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THE VITALITY OF AN IMAGE

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MAPPING NERVES. AN INVESTIGATION INTO THE VITALITY OF AN IMAGE

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ABSTRACT

This article proposes that one possible version of writing the biography of a scientific image might be to populate it densely with meaning by writing about the relations it entertains with things that themselves lie outside of it, thereby supplying it with a specific mode of existence, infusing it with vitality and thus transforming it into a potential object of biographical endeavour in the first place. Consequently, the article commences and ends with the same image that in the beginning appears to be a more or less meaningless photograph of a male left hand on which a bizarre drawing is superimposed. In the course of the article, this image is reanimated: the medical questions that led to the experiment in whose context the image was produced, as well as the applied experimental strategies and techniques, are closely investigated; in relating it furthermore to a series of other images and by reflecting its epistemic status, the very same image in the end of the article appears as something completely different: a part of a map of the cutaneous nervous system of a male subject around 1900.

Keywords: Selfexperiment, Life sciences, Nervous system.

What we see at first sight in this image is the printed version of a black-and white photograph displaying a male left hand and on it a bizarre drawing of a slightly bent continuous and a dashed rounded line. Together, these two lines form an enclosed space below the middle and index finger on the back of the hand. On closer inspection, it becomes clear that this shape was not drawn onto the hand when the picture was taken, but was rather superimposed onto its photographic reproduction. First of all, the line is stronger in contrast than the other parts of the photograph and secondly, it does not follow the uneven planes of the hand's surface, but instead appears quite two-dimensional. If we read the accompanying text, we not only learn that

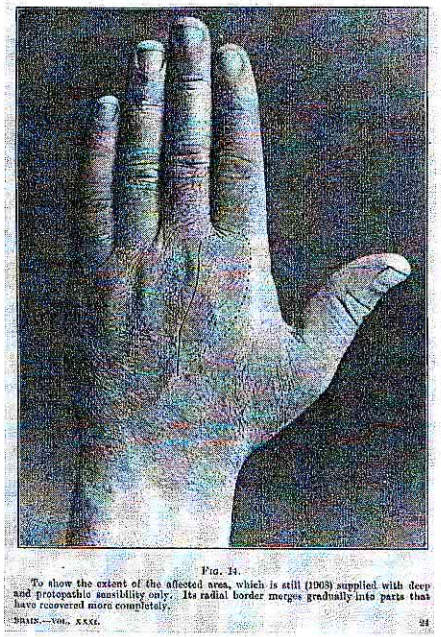

Fig. 14.

To show the extent of the affected area, which is still (1908) supplied with deep and protopathic sensibility only. Its radial border merges gradually into parts that have recovered more completely.

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Fig. 1.

the image is the 14th figure in a series of images but also that the indicated area "is *still* (1908) supplied with deep and protopathic sensibility only". Our first question thus might be: What does the *still* refer to, what happened before? If I tell you, however, that the image could at the same time be understood as the representation of a state of sensibility that most closely resembles that of a 'normal' Western subject around 1900, additional questions might arise. You might want to know more. You might want to get acquainted with the image's biography.

What could the biography of a scientific image contain and how could it proceed? Based on the etymology of bio-graphy (*bios graphein*), the premise for the existance of such a genre must one might argue first of all be that the image under investigation has some kind of *bios*, a life. If we define life in the terms of Alfred North Whitehead as something that "lurks in the interstices",[1] as something that happens in-between, or to put it differently as a fundamentally relational process of permanent becoming, we might want to look for the image's life by reconstructing the various relations it has entertained and entertains with things that lie themselves outside of it and are consequently not visible. We might thus want to have a look at the instruments, practices and theories linked to the production process of the image as well as its subsequent uses in order to discover something about its 'life'.

But you could also reverse the argument and say that only by following as many lines as can be found, only by densely populating the image with as much meaning as possible and thus by writing (*graphein*) a specific history of its mode of existence can we hope to render it vivid, infuse it with vitality and thus provide it with a *bios*. Taken together, these two propositions reveal that the task of writing a scientific image's biography would not simply involve documenting the complete life of a singular entity, it would much rather encompass the textual construction of a relational space, a kind of stage on which the image's life could unfold itself in interesting ways. The process of writing a biography would thus have a lot in common with the scientific method *par excellence*: experimentation. That is, if we assume with Hans-Jörg Rheinberger, that the productive quality of an experimental-system lies largely in its capacity to produce "a *representational space* for the *entry* of epistemic objects."[2]

The particular image that we are dealing with here is itself closely linked to an experiment that was carried out between 1903 and 1908 by the British neurologist Henry Head and the experimental psychologist William Halse Rivers, the so-called Head-Rivers-Experiment. The image served as illustration 14 in the final publication of the experiment's results, a long article that appeared in the British journal *Brain* in 1908 under the title "A Human Experiment in Nerve-Division".[3] The hand depicted in the image belonged to a human being whose nerves had been divided five years earlier in 1903. This human being was the neurologist Henry Head himself. In order to begin to understand some of the issues that are at stake in the image under investigation and thus to slowly raise it from the dead, it might be useful to first of all understand Head's decision to become a self-experimenter. In a second step, I will provide some information about the experimental methodology chosen by the two experimenters and than take a closer look at the concrete experimental-system, its practical specificities and theoretical assumptions and last, but not least the ways in which it handled images.

From a Clinical Case to Experimental Destruction

In 1896 Head began working at the *National Hospital for the Paralysed and Epileptic* as an assistant to the neurologist Hughlings Jackson (1835-

[1] Alfred North Whitehead, *Process and Reality. An Essay in Cosmology* (New-York: Free Press, 1978), pp. 105-106. I would like to thank Didier Debaise for having pointed me to this quotation.

[2] Hans-Jörg Rheinberger, *Experiment. Differenz. Schrift* (Marburg an der Lahn: Basilisken-Presse, 1992), p. 73. Translation K.S.

[3] Henry Head – William Halse Rivers, "A Human Experiment in Nerve Division", *Brain*, 1908, *3*, pp. 323-450.

1911). The hospital, founded at Queen Square in London in 1860 as the first one of its kind in Great Britain, basically housed, as the name suggests, two groups of patients: epileptics and paralytics – patients either moved and perceived too much in uncontrolled ways or too little. When Head started working at the hospital the originally small institution had already expanded to 100 beds and in 1896 been appointed one of the official teaching hospitals in London. At a celebration of the appointment, the neurologist Sir William Gowers gave an enthusiastic commemorative speech in which he announced proudly that "[t]he great facilities for the acquisition of knowledge which is secured by the aggregation of the same general class of disease have already made this hospital known wherever medicine is studied, for an institution of corresponding character and size will be sought for in vain."[4] We must thus note that Head was at the time part of the neurological avant-garde.

Together with his colleague James Sherren, Head mainly worked with paralysed patients and thus consequently focused mostly on the deficiencies and failures of sensibility. Gradually they grew more and more interested in all the details of the mechanisms of the peripheral nervous system. The concrete questions that finally lead to Head's self-experiment, derived from their observation of symptoms that contradicted all existing theories concerning the structure of the nervous system. The neurological patients they were working with showed symptoms that required new modes of explanation focusing on the function and dysfunction of nerves in process rather than on their anatomy. In contrast to anatomy, physiology as well as neurology had to ask time-related questions as their practices were concerned with living bodies; one of the Head and Sherren's main goals was to generate knowledge about the cutaneous nervous system, its various parts and the respective time-spans required for regeneration. Knowledge about the precise temporality of the peripheral nervous-system would hopefully not only render their patients' often mysterious symptoms more understandable and eventually treatable, but would also be extremely useful during surgery. Surgeons would thus be more conscious about the risks involved, when wounding a specific part of the nervous system due to their knowledge of the respective time span it required for full regeneration. Head and Sherren's precise experimental question was thus fundamentally a temporal one, they had to investigate a process or rather

[4] Inauguration Address by Sir William Gowers, quoted from: B. BURFURD RAWLINGS, *A Hospital in the Making. A History of the National Hospital for the Paralysed and Epileptic (Albani memorial) 1859-1901* (London: Pitman, 1913), p. 202.

various layers of processes. However, the nervous system and its function with respect to the transmission of sensations could only be investigated b taking a detour. This was due to the fact that the nerves were hidden in th interior of their patients' bodies and thus reactions to stimuli could not b observed directly. Instead the function of the nerves could only be graspe by relating measurable exterior stimuli to secondary effects, i.e. th respective qualities of sensations that an experimental subject woul experience and eventually articulate. But this was by far not the onl difficulty the scientists encountered:

> Throughout this work we have been occupied with disorders of function, an more particularly with the study of changes in sensation. This cannot be carrie out by experiments on animals, in whom it is not possible to obtain any but th crudest sensory reactions. On the other hand, in man the lesion is not under ou control.[5]

This quotation epitomizes three major problems the experimenters wer confronted with in the clinical context: the irrationality of pathologica sensation, the (in)ability of untrained experimental subjects to articulat their introspectively observed or rather perceived experiences and th inaccuracy or contingency of the patients' injuries.

The neurologists often witnessed sensibilities that by no means seemed t correlate with the injuries in their patients' bodies in as far as these wer accessible. Pain was 'reflected' to parts of the body that had no clear link t interior injuries and areas that were cut off from the nervous system wer insensitive towards certain stimuli, but at the same time prove hypersensitive towards others. In short the neurological patients pose riddles for the neurologists that appeared to be unsolvable within th everyday routine of hospital life.

In 1901, Head and Sherren therefore decided to undertake a systemati clinical study regarding the peripheral and more precisely the cutaneou nervous system. A number of patients with injuries concerning th neuronal connections between the skin's surface and the underlyin nervous system were subjected to a set of tests in order to discover how th capability of sensation regenerated in such areas and in which tempora order 'normal' functions reappeared. At this time, the two physicians wer already working together with their former colleague William Halse Rivers who at the time held the first professoral position for experimenta

[5] HENRY HEAD in collaboration with WILLIAM HALSE RIVERS, *Studies in Neurology*, 2 vols. Vol. 1 (London: H. Frowde; Hodder & Stoughton, 1920), p. 6.

psychology in Great Britain, at Cambridge University and who was mainly interested in the psychophysical aspects of their research.

However, the decision to experiment with patients brought up a second major problem: the patient's inability or at least unsatisfactory ability to accurately introspect. The experimenters expressed this problem as follows: "[S]uch patients can tell little or nothing of the nature of their sensations, and the time they are able, or willing, to give is insufficient for elaborate psycho-physical testing." And it is therefore, they continued, "unwise to demand any but the simplest introspection from patients, to whatever class they may belong."[6] In addition, in the case of neurological pathologies, the ability for introspection was limited by the very pathology in question. In short, the patients were considered untrustworthy experimental subjects due not only to their untrained observational skills, i.e. because they were not scientists, their time-budgets and their degree of willingness, but moreover because of the very dysfunction of their nervous systems.

As already mentioned before, the third fundamental problem was the contingency of the patients' injuries. Whether a patient suffered from a neurological illness or whether he or she had been the victim of an accident, the exact identification of the degree and area of material destruction was impossible within medical practice, simply because identification couldn't be accomplished from an exterior point of view and because it was and is illegal to open up a living human organism purely out of scientific curiosity without pursuing a well-defined therapeutic goal. Put together these three complications, as encountered within the clinic, hindered precise and efficient experimentation. In the course of Head and Sherren's clinical trial, it thus "became obvious, that in order that we might examine more exhaustively the sensory condition of parts that had been robbed of their nerve supply, it was necessary that the patient should be a trained observer, and the injury determined beforehand."[7] In practice, this meant that the injury had to be produced artificially and that the experimental subject ideally had to be a scientist, well trained in the art of observation. Self-experimentation thus became an ethical as well as an epistemological necessity; Henry Head volunteered for the precarious role of self-experimenter and in spring of 1903 became an artificially produced neurological patient.

[6] HEAD – RIVERS, "A Human Experiment" (cit. note 3), p. 324.

[7] HEAD, "The Afferent Nervous System from a New Aspect", *Brain*, 1905, 2: 99-115, p. 102.

THE 'DESTRUCTIVE' EXPERIMENTAL METHOD

On Saturday, the 25th of April 1903, three seemingly healthy men, Head, Sherren, and Rivers arrived at the private house of a man called Mr. Dean. After some short hesitation and – we imagine – a quite agitated, slightly aggressive conversation, Head finally rang the bell, the door was opened and the three physicians entered the house. Some hours later, the door opened again and the same three men were obviously about to leave. Had we been observing them from the other side of the street, we would have been surprised by the severe transformation they had undergone within this short period of time, the three middle-aged men now seemed exhausted. One of them, Henry Head even appeared to be seriously injured, holding up his left arm in a splint. All of the men were staring at it attentively, he staggered slightly, while slowly moving out into the street.

Some years later, Head reported the following about that Saturday in spring 1903: "On April 25, 1903, the radial (ramus superficialis nervi radialis) and external cutaneous nerves were divided in the neighbourhood of my elbow, and after small portions had been excised, the ends were united with silk sutures."[8] The limb was put up in a splint with the forearm flexed at the elbow, and the whole hand was left free for testing.[9] Now that we know what happened inside Mr. Deans house, our astonishment at the fatigue that we observed in all three men when leaving, diminishes. While Henry Head had been under the influence of anaesthesia, the other three men had attended to an operation whose task was to produce serious injuries on their friend and colleague; something that was guaranteed to generate a maximum of tension in men that had dedicated their life to the Hippocratic oath.

The Head-Rivers-Experiment has become legendary in the history of neurology as well as experimental psychology and physiology. Although it might, at least from a clinical point of view, seem very strange to destroy parts of a healthy body instead of repairing an ill one, this procedure is one of the most common applied techniques in the history of physiological research. In a methodological tradition that can be traced back to Galen, the functions of a given part of the body are determined by removing it from the organism. By observing the transformations caused by the removal, the experimenter subsequently reasons *ex negativo* about function

[8] *Ibid.*

[9] HEAD – RIVERS, "A Human Experiment" (cit. note 3), p. 325.

of the respective body-part, e.g. a nerve. Something is removed in order to observe the 'natural' consequences of this intervention on the artificially ill organism; the functions of an organ are determined through its absence. Or to put it differently, the organ is supposed to reveal its mechanisms in the living organism by way of non-functioning.[10] Insofar as the organism is supposed to dissect itself in such procedures, in his *An Introduction to the Study of Experimental Medicine*, Claude Bernard not only termed them 'experiments by destruction' but also considered such experiments based on the partial destruction of an organism, fundamentally *analytical*.[11] The reduced organism modelled functions that were no longer active.

In Great Britain, the physiologist Charles Scott Sherrington (1857-1952) – some time after Bernard in France – promoted a similar approach to the experimentation of physiological processes. In his experiments on reflex movements, Sherrington favoured decerebrated cats as experimental subjects. He claimed that 'pure' reflexes could only be isolated if all other nervous functions that are usually part of a living organism have been destroyed; according to him, decerebration was thus a necessary condition for experimentally producing précis, that is pure reflexes, which made for good scientific objects. Only in a next step, could these isolated reflexes then be integrated or, reintegrated in the context of the whole organism.[12]

In the introduction to the reissue of major parts of the results of the Head-Rivers experiment in a book entitled *Studies in Neurology*, Henry Head explicitly refers to Sherrington as a friend and to his method as a model for his own self-experimental practice. Together with Sherrington, Head favours a method of revealing the functions of the body via the detour of their artificial destruction or pathology, even though such an approach was viewed very critically in the physiological context:

> This concept has been combated by certain critics mainly on the grounds that the conditions under which our observations were made were 'pathological'. To many physiologists a phenomenon, which can be labelled 'pathological' is banned to the limbo of medicine, with which they refuse to have any concern. We, on the other hand, contend that these dissociations of function give the clue to the complex activities of the nervous system.[13]

[10] See for a detailed reflection on this method: CLAUDE BERNARD, *An Introduction to the Study of Experimental Medicine* [1865]. First English translation by Henry Copley Greene (New-York: Dover Publications, 1957).

[11] *Ibid.*

[12] See e.g. CHARLES SCOTT SHERRINGTON, *The Integrative Action of the Nervous System* (New York: Charles Scribner's Sons, 1906).

[13] HEAD, *Studies in Neurology* (cit. note 5), p. 8.

The specificity of the Head-Rivers-Experiment with respect to the method defended in this quotation was that it did not simply determine functions via their absence in order to reintegrate them in a next step more or less theoretically into the organism as a whole. Because the part the researchers removed was not an organ such as the liver or the kidney, nor as with Sherrington, the head, but merely some nerve-material and thus a part of the body that would at least mostly regenerate, their experiment could proceed in an even more detailed way. Head and Rivers could observe the reappearance of functions that had been destroyed over time, and this is exactly what they did.

THE PROBLEM OF INTENSITY

In the first days after the operation, Head's arm was acutely observed with regard to the recovery of the injury, precautions were taken in order to prevent dangerous inflammations and other complications that could adulterate the transformations of sensibility as produced by the voluntary nerve division. In this respect, the scientists were successful. The external wound produced by the operation healed "by first intention."[14] But they were successful in yet another way. Only one day after the operation, first tests were conducted on Head's arm with respect to its sensibility. It turned out that while Head was unable to perceive certain stimuli such as pricks, cold or heat on most parts of his arm, the sensation of pressure appeared to be quite intact: "the whole of the affected area became insensitive to prick, to heat, and to cold; two points of the compasses, applied simultaneously, could not be appreciated".[15] It was Sunday, the 26th April 1903. The three men had probably returned to Mr. Dean's house as they emphasize that the surgeon, who was not familiar with the observations that Head and Sherren had been making in their clinical experimentation was astonished by the fact that albeit the nerve-division he had performed the day before "[p]ressure with the finger, with a pencil, or any blunt object was immediately appreciated."[16] The degree of remaining sensibility even made him confess that he "should have thought that sensation of touch was intact, had he not known the nerves had been divided."[17]

[14] HEAD – RIVERS, "A Human Experiment" (cit. note 3), p. 325.

[15] *Ibid.*, p. 340.

[16] *Ibid.*, p. 325.

[17] *Ibid.*, p. 326.

However, to Head and Sherren the diagnosis of such an ambivalent state of sensibility in Head's arm meant that the first step of their model was a success. The operation had produced a kind of 'irrational' sensibility analogous to the ones they had been confronted with in the clinical context and that had attracted their scientific curiosity and led to the Head-Rivers-Experiment in the first place. With one decisive difference: they now knew exactly which nervous tissue had been destroyed.

During the years following the primary intervention into the peripheral nervous system of Head's arm, the neurologist observed the gradual regeneration of most of the deactivated functions through introspection, while the experimental psychologist Rivers took on the task of correlating these interior 'observations' with measurable objects existing in exterior reality. One thing, however, was clear from day number one: there were certain sensations, such as pressure, that could be produced by exterior stimulation on the skin's surface, but which were not conducted by the cutaneous nervous system. Head and his colleagues later on named the parts of the nervous system, which they considered to be responsible for such sensations, as well as the sensation of pain, *protopathic*. And they coined the term *epicritic* for functions of the nervous system that proved to be absent after the operation, such as precise localisation and the distinction of simultaneously applied stimuli. The task of the following experimental process was then to precisely register the regeneration, that is the reappearing variation of sensibility over time, and to try to link it to a specific part of the cutaneous nervous-system.

However, one of the problems originally encountered within the clinic had not been solved. The question was how to construct an experimental-system that would allow for the translation of immediate, internal and subjective experience into a system of visible and objective scientific facts? Or to put it differently: How to find ways to extensify the intensive? Although the injury of Head's nervous system was precisely determined, introspection remained a fundamentally ephemeral practice, even when accomplished by a scientist. In order to produce scientifically useful results, Head's transforming sensations had to be somehow translated into a form that was accessible from an exterior point of view. If the experimental results should be of any precision, a form of translation into a system of visibility and measurability, some kind of objectification was necessary. It therefore became imperative to supplement direct sensations and their transformations with an arsenal of instruments. However, in a first step the task of such instruments could only be relative. Head's transforming sensations had to be related by technical means to something exterior that

was precisely measurable, like the weight of a touching object, its temperature or the distance of two stimuli induced at the same moment.

In his doctoral dissertation, Henry Head had already worked on the transformation of cutaneous sensations in visceral diseases. He had tried to find ways to visualize the specificities of sensibility that accompanied illnesses such as Herpes zoster by drawing maps on the body, marking the zones on which the patients' pain produced in the interior was 'reflected' on the exterior surface of their body – their skin. A decisive outcome of these researches was the discovery of the so-called *Head zones*.[18] In comparison to this research, the Head-Rivers-Experiment had an important methodological advantage; as it was dedicated to understanding the characteristics of the *cutaneous* nervous system, and thus the nervous system closest to the enveloping layer of the body accessible from the outside, the skin, it required relatively few steps to get from the exterior stimulus to the nervous system responsible for conducting it. Whereas in the case of visceral diseases, the accompanying sensibility of some areas of skin could only vaguely be correlated to their organic origins, in the case of experimentation on the cutaneous nervous system, there was a much clearer relationship between exteriorly applied stimuli and perceived sensations. Sensations could be related to objects without much problem. But how to express this relation in a scientifically accessible form?

The very first vehicle to accomplish this difficult task of translating intensive into extensive sensations, so to say, was the experimental psychologist William Halse Rivers himself. Throughout the entire experimentation process of over five years, Rivers functioned as Head's co-experimenter. Whereas Head observed or rather experienced introspectively and thus subjectively, Rivers task was to relate Head's changing sensations to exterior, material and ideally quantifiable objects or stimuli. In short, Rivers stimulated Head's arm in various ways and Head, with eyes closed had to report the sensations, he was experiencing introspectively. These two systems, one of exterior stimulation and one of interior sensation were then related to one another.

Rivers had been significantly involved in the process of founding the new discipline of experimental psychology in Great Britain. "In 1897, he was temporarily put in charge of the new psychological laboratory at University College. This was the same year in which Foster assigned him a room in the Physiology Department at Cambridge for use in psychological research. As

[18] See: HEAD, "On some Disturbances of Sensation, with special Reference to the Pain of Visceral Disease", *Brain*, 1893-1896, *16*, *17*, *19*, pp. 1-133, 339-480 and pp. 153-276.

a result, Rivers is listed in histories of experimental psychology as simultaneously the director of the two first psychological laboratories in Britain."[19] Because the first laboratory for experimental psychology at Cambridge University had been founded as an extension of the physiological one, the greater part of the tools the scientists had at their disposal had their origins in experimental physiology. However, the most crucial instruments employed in the Head-Rivers-Experiment derived from the context of the physiology of sensations that had from the beginning been prone to exist on the threshold of physiology and psychology as it required sensitive subjects and their expression or articulation in order to relate them to the respective exterior stimuli. Two of the most relevant instruments were e.g. the compass that enabled physiologists to register the point at which two stimuli were perceived as a single one and the so-called 'von Frey pain hairs' that made it possible to stimulate an independent part of the nervous system responsible for nothing, but the transfer of sensations of pain.

At this point, it is not necessary to enter into the details of these respective instruments. It is, however, crucial to note that both of them were applied to the skin and thus to the organ that excludes a living organism from its environment and that can at the same time be considered the interface between its interior and its exterior existence. In this sense, the skin has some qualities in common with a canvas or screen, its specificity being that it can be engraved on or inscribed on from two directions in different ways. It was thus the skin of Head's arm that must be considered the first image to come into play in the experimental process.

Experimental Procedures

The experimental procedures were intensified as soon as the open wound on the surface of Head's skin had healed. From this moment on and during the following five years, Head travelled from London to Cambridge almost every Friday evening or Saturday morning. Getting off the train at Cambridge station, he walked towards one of the biggest and most prestigious Colleges, St. Johns College. Head entered into the second courtyard, then went through a door, climbed the stairs, rang a bell and was welcomed by his friend William Halse Rivers. The two men entered

[19] Richard Slobodin, *W.H.R. Rivers: Pioneer Anthropologist and Psychiatrist of the Ghost Road* (New York: Sutton Publishing, 1978), p. 16.

Rivers' apartment, passed by some rooms and finally arrived at the central room, closed the door carefully so that all possible distractions would be excluded and set down at an elegant table. This table was not set with tea and biscuits nor with lunch or dinner, but rather with a whole arsenal of bizarre-looking instruments and holloware. Then the two scientists took up their weekly experimental session.

For hours Rivers would stimulate Head's arm with various objects, while the latter kept his eyes closed. The two experimenters proceeded step by step. Rivers asked questions such as "How many stimuli do you perceive?"; "Where would you localize the following stimulus?" and "Which kind of sensation are you experiencing now?" Then he would stimulate Head's arm with cotton wool, a compass, various hairs and bristles, ice cubes, hot bottles, needles, etc. And Head would answer in one or the other way by uttering a number, pointing to his arm or describing his sensations with adjectives, such as burning, pricking, hot, cold, painful or tickling. Sometimes he would just scream and jump up from his chair when Rivers e.g. courageously scratched over his arm with a fixing pin to strongly for Head to bear the pain. All these tests were repeated frequently and transformations in Head's sense of perception were documented carefully as the experiment's aim was to grasp the regeneration process of sensitivity over time.

The new neurological distinctions that came about over the course of this long period of experimentation were accordingly also of a temporal nature. The two subsystems of the peripheral nervous system, the *protopathic* and the *epicritic*, were not only different with respect to their functions, but also with respect to their temporalities. That time was of crucial importance in the Head-Rivers-Experiment is particularly obvious in following paragraph, in which the authors give an account of the complete process of experimentation in the form of a telegraphic diary some excerpts of which I would like to cite:

> "*Forty-three days* after the operation (June 7), the extent of the cutaneous analgesia had begun to diminish.
>
> *Fifty-six days* after the operation (July 20), the whole forearm responded to prick, and the back of the hand was becoming rapidly sensitive to this form of stimulation. [...] *One hundred and twelve days* after the operation (August 15), the proximal part of the affected area over the forearm had become sensitive to cold. [...]
>
> *Two hundred and twenty-five days* after the operation (December 6), the hairs on the back of the hand responded with a diffused tingling to cotton wool, but the whole affected area of the forearm and hand still remained insensitive to von Frey's tactile hairs. [...]
>
> *Three hundred and sixty-five days* after the operation (April 24, 1904), the proximal patch on the forearm began to be sensitive to cotton wool after shaving. [...]

Five hundred and sixty-seven days after the operation (November 12, 1904), the greater part of the affected area on the back of the hand had become sensitive to cunateous tactile stimuli, and temperatures below 37°C. evoked sensations of warmth."[20]

Head and Rivers together worked like two detectives on the securing of evidence one from the inside, the other from the outside perspective. That was because the process of regeneration did not proceed in a consistent fashion. Therefore every inch of Head's arm had to be investigated again and again by applying all kinds of stimuli. In areas that were in a *protopathic* state, for example, the pain threshold proved to be higher than in other areas. In turn, pain did not announce itself, but appeared suddenly and more intensely than in regions that had not been cut off from their nerve supply. In areas, where *epicritic* abilities returned, such 'irrational' sensations slowly vanished. These observations inspired the experimenters to engage in evolutionary speculations about the nervous system. Taking up their teacher's – Jackson – indebtedness to Spencer's theory, Head and Rivers put forward the claim that the *protopathic* abilities, which regenerated before all others, were also older with respect to evolutionary time. They also postulated that lower animals would thus be more endowed with such sensibilities and the correlative layers of nervous material, whereas *epicritic* sensibility was reserved for modern, cultivated Western human beings and thus had to be attributed to a later phase in the evolutionary process.[21]

Protopathic thus not only designated a specific kind of sensibility, but also a primitive evolutionary state, whereas *epicritic* referred to a recent state of evolutionary development. By dividing the nerves of Head's arm, the experimenters had without knowing it thus artificially produced a body part that participated in an earlier stage of evolution. The process of regeneration therefore no longer only served to model the symptoms of the experimenter's neurological patients, it was also regarded as a demonstration of the process of the nervous system evolving fast forward. Looking back on the image, which we took as a starting point to this paper, this means that the area marked on it by black lines, the area that remained *protopathic* even five years after the primary intervention into Head's arm, also illustrated to the experimenters a primitive

[20] HEAD – RIVERS, "A Human Experiment" (cit. note 3), p. 340ff.

[21] See especially: HUGHLINGS JACKSON, "Remarks on Evolution and Dissolution of the Nervous System", in *Journal of Mental Medicine*, 1887, pp. 25-48.

evolutionary state while the rest of Head's arm and hand had again arrived in the present.[22]

VISUALITIES

During the five-year long experimental process, visual traces were produced by the reactions of Head's skin on the one side and by exterior application on the other. At the very beginning of the experiment, one thing was most striking visually: the scar produced by opening up the arm and closing it again with silk sutures. One could see each single stitch. In a next step, the arm's exterior appearance changed due to various factors. It was shaved in order to start the precise examination concerning its slowly transforming abilities to perceive various sensations. But it also transformed itself, obviously due to reactions that were located in the interior of Head's body. Parts of the skin became extremely dry just that of very old people – Head was only 41 years old. It turned dark-red, developed blisters and trophic sores that healed in one place just to reappear at another. The experiments with various stimulating instruments did not aid the healing-process. For example, when Rivers tested Head's

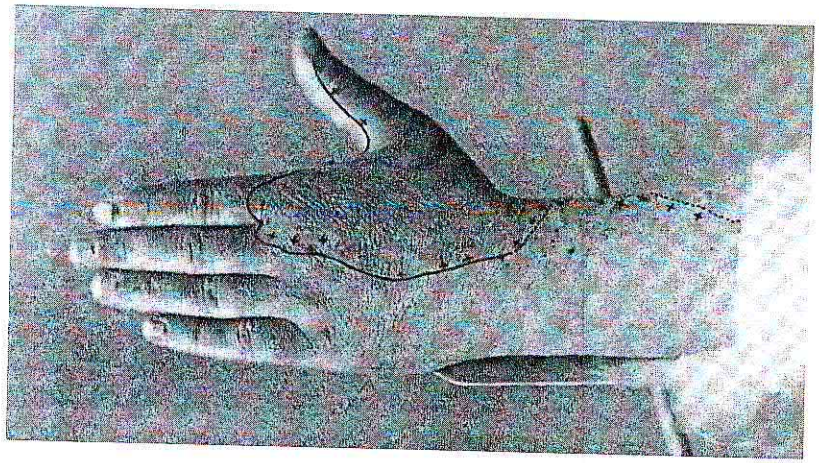

Fig. 2. The photograph that lies at the basis of this image shows a darker area towards the thumb. The black line and the red crosses mark particular zones of sensibility.

[22] See e.g. HEAD – RIVERS, "A Human Experiment" (cit. note 3), p. 389.

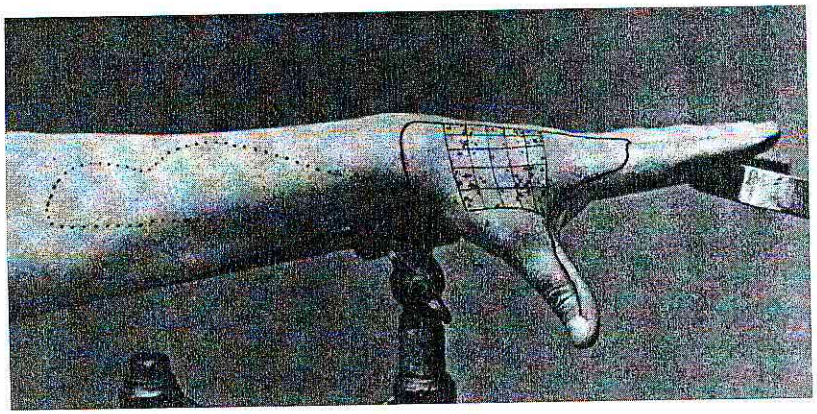

Fig. 3. Due to the distortion of the grid-pattern that follows the pose of the hand, as we see it on this image, it becomes obvious that it was not superimposed on the photograph but applied to Head's hand when the photograph was taken.

arm with a needle by scratching over his skin, the red lines produced by this procedure, which quickly disappeared on the 'normal' parts of the skin, remained visible for several days on the affected area. But tests regarding the appreciation of all kinds of temperatures also added to further injury. All these transformations, however, have not made their visual way to the publication of the experimental results, they have disappeared on the black-and-white photographs, or at least they require some imagination in order to be perceived.

As we can see on this picture, another system was invented in order to visualise Head's permanently transforming sensibility. This system of lines and crosses mainly fulfilled the task of showing areas that appeared to be anaesthetic, analgesic or of another particular sensibility towards certain stimuli. What we see here might, however, lead us to the wrong assumption that these signs were – like on the image whose biography I am trying to write here – *only* applied on the photographs after the actual experiment. However, some of them at least were already present during the experimental process. Head's skin not only served as an interface between his physiological reactions to the cruel intervention into the nervous system. Thus it did not only engrave signs such as redness from the inside. Rather it also served as the screen on which all kinds of signs were inscribed with the help of ink. The skin thus can be considered *the* interface on which the results of the external and internal experimentation were made visible: e.g. a grid pattern serving experiments on localization

was drawn on Head's hand, which slowly became a complex neurological map.

In order to preserve this system of signs, Head sometimes had to wear gloves for weeks without washing his hand and arm. However, at some point the drawings would rub off and thus it quickly became necessary to reproduce Head's arm regularly – whenever he came back to London, Head now went to a photographer and had his arm photographed. "On returning to London after each series of sittings, life-sized photographs were taken of the markings on the back of the hand and another set on a smaller scale, including the forearm. Our best thanks are due to Mr. Wilson, photographer to the London Hospital, for the care and skill with which these records were taken."[23] The all too quick disappearance of the signs drawn on Head's arm even led the experimenters to comment "that if this experiment is repeated it would be wise to tattoo certain fixed points on the skin before the operation. This would ensure that each square always occupied the same area."[24]

The Risk of Knowing Too Much

Whereas the relevance of fixing points on the affected area and other technical questions of general character were discussed between Head and Rivers, the experiments, they were working on at a precise moment were only known vaguely by Henry Head, who should not be influenced by too much knowledge. "Since Head was at the same time collaborator and patient, we took unusual precautions to avoid the possibility of suggestion. No questions were asked until the termination of a series of tests. ...The clinking of ice against glass, the removal of the kettle from the hob, tended to prejudice his answers and destroyed that negative attitude of attention essential to such experiments."[25]

But even if the two experimenters then decided about the general procedures together, Rivers would always change some parameter. He did so in order for Head not to know precisely what an experiment was aiming at or rather what kind of questions he was exactly answering. The goal was for him to be in a state in between attention and distraction.

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[23] *Ibid.*, p. 346.
[24] *Ibid.*
[25] *Ibid.*, p. 345.

"Under no circumstances was H. allowed to know at the time whether his answers were right or wrong. For if he was told he had answered wrongly, he was roused to an intense determination to do better, producing thus a mental condition, which was found to be unfavourable for the appreciation of sensory stimuli. Knowing his answers had not been correct, he would catch at every accessory circumstance in his attempt to interpret his sensations."[26]

Here it becomes very obvious that the well trained observational skills that had been considered as indispensable for the experiment in 'Nerve-Division' to be successful also produced risks that were absent in the clinical trial with patients, who had no understanding of, or at least no particular interest in the experimental aims they worked for. The fact that Head had set up the experiment himself made him at the same time a risky and rather unreliable subject, as he was prone to interpret what was going on and in doing so change the experimental results. What thus had to be reached on Head's side was a state of detachment, a detachment, however, that did not go hand in hand with inattentiveness. During the experimental procedures, Head had to succeed in being attentive towards specific phenomena of his interior and at the same time inattentive to what was going on around him in Rivers' laboratory. He thus didn't really have to *observe*, but instead had to close his eyes and send his body into a state between sleep and waking, a sphere of thoughtlessness or 'negative attitude of attention':

> Occasionally, especially after exercise in the open air, this condition of detachment would pass into sleep. We noticed that the answers seemed to improve up to the point at which H. ceased to reply.[27]

However, as many of the tests Rivers executed on Head's arm had to do with questions concerning Head's ability to localize stimuli very precisely, the state of complete detachment was not always very helpful. Furthermore, Head's inability to remember tactile experiences did not facilitate the precision of distinction between different stimuli and thus hindered effective objectification.

> Again, some unexpected feature in the sensation might arouse H.'s attention, but inability to reproduce the sensory image greatly hindered its introspective study. It was often necessary to repeat the stimulus several times before H. could appreciate each separate aspect of the sensation.[28]

[26] *Ibid.*, p. 443.
[27] *Ibid.*, p. 353.
[28] *Ibid.*, p. 344.

Whereas Head's ability to recall sensations in any precise way was thus obviously extraordinarily bad, his ability to imagine visual impressions in front of his inner eye was particularly good: "He was able to reproduce the image of a thing seen with such an accuracy that it could be searched for details, at first unnoticed."[29] In addition to what we might call a 'photographic memory', Head is also described repeatedly as a synaestheticist in whose imagination the days of the week, numbers and even abstract ideas such as cowardice or virtue were related to specific colours. These characteristics of Head's cognition are not simply mentioned by the authors of the "Human Experiment in Nerve-Division" in an anecdotic way but they rather consciously took advantage of them for the organisation of their experimental approach. Head could not only let the notes of a musical piece appear in front of his eyes or reconstruct the image of a landscape that he had once seen to a precision that he could search this virtual image for hidden figures. He was just as much capable of *seeing* the tactile stimuli Rivers induced on the skin-surface of his arm, while his eyes were well closed.

Through this particular, very individual ability, Head was thus able to solve or at least to facilitate the translation of intense, subjective perception into a system of exterior, visual and thus representative objectification. Because Head could permanently see his arm even though his eyes were closed and thus could transpose in his mind's eye the induced stimuli into lines and points on a map on the surface of his body, he functioned as what could be considered a 'natural' machine for the translation of intensities into extensive phenomena that could be made visible in a further step.

> H.s strong powers of visualization rapidly led to the development of what may be called a visual map of the affected area. He had but to close his eyes to see a picture of his hand with the affected area marked upon it as clearly *as in a photograph*. As soon as a spot was stimulated, he saw its position on this map and at once described the neighbouring landmarks. He could even give approximate measurements.[30]

These measurements became more and more precise as Head integrated the landmarks that had already been inscribed on his arm or its photographic reproduction into the respective descriptions of his sensations. Whereas in the beginning there had only been the scar that could serve as a referential mark, the referential visual system became more and more complex and precise with the successive progression of the experiment. As we have seen

[29] *Ibid.*
[30] *Ibid.*, p. 355.

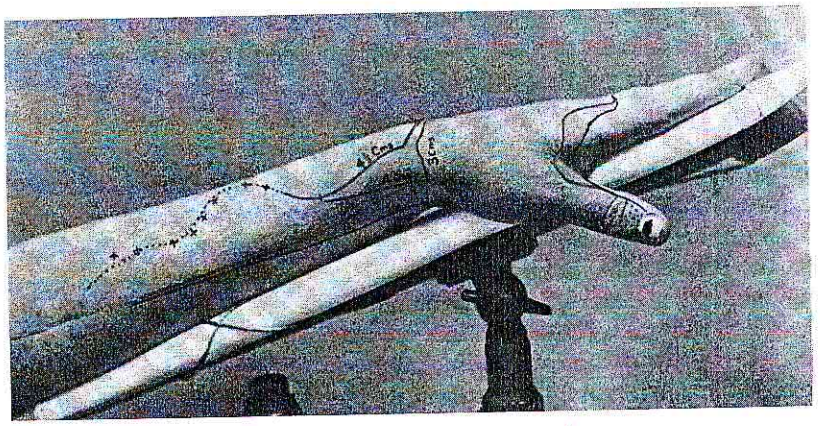

Fig. 4. Lateral view of Head's arm, photographed on the 26 of may 1903.

researchers created a system of notation in which certain crosses, lines and point represented the respective sensibility or insensibility of a certain area. By painting them on Head's arm, the neurological *tabula rasa* after the initial operation step by step became a map on which at least those who could read it could easily navigate. The possibility of proper orientation, as already hinted at, had to be preserved however. Whereas in the case of the grid pattern, a tattoo might have been useful, other inscriptions changed over time due to the transforming sensibility of Head's arm. This was the reason that photography played such a crucial role.

However, the photographs not only lacked colour and therefore let the transformations that Head's skin showed as a result of the various interventions carried out on his arm disappear. It also seems that some of the exteriorly applied inscriptions got lost in this step of mediation from the three dimensional arm to its photographic reproduction. In the publication at least, many of the lines on Head's arm and hand were therefore superimposed onto the photographs or rather their printable versions, some of them in colour probably to facilitate discrimination.

The photographs, however, by no means only played a role in illustrating and documenting the process of experimentation, they also played a rather explicit role inside it. One of the major tests concerning Head's ability to localize proceeded as follows: Head "was asked to mark the spot touched on a life-sized photograph of his hand."[31] How did this work?

[31] *Ibid.*, p. 411.

During this part of the procedure, each of the experimenters had a photograph of Head's arm at his disposal. Rivers marked some spots on his image by drawing circles. In a second step, he stimulated Head's 'real' arm exactly at these precise spots. Head then had to mark the spot, where he had perceived the stimulus on the photograph at his disposal. Head's arm was thus present three times during this kind of test: as a plane, as a three dimensional object and again as a plane. However, in this procedure, two slightly different images were produced. In a last step, these images had to be compared to one another. This comparison was carried out on the level of two-dimensional visibility: the two images were superimposed and through this procedure the difference between the induced stimulus and the perceived one became not only visually accessible, but also measurable. On the printed versions of these 'composite' images, Rivers' circles are black and carry large numbers, whereas the spots marked by Head are small red numbers.

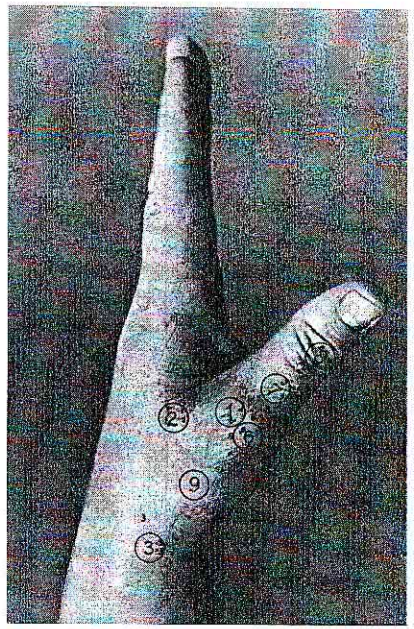

Fig. 5. The Black circles were inscribed by Rivers, the red numbers by Head.

If we might have asked ourselves earlier why Head and Rivers felt it necessary that their experiment should require a *trained observer* rather then *trained senser*, and why Head was more likely to fulfil this task than random neurological patients, then this question is elegantly answered by the representational strategies that both were able to introduce during the process of experimentation thanks to Head's extraordinary visual skills.

Representation Of or As

Finally let us consider modern science as a practice that is concerned with understanding reality by making all its elements *representable*. From this

point of view, it becomes clear that one of the major tasks of educating scientists such as physicists, chemists, or physiologists must consist in training them to be good at producing representations. Representation, however, is a practice that carries various meanings: first of all, it designates a practice of re-presenting an object in a different symbolic-system. Such representation bears a certain similarity to the primary phenomenon, it is a representation *of* something. The theatrical context is another different case: an actor represents something, he goes on stage *as* someone else. However, a third meaning must also be taken into consideration. In a chemical laboratory, a substance that is being 'represented' designates the procedure of its very production rather than a relation with this substance. In this case "the meaning of embodiment in the sense of the production of a specific substance is brought to the fore. In this case representation designates the realization of a thing," "On closer inspection", Hans-Jörg Rheinberger continues, "any putative representation 'of' reveals itself simultaneously as a representation 'as'".[32] This is the case insofar as that the representation 'of' a scientific object and its coming into existence can never clearly be distinguished from one another. The two kinds of re-presentation are instead always intertwined with one another in a constitutive way.

The way in which Head and Rivers dealt with photographs in their experiment makes this obvious in a particular way. Even though the images produced in the experiment do not show or visualize the actual objects under investigation – the nerves, well hidden in the interior of Head's body – they nevertheless give these hidden phenomena and their vital functions some kind of objective reality. They do so by letting some traces of these interior functions surface, producing traces that in turn evoke some kind of visual image of the underlying nervous system. And this claim could be further radicalized by saying that the images realize the peripheral nervous system as an object of knowledge or at least its newer, more complex version in the first place.

The three modes of representation furthermore can be rediscovered as three layers in the images as published in the article finalizing the Head-Rivers Experiment. The first layer is the photograph of Head's arm, the second is the skin's reactions and the lines drawn on his arm before the photographs were taken. The third layer was produced by the lines and spots that were superimposed for the publication. The simple photograph

[32] Hans-Jörg Rheinberger, *Experimentalsysteme und epistemische Dinge. Eine Geschichte der Proteinsynthese im Reagenzglas* (Göttingen: Wallstein, 2001), p. 111.

could be considered a representation *of* Head's wounded arm as neurological *tabula rasa* on which neurological knowledge is made visit The second layer, as built by lines, spots and the grid pattern, could considered a representation of Head's arm *as* a scientifically interesti phenomenon on which traces of sensibility were inscribed. The third lay finally, the one with the superimposed drawings that were produced order to present the experimental results to a larger public, can at the sa time be identified as the layer that shows the artificiality of the functions the nervous system as they are produced under experimental circumstanc

In the case of the Head-Rivers-Experiment, Head's arm became the pla that was stimulated, inscribed and re-inscribed, photographed and la published. Head took on the interior perspective of an ideal experimen patient or rather he took on this perspective whenever he borded the tra to Cambridge to spend his weekend there with Rivers. However, after fi years of continuous experimentation, the two scientists declared t experiment to be over. Apart from the scar produced by the init operation Head kept only one trace that was almost unperceivable: A sm area on the back of his hand where his sensibility continued to be rath imprecise, an area where he could not tell the two peaks of a compa apart, an area that had remained in what Head and Rivers had becon used to address as *protopathic*.

Conclusion

To conclude, I would like to take up the initial proposition to understar writing the biography of a scientific image as an experimental process textually producing a space for the image to unfold itself in interestir ways. I tried to do so in the course of this article by taking up various lin of thought, techniques and practices that are in one or the other w connected to it. This procedure implied – analog to the experiment method of 'destruction' we have encountered it in the Head-River Experiment – to remove or abandon the object of interest, that is th image, in a first step in order to observe its gradual reappearance, its ris from the dead by following the complex process of its coming into being.

The primary object of the Head-Rivers-Experiment was the peripher nervous system; after removing it from the large part of Head's left ar and by employing various instruments, methodological tricks an techniques of mediation, the scientists finally got to know something abo their object's life by following the long process of its regeneratior

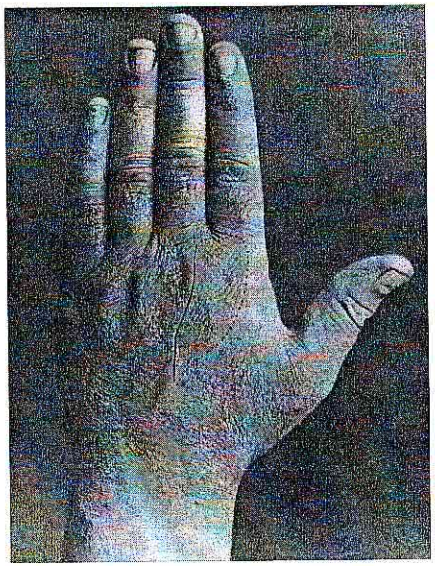

Fig. 6.

However, in the meantime, its mode of existence had fundamentally transformed. The peripheral nervous system now consisted of two sub-systems, the *protopathic* and the *epicritic* and each of them not only occupied a specific space, but also belonged to a particular time period within the temporality of evolutionary theory. This new mode of existence largely became real through the sophisticated visualisation techniques employed by Head and Rivers in order to exteriorise Head's interior sensations. The two scientists had found ways by which they could let the regenerating nervous system surface on Head's skin, to cause it to leave traces, to write (*graphein*) its own life (*bios*) as one could say onto Head's arm and in a next step on the photographic reproductions of this artificially ill limb.

In the same way, my biography tried to give the initial image a chance to transform itself from a dead, more or less meaningless thing into an assemblage of a multiplicity of practices and discourses and thus into an object overcharged with meaning. The reader must judge for himself or herself whether this procedure has been successful simply by having another look at the very same image after having read this essay on its biography. If what you see now is no longer the same as what you saw when beginning to read this article, if what you see now is more than the photograph of a male left hand on which a small territory is marked by a continuous and a dotted line for unknown reasons, if what you see now is an image that is densely populated with all kinds of activities, stories, human and non-human actors, if in short what you see now is something that has a life of its own, I consider this essay deserving to be titled "The *Biography of a Scientific Image*".