INTRODUCTION TO THE SPECIAL ISSUE

Changing graphic representations of the brain from the late middle ages to the present

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“The brain is in the skull. The brain is in the skull.” When I was a fledgling medical student at the Medical College of Wisconsin in 1981, this was the mind-numbing daily mantra intoned as a microphone check before neuroanatomy lectures by research neuroscientist Robin L. Curtis (1926–2020). Curtis would then show image after image of the nervous system, describing elaborate neural pathways and often waxing eloquent about such then-strange and esoteric topics as “the fields of Forel” (Forel 1877; Horisawa et al 2021; see Figure 1). Many of the images were difficult for neophyte medical students to fully grasp, and some of the material seemed unlikely to have any potential clinical application (or so I thought at the time). Less than four decades later, the fields of Forel are being increasingly considered as potential targets for stereotactic interventions in the treatment of movement disorders, behavioral disorders, and epilepsy (Neudorfer et al. 2017; Neudorfer and Maarouf 2018).

Our current multifaceted and multilayered “picture” of the brain developed from the gradual evolution of graphic representations, particularly over the past 500 years, through recursive observation, abstraction, and conceptual interpretation. How such images are presented, even today, varies considerably among different scholars and when presenting material to different audiences.

In 2016, the editorial board of the Journal of the History of the Neurosciences charged me with the responsibility for developing a special issue on the evolution of graphic representations of the brain. I had begun work on this topic in 2012 with studies related to plagiarisms of Andreas Vesalius’s (1543) by Juan Valverde de Hamusco and Geminus (Thomas Lambert or Lambrt); followed in 2014 by studies of the evolution of Vesalius’s representations of the brain in the period from 1538 to 1555; and then, finally, from 2016 to the present, by a much-expanded survey of the development of neuroanatomy and depictions of the brain (Lanska 2014a, 2014b, 2014c, 2015, 2018a, 2018b, 2018c, 2018d, 2018e; Lanska and Lanska 2013a, 2013b, 2014). Some aspects of this program of study were presented as special museum exhibits at the Dittrick Medical History Center for the 2018 meeting of the International Society for the History of the Neurosciences (ISHN), which was held in...
Figure 1. Top: Neuroanatomical drawing from Swiss neuroanatomist and psychiatrist Auguste-Henri Forel (1848–1931), a cofounder of the neuron doctrine. In 1877, Forel first described the zona incerta, a horizontally elongated region of gray matter in the subthalamus (Forel 1877). He gave it this name as it is a “region of which nothing certain can be said,” a situation now not much changed from Forel’s day. In the same paper, Forel described the H fields, a dense concentration of fiber bundles including cortico-fugal, pallidothalamic, cerebellothalamic, and other projections (Neudorfer and Maarouf 2018; Hirosawa et al. 2021). Among the various structures labeled in Forel’s original diagram are the zona incerta (Zon inc) and Forel’s fields H1 and H2. Source: Forel (1877, Table 7, Figure 14). Bottom: A modern schematic diagram of Forel’s field H, H1, and H2, and the pallidothalamic tract, showing many of the same structures Forel showed in his original diagram in 1877. The pallidothalamic tract consists of the ansa lenticularis and the lenticular fasciculus. Two sets of fibers merge at Forel’s field H and then ascend to the thalamus through Forel’s field H1. Forel’s field H, H1, and H2 and the zona incerta are situated close to each other. Source: Hirosawa et al (2021, 226). Creative Commons Attribution License.
Cleveland when I served as president of the organization (Lanska 2018a, 2018b; Schillace, Edmonson, and Lanska 2018). Further aspects were presented at later international venues that were an outcome of the 2018 ISHN meeting (Lanska 2018c, 2018d, 2018e).

To further develop this program of inquiry, I solicited the involvement of a multidisciplinary international group of colleagues for a symposium on this topic at the 2019 ISHN meeting in Vilnius, Lithuania: Peter J. Koehler, M.D., Ph.D. (The Netherlands); J. Wayne Lazar, Ph.D. (United States); Boleslav Leonidovich Lichterman, M.D., Ph.D. (Russia); and Catherine E. Storey, M.B. B.S., M.Sc. (Australia; see Lanska et al. 2019). The symposium traced the evolution of published graphic representations of the brain, particularly from the late-fifteenth century into the twentieth century. Attention was given to recognition in published works of medieval representations of brain structure and function, major features of the cerebral cortex, evolution of representations of the cranial nerves, later approaches to cross-sectional anatomy, brain histology (i.e., microscopic anatomy), the development and evolution of functional brain mapping, and the great neuropathologic atlases—topics that collectively introduce representations of the form, function, and dysfunction (diseases) of the brain.

The articles chosen for this special issue of the Journal of the History of the Neurosciences represent only a small fraction of the materials my colleagues and I presented on graphic representations of the brain in 2018 and 2019. A complete survey of the development of neuroanatomy—or even of graphic representations of the brain from anatomical, physiological, and pathological perspectives—would far exceed the space available in a special issue of the journal. Therefore, I have chosen to present in this issue only selected aspects of the evolution of graphic representations of the form, function, and pathology of the brain, as depicted in printed books from the sixteenth century to the early-twentieth century. Given limitations of space, this cannot be comprehensive. I have emphasized topics that have not been well covered previously, or for which there are new interpretations of previously discussed illustrations.

The transition from medieval medicine to the Renaissance is covered in four articles concerning (a) representations of the medieval cell doctrine; (b) a novel interpretation of pre-Vesalian representations of the olfactory bulbs and tracts; (c) summaries of the medieval anatomy of the head and brain in single images by Magnus Hundt (1501) and Johann Dryander (1537); and (d) persistence of Galenic concepts of the rete mirabile in illustrations and text by plagiarists of Vesalian well into the seventeenth century (Lanska).

These are followed by a centuries-spanning discussion of representations of the cranial nerves (Storey). The development of illustrations of brain pathology is considered in a comparison of the six main pathology atlases that were published after Giovanni Morgagni’s unillustrated De Sedibus (1761) until Jean Cruveilhier’s comprehensive and illustrated Anatomie pathologique (1829–1842; see Koehler and Lanska). The advent of topographical anatomies of the nervous system in the late-nineteenth century is addressed by a critical analysis of Nikolai Pirogov’s “ice anatomy” from the mid-nineteenth century (Lichterman and Lanska).

Next is a critical review of the sensationalism and gruesome theater provided by Eugène-Louis Doyen and his Atlas d’anatomie topographique in 1911, with a review and comparison with prior topographic anatomies of the brain based on serial sections of entire cadavers, the decapitated head, or the excised brain in the late-nineteenth century, as well as with the plastination technique in the late-twentieth century (Lanska). Then, Ada Potter’s
pioneering atlases of rabbit and cat microscopic brain anatomy (in 1911 and 1914, respectively) are discussed (Koehler and Visser). Finally, the development of different brain maps of cerebral function in the nineteenth and twentieth centuries is summarized (Lazar).

Collectively, these studies examine important historical works on the anatomy, physiology, and pathology of the brain from the perspective of the illustrations in printed books. Although there was a long manuscript tradition of illustrations spanning many centuries before the advent of printed books, such works and their component illustrations could be accessed by only a privileged few; in addition, because manuscript illustrations were produced individually by scribes and artists of different knowledge and ability, the artistic features and pedagogical utility were highly variable. The advent of moveable metal type in the mid-fifteenth century ushered in an intellectual revolution as important scholarly works became much more widely accessible; but it was not until the integration of printed text and illustrations, beginning at the end of that century, that anatomical concepts became clarified and ultimately refined and corrected, a process that led to a dramatic expansion of knowledge—particularly, knowledge of the brain.

Having access to images of brain anatomy, or simple models of how it was thought to function, did more than clarify concepts, however. The images themselves could be interpreted and presented as distinct entities separate from the text. Some illustrations were heavily plagiarized, sometimes by multiple subsequent authors (often to the extreme annoyance of the original authors and artists), and the plagiarized applications were sometimes diametrically opposed to the original purposes for which the illustrations were created (Lanska and Lanska 2013a, 2013b). Particular examples discussed in this special issue include Reisch’s (1503) diagram of the medieval cell doctrine and Andreas Vesalius’s (Vesalii 1543) images of the rete mirabile (Reisch 1503; Vesalii 1543). Numerous later authors reproduced versions of Reisch’s diagram, serving to reinforce its erroneous formulation for a much longer period and to a much wider audience than would have occurred from later editions of Reisch’s text. Similarly, Vesalius’s images of the rete mirabile were widely copied for well over a century following publication of his de Humani corpora fabrica (1543) but, whereas his illustrations were intended to illustrate an erroneous concept of Galen, the later, plagiarized versions were often used as purportedly realistic representations of the structure Vesalius had refuted.

Many of the articles here are synchronic analyses of illustrations in specific texts within a restricted time period, even if they discuss the importance of that work in a longitudinal sense. Some, however, are diachronic (as is the collection as a whole). Diachronic analyses are particularly evident in the articles on the medieval cell doctrine (Lanska), persistence of Galenic concepts through plagiarisms of Vesalius’s illustrations of the rete mirabile (Lanska), graphic representations of the cranial nerves (Storey), development of illustrations of brain pathology (Koehler and Lanska), and the development of brain maps (Lazar).

Figures in manuscripts and printed books can be considered as a component of the “paratext,” a concept initially developed and expounded by French literary theorist Gérard Genette (1930–2018) in the 1980s (Genette 1987, 1997). Paratext is the other material that supports the main text, which is supplied by the authors, editors, illustrators, printers, and publishers, including the cover art, front matter, back matter, footnotes, and illustrations. As Genette explained, the paratext “is at the service of a better reception for the text and a more pertinent reading of it” (Genette 1997, 2). Indeed, illustrations and other
components of paratext can change the reception of a text or its interpretation by the public, and sometimes can have a significance well beyond that of the main text (e.g., the illustrations from Vesalius’s de *Humani corpora fabrica*).

In a more extended formulation, paratext is composed of peritext and epitext, in which peritext is the collection of nontext components of a published work, whereas epitext is material that falls “outside of the text” but that nevertheless concerns it—for example, preliminary drafts, correspondence concerning the text or figures, press announcements, costs of purchase, print runs, critical reviews of the work, and the author’s responses to such critiques (Genette 1987, 1997; Tweed and Scott 2018). Most of the articles in this special issue concern illustrations as peritext, but some address aspects of epitext.

The interval since the end of the fifteenth century saw major advances in the printing of images, initially with woodcuts printed using screw presses, and later with engravings on copperplates printed using roller presses, and still later with lithography and then photography—all of which are represented herein. Some illustrations were highly abstract and schematic, whereas others sought to achieve a high degree of realism. In some cases, the preparation of hand-drawn images was facilitated by either grid-based techniques to transfer images to paper or use of the camera lucida or other optical projection systems.

This collection of articles provides new insights on many aspects of the evolution of graphic representation of the brain over the past five centuries. I wish to thank the many colleagues who participated in the special exhibits at the Dittrick Medical History Center in 2018, and especially the colleagues who participated in the 2019 ISHN symposium and this special issue. I treasure the support and insights provided by my colleagues, as well as the breadth and depth of their knowledge.

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**References**

Forel A. 1877. Untersuchungen über die Haubenregion und ihre oberen Verknüpfungen im Gehirne des Menschen und einiger Säugetiere, mit Beiträgen zu den Methoden der Gehirnuntersuchung. Archiv für Psychiatrie und Nervenkrankheiten 7:393–495. doi:10.1007/BF02041873.

Genette G. 1987. *Seuils*. Paris: Éditions du Seuil.

Genette G. 1997. *Paratexts: Thresholds of interpretation (literature, culture, theory)*. Translated by J. E. Lewin. Cambridge, UK: Cambridge University Press.

Horisawa S., S. Miyao, T. Hori, K. Kohara, T. Kawamata, and T. Taira. 2021. Comorbid seizure reduction after pallidothalamic tractotomy for movement disorders: Revival of Jinnai’s Forel-H-tomy. *Epilepsia Open* 6 (1):225–29. doi:10.1002/epi4.12467.

Lanska D. J. 2014a. Vesalius: The advent of modern human anatomy, and the iconography of the *Fabrica*. Invited Keynote Address, 19th annual meeting of the International Society for the History of the Neurosciences, July 3, Université Catholique de Louvain, Louvain-la-Neuve, Belgium.
Lanska D. J. 2014b. The evolution of the views of Andreas Vesalius concerning Galen’s anatomy. Invited lecture, Scientific International Conference: Galen: History and Tasks of Research Studies, November 21, I.M. Sechenov First Moscow State Medical University, Moscow, Russia.

Lanska D. J. 2014c. Vesalius on the anatomy and function of the recurrent laryngeal nerves: Medical illustration and reintroduction of a physiological demonstration from Galen. Journal of the History of the Neurosciences 23 (3):211–32. doi:10.1080/0964704X.2014.884885.

Lanska D. J. 2015. The evolution of Vesalius’s perspective on Galen’s anatomy. Istoriya Meditsiny [History of Medicine, Moscow] 2 (1):13–26.

Lanska D. J. 2018a. Special museum exhibit: Dissection of the brain in woodcut: A visual exploration of Renaissance anatomy from Gersdorff to Vesalius. Dittrick Medical History Center, Case Western Reserve University, Cleveland, OH.

Lanska D. J. 2018b. Special museum exhibit: Examining rare books of the Dittrick Medical History Center (e.g., Vesalius, Estienne and de la Rivière, Eustachius, Willis, Bartholin, d’Agoty, Bell). 23rd annual meeting of the International Society for the History of the Neurosciences, June 22, Dittrick Medical History Center, Case Western Reserve University, Cleveland, OH.

Lanska D. J. 2018c. The Rose and Anton Zverina Lecture. Hidden in plain view: Discovering the work of a 16th-century anatomist hidden in the historiated initials of Andreas Vesalius—Surprising images of the healing, stealing, dissecting, and vivisecting of bodies. Invited lecture, October 25, Dittrick Medical History Center, Case Western Reserve University, Cleveland, OH.

Lanska D. J. 2018d. A 16th-century surgeon’s duties and the preparation of human anatomical specimens as illustrated in the historiated initials of de Humani corporis fabrica by Vesalius. Congress of the Russian Society of Medical Historians, November 15, Scientific Institute of Public Health, Moscow, Russia.

Lanska D. J. 2018e. A 16th-century surgeon’s duties and the preparation of human anatomical specimens as illustrated in the historiated initials of de Humani corporis fabrica by Vesalius. In: Russian Society for the History of Medicine. Opera Medica Historica: Proceedings of the History of Medicine. Moscow: Almanac Vypusk 3:77–79.

Lanska D. J., and J. R. Lanska. 2013a. Juan Valverde de Hamusco’s unauthorized reproduction of a brain dissection by Andreas Vesalius. Neurology 80 (9):852–56. doi:10.1212/WNL.0b013e31828407dc.

Lanska D. J., and J. R. Lanska. 2013b. Medieval and Renaissance anatomists: The printing and unauthorized copying of illustrations, and the dissemination of ideas. In The fine arts, neurology, and neuroscience: Neuro-historical dimensions, ed. S. Finger, D. Zaidel, F. Boller, and J. Bogousslavsky, 33–74. Amsterdam: Elsevier. Progress in Brain Research 203.

Lanska J. R., and D. J. Lanska. 2014. Andreas Vesalius. In Encyclopedia of the neurological sciences, 2nd ed, ed. M. J. Aminoff and R. B. Daroff, Vol. 4, 638–39. Oxford: Academic Press/Elsevier.

Lanska D. J., P. J. Koehler, W. Lazar, B. Lichterman, and C. E. Storey. 2019. Symposium: Graphic representations of the brain from medieval times into the 20th century: Form, function, and disease. 24th Annual Meeting of the International Society for the History of the Neurosciences, July 11, Vilnius, Lithuania.

Neudorfer C., and M. Maarouf. 2018. Neuroanatomical background and functional considerations for stereotactic interventions in the H fields of Forel. Brain Structure & Function 223 (1):17–30. doi:10.1007/s00429-017-1570-4.

Neudorfer C., F. El Majdoub, S. Hunsche, K. Richter, V. Sturm, and M. Maarouf. 2017. Deep brain stimulation of the H fields of Forel alleviates tics in Tourette syndrome. Frontiers in Human Neuroscience 11:308. doi:10.3389/fnhum.2017.00308.

Reisch G. 1503. Margarita philosophica. Friburgh [Freiburg im Breisgau]: Joanne[s] Schottu[s] Argen[torati] [Strasbour].

Schillace B., J. Edmonson, and D. J. Lanska. 2018. Special museum exhibit: Visualizing the brain in books: Early images that shaped neurology. Dittrick Medical History Center, Case Western Reserve University, Cleveland, OH.

Tweed H. C., and D. G. Scott. 2018. Authority, authenticity, and reputation: An introduction to medical paratexts. In Medical paratexts from medieval to modern, ed. H.C. Tweed and D. G. Scott, 1–12. Cham, Switzerland: Palgrave MacMillan. Palgrave Studies in Literature, Science and Medicine.

Vesalius A. 1543. Andreae Vesali Bruxellensis, scholae medicorum Patauinae professoris, de Humani corporis fabrica Libri septem. Basil: Joannis Oporini.