The space inside the skull: digital representations, brain mapping and cognitive neuroscience in the decade of the brain

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The Space inside the Skull: Digital Representations, Brain Mapping and Cognitive Neuroscience in the Decade of the Brain

Summary

The last two decades have seen a resurgence of interest in exploring the space inside the skull in relation to human activities such as reading, reasoning, or remembering. This new stream of research, often labelled ‘cognitive neuroscience’, relies to a great extent on techniques of brain mapping, which link functions (these human activities) and anatomy (the space of the brain). Brain mapping is in turn deeply reliant on technologies of brain scanning, such as MRI and PET, to produce and relate measurements of function and anatomy.

Within this research, which ends up linking human mental activity and the hardware of the brain, two important processes are at play: biologisation and digitalisation. The ‘mind’ is in the course of being ‘biologised’, as physical substrates for thought and emotion are being localised in various brain areas, and conceptualised as the functions of brain-based networks. Second, this approach is highly embedded in the use of digital technologies, and relies on the creation of a digital context in which measurements of function and of anatomy can be compared. The development of these digital resources in the study of the mind and brain is especially supported by the Human Brain Project, an on-going US-based project, which arose with the Decade of the Brain (the 1990s).

My research addresses the complex new social and technological arrangements in scientific culture that subtend these process of biologisation and digitalisation, based on fieldwork in two leading research centres in Britain and Canada, and through an analysis of the professional literature. Although the focus is on research settings, this dissertation is written with an awareness that brain mapping reshapes our definitions of mind and brain, and that this has significant consequences for concepts of the physical and the mental. The institutions in which these concepts find their articulation are also affected--the legal system where responsibility for one’s actions depends on mental state: medical practices of diagnosis and screening, as well as patterns of care; social provisions for the mentally ill; and strategies for education and child care. Where possible, these social consequences are signalled.

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Science and technology studies have amply shown that new knowledge only becomes recognised as meaningful once a context for its use has been developed. Other scholarship in this area has shown how the production of traces, and their circulation, are key components of scientific work. A focus on representations, which guides this dissertation, enables me to address both themes: representations are only meaningful once there is
agreement on their production and interpretation, and the circulation of representations of the mind and brain give insight into the deployment of this new stream of research. What started out as an illustrative metaphor for this project, “a new view of the brain” has turned out to be at the core of my analysis of this growing stream of research.

These insights from science and technology studies led me to ask the following questions: How are scans read? What does a map of the brain show? How do atlases of the brain become authoritative? Each chapter traces how a specific type of representation has developed. These include: the application of brain imaging technologies (scans) to new phenomena that bridge the disciplines of mind and brain, new concepts of the brain’s function and the development of new experimental paradigms (maps), the constitution of a new research community whose members share an empirical style (imagers), and finally, the intersection of brain mapping and the Human Brain Project, where a new digital kind of immutable mobile arises (atlases). Each chapter therefore addresses increasingly complex instances of the creation, manipulation and circulation of representations.

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The first chapter sets out the importance of representations in the field of brain mapping. It also contains a discussion of how representations are to be studied, and of the features relevant to their analysis. The relation of representations to digitalisation and biologisation are also explored. Chapter 2 considers the colourful scans used in this research. Here, scans are examined as representations that have had different meanings, depending on the uses to which they have been put. I trace the changing definitions of what these scans show, contrasting early use in neurological settings and later use in psychological experiments. The different ways in which researchers ‘make sense’ of the information provided by scans are examined in terms of the type of questions asked (diagnostic-clinical v. research), the way scans are understood (visually examined v. quantitatively analysed), and the way activity detected by scanners is reconciled with the anatomy of the brain. The development of the Talairach conventions features prominently in this chapter, since they come to constitute the digital context in which function and anatomy can be related, ultimately providing a way to show the mind-in-the-brain.

Maps are the focus of Chapter 3. Functional imaging claims to investigate the highest human functions, in the whole, intact brain, in vivo, and to represent these functions in the shape of maps. This chapter addresses first of all how experiments are designed to contrast functions in human brains and produce these maps. It also examines how these experiments, and the evidence they produce (functions mapped unto the brain), differ from other approaches in cognitive and neural science. The range of functions that are mapped is also considered, with special emphasis on how cultural and social influences on the mind come to be inscribed onto maps of the brain. I argue that the project of mapping the brain is best understood when not solely regarded as ‘reductionist’, but also as being productive of new relations. By inscribing the mind into the brain, the ‘mind’ can circulate in the areas where the body is considered, namely biomedical institutions.
The ways in which brain mapping contrasts with other approaches to the mind and brain is further investigated in Chapter 4, by focusing on the way representations used in brain mapping constitute a particular empirics, a way of knowing that is specific to this group of researchers. Brain mappers both love and reject the images they use. This paradoxical relationship is the result of the rejection of some aspects of representations (the visual appeal, for example, which is seductive and therefore not rational), and the simultaneous reliance on other aspects (for example, the use of representations to convey spatiality). The manner in which brain mappers discuss the representations they use is analysed in relation to the claims they make for the unique insights provided by brain mapping. By identifying the elements that are embraced and rejected in the use of representations, a specific digital esthetic is shown to be arising in the context of functional imaging, and the boundaries of the community can be traced according to this shared understanding of images.

Atlases of the brain are the final representations to be analysed. While their development originates in the brain mapping community, as an answer to the need for a baseline to interpret activations, the Human Brain Project has fostered the expansion of these atlases. This chapter traces the background to the HBP's explicit goal: the development neuroinformatics in order to integrate the various subdisciplines of neuroscience through a number of digital resources. These atlases are analysed in terms of their dual role as new authoritative representations of normality and disease, as well as repositories of many types of knowledge about the brain (different levels of anatomy, of functional and metabolic information, etc). Both functions (evaluating scans from different subjects, and comparing different types of data about the brain) are shaped by the possibility of automatically manipulating and accumulating large numbers of scans, through the development of standard spaces for handling digital information. The impact of these new atlases on concepts of objectivity, normativity and scientific progress is also analysed in this chapter.

The final chapter reviews the main findings, regarding the way functional imaging moves scientific work with scans of the body away from an optical understanding and towards a digital mode of knowing. The implications of the new ideals of quantitation and automation (core elements of this digitality) are also discussed, especially in terms of their consequences for the biological. Degrees of variability, probability of normality, and averaged diseased brains become so many new concepts in the evaluation of health and illness as measurable sets of factors. The challenges to clinical traditions posed by these changes are also noted. Finally, this chapter considers brain mapping and the HBP in relation to other contemporary projects, which also involve biologisation and digitalisation (the Human Genome Project, the Cochrane Initiative, the Visible Human Project), in order to reflect on the particularities of the endeavour to explore the mind-in-the-brain and the general trend towards the use of digital tools in science.

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196