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Constituting the human via the animal in eighteenth-century experimental neurophysiology: Albrecht von Haller's sensibility trials¹

Die neurophysiologische Konstitutierung des Menschen durch das Tierexperiment im 18. Jahrhundert: Albrecht von Hallers Versuche zur Sensibilität

Summary: This paper will address the use of animal models as a vital constituent of 'life science in the making' by focussing on the 'sensibility trials' conducted by the Swiss physiologist Albrecht von Haller (1708–1777). Haller was a pioneering figure in the early days of neurophysiological research, being not only influential for establishing animal experimentation as a viable method to gain knowledge about (human) neurological functions. He also tackled the question of sensibility as the most fundamental property of living bodies, which came to influence our conception of bodily feeling. In analysing some of his experiments on the nervous system, this paper addresses the following questions: what does sensibility or sensation signify in eighteenth-century physiology? How was it assessed or measured during experimentation? How were nervous functions 'read', i.e. how was the observable behaviour of an experimental animal interpreted? And finally: how did Haller address the differences between humans and animals in the context of his investigations?

Key words: neurophysiology – experimentation – human-animal analogy – pain – Albrecht von Haller

Zusammenfassung: Der vorliegende Beitrag widmet sich der tierexperimentellen Methode als essentiellen Bestandteil der Wissensformierung in den Lebenswissenschaften und untersucht dies am Beispiel des Schweizer Physiologen

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Albrecht von Haller (1708–1777) und seinen Experimenten zur Sensibilität. Hallers wegbereitende Forschungen am Nervensystem etablierten den Tierversuch als verlässliche Methode, Wissen über die neurologischen Funktionen des menschlichen Körpers zu erlangen. Seine Forschung ist zudem ein Beispiel für die zeitgenössische Auseinandersetzung mit dem Phänomen der Sensibilität als wichtigster Eigenschaft des lebenden Körpers und legte den Grundstein für unser heutiges Verständnis der körperlichen Empfindungsfähigkeit. Im Hinblick auf Hallers Experimente am Nervensystem, widmet sich der Beitrag insbesondere den folgenden Fragen: Was bedeutete *Sensibilität* in der Physiologie des 18. Jahrhunderts? Wie wurden Nervenfunktionen am Tierkörper ‘lesbar’ gemacht? Und vor allem: Wie wurde die vermeintliche Mensch-Tier-Differenz den Erfordernissen des Experiments angepasst?

Schlüsselwörter: Neurophysiologie – Experiment – Mensch-Tier-Analogie – Schmerz – Albrecht von Haller

Despite the ‘practical turn’ in the history of science and medicine, one important aspect of experimentalism has not yet received sufficient attention: the systematic reliance on animal models for the formation of knowledge in (human) physiology and medicine.² William F. Bynum is one of the few medical historians who devoted an article to the subject, concluding that “[g]iven the importance of animal disease models in the past century or so, it is surprising that there appears to be so little historical literature on the subject.”³ The epigraph for Bynum’s article was an event taking place at the London Medical Congress in 1881 at which the physician and neurosurgeon David Ferrier (1843–1928) demonstrated a monkey with symptoms of paralysis induced by an experimental ablation of the motor area of the brain’s left hemisphere. The limping animal led one member of the congregation, the French neurologist Jean-Martin Charcot (1825–1893), to exclaim

2 For a recent overview of approaches in the history of experimentation, see Stahnisch, Frank Walter: *Historical and Philosophical Perspectives on Experimental Practice in Medicine and the Life Sciences*. *Theoretical Medicine and Bioethics* 26 (2005), 397-425; and Rheinberger, Hans-Joerg: *History of Science and the Practice of Experiment*. *History and Philosophy of the Life Sciences* 23 (2001), 51-63.

3 Bynum, William F.: “C’est un malade”: Animal Models and Concepts of Human Diseases. *Journal of the History of Medicine and Allied Sciences* 45 (1990), 397-413, p. 399. See also the more recent book by Anita Guerrini: *Experimenting with Humans and Animals: From Galen to the Rights of Animals*. Baltimore, London 2003. Other notable exceptions are Holmes, Frederic L.: *The Old Martyr of Science: The Frog in Experimental Physiology*. *Journal of the History of Biology* 26 (2) (1993), 311-328; and Harrison, Peter: *Reading Vital Signs: Animals and the Experimental Philosophy*. In: Fudge, Erica (ed.): *Renaissance Beasts. Of Animals, Humans, and Other Wonderful Creatures*. Urbana, Chicago 2004, 186-207.

- “C’est un malade!” – which alluded to a recognition of behaviour in similarly afflicted patients in hospitals.

It is no coincidence that Bynum picked the showcase of an experimental neurologist to introduce the subject. The history of neurophysiology is a particularly rich field for investigating the role that animal models played in the life sciences. In Bynum’s example, the symptoms displayed by the monkey – motor dysfunctions – were comparatively easy to identify, hence the quick identification by Charcot and other members of the conference. A disorder of sensory functions, on the other hand, would have required further explanations since the outward signs of sensory functions in health and disease are much more subject to interpretation than a reduction or absence of motion in limbs. In a clinical context it normally requires a thorough interrogation of the patient to determine neurological conditions such as anesthesia (absence of sensation) or hyperesthesia (increase in sensitivity). In an experimental context, where the underlying causes of such conditions are mostly studied, the situation is somewhat different. Apart from the problem of sensitivity as subjective experience, the main question here is whether an analogy of human and animal sensual experience can and could at all times be upheld in the experimental process. Bynum’s paper focuses mainly on the rise of experimental medicine and pathology in the nineteenth century, but the questions he raises about animal models in medical research can be applied for other periods in which experiments were practised.

This paper focuses on the early days of experimental neurophysiology and seeks to establish what Bynum termed “the intellectual framework that justified the extrapolation of information obtained in animals to human beings.”⁴ It will be seen that the knowledge gained from neurophysiological experiments remained (and often still remains) ambivalent since the non-physical aspects of nervous functions, in particular the cognitive dimension of sensation, had little possibility of rigorous verification in an animal. How the animal became nonetheless an experimental representative for human bodily sensation will be investigated by analysing the *Sensibility* experiments of the Swiss physiologist Albrecht von Haller (1708–1777). Haller set the standard, not only for conducting experiments on the nervous system, but for investigating bodily sensation almost exclusively on animal bodies. How the concept of sensibility had been negotiated and established in Haller’s experimental trials has been aptly illustrated in the recent comprehensive account of Haller’s research by Hubert Steinke.⁵ But the dif-

4 Ibid., p. 401.

5 Steinke, Hubert: *Irritating Experiments: Haller’s Concept and the European Controversy on Irritability and Sensibility, 1750–90*. Amsterdam, New York 2005. A discussion of Haller’s concepts of irritability and sensibility also features in a most recent article by Boury, Dominique: *Irritability and Sensibility: Key Concepts in Assessing the Medical Doctrines of Haller*

faculties accompanying Haller's experimental attempts to elucidate knowledge about (human) nerve properties via animal models has so far not been analysed in depth. It will be shown that in Haller's research the concept of sensibility had to be adapted to accommodate both, the immaterial functions of sensibility and the alleged differences between humans and animals.

The first section gives a brief overview of the uses of animal models in anatomy and physiology, followed by an account of the heightened interest in the nervous system and sensation in Haller's time. The discussion will then turn to contemporary debates about the conception of sensation and its implications for the human-animal continuity. Finally, close attention will be paid to Albrecht von Haller's experimental trials and his understanding of sensibility. I will argue that the adjustment, or rather modification, of the species' difference has been an essential aspect of the experimental practice in (neuro) physiology, influencing the formation of physiological concepts as well as our understanding of bodily feeling in health and disease.

Animal models and the beginnings of experimental (neuro) physiology

The driving force for comparative research within the life sciences has been the quest for understanding the mechanisms of the human body.⁶ The study of anatomical structure, that is the body's material components, presented thereby less of a problem. Due to anatomical dissections, the physical similarity between animals and humans could be directly observed and provided accordingly a legitimate basis for this mode of research. The dissection of animals, which were after all easier within reach of the anatomist, had therefore since antiquity without any serious eruption of disputes been an acceptable means of obtaining knowledge about the human body. Difficulties arose when in the seventeenth and more so in the eighteenth century, anatomy and physiology increasingly turned their attention to function: internal processes such as the workings of inner organs, the circulation of the blood, muscle contractility and the like, could only be observed and studied in the living organism. Though the vivisection of animals had equally since antiquity served as a means of instruction, new discoveries about vital properties could not as easily be verified in comparison to the human

and Bordeu. *Science in Context* 21 (4) (2008), 521-535. In contrast to Steinke, however, who acknowledges the problem of the human-animal analogy in his book, Boury does not mention this aspect.

6 See Cole, Francis Joseph: *A History of Comparative Anatomy. From Aristotle to the Eighteenth Century*. London 1944.

body.⁷ Disciples of the “New Science” who increasingly shifted their attention from structure to function and whose findings were primarily based on experimental investigations of animal bodies had to contend with a rising criticism of a seemingly boundless acceptance of the animal-to-human transference of experimental results.⁸ Nevertheless, the use of animal experiments had been a steady source for the formation of knowledge about human bodily functions since the seventeenth century.⁹ The necessity to legitimise the use of animal models led to an ever-increasing emphasis on the species’ similitude within science until the development of neurological concepts in the eighteenth century gave the analogy question a new dimension.

Research on the brain and nervous system raised unsettling questions about this last point of reference from which the alleged difference between humans and animals could be asserted: consciousness. Once the brain became the acknowledged site of mental processes and the nerves the carriers of sensation, physiology struggled with the need to extend the human-animal analogy to incorporate an affinity of nervous functions, and yet maintain a crucial distinction to the human mind and bodily feelings.¹⁰ The relevance of nervous properties as the principle of life for constituting the ‘human’ was therefore not necessarily established in relation to its animal counterpart; often enough it was embedded within a specific search for markers of difference between humans and animals. Experimental neurophysiology thus provided a platform for testing hypotheses about the ostensible difference between the species and for debating unresolved issues related to ‘humanity’ that went beyond the investigations of physiology.

Eighteenth-century science saw a rising occupation with these issues: a heightened interest in sensation as an alleged function of nerves, a systematic use of experimentation as a means to gain knowledge about vital phenomena, and a methodical use of animal models as a substitution for the human body. Albrecht von Haller is a key figure in this development because, firstly, his research on sensibility represents the eighteenth-century shift from motion to sensation as the most fundamental property of living bodies. Secondly, Haller’s experiments set the standard for conceiving the physiological mechanisms of feeling (sensation) which, in an experimental context, translated into an analysis of pain expressions

7 See Maehle, Andreas-Holger: *Kritik und Verteidigung des Tierversuchs. Die Anfänge der Diskussion im 17. und 18. Jahrhundert.* Stuttgart 1992.

8 The year 1662 marks the official establishment of the ‘New Science’ in Britain; in that year the *Royal Society of London for the Improving of Natural Knowledge* received its royal charter (by Charles II); see Hunter, Michael: *Establishing the New Science: The Experience of the Early Royal Society.* Woodbridge 1989.

9 See Maehle (1992) [see note 7], and Guerrini (2003) [see note 3].

10 See Hagner, Michael: *Homo cerebialis – Der Wandel vom Seelenorgan zum Gehirn.* Berlin 2000 (first 1997).

in animals. And thirdly, he referred to his experiments as an undisputable proof for illuminating *human* bodily functions.

Albrecht von Haller's experimental physiology

Haller received his medical training first in Tübingen, then in Leyden under Herman Boerhaave (1668–1738) where he graduated in 1727. In 1736 he was appointed Professor of Anatomy, Botany, and Surgery at the newly founded University of Göttingen. Between 1739 and 1744, he published Boerhaave's lectures with critical commentaries which some see as a departure from his teacher's mechanical thought. However, Leyden was the only medical school at the time that followed an uninterrupted tradition of animal experimentation, with anatomist Jan Swammerdam (1637–1680) and Boerhaave at the height of this tradition.¹¹ Haller was certainly influenced by this tradition as his own experimental research in Göttingen testified. Apart from a physiological textbook published in 1747,¹² the eight volumes of his opus magnum *Elementa physiologiae* (1757–1766)¹³ also reveal his main interest: the physiology of the human body. In Göttingen, he found ideal conditions to pursue this interest, most notably exemplified by the experimental queries that led to his orations *De partibus corporis humani sensilibus et irritabilibus* (1752).¹⁴ As Mary A. Brazier rightly stated, the years Haller spent in Göttingen certainly marked “the experimental part of his career,”¹⁵ though the European controversy that ensued after the publication of *De partibus* sparked a more thorough account of his experiments in the later published *Memoirs sur la Nature Sensible et Irritable des Parties du Corps Animal* (4 vols., 1756–1760).¹⁶ That there was a European controversy already indicates that Haller did not do his research in isolation. Haller was a member of several European academies and elected president of the Göttingen Royal Academy of

11 See Steinke (2005) [see note 5], p. 39.

12 von Haller, Albrecht: *Primae Lineae Physiologiae in Usum Praelectionum Academicarum*. Göttingen 1747.

13 von Haller, Albrecht: *Elementa Physiologiae Corporis Humani*, 8 vols. Lausanne, Bern 1757–1766.

14 As the English translation is sometimes inadequate, if not otherwise stated I use my own translation based on the contemporary German edition: *Untersuchung der empfindlichen und reizbaren Theile des menschlichen Körpers von Albrecht von Haller*. In: *Der Königl. Schwedischen Akademie der Wissenschaften neue Abhandlungen aus der Naturlehre, Haushaltungskunst und Mechanik* 15 (1756), 14–39.

15 Brazier, Mary A.: *A History of Neurophysiology in the 17th and 18th Centuries*. New York 1984, p. 118.

16 von Haller, Albrecht: *Memoires sur la Nature Sensible et Irritable des Parties du Corps Animal*. 4 vols. Lausanne 1756–1760.

Sciences. As a true eighteenth-century universal scholar, he upheld a vast correspondence with scientists all over Europe.¹⁷ Because of this extensive European network in which he developed, tested and critically evaluated his and his contemporaries' ideas about bodily functions, Haller is an important representative of Enlightenment knowledge about human and animal nervous functions.

How did Haller view the method of experimentation as part of a physiological investigation? In his foreword to the *Elementa Physiologiae*, Haller maintained that the 'Art of Dissection' is the only means to understand the physiology of the body properly, lamenting at the same time the separation of physiology from anatomy.¹⁸ Those that restricted themselves to dissecting the dead bodies of humans, he argued, would never know or fully understand bodily functions such as the circulation of the blood. To them, the complete physiology of the body would always remain a mystery.¹⁹ At no point in his *Elementa* did Haller infer a complete analogy of human and animal bodies as an underlying logic for the recourse to animal experimentation. He argued rather cautiously and long-winding that a thorough knowledge of the function of animated bodies needed to be established in animals as well, such as in "four-footed beasts, birds, fish, and even insects"²⁰ which seems to mirror the hierarchical classification in Linnaeus' *Systema naturae* (1735). As the dissection of dead animals was not sufficient for elucidating function, one had to 'open up' the living ones. His emphasis on the need to 'sacrifice' the lives of many animals seems to display an in-built defence against moral accusations, as he speaks of it as "a cruelty that has so far brought more advance to the true and established physiology than all the other arts that are part of our science."²¹ Here, one could argue, it happened for the first time that the dominance of animal experimentation over anatomical dissections was explicitly stated. Such statements are generally deemed important only within the context of nineteenth-century physiology that became entirely associated with the investigation of function via experimentation whereas anatomy continued to be referred to as the 'art' of dissecting dead bodies for elucidating structure. Andrew Cunningham, for instance, sees in Haller an exemplar of the 'old art of anatomy' and places him in contrast to the French School of experimental physiology that

17 See Stuber, Martin; Hächler, Stefan; Lienhard, Luc (eds.): *Hallers Netz. Ein europäischer Gelehrtenbriefwechsel zur Zeit der Aufklärung*. Basel 2005. Concerning the European controversy on irritability and sensibility, Haller's main research project, see the table showing the wide-ranging correspondence that Haller was engaged in at the time, in Steinke (2005) [see note 5], p. 129.

18 Haller (1757) [see note 13], vol. 1, preface, pp. 1-2.

19 *Ibid.*, p. 2.

20 *Ibid.*, p. 3.

21 *Ibid.*, pp. 3-4.

came into being at about 1800.²² He claims that Haller exclusively referred to himself as ‘anatomist’ but seems to have overlooked Haller’s own linkage between physiology and the practice of experiment.²³ Even though Haller did not institute a continuous experimental tradition, mainly due to his departure from Göttingen in 1753 and premature death of some of his pupils,²⁴ the experimental methodology of the later French physiologists closely mirrors that of Haller. Recent trends in the history of experimentation therefore suggest a new timeframe for incorporating early modern anatomists *and* physiologists for their systematic use of the practice.²⁵ The potential for establishing an experimental tradition lies also in Haller’s early emphasis on a frequent repetition of trials and elimination of variables to ensure the description of unchanging phenomena as ‘nature herself has produced them’.²⁶ This, again, is an essential feature of ‘laboratory practice’ as normally associated with later physiologists, such as François Magendie (1783–1855) and Claude Bernard (1813–1878). The way that experiments were conducted on the nerves in later investigations, especially with regard to sensibility, remained altogether remarkably similar to Haller’s experimental trials.²⁷

In Haller’s research on sensibility, the meaning of the concept and its relation to the body, as well as the analogy between humans and animals was, for the first time, negotiated and enacted in a systematic manner. In noting that the phenomena of sensibility and irritability had been known prior to Haller’s investigation, Owsei Temkin observed that “the significance of Haller’s contribution lies in the method by which he approached the subject.”²⁸ However, viewed in its specific historical context, one could say that Haller’s experimental method captured nothing more than an eighteenth-century understanding of what sensibility ought to be and possibly look like in non-human subjects while experimentally investigating the function of nerves. Furthermore, as Haller’s preconceived notions of ‘sensibility’ inhabited a realm beyond the physical, it remained a concept

22 See Cunningham, Andrew: *The Pen and the Sword: Recovering the Disciplinary Identity of Physiology and Anatomy before 1800 - I: Old Physiology – the Pen*. *Studies in History and Philosophy of Biological and Biomedical Sciences* 33 (2002), 631-665.

23 See also Steinke on Cunningham; Steinke (2005) [see note 5], pp. 75-77.

24 *Ibid.*, p. 58.

25 See, for instance, Buscaglia, Marino: *The History of the Experimental Method in the Life Sciences as an Illustration of Versatility in Interpretation*. In: Montangero, Jacques et al. (eds.): *Conceptions of Change over Time*. Genève 1993, 45-64.

26 Haller (1757) [see note 13], vol. 1, p. 12. Haller himself stated that the ‘experimental law’ of repetition had been introduced by the Italian anatomist Giovanni Battista Morgagni (1682–1771); see also Maehle (1992) [see note 7], p. 54.

27 See for instance Magendie, François: *Leçons sur les Fonctions et les Maladies du Système Nerveux*. Paris 1839.

28 Temkin, Owsei (ed.): *A Dissertation on the Sensible and Irritable Parts of Animals by Albrecht von Haller* (London, 1755). Baltimore 1936, p. 1.

that could not be fully grasped within a strict scientific framework of reference in which observable phenomena could ideally be measured, classified and reproduced. Physiologists of a century later were, for instance, still struggling to overcome the need of accommodating the mental aspects of sensation and motion within specific functional concepts, such as in Marshall Hall's reflex theory.²⁹ The use of animal models played a large role in this struggle as the association of sensation with 'mind', or soul in Haller's time, necessarily limited animal experiments to the study of external bodily signs. Before turning to Haller's experiments on sensibility, the various debates surrounding the meaning of sensation, its link to the soul and its implication for the conception of the human-animal boundary in the eighteenth century shall be discussed.

The doctrine of sensation

"Whereas in 1700 life was equated to motion, with heart and muscle as its organs, in 1800 life was envisaged as sensibility, a quality inherent in the nerve and the nervous system."³⁰ Haller represents or might have even induced this eighteenth-century shift from motion to sensation as the most fundamental property of living bodies, although he was certainly not the first to show an interest in sensation. Among the debates prior to Haller's experimental enterprise on the nervous system and the brain, sensationalism, a theory about the mental reception of bodily sensation, provided a theoretical foundation for the link between mind and bodily feeling. John Locke (1632–1704), in his *Essay Concerning Human Understanding* (1689), was among the first to perceive sensations as mechanical interactions of the nervous system with external objects, which was amplified by David Hartley's (1705–1757) *Observations on Man* (1749) who explicitly linked mental perception with the 'vibrations' of nerves; a somewhat materialist psychology which was certainly influenced by anatomical and physiological investigations.³¹ The theory of sensation, which gathered increasing support

29 See Leys, Ruth: *From Sympathy to Reflex. Marshall Hall and his Opponents*. New York, London 1990.

30 Steinke (2005) [see note 5], p. 20

31 In particular those by the physician and anatomist Thomas Willis (1621–1675) who was also Locke's medical teacher at Oxford. The main works of Willis on the subject are *Cerebri anatome: cui accessit nervorum descriptio et usus* (1664) and *De anima brutorum quae hominis vitalis ac sensitive est, exercitationes duae* (1672); see Hughes, J. Trevor: *Thomas Willis, 1621–1675: His Life and Work*. London, New York 1991. For Hartley's doctrine of nerve vibrations, see Glassman, Robert B.; Buckingham, Hugh W.: *David Hartley's Neural Vibrations and Psychological Associations*. In: Whitaker, Harry et al. (eds.): *Brain, Mind and Medicine. Essays in Eighteenth Century Neuroscience*. New York 2007, 177-190.

from empirical studies of naturalists during the eighteenth century is interesting for yet another reason:³² although Locke upheld the belief that there was a large gap between human and animal reason, by maintaining that the human mind draws on the same resources available to the animal – the nervous system – sensationalism implied that every living being in possession of nerve and brain tissue must have some sort of mental faculties.³³ One obstacle to the immediate acceptance of this aspect of the sensationalist doctrine in physiology was the unresolved question of the ‘soul’ which was still assumed to play a major role in the workings of the nervous system. Since the possession of a soul continued to be denied to non-human species, it remained difficult to assert experimentally how exactly the nervous system functioned as a mediator between body and soul/mind (see p. 14f.). Attempts to assign a ‘mind’ to animals only created further sources of confusion, although these discussions would eventually form the basis for the concept of instinct.³⁴ Different conceptions of ‘mind’ in animals included, for instance, neo-Aristotelian theories which maintained that animals were endowed with intelligence, but of a kind inferior to human reason; their (non-unified) bodily ‘souls’ could manipulate sensory images, but not abstract ideas or thoughts. Animal movements were explained as patterns of behaviour directed by innate images and designed for the species’ welfare. Another conception was the mechanist notion that denied animals any cognitive faculties and considered the action of animals to be the immediate result of neural or cerebral organisation. Animal behaviour was thus thought to consist of mere mechanical responses that were determined by pre-established and therefore fixed nerve connections. Sensationalist theory, on the other hand, implied no difference between human and animal reason, at least on a theoretical level, for both were thought to be guided by images derived from sense experience. Evolutionists in the first half of the nineteenth century eventually merged mechanist and sensationalist notions by arguing that animals rationally developed new habits, which through generations of practice gradually became innately determined and mechanically fixed instincts.³⁵

The sensationalist approach to the question of the soul provides an interesting transitional conceptualisation of the human-animal continuity because the mean-

32 The most prominent among these were David Hume (1711–1776), Étienne Bonnot de Condillac (1715–1780) and Erasmus Darwin (1731–1802); see here especially Richards, Robert J.: *Instinct and Intelligence in British Natural Theology: Some Contributions to Darwin’s Theory of the Evolution of Behavior*. *Journal of the History of Biology* 14 (2) (1981), 193-230, n. 27.

33 See also Richards, Robert J.: *Influence of Sensationalist Tradition on Early Theories of the Evolution of Behavior*. *Journal of the History of Ideas* 40 (1) (1979), 85-105.

34 *Ibid.*

35 *Ibid.*, pp. 200-201.

ing of ‘soul’ was here mainly equated with properties of the ‘mind’ as based on sensory experience alone. The intensified experimental approach to the question of sensibility as inaugurated by Haller also appears to have signified a gradual shift towards the redefinition of sensation as an exclusive corporeal phenomenon. However, since the metaphysical concept of ‘soul’ continued to be negotiated within physiological experiments, it could not be settled whether ‘sensation’ involved an intervention of the soul/mind or was an exclusive property of nerve tissue. Haller serves as a good example for the mutual influence of these dominant doctrines, i.e. the doctrine of the soul vs. the doctrine of the nerves, within physiological and metaphysical debates alike.³⁶

What, then, was Haller’s understanding of sensation? The tenth and the twelfth book of his *Elementa* elaborate on ‘sensibility’ (vol. 4 § 1 *Sensus quid sit*) and ‘feeling in general’ (vol. 5 §1 *Tactus in universum*). He acknowledged right from the beginning the twofold meanings attached to the term ‘feeling’, i.e. its relation to the external sense of touch and the inner perception of it. Feeling as ‘sensibility’ is, on the one hand, described in terms of its structural location, which is conceived in the medullar part of the nerves originating in the brain. The function of sensibility is to alert the body to the intensity and quality of a physical contact with another object. Its purpose is obviously to safeguard the body from physical harm, and sensibility as a functional entity was in this sense already deemed synonymous with pain – the unit of measurement used in Haller’s animal experiments. Feeling, as described in the *Elementa*, is ‘a business of the nerves’,³⁷ with sensibility being closely related to the sense of touch. A whole paragraph is devoted to the skin as the surface of the body that receives the first sensual impression of any contact with external objects which in turn brings about changes in the body – but also in the soul. And it is at this point that the gap induced by experimental inquiries becomes obvious: the theoretical musings about the conscious impression of sense experience in humans, which were altogether vague and inconsistent, remained detached from the more detailed descriptions of bodily changes in the animal during experimentation.

Haller’s experimental investigation of sensibility

The changes that the title of *De Partibus Sensilibus et Irritabilibus Corporis Humani* (1752) received in the translated editions already implicate Haller’s in-

36 For an overview of the concept of soul and its link to the nerves, see Ingensiep, Hans Werner: *Seelenordnungen und Neurozentrik. Auf den Spuren der Seelenlehren in der Antike, der frühen Neuzeit und der Gegenwart*. In: Kindermann, Ute; Hattenbach, Almuth: *Die Sonderstellung des Gehirns – eine biologische Tatsache?* Gießen 1997, 11-31.

37 Haller (1762) vol. 4, pp. 269-270, and (1763), vol. 5 [see note 13], p. 1.

consistency in referring to human and animal bodies interchangeably in his orations (as well as throughout the *Elementa*). The Latin and the German edition both refer to the human body in its title, whereas in the French translation of 1755 and its English counterpart of the same year, publishers deliberately used the term ‘animal’ instead.³⁸ As will be seen in his discussion and evaluation of experiments and experimental results, Haller continuously switched between human and animal bodies.

A notebook entry from 12 November 1750 marks the actual beginning of Haller’s explicit experimental investigation of irritability vs. sensibility.³⁹ In order to determine the separate function of nerves and muscles, Haller changed the quality of experimentation by administering different stimuli in a more systematic manner and applying irritation with greater care. What he also did was changing the types of animal species. Having mainly used frogs before, from then on he mostly worked on cats and dogs. This is interesting because it suggests his belief that the latter species would display a greater and possibly more human-like variety of bodily responses. In his orations, Haller mentions a total number of 190 animals of various kinds that he experimented upon since 1751 and devoted a short paragraph to his mode of experimenting.⁴⁰ Assuming he must have instantly recognised the alleged nervous property ‘sensibility’ once it was before him, what signs in the animal body did he expect to see?

I exposed the parts in question in living animals of several kinds and of varied age; I waited till the animal had ceased to struggle and complain. I then irritated the exposed part by blowing, heat, spirit of wine, the knife, lapis infernalis, oil of vitriol, and butter of antimony. Then I observed with care whether the animal upon being touched, lacerated, cut, burned, and torn, would loose its calmness and composure; whether it would throw itself from side to side, pull the limb towards it and whether its wound was twitching, or the limb twitched convulsively - or if nothing of the sort would happen.⁴¹

In elucidating which body parts were sensible and to what degree, Haller had to be able to read and interpret the behaviour of different types of animals to whom different painful stimuli were administered. Haller’s mode of stimulating as well as his choice of stimuli suggest that prior to his experimental investigations he must have had a more or less clear understanding of the kind of physical responses that could be expected. The quote reinforces the notion that sensibility is taken for pain or rather the bodily signs that are associated with it. The fact that pain

38 See Steinke (2005) [see note 5], p. 144.

39 Ibid., p. 60.

40 Haller (1756) [see note 14], p. 15. Maehle mentions in his book an over-all estimation of 560 animals that Haller experimented upon while investigating irritability and sensibility; see Maehle (1992) [see note 7].

41 Haller (1756) [see note 14], p. 18.

was the unit of measurement with which the degree of sensibility was assessed implies furthermore that Haller needed to look beyond the nerve or body part under investigation. It was not the visible reaction of the *nerve* that Haller described in his experiments but the animal body as a whole that needed to be scrutinized for any possible sign of sensibility/pain that manifested itself. By 1751, Haller had experimented on a great number of animals, so the common reactions to pain must have been familiar to him. To determine the *degree* of sensibility, however, was yet another matter. The rough-hewn means of irritation that brought about equally coarse reactions in the experimental subject left no room for fine-tuned differentiations of the various grades of sensation. In the end it was either the presence or the absence of an animal's reaction to a stimulus that gave evidence of sensibility. Thus, when Haller spoke of using the greater sensitivity of the skin as a constant in 'measuring' sensation, he appears to have used it solely as a means to rule out the possibility of weakened or deadened sensual perception as an acquired artefact during the experiment:

Among the parts of the human body, the skin is sensitive to a very strong degree: for one can irritate it wherever one wants, the animal moans, is shaking itself and gives all the signs of pain of which it is capable. The skin has therefore served me as a measure of testing sensibility: and when the animal stays calm while irritating a specific part but shows signs of pain when the adjacent skin is irritated, I conclude that the respective part must be of lesser sensibility.⁴²

It is in this context interesting that Haller mentions the great sensitivity of the human skin but switches to a description of bodily responses of animals to underline his argument. The way he described the animal's behaviour also implies that Haller was seeking reactions that were similar to those of a human being in pain. Although the whole experimental enterprise was conducted to shed light on human sensual experience, it is often not clear whether Haller speaks of human or animal bodies in his writings. However, his actual definition of sensibility in his orations is given in terms of a slight but fundamental difference between human and animal sense perception:

I call that a sensible part of the human body which, on being touched, transmits to the soul the impressions of this contact; in animals, about whose soul we have no understanding, I call those parts sensible that, on being irritated, bring about obvious signs of pain and indisposition. On the contrary, I call that insensible, which being burnt, torn, pricked, or cut till it is quite destroyed, occasions no sign of pain nor convulsion, nor any sort of change in the situation of the body. For it is very well known, that an animal, when it is in pain, endeavours to remove the part that suffers from the cause that hurts it; it pulls back the leg if it is hurt, shakes the skin if it is pricked, and gives other evident signs by which we know that it suffers.⁴³

42 Ibid., p. 19.

43 Ibid., pp. 16-17.

It is interesting to see how he endeavoured to put a slight emphasis on the difference of animal and human conceptions of sensibility/pain, although to him at least the physical response to pain showed no difference. But sensibility in humans is described in terms of the soul which in this context is equated to the conscious perception of touch. Human sensibility is altogether captured in only one sentence and relates at the same time to the second meaning or trait of ‘feeling’ – consciousness. As this aspect of feeling could not be established in his experimental subjects, Haller elaborates in much greater length and detail on the *bodily* changes occurring in the animal. Thus, his definition of corporeal sensibility within an experimental context appears to be more straightforward, since the material reality of the (animal) body under investigation made him focus on reactions that could actually be observed and described.

Steinke observes that in Haller’s writings, irritability and sensibility as concepts could both be described from three different angles, that is, they were either “represented as a specific visible reaction, as a functional entity, or as a property of a specific structure.”⁴⁴ Although for Haller, pain was apparently only one particular mode of sensation, “in order to make this functional entity coincide with an observable reaction, he had to restrict it to the feeling of pain.”⁴⁵ This makes sense as only a painful stimulus would bring about an observable reaction in the first place. It is at this level that sensibility is represented as a specific ‘visible reaction’ which raises once more the question what preconceived notions Haller had regarding the kind of reactions his experimental, i.e. non-human, subjects would and should ideally display.

With irritability, one can presume that Haller had no difficulties in stating the obvious. In observing and describing the contraction of an irritated muscle – which, due to its assumed lack of sensibility, would produce no other changes in the body – an experimenter did not necessarily need a particular framework of reference for defining motion.⁴⁶ Describing sensibility in terms of ‘visible reaction’, however, required a different mode of ‘reading’ and interpreting the various responses of his experimental animals. On a theoretical level, Haller’s understanding of sensibility testifies to the short-comings of using animals for his investigations since the concept of sensation was still inextricably linked to the ‘soul’ or the ‘mind’. However, Haller’s experimental or rather behavioural criterion for sensibility – the feeling of pain – rested on the inference that external signs of unrest in animals were caused by the same mental states which

44 Steinke (2005) [see note 5], p. 102.

45 Ibid., and p. 63.

46 In contrast to the concept itself: see Hans-Jürgen Möller’s analysis of the different and changeable meanings of irritability, in: Die Begriffe „Reizbarkeit“ und „Reiz“: Konstanz und Wandel ihres Bedeutungsgehaltes sowie die Problematik ihrer exakten Definition. Stuttgart 1975.

caused corresponding movements in humans. Although Haller never openly affirmed an analogy of human and animal minds, his insistence on the conscious perception of sensation left no other conjecture. Thus, in assessing sensibility, an analogy to the human experience of pain was necessary to ascertain not only the physiological but also the psychic functions in animals. Yet, the crux of using animal models was precisely that doubts would always remain regarding a positive knowledge of the existence or non-existence of a soul (i.e. psychic functions) in animals. Functions such as sensation, which were deemed at least partly psychic, could only be assessed by closely observing *external* bodily actions and behaviour. As it was, only humans could positively confirm the existence and degree of sensation by an introspective examination and articulation of their own consciousness. Robert M. Young accordingly notes in his article on ‘Animal Soul’ (1967) that within the framework of Cartesian dualism, the interpretation of animal mind continued to depend on an “inescapable anthropomorphism.”⁴⁷ The debates over Haller’s physiological concept of sensibility are thus especially interesting for their implications regarding the animal mind. The impossibility of extracting full knowledge about certain nervous functions from animals testified to the limits of the experimental method, but also left room for contemporary speculations and discourses on the animal soul, the animal mind, and an equation of feeling in humans and animals.

The soul and sensibility

As we have seen in Haller’s research on sensibility, within physiology the soul still loomed large as a conceptional device for interpreting the outcome of experimental results with regard to the human body. The Cartesian division of mind and body together with the notorious concept of the *beast-machine* prompted philosophical contemplations on souls in general and animal souls in particular throughout the eighteenth century.⁴⁸ In these debates, the human soul was mainly referred to as the rational soul, though non-Cartesians continued to invoke the Aristotelian notion of a sensitive, i.e. bodily, soul shared by humans and animals

47 Young, Robert M.: Animal Soul. In: Edwards, Paul (ed.): Encyclopedia of Philosophy (1967), 122-127, p. 125.

48 See Maehle (1992) [see note 7]; and: Cruelty and Kindness to the ‘Brute Creation’: Stability and change in the ethics of the man-animal relationship, 1600–1850. In: Manning, Aubrey; Serpell, James (eds.): Animals and Human Society. Changing Perspectives. London, New York 1994, 81-105, pp. 87-89.

alike.⁴⁹ Impressions on the soul, i.e. conscious perceptions, were also increasingly linked to the functions of nerves and brain, which, because of the structural analogy of human and animal nervous systems, provided the actual foundation for debates on animal souls.⁵⁰ However, because of the many connotations of the term ‘soul’, which altogether encapsulated notions of immortality, consciousness, emotion, and intellectual functions, its definition, like the human-animal boundary, necessarily had to remain flexible. Hans-Werner Ingensiep’s investigation of the changing conceptions of the animal soul within philosophy convincingly establishes that from around 1700 onwards the soul becomes, in his terms, a field of projection for the prevailing concepts of human nature.⁵¹ His timeframe overlaps with the shift from motion to sensation as the principle of life, the growing interest in the nervous system, and the rising use of animal models within physiological investigations. It is therefore no coincidence that Ingensiep interprets the disputed notions of the animal soul as the first ‘biological’ controversy of the modern period, considering that the concept of ‘soul’ and its synonyms were heavily negotiated within the life sciences.⁵²

How did Haller himself conceptualise the influence of the soul on bodily functions in his writings? Next to his account of the external senses, book seventeen of the *Elementa* (Bd. 6) deals with the internal senses and it is here that Haller gave an, albeit short, insight to his conception of the mind. In the very first sentence he admitted that the subject was full of speculations and hypotheses.⁵³ As in many of his theoretical musings, he remained vague and unspecific but believed that greater knowledge about the soul could be achieved once opportu-

49 As, for instance, in the ‘sentient principle’ of the Edinburgh physiologist Robert Whytt (1714–1766); see French, Roger K.: *Robert Whytt, the Soul, and Medicine*. London 1969.

50 See, for instance, Winkler, Johann Heinrich: *Die verschiedenen Meynungen einiger Weltweisen von der Existenz der Seelen der Thiere, in einer Gesellschaft guter Freunde untersucht*. Leipzig 1741–1745.

51 Ingensiep, Hans Werner: *Tierseele und tierethische Argumentationen in der deutschen philosophischen Literatur des 18. Jahrhunderts*. NTM N.S. 4 (2) (1996), 103–118, p. 117. Though Ingensiep looks mainly at German debates, he argues convincingly that within a European context the lines of thought were remarkably similar, not least because of a mutual exchange of thoughts and theories among philosophers and physiologists of various countries.

52 Andrew Cunningham claims that from 1800 onwards the ‘soul’ was altogether rejected in any form from the discussions. See: *The Pen and the Sword: Recovering the Disciplinary Identity of Physiology and Anatomy before 1800*, II. *Old Anatomy – the Sword*. *Studies in History and Philosophy of Biological and Biomedical Sciences* 34 (2003), 51–76, p. 58; whereas Ingensiep asserts that by the beginning of the nineteenth century, a fundamental discourse on whether animals *did* have a soul did no longer take place mainly because it was taken for granted that animals *did* have a soul; see Ingensiep, Hans Werner: *Zur Lage der Tierseele und Tierethik im Deutschland des 19. Jahrhunderts*. In: Niewoehner, Friedrich (ed.): *Die Seele der Tiere*. Wiesbaden 2001, 283–331, p. 285.

53 Haller (1763) [see note 13], vol. 5, p. 529.

nities were more often seized to posthumously dissect humans who had suffered from a mental disorder or had lost their memory. Significantly, the second-best method for Haller was to compare the brains of animals and humans. As Haller kept switching between matters of the body (brain) and workings of the mind (soul), it is never quite certain to which one he refers in a specific context. But if we take his last statement as a claim that comparative physiology could elucidate the human mind, then one could argue that Haller indirectly expressed his belief in the existence of an animal mind that was, at least in terms of structure and function, fundamentally similar to those of humans. With his notion of irritability as a sole property of muscles, he had in effect already removed one of the fundamental properties of living bodies, motion, from the exclusive realm of the human will and mind.⁵⁴ It was, however, unthinkable to him and his contemporaries that *feeling* would be triggered by chemical or mechanical changes in the nerves and brain only. Although the transmission of sensation through the nerves to the brain was described by him in terms of a mechanical action, the phenomenon of sensation as such was still tightly knotted to relevant impressions received by the soul. Feeling for him was first and foremost a conscious process. Haller never tried to offer an explanation of how the conscious processing of touch or pain worked and openly acknowledged this to be out of his, the physiologist's, command. But his insistence on the intervention of the soul in vital phenomena, which could not be explained in terms of physical laws, ensured that the prevailing metaphysical connotations of soul and mind upheld the gap between the species more so than the scientific-mechanistic notion of the 'mind' as seated in the brain alone would have done. Theoretically, the latter contention reduced the species' gap considerably by equating a similarity of brain structure with a similitude of mental faculties. This was even implicated in David Hartley's *Observations on Man* (1749) and later in Franz Joseph Gall's (1758–1828) and Johann Caspar Spurzheim's (1776–1832) organology at the end of the century. Such notions, however, prevailed for only a short time and were not fully accepted until their revival in modern neuroscience.⁵⁵ In Haller's time, various

54 See, for instance, Haller's comments on the heartbeat in his *Elementa* (1757) [see note 13], vol. 1, §11 *Anima non habitat in corde*, p. 485.

55 Haller had in fact criticized Hartley for his too mechanical outlook on the soul; see Hochdoerfer, Margarete: *The Conflict between the Religious and the Scientific Views of Albrecht von Haller (1708–1777)*. Nebraska 1932, p. 28. For a discussion of Gall's phrenology theory and contemporary debates see Michael Hagner (2000) [see note 10], pp. 89–124; and Richardson, Alan: *British Romanticism and the Science of the Mind*. Cambridge 2001, pp. 20–22.

theories discussed the link between nerves, sensibility and the soul – all of them having different implications for the human-animal analogy.⁵⁶

The German physician Johann August Unzer (1727–1799), for instance, offered an interesting solution to Haller's inconsistency regarding the definition of sensibility. His treatise *Grundriß eines Lehrgebäudes von der Sinnlichkeit der thierischen Körper* (1768)⁵⁷ maintained Haller's separation of irritability as a property of (muscle) fibre and sensibility (*Empfindlichkeit*) as a property of nerves. But whereas Haller insisted on a link between sensibility and impressions received by the soul, Unzer distinguished between external and internal sensual impressions as two different forms of nervous power (*Nervenkraft*); the one being a sole property of the nerves (body), the other being perceived by the soul. He referred to both impressions as 'feeling' (*Gefühl*) but linked the reception of external sense experiences to the *Sensorium*, the material 'switch organ' (*Umschaltungsorgan*) of impressions received by the external senses. Sensitivity (*Sinnlichkeit*) was in this sense simply conceived as a property of the nerves, the brain and the spinal cord (which he termed *Sensorii*). In this understanding, the feeling of animals was described as a specific condition of the nerves after an (external) impression had been made on them. One could argue that the analogy question could and would have been easily dissolved by this careful separation of sensibility (*Gefühl der Nerven*) and sensitivity (*Empfindung der Seele*),⁵⁸ since the question of whether animals have souls or not would have become irrelevant. But Unzer's proposition did not replace Haller's theorem and the debate over the involvement of consciousness/ the soul in nervous functions remained unresolved and continued well into the nineteenth-century.⁵⁹

All in all, once the physiological analogy between humans and animals could no longer be denied, debates about the human-animal interrelatedness continued to be centred on the possible existence of a 'soul' in animals, debates that were triggered or at least intensified by a rising preoccupation with the nervous sys-

56 For instance, those of the afore-mentioned Edinburgh physiologist Robert Whytt (1714–1766) and the French physician Théophile Bordeu (1722–1776), both of whom had different conceptions of sensibility and criticized Haller for his mechanist view; see French (1969) [see note 49]; and Haigh, Elizabeth L.: Vitalism, the Soul, and Sensibility: The Physiology of Théophile Bordeu. *Journal of the History of Medicine and Allied Sciences* 31 (11) (1976), pp. 30-41.

57 Unzer, Johann August: *Grundgebäude von der Sinnlichkeit der thierischen Körper*. [Nebst einem Vorberichte wegen der auf Subscription zu druckenden neuen Auflage der medicinischen Wochenschrift]. In: Berth, Gotthilf Christian: *Der Arzt*. Lüneburg, Rinteln 1768. Unzer is best known as the founder of the medical journal 'Der Arzt' (1759–1764); see Reiber, Matthias: *Anatomie eines Bestsellers: Johann August Unzers Wochenschrift „Der Arzt“*. Göttingen 1999.

58 Unzer (1768) [see note 57], p. 7.

59 See Richardson (2001) [see note 55].

tem in physiology. The term ‘soul’, however, seems to have had the function of a carrier of various notions of what constitutes specific human attributes. It was, moreover, increasingly used interchangeably with ‘mind’, ‘reason’, ‘intellect’ and ‘emotion’ – the vagueness of the terms already suggesting that a clear-cut definition of ‘soul’ or even ‘mind’ was missing altogether. In general one could say that references to the soul or mind provided not only a field of projection for human attributes but also served as markers of species difference. The inability of defining such immaterial entities thus constituted one of the main reasons for ongoing debates about the human-animal analogy: if there was no mutual understanding or consent about what actually constitutes the ‘human’, an understanding of species difference was likewise difficult to obtain.

Conclusions

Haller’s systematic experimental approach to the nervous system not only raised an awareness of the importance of experiments to verify hypotheses, it also stressed the necessity of using animals as models for the human body. On a corporeal level, Haller associated sensibility with the transmission of sensations through the nerves but – influenced by sensationalism – also with their reception in the brain. This conception of life forces, together with the experimental approach to the material and metaphysical concepts related to the nervous system, also indirectly changed the conception of the human-animal boundary. As Roselyne Rey aptly stated, the major conclusion drawn by Enlightenment physiology was “that everything that lives and feels is capable of suffering.”⁶⁰ Haller’s experiments exemplify this insight more than any theoretical hypotheses about mechanistic or vitalistic workings of the body, as much as he was influenced by these frameworks of thought. It is no coincidence that Haller cannot be classed among either the mechanists or the vitalists. His position is at best ambivalent. Steinke maintains that “[i]f we have to locate Haller’s physiology within eighteenth-century medical systems, it is probably best seen as a non-reductionist mechanism,”⁶¹ a kind of intermediate position between vitalist and mechanist notions of life forces. However, Haller’s experiments show that regarding the human-animal analogy, he maintained a dualism of body and mind. Operating with different levels of sensual experience (bodily vs. mental) was the only way that allowed for a similarity between human and animal bodies,

60 Rey, Roselyne: *The History of Pain*. Paris 1993, p. 122.

61 Steinke (2005) [see note 5], p. 114. Anita Guerrini, on the other hand, maintains that Haller was “philosophically a vitalist”; in Guerrini (2003) [see note 3], p. 63.

but also helped to maintain a difference regarding the mind. In this he seemed to follow his teacher Boerhaave, who is otherwise considered “the most prestigious eighteenth-century spokesman” of mechanism in anatomy and medicine.⁶² Yet, Haller’s experimental approach to the question of sensibility required at the same time the animal’s full consciousness during the experiment which, again, raises the question how Haller (and other experimentalists) ‘read’ the signs of the animal body in order to determine an animal brain’s reception of sensation – especially since the phenomenon of sensibility was at that point still associated with sentience in the sense of ‘knowing’ and ‘feeling’. As we have seen, in order to evaluate a nerve’s sensibility, Haller measured the degree of pain as manifested by the animal to assess the degree of sensibility. The analogy to humans was not necessarily presupposed but mainly drawn after the experiment, that is, since the animal’s reactions to a painful stimulus were read by Haller as similar to human responses to pain, their nervous system was assumed to be of a similar design. Thus, despite the metaphysical difference between the species, the conclusion was drawn that the bodies of humans and animals had the same elementary configuration – including a similarity of nervous processes such as pain.⁶³ Haller was nevertheless aware of the difficulty that arose by simply transferring to the human physique the observations made on the animal body. The current belief in the soul mediating between body and mind, and possibly his personal religious background, were partly responsible for his unease.

Haller’s experimental approach altogether encapsulates two main dilemmas within comparative (animal-to-human) research on the nervous system. Firstly, his acknowledgment of the human ‘soul’ being the medium for transmitting pain raises the aforementioned transferability problem: if the animal was denied this marker of ‘humanity’, then the experimental results observed on the animal body were not adequate to describe human ‘sensibility’. Secondly, even if animals had been assigned a soul, something as immaterial as the soul or the mind could not be directly observed or experimented upon. Thus it happens that experimental research on the physical side of pain altogether amounted to “substantial evidence that pain was mediated by specific nerve endings and pathways. [...] But it also led to a minimization [or rather neglect] of the importance of emotion in pain perception.”⁶⁴ The latter may also be resulting from the fact that the articula-

62 Haigh (1976) [see note 56], p. 30.

63 See Steinke [see note 5], p. 145.

64 Hodgkiss, Andrew: *From Lesions to Metaphor: Chronic Pain in British, French and German Medical Writings, 1800–1914*. Amsterdam, Atlanta 2000, p. 7.

tion of 'emotion' could of course not be provided by the experimental, i.e. non-human, subject.

The same difficulty was encountered within the specific context of research on the brain which reached a climax in the first half of the nineteenth century. The development of neurophysiology as a discipline was altogether accompanied by fierce debates about the role of the 'sentient' brain, the mind-body interaction, and negotiations of the specific criteria that constituted the human.⁶⁵ As mentioned above, similar to the theory of sensationalism, F. J. Gall's mechanistic approach to 'the science of the mind' invoked the contention that due to the similarity of brain structure, animal minds possibly differed from those of humans only in degree not in kind. With intensified comparative research on the brain and nervous system, a gradation of cerebral organisation became in fact the new demarcation criteria for a human-animal division, though this notion was not fully articulated before the late nineteenth century. Although phrenology itself was soon considered outdated in public, Gall's neuroscientific principles were taken up by succeeding experimentalists, who declared human intellect to be simply the result of brain action.⁶⁶ As with the consciousness of sensation, it is difficult to assert how this proposition was to be established experimentally since 'intellect' (like the rational soul) was and is still believed to be exclusively human. The scientific mode of research as based on observation and experiment within the life sciences generally reached a limit whenever scientists attempted to find a material basis of metaphysical concepts. It could be argued that the inability of defining immaterial entities related to the mind such as reason, intellect or emotion also constituted one of the main reasons for ongoing debates about the human-animal analogy. As mentioned above, if there was no mutual understanding or consent about what actually constitutes the 'human', an understanding of species difference or affinity was likewise difficult to obtain. Thus, the traditional association of the (human) mind with the brain could not but set limits to the experimental method as such, not only because the operations of the mind could not be observed on the organ itself, but also because scientists could not reach consent regarding the unstable categories it intended to investigate. It might be for these reasons that physiology continued to focus on the organic roots or functions of the mind, which would also account for the failed attempt to exceed the analogy of humans and animals beyond the physical borders of the body.

65 See Price, Elfed Huw: *The Emergence of the Doctrine of the 'Sentient Brain' in Britain, 1650–1850*, unpublished PhD thesis, University of Oxford 2005.

66 See Hagner (2000) [see note 10].

In the 1970s, Michael Lynch conducted an ‘ethnography of a neurosciences laboratory’, investigating how laboratory discourses and ritual practices turn the bodies of animals into “bearers of a generalized knowledge” about the human body.⁶⁷ During an experiment, the anatomical and physiological properties of a rat’s brain, for instance, are generalised in such a way that it represents the brains of all mammals, including the human brain. The animal’s body, or body parts, thus become an object of human identification; without this process of transformation, the experimental enterprise would extract no other knowledge than that about the properties of the animal’s own nerve or brain tissue. We have seen that in the eighteenth century an experimental investigation of nerve function likewise turned into a comparative study of human and animal pain. One consequence of this comparative approach that is linked to experimentation is that pain can no longer be classed as a ‘*differentia specifica*’ between humans and animals.⁶⁸ The whole scientific enterprise of Haller and later experimentalists rested on the unspoken assumption that pain is felt as much by animals as it is by humans. The mind-body divide, however, helped to maintain the difference, for it were the bodily mechanisms of pain (including pain behaviour) that were thought equal, but not the mental experience of it. The heated debates about mental abilities in animals can in this context only be understood as a search for further differences, while the life sciences detected more and more (bodily) analogies.

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67 Lynch, Michael: Sacrifice and the Transformation of the Animal Body into a Scientific Object: Laboratory Culture and Ritual Practice in the Neurosciences. *Social Studies of Science* 18 (1988), 265-89, p. 266.

68 See Galert, Thorsten: *Der Schmerz der Tiere: Grundlagenprobleme der Erforschung tierischen Bewußtseins*. Paderborn 2005, p. 16.