Reprint Series
5 November 1999, Volume 286, pp. 1093–1094

Science

Of Two Minds and One Nature

Rhonda Roland Shearer and Stephen Jay Gould

Of Two Minds and One Nature

Rhonda Roland Shearer and Stephen Jay Gould

Rhonda Roland Shearer, an associate of the Harvard Department of psychology and a visiting scholar at New York University's physics department, is a New York–based artist who directs the not-for-profit Art Science Research Laboratory. Stephen Jay Gould is the Alexander Agassiz professor of zoology and professor of geology at Harvard and is curator for invertebrate paleontology at the university's Museum of Comparative Zoology. He also serves as the Vincent Astor visiting professor of biology at New York University.

Our propensity for thinking in dichotomies may lie deeply within human nature itself. In his *Lives and Opinions of Eminent Philosophers* (written circa A.D. 200), Diogenes Laertius quotes a much older maxim of Protagoras: "there are two sides to every question, exactly opposite to each other." But we can also utilize another basic trait of our common humanity—our mental flexibility, and our consequent potential for overcoming such innate limitations by education.

Our tendency to parse complex nature into pairings of "us versus them" should not only be judged as false in our universe of shadings and continua, but also (and often) harmful, given another human propensity for judgment—so that "us versus them" easily becomes "good versus bad," or even, when zealotry fans our xenophobic flames, "chosen for martyrdom versus ripe for burning."

The contingent and largely arbitrary nature of disciplinary boundaries has unfortunately been reinforced, and even made to seem "natural," by our drive to construct dichotomies—with science versus art as perhaps the most widely accepted of all. Moreover, given our tendencies to clannishness and parochiality, this false division becomes magnified as the two, largely noncommunicating, sides then develop distinct cultural traditions that evoke mutual stereotyping and even ridicule. (Scientists, who nearly always speak extemporaneously in public presentations, note that humanists almost always read papers at professional meetings, and rarely show slides—except for art historians, who always use two screens simultaneously—even for the most visual subjects. Why, "we" ask, do "they" not realize that written and spoken English are different languages, and that very few people can read well in public—a particular irony since humanists supposedly hold language as their primary tool of professional competence. But "they," on the other hand, rightly ridicule "our" tendencies to darken a lecture room even before we reach the podium and to rely almost entirely upon a string of pictures thereafter. A stale joke proclaims that if Galileo had first presented the revolutionary results of *Siderius Nuncius* as a modern scientific talk, his opening line could only have been: "first slide please.")

The worst and deepest stereotypes drive a particularly strong wedge between art (viewed as an ineffably "creative" activity, based on personal idiosyncrasy and subject only to hermeneutical interpretation) and science (viewed as a universal and rational enterprise, based on factual affirmation and analytical coherence). We do not, of course, deny the differences in subject matters and criteria (empirical versus aesthetic judgment) in these two realms of human achievement, but we do believe that the common ground of methods for mental creativity and innovation, and the pedagogic virtues of unified nurturing for all varieties of human creativity, should inspire collaboration for mutual reinforcement.

> **"...stereotypes drive a particularly strong wedge between art [...] and science..."**

At least we should recognize, if only for practical reasons, that both fields meet resistance in educational lobbies of primary and secondary public schooling—with art classes viewed as superfluous icing on a cake already stripped to a bare minimum of supposedly essential nutrients, and science classes regarded as "too hard" for most students, and too expensive for most constituencies. (How can we forget the infamous words that Teen Barbie once spoke—"math class is tough"—before a public outcry led her makers to eliminate this philistine aspersion upon half of America's students?) If art and science could join forces by stressing our common methods in critical thinking, our common search for innovation, and our common respect for historical achievement—rather than emphasizing our disparate substrates and trying to profit from the differences in playing a zero-sum game at the other's expense—then we might, in Benjamin Franklin's remarkably relevant pun, truly hang together rather than hang separately.

Rather than indulging in such general, and tendentious, preaching, we can best illustrate the potential junction of art and science in the work of creative people whose innovations cannot be neatly slotted into either camp but can only be understood as a reinforcing unification of goals usually parsed between the two realms under Kipling's motto "never the twain shall meet."

The standard examples of Leonardo and other Renaissance figures have been well and justly referenced. But our best cases should not be sought in an earlier age that did not recognize our modern disciplinary boundaries and did not even possess a word for the enterprise now called "science." If we look instead to 20th-century figures who suffered the penalties of mistrust and misunderstanding for working in both domains simultaneously, we can make our major point in more immediate terms.

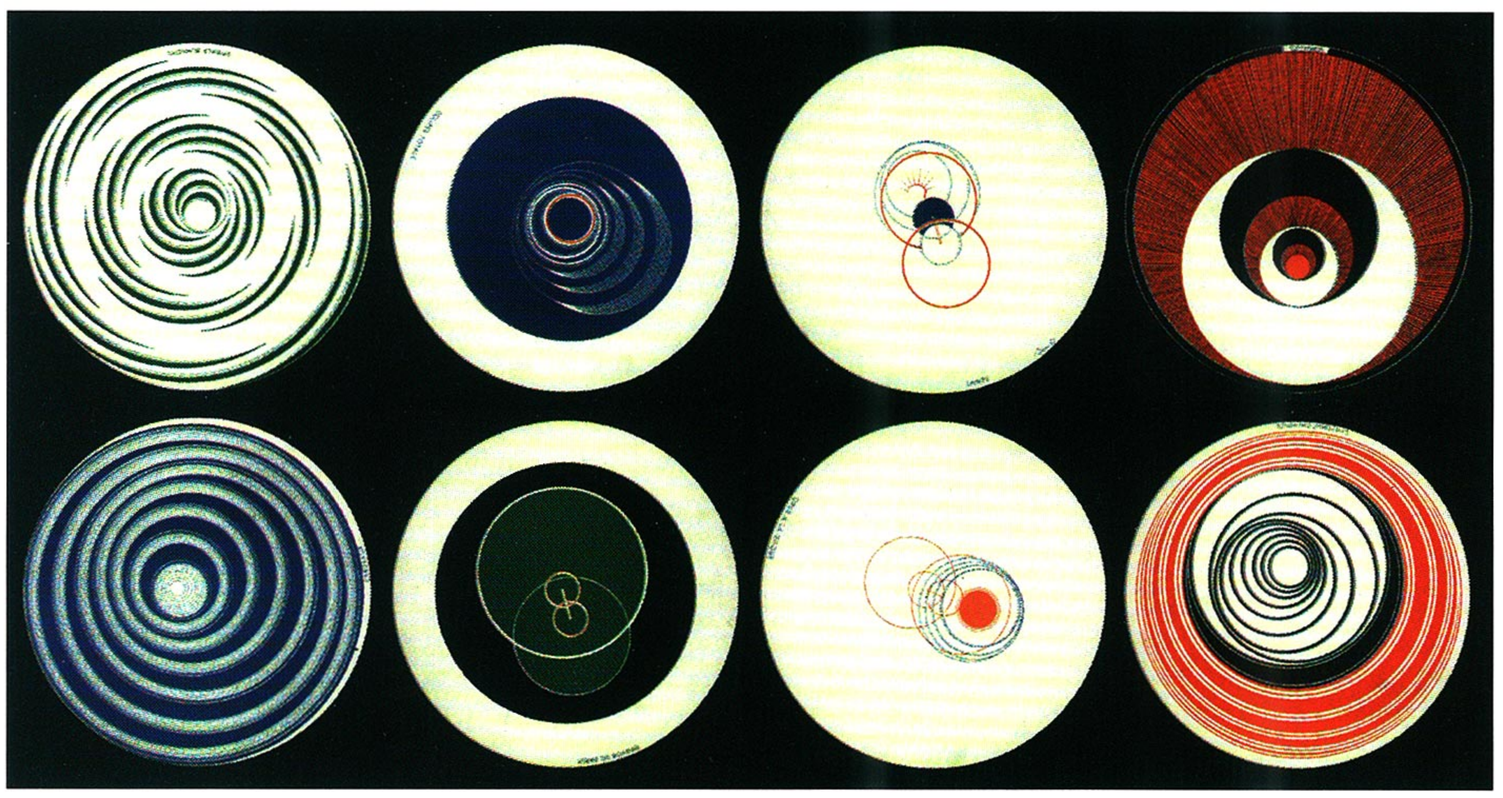
Marcel Duchamp (1887–1968) may even surpass Picasso in his influence upon the history of 20th-century art—especially in his conventional image as the ultimate Dada jokester, the enfant terrible who festooned the Mona Lisa with a beard, a moustache and a salacious caption, and

The authors are at the Art Science Research Laboratory, 62 Greene Street, 3rd Floor, New York, NY 10012–4346. E-mail: sgturbo@aol.com. They are coordinating a Harvard University Symposium, "Methods of Understanding in Art and Science: The Case of Duchamp and Poincaré" 5 to 7 November. E-mail: www.marcelduchamp.net

CREDIT: ALLAN BURCH

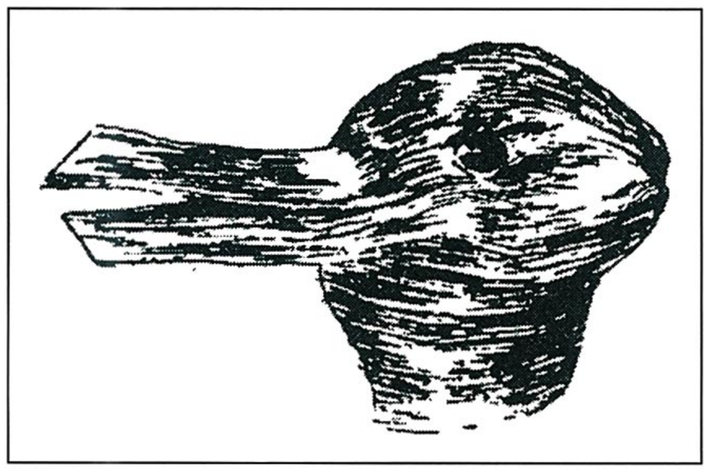
then called the product art under his own signature; the man who submitted an ordinary urinal as his own sculpture, entitled "Fountain," to a major art show. But Duchamp, as a disciple of Henri Poincaré, also understood the mathematics of non-Euclidean geometry and higher dimensionality in a far more serious and technical way than any other artist of his time. He maintained a passionate interest in science throughout his life, and he made several innovations, in optics, mathematics and perception, that we have not understood both because Duchamp himself chose to be maddeningly cryptic about his intentions and achievements, and because we have not been open to the possibility that an acknowledged genius, once categorized as an "artist," could also be innovative in science.

Among his many hybrid ventures—experiments in optics and perception, mixed with aesthetic achievements in what he called "non-retinal" art or the beauty of the mind or "gray matter"—Duchamp devoted considerable attention and expense (he even trademarked the name) to developing a series of twelve discs, called "Rotoreliefs," (see the figure below) and designed for spinning in circular motion on a record turntable (preferably mounted on a wall, so that an observer can view the spinning discs face on).



Duchamp's Rotoreliefs provide a striking impression of three-dimensional depth. See www.artscienceresearchlab.org/nav/barbiesf.htm for an animation.

Although Italian scientists (unaware of Duchamp's work) found and named this particular form of illusion as "the stereo-kinetic effect" in 1924, Duchamp apparently discovered this perceptual phenomenon independently in the early 1920s, and completed his first set of discs in 1923. Duchamp recognized that by spinning designs composed as sets of eccentric but concentric circles, a viewer would see the resulting pattern as a three dimensional form even through one eye alone, without the supposedly necessary benefit of stereoscopy! By the 1930s, Duchamp had constructed from his experiments a wonderfully whimsical set of 12 spinning images—from a goldfish in a bowl, to the eclipsed sun seen through a tube, to a cocktail glass, to a light bulb—in order to emphasize his discovery of these three-dimensional effects. (Ironically, as another example of harmful separation between truly unified aspects of art and science, art museums almost invariably exhibit these discs as framed, static objects on a wall—whereas they have no meaning, either artistic or scientific, unless they spin. We are constrained to present a similarly static image in this printed magazine, but readers can observe the discs in their proper motion at www.artscienceresearchlab.org.



Is it a duck? Is it a rabbit?

Duchamp knew what he had done, and he explicitly regarded the Rotoreliefs as a contribution to science. He wrote to Katherine Dreier in 1935: "I showed it to scientists (optical people) and they say it is a new form, unknown before, of producing the illusion of volume or relief.... That serious side of the play toy is very interesting." Moreover, Duchamp took great pleasure in the efforts of a professor who wished to use his Rotorelief discs to retrain the three-dimensional insights of soldiers who had lost one eye in the First World War. [At a recent talk, one of us (R.R.S.) demonstrated the rotating discs to a physics professor, blind in one eye for more than a decade, who almost wept for joy at his first sight of three dimensions in so many years]. Duchamp also understood the general basis of his illusion when he wrote in a letter: "I only had to use two circumferences—eccentric—and make them turn on a third center."

We could cite many other examples of innovators, labeled as "artists," who used the tools of their trade to make discoveries that had eluded official "scientists" within their own parochial world. In the 18th century, the Dutch artist Petrus Camper established rules for depicting characteristic differences in the physiognomies of human groups (sexes, ages, and ethnicities) after he noticed that many Renaissance paintings of the Three Kings had depicted Balthazar, the black magus, as a European painted dark, rather than a native of sub-Saharan Africa. (European artists could find few African models at the time.) At the beginning of our century, the celebrated American artist (and amateur ornithologist) A. H. Thayer discovered the adaptive value of countershading [not for concealment by cryptic coloration, as evolutionary biologists had previously assumed, but rather for making a three-dimensional object fade into invisibility because countershaded organisms appear entirely flat (two dimensional) against their background]—a solution that had eluded scientists but seemed starkly clear to an artist who had spent his life promoting the opposite illusion of making flat paintings look three-dimensional. Abbott's work led to important advances in naval camouflage and saved countless lives in 20th-century warfare.

What could be more precious, or more difficult, than conceptual innovation? We need to access all the tools at our command—even when linguistic and sociological convention parcels out these common mental devices among noncommunicating disciplinary camps—if we wish to triumph in this hardest, yet most rewarding, of all intellectual pursuits. In a key passage from one of the most influential books of our times (*The Structure of Scientific Revolutions*), T. S. Kuhn bridged the disciplinary gap between visual representation and conceptual innovation when he used the famous gestalt illusion of the duck-rabbit (see the figure above) as a primary symbol for the meaning and nature of scientific revolution: "It is as elementary prototypes for these transformations of the scientist's world that the familiar demonstrations of a switch in visual gestalt prove so suggestive. What were ducks in the scientist's world before the revolution are rabbits afterwards."