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Corrections

- An article on charitable giving in 2003 (The Chronicle, June 25) incorrectly stated that a decline in donations to education could be partly ascribed to new reporting standards instituted by the Council for Advancement and Support of Education. The new standards take effect this week, so they could not have influenced last year's reports.

- A table accompanying an article on a high-security laboratory that Boston University plans to build (The Chronicle, June 25) misclassified anthrax as among the most dangerous of diseases, caused by a "Biological Level 4" microbe. It is a Biological Level 3 organism.

- An essay about the decline of American industrials and the rise of British ones in the United States (The Chronicle Review, June 18) misprinted the name of a British clothier. It is Turnbull & Asser, not Turnbull & Asser.
Art History Can Trade Insights With the Sciences

By Ellen Winner

In recent years, it has become clear that the study of art need not be the exclusive domain of humanists. Economists, sociologists, and anthropologists have applied the methods of their respective disciplines to determine how market, social, and cultural forces have affected the productivity of artists; psychologists have examined the effects of mental illness on the creative process, analyzed drafts of paintings as windows into that process, and documented the influences of the visual system on the perception and production of art. As a psychologist previously trained in the humanities and in studio art, I have spent my career applying the science of cognitive psychology (and now cognitive neuroscience) to studying the creation of and response to art.

To be sure, we scientists who wander into the museum have to guard against many pitfalls: blind empiricism, testing hypotheses that are not theoretically grounded; unconsciously finding data to fit our theories; waiting for others to try to falsify our theories. We need to avoid reductionism: a scientific explanation of an artistic phenomenon—say, why we are moved more by some paintings than others—is not supposed to have any role in explaining why it replaces an explanation at the humanistic level.

Despite the dangers, however, there is much to be learned from the scientific study of art. Why, then, are so many humanists critical of it?

The very different cases of two scientists who have ventured into the field of art history, one from physics, the other from economics, provide a starting point. Both discovered a genuine phenomenon and proposed an explanation for it. The story of the physicist shows how science can make a valuable contribution to our understanding of art and suggests why humanists have failed to recognize the contribution. They are unwilling to play the science game and think like scientists. The story of the economist shows how important it is for scientists not to apply less stringent criteria when they explain artistic phenomena than when they offer explanations of phenomena in their home discipline.

When Charles M. Falco, a physicist at the Optical Sciences Center at the University of Arizona, presented mathematical support for artist David Hockney's contention that certain early Renaissance painters used lenses to project images that they then traced, he was greeted with fury and indignation by art historians. Falco's arguments were most widely publicized in 2001 in Hockney's extensively reviewed Secret Knowledge: Rediscovering the Lost Techniques of the Old Masters, and they were presented at a high-profile conference at New York University that same year with Hockney and art historians, but they can also be found in his journals. Still, even recently, when I've broached Falco's arguments to art historians, I've been greeted with surprise that I can take them seriously. The assumption seems to be that the claims have been shown to be wrong and can be dismissed. However, then I discover that the art historians don't even know the details of the argument. The devil is in the details, and understanding the exact science does matter.

The controversy over Hockney and Falco grew out of Hockney's discovery of a sudden shift toward naturalism in the 1420s and '30s in Flanders. Hockney claimed that the shift was too abrupt to have occurred without the use of optical aids that allowed artists to project images of the 3-D world onto a canvas and trace them. With the entry of Falco, evidence took the place of opinion. Falco pointed out that concave mirrors can serve as lenses that project images and that such mirrors were available as early as the 13th century. He went on to compare anamorphias in certain paintings that were consistent with the use of a lens and—most important—difficult to explain otherwise.

Lorenzo Lotto's painting called "Husband and Wife," of 1523-24, depicts a carpenter with a complex geometric design covering a table. The carpenter recedes into space. Falco demonstrated that the lines on two of the borders of the design start off receding toward one vanishing point and then move slightly toward another vanishing point. It's strange that there are two vanishing points. It's even stranger that the vanishing points of both borders shift at approximately the same depth into the scene.

But Falco offered an intriguing (somewhat technical, very precise) explanation: Lotto's use of a lens led to systematic and predictable errors. Falco calculated that Lotto must have been decades long in focus. From the carper he was painting and 84 cm. from the canvas onto which he was projecting the image of the carpenter. He also calculated the focal length (54 cm.) and diameter (2.5 cm.) that Lotto's lens had to be. These calculations were all derived from one measurement: a comparison of the shoulder width of the woman in the painting with the average shoulder width of actual women today. The difference in size between the two widths showed how much the objects on canvas were reduced—in this case, by 6 percent.

When a lens is used to project an image, the lens that image is reduced in size, the lower the depth of field that the lens can project. Because Lotto was projecting images reduced in size by only 56 percent, he had a problem—he could project only part of the image onto the canvas. Once that part was traced, he would have had to move the lens just a tiny bit to focus farther back. Hence a slightly different vanishing point and a slightly different magnification—both subtle errors. Falco calculated exactly how much the two vanishing points would diverge and the magnification would decrease, and his calculations agreed within 1 percent with measurements he made from the painting. Falco tested his lens hypothesis against many paintings and found other instances in which the errors were mathematically predicted by the use of a lens. His hypothesis did not rely only on such...
predictions; he also found that sometimes highly complex, three-dimensional, non-geometrical objects were rendered so precisely that use of a lens was highly prohibit- ible. But the litmus test of the lens hypoth- esis was Falco's ability to so precisely predict nonrandom errors.

The arguments amounted to art his- torian against his theory fell into seven categories: (1) artists did not need to "cheat" because they were highly trained in drawing from observation; (2) artists did not need lenses because they were so tal- ented; (3) such devices would have been too cumbersome; (4) no written proof, from artists or others, exists that lenses were used; (5) artists could have used a grid instead of a lens to get the perspective right; (6) the lens hypothesis has been overrated; and (7) even if true, it is of no interest to art historians.

The problem with numbers 1-4 is that they fail to rule out the use of optical de- vices. Whether or not artists had the skill and/or training to draw without lenses, whether or not the lenses were cumbersome, and whether or not anyone at the time wrote about them, artists still may have used lenses. The arguments about training and talent are also inconsistent with the general acceptance by art his- torians that Renaissance artists used geometry to draw in perspective (no one suggests that artists were so talented or trained that they could draw in perfect perspective just by looking closely), and that Renaissance artists sometimes used tools such as strings, grids, and planes of glass ("Leonar- do's window") to get the perspective right. The problem with the grid argument is that the use of a grid might explain how artists got the perspective right, but not predict the smoking gun, the errors.

DAVID W. GALISON, an economist from the University of Chicago, believed he could demonstrate two different kinds of creative processes in great artists, and he made his case in a book called Painting Outside the Lines: Patterns of Creativity in Modern Art (Harvard University Press, 2001). Using 19th- and 20th-century French painters and 20th-century New York painters as his sample, Galison showed that some artists produced their greatest works (as measured by art historians) at young ages (the early peakers), while others produced their greatest (most profitable) works at older ages (the late peakers). While some art his- torians might object to the use of price as a measure of the greatness of a work, Galison showed that auction price also corre- lated with frequency of the work being re- produced in art-history textbooks (clearly reflecting a value judgment made by art historians).

Consider these contrasting examples. Pablo Picasso's "greatest" painting, "Les Demoiselles d'Avignon" (1907), marked the beginning of the Cubist revolution, and was painted when Picasso was 26. Paul Cézanne's "greatest" painting, "Les Chasseurs en Béarn" (1900-5), was painted when the artist was in his 60s. Galison argued that early peakers use a different kind of creative process from late peakers. Early peakers are "conceptual innovators" who produce individual breakthroughs; late peakers are "experimental innovators," whose work changes incrementally. Con- ceptual peakers preconceive their works and make sudden radical innovations. They are "finders." Experimental artists work by trial and error and make gradual innova- tions. They are "seekers."

There is no denying that Galison demonstrated that the price curve for some artists' work peaks early in their lives and then declines, while for others it rises steadily with age. But the explanation given was unsatisfactory. He entered the realm of psychology, but failed to subject his psychological theory to a scientific test.

To classify artists, Galison selectively on the artists' own reflections on how they worked. But cognitive psychology has demonstrated the unreliability of self-co- pant. Richard E. Nisbett, for example, showed some time ago that people don't understand the causes of their behavior and cannot report accurately on their mental processes. David N. Perkins showed that artists make claims about their creative process (for instance, that they solve problems unconsciously) that don't stand up to scrutiny.

Galison also used another kind of evi- dence: Artists who made changes from in- tial draft to final product were classified as experimental—they searched as they painted. Those who made preliminary sketches but (supposedly) didn't make major changes after starting work were classified as conceptual—they preconceived their paintings. The problem here is that there is no principled distinction be- tween planning a work through prelimi- nary sketches and planning a work by making changes on the canvas—both in- volve searching. In addition, it is not possi- ble to demonstrate that an artist does not make major revisions on the canvas, since many changes get covered up with paint. However, in the case of Picasso, classified as conceptual, we do have evidence incon- sistent with his classification. Not only did Picasso make many preliminary sketches for "Guernica," painted when he was 56, but we know he made major changes on the painting after he began, because we have photographs of initial and interim states of the painting.

To test the hypothesis of the two kinds of creative process in a rigor- ous social-scientific way (or by another researcher), one must acquire the following. First, list the objective, measurable criteria for classifying an artist as conceptual or experimental; for example, the existence or absence of preliminary sketches; changes or no changes once the painting was begun; some kind of measure- ment of the degree of radicality of the In- Continued on Following Page

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novation, etc. Second, we chose to classify a new set of artists as either conceptual or experimental, ones for whom we do not yet know the age when the most valued work was created. Finally, we checked whether the artist classified as conceptual turn out to have peaked early, while those classified as experimental turn out to have peaked late. That would provide an objective test of Galton's hypothesis. Were his theory to hold up, art history would be enriched.

In contrast to Falco's theory, Galton's has received little attention by art historians, despite the fact that he is a major scholar at a major university, and that his book, published by a major press, makes a revolutionary claim about the value of art and the creative process. I suspect that Falco's analysis would also have been bypassed by mainstream art history had Hockney not been involved and had the discipline not been directly attacked. Art historians felt insulted by David Hockney, who dismissed their observational skills when he wrote that the ones he noticed "could only have been seen by an artist, a mark-maker, which is not as far from practice, or from science, as an art historian."

Science has already illuminated many issues about the arts. For example, Margaret Livingstone, a neurobiologist, showed in 2002 how properties of the visual system affect how we see art. She put forth a scientific explanation for why the Mona Lisa's smile has always been found to be ambiguous. When we look at her lips with our peripheral vision (not looking directly at her mouth), our visual system interprets her smiling smile and her smile seems more smiling. When we look directly at her mouth, using central vision, we have a sharper image and the smile looks less cheerful—the smile you thought you saw disappears.

As another example, in 1993 Kay Redfield Jamison, a psychologist, documented in her book Touched with Fire: Manic-Depressive Illness and the Artistic Temperament a strong link between bipolar disorder and artistic creativity. She pointed out that the thoughts processes involved in the beginning stage of mania can contribute to creative work—during this state thought is rapid, energy is high, and categories broaden so that things not ordinarily classified together might be seen as similar, fostering metaphorical thought. In my current work (in collaboration with Gottfried Schlaug, a neuroscientist at Harvard University), we are searching for the brain basis of musical talent. We are following children over several years, as they begin to study a musical instrument, and comparing their brain growth, through the use of magnetic resonance imaging, to that of children studying a foreign language or engaging in intensive sports. After several years of instrumental study, children will be rated by music educators in terms of their level of "talent." We will then look back at their brain images to find out whether there are any brain markers of musical giftedness prior to training, and whether the way in which music training affects brain development differs in those children with musical talent.

Of course, humanists should not uncritically accept that scientists claim about art. To decide whether or not to accept a scientific explanation of an artistic phenomenon, one must evaluate the evidence. One has to determine whether the evidence supports the claim, and if not, how the claim could be subjected to further, de
ductive tests. One has to think scientifically. And therein lies the problem. Humanists are not trained to think in terms of propositions testable via systematic empirical evidence. A scientific interpretation may therefore be unfairly rejected without a careful evaluation of the evidence. That is, I believe, what has happened in the case of Charles Falco. While I do not argue that artists did not need lenses because they were so talented, they seem not to realize that the argument does not rule out the use of lenses. When they say that artists could have used a pencil or a right, they seem not to realize that the use of a grid would not predict the errors.

True, Falco and Hockney did not speak to the meaning or value or the future of art, even if that was the reason they were engaged. But why didn't art historians think it important to learn how an artist created that work? When the psychologist Howard E. Crosher and neurologist's creative process (in his 1974 book, Darwin on Man: A Psychological Study of Scientific Creativity), showing that Darwin's insights were gradual and incremental rather than sudden, historians were interested. When John W. Tukey used statistical methods to determine authorship of certain disputed Federalist Papers, historians, listened. Leonard Meyer, a musicologist, used the science of information theory to explain our reactions as we listen to a piece of music. There is thus ample precedent for the influence of science on humanists. Knowing that artists used lenses should interest art historians because the knowledge changes our understanding of how artists emerged and also gives us a new way to experience paintings.

But scientists also have to assume certain responsibilities when they cross the line between science and art. They must remain scientists, and must subject their propositions about art to scientific standards. Otherwise they do the cause of interdisciplinary work a great disservice. Galton's failure to put the psychological part of his theory to scientific test is the reason when he wonders why art historians have ignored him.

Today neuroscience is moving into the study of the arts. Brain imaging allows us to track how the brain processes works of art, what parts of the brain are involved as artists develop a work of art, and how training in an art form stimulates brain growth. Scientists who do that kind of work will need a deep understanding of the form art is studying. Humanists and cognitive scientists are, therefore, most likely going to be teaming up more to study humanistic phenomena from a scientific perspective.

Thus the clash of cultures may be lessening. To be sure, their methods will always differ. Humanists do not make judgments and support them with a range of qualitative evidence and arguments; scientists are trained to test arguments with empirical, replicable evidence and to use quantification as a tool. Inhibitory work will flourish when both sides realize that scientists question about art do not replace humanistic ones. They are simply different. The disciplines of the sciences and art history ought to trade insights rather than insults.

Ellen Winner is a professor of psychology at Boston College and a senior research associate at Project Zero at the Harvard Graduate School of Education. Her recent works include Gifted Children: Myths and Realities (Basic Books, 1996).