NEUROIMAGI(NI)NG IN PAST AND PRESENT – REPRESENTATION, EPISTEMOLOGY AND CIRCULATORY REFERENCES

Heiner Fangerau, Robert Lindenberg

ABSTRACT

Visualization of the human brain and representations of its functional state play a prominent role in contemporary neuroscience research. The present paper aims to elucidate the process of imaging and imagining the brain from three perspectives: (a) visualization and the cultural techniques of producing images; (b) the historical context of neuroimages; and (c) the insight afforded into current research and analysis methods. The concept of circulatory references, proposed by Bruno Latour, serves as a heuristic guideline to illustrate the interconnectedness of representation and epistemological processes. Special emphasis is placed on the epistemological status of functional “digital images” compared to traditional imaging techniques.

IMAGINING THE BRAIN

It has become a truism that we can only see what we know (Fleck, 1983 [1947]). Every student of anatomy – microscopic or macroscopic – must learn a pictorial vocabulary to gain the ability to differentiate structures. The view under a microscope may appear as a meaningless, unstructured coloured picture to the untrained eye. Similarly, cerebral components of the brain may appear indistinguishable. Early descriptions compared the appearance of the brain to that of the lower intestines and later, gyri were even described as having the appearance of a plate of macaroni (Clarke and Dewhurst, 1996, p. 65).

For many years descriptions of the brain surface remained vague. Until the 16th century illustrations of the brain emphasized the ventricles, which at the time were considered to host the soul. Hence, the ventricles were the only intracranial structures depicted in detail. Illustrators abstracted from first aspects, natural appearance or “reality” by placing their drawings into a common theory concerning the assumed role and function of the brain. The rediscovery of the dissection method was crucial for this development (Gombrich, 1987, pp. 77–99; Sawday, 1995). “Dissection” was so named due to the necessity of destroying the surface of the body to gain insights into the mechanisms of interacting structures.

During the Renaissance, many doctrines concerning science and society were challenged, and anatomy was not exempt. Until the 15th century, clinging to the principles of Galenic medicine, doctors did not see the need to perform dissections.
With the re-appraisal of antiquated theories came the idea of using human dissections to gain insight into the mysteries of life. Furthermore, dissection provided access to the physicality of the brain and its structures. The inner organization of the brain became the main focus of study. The anatomist Andreas Vesalius (1514–1564), for example, systematically sliced axial cuts through the brain. Vesalius described his dissection techniques in detail so as to allow for replication, thus standardizing brain dissections. Along with a standardized approach to brain dissections was the idea of providing illustrations as visual documentation to aid in the understanding of brain anatomy. Realistic illustrations together with detailed descriptions would serve to be convincing to contemporaries and to guide fellow scientists in the replication of findings (Saunders, 1982).

Various levels of abstraction (from data to icons) were created as a means of visualizing the brain in numerous ways. Physical dissection allowed Vesalius, as one of the most prominent pioneers of new anatomy, to move from schematic diagrams, concentrating on Galenic dogmata, to virtually three-dimensional representations. While the drawings of Vesalius and others were progressive as compared to previous images, they were still bound by the technology of the time. The application of human dissection along with new techniques and instruments (e.g. the microscope) facilitated the ability to view different aspects of the cerebrum. The new images produced by these techniques provided an inside-outside, layered perspective, opening up a deeper understanding of the body. This method consisted of reducing a multi-facetted holistic view to a key-feature (Veltman and Keele, 1986, pp. 209 sqq.).

Contemporary neuroscience research has greatly benefited from the path paved by Vesalius and his followers. Current brain images fit within the framework established by the dissection method. Today, three-dimensional images of the human brain along with the ability to view the brain “at work” through functional magnetic resonance imaging (fMRI), positron emission tomography (PET), magnetoencephalography (MEG), and electro-encephalography (EEG) play a prominent role in understanding brain function. However, while the data used to generate these images are fully three-dimensional, the actual presentation of digital images follows earlier anatomical representations of dissected brains.

The connection of brain images and their theoretical background as well as the associated paradigm-shifts in the history of medicine have been examined thoroughly elsewhere (e.g. Meyer, 1971; Lantos, 1983; Clarke and Dewhurst, 1996; Breidbach, 1997; Hagner, 1997; Maudgil, 1997; Linden, 2002). Similarly, the development of symbolic representations such as the iconography of arrows to illustrate cerebral function has been analyzed (Schott, 2000). Amongst others, Illes examined the ethical challenges put forward by contemporary functional “imaging or imagining” (Illes, 2005).

Here we describe three crucial transitions in methods of generating brain images. In order to demonstrate the role of the cultural and scientific background inherent to any image of the brain, we start with a short description of the difference between “image” and “picture”. We then focus on the transitions from (1) drawings to woodcuts, (2) woodcuts to radiographs, and (3) radiographs to digital imaging. A
The spectator generally does not reflect on the production process behind functional “digital images” while accepting their outcome. This has an impact on the epistemological value of the images. The epistemic status of those images can be considered as two-fold. On the one hand they serve as illustrations for theories on brain function. On the other hand they are also the source of new theories. Spectators must be aware, however, that these images are the result of a long chain of computing steps influenced by the scientist. In a way, the scientist becomes an artist comparable to the pre-modernist illustrator. In terms of the history of art, the scientist is “making” an object by preparation, colourization and exposing. This production process allows for adjustment to the final result. The resulting brain images follow stylistic traditions set in anatomical drawings. Spectators are familiar with the proposed visualizations and thus accept them as “real”. A digitally produced image of the brain is less a realistic account of the physical brain and more a visualization of numbers translated into signs supported by a technical epistemic framework. And as with any media: the process of encoding is deeply connected with the spectator’s competence for reading (decoding) and comprehending.

Reading and comprehending capabilities are often enhanced by “special” effects. Three dimensional perspective, rotating images, shadow and colour effects lead to “hyper-realistic” representations. In his theory on contemporary culture, Baudrillard expressed the opinion that “the hyperreal itself […] retains all the features, the whole discourse of traditional production, but it is no longer anything but its scaled-down refraction […]. Thus everywhere the hyperrealism of simulation is translated by the hallucinatory resemblance of the real to itself” (Baudrillard, 1993, p. 23). This, of course, is a conclusion that holds true for imaging and imagining the brain with the help of functional digital methods. While the beauty of produced images may lead to an unquestioned acceptance by the layman, the ambiguity of the heuristic value needs to be clarified by the scientist.

REFERENCES
