Magic, Science, and Metascience: Some Notes on Perception

Magic is a deep reservoir of knowledge about perception. Scientists are ill-advised to dismiss it as simply entertainment.

Dorion Sagan

This article is based on a presentation, punctuated with sleight-of-hand demonstrations (described in italics), that the author gave at a physics colloquium at Syracuse University.

THE MAGICIAN James ("The Amazing") Randi is widely known for debunking the psychic claims of Uri Geller, carrying out his famous Project Alpha, and most recently exposing fraudulent faith-healers. Randi showed that Geller, though not a psychic, was once a birthday-party and night-club magician and that all his feats could be duplicated by known means. But a few mathematicians and physicists took Geller's effects as evidence of the paranormal. Harold Puthoff and Russell Targ of SRI International published a report in 1974 in the British scientific journal *Nature,* and reportedly still believe, that Geller's spoon-bending and other feats necessitate a reevaluation of the laws of physics.

Magicians draw upon a unique tradition that permits them to be at least as skeptical as scientists. Persi Diaconis, the Stanford University statistician who as a boy ran away with sleight-of-hand master Dai Vernon, said that if

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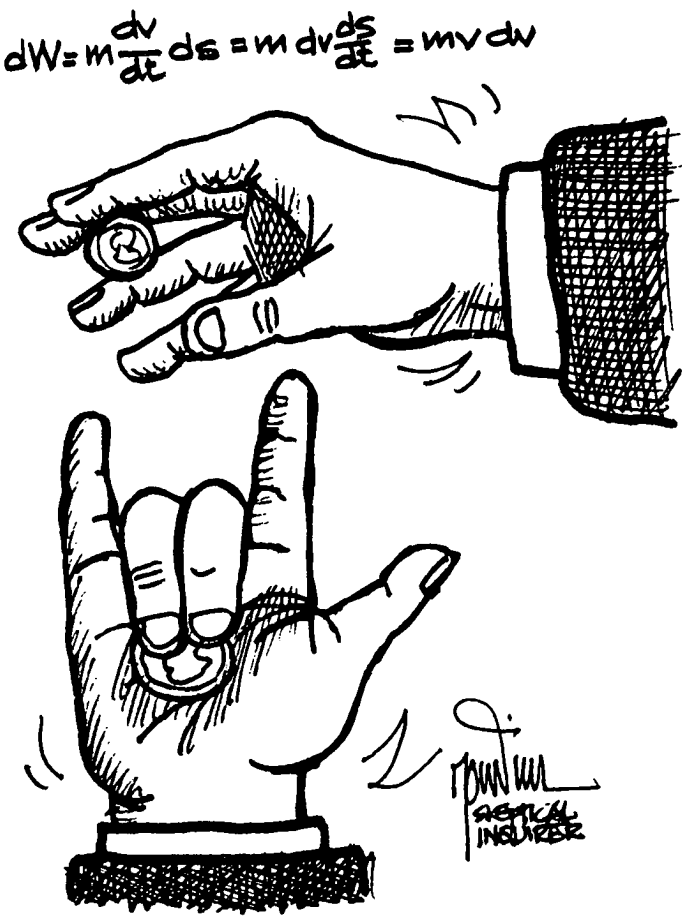

there were such a thing as a doctorate in magic he would have gone for that instead of statistics, for which he won a MacArthur Award. (Randi received a MacArthur Award last year.) Unfortunately, however, historically secretive techniques of magic have led to a divide between magic and science. Since about the time of Paracelsus, magic has not been taken seriously. If considered more than a form of entertainment, magic develops negative connotations. We can see this reflected in words like "fooling," "trickery," and "deception." But magic is based on a deep knowledge of perception. The magician influences his spectators to make perceptual deductions based on insufficient evidence. Magic effects contradict ordinary experience. From the magician's point of view it becomes clear that sensory input is not passive, direct, and inductive but deductive and participatory, based on the continual generation by the spectator of perceptual assumptions, of putting together the jagged pieces of visual experience into a single smooth whole.

(Two sponge balls are removed from an apparently empty purse frame.

One of these is torn into two. Upon blowing on them, both pieces expand into two full balls. The Roy Walton Bowl Trick is then performed, each ball consecutively disappearing from the magician's hand only to reappear under the bowl.)

Magicians recognize that scientists are among the easiest to fool. Though they are used to doubting at the level of hypothesis, scientists assume that their data are "raw" and objective. Due to the success of the scientific method, scientists become overconfident that they have a handle on the truth. Thus, paradoxically, they are even more vulnerable to the techniques of misdirection. While magicians will go to great lengths to misdirect, scientists assume nature to be passive, to "play fair."

The magical method of misdirection and the scientific method have certain differences. In science, results must be repeatable. In magic, tricks should never be repeated. Scientists openly state their theories and look for evidence to support or refute them. The magician, by contrast, never says what will be done in advance. The scientist usually confirms our view of reality. The magician usually upsets it. Nevertheless, magicians sometimes reveal their tricks and confirm our view of reality and scientists sometimes dramatically change our view of the world, which demonstrates that the division between magic and science is not ironclad. Both are really modes of perception.

Phenomena are explained differently depending on perspective. Consider someone who continually and correctly guesses five zener-card symbols (star, square, circle, plus sign, wavy lines) in a laboratory. Since they are called "ESP symbols," the subject may consider his correct guesses as evidence for precognition (if the cards were hidden from view) or clairvoyance (if one person looked at each card and asked another to receive his thoughts).

Since I don't have any special ESP cards, I'd like to do an experiment with a regular set of playing cards. Even though you may not trust me as much as when we began, I will try to simulate the controlled conditions of a parapsychological laboratory.

(Paul Curry's "Out of This World with Double-Blind Patter" is performed: The spectator shuffles and, without looking at them, says whether the cards should be put into a "black" or a "red" pile. The magician, having previously withdrawn a card from the pack in plain view, puts it down in the designated pile. After about 13 cards are placed down in this manner, two new piles are designated "red" and "black." The magician gives the deck to the spectator, who, without looking, deals the cards into whichever pile he selects. This second part of the experiment is considered "double blind," since neither the magician nor the spectator sees the cards. At the end of the pseudo-experiment, the colors of all the cards are shown to have been correctly divined. This is a so-called self-working trick: it does not require sleight of hand.)

I will not tell you how "Out of This World" is done because I want you to realize that if you can't figure something out immediately that doesn't mean you should postulate new or unproven principles. If people are really in-

terested in how such tricks are done, I strongly suggest they contact their local magician's supplies dealer and ask for a good book on mentalism.

If a Coke machine breaks near Uri Geller and he takes credit for it, some will consider it as proof of his power. The problem with this has been called the golf-ball-on-the-fairway fallacy. It is truly amazing that a golf ball lands on any one particular blade of grass. But that it lands on any is nothing special at all. For example, if you divide the height of the world's tallest building, the Sears Tower in Chicago, by the height of the Woolworth building in New York, you get 1.836, exactly one thousandth of the mass of a proton divided by the mass of an electron. Associations that to some seem meaningful, what Carl Jung called "synchronicity," are to others mere coincidences. But scientists, like spectators at a magic show, also "hunt" for and perceive patterns. Since all sciences depend on perception for data accumulation, and since magic is a deep reservoir of knowledge about perception, scientists are ill advised to dismiss magic simply as entertainment.

I have given a couple of examples of associations: Uri Geller and the Coke machine, ratios of tall buildings and small particles. To most educated people such associations seem arbitrary. In general, though, the value given to associations depends on how you have been directed, consciously or unconsciously, to see. From the standpoint of a magic show this could literally be your point of view. If you stand backstage, you see the mechanics of the show but not the effects. In the audience it is reversed: You can see the effects but not the mechanics. In physics, planetary motions can be described in a Newtonian or a relativistic way, but not both for all the available data at the same time. Is the Heisenberg Uncertainty Principle, that you can't measure both the position and the momentum of the same moving particle simultaneously, really a special case of a more general law of perception where the perceiver must make limiting choices? If a ball vanishes in my hand and appears under a bowl, is it a disappearance and production or an invisible transference that we perceive? Or do we perceive what is supposedly "really" happening, which is to say, the secret removal of the ball in question to one hiding place while a camouflage is stripped away to reveal a similar object in another place?

The shortest route between two mental points, like the shortest distance between two physical points on a Euclidian plane, is a straight line. This explains the compelling nature of symbolism, which connects things of a like nature, and also the psychological power of sympathetic magic. Sympathetic magic is where "like makes like," whether it be sticking pins in a doll to hurt a person or manipulating computer models to forecast the climate. Likewise, the dictum of Occam, popularly known as Occam's Razor, is an old standby of scientific reasoning that tells you to connect bits of evidence in the simplest fashion that will explain your observations. (See Elie Shneour's "Occam's Razor," *SI,* Summer 1986.) In science, Occam's Razor is useful because it helps connect the experimental results and observations of an enormous number of researchers into a cohesive whole. But this same mode of con-

necting perceptions—in the simplest fashion that makes sense—which is held up as a virtue in the interpersonal realm of science, is often considered a deficiency of individual thought. The easy or ad hoc association of an event with one preceding it or connected to it by some other blatant characteristic is called superstition. But, if this same easy association of events near to each other in time occur together a sufficient number of times, we take their connection to be invariable or even causal. As processes or things are correlated a fewer number of times, their relationship becomes one of "superstition." When birds are given food periodically, they move in circles, hop, or develop other quirks. They associate the food with their quirks. When their food comes their behavior is reinforced. Are these merely "superstitious" birds, or are they doing something akin to the generation of scientific hypotheses, albeit ones that in their minds have not yet been proven incorrect? I believe, and I am not the first, that it is very healthy to be skeptical not only in science but about science.

Science is individual perception writ large. Ludwig Fleck, in his book *The Genesis and Development of a Scientific Fact,* shows that for a long time syphilis was seen as a "carnal scourge," as evil spirits punishing those fallen from virtue. As medicine grew more rigorous, syphilis was differentiated from other genital skin diseases and began to be treated with mercury injections. It is almost humorous that mercury poisoning then became recognized as a distinctive symptom of syphilis.

Today syphilis is diagnosed by the Wasserman reaction, a test that detects cardiolipin correlated with the *Treponema* spirochetes said to cause syphilis. But is there any reason to believe that this time we have finally found the "true cause" and not just another correlation? I don't think so. The relation between spirochetes and syphilis seems more like that between worms and dead men: While the two almost inevitably correspond and while worms inhabiting half-eaten organs can be used as a reliable test for dead men, the idea that spirochetes cause syphilis, like the idea that worms cause dead men, can itself be labeled superstitious.

For me, both science and superstition partake of a magico-religious mode of thought for the simple reason that observations must be organized and the simplest working pattern proves the most expedient. That there is a gradation between superstitious and scientific thinking and not a sharp barrier is upsetting because it makes us realize knowledge is not absolute. (We only had to look at the rise of the importance of statistics to realize this.) Such a gradation explains why children are not deceived by magic tricks that baffle their elders: Having seen events or things connected fewer times than adults they are less likely to consider them causal. Young children see almost everything as magic because so few connections have been established. A grown-up, however, will make assumptions that a toddler would not even dream of. No list of scientific studies is needed to prove this, because without it magicians the world over could not ply their trade. If I close my left hand slowly over a coin held at the tips of my right finger and thumb and then my hands

naturally separate and you no longer see the coin at my right fingertips, you assume the coin is in my left hand. *(Retention-of-vision pass.)* So strong is this assumption, based on nothing other than repeated personal experience of moving things from hand to hand, that you actually see the coin in my left hand when it is not there. This impression is strongest when it has not been done before or explained. It shows us not that the hand is quicker than the eye, because it can be done very slowly. It shows us the opposite of the old phrase "Seeing is believing," that believing is seeing. What we believe—that the earth goes round the sun or the sun goes round the earth—crucially limits what we see and what we *can* see. Fleck calls this principle "directed perception," and the perceptual ecologist-magician David Abram, who visited with shamans in Sri Lanka and Nepal, calls it "participatory perception." If we see an object in one place and then suddenly it appears someplace else, we assume it traveled. This is part of the mode of human thought that corresponds to Occam's heuristic razor. Magicians viewing magicians have a different sort of directed perception. We may be looking for a secret hiding place or camouflage that takes away one object and some device that makes another appear. But in this case our form of perception will be equally directed and thus no less limiting. A magician or spectator on the lookout for method misses the magic; a spectator or magician ready for magic misses the method.

A question arises here, one that Abram is fond of stressing: Why do we call one form of perception magical and the other ordinary? Indeed, all perception is participatory—determined by what the spectator, researcher, or observer is looking for and ready to see. There are far too many details in daily life—not to mention those in the wider world detected by scientific instrumentation—to be organized without oversimplification and editing. Only details that fit in are included to form a cohesive view of the world. Others may be discarded, literally overlooked. Some valuable ones appear to science as magic tricks, and their inclusion may spur the development of a new world-view capable of explaining them. The advantage of science over superstition is that it organizes more bits of information and makes a conscious effort to doubt forms of directed perception, which it calls hypotheses or theories, that contradict or at least do not account gracefully for the collected facts. Unfortunately, this doubt at the level of theories and hypotheses is a source of scientific self-confidence that may turn into overconfidence at the level of fact-gathering, which is not always recognized for the highly selective process it is. I do not view its unusual doubting and openness to change as the primary strength of science but rather its station as a form of group perception. Science evolved beyond shamanism not because its associational tendency differs in kind from superstition but because language has amplified the available data to be correlated by the basic Occam's Razor style of human thought to massive numbers.

Perhaps the best way to view perception is as a statistical process where we sense only a portion of the world and must actively imagine the rest to

form a cohesive picture. Eyes do not rest but constantly dart around, lighting on different objects. Nonetheless a whole picture is formed of the world from this small sample. What the magician does is to offer a nonrepresentative sample to his audience. The spectator connects this preselected sample of data in normal ways only to realize it does not conform to normal reality and therefore must have been preselected. But the sample itself is not "wrong." It is just unlikely. Nobel laureate Sheldon Glashow's likening the world of theoretical particle physics to a cosmic magic show in which scientists try to figure out how things are done seems to strengthen the idea that perception is not passive but an active, participatory phenomenon.

In the *Doors of Perception,* Aldous Huxley compared perception to a "funnel" in which only a very selected portion of the nearly inexhaustible sensory stimuli are processed. Mind-altering drugs may work by breaking the funnel or by connecting "funneled" stimuli in new ways. The results are less entrained modes of perception with greater novelty than ordinary perception, but these are also more difficult to communicate because they are more diverse. Infants and children have not been trained to connect data in accepted ways and so are perceptually less directed yet have more potential to make fresh connections and see in new ways.

Understanding of perception on the personal level is important simply as a basic prerequisite to understanding science and technology as rational thought and conscious action at the societal level. In the history and evolution of science certain philosophers, such as Francis Bacon and Karl Popper, have come up with what we might call metascientific principles. For Bacon this meant calling attention to what he called simple induction by enumeration even though he often considered it insufficient "mera palpatio"—only that which can be told from a sort of feeling around in the dark. Karl Popper enunciated the principle of falsifiability whereby hypotheses were considered valuable insofar as they could be falsified, in other words proved wrong by new experimental evidence. Bacon used the phrase "interrogating nature" and contrasted it to merely accepting what seems to be the case. The problem is that where theories would be proved wrong because of new evidence the experimental results themselves are often dismissed or not even perceivable within the theoretical framework. Bacon and Popper nonetheless enunciated metascientific precepts that helped shape modern science. Since science leads to technology, it gives those who use it an advantage over those who don't.

I believe science is but one form of directed perception within the body politic, the most useful and methodic one but one that only shadows the full perceptual abilities of the individual. Maybe this is because, while the ancestors of individuals have been perceiving for millions of years, the group perception called science is much younger, having really evolved only with cities, writing, and the like. The potential of the group perception called science is greater but more immature than that of the average adult. Science perceives a far wider range than any individual. It is, for instance, very unlikely that any single person would see a meteorite land at his feet. Thomas

Jefferson, upon hearing that a stone had fallen from the sky in New England and that scientists from Brown and Harvard had gone to investigate eyewitness accounts, said: "I would rather believe that two Yankee professors lied than that stones fall from the heavens." While Jefferson was no dummy, science, able to pool a wide sample of individual perceptions, has shown that meteorites do land on Earth.

To take a similar example, recent evidence from the frontiers of astronomy suggest that galaxies are not uniformly spiral, circular, or combinations of the two. In far reaches of the sky, where we look back into time as well as space, great jets and fountains of stellar fluid are ejected into space. Sometimes galaxies meet and form new patterns, shooting jets of star spray over one another's shoulders. Looking back in time through telescopes, the early universe is seen to have been more highly energized but less regular in its star configurations. From the standpoint of directed perception, it seems our planet itself is only one particular point of view.

People seem to have reacted to the tremendous increase in record-keeping and knowledge by the use of Occam's Razor and similar methods of simplification. Our populations have expanded to such an extent that we have had to find ways of keeping our ever-more-crowded house in intellectual order if only to stay sane. These are not fundamentally new ways of seeing but evolutions of the old perception of the individual, sympathetic magic writ large. If society ever attains the level of perception that is the birthright of the individual, the smooth connection of events that we take for granted (to the unending glee of magicians), science will become a fascinating phenomenon indeed. •