

giving the viewer the impression of seeing the picture from several perspectives, and thereby enhancing its visual effect. This is complemented by the fact that objects in the picture are geometrically broken up through the faceting that Picasso applied. Although it is interesting that contemporary occultists perceived four dimensions to the picture, this is difficult to validate from the point of view of the picture's composition. And it leaves open the question of how fundamental, or otherwise, is its derivation from Poincaré.

Perhaps surprisingly, the case for Einstein appears even more questionable. Although Poincaré's place in the prehistory of special relativity is long acknowledged, there is the stumbling block that Einstein's Special Theory is not presented geometrically by Einstein. He treated electrodynamics not in any markedly geometrical way but rather by an abstract reconsideration of the relations between rigid rods, perfect clocks and light signals — that is, by proposing a theory of measurement that respecified the nature and meaning of fundamental physical quantities.

Miller's argument may be on stronger ground at a later period — with the formulation of analytical cubism by Picasso and Georges Braque, and with general relativity's fundamental space-time geometry. But for the main period on which the book focuses, 1905–07, his case, however vigorously and enjoyably portrayed, remains tantalizingly unmade. ■

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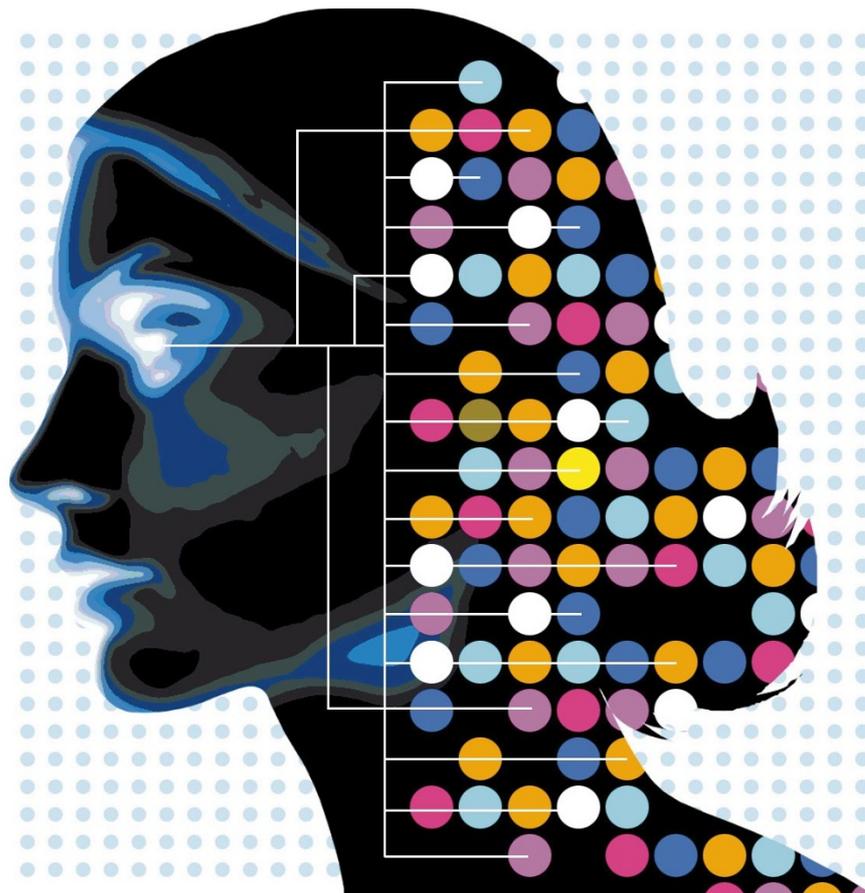
.....  
 ... but what does  
 'blue' smell like?

**Synaesthesia: The Strangest Thing**  
 by John Harrison

*Oxford University Press: 2001. 250 pp.  
 £16.99, \$35*

**Ilya Farber**

Of all the neurological disorders known to modern science, synaesthesia may be the only one that routinely inspires envy in those who study it experimentally. The experience of the synaesthetic seems somehow richer and more compelling; after all, who wouldn't want to experience music in full, glorious colour? Most 'normal' humans experience occasional cross-modal associations, perhaps with the assistance of Mahler or LSD, but this seems thin compared with the inner world of the synaesthetic painter who always experiences the spoken word 'Moscow' as "darkish grey, with spinach-green and pale blue in places". How can one not envy the woman who experiences shapes accompanying smells, so that the smell of wintergreen evokes "ragged



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edges", and peanut butter smells like "things falling down and backward"?

For the past decade, John Harrison has been studying such people, and his book provides an accessible survey of what is known about this most intriguing of disorders. Although he wrote the book alone, most of the work he reports was done in collaboration with Simon Baron-Cohen, and the theory that they jointly developed forms the basis for much of Harrison's approach.

This theory begins with the well-established fact that all humans are born with substantial interconnections among the different sensory pathways in the brain. These normally die off within the first six months of life, but if a pathway's normal source of input is cut off, as occurs in congenital blindness, it may retain its connections to other pathways. Harrison draws the reasonable inference that in synaesthesia some of these pathways are somehow preserved into adulthood. He supports this hypothesis by pointing out that synaesthetics usually say they have had the condition for as long as they can remember, and that (according to an analysis of the limited pedigree data available) the most common form of the condition appears to be genetic — specifically, an X-linked dominant trait that is partially lethal in males.

Unfortunately, definitive tests for neuroanatomical connectivity are impossible in humans, as they require the use of injected tracers, followed immediately by post-mortem sectioning and staining of the brain. Harrison does present neuroimaging data

showing that, when colour-word synaesthetics listen to words while blindfolded, some of the brain areas activated are those that have been implicated in colour processing. But most of these areas are known to be driven by stimuli other than just colour even in normal people, and some of the areas activated in Harrison's imaging studies are not sensory at all. Even the clearest result, which shows activity in a highly specialized colour area, cannot identify the source of the activity. So it remains a possibility that the visual pathway is being driven not by cross-wiring but by something more like visual imagination.

Overall, Harrison's theoretical discussions are relatively superficial; where the book really shines is in discussing the data. Reading this book is like looking over a detective's shoulder at the collection of case-files and newspaper clippings spread out on his desk. Harrison has done all the arduous work of gathering the raw data and sorting through historical reports; now he invites the reader to join him in sifting through it for patterns and meaning.

And a fascinating deskful it is. Harrison calculates that the overall population prevalence of synaesthesia is at least 1 in 2,000; most of the synaesthetics he has found are word-colour synaesthetics, and about 85% of these are women — though, perhaps unsurprisingly, all of the famous historical candidates for synaesthesia that Harrison found are men.

It turns out that the colour of a word is usually determined by its first letter, and that

each synaesthetic's list of associations is idiosyncratic, with no discernible commonalities even among identical twins. But any one person's associations remain very stable over time. This is the basis of the now-standard 'test for genuineness', which checks the constancy of a subject's associations for a given list of words — non-synaesthetics tend to match fewer than 40% of their previous associations, whereas synaesthetics average more than 90%.

The organization of the book is somewhat frustrating. At times it's structured like an autobiographical narrative, at others it's more like a standard scientific monograph, while in many places it becomes an introductory text in scientific methods. Harrison's pedagogical digressions are sometimes important, but more often baffling. For example, the very brief discussion of neuroimaging data is preceded by more than 20 pages on the general history of neuroimaging. Ultimately, though, he doles out enough fascinating tidbits to keep the reader's interest, and the unanswered questions are tantalizing. I found the book especially good 'afternoon coffee-break' reading — although doubtless some synaesthetics would find that an unconscionable clash of tastes. ■

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## Creationism by stealth

**Icons of Evolution: Science or Myth? Why Much of What We Teach About Evolution is Wrong**

by Jonathan Wells

Regnery: 2000. 362 pp. \$27.95

Jerry A. Coyne

Opposition to evolution is found in many corners of the American religious landscape, including the Unification Church. Church founder Sun Myung Moon has frequently condemned darwinism for giving God no role in the history of life. In 1976, Jonathan Wells, a student in Moon's seminary, answered his leader's call. He writes, "Father's [Moon's] words, my studies, and my prayers convinced me that I should devote my life to destroying Darwinism, just as many of my fellow Unificationists had already devoted their lives to destroying Marxism. When Father chose me (along with about a dozen other seminary graduates) to enter a PhD program in 1978, I welcomed the opportunity to prepare myself for battle." The University of California supplied Wells with his weapon, a PhD in biology and, with *Icons of Evolution*, Wells has fired the

latest salvo in the eternal religious assault on Charles Darwin.

This personal history, taken from the Unification Church website (<http://www.tparents.org/Library/Unification/Talks/Wells/0-Toc.htm>), is conspicuously missing from the author's biography in *Icons*. The book, aimed at the non-specialist, masquerades as a scientific critique of classic examples of evolution, but is actually a polemic intelligently designed to please Father Moon. *Icons* is a work of stealth creationism, and strives to debunk darwinism using the familiar rhetoric of biblical creationists, including scientific quotations out of context, incomplete summaries of research, and muddled arguments. But because Wells has scientific credentials, studiously avoids mentioning religion or God (who appears only under the alias "intelligent design"), and presents his book as an objective critique (complete with 70 pages of references and research notes), it is easy for the non-scientist to be taken in. *Icons* has been embraced with glee by anti-evolutionists, who want it included in the American school science curriculum.

Wells's book rests entirely on a flawed syllogism: hence, textbooks illustrate evolution with examples; these examples are sometimes presented in incorrect or misleading ways; therefore evolution is a fiction. The second premise is not generally true, and even if it were, the conclusion would not follow. To compound the absurdity, Wells concludes that a cabal of evil scientists, "the Darwinian establishment", uses fraud and distortion to buttress the crumbling edifice of evolution. Wells's final chapter urges his readers to lobby the US government to eliminate research funding for evolutionary biology.

To see his argument at work, let's look at development, which Wells has referred to elsewhere as "the Achilles' heel of Darwinism". As Darwin first realized, some aspects of vertebrate development — especially transitory features — provide strong evidence for common ancestry and evolution. Embryos of different vertebrates tend to resemble one another in early stages, but diverge as development proceeds, with more closely related species diverging less widely. This conclusion has been supported by 150 years of research.

Wells tries to refute this mountain of work by noting that, in 1891, the German biologist Ernst Haeckel published illustrations of vertebrate embryos that exaggerated their similarity, and that some biology textbooks still display these doctored drawings. This embroidery, however, was first reported by the British zoologist Adam Sedgwick in 1894, and has repeatedly been used to show the failings not of darwinism, but of Haeckel (see, for example, *Nature* **410**, 144; 2001).

Despite Wells's arguments, one does not need Haeckel's wishful pencil to draw copious evidence for evolution from develop-

mental biology. Human embryos, for example, have pharyngeal pouches, a tail and six aortic arches — all features found in embryonic fish. But our pouches become glands and ducts instead of gill slits, our tail disappears, and our aortic arches (which remain six in some fish) either disappear or are transformed into carotid, systemic and pulmonary arteries. In our first trimester we develop the lanugo, a coat of hair that is shed before birth.

Are these patterns mere whims of the Intelligent Designer, or evidence of our common ancestry with fish and furry primates? Embryos of whales and some snakes develop hindlimb buds that regress before birth; embryos of baleen whales possess teeth that later disappear; and horse embryos have three well-developed toes, with the outer two shrinking to leave the single-digit hoof. Such examples abound, but you won't find them in *Icons*.

Wells also notes that the earliest vertebrate embryos (mere balls of cells) are often less similar to one another than they are at subsequent stages when they possess more complex features. According to Wells, this counts as evidence against biological evolution, which supposedly predicts that the similarities among groups will be strongest at the very first stages of development. But darwinism makes no such prediction. Darwin himself noted that embryos must adapt to the conditions of their existence, and the earliest stages of vertebrate embryos show adaptation to widely varying amounts of yolk in their eggs. Wells repeatedly fails to grasp the evidential value of phenomena that can be understood only as the result of a historical process, even if the results were not predictable. Perhaps an observer in the early Cenozoic could not have predicted that a lineage of ungulates would lose their hindlimbs as they became aquatic, but the development of the hindlimb in embryonic whales can be understood only as a result of descent with modification from a four-legged ancestor.

When discussing other 'icons', Wells uses the same tactic of selective omission to distort a body of literature he pretends to review. Nowhere is this more visible than in his chapter on human evolution. Faced with a series of hominid fossils showing transitions from ape-like to modern human traits over 4 million years, Wells can only mumble about the Piltdown Man hoax, and imply that the vigorous scientific debate about the course of human evolution proves that humans did not evolve.

It is telling that, although Wells repeatedly attacks evolution, he gives no hint of his own ideas about the origin and development of life. There is good reason for this. As one learns from his website sermon, *Evolution by Design*, Wells believes that "the human species was planned before life began, and that the history of life is the record of how this