

Articoli/Articles

NERVOUS SYSTEM IN THE FIBRILLAR THEORY OF  
GIORGIO BAGLIVI

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SUMMARY

*NERVOUS SYSTEM IN THE FIBRILLAR THEORY OF  
GIORGIO BAGLIVI*

*The drafts, epistles, headwords, and conceptual basis known as the fibrillar theory of Giorgio Baglivi, published in his book entitled De fibra motrice et morbosa, were analyzed in an attempt to re-evaluate Baglivi's contribution, generally considered quite modest, to the development of scientific thought on the nervous system functions. The analysis revealed Baglivi's identification of the reflex organization, vegetative nervous system function, and neural aspect of the vasomotor function to be surprisingly valuable. I believe that the lucidity and genuine contemporariness of Baglivi's standpoints arise the question of the historical precedence in the discovery of these functions (it is usually attributed to F.X. Bichat for vegetative nervous system, and to Claude Bernard for vasomotor nerves). In the light of these facts, the need of an expert revision of the history of discovering nervous system functions is suggested.*

1. Introduction

The book *De fibra motrice et morbosa* is one of the most important events in the history of biostructuralism, where Baglivi has presented his original theory on fibrillar pathology, a forerunner of Virchow's cellular pathology<sup>1,2</sup>. In this book, Baglivi's considerations of the nervous system function are ridden with his misapprehension of the role of *dura mater*. His theoretical presumptions have been built upon this misapprehension, and wrong conclusions on the role of meninges have blurred his otherwise fragmentary presentation of the nervous system ana-

*Key words:* Fibrillar theory - Vegetative nervous system - Neural vasomotor function - Hematoencephalic barrier.

tomy, function and clinical pathology, so that he has generally been considered a minor author in the historical development of the thought on the nervous system structure and function<sup>3,4,5,6,7,8,9</sup>. The present analysis of the fragments dealing with the nervous system was an attempt to find and identify the possible valuable observations and anticipations in *De fibra motrice et morbosa*, that may have escaped the attention of those studying Baglivi's work.

## 2. Nervous system in *De Fibra Motrice et Morbosa*

Baglivi's engagement in the nervous system, presented in his book *De fibra motrice et morbosa*, can be divided into the scientific experimental section, theoretical considerations on neural anatomy and physiology, and clinical neurologic practice and pathogenesis of neurologic diseases<sup>10</sup>.

### 2.1. Scientific experimental studies

Baglivi's experiments with intrathecal application of chemicals in dogs and other domestic animals, and the conclusions he reached from the effects thus observed are quite interesting. On page 73, he writes:

*So, when the vertebrae in the dog, pig, rabbit, sheep, etc., were opened in various ways, alcohol and slightly aromatic fluids were observed to cause mild tremor, but the animal soon resumed normal and active behavior. However, when acidic fluids were instilled, they readily caused severe tremor, convulsions, howling, flatulence, vomiting, stiffness, paralysis, walking difficulties, excessive urine and feces excretion, occasionally complete failure of these excretions, etc., depending on the lesions and punctures of the spinal cord meninges<sup>11</sup>.*

These results convinced him that stimulation of the meninges was responsible for all the phenomena observed which, however, also depend on the nature and concentration of the chemical agent used<sup>12</sup>.

As appropriate for the most distinguished follower of Marcello Malpighi, the founder of the microscopic anatomy, Baglivi's microscopic studies were excellent for his time<sup>13</sup>. He prepared tissue fragments in a special way, then he observed them

using a special microscope with four lenses. He concluded that fibril was the basic structural element of both animal and human body. He was among the first to demonstrate morphological differences between the striated and smooth muscle fibers in the group of fleshy fibers (as he named them)<sup>14</sup>. He found parallelism to be the main characteristic of fleshy fibers. However, intersection was the major feature of membranous fibers (*fibrae*), thus also in neural fiber<sup>15</sup>.

### 2.2 Anatomy and physiology

In his neuroanatomical and neurophysiological considerations, scattered in particular fragments of the book, Baglivi always starts from his and Pacchioni's basic mistake about the function of meninges, and makes wrong conclusions based on this erroneous premise.

Membranous fiber is formed from neural fluid and lymph; it is a continuation of the meninges<sup>16</sup>. He was convinced that all membranous fibers were moved by dura mater of the brain. He was aware that the continuity of hard segments ensured functional continuity as an indispensable premise of the organization of the nervous system as a system superior to all other systems<sup>17</sup>.

Only the membranous system has the capacity of sensation. This concept of Baglivi paved the way for the studies of Albrecht v. Haller on the sensitivity (*sensibilitas*) and irritability (*irritabilitas*) as the fundamental features of living structures<sup>18</sup>.

Although almost obsessively bound to his and Pacchioni's discovery of the role of meninges, Baglivi admitted the superiority of brain to all neural events, which is especially apparent in the following citation:

*... Furthermore, it should be noted that of all parts of the human body, brain is outstanding for numerous adorable strings presumed to penetrate its complex... Pointing to this, it should be mentioned that the strings of the brain and other structures originating from the brain are triggered in two ways, i.e. either from the end part outside the brain, in the sensory and internal visceral organs, and then, as soon as external objects touch the strings or fluids circulating through visceral organs and irritate them, the contact is immediately transferred to the string origin, i.e. to the brain,*

where the judgment on the object is formed; or from the end part within the brain, so that pulsations and vibrations are imprinted by the soul via spiritus into the end part, and are in no time manifested at the external parts... Namely, thus induced vibrations, like the vibrations of musical instrument strings, reach the beginning or the end of the strings. And as long as we are awake and healthy, one of their ends cannot be moved without triggering consistently the opposite end, due to their permanent tension<sup>19</sup>. Baglivi also writes: The supreme and overall power belongs exclusively to the brain, not so much for some fluid secretion but for the continuous vibration of its meninges, their effect then reaching individual parts<sup>20</sup>.

### 2.3. Clinical and clinicopathologic considerations

*De fibra motrice et morbosa* contains numerous case reports of clinical neuropathology. The interpretations of their pathogenesis reflect Baglivi's iatrophysics, unavoidably emphasizing the role of the meninges. For instance, on autopsy of three patients who had died from cerebral infarction, he found adhesions between the dura and cranium, which led him to speculate on the possible role of meninges also in apoplexy<sup>21</sup>.

Baglivi also refers to the pathogenesis of periodical headaches (obviously, migraine). On the basis of the postulated authentic pulsation of the meninges and their marked painfulness in both experiments and clinical pathology, he considered them to be caused by meningeal changes<sup>22</sup>. Interestingly enough, a similar opinion based on the existence of parenchymal and meningeal trigeminovascular connections and presumed neurogenic inflammation of the meninges, is currently one of the most widely accepted explanations of migraine pathophysiology<sup>23</sup>.

Pain is a phenomenon tackled in several sections of the book. Baglivi refers to pain in the possible context of reflex pain, then as a modality in triggering synesthesias, and describes his clinical experience with individuals in whom chronic pain subsided with the occurrence of a new painful locus<sup>24</sup>.

Also, Baglivi reports on a case of congenital hydrocephalus, interpreting it in an erroneous and quite naive manner<sup>25</sup>.

### Discussion

Previous achievements in the field and attitudes adopted in the Baglivi's time should be briefly surveyed to be able to eva-

luate the possible contribution to the development of scientific thought on the nervous system function in the work of Giorgio Baglivi. According to Galen, brain is the center of the nervous system, the seat of soul, and the source of movement, feeling and thinking<sup>26</sup>. Brain receives *spiritus vitalis* from arteries and transforms it in his ventricles into *spiritus animalis*, which controls all brain functions and is transferred via nerves to the periphery<sup>27</sup>. Later on, Vesalius also agrees with the idea that *spiritus animalis* flows via nerves from the brain<sup>28</sup>.

The papers and opinions of Marcello Malpighi, Baglivi's renowned teacher, are relevant for the present considerations. Malpighi boiled brains to harden, then he performed section and studied them under the microscope<sup>29</sup>. He interpreted microscopic findings according to Hippocrates' theory on the glandular structure of the brain<sup>30</sup>. Under the microscope, Malpighi saw the grey substance of the brain cortex, considering it an aggregation of small glands. He thought the white nervous fibers to be draining ducts of these glands. According to Malpighi, the brain excretes a fluid serving as a carrier of movements and sensations transferred from the brain to the periphery<sup>31</sup>.

Baglivi starts from the postulation that *fibrae*, living fibers, are the basic structural elements not only of the human body but of all animal bodies as well. For him, *fibrae* are carriers of vital functions and seats of disease, and are more important than the four bodily juices of the then traditional, so-called humoral medicine and pathology. They are composed of atoms, and possess *vis innata*, an innate feature of irritability and active contractility, in addition to passive mechanical properties of the hard segments<sup>32</sup>. Baglivi divides bodily fibers into fleshy and membranous ones. The fleshy fiber is a constitutional material for muscle, tendon and bone. It is important for this review that Baglivi differentiates smooth from striated muscle, which is also decisive for their different function in the context of his hinted distinction between the autonomic (natural) and voluntary (animal) nervous system<sup>33</sup>.

Membranous fibers are even finer than the fleshy ones, and are especially important because they are formed from the nervous fluid and lymph, represent a continuation of the menin-

ges, and serve as a constitutional material for the nerves, glands, and sensory and visceral organs<sup>34</sup>. Muscle is also wrapped in a membrane originating from the nerve, which was used by Baglivi to explain the fact that the brain could influence the muscle although not being its organogenetic origin<sup>35</sup>.

Emphasizing the function and pathophysiology of the rigid parts of the body, in his iatromechanics Baglivi directly and indirectly supports a principle with the movement or oscillation as a paradigm at the apparent macromorphological level. Pulsating structures are the best example to illustrate oscillations. Therefore, he could be exempted for his misapprehension of an authentic pulsation of *dura mater*. Another mistake arising from this one, i.e. on the reflex connection between the brain and heart on the hemodynamic basis, could possibly be substituted by the real neural connections between the center and periphery. In these terms, Baglivi's systaltic and countersystaltic movement appears to be more analogous to the afferent and efferent movement in the reflex neural communication within the vegetative nervous system complex. Namely, some parts of the book appear to suggest that Baglivi was fully aware of the specificities of neural bonds between the nervous system and visceral organs<sup>36</sup>.

The body is a machine, a sort of clock, *horologium oscillatorium*, that is continuously controlled by the soul<sup>37</sup>. The soul is seated in the brain, near the meninges, which Baglivi considered a sort of control panel ensuring co-ordination of the parts<sup>38</sup>. The idea of analogy between the human body and clock was not original concept of Baglivi, however, he was the first to locate bodily clock's pacemaker within the brain. The concept of a biological clock is completely consistent with his iatromechanics. It is known that a biological clock in the bodies of mammals and humans has been identified in the structure of suprachiasmatic nucleus<sup>39</sup>.

Baglivi was among the first to point to the temporal dimension in the physiological and pathophysiological processes occurring in the animal world including man, because the recognition of the continuity of motion and pointing to the semblance of rest are the basic ideological abstracts of the fibrillar theory.

Oscillations and oscillation-derived biorhythms, and the presumed existence of the biological clock are in a way recognition

of the archetype of time at the biological level. Baglivi relates this temporal dimension exclusively to vegetative functions, which is very close to the current concepts of the role of the suprachiasmatic nucleus as a biological clock controlling the vegetative function biorhythms<sup>40</sup>.

According to my opinion, in *De fibra motrice et morbosa*, Baglivi has provided the first complete and consistent survey of the function and role of the vegetative nervous system as a carrier of biorhythmical functions. This is convincingly illustrated by the following citation:

*... thus, all blood vessels that are tissues made from fleshy and membranous fibers, and a consistent mixture of two movements subject to the two initial triggers, i.e. the heart and dura mater, obviously constitute a separate system independent of other parts...; therefore, the nature and function of blood vessels ought to be elucidated by serious observation and study, and this should be accomplished much more thoroughly than it has been done by the anatomists to date. The more so, by performing tests and thinking properly, we will realize that they - due to their conical shape and harmonious merging of sensory and motor fibers - thus arise hidden movements and impulses in the liquid parts; these impulses have nothing in common with cardiac impulses<sup>41</sup>.*

A description of the neural aspect of the vasomotor function can hardly remain unrecognized in this citation. Interestingly enough, it was only in 1854 when the description of vasomotor nerves by Claude Bernard appeared<sup>42</sup>.

Baglivi proceeds with his consideration of the vegetative nervous system as follows:

*.... the difference between innate (vegetative) and voluntary (animal, somatic) movement results from different constitution of the parts that are moved naturally and without a voluntary decision, such as the heart, vessels, intestine, and sphincters... Concerning the parts formed from membranous fibers, ... the glands, viscera, blood vessels, and any part that is not fleshy or red, ... all these parts are nothing but a product and continuation of the two brain membranes and marrow fiber. Being tacit on the point of rest, I will take the example of paired nervus vagus, which has the most extensive distribution; the pair of the nervus vagus is so widely distributed throughout the body that its branches reach almost all parts...*

(he describes the central parasympathic segment of the autonomic nervous system)<sup>43</sup>.

It is generally considered that F.X. Bichat was the first to differentiate vegetative from the somatic nervous system at the beginning of the 19th century<sup>44</sup>, however, I believe that the facts presented above justify a discussion on the precedence to be attributed to Giorgio Baglivi.

In his book *De fibra motrice et morbosa*, membranes have a central place in Baglivi's conceptual considerations both in the global organization of the body and functioning of the nervous system. Membranes represent a demarcation line between the rigid and liquid parts, and their continuity is the basis and a sort of skeleton that ensures functioning of the whole body as well as of its particular systems. Baglivi could not have anticipated, either at the then scientific information level or at his own intuition level, the roles that are presently ascribed to cell membrane in general, and to neuron membrane in particular. To his credit, we have to admit that the features of irritability and sensitivity, which he was the first to define, have subsequently been verified as substantial membrane functions. In Baglivi's teaching, membranes were attributed a mediatory and integrative function<sup>45</sup>, which is not far from the current concepts.

Would it be presumptuous to presume that in his considerations of the membranes, Baglivi was actually a precedent of the concept of blood-brain and blood-cerebrospinal fluid barrier? In this relation, the following paragraph appears to be quite intriguing:

*It is widely known that the occipital (vertebral) arteries and main cervical (carotid) arteries, when reaching the brain cortex glands, are so thin, small and motionless due to almost unlimited ramifications, that they are hardly discernible; likewise other glands in the body, the task of the very small brain cortex glands is to separate neural fluid from the blood, and to transport it to other parts of the body via excretory vessels; all excretory vessels that belong to the brain cortex glands constitute an important part of the brain, while the brain - dividing into various branches, thus being distributed both within the head and outside the head in the spinal cord - produces nerves that serve as ducts for the previously filtered fluid<sup>46</sup>.*

In this sequence of thoughts, anatomical errors are easy to observe, however, the true value lies in the clearly expressed necessity of separating the two fluids (i.e. blood and cerebrospinal fluid) as well as in the indirect conclusion that this function must be exerted by the rigid membranous parts at the level of terminal ramifications of the vascular trees (i.e. capillaries), which means the finest, cellular elements of the brain cortex - neurons (to correct Baglivi's erroneous term of brain cortex glands). Beside this, the term filtrate undoubtedly points to an active fluid production.

Functionally, Baglivi explicitly distinguishes sensory (afferent) from motor (efferent) parts of the nervous system, and also speaks about the reflex organization of the nervous system, locating the reflex center within the meninges. Emphasizing the need of separating the sensory from the motor leads him to postulate on different projection sites for these systems.

With this idea, Baglivi is in a way a pioneer of the concept of membranes as an insulation material<sup>47</sup>.

However, being misled by his misapprehension of the role of the meninges, he erroneously locates the projection sites - as mentioned above - in the soft and hard membranes<sup>48</sup>.

*De fibra motrice et morbosa* is an unfinished book, thus it can only be guessed what direction may have Baglivi's ideas followed, the ideas in which germs of some very modern concepts have been detected, as shown above. In one of his epistles, referring critically to the great enterprise he had undertaken, Baglivi says that such a novel and comprehensive work he would hopefully be able to complete only when, as an 80-year-old man, he collects, may God help him, an adequate amount of experience<sup>49</sup>. Premature death prevented him to witness von Haller's contesting his misapprehension, or maybe to correct it himself, and deprived him of Galvani's discovery of bioelectricity which, we are sure, would have certainly opened new horizons and provide material to a bold philosopher like Baglivi for further elaboration of his concepts.

Baglivi's papers compiled under the title *De fibra motrice et morbosa*, consisting of drafts, unproven postulations, epistles, headwords, even promises, and written in a baroque lexical

manner with numerous flowery and redundant digressions, are by no means easy to interpret<sup>50</sup>. However, in such analyses, differences that become obvious when comparing the bygone and current professional terms and taxonomy at the present level of information on human anatomy and physiology should be eliminated first. It is certainly easier to assess precedence in the field of anatomical discoveries. In contrast, it is by far more difficult to do in the field of physiology and functions, where the only genuine criterion frequently is our recognition of correct anticipations and hints noted by masters of medical history. It is additionally complicated by the fact that the text to comment on was written in different times and for a different purpose, resulting in a number of inconsistencies. Nevertheless, I am inclined to believe that an adequate body of arguments have been presented to provide a basis for the experts in the field of medical history to reconsider and re-evaluate the contribution of Giorgio Baglivi to the development of the scientific thought on the nervous system functions.

Have I hopefully interpreted his ideas and standpoints correctly, he was among the first to *recognize the vegetative nervous system function*, and to clearly differentiate it from the somatic (animal) nervous system.... Therefore, the established precedence of F.X. Bichat (1800) in dividing bodily functions into the animal and vegetative ones becomes highly questionable.

Then, Baglivi's description of the *neural (reflex, sensorimotor) aspect of the vasomotor function and its independence on cardiac effects* is, according to my opinion, quite clear and explicit.

There also are elements to conclude that Baglivi was a precedent of the *concept of the hematoencephalic barrier*.

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Articoli/Articles

LA TERAPEUTICA DI BAGLIVI E LA TRADIZIONE DELLA  
*MEDICINA EXPECTANS*

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SUMMARY

*GIORGIO BAGLIVI: AN ADVOCATE OF PRUDENCE IN HEALING*

*Giorgio Baglivi's name is usually connected to the Iatromechanic approach but the medical theory outlined in his major work, De Praxi Medica, denounces how deeply he was influenced by hippocratic tradition and mainly by the holistic approach to therapeutics centered on the idea of an inborn healing power of the body. It is proposed that the contraddiction was avoided by Baglivi simply assuming the preminence and autonomy of the clinical point of view in front of the biological research to which he attached great theoretical interest but little therapeutical relevance.*

L'opera principale di Baglivi, *De Praxi Medica*, si apre con un significativo appello che dovrebbe costituire il primo e fondamentale cardine dell'insegnamento medico:

*La cosa più importante nel giudicare rettamente delle malattie è la prudenza; la medicina infatti è o una prudenza o una specie di prudenza; e poiché in nessun modo si giunge a conquistarla che con l'esperienza non è da meravigliarsi se non essendo stata questa affatto usata o usata male sia tanto grande in medicina il numero degli errori e di coloro che li commettono<sup>1</sup>.*

Si tratta di un appello ricorrente in tutta l'opera e ribadito in particolare in un passo significativo del secondo libro:

*In nessun altro campo quanto nella medicina è necessario sapere molto e agire poco soprattutto quando si ha a che fare con la cura di malattie particolarmente acute o troppo complicate<sup>2</sup>.*

Key words: Giorgio Baglivi - Therapeutics - Vitalism - Hippocratism