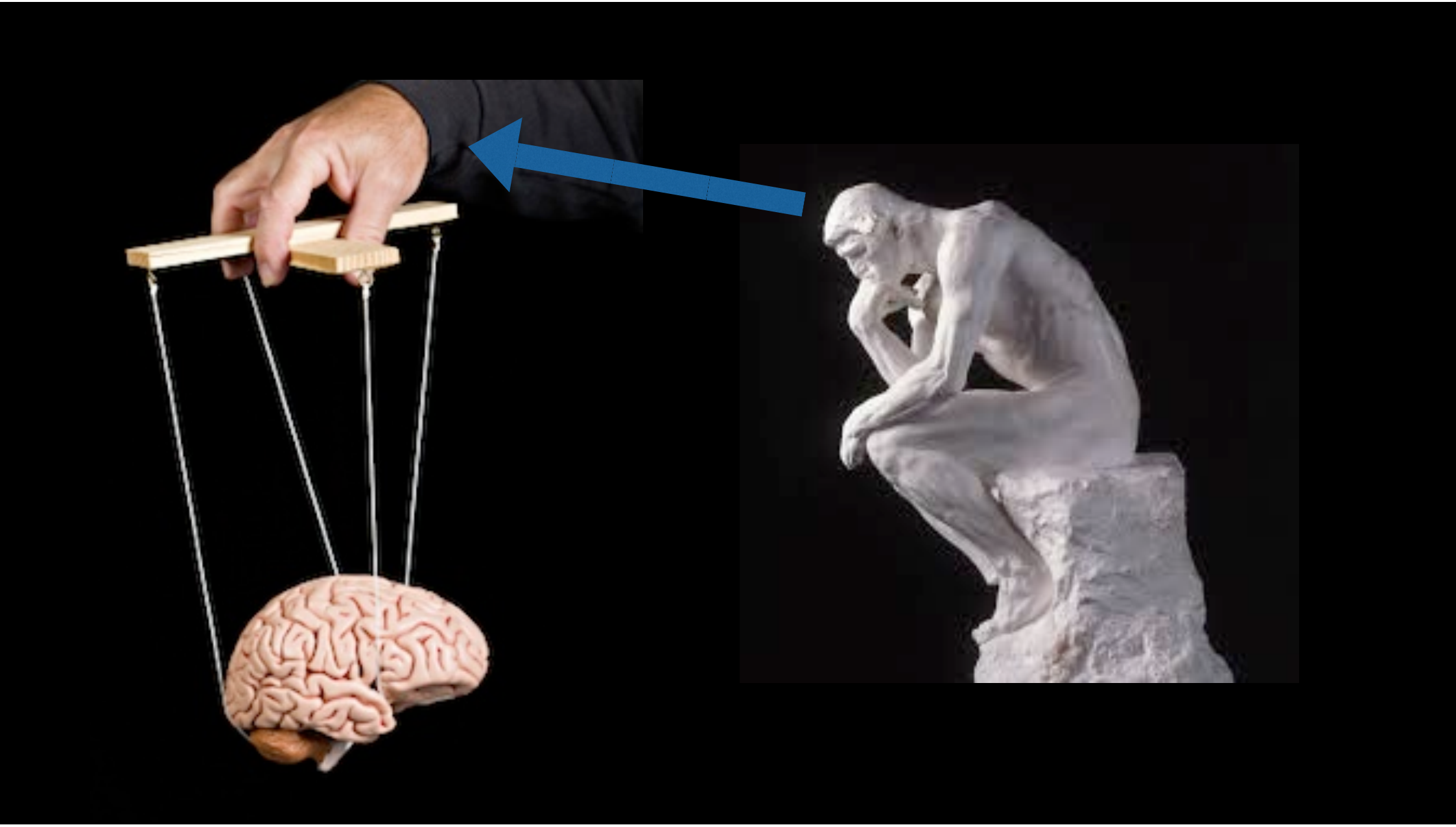
Trait phenomenological control predicts experience of mirror synaesthesia and the rubber hand illusion

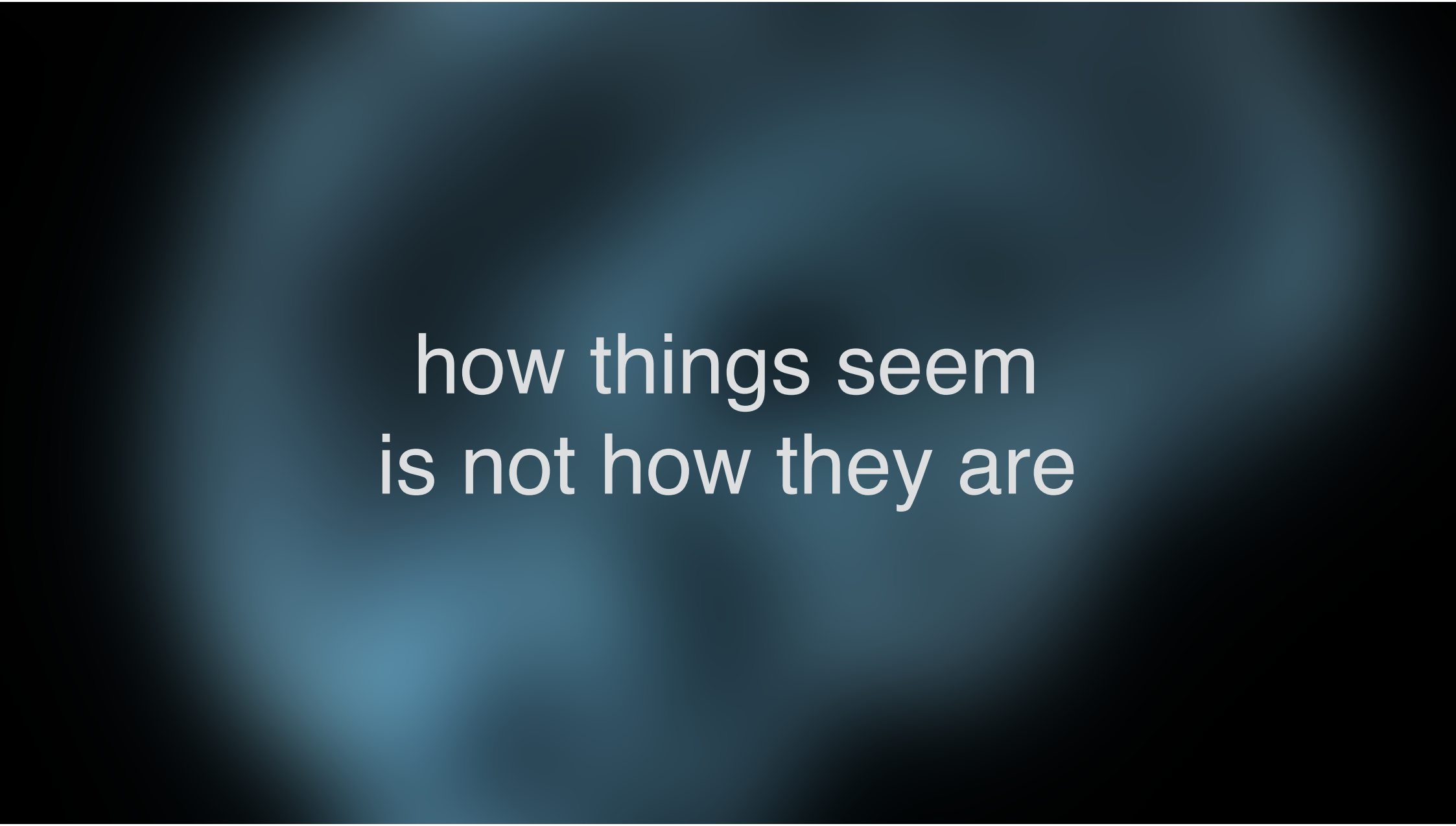
P. Lush[1,2✉], V. Botan[1,3], R. B. Scott[1,3], A. K. Seth[1,2,4], J. Ward[1,3] & Z. Dienes[1,3]

In hypnotic responding, expectancies arising from imaginative suggestion drive striking experiential changes (e.g., hallucinations) — which are experienced as involuntary — according to a normally distributed and stable trait ability (hypnotisability). Such experiences can be triggered by implicit suggestion and occur outside the hypnotic context. In large sample studies (of 156, 404 and 353 participants), we report substantial relationships between hypnotisability and experimental measures of experiential change in mirror-sensory synaesthesia and the rubber hand illusion comparable to relationships between hypnotisability and individual hypnosis scale items. The control of phenomenology to meet expectancies arising from perceived task requirements can account for experiential change in psychological experiments.

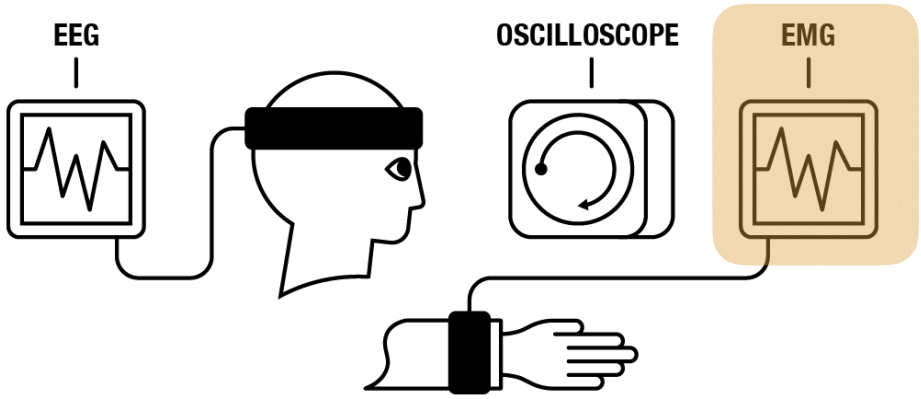
Lush et al (2020) Nature Communications
Seth et al (2020) Neurobanter


voluntary action

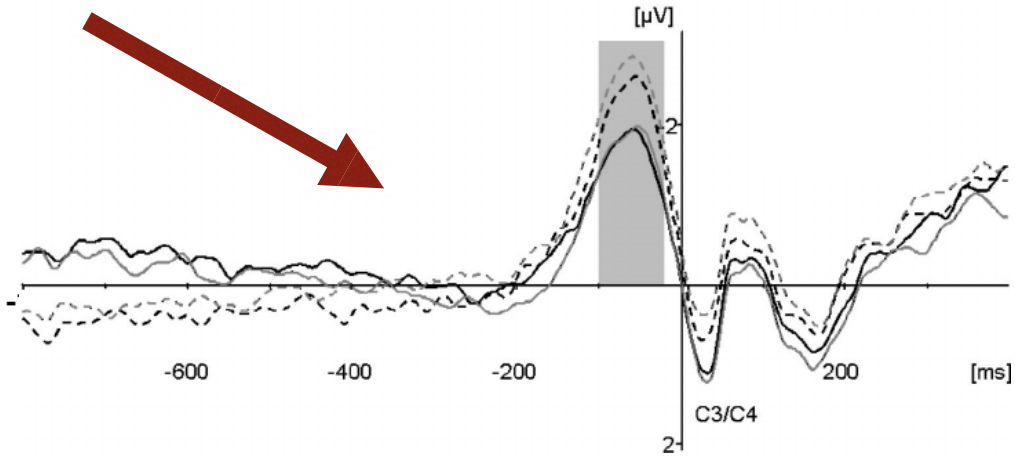



how things seem
is not how they are

the Libet studies



‘readiness potential’



Libet et al (1983) Brain

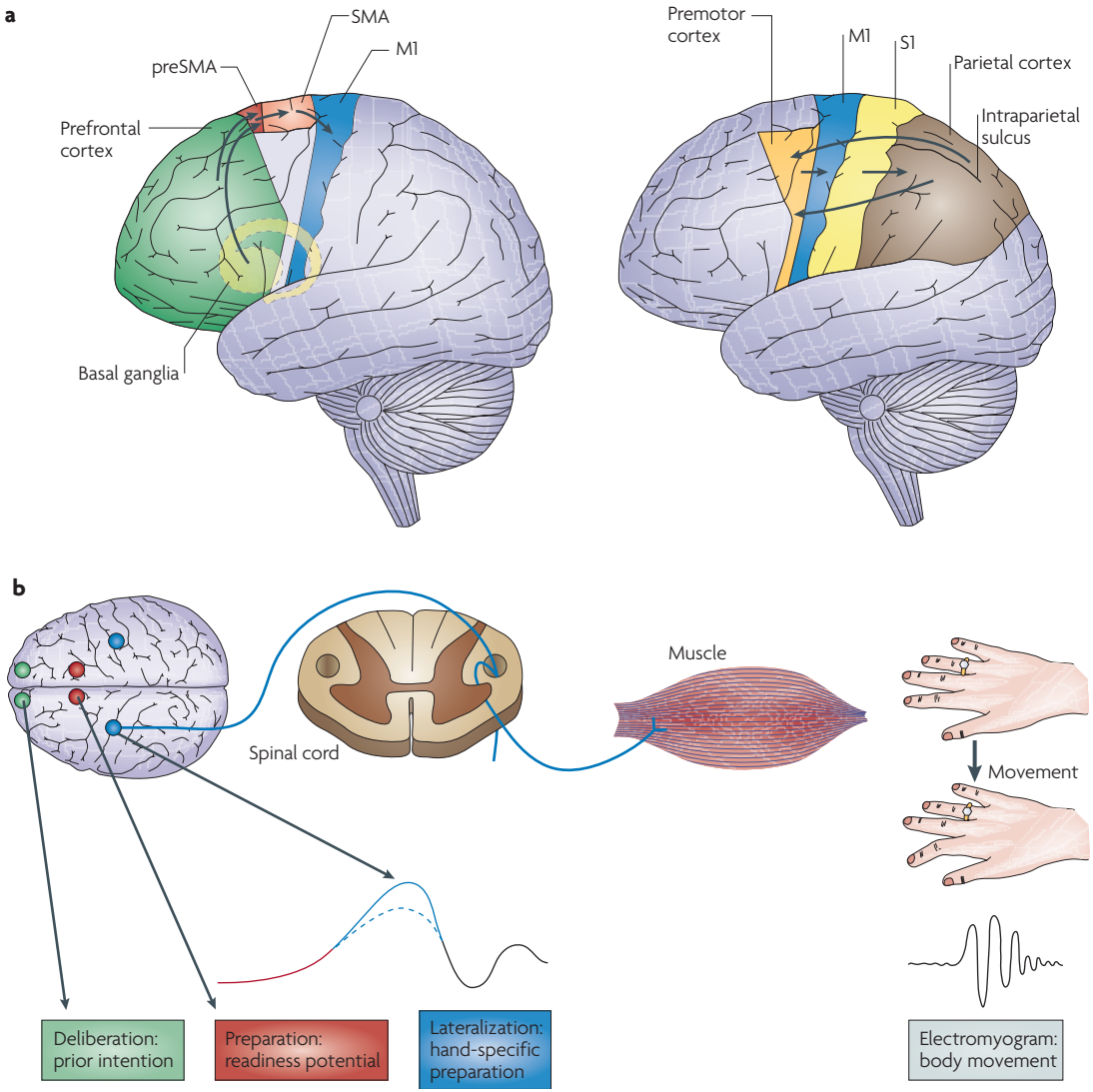
the Libet studies

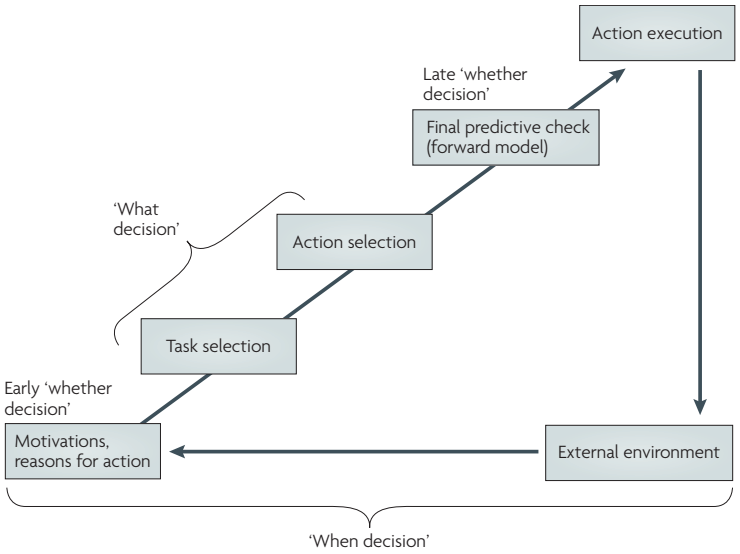
- does the conscious ‘urge’ cause the voluntary action?
- does the readiness potential cause both?
- if so, what place could there be for ‘free will’?
- (maybe there could still be ‘free won’t’?)

- the experience of volition is a special kind of perception

what do voluntary actions feel like?

- feeling of being aligned with beliefs, values, and goals (which I cannot choose)
- feeling that 'I could have done otherwise'
- feeling of being caused 'from within'





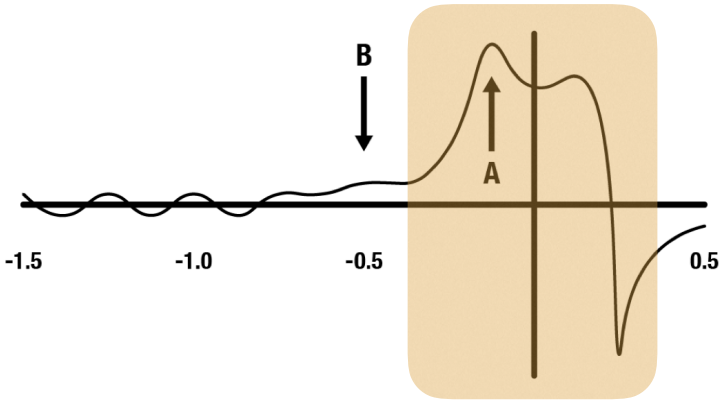
Haggard et al (2008) Nat Neuro Rev

the experience of ‘free will’

- the experience of free will is the perception of the looping operation of this network
- experiences of ‘free will’ do not cause things to happen
- experiences of ‘free will’ are perceptions of the causes of voluntary actions

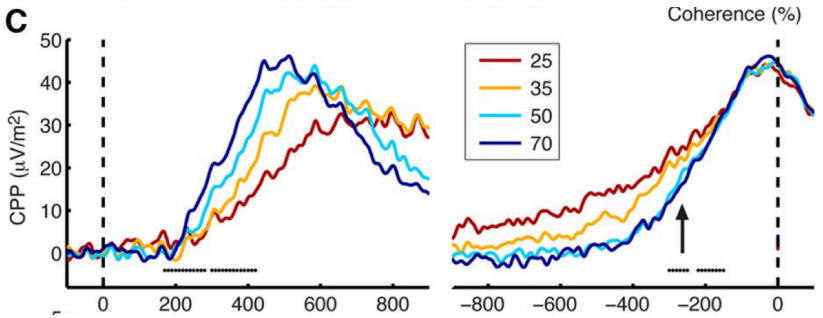
- just as the content of a visual experience might be ‘red’, the content of a ‘free will’ experience might be ‘I caused something to happen’
- … and just as ‘red’ doesn’t really exist, neither does ‘free will’

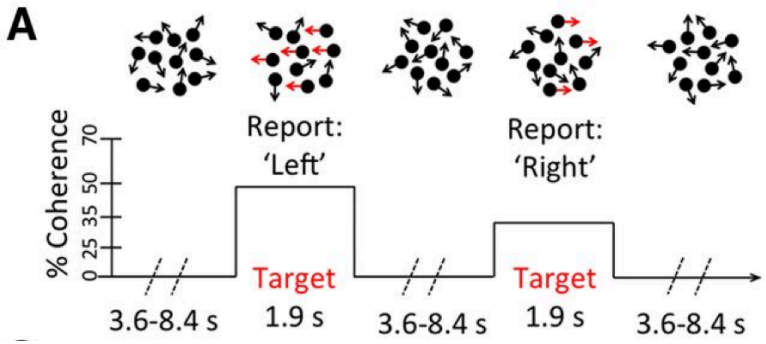
volition



Schurger et al (2012) Proc Nat Acad Sci USA

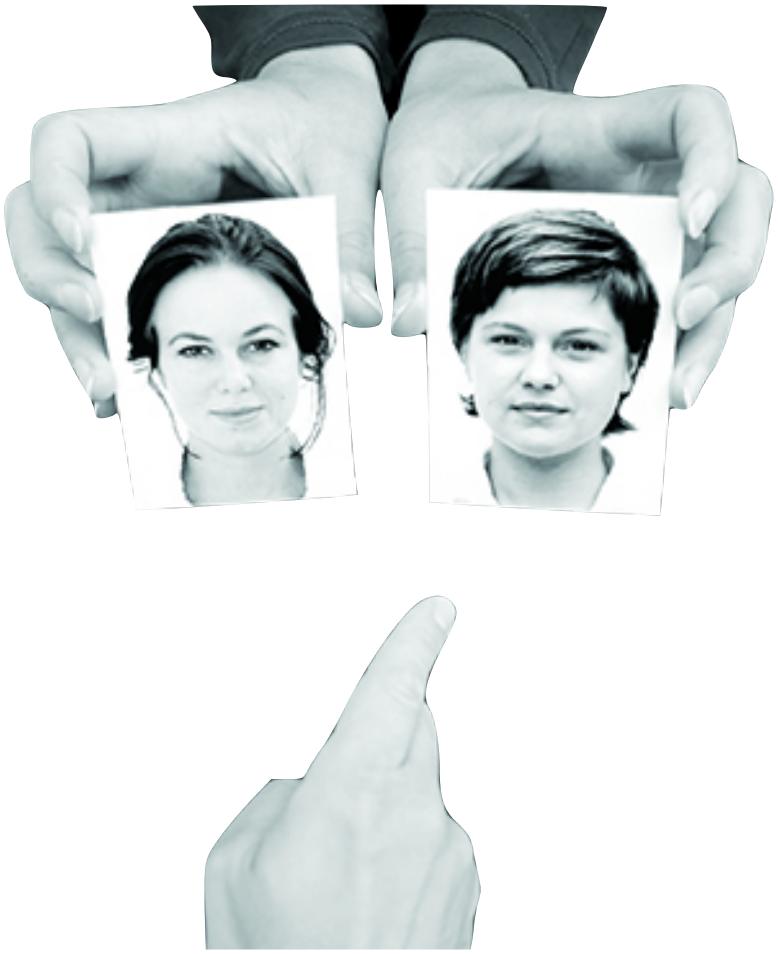
perception

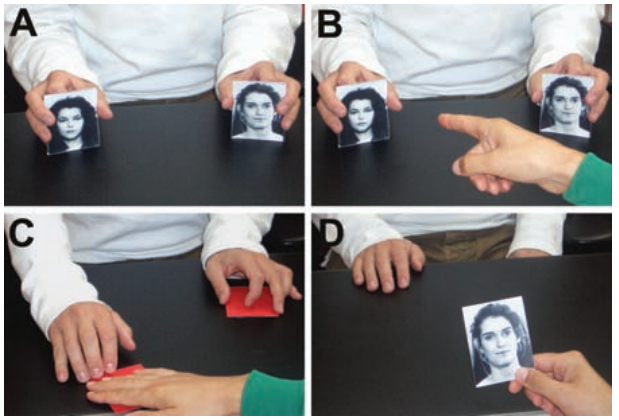




Kelly & O'Connell (2013) J Neurosci

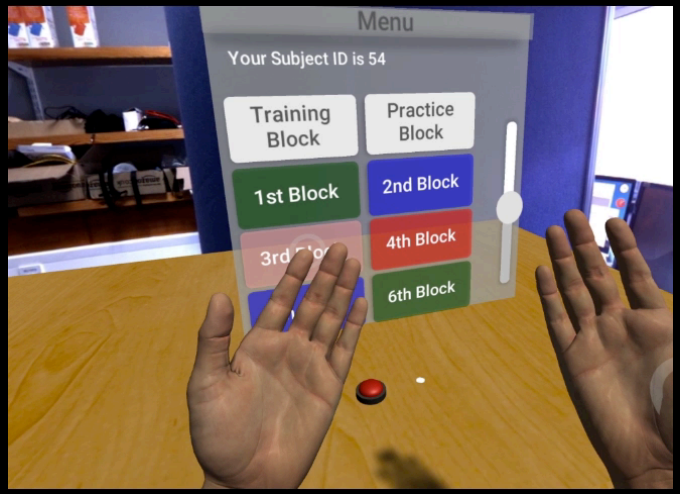
Seth (2021) Being You



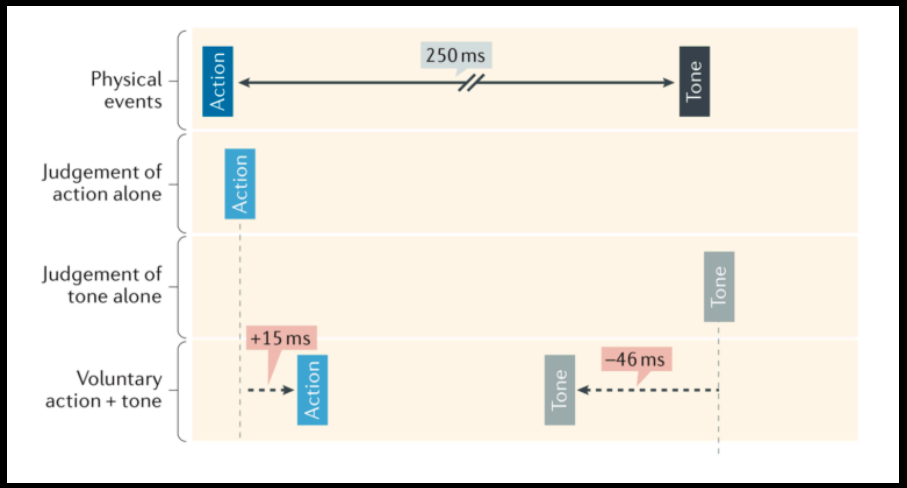


Type	%		
Specific Conf.	13.3		She's radiant. I would rather have approached her at a bar than the other one. I like earrings! [M]
Detailed Conf.	17.3	She looks like an aunt of mine I think, and she seems nicer than the other one. [F]	
Emotional Conf.	9.3		Yes, well, [laughter] she looks very hot in this picture. [M]
Simple Conf.	10.8		Just a nice shape of the face, and the chin. [M]
Relational Conf.	21.3		I thought she had more personality, in a way. She was the most appealing to me. [F]
Uncertainty	11.6	Eh... I don't know. [F]	
Dynamic report	5.2		Oh, [short laughter] Why did I choose her? She looks very masculine! [M]
Original choice	11.2	Because she was smiling. [F]	

Johansen et al (2005) Science



active movements



intentional binding

passive movements

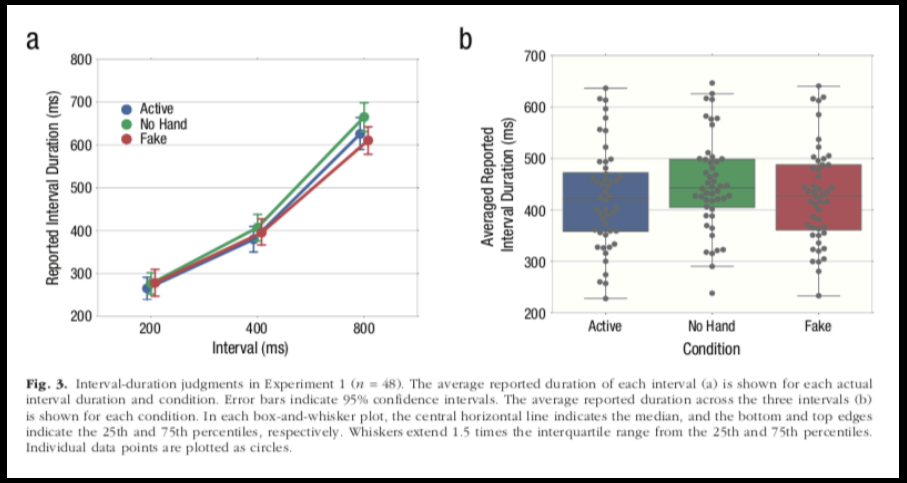


Fig. 3. Interval-duration judgments in Experiment 1 (n = 48). The average reported duration of each interval (a) is shown for each actual interval duration and condition. Error bars indicate 95% confidence intervals. The average reported duration across the three intervals (b) is shown for each condition. In each box-and-whisker plot, the central horizontal line indicates the median, and the bottom and top edges indicate the 25th and 75th percentiles, respectively. Whiskers extend 1.5 times the interquartile range from the 25th and 75th percentiles. Individual data points are plotted as circles.

Suzuki et al (2019) Psychological Science

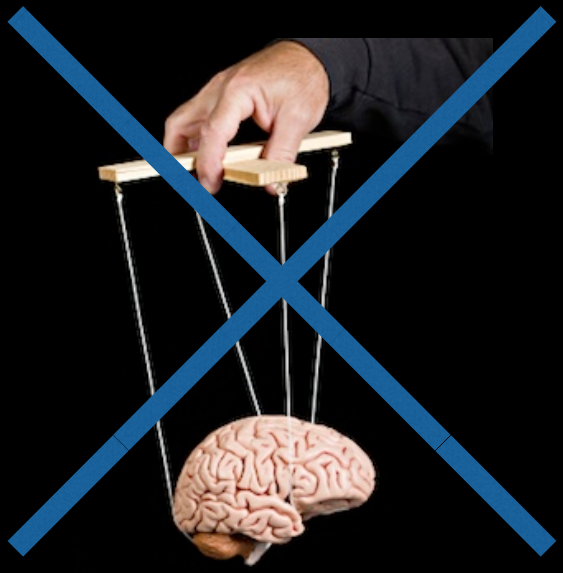
free will is for the future

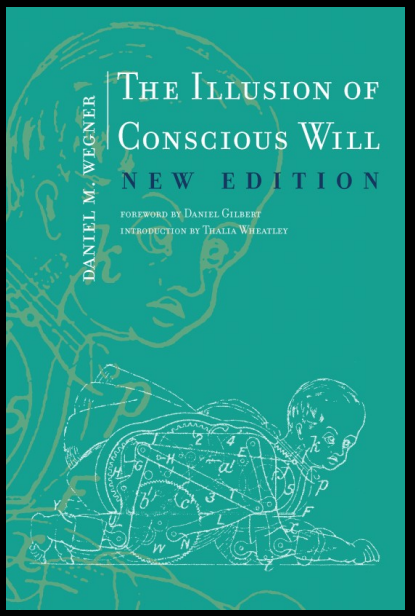
- if experiences of ‘free will’ do not cause things to happen, what is the point of having them?
- experiences of volition are the brain’s way of keeping track of those actions that are caused largely from within
- (and their consequences)
- this is useful for learning
- the utility of feeling ‘I could have done otherwise’ is that next time, you might


experiences of free will
help us learn

is ‘free will’ an illusion?

- yes
- there is no spooky soul-powered ‘uncaused cause’, no Cartesian residue of immaterial rationality



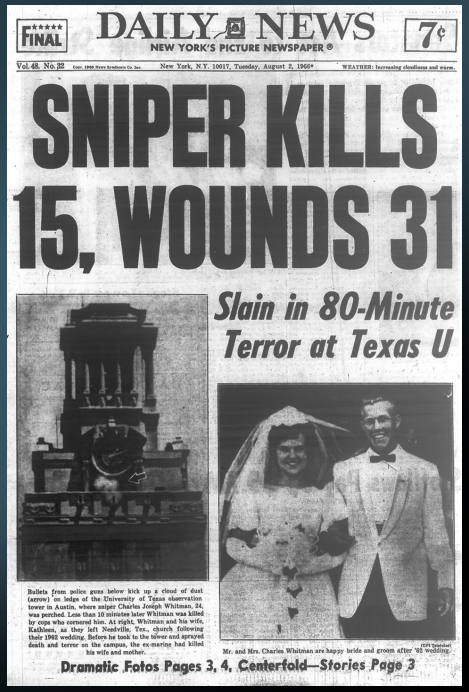


Daniel Wegner (2002)

is ‘free will’ an illusion?

- no
- the ability to perform voluntary actions (and learn from their outcomes) is very real indeed

alien hand syndrome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DAILY NEWS
NEW YORK'S PICTURE NEWSPAPER

7¢

Vol. 48, No. 32 New York, N.Y. 10017, Tuesday, August 2, 1966*

SNIPER KILLS 15, WOUNDS 31

Slain in 80-Minute Terror at Texas U

Bullets from police guns below kick up a cloud of dust (arrow) on ledge of the University of Texas observation tower in Austin, where sniper Charles Joseph Whitman, 24, was perched. Less than 10 minutes later Whitman was killed by cops who cornered him. At right, Whitman and his wife, Kathleen, as they left Needville, Tex., church following their 1962 wedding. Before he took to the tower and sprayed death and terror on the campus, the ex-marine had killed his wife and mother.

Mr. and Mrs. Charles Whitman are happy bride and groom after '62 wedding

Dramatic Fotos Pages 3, 4, Centerfold—Stories Page 3

Charles Whitman

responsibility and reward

- western law assigns blame based on *actus rea* (guilty action) and *mens rea* (guilty mind)
- we don't choose to have the brains that we have

THE SATURDAY EVENING POST 17

What Life Means to Einstein

An Interview by George Sylvester Viereck

RELATIVITY! What word is more symbolic of the age? We have ceased to be positive of anything. We look upon all things in the light of relativity. Relativity has become the plaything of the parlor philosopher.

Is there any standard that has not been challenged in this our post-war world? Is there any absolute system of ethics, of economics or of law, whose stability or permanence is not assailed somewhere? Can there be any permanent value or any absolute truth in a world in which the three angles of the triangle have ceased to be equal to two right angles—in a world in which time itself has lost its meaning, in which infinity becomes finite, and the finite is lost in the infinite?

Einstein refuses to sponsor newfangled theories which draw their justification from his own assault upon the certainties of mathematics. His voice was bell-like and gentle, but his words were decisive when he smashed with one sentence the rash application of the term "relativity" to philosophy and to life.

"The meaning of relativity," he said, "has been widely misunderstood. Philosophers play with the word, like a child with a doll. Relativity, as I see it, merely denotes that certain physical and mechanical facts, which have been regarded as positive and permanent, are relative with regard to certain other facts in the sphere of physics and mechanics. It does not mean that everything in life is relative and that we have the right to turn the whole world mischievously topsy-turvy." I now remembered that some years ago, when I first met Einstein in New York, he had emphatically resisted the suggestion that he was a philosopher. "I am," he said, "solely a physicist." In spite of these denials, Einstein stands in a symbolic relation to our age—an age characterized by a revolt against the absolute in every sphere of science and of thought. He is a child of his age even if he eschews metaphysics.

A Born Teacher

LIKE Napoleon, like Mussolini, Albert Einstein has the distinction of having become an almost legendary figure in his own lifetime. No man since Copernicus, Galileo and Newton has wrought more fundamental changes in our attitude toward the universe. Einstein's universe is finite. Seen through Einstein's eyes, space and time are almost interchangeable terms. Time appears caparisoned as a fourth dimension. Space, once undefinable, has assumed the shape of a sphere. Einstein taught us that light travels in curves. All these facts are deducted from the theory of relativity advanced by Einstein in 1915.

The World-Famous Physicist and Mathematician Explaining a Problem to His Secretary While Dictating to Her

With the advent of Einstein, mathematics ceased to be an exact science in the fashion of Euclid. The new mathematics appeared in the midst of the World War. It is not impossible that in the evolution of human thought Einstein's discovery may play a greater part than the Great War. His fame may outlive Foch and Ludendorff, Wilson and Clemenceau.

Einstein, in the words of his favorite colleague, Erwin Schrödinger, explains the fundamental laws of mechanics as geometrical proportions of space and time.

I shall not attempt to expound this statement. It is said that only ten men understand Einstein's theory of relativity.

PHOTOS FROM KEYSTONE VIEW COMPANY, INC.

Doctor Einstein Accompanying Mrs. Einstein's Piano Song With His Violin

Einstein's patience is infinite. He likes to explain his theories. A born teacher, Einstein does not resent questions. He loves children. The ten-year-old son of a friend was convinced that he had discovered the secret of perpetual motion. Einstein painstakingly explained to him the flaw in his calculations.

Whenever a question involving a difficult mathematical problem comes up, Einstein immediately takes up his pencil and covers page after page with the most intricate equations. He does not refer to a textbook; he works out such formulas immediately himself. Often the formula thus obtained is clearer, more comprehensible and more perfect than the equation that is found in books of reference.

Time in Space

RECENTLY someone talked to him about color photography. Einstein immediately revolved the subject in his mind. He studied the camera, he made various calculations, and before the evening was over, he had evolved a new method of color photography.

It is difficult for him to explain his theories when he writes an article for lay consumption. But when the inquiring layman exposes the abysses of his ignorance face to face with Einstein, the great mathematician usually succeeds in bridging the gulf with an apt illustration. Talking to him, I saw in a flash not only a fourth dimension but numerous others. Glowing with pride in my achievement, I scribbled down a sentence here and there, but afterward my notes were as difficult to interpret as the fantastic network of a dream.

"How can I form at least a dim idea of the fourth dimension?"

"Imagine," Einstein replied, slightly inclining his head with the crown of curly white hair, "a scene in two-dimensional space—for instance, the painting of a man reclining on a bench. A tree stands beside the bench. Then imagine that the man walks from the bench to a rock on the other side of the tree. He cannot reach the rock except by walking either in front of or behind the tree. This is impossible in two-dimensional space. He can reach the rock only by an excursion into the third dimension.

"Now imagine another man sitting on the bench. How did he get there? Since two bodies cannot occupy the same place at the same time, he can have got there only before or after the first man moved. He must have moved in time. Time is the fourth dimension. In a similar manner it is possible to explain five, six and more dimensions. Many problems of mathematics are simplified by assuming the existence of more dimensions."

(Continued on Page 110)

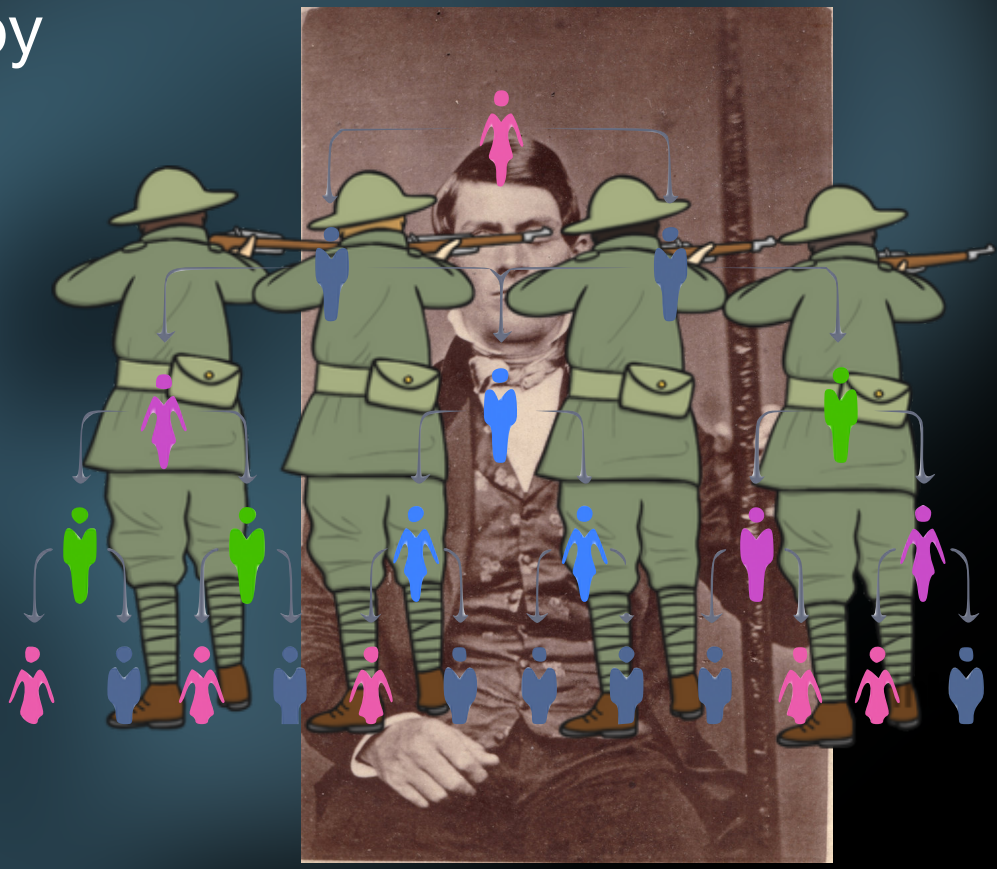
Saturday Evening Post (1929)


implications

it’s not all about rationality

voluntary actions have many causes

- voluntary actions are shaped by
  - intentions
  - emotions
  - other people



Phineas Gage

Caspar et al (2020) Nature Communications


free will is for the future
Choice
EXIT NOW

summary

summary

- ‘spooky’ free will doesn’t exist,
- but voluntary actions are real
- experiences of free will do not cause voluntary actions …
- … they are perceptions of the causes of these actions,
- and they are essential for learning (so that we might do better the next time)

- cultivating peoples’ experiences of intention and agency over their actions may help them learn to do better - when flexibility and innovation are required

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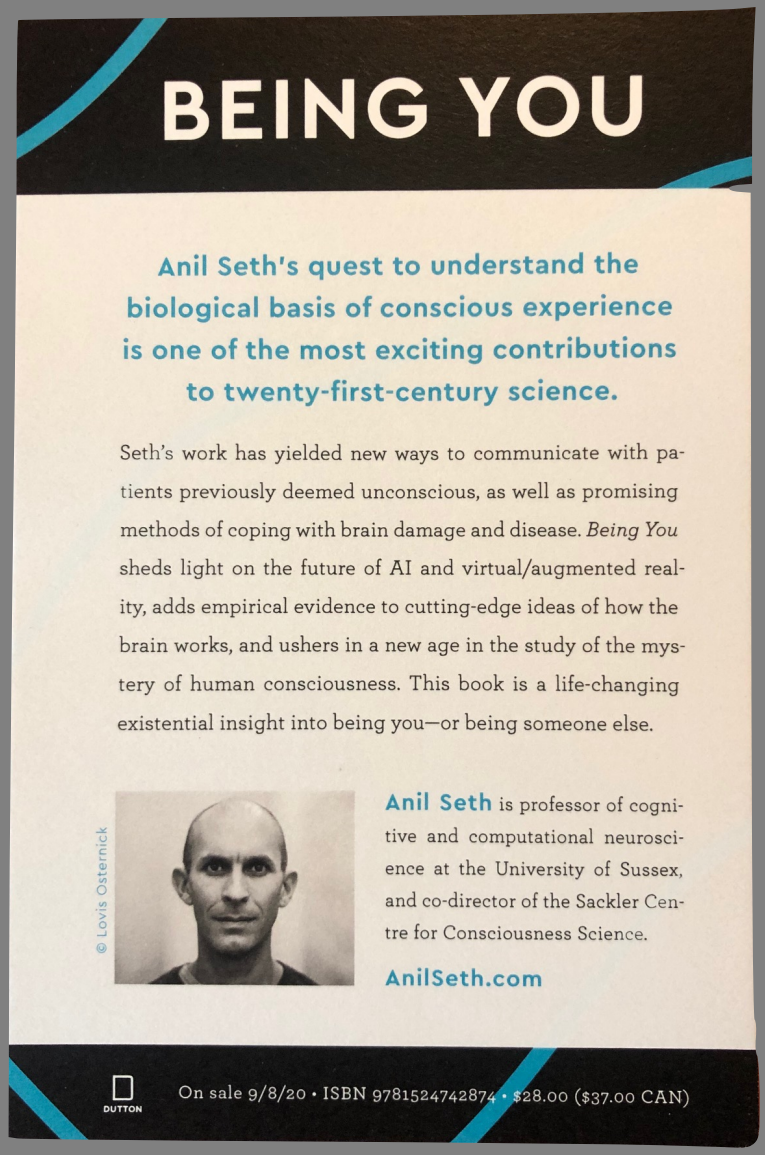


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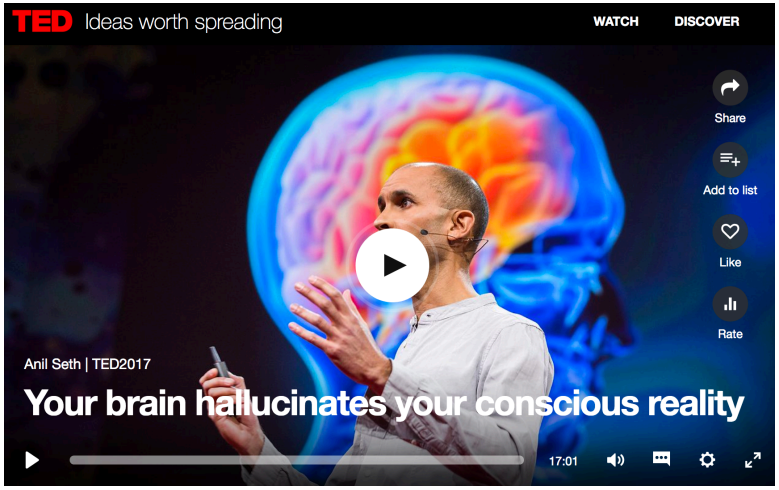
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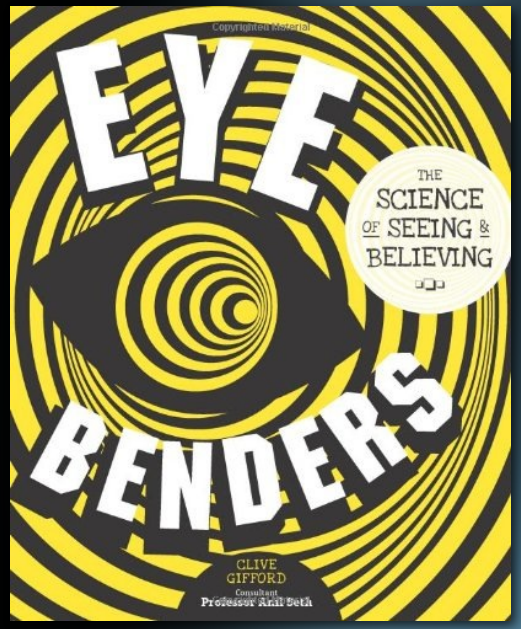
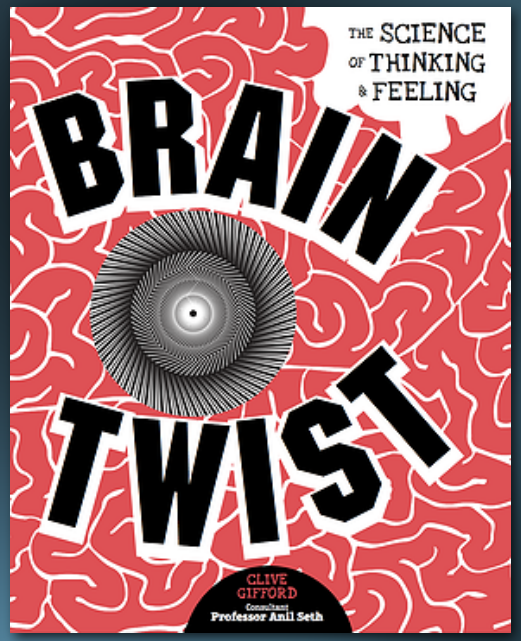
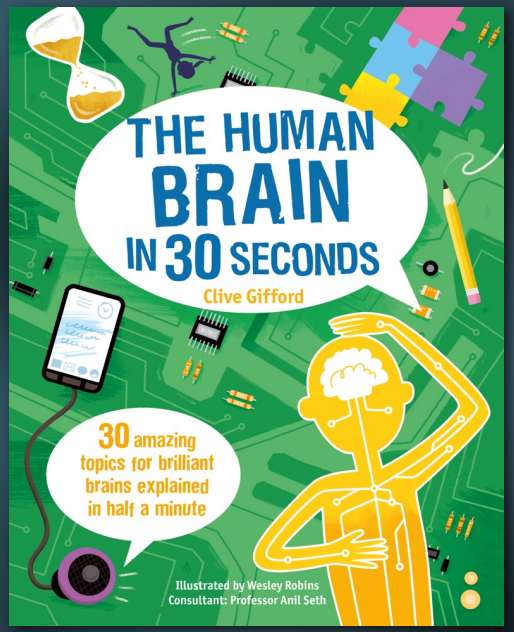
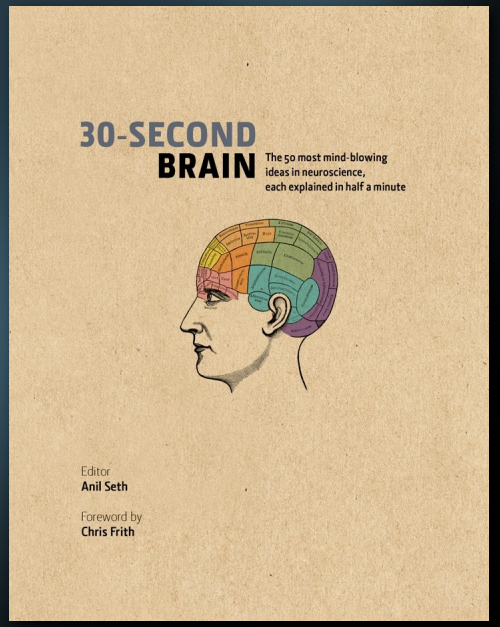
THE MOST UNKNOWN









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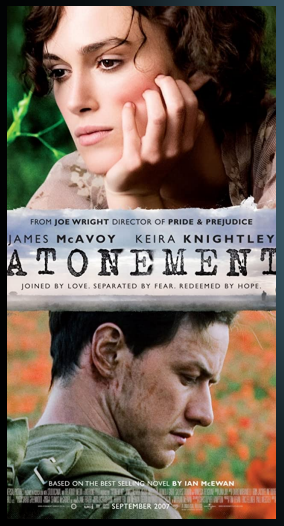
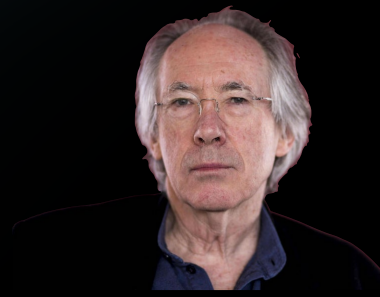
Being You: A New Science of Consciousness
coming September 2021, Faber/Penguin

“She bent her finger and then straightened it. The mystery was in the instant before it moved, the dividing moment between not moving and moving, when her intention took effect. If she could only find herself at the crest, she thought, she might find the secret of herself, that part of her that was really in charge”





Ian McEwan (2000) Atonement

outline

- perception as inference
- the problem of voluntary action
- voluntary action as a special kind of perception
- ‘free will’ is for the future
- why we make the choices we make

group decision making

- when decisions are made by groups, people's opinions are 'weighted' by the confidence with which they are expressed
- but people differ in how confident they are, for a given level of accuracy
- so how to reach the optimal consensus?
- evidence indicates that people engage in confidence matching

Bang et al (2017) Nature Human Behavior