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Introduction: Visual Images and Visualization in the Neurosciences

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In the history of the neurosciences, physical images and cognitive visualization offer two frames of reference for thinking about the historical development of the field. The images of neurological illustration, for example, constitute a sourcebook on early medical theories. We can also identify a body of images that articulate how cultural beliefs influenced conclusions about behavior and learning as they relate to anatomy, physiology, biochemistry, and our nervous system. More recently, the enthusiasm generated by brain imaging technologies has highlighted the role of visual images in our efforts to capture the form and function of the brain. In light of the many precursors that show our urge to know the brain has long had a visual component, it seems that the time is ripe to reexamine the historical role of visual images and visualization techniques in enhancing our understanding of the brain and human behavior. The eight articles that comprise this compendium offer a small step in this direction.

To open the volume, a paper on "Visual Thinking and Neuroscience" by C. U. M. Smith analyzes why visual thinking is at the core of neurobiological thought and has always played a major role in reporting and progressing science. In a general sense, images and diagrams encapsulate thinking and communication about vast amounts of work and information. We can point to histograms, charts, graphs, micrographs, brain scans, flow charts, freehand drawings, cartoons, etc. Some of these images are diagrammatic (e.g., graphs, histograms, pie charts, etc.) and are used as an aid in comprehending complex numerical data. Others are used as shorthand and allow us to comprehend in one "gestalt" vast quantities of anatomical and functional detail. Smith fleshes out his thesis with three examples of particular interest to the history of the neurosciences: the column, the retina, and the impulse.

Nicholas J. Wade's contribution, "Vision and Visualization," highlights the role of visual communication in the history of vision science. Wade conveys that scientists frequently express their ideas graphically through a number of images he presents in support of his thesis. Diagrams of anatomical structures, like the eye and visual pathways, and figures displaying specific visual phenomena have assisted in the communication of visual ideas for centuries. He also shows that, as with any science, vision can be subdivided. The classification adopted by Wade is in terms of optics, anatomy, and visual phenomena. Optics can be considered in terms of the nature of light and its transmission through the eye. Understanding of the gross anatomy of the eye and visual pathways was initially dependent upon the skills of the anatomist whereas microanatomy relied, largely, on the instruments that could resolve cellular detail, mediated by the observational skills

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of the microscopist. The balance between research skills and the added value technologies bring to research is a component of his essay that bears on the close relationship between art and science; a subject touched upon in many of these articles.

The next paper, "Brain, Mind, and Body: Interactions with Art in Renaissance Italy" by Sheryl R. Ginn and Lorenzo Lorusso, also speaks of the art and science interface. Their research pinpoints areas where the cross-fertilization of art and science was mutually beneficial and provided new ways of explaining the mysteries of the human body and mind. This article balances the work of key figures (Vesalius, Leonardo, Estienne, Eustachius, etc.) with technologies that aided in disseminating their scientific investigations and research, (e.g., printmaking and wax modeling). As they show, key advances in neuroanatomical methods at that time shed light on the value of human dissection to Renaissance scientific and artistic practice. In addition, their summary of pre-Renaissance theories adds immensely to our understanding of why the first systematic anatomical and physiological studies of the brain and human body during the Renaissance are characterized as revolutionary.

Lorenzo Lorusso's "Neurological Caricatures since the Fifteenth Century" further establishes the art/science connection. He shows that caricatures and cartoons have a long history of use in art, science, and neurology. Drawings and prints were used to illustrate and to educate both professionals and lay persons about medicine (and about the perils of medicine and neurology as well). In the caricature form, graphics were historically disseminated as artwork and to a public eager to learn how neurology would benefit the meaning of bodily expression. Among the artists who sought to portray the emotional or the physical qualities of humans and/or caricatural aspects of medical activities were Leonardo da Vinci, Albrecht Dürer, Hieronymus Bosch, Pieter Brueghel, William Hogarth, Thomas Rowlandson, James Gillray, the Cruikshanks, Francisco Goya, and Honore Daumier. Some used caricature for emphasis, while others present humorous and/or polemical attacks. Also discussed are physicians such as Charles Bell and Jean-Martin Charcot, talented caricaturists who offered a quite different "image" of neurology from that presented by the artists. Lorusso's thorough examination brings to light that caricatures were popular portraits of developments in science and medicine and were frequently used whenever scientific language was too difficult to disseminate, in particular in the field of neurology.

Images continued to play an integral role in eighteenth and nineteenth century advancements. Marco Piccolino's paper, "Visual images in Luigi Galvani's Path to Animal Electricity," reviews the scientific endeavor that led Luigi Galvani to his hypothesis of "animal electricity", i.e., of an electricity present in a condition of disequilibrium between the interior and the exterior of excitable animal fibers. Through outlining the role played by visual images in Galvani's path of discovery, Piccolino's paper helps us better conceptualize how Galvani's research earned him the designation of one of the founding fathers of neuroscience.

Sarah de Rijcke's paper, "Light Tries the Expert Eye: The Introduction of Photography in Nineteenth Century Macroscopic Neuroanatomy," speaks to the world of nineteenth-century images. She argues that new technologies were not always favored. While photography's scientific inauguration in the nineteenth century meaningfully coincided with a shift towards the ideal of mechanical objectivity, we can find exceptions to this in neurology. Indeed, after the publication of the first neuroanatomical atlas to contain photographs, Jules Bernard Luys's *Iconographie Photographique des Centres Nerveux* (1873), the use of photography in macroscopic neuroanatomy remained rare. Her article sketches this largely overlooked terrain of investigation and expands on why macroscopical neuroanatomy photography failed to offer a satisfactory alternative to drawing or

engraving. One of de Rijche's premises is that scientific images are not merely pictorial illustration but facilitate research goals. When she notes that prints and engravings were seen by some to communicate more fully than the mechanical representations of photography, she offers a useful counterpoint to the role of printmaking in Renaissance advancements presented by Ginn and Lorusso.

With the twentieth century, our ability to penetrate deeper into brain activity was accompanied by some enthusiastic speculation that researchers could possibly resolve many of the age-old mysteries surrounding the relationship between cognition and epistemological questions. Cornelius Borck's contribution, "Recording the Brain at Work: The Visible, the Readable, and the Invisible in Electroencephalography," takes on this topic. He looks at the electroencephalogram (EEG), and how the graphic recording of the electric activity of the human brain kindled far-reaching speculations about the imminent deciphering of mind and brain in the 1930s. With evermore groups specializing in electroencephalography, however, the deciphering of mind and brain did not materialize but moved further away from this goal due to the quantity of information produced. In the various approaches employed in EEG research, such as the analysis of the activation code, the search for pathognomic patterns or the imaging of cognitive processing, visualization guided research as well as theorizing; its productivity continued to keep the epistemological question open.

The issue closes with Alan G. Gross's article, "The Brains in *Brain*: The Coevolution of Localization and Its Images." His paper analyzes images of brain localization in the journal *Brain* from its inception to the present. Textual representations and their accompanying images are shown to coevolve; that is, the technological and conceptual development of the research program of localization is shown to evolve simultaneously with the exploitation of visual resources that support these developments. The semiotics of Peirce, the social semiotics of Kress and van Leeuwen, and the insights of Gestalt psychology provide the critical vocabulary he uses to describe and to analyze these visual resources. Gross concludes that brain images evolve in a manner that reflects the uniformity in measuring instruments and the increase in their precision in the localization of brain functions; at the same time, they draw attention away from a persistent constraint: the brain functions so precisely localized are just those that are not constitutive of our humanity.

These eight articles, although providing a preliminary sketch of the use of visual images and visualization in the history of the neurosciences, hardly begin to make inroads into the subject. They do, however, demonstrate that visual analyses played a key role in science and medicine historically, as they do in our time. Many of the examples presented by these authors, and many of the untapped others, offer fertile ground for further consideration. It may be hoped that this sample will further stimulate interest in this field, and that future work will extend this topic much further. For example, the cross-cultural use of medical images is a fertile area, with a long history, that is not considered here. Another topic among those worthy of more discussion is the addition of movement to images, which has been invaluable in capturing principles of dynamic organization.

Finally, this issue would not be complete without a profound thank you to Stan Finger, who stimulated my interest in the area and invited me to put this collection together. Thanks are also due to Chris Smith and Nick Wade for their feedback and assistance as the issue developed, and to the International Society for the History of the Neurosciences Board of Directors for their vote of confidence in this project. A large note of appreciation is also due to the authors. Their wide-ranging and original contributions made my task as editor a stimulating one, and I learned much from their studies. I would also like to thank Christopher W. Tyler for his astute feedback and perceptive comments as this volume came together.