



# Thomas Willis: The faculties and his two cognitive frameworks



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## ABSTRACT

Thomas Willis' 1664 study *The anatomy of the brain* is widely regarded as one of the first clinical studies of the brain. In *The anatomy*, Thomas Willis explicitly connected the cognitive faculties and the nerves. Willis' later, 1672 work, *The two discourses concerning the soul of brutes*, severely undermined the materialism of Willis' first study: he affirmed dualism and cognitive immateriality; changed the anatomical locations of cognition; and reasserted a division between the rational and sensitive souls. His exact motive to return to orthodoxy is unclear, but contemporary scholarship of Willis has compounded the confusion with by relying predominantly on *The soul of brutes* instead of *The anatomy*. We trace Willis' career and examine his methodological practices, which help explain the historical practices and pressures. A closer examination of Willis' *Anatomy of the brain* reveals a much more materialistic account of the brain, the faculties, and nervous system. In this article, we present our own analysis of Willis' concept of rationality in the *Anatomy* and explain its importance for nervous physiology and understanding the analytic techniques for first defining faculty localizations. We then explain the role of the imagination and the immortal soul in the rearticulated anatomical concepts from *The soul of brutes*.

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## 1. Introduction

In 1664, Thomas Willis published *The anatomy of the brain*. It is widely regarded as one of the first clinical studies of neurology, and it provides one of the first material accounts of cognition. *The anatomy* went through numerous editions and continued as “the definitive textbook on the subject for about one and half centuries” (Hughes, 1991, p. 91). In *The anatomy*, Thomas Willis explicitly connected the cognitive faculties and the nerves. Willis' later, 1672 work, *The two discourses concerning the soul of brutes*, severely undermined the materialism of Willis' first study: he adopted an immaterial framework for cognition, changed the anatomical location of the imagination, and reasserted a division between the rational and sensitive souls. His exact motive to return to orthodoxy is unclear, but contemporary scholarship of Willis has compounded the confusion with by relying predominantly on *The soul of brutes* instead of *The anatomy*. A closer examination of Willis' *Anatomy of the brain* reveals a much more materialistic account of the brain, the faculties, and nervous system. In this article, we try to explain the variations between Willis' two works and bring to light the unexamined concepts relevant to the history of neurology. We trace Willis' career and

examine his methodological practices, which help explain the historical practices and pressures. We then present our own analysis of Willis' concept of rationality in *The anatomy* and explain its importance for nervous physiology and understanding Willis' techniques for determining faculty localizations. We review the criticisms that caused interpretative errors for understanding the *Anatomy*, the theoretical concepts that have been overlooked, and the role these concepts could contribute to the history of neural pattern recognition, faculty interdependence, and acquired automatic responses.

## 2. Thomas Willis and his collegial circle

In England, Thomas Willis (1621–1675) was one of most famous physicians of his generation. Willis' medical training at Oxford (1643–46) coincided with the English Civil War (1642–1651), a time during which William Harvey (1578–1657) also lived at Oxford (1642–46). Willis received the chair from Gilbert Sheldon (1598–1677), another loyal Royalist fellow, who also used his influence as Archbishop of Canterbury to call Willis to London (Dewhurst, 1964; Dewhurst, 1980). In 1660, at the probable request of John Fell (1625–1686), Willis became Sidleian Professor of Natural Philosophy at Oxford and, soon after, he received the appointment of a doctor of medicine.

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Traditionally, the Sedleian Professorship required lectures upon Aristotle, but Willis' anatomical and physiological empirical investigations replaced Aristotle's natural philosophy. Willis participated in the intellectual activities at Oxford. Willis was part of the larger cultural movement at Oxford that researched the physical without overtly challenging the theological. He was a founding member of the Royal Society of London (1660) and a member of its precursor, The Invisible College (1646–1647). Willis had a close relationship with William Petty (1623–1687), professor of anatomy and political theorist, and they gained renown for the revival of (i.e., resurrection of) Anne Greene. Following the common practice of the seventeenth century, Willis' research into anatomy, and the *Anatomy of the Brain* in particular, was a collaborative effort. A number of individuals deserve credit for the result of the *Anatomy*. Ralph Bathurst (1620–1704) may have helped revise the *Anatomy of the Brain* (Hughes, 1991, 39). Thomas Millington (1628–1704), who succeeded Willis' Professorship and later became President of the Royal College of Physicians, conversed and helped analyze Willis' research. Christopher Wren (1632–1723) participated in the development of procedures to adequately dissect the brain, and he drew many of the illustrations for Willis' text. In like regard, Richard Lower (1631–1691) also illustrated the *Anatomy* and contributed to Willis' research. Other notables in Willis' circle include his apprentice Robert Hooke (1635–1703) who was an assistant to Willis and probably upon his recommendation later worked under Robert Boyle (1627–1691). Then, of course, there was the diligence of John Locke (1632–1704) through whose efforts Willis' lectures come to posterity.

### 2.1. Theoretical and methodological background

Willis' understanding of brain as the definitive foundation for cognition challenged the previous conventions of medical research from Aristoteleanism, chemical atomism, the medical humours of Galen (129–217) and Hippocrates (460–270 BCE), and the still contested Harveian theories. Willis distanced himself from Harvey's theories on the heart and blood in order to justify the preeminence of the brain and nervous system. Before Willis' clinical innovations, seventeenth-century medical training usually involved a basic anatomical knowledge accompanied by the scientific logic of Aristotle (384–322 BCE). The methods of Francis Bacon's (1561–1626) empiricism did not yet play a prominent role in the education of physicians, and medical empiricism, or clinical pathology, did not come to the forefront in research until Willis' theory of aetiology included physiology.<sup>1</sup>

Beyond the methods from the new science, Willis was by no means free from influence. He localized the faculties of the brain that originated in Galen, but he had the more immediate predecessors: Pierre Gassendi (1592–1655), the anti-Cartesian, who used empiricism to explain the foundation of the senses (1658); Paracelsus' (1493–1541) chemical investigations, who challenged the concept of the homeostatic identity of the body by suggesting it constantly undergoes changes; and, William Harvey's theory (1628) of circulation of blood by the heart, which Willis kept to help explain the circulatory system, but it was placed as a subsidiary organ to the brain. The heart, Willis' argued in the *Anatomy*, only aided in the movement of animal spirits throughout the body. In the larger scientific culture, empiricism was aided by the revival of Atomism, which had been aggressively censored in the middle ages.

<sup>1</sup> This was largely to the credit of Willis – physiology provided Willis with a distinctively modern edge over Thomas Sydenham (1624–1689). The latter's medical practises rejected the physiological system in his empirical curatives (Martensen, 2004).

## 3. The faculties

Willis distinguished memory, imagination (i.e., associative thinking), phantasy, and appetite as distinct intellectual faculties,<sup>2</sup> but he also proposed that absolute divisions were a fallacy; each faculty relied on the other to properly function and communicate information/sensation.

### 3.1. The interdependence of memory and imagination

The faculties of imagination and memory complemented and reinforced each other: “For it seems, that the Imagination is a certain undulation or wavering of the animal Spirits, begun more inwardly in the middle of the Brain, and expanded or stretched out from thence on every side towards its [the hemispheres] circumference” (Willis, 1664, p. 58); and the memory was the inverse process, moving from the exterior gyri of the hemispheres to the center of the brain. Imagination coordinated images and ideas throughout the hemispheres, and memories informed the imagination's decisions. The imagination expanded and contracted throughout the crevices (i.e., the sulci) to the exterior parts of the hemispheres.

From the central command centre of the corpus callosum, the imagination summoned information from memory at the exterior of the brain: “the act of Memory consists in the regurgitation or flowing back of the Spirits from the exterior compass of the Brain towards its middle” (Willis, 1664, p. 58). At the beckoning of the imagination, the specific ideas of memory moved inwards to aid in decision-making. The interdependence of the two faculties centered on memory providing the context for the imagination to act; while imagination carried out its responses framed from experience. The content of memory was accessed by animal spirits through the channels of sulci. These habitual pathways informed the imaginative process and provided a predictive framework for experience. More than a simple model of faculty localization, *The anatomy of the brain* sought to explain how the faculties worked together; how cognitive action and experience depended on each other. Imagination and memory relied upon a continual interchange, seepage, and movement of animal spirits – a spiral circuit. These turnings/ movements of thought depended upon the animal spirits, but the animal spirits responded to the imagination, which, in turn, was influenced by memory (the gyri) that it accessed through the “crankling turnings and windings” of the sulci (Willis, 1664).

## 4. Memory and natural memory

Willis had two different faculties of memory: a cerebral memory located in the gyri; and, a natural memory that remembered nervous impressions – a simple version of an automatic, reflex response that functioned at an involuntary level.

### 4.1. The storehouses of memory

Willis' associative physiology linked cognitive patterns with recurrent physiological movement. The habitual pathways of sensation gradually formed specific ideas through repetition, and these ideas were stored in the memory storehouses of the gyri:

<sup>2</sup> During the Enlightenment, the Imagination was not a universally agreed upon term for cognition. If the faculty of Imagination was used as the primary cognitive principle, it indicated a materialist standpoint, reason or understanding designated a dualist philosophy that defined higher, cognitive processes as immaterial. From the larger critical perspective of reconstructing anatomy and deciphering the terminology, some early seventeenth-century materialists used imagination and understanding interchangeably, a lack of distinction that later rival schools of philosophy/physiology carefully delineated.

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