Bridging the Two Cultures: Disciplinary Divides and Educational Reward Systems

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Abstract

In 1959 C.P. Snow believed that communication and education could span the cultural gap between the sciences and the humanities. In the twenty-first century, language, research models, and academic structures hinder intellectual communication between art history, cognitive neuroscience and perceptual psychology — three disciplines dedicated to researching vision and visualization. Multiple definitions of basic words such as image, perception, and perspective invite confusion and differences in professional tone can lead to misinterpretation about the validity of research. Standards of evidence vary according to assumptions about what is real, such as the use of photographs in brain scan research to study visual responses to physical objects.

However the reward system of universities creates barriers that are harder to surmount than disciplinary differences. American universities promote interdisciplinary research in theory, but in practice faculty evaluation reinforces disciplines by following a vertical path from the department to the administration. Universities prioritize original research delivered in conventional text publications and devalue research, original or synthetic, that aims for an audience beyond fellow academics. Ironically, universities tend to denigrate "educational" publications and the lower the age of the audience, the less value accorded the research. This creates another cultural divide where interdisciplinary concepts long rejected in the face of academic research persist in K-12 education and popular culture. Examples include Betty Edward's *Drawing on the Right Side of the Brain* and Jean Piaget

's developmental model of children's art that associates western linear perspective in art with maturity.

Introduction

C.P. Snow places the cultural differences between science-math and arts-humanities in the context of a larger problem: the difficulty of disseminating research knowledge and ideas to the people who can use them to make the world a better place.[1] Research on the cognitive process of perspective techniques in art reveals some of the problems with bridging art history, cognitive neuroscience, and perceptual psychology. Variations in the definitions of common words, different interpretations of professional tone, and contrasting standards of evidence inhibit interdisciplinary research. Disciplinary differences can be as fundamental as whether photographs should be equated with real objects in neuroscience experiments.

While interdisciplinary issues can be surmounted by faculty with time, intellectual flexibility, and energy, institutional support is essential. In 1990 Ernest Boyer criticized

1. Snow delivered his essay "The Two Cultures" at Oxford University in 1959. In 1963 he responded to criticism with his second essay, "The Two Cultures, A Second Look." Snow 1993a, Snow 1993b.

American universities for being preoccupied with prestige in their narrow assessments of research and urged a broader approach that included teaching and service.[2] More than fifteen years later, the quest for institutional status has intensified the focus on speed, quantity and category of publications, deterring interdisciplinary research that requires extensive time or extends beyond established methodologies. Long after Snow expressed his concern that university research needs to focus more on public benefit, the hierarchy of research recognition continues to create a gap between the production of knowledge in universities and its dissemination. As a result K-12 school systems and the general public use outdated and inaccurate knowledge and a lifetime of exposure to discarded research may not be remedied by a few university classes. Thus Betty Edwards' *Drawing on the Right Side of the Brain* thrives in popular culture and Jean Piaget's western ethnocentrism permeates educational systems by identifying Renaissance linear perspective with individual and cultural maturity while branding much of the world's art and its culture as the product of a childlike stage of development.

Part I. Connecting Visual Brain Processing to Art

Linear perspective, an artistic technique often touted as a sophisticated and accurate representation of three-dimensional forms on a two-dimensional surface (fig. 1), appears first in fifteenth-century Italian Renaissance painting.[3] If linear perspective is accurate, then presumably it corresponds to what we see but this assumption prompts questions about how vision works in the eye and the brain. Since cultures across the globe and across history have been judged as culturally advanced if they adopted linear perspective, then is the technique the product of

2. Boyer 1990.

3. Linear perspective is also known as vanishing point perspective, geometric perspective, or scientific perspective. Leon Battista Alberti published instructions for the technique in Latin in 1435 and in Italian in 1436. Alberti 1966, 56-58.

western culture or the biology of sight? The answer depends on the date and type of research.

In the early twentieth century, research on the biology of perception followed two basic approaches: agnosia studies that located different aspects of visual processing in the brain according to individual injuries and perceptual psychology experiments that isolated visual elements such as parallel lines (gratings) and color squares. This research yielded little material that could be directly applied to art history.[4]

In the 1990s, the field of cognitive neuroscience enlisted medical scanning and electrophysiological techniques such as PET, fMRI, EEG, and MEG to study responses to photographs and drawings of ordinary objects like faces or buildings.[5] For example, fMRI experiments showed activation in the face fusiform area (FFA) on both the right and left hemispheres of the brain in response to images of faces while the parahippocampal place area on both the right and left sides of the brain activates in response to places (fig. 2).[6] Another fMRI experiment demonstrated that specific areas of the cerebral cortex seem to be responsive to particular objects regardless of whether the subject viewed photographs or drawings (fig. 3).[7] An extensive EEG study identified specific neural areas that responded to particular parts of faces or

4. The location of brain injuries led to theories about the relationship between loss of function and specific areas of the brain. Patient DF who lost visual capabilities due to carbon monoxide poisoning has been the subject of a series of articles such as Goodale et al. 1991, 154-156. Many artists are familiar with the anecdotal essays on agnosia patients in Sacks 1985. For a contrast of gratings and natural scenes in vision research, see Barinaga 1998, 614-616; Young 2000, 137-146. In the 1950s, Gombrich and Arnheim applied perceptual psychology to the study of art history. Gombrich's A. W. Mellon Lectures in the Fine Arts, delivered in 1956 were published as Gombrich 1961 and Arnheim 1974 was first published in 1954.

5. For a discussion of the advantages and disadvantages of blood flow analysis with PET (positron emission tomography) and fMRI (functional magnetic resonance imaging) and electrophysiological techniques with ERPs (event-related potentials) and MEG (magnetoencephalography), see Cabeza and Nyberg 2000, 1-3.

6. Kanwisher, McDermott, and Chun 1997, 4302-4311; Epstein et al. 1999, 115-25.

7. Because photographs define objects with texture and luminance (value) and line drawings define objects by edges (contours), similar neural responses to drawings and photographs of an object indicate the brain is responding to identification of the object, e.g. a house, rather than the method of representation. Ishai, Ungerleider, and Haxby 2000, 979-990. For similar conclusions from tests of ERP responses in face-selective neural sites to color or grayscale photographs, regular photographs, blurred photographs or line drawings of faces, see McCarthy et al. 1999, 431-444.

particular viewpoints of faces.[8] Because all of these experiments tested people with normal vision by using photographs or drawings to study the cognitive process of sight, the data could be more easily related to the cognitive process of making and viewing art.

Connections between neuroscience research on sight and common features of artistic style could reshape art historical research by connecting neural pathways to visual choices in making art. Neuroscience experiments and agnosia research document the presence of two pathways, a ventral "what" pathway that identifies objects regardless of viewpoint or distance and a dorsal "where" pathway that identifies the location of objects in space according to their distance from the person (fig. 1).[9] The ventral-what path explains our ability to recognize objects, such as a cow, from a variety of viewpoints or if parts of the cow are hidden.[10] The dorsal-where path allows us to assess the distance of an object so we can grasp it or run from it. While the pathways present continuous feedback loops and more complexity than a simple diagram, Young and Casanova observe that these pathways in visual processing are exceptionally well documented and accepted in biology.[11] In perceptual psychology these categories of vision correspond to theories of object-centered (allocentric) perception and viewer-centered (egocentric) perception.[12]

The significance of this research for art history is that canonical views, such as a frontal or profile view, seem to stimulate specific neurons in the ventral-what path, indicating that

8. Allison et al. 1999, 415-430; McCarthy et al. 1999, 431-444; Puce et al. 1999, 445-458.

9. The research is supported by numerous neuroimaging studies as well as brain injury case studies. The ventral-what pathway is also linked to categorization of objects while the dorsal-where path links the assessment of distance to motion. Ungerleider and Mishkin 1982, 549-586, Goodale and Milner 1992, 20-25; Ungerleider and Haxby 1994, 157-165; Courtney et al. 1996, 39-49; Goodale 2001, 313-331; Creem and Proffitt 2001, 43-68.

10. Called constancy or invariance in perceptual psychology, this ability can be associated with specific attributes such as shape or scale.

11. Casanova and Ptito 2001, ix; Young 2000, 137-146.

12. Norman 2002, 73-144. Norman fuses contrasting theories established in perceptual psychology over thirty years ago by tying Richard L. Gregory's theory to the ventral path and J. J. Gibson's theory to the dorsal path.

canonical views of common forms such as faces are "hardwired" in the brain.[13] Thus the fusion of frontal and profile views in Egyptian art seems to be directly related to the way the human brain processes the recognition of objects (fig. 2). In other words, Egyptian art fits a key neural pathway for human vision. This biological explanation differs from earlier characterizations of Egyptian style as a primitive, childlike, rigid, and stylized approach to art.[14]

In the western representational tradition from the fifteenth through the nineteenth centuries, the visual information processed through the egocentric dorsal-where path became the dominant method of rendering forms. By rendering the location of an object in a specific time and place using perspective techniques such as shading, foreshortening, and linear perspective, artists satisfied the western standard for "good art." Ignoring the rigidity, monocular viewpoint, and trapezoidal distortions of rectangles in Renaissance linear perspective, influential scholars including Piaget and Arnheim regarded the technique as accurate.[15] For Alfred Crosby and Samuel Edgerton, Jr. the gridded, measured, infinite uniformity of linear perspective contributed to the technological and scientific dominance of western culture and the development of the industrial revolution.[16] Yet, like the ventral-what path, this visual processing only corresponds to one aspect of the biological process of vision.

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13. McCarthy et al. 1999, 439. Recent studies on cortical responses to canonical views include James et al. 2002, 793-801; Pourtois et al. 2005, 1043-1057.

14. Jean Piaget identified the fusion of frontal and profile views in drawings as a developmental stage for children ages four to eight. Piaget criticizes young children (and by implication, ancient Egyptians and many other cultures) for producing "pseudo-rotations", "distorted" images and "jumbled points of view" when they use profile and frontal views in the same figure. Piaget and Inhelder 1967, 49-51, published in France 1948, in England 1956. Like Piaget, Arnheim also influenced art educators and similarly characterized the style of Egyptian art as an "early level of visual conception" and "an elementary procedure for representing pictorial space." Arnheim 1974, 283.

15. For Piaget, linear perspective demonstrates accurate and mature drawing of what we see in a unified and proportional space. The skills to create an empirical approach to linear perspective he attributes to children around age nine, substage IIIB.. Piaget and Inhelder 1967, 173-193. Arnheim also regards linear perspective as "realistic" and ties the technique to the "objectively correct description of physical nature." Arnheim 1974, 283.. For a more complex treatment of whether linear perspective as scientifically accurate or a cultural construction, see Kemp 1990, 336-341.

16. Crosby refers to "proper representation of 3-D forms on a 2-D surface" and to "progress" toward perspective. Crosby 1997, ix-xi, 17, 166, 176, 177, 227-234, 239. Edgerton connects the development of isotropic

Neither the ventral-what path nor the dorsal-where path provides sufficient information for visual processing; vision depends on feedback loops to integrate this information for our daily sight. Similarly, neither system in art is, by itself, a realistic rendering of vision (fig. 2).[17]

While our vision fuses both approaches as we see, remember, and navigate through our environment, art produced on a two-dimensional surface cannot replicate the complexity of sight and visual memory and so artists must make choices about what to include and what to delete.[18] The decision to use an object-oriented ventral approach or a distance-oriented dorsal approach can best be explained by cultural factors: which representational system best fits the cultural function of the art? The egocentric dorsal approach fits cultures that emphasize the experience of individuals in the present while the allocentric-what approach fits cultures that emphasize the timeless significance of forms. Ancient Egyptian tomb painting produced to ensure an infinite afterlife accords with the ventral-what path in visual processing and the western emphasis on personal experience in the here and now relates to the dorsal-where path.[19]

Part II. Challenges to Bridging Disciplines.

(continuous homogenous space) in fourteenth-century Medieval Europe to the influence of Euclidian geometry as well as neo-Platonic concepts but affirms that the method is the product of vision more than culture. Edgerton 1991, 10, 16.

17. Simple dichotomies of Egyptian-ventral style and Renaissance-dorsal style can be misleading. The dorsally-related perspective technique of foreshortening appears in Egyptian art in images of servants, as in "Ti Watching a Hippopotamus Hunt," Tomb of Ti, Saqqara, Egypt. Scale based on importance rather than distance, a ventral approach, appears in the first extant painting with linear perspective, Masaccio's *Trinity* fresco in Santa Maria Novella, Florence, and continues in some Renaissance religious paintings where the central figure is larger in scale relative to spiritually less important figures. Michelangelo's Sistine Chapel ceiling uses multiple points of view, a characteristic ascribed to Egyptian and Medieval art.

18. Even motion pictures and video are merely a series of static images presented at a rate of speed so that we think we see forms in motion.

19. When asked to draw a human eye, over 99% of hundreds of university students produced a canonical frontal eye rather than a profile, three-quarter, or other view of an eye. The exercise reveals that while we may not be aware that we are visually processing canonical forms, these viewpoints are part of our visual identification. Schiferl 1995, 304; Schiferl 2002.

In the early twentieth century, western art history used art associated with the dorsal-what path as the standard for judging the art and social level of entire cultures while in the 1980s, art history shifted toward investigating art in the context of a culture's values rather than western style. However, both these approaches emphasize cultural *differences* between people. By showing how differences in artistic style can be explained by the neuroscience of vision, art history moves toward an explanation of cultural choices in art that emphasizes human similarities more than differences. While this approach could lead to a new avenue for research in art history, the problems with delving into this type of interdisciplinary research include terminology, professional tone, standards of evidence, and research models.

1. **Terminology:**

Learning specific technical vocabulary is one of the entry points into a new discipline. However, a key problem with understanding neuroscience research is ordinary words defined differently in cognitive neuroscience, perceptual psychology, and art history. The primary visual cortex, area V1 in the occipital cortex, or the parahippocampal place area are technical terms that can be defined with some precision. But common words like "image," "perception" and "perspective" can hold very different meanings. In medicine, "image" may refer to the physical PET or fMRI scan, while in perceptual psychology or neuroscience research it may refer to a mental image such as what people imagine or remember. In art history, "image" refers to the art work itself or the objects represented in it. Perception may refer to vision based on retinal data, to the complex cognitive process of vision within the brain that involves both memory and retinal data, or to a level or understanding as in Goodale's "Different Spaces and Different Times

for Perception and Action."[20] Retinal sensory inputs may be referred to as optical in art, as veridical in perceptual psychology, and retinotopic in neuroscience. Deeply ingrained disciplinary definitions of common words invite confusion and make it harder to communicate across disciplines.

2. **Tone**

C.P. Snow contrasts the declarative tone of the sciences with the more suggestive and cautious language of humanities research but now the opposite seems true.[21] Scientific research in cognitive neuroscience adopts a cautious tone, frequently using words such as "suggest", "seem" and "indicates." For example, Kalanit Grill-Spector writes: "our data from the FFA are consistent with several other recent findings, and extend them in interesting ways. First, the correlation observed here between FFA responses and performance on face detection and identification parallels findings that the face-selective M170 response measured by magnetoencephalography (MEG) is correlated with both detection and identification of faces."[22] In contrast, post-modern humanities research often uses a declarative, assertive tone such as this description of Cindy Sherman's photographs: "Most of the film stills derive from 1950s stereotypes, depicting women whose emotional vulnerability is not meant to signal physical availability. Neither narcissism, exhibitionism, nor voyeurism pertain, though Sherman herself appears in all of the photographs."[23]

When it comes to evaluating the validity of research, disciplinary preferences for a cautious or assertive tone can affect evaluations of the research. In the humanities, the cautious

20. Goodale 2001, 313-331. For different definitions of perception related to conscious and unconscious awareness, see Norman 2002, 73-74.

21. Snow 1993a, 4.

22. Grill-Spector, Knouf, and Kanwisher 2004, 555.

23. Kurtz 1992, 192.

tone of science research may seem hesitant and unconvincing; for the sciences, the declarative language in humanities research may seem more like preaching than investigating.

3. **Standards of Evidence**

What constitutes scholarly evidence in one field may not be acceptable evidence in another field. For example, research on the process of vision in both cognitive neuroscience and perceptual psychology often uses photographs of objects as evidence of how humans recognize and respond to objects. Contrary to the popular phrase "as realistic as a photograph," for an art historian, photographs are two-dimensional images that differ significantly from the objects they portray. Produced by cyclopean cameras, photographs are flat, static images that distort distance, lighting, and scale. Neuroscience research experiments generally ignore this difference, treating responses to a digital photograph of a house as equivalent to looking at a house.[24] The research on responses to photos may thus yield more information on how people respond to photographs of objects than to the actual objects. However, the reliability of PET, fMRI scans and ERP studies based on responses to photographs and drawings increases when affirmed by agnosia studies which document the daily experience of vision for people with brain injuries, as is the case for the what and where path research.[25] The use of three-dimensional objects in scanning research offers additional support, such as Pietrini's recent experiment which uses three-dimensional forms of common objects, such as a bottle, and a sculptured relief replica

24. For example, the "real objects" studied by Vuilleumier et al. 2002 , 491, fig. 1, are flat, grayscale digital photos of objects.

25. Cognitive neuroscience experiments on vision conducted in the twenty-first century may include a variety of experimental data in their review of literature as part of the fusion of perceptual psychology and cognitive neuroscience. This includes variations in the type of form presented to the subject (grating, photograph, line drawing), the type of response documentation (behavioral, fMRI, PET, ERP, agnosia) and the type of subject (monkey or human).

of a face to test responses to an actual face.[26]

4. Research Models.

The scanning devices that make this research possible also constrain the way vision can be tested. In PET and fMRI experiments, subjects may see photographs or drawings by viewing a mirror angled above their heads that reflects computer generated images.[27] For some experiments, the position of the head and eyes may be artificially held in place.[28] While the goal is to investigate the process of sight, the problem for these scanning experiments is similar to an issue often encountered with behavioral experiments in perceptual psychology: how reliable is research on vision produced in artificial viewing environments? The use of photographs brings the research closer to the experience of viewing art but farther from the usual experience of sight while moving through space.

PART III: Redesigning Reward Systems

A year after C.P. Snow published his lecture on *The Two Cultures,* art historian Leo Steinberg delivered a lecture on the difficulties people encounter when confronted with The New, in his case the new art of Jasper Johns. Entitled the "Plight of the Public," he defined the public as anyone with an established sense of identity and confidence in a specific set of values who needs to sacrifice their values, not just their comfort with the familiar, to accept the new style. The Impressionist painter Paul Signac confronting Henri Matisse or Leo Steinberg faced

26. Pietrini 2004, 5658-5663.

27. For a diagram, see Neri, Bridge, and Heeger 2004, 1882, fig. 2A..

28. To keep subjects' attention focused on the images, researchers often ask them to press a button in response to a question, such as whether they have already seen the same image. Some experiments mechanically limit head movement. For some of the problems with artificial eye fixation, see Culham and Kanwisher 2001, 160, and for an effect on neuroimaging responses, see Deutschländer et al. 2005, 4-13.

with Jasper Johns' *Target with Faces* must sacrifice something to gain something. Steinberg notes that the people who were most conservative in their evaluations of new styles in painting, the most vocal in denouncing the new, were the painters who had already achieved success.[29]

Crossing interdisciplinary boundaries involves a learning curve, becoming a student again and making elementary mistakes out of ignorance. In my experience, the faculty most likely to embark on interdisciplinary research and teaching are the most confident in their professional ability. Their identity is not vested in their disciplinary authority, but in a keen interest to expand their research and knowledge because it is intellectually invigorating. With time, the differences in terminology, tone, standards of evidence, and research models can be overcome by faculty if they have the interest, confidence, and institutional support.

Institutional support is vital. If we want to encourage more intellectual interaction between science-mathematics and arts-humanities, the place where we can make changes the most effectively in American universities is not by changing the disciplines but by changing the evaluation structure. This is even more crucial for the real goal of C. P. Snow's essay: making academic research available to people who can use it to benefit humanity. His solution was to reshape communication by restructuring education.[30]

While rewarding university teaching has been the focus of many discussions on faculty evaluation systems since Boyer's publication of *Scholarship Reconsidered* in 1990, Boyer's concern that reward systems feed the hunger for institutional prestige continues to be a issue in higher education.[31] Since 1990 the expectations for publications in peer-reviewed journals and

29. Steinberg 1966, 27-47. From a lecture delivered at the Museum of Modern Art, New York, in 1960 and published in *Harper's Magazine* in 1962.

30. Snow 1993a, 29-51; Snow 1993b, 60-61, 99-100. Snow focused on the structure of undergraduate education as the source of the problem and the beginning of the cure.

31. Boyer 1990, 12; Ohio State Legislative Office of Education Oversight 1993, 11-14; Sid Richardson Foundation 1997, 11; Wilson 2001, A12.. Heineman states "good colleges make mediocre universities" and cautions against increasing research standards for "wannabe" colleges. Heinemann 1999, 2, 8-9

books have accelerated partly because this continues to be the simplest method for measuring productivity.[32] Financial rewards also spur scholarly publications. The more peer-reviewed publications faculty produce, the higher their salaries whether four year institutions are considered jointly or doctoral, research and liberal arts colleges are considered separately.[33]

For many American universities, a primary goal of academic reward systems is to encourage the production of quality research. (The term "university" includes colleges as well). Thus some of the standard questions asked in reviewing faculty performance are:

1. How original is this research?
2. Does this research make a significant contribution to the discipline?
3. How many peer–reviewed and university press books have been published recently?

However, these questions tend to undermine Snow's twin goals of fostering interdisciplinary connections between arts-humanities and science-mathematics and making university research available to a broad spectrum of people. My proposed alternative questions aim to promote quality research and make research content accessible to faculty in other disciplines, to the public, and to K-12 teachers.

Current: How original is the research?

Proposed: What is the potential impact of this research beyond the university? How useful is this research? How original is the research?

C. P. Snow asserts that education is the key to bridging the gap between rich and poor.[34] Yet, ironically, institutions of higher education tend to look askance at educational publications,

32. Rice 2002, 16.. The emphasis on publication of refereed articles and books in evaluating faculty was affirmed through questionnaires sent to 245 universities by Marchant and Newman1994. Escalating expectations for publications are noted by Serow's interviews with physical, applied and behavioral science faculty and Seipel's evaluation of 139 graduate programs in social work. Serow 2000, 449-463; Seipel 2003, 79-88.

33. Fairweather 1993, Table 1.

34. Snow originally intended to title "The Two Cultures" essay "Rich and Poor." Snow 1993b, 81.

from textbooks for college courses to software designed to present new research to elementary school students. A similarly dismissive attitude carries over to mass audience books. In general, the lower the age of the people who will access the research and the larger the number of people exposed to the research, the less value the research has in the academic publishing hierarchy. In this inverse hierarchy, the research with the least impact may gain the most respect.

When universities reward original research in peer–reviewed publications and university press books and look with disfavor on faculty who communicate research to a broader audience or who produce educational materials, they essentially abdicate a key reason for their existence and give this responsibility to people who may be far less qualified. As a result, people who can present research in an accessible form by using ordinary language may gain an inordinate influence. Methodologies and content that academic research discarded thirty to forty years ago continue to have a long life in K-12 school systems and popular culture partly because that is what is available. One or two lectures on a subject to update university students has little chance of replacing decades of immersion in outdated approaches.

Betty Edwards' *Drawing on the Right Side of the Brain* exemplifies the problem. Edwards published her book in 1979 based on scientific research published by Roger Sperry in the 1960s and 1970s.[35] The simple division of left-brain processing of language, logic, and math and right-brain processing of visual imagery gave a biological validation to people who struggled with math and language; they weren't stupid, they were right-brained, they were visual learners. In less than a decade, Edwards' book sold over 125,000 copies and was translated into ten other languages. In the twenty-first century, it is still common to hear American artists describe

35. Edwards 1999. First published in 1979, Edwards revised the book in 1989 and again in 1999. Sperry 1968, 723-733; Sperry 1973, 209-229.

themselves as "right-brained."[36] The simple dichotomy between right and left brain processing was easy to understand and easy to remember. However, brain scan research conducted since the 1990s provides ample evidence that visual processing takes place on both sides of the brain. Brain scans in neuroscience research journals make this readily apparent to visually oriented people but few art education instructors are likely to locate and read an article titled, "The Fusiform Face Area. A Module in Human Extrastriate Cortex Specialized for Face Perception" published in the *Journal of Neuroscience*.[37]

The reliance on this outdated research may have significant consequences. Despite hundreds of articles devoted to brain scan research on vision, Edwards' 1999 bibliography was almost the same as her 1979 bibliography.[38] Yet Edwards assures readers that the 1999 book is revised, updated and accords with recent cognitive neuroscience.[39] Teachers continue to present her art theories as if they represent current science.[40] While the goal was to make visual learning as respectable as mathematical and verbal learning, the simple dichotomy means that some people who identify themselves as either right-brained or left-brained assume they are biologically hardwired to excel in either mathematics or art. Believing such a simple and rigid label may hinder their educational and professional development.

Edwards' book carries implications for cultural understanding as well by perpetuating the concept that non-western art is childlike and primitive while western illusionism is sophisticated,

36. The book title reinforces the concept of "right-brained" artists, but in the text Edwards also uses the terms "right-mode" and "left-mode" which she defines according to Sperry's research on the functions of right and left hemispheres in split-brain patients.

37. While many neuroscience experiments on vision show strong bilateral (right and left hemisphere) responses, some studies do affirm a strong lateral response to a particular visual stimulus or a moderate bilateral activation. For examples of scans that show activation to visual forms on both sides of the brain, see Kanwisher, McDermott, and Chun 1997, 4302-4311; Ishai, Ungerleider, and Haxby 2000, 979-990; O'Craven and Kanwisher 1997, 1013-1023; Yovel and Kanwisher 2004, 889-898. For a strong right hemispheric response, see Beauchamp et al. 2002, 149-159.

38. The 1999 bibliography lists 105 sources. None is from the 1990s, four non-scientific sources date to the 1980s, 49 are from the 1970s and the remaining 51 are prior to 1970. Some additional sources quoted along the margins of the book are not included in the bibliography. Edwards 1999, 279-282.

39. Edwards 1999, xvii, xxii, xxiv-xv, 81.

40. For criticism of "brain-based" educational approaches, see Bruer 1999, 648-657.

correct, and mature—an approach discarded by post-modern art historians for its elitist (and less informed) view of cultural history. Because she regards realistic drawing in the western style as an achievement, Edwards apparently does not endorse the spatial logic, intellectual sophistication, or cultural context of non-western drawing. Instead cultures that choose a different drawing style are identified as parallel to earlier stages of development. When a twelve year old boy draws a frontal eye on a profile view of a face, the combination used systematically by ancient Egyptian artists (consonant with the ventral-what path), Edward considers his approach a holdover from an earlier stage of childhood development.[41] She also links ladder perspective in children's art to art from ancient Egypt and Asia.[42]

In her chapter on childhood memories, Edwards enlists the Piagetian developmental assumptions that permeated American school systems a half-century ago. Piaget parallels childhood development with cultural development, a cultural adoption of the nineteenth-century premise: ontogeny recapitulates phylogeny.[43] Piaget characterizes the art of children less than seven years old as "primitive" while children ages seven to eight "advance" in their approach until they achieve unified perspective renderings at age ten or eleven which are "real" and "true."[44] The type of Renaissance illusionism Edwards considers realistic, accurate, and a replication of what we see is adopted by some twentieth-century children around age ten or

41. Edwards 1999, 78., fig. 5-15.

42. Edwards 1999, 142, 170. Ladder perspective places objects that are farther away from the viewer higher on the surface. If people stand in two rows, the figures in the back row are raised so their faces can be seen. Her statements about ladder perspective in Egyptian art reveal significant problems with understanding the cultural context of Egyptian art. No example from any period or region within Asia is provided. She does not acknowledge parallel (axonometric) perspective, the approach selected by many Chinese and Japanese artists as well as many western architectural firms, because there is less distortion of receding walls than in western linear perspective. Some examples of parallel perspective: *Night Attack on the Sanjo Palace*. Handscroll, thirteenth-century Japan. Museum of Fine Arts, Boston; Chapters from the *Tale of Genji*. Folding screens, sixteenth-century Japan. National Museum, Tokyo; Zhou Fang (style of). *Ladies Playing Double Sixes*. Handscroll, tenth-eleventh century China. Freer Gallery of Art, Washington, D. C.; *Daoguang Emperor and his Children*. Painting on silk, nineteenth-century China. Palace Museum, Beijing.

43. Piaget 1971, 83-84; Gould 1977, 144-147; Sander 2002, 523-533; Langer 2004, 73-76.

44. Piaget and Inhelder 1967, xii, 4, 6, 7, 8, 9, 50-52.

eleven. However, cognitive neuroscience of the ventral-what path and the dorsal-where path provides evidence that both the Egyptian and Renaissance approaches are complementary halves of a whole; they are both integral to vision but each path presents incomplete visual information. At the root of Edwards' and Piaget's western perspective ethnocentrism is a tendency to denigrate entire groups of people and nations as childlike for choosing a different type of art. By using research that is decades out of date, Edwards seems to be presenting a scientific rationale for western superiority. From both the cultural and scientific perspectives, this book is as problematic as it is popular. Yet without incentives to produce well-researched publications targeted to the general public or teachers, universities silently reinforce such outdated approaches.

Current: Does this research make a significant contribution to the discipline?
Proposed: What is the significance of this research? How can this research benefit humanity?

In theory, universities promote original thinking but in practice a "significant contribution" is typically assessed by people making similar contributions. And the standard question, "Does this research make a significant contribution to the discipline?" reveals a strong disciplinary bias. Original research becomes narrowly defined as something that fits within established methodologies. Thus the academic reward system favors the status quo by reinforcing faculty who publish in established areas of research.

In the United States, many universities applaud cross-disciplinary approaches in theory but evaluate the quality of research in a linear sequence starting from the discipline within a department. The larger the university, the more separated the disciplines become. The tendency to ask for more and more documentation of research, teaching and service—while intended to provide a more professional and less political basis for evaluating faculty performance—results

in an overwhelming amount of documentation that few reviewers take the time to read.[45] As long as evaluation moves vertically from departments to deans to vice-presidents, evaluators at each ascending step will spend less time evaluating the material personally, thus automatically prioritizing the role of the academic disciplines in evaluating performance no matter how much universities preach the value of interdisciplinary involvement.[46]

Current: How many peer–reviewed and university press books have been published recently?

Proposed: What is the quality and significance of the research?

Assessments of the quantity, category, and speed of publications put more emphasis on the illusion of objective standards than on the quality or impact of research.[47] Ideally, the focus on recently produced work encourages faculty to be actively engaged in research and publication; in practice the focus on the quantity of recent publications encourages faculty to select projects based on how fast they can be converted to peer-reviewed articles. When speed is a factor, research should be original but not so new that it will be difficult to place in conventional journals. Worthwhile projects that require investments of time will be sacrificed

45. For the negative impact on the volume of documentation required for tenure and promotion, see Fairweather 2002, 100.

46. A vertical flow chart of the evaluation sequence in Ohio universities appears in Ohio State Legislative Office of Education Oversight 1993, 8 . This study also notes the disincentives to collaborate across disciplines because it is harder to review interdisciplinary work or assess who should be given credit in multi-author publications.

47. Braxton and Del Favero outline how counting refereed articles could inconsistently affect the evaluation of faculty on the basis of the publication patterns of different disciplines. Braxton and Del Favero 2002, 19-31. Speed is a factor in the timeline for tenure but also becomes increasingly important for institutions who compare their publication production per year according to the data compiled by the National Center for Educational Statistics (NCES). The NCES tracks the number of publications produced per faculty according to educational institution and rank. Cataldi, Bradburn and Fahimi 2005, 1, 33, Table 23. Because different criteria were used in counting the number of publications, e.g. group vs. sole authorship, the data for Fall 2003 in Table 23 cannot be compared directly to data from previous surveys in 1987-1988, 1992-1993, and 1998-1999. The survey data from 26,100 respondents represents 2.2% of approximately1,200,000 postsecondary instructional faculty and staff in the United States.

for projects that generate rapid publications. The focus on speed also encourages faculty to stay within established disciplinary approaches and avoid the time-consuming learning curve involved with interdisciplinary research. The constant pressure to produce new research also deters faculty from producing two versions of their research: one aimed at peers in the profession and another aimed at teachers or the general public.

Conclusion.

In 1959 C.P. Snow urged communication between the sciences-math and arts-humanities for the public good; in 1960 Leo Steinberg acknowledged the painful process of accepting something new that requires a sacrifice of established values. For faculty this requires an investment of time and energy to expand beyond the vocabulary, assumptions, and methodologies of their discipline but promises to open new avenues of research. For universities, this involves reviewing how reward systems interfere with interdisciplinary research and the dissemination of knowledge. By sacrificing the quest for prestige to the ideal of making quality research accessible to humanity, universities can encourage more researchers to present their work for the benefit of people beyond the rarified atmosphere of academic disciplines.

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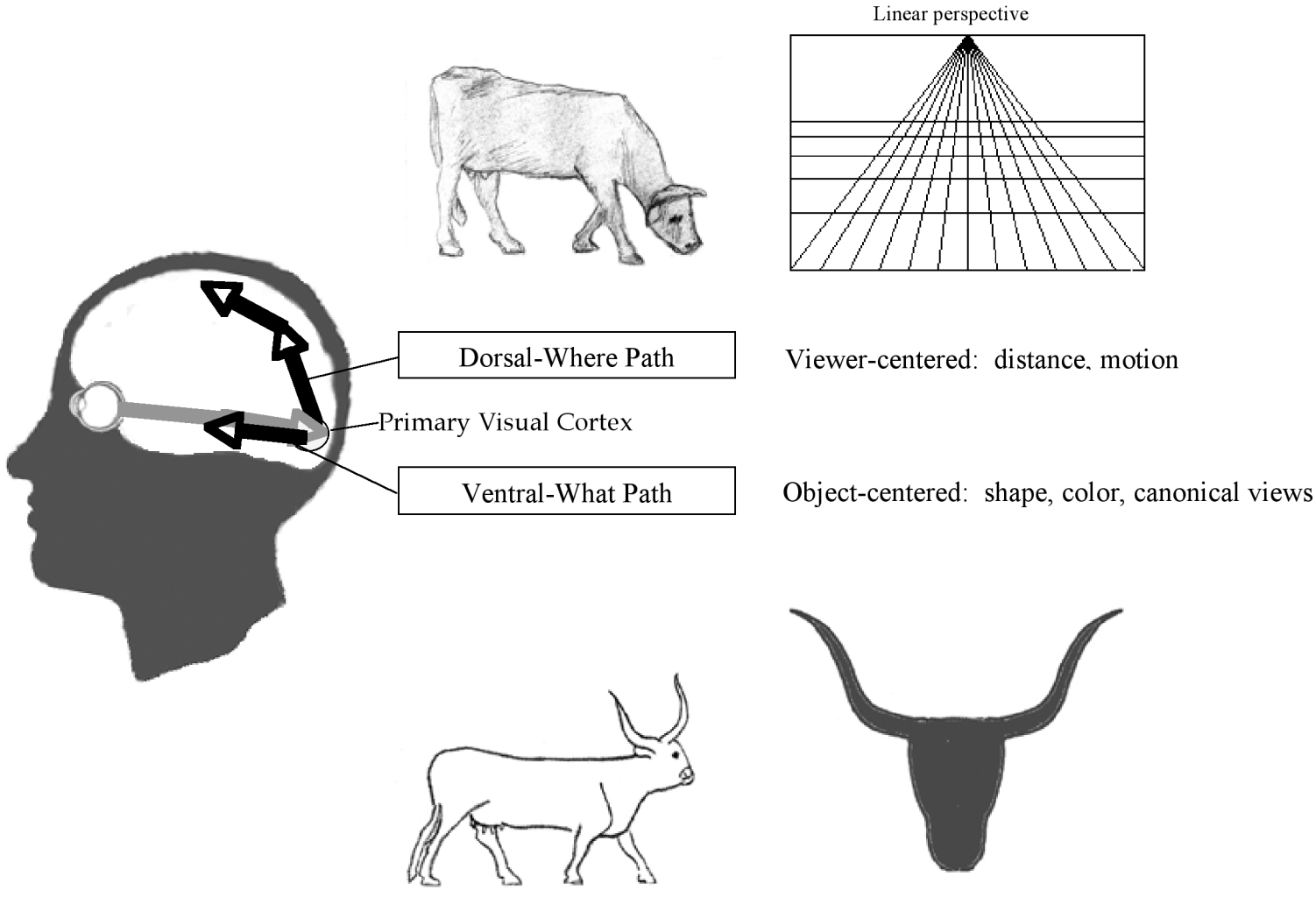

Fig. 1. Dorsal-Where and Ventral-What Paths for Vision

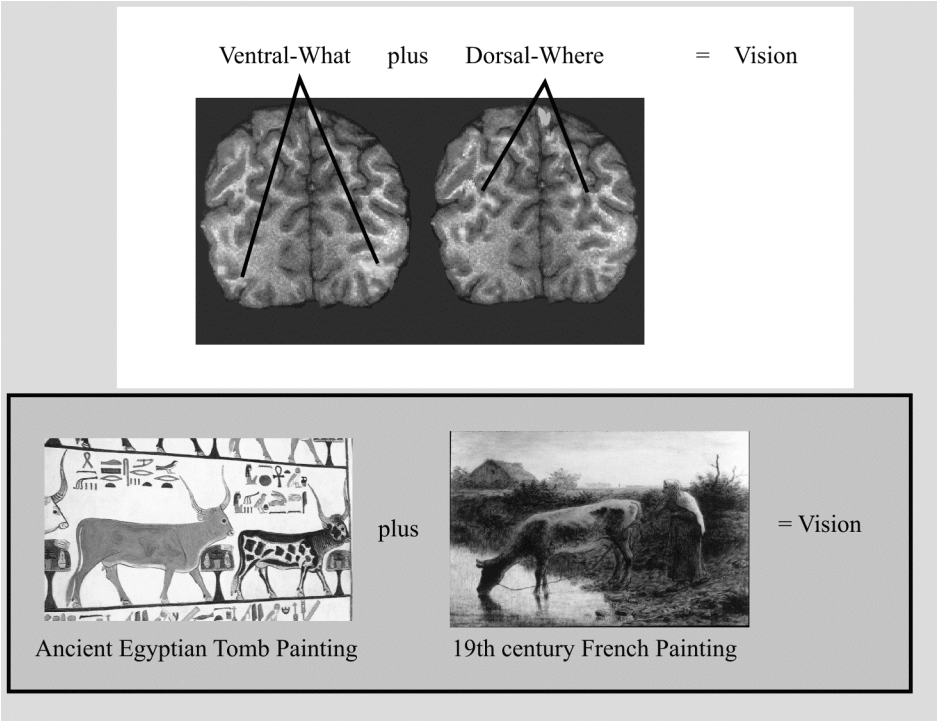

Fig.2. Vision combines neural responses from the ventral-what and dorsal-where Paths. Like the ventral-what path, the painters of the tomb of Queen Nefertari adopted canonical views to identify objects beyond a specific place and time. Like the dorsal-where path, Millet emphasized action and distance from the viewer.

Tomb of Queen Nefertari, d. 1255 BCE. Painting. Getty Conservation Institute and J. Paul Getty Museum, Los Angeles. © Courtesy of the Getty Conservation Institute. ©The J. Paul Getty Trust, 1999. All Rights Reserved.

Jean-François Millet, *Peasant Watering Her Cow*, c. 1863. Oil and conte crayon on canvas, 46 x 55.5 cm. Museum of Fine Arts, Boston. Photograph © 2007 Museum of Fine Arts Boston. Reproduced by permission.

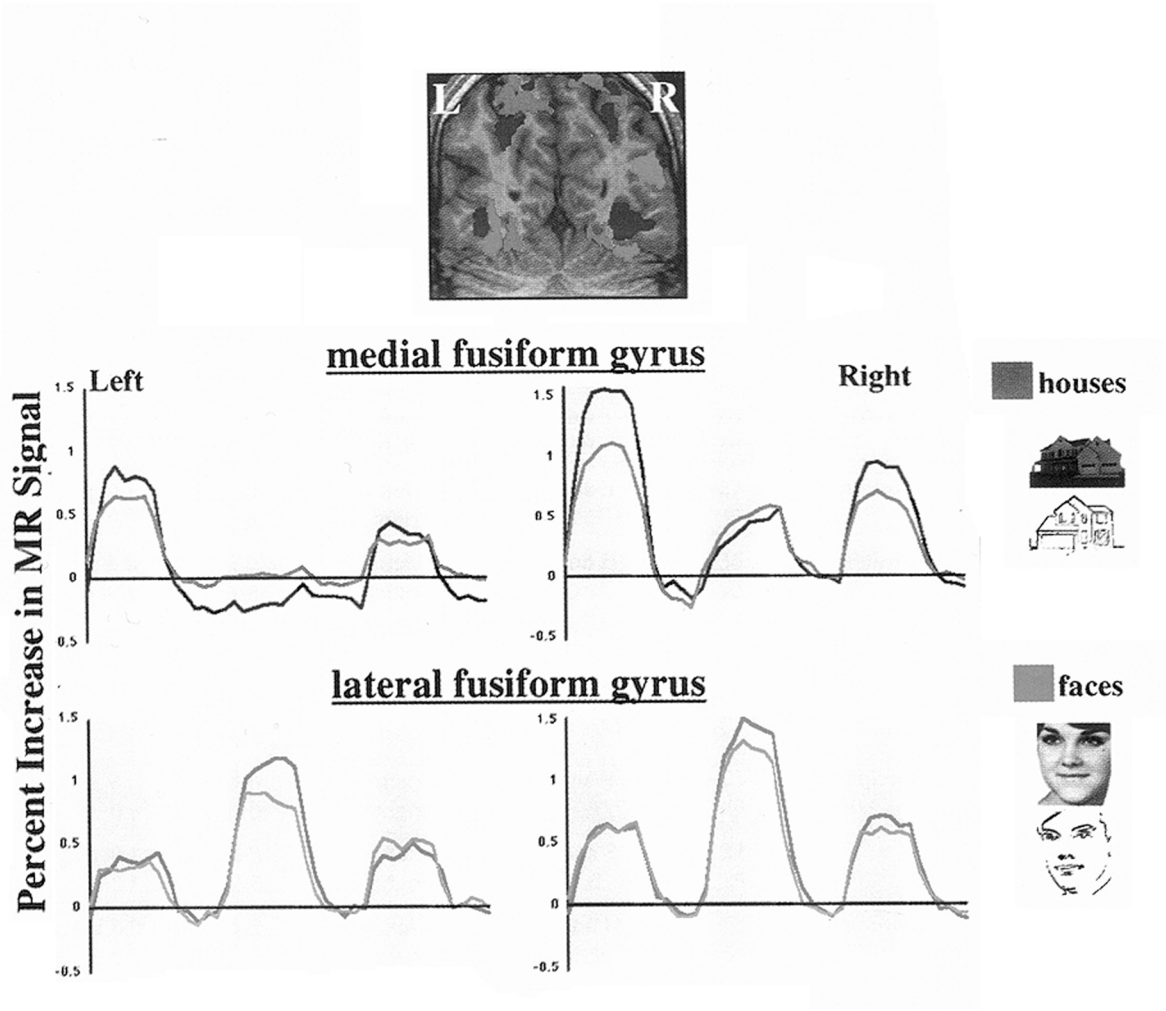

Fig. 3. FMRI responses to photographs and drawings of houses and faces on both right and left hemispheres. (Alumit Ishai, et al. "The Representation of Objects in the Human Occipital and Temporal Cortex," *Journal of Cognitive Neuroscience* 12, Supplement 2 (2000) fig. 2. Reproduced by permission of MIT Press Journals).