

## NEUROSCIENCE

# Consciousness: What, How, and Why

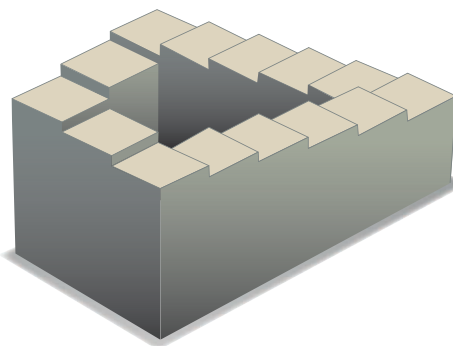
Michael J. Proulx

Children love perceptual illusions such as Penrose stairs (see illustration), which appear to always proceed up (or down), or the similar audio experience provided by a Shepard-Risset glissando (1). Cognitive scientists, curious and young at heart, do, too. Why do many other adults grow out of this fascination with the ways the brain plays tricks on us? One reason might be that illusions are “magic tricks” and therefore seem irrelevant when it comes to normal experience. After all, stairs and musical notes cannot rise or fall continuously and end up back where they began. Illusions are scientifically interesting, however, precisely because they are directly relevant to daily life and reveal that even perceiving something as simple as this black pigment on a page is an illusion in a sense. The “magic” of consciousness is that we think we are experiencing the world through our eyes and ears, but really everything is seen and heard in the brain.

These facts (and their possible implications for a biological definition of the soul) were the crux of Francis Crick’s “astonishing hypothesis” (2). Crick focused on research methodology to examine an “easy” aspect of consciousness: that of awareness for simple visual elements such as color. When many people think about what it is to be conscious, however, something much harder comes to mind: one’s private, inexplicable feelings that arise from thinking about something. In *Soul Dust*, Nicholas Humphrey begins where Crick and others have left off. He audaciously aims to provide a theoretical basis for understanding the level of consciousness that corresponds with one’s personal qualitative experience. Whereas Crick might have focused on the representation of one’s awareness of one aspect of the Penrose stairs, Humphrey (a psychologist at the London School of Economics) wants to explain the entirety of one’s feeling of what it is like to experience that illusion. As he warns, the book is not an easy read. But his very personal account of his ideas and their development offers engaging “excursions into speculative neuroscience.”

Just as the trick that makes an illusion possible takes place in the brain, all conscious

experience is created there. Humphrey describes the personal experience of a tomato’s redness. That one’s experience of redness is personal, private, and constructed in one’s brain does not mean that the tomato is an illusion or that it might not really be red. Peripheral sensory receptors (such as cone cells) translate the light reflected from the tomato into electrical signals, and the brain represents the tomato’s redness through the activity of neurons. This perception of a discrete color category is an illusion based on a physically continuous spectrum of light. While this category of red is monitored in the brain, that representation may itself be resampled, giving rise to a phenomenological feeling of redness. The personal experience of the color is applied to the tomato even though the feelings of red are all taking place internally. This



projection from internal experiences to external object is the spreading of “soul dust” that informs the book’s title.

For a cognitive scientist who refuses to grow up, this epiphany is empowering. By grounding the hard problem of private, phenomenal consciousness in the easy problem of sensory awareness, Humphrey has laid out a new agenda for consciousness research. Surprisingly, he doubts whether such investigations can be undertaken experimentally at present, and he disparages the approach of looking for consciousness in cognitive studies (such as those examining how we pay attention). He does not, however, entirely write off neuroscience, noting that the presence of primary visual cortex layer 4A in humans (3) but not other apes or monkeys might underlie unique features of our sensory-based consciousness. Humphrey’s empirical pessimism

might have arisen, in part, from his not having delved into the experimental literature as far as Crick did—and thus seeing how far this approach has progressed.

One approach to researching the phenomenology of sensations is hinted at in Humphrey’s quotations from the painter Wassily Kandinsky, who uses musical metaphors to describe color. Kandinsky exhibited synesthesia, the neurobiological condition in which stimulation of one sensory pathway gives rise to automatic experi-

ences in another. Synesthesia research provides the opportunity to study phenomenal experiences that are not present externally.

Toward the end of the book, Humphrey provides some interesting arguments for why consciousness might be adaptive and could have arisen gradually through natural selection, but his discussion falls short of describing a natural history of consciousness. His conclusion that humans are special and have a unique form of consciousness comes across as species chauvinistic and is not well supported. Nonetheless, he makes the point that this should and can be addressed empirically. Perhaps bigger brains provide more circuits for self-reflective (or reentrant) processing

**Ever upward to no avail.** Penrose stairs always return you to the level at which you started.

that gives rise to phenomenal experience. And even in the absence of an evolutionary increase in brain volume, the novel compartmental organization of human primary visual cortex might have increased circuitry: more connections could lead to different reentrant information processing that supports unique, conscious experiences.

Humphrey also considers how the human sense of self and spirituality might have arisen from the adaptive nature of consciousness. His discussion provides an important connection between the current scientific approaches to consciousness that he considered in the early chapters and the crucial aspects of the soul as society sees it. Here he again regrets what he sees as the limited scope of contemporary cognitive science, with its focus on attention instead of attitudes and values. Many cognitive scientists are, however, currently examining the relation between values and attention and thus already on the way to closing this gap.

Crick ended *The Astonishing Hypothesis* with a challenge for vision scientists:

**Soul Dust**  
The Magic  
of Consciousness

by **Nicholas Humphrey**  
Princeton University Press,  
Princeton, NJ, 2011.  
255 pp. \$24.95, £16.95.  
ISBN 9780691138626.

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“consciousness now.” Humphrey’s *Soul Dust* should encourage research into a fuller understanding of phenomenal consciousness and its evolutionary origins: the magic of consciousness now.

#### References and Notes

1. [http://en.wikipedia.org/wiki/Shepard\\_tone](http://en.wikipedia.org/wiki/Shepard_tone).
2. F. Crick, *The Astonishing Hypothesis: The Scientific Search for the Soul* (Scribner, New York, 1994).
3. T. M. Preuss, G. Q. Coleman, *Cereb. Cortex* **12**, 672 (2002).
4. Thanks to A. de Sousa for discussions about the book.

10.1126/science.1206704

#### EXHIBITION: ART

## “All Bespeckled with Yellow Stains”

Dirt is inescapable, nor can we escape the ironies it generates. Those who work in laboratories constantly worry about contamination from dirt, but others make a living from organizing dirt or scavenging in our waste tips. Fortunately, the exhibition *Dirt: The Filthy Reality of Everyday Life* is arranged in a perfectly clean room. In case we are worried, there is a broom propped in one corner. This appears to be splattered in paint and quite forgotten, but this is the Wellcome Collection—and sure enough, there is an explanatory plaque that relates to it. The splatters are in fact precious stones embedded in the woodwork by the artist Susan Collis, who likes to challenge our perceptions of the value of the everyday. Thus too, scavengers value everyday dirt that the privileged can afford to discard.

The exhibition offers a grand tour of conceptions of dirt from grit to germs at six locations and periods. We start in 17th-century Delft, where cleanliness was indeed devotional. But one citizen of Delft, Antonie van Leeuwenhoek, inspected life in Delft more closely with his tiny single-lensed microscopes and discovered an unsweepable universe of the minuscule. Blue and white ceramic Delftware portraits of him were quite common, perhaps encouraging the vir-

#### Dirt

The Filthy Reality of Everyday Life

*Kate Forde, James Peto, and Lucy Shanahan, curators*

Wellcome Collection, London. Through 31 August 2011. [www.wellcomecollection.org/whats-on/exhibitions/dirt.aspx](http://www.wellcomecollection.org/whats-on/exhibitions/dirt.aspx)

#### Dirt

The Filthy Reality of Everyday Life

*by Rosie Cox, Rose George, R. H. Horne, Robin Nagle, Elizabeth Pisani, Brian Ralph, and Virginia Smith*

Profile, London, 2011. 224 pp. Paper, £20. ISBN 9781846684791.



**Dust for bricks.** E. H. Dixon’s watercolor (1837) of the Great Dust-Heap at King’s Cross, London. The mound, next to Battle Bridge and the Smallpox Hospital, was removed in 1848 “to assist in the rebuilding” of Moscow.

tuous housewives of Delft to even more strenuous efforts. The engravings of Geertruid Roghman are a testament to the sheer hard labor required of women in their daily efforts to keep Dutch households clean.

Serena Korda, inspired by the commodification of waste in Victorian London, has made a pile of red bricks using dust for their matrix. A list of dust sponsors hangs beside the bricks and includes, suitably, donations from occupants of the London School of Hygiene and Tropical Medicine. Brick was, of course, the primary building material for the Victorians’ most magnificent engineering achievement: Joseph William Bazalgette’s sewers were built to enclose and divert the stench of the Thames downstream. The huge (and valuable) dustheaps at Gray’s Inn Road and King’s Cross, from which Victorian brick was made, have long gone; fittingly, a vast medical research center is now under construction in this area. But in 1854 the Thames was London’s sewer, and cholera stormed through Soho via the contaminated water of the Broad Street pump. Despite the Medical Council’s studious collection of detailed data, John Snow’s painstaking work to identify the source of cholera was trashed by the miasmatisms who persisted

in believing the infection was caused by bad air. Filippo Pacini discovered the cholera vibrio in 1854, but it was not until 30 years later that Robert Koch developed the germ theory of disease, and European slums were cleaned up systematically. Meanwhile, a small flask of grayish liquid offers a disquieting souvenir of the emissions from a choleric London gut.

Another form of dirt took over in Soho during the 20th century in the form of strip clubs and brothels. Vice may be considered dirty, but in India dirt from the doorways of brothels is valuable, as this is the place men shed their virtues. A nugget of this virtuous dirt forms the heart of the statue of the goddess Durga, with the rest of the body being made from Ganges mud. Although the brothel dirt is not a problem, the holy Ganges mud is, making the sculptors ill and their skin erupt into sores.

Dirt being given this degree of intellectual consideration becomes absorbing, even thrilling—particularly when one is made sensitive to its barely controlled ubiquity. It is horrifying, too, to contemplate the ghastly nightmare of lives on the dustheaps of the world’s megacity slums. With almost 7 billion people on our planet and despite the best efforts of the good wives of Delft to sweep our dirt away, ultimately there is no place “away,” and we must relearn how to value our dirt. This exhibition thus gives us a glimpse into a choice of possible futures: life in a recycled paradise or grim existences eked out on a planetary garbage dump.

—Caroline Ash

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