History of Human Movement Studies

Subjects: Anatomy & Morphology | Classics | Others

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Knowing the genesis of ideas is important to understand why we are studying a topic. This topic review is an historical excursus about the origin of movement studies, following the ideas of Aristotle until positivism. The main ideas at the origin of biomechanical studies are historically reviewed, with special focus on the enlightment era. Key figures at the origin of movement studies were presented, together with the main ideas they introduced, most of which are still at the basis of modern research in the field of biomechanics. The entry can be of interest for all professionals working in the field of human and animal movement studies.

movement studies | muscular function | measurement techniques

1. Introduction

The study of biomechanics, human and animal motion, are flourishing since several centuries. The current topics in this field of research, has their basis and rationale in the history of the discipline, which pose its basis in the classical world. To understand why and what we are searching for , and its rationale, it is important to know the origin of the ideas.

2. History--The classical world

Aristotle introduced the concepts of *Energeia* and *Entelechia.* Energeia means "at work", while Entelechia means "at an end". To be alive for Aristotele, is to be "at work". Aristotle's theory of motion was studied and improved over the centuries. For instance, St. Thomas Aquinas further expanded the concept of motion in time. He observed that, to say that something is in motion is like to state that it is both what it already is and something that it is not yet ("the becoming"). Accordingly, motion is the modality in which the future belongs to the present [1]. This concept is quite intriguing.

3. Middle age and Renaissance

In the XIV century, Duns Scoto, (Duns, 1265/1266 – Koln, 8 Nov. 1308) an Irish scholar who taught, among other universities, at Bologna University, speculated about the motion as "Forma Fluens" ,reconsidering Aristotele´s thoughts. The displacement of the human body in time was seen as a continuum of changing shapes [2]. This very elegant concept of *"Forma Fluens"* seems to inform some modern art masterpieces, such as Umberto Boccioni (1882-1916) in his masterpiece "Unique forms in the space continuity" of 1913.

This idea was very ahead of its time , considering that cinematography would be invented only five centuries later by the French physiologist Jules Marey (1830 -1904) and by the British photographer Edward Muybridge (1830-1904).

Starting from the Renaissance and following the first dissection studies, human movement studies spread over Europe in the XVII and XVIII centuries and, as for all other sciences, flourished during Enlightenement . In Germany, the legacy of earlier studies was embraced by several scientists of the Positivism era. These individuals were dealing with the development of new techniques for the study of human movement, fostered by the Industrial Revolution and the advent of machines. Between these two historical periods there was indeed a strong development of anatomy-in-motion studies in Europe.

4. The Enlightment Era

An interesting approach was that of Giorgio Baglivi [3][4] (1668-1707) who investigated muscular functionsin his books «De fibra motrice et morbosa» and "Mirabilis Machina [5].

At that time, two main theories were spreading over Europe, one conflicting with the other. The iatrophysical theory, which stated that the human body acts like a machine, and thus its functioning can be explained bythe laws of mechanics only, and the iatrochemical theory, which ascribed to chemistry all of body functioning. Baglivi was a supporter of the iatrophysical theory, even though he later begun to think of a way to unify the two theories. The debate was very lively at the time [6].

However, Baglivi is not aswell known as Alfonso Borelli [7], who published the "De motu animalium" in 1680 and 1681. These books are considered to be the first treatises of biomechanics, which is the study of human and animal motion. At that time the influence of Isaac Newton was very strong, while chemistry was just starting to move its first steps out of alchemy, and this Newtonian influence explains the spread of biomechanical studies.

Georg Ernst Stahl [8] (Ansbach, 22nd October 1659 – Berlin, 24 May 1734) rejectedthese two theories, proposing the so-called "animist" theory, which refused both approaches in favor of a superior function of the soul in animating the body and all its organs. Stahl theories were refuted in Germany by Friedrich Hoffmann [9] (Halle, 1660 – Halle, 1742). An eminent scholar of Hofmann, Johann Heinrich Schulze [10] (Colbitz, 12 May 1687 – Halle, 10 October 1744), an anatomist and physiologist, become famous not for his physiological studies (e.g. : De athletis veterum eorumque diaeta ac habitu, 1717) , but because was the discoverer of a chemical compost that was able to react to light, thus allowing for the invention of photography. Photography would bethe basis for the realization of Aristoteles's dream, to capture the movement.

Browne Langrish [11] (died in Basingstoke, Hampshire, in 1769), in the Croonian lectures on muscular motions (1747), investigated the function of muscles. In the theory of Langrish, muscles were "inflated by air". This theory was illustrated by Langrish upon the invitation of the Royal Society, an honor that was later granted to other physiologists of muscular functions, such as George Fordyce [12] (1787) and later, the Nobel Prize Arthur V. Hill

(1936). Francis Glisson [13] (1597 – 1677) disputed the theory of Langrish, and demonstrated that muscles contract and not expand as believed by the iatrophysicists. Glisson's "irritability" (as the muscle contraction was named) was later elaborated by Albrecth von Haller [14] (1708-1777) who stated that muscle contraction exists independently of the nervous system. The same observation was made by Luigi Galvani (1737 – 1798), or by his assistant, as some source reported, in Bologna who, during a storm, noted the leg of a dissected frog contracted by itself on the dissection table as the result of air electricity [15].

The concept of man as a machine is recurrent in several studies. The book "L homme machine "(La Mettrie, 1747 [16], posed the basis for the interpretation of the human body as a machine, reviving the iatrophysical theory.

The Principles of Mechanics (1758) by the mathematician William Emerson [17] (1701–1782) and especially his book "Mechanics, or the Doctrine of Motion" (1769), also deeply studied the laws of motions, applying it to several subjects, including human motion.

5. Positivism Era

Wilhelm Eduard Weber [18] (1804-1891) and his brother, Eduard Friedrich Weber (1806-1871) published the results of their collaborative study on the mechanism of walking in 1836. They discovered that man could last longer walking than standing, and, starting from this simple observation, developed a theory of human walking, studying the muscular actions.

The Enlightenment Era was thus a critical period for the development of biomechanical sciences, posing the basis for the later developments of this field of science. In Germany, Otto Braune and Wilhelm Fischer,were without doubt the most prominent scientists in this field, and their work spread all over the world.

Christian Wilhelm Braune [19](17 July 1831 Leipzig – 29 April 1892) , an anatomist, together with the mathematician/physiologist Otto Fischer (26 April 1861 – † 22 December 1916) wrote several books and papers about biomechanics [20]. Fischer [21] especially incorporated mathematics into the study of human motion, collecting the legacy of the Enlightenment era.

6. Conclusions

As it usually happens for several scientific and technical developments, technological progress must advance to a point that allows these developments. For instance, the discovery that argent salts can change their physical properties when exposed to the light allowed for the development of the first photographic machine and later of the first movie machines. Thus, the idea of conceptualizing the future in the form of an image, 2000 years after Aristotle, came to a realization.

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