Conclusion

In the closing words of the medical dissertation he completed in 1892 under Charcot's mentorship, Janet made the following impassioned plea: "The word 'hysteria' should be preserved, although its primitive meaning has much changed… [B]ut since every epoch has given it a different meaning, let us try to find out what meaning it has today."[1] My enquiry has echoed this line of reasoning. I have sought to find out not just what hysteria meant in Charcot's image-based research but also to uncover the new meaning that this elusive disorder has begun to acquire in the context of the systematic functional neuroimaging investigation within the first two decades of the twenty-first century.

Two aspects of my enquiry have been of particular significance. First, my use of the word 'hysteria' was not meant to imply the existence of either a unitary or a transhistorical disease entity. The term 'hysteria' has served as shorthand for a collection of highly heterogeneous somatic symptoms, which were once at the centre of Charcot's research and have now become the focus of current fMRI investigations. Importantly, the clinical features of these symptoms, which include hysterical paralysis, anaesthesia, visual disturbances, pseudoepileptic seizures, and contractures, have shown remarkable consistency across these two historical periods.

Second, my enquiry has singled out and focused on these two specific periods of hysteria research because of the key roles that images played in them. I have shown that, both in Charcot's and in the present-day fMRI hysteria research, images, although of very different kinds, were and are being used as crucial investigation tools. In contrast to my detailed analysis of these two specific periods, the entire twentieth century, during which images were purged from hysteria research, has only been addressed briefly in the course of this enquiry (chapter 2). The central issue for me has been to delineate the active, constitutive roles that different types of images played and are

1 Janet, *Mental State*, 527. In the segment I left out, Janet pleads for the continued use of the word 'hysteria' due to its "great" and "beautiful" history. Ibid. While I agree with Janet that it is crucial to take hysteria's history into consideration, I strongly disagree with his designation of it as either great or beautiful. For a historical account that foregrounds the suffering of patients, see, e.g., Showalter, *Female Malady*.

playing in determining the medical meaning of hysteria at the end of the nineteenth and the beginning of the twenty-first centuries. More specifically, I have aimed to show that, although inherently unstable and by no means uncontested, the dominant medical meaning of hysteria emerging during these two specific periods has been inextricably linked to how specific kinds of images were and are being used in medical research.

It should be emphasised that my above claim is in no way equivalent to the currently still dominant view, whose most influential proponent in the humanities has been the French art historian Didi-Huberman. According to this view, Charcot used images, notably photographs, to invent and manufacture hysteria "like an art, close to theatre or painting."[2] In fact, it seems to me that this accusation of a lack of scientific merit, although explicitly aimed at Charcot, has implicitly cast doubt on the potential epistemic validity of any image-based research into hysteria. This implicit yet apparently lingering doubt that any type of images could be used to generate potentially valid medical knowledge of hysteria might explain why the humanities have so far largely ignored the current fMRI investigations into this disorder. It is precisely such wholesale epistemic rejection of image-based hysteria research that I have argued against in *From Photography to fMRI*.

Instead, my analysis has tried to offer a more nuanced account of historical (chapter 1) and present-day image-based hysteria research (chapters 3 and 4). I have focused on emphasising the epistemically productive and innovative aspects of both Charcot's and contemporary fMRI-based research on hysteria within the given historical contexts. At the same time, however, my analysis has also underscored what I have perceived as the limitations and pitfalls of these two particular research practices. Most importantly, I have argued that to understand how different types of visualisation techniques were and are being used in the given historical contexts to produce new medical insights into hysteria, it was necessary to go beyond the surface of the resulting images. The major part of my analysis has, therefore, examined how the images were produced within particular experimental setups. Moreover, throughout the enquiry, I have also insisted that it was just as necessary to pay close attention to the dynamic semantic interactions between the images and the broader conceptual frameworks that informed the interpretation of images within the scientific context. On the one hand, I have claimed that the initial development of particular neurophysiological concepts and theories made the use of images as investigation tools in hysteria research at a given time epistemically possible. On the other hand, I have also shown that the broader conceptual frameworks within which the use of specific images was embedded became modified through the interpretation of the ensuing imaging findings. In short, instead of merely passively illustrating pre-existing neurophysiological concepts of hysteria, images actively reshaped them.

On the whole, it can be said that both in the case of Charcot's and the contemporary image-based research, hysteria emerged as a set of genuine (i.e., not feigned) and potentially reversible somatic symptoms. Even more to the point, in each case, hysterical symptoms became explicitly linked to a brain dysfunction presumed to arise from a combination of predisposing and precipitating factors and to result in the disruption

2 Didi-Huberman, *Invention of Hysteria*, xi.

of the normal hierarchical organisation among the bottom-up and top-down neural processes. As we have seen, in both cases, these insights were gained through the systematic use of images as epistemic tools. Significantly, I have shown that Charcot relied on various image-based measurements of the symptoms' physiological features as a proxy for the hypothesised brain dysfunction, which he could not visualise more directly. His interpretation of image-based findings was firmly embedded in the late-nineteenth-century paradigm of cerebral localisation. Such use of images enabled Charcot to postulate the existence of a clearly circumscribed functional lesion in those areas of the brain cortex, which, at the time, were thought to control the sensorimotor functions that were affected by the symptom under investigation (chapter 1). According to Charcot, the anatomical location of the hypothesised brain lesion, therefore, had to vary from one type of hysterical symptom to another.

In contrast, current research, using fMRI, has obtained a considerably more neuroanatomically proximate, yet, as I have shown, nevertheless highly mediated access to measuring and visualising the hysteria patients' brain function (chapter 3). As a result, the current research has started to attribute hysterical symptoms to complex and highly dynamic interactions among multiple, anatomically widespread functional disturbances. Such disturbances appear to affect not just cortical but also subcortical neural circuitries. And many of the implicated areas are located outside the brain regions directly responsible for the disrupted sensorimotor functions, which characterise a particular symptom (chapter 4). In other words, the concept of the functional lesion with which the current neuroimaging research operates is multicomponential. It is also far more intricate and fine-grained than the one that informed Charcot's investigation of hysteria—instead of being limited to a single specialised brain region, the functional lesion is now thought to occupy one or more multifunctional networks. Hence, suggesting that fMRI studies have merely uncritically revived Charcot's concept of the functional brain lesion as the underlying cause of hysteria, which for over a century had been discarded as erroneous, appears to me to underestimate the epistemic contribution of the current research. Instead, based on the developments I have identified in detail in chapter 4, it is more accurate to claim that fMRI research has substantially redefined Charcot's concept of the functional lesion, endowing it with a new meaning.

Although the neuroimaging research on hysteria is currently burgeoning, the exact details of the thus redefined dynamic functional lesion have continued to elude present-day scientists. The findings generated so far by the individual, mostly small-sized fMRI studies are still fragmentary, highly tentative, and, in some cases, even mutually contradictory (chapter 4). For this reason, at the moment, it is difficult to predict possible outcomes of future developments in this highly dynamic research field. The optimism in the neuroimaging community remains high.[3] By contrast, many of my colleagues from the humanities with whom I have discussed my work while writing this book have repeatedly expressed their scepticism about the fMRI-based research being able to solve the riddle of hysteria. To some extent, I can understand the scepticism of my colleagues, although I do not fully share it.

3 See, e.g., Voon et al., "Functional Neuroanatomy," 186.

One problem that I do see, however, is that due to the limitations of its medium-specific procedural logic, fMRI research struggles with the problem of how to adequately address the role of patients' idiosyncratic life experiences and individual emotional responses in the generation and maintenance of hysterical symptoms.[4] This is a potentially significant limitation since even Charcot claimed that "a lesion of the same nature, of the same extent and the same localisation, may in different subjects reveal itself in different clinical phenomena," depending on the patient's personal history and emotional make-up.[5] Thus, it appears to me that without taking into account the psychological and emotional idiosyncrasies of affected individuals in their full complexity, no complete picture of hysteria can emerge.

In all due fairness, it is entirely understandable that much of the initial research on hysteria has focused first on demonstrating the physiological reality of this contested disorder. Yet now, it might be the time to broaden the scope of the enquiry and start paying more attention to individual differences among patients and the role of psychological factors in triggering the neurophysiological mechanisms that underpin the formation of hysterical symptoms. Hence, I think that in the future, it might be epistemically fruitful to combine fMRI research with complementary non-imaging approaches, such as patients' self-reports and various types of interviews.[6] After all, such non-imaging approaches might be better suited to examining those idiosyncratic psychological and social aspects of hysteria that, as we have discussed, necessarily elude functional neuroimaging studies.

These limitations notwithstanding, my analysis has delineated the continual, not just technical, but primarily conceptual refinement that fMRI research on hysteria has undergone within the first two decades of the twenty-first century. There is no reason to presume that this development will not continue, possibly even accelerate, in the foreseeable future.[7] Therefore, with all due caution, I think it conceivable that, at some point, this research might deliver insights into hysterical symptoms, which may find application in the clinical context in terms of diagnosis, or contribute to the development of new treatments.

But even if the future fMRI research on hysteria should entirely fail to deliver any clinically applicable insights, the studies we have discussed have already achieved one remarkable feat. These studies have made hysteria once again visible in the medical context. They have done so by re-anchoring the baffling hysterical symptoms into a neurophysiological framework of interpretation, thus dislodging the previously

4 See section 4.3.1 for a detailed discussion.

5 Charcot, "Appendix 2: Muscular Sense," 400.

6 A pertinent example of a potentially productive non-imaging approach is provided by a study published in 2016, which was conducted on thirty-six hysteria patients. In it, researchers used a so-called qualitative interview with open-ended questions to gain insights into "patients' understanding of their illnesses" and subjective experience of their emotions. Epstein et al., "Insights," 566. This, however, was the first and, to this day, remains the only such study. It is worth pointing out that all of the co-authors of this study are also active in fMRI-based hysteria research.

7 For a succinct analysis of new approaches that have started to emerge in the fMRI-based research into hysteria at the beginning of the third decade of the twenty-first century, see Muhr, "Epistemic Productivity." See also Drane et al., "Framework"; and Perez et al., "State of the Field."

prevalent view that hysterical symptoms are either physiologically impossible or medically unexplainable. In the process, the image-based findings of fMRI studies have also played a decisive role in inducing a shift in the medical attitudes towards present-day hysteria patients. As a result of this still ongoing shift, hysteria patients are no longer summarily dismissed by doctors as mere simulators but deemed worthy of sustained scientific research, as well as medical attention and care (section 2.4.2). As I am finishing the writing of this book, hysteria, under its new nosological guise of functional neurological disorder, has become "one of the commonest diagnoses made in neurology clinics."[8] At the same time, broader medical research into this disorder continues to gain pace.[9]

Finally, I would like to conclude by drawing together the central findings that my enquiry has generated concerning the specific epistemic functions of images in the context of scientific research on hysteria. To begin with, I have shown that although much has been written about Charcot, new insights can still be gained by shifting the perspective from which his hysteria research is analysed. Rather than focusing on the iconographic aspects of Charcot's images, my analysis has foregrounded their operational nature. First, by analysing the medium-specific procedures of his image production, I have shown that Charcot actively used different kinds of images to disclose and examine multiple aspects of hysterical symptoms that eluded unaided observation. These aspects ranged from repetitive manifestations of the hysterical attack to fundamentally invisible topographic distributions of hysteria patients' various sensory disturbances. It is, first and foremost, through the mediation of images that these phenomena became accessible to medical analysis.

Second, I have argued that, instead of using single images in isolation, Charcot combined diverse images, such as photographs, sketches, schematic drawings, myographic and pneumographic curves, diagrams, topographic brain maps, body maps, and line graphs. The combined use of these images and their mutual intermedial and intramedial relations enabled Charcot to generate new insights into the underlying neurophysiological basis of various hysterical symptoms. Third, I have insisted that to understand how Charcot generated such insights, we have to reconstruct, first, how he 'read' the images in the sense of using them to obtain information of interest about hysteria patients' bodies; and, second, how he interpreted the images by attributing to them medically operative neurophysiological meanings. Crucially, the neurological meaning Charcot attributed to the images was not self-evident in their visual features.

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8 Edwards, Cope, and Agrawal, "Functional Neurological Disorders," 274.

9 See, e.g., Perez et al., *Special Issue: Functional Neurological Disorder*. An additional pertinent indicator of the intensifying medical research into hysteria is the recent establishment of an international professional society called the Functional Neurological Disorder Society (www.fndsociety.org). The FND Society gathers medical researchers and other healthcare professionals and has its roots in the international conference on functional neurological disorders that was organised in Edinburgh in September 2017. The Society aims to "advance scientific research pertaining to functional neurological disorders," organise international conferences open to multidisciplinary audiences and "increase awareness among healthcare professionals and the public" about this disorder. "About Us," Functional Neurological Disorder Society, accessed January 17, 2022, https://www.fndsociety.org/about-us/.

Instead, it was constructed discursively and dependent on the embeddedness of these images into the neurophysiological theories of the time, in particular, the paradigm of cerebral localisation.

Novel findings have also emerged from my analysis of the epistemic use of images in the context of present-day fMRI hysteria research. First and foremost, drawing on Latour and Jäger, I have shown that each group-level fMRI brain map creates its referent, which as such did not exist independent of the chain of physical, mathematical, and discursive operations through which a particular map was produced. Just as importantly, we have seen that this very chain of operations also establishes an indexical link between the referent and the map. The thus constructed indexicality is a precondition for the resulting map's ability to produce insights into a potential neurocognitive basis of hysteria. Hence, and this is crucial, what matters in the research context is not how the resulting fMRI maps look or which particular colours have been used to visualise them. Instead, as I have shown, what matters is whether or not the resulting fMRI maps were produced through sufficiently consistent chains of mutually interlinked physical, mathematical, and discursive operations.

Moreover, I have highlighted how the protracted and highly mediated process of producing fMRI maps entails generating, transforming, and interpreting a range of intermediary images. Within an fMRI experiment, such intermediary images fulfil various epistemic functions. But to do so, they have to be submitted to precisely tailored transcriptive operations. It is crucial to understand the transcriptive operations that underlie the process of producing fMRI maps, the intermediary images that partake in it, and the different functions of such intermediary images within an fMRI experiment if we want to assess the epistemic validity of the experiment's findings in an informed way.

Some of these intermediary images, such as the initial fMRI imaging data, are what I have designated illegible. In my use, the term 'illegible' refers to images in which the information of interest—in our case, about the experimentally isolated neural activity—is not encoded in visually recognisable ways. Thus defined, illegibility is an intrinsic property of such images so that they necessarily remain opaque to visual inspection by any human user. Whichever way their users choose to look at them, these images are impossible to read (in the sense of accessing the information of interest), even for a trained expert. For this reason, such illegible images serve merely as material for elaborate mathematical transformations performed by computer algorithms.

Only after the multi-stage algorithmic processing has transcribed the illegible fMRI data into potentially readable fMRI maps does the information of interest about the location of the task-induced brain activity become accessible to visual inspection by a human user. Having thus constructed fMRI maps through the algorithmic modelling of the illegible data, researchers then engage in the process of reading these maps. At this stage, different, potentially readable intermediary images, such as 'glass brains'—which explicitly address the human eye—play crucial roles in allowing researchers to grasp, visually evaluate, and semantically interpret their empirical findings. Importantly, the readability of such intermediary digital images, many of which are interactive,

hinges on the background knowledge of their designated users.[10] To be able to read these images and thus obtain from them the information of interest, researchers have to know how to look at the images selectively. Specifically, they have to learn to recognise and focus on the salient visual details while at the same time ignoring the images' semantically irrelevant visual features. Hence, for an fMRI experiment to generate insights into brain dysfunctions that underpin hysterical symptoms, different intermediary images—both illegible and readable—must be used in mutually complementary ways by experts trained how to produce, transform, read, and interpret these images.

In sum, my analysis has demonstrated that what was of crucial importance both in Charcot's and in the present-day image-based hysteria research was not how the images that served as epistemic tools looked. Instead, what was of crucial importance was how various kinds of images were used to obtain the information of interest about hysteria patients' bodies and brains and how the information derived was interpreted to acquire medically operative meanings. In other words, the limits of knowledge production concerning hysteria were not solely determined by the technical possibilities of the visualisation techniques used at a particular time. Rather, the limits of knowledge production depended on researchers' ability to translate chosen aspects of hysterical symptoms into images that were readable and interpretable within the governing neurophysiological conceptual frameworks of the time. In short, it is not about the production of sheer visibility. Only the images deemed readable and interpretable by a community of expert practitioners can become productive epistemic tools capable of inducing shifts in the very conceptual frameworks that had initially enabled their implementation.

Finally, in my analysis of fMRI studies, I have shown that the epistemic operativity of fMRI maps is constructed through elaborate medium-specific operations. These operations gradually translate the initially illegible measurement data into potentially readable digital images of an otherwise inaccessible neural activity of interest to which researchers assign symbolic meanings and thus produce new insights into hysteria. My findings and, in particular, the methodological approach I have developed for analysing the epistemic functions of new kinds of scientific images that visualise previously inaccessible phenomena have implications that go beyond our understanding of how images are used in medical research on hysteria. With the introduction of the key analytical distinction between legible and readable images, this approach enables us to disentangle and systematically delineate a wide range of epistemic operations that researchers perform on and with different types of images at various stages of knowledge production in the context of a particular, historically situated scientific

10 In my use, legibility designates an intrinsic property of an image that was purposefully produced and deployed as an epistemic tool. In contrast, as I define it, readability foregrounds the interaction between an image and its user within a particular context. Legibility is a necessary precondition for readability. But a legible image is still unreadable for uninformed users, who lack the visual skills required to decode the visual information that had been intentionally encoded into the image during its production. Thus whereas an illegible image is impossible to read for anyone, a legible image can be readable for some and, at the same time, unreadable for others.

practice. As such, this approach can be applied more broadly to analyse the epistemic operativity of images as research tools in different areas of natural sciences, from medicine in general to biology and physics. And this is a rich vein for future studies.