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Beyond the pineal gland assumption: A neuroanatomical appraisal of dualism in Descartes' philosophy

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ABSTRACT

Objective: The problem of the substantial union of the soul and the body and therefore the mechanisms of interaction between them represents the core of the Cartesian dualistic philosophy. This philosophy is based upon a neuroanatomical obvious misconception, consisting mainly on a wrong intraventricular position of the pineal gland and its capacity of movement to act as a valve regulating the flow of animal spirits. Should we consider the Cartesian neurophysiology as a purely anatomical descriptive work and therefore totally incorrect, or rather as a theoretical conception supporting his dualistic philosophy?
Method: From the various pre-Cartesian theories on the pineal organ, we try to explain how Descartes used his original conception of neuroanatomy to serve his dualistic philosophy. Moreover, we present an appraisal of the Cartesian neuroanatomical corpus from an anatomical but also metaphysical and theological perspectives.
Results: A new interpretation of Descartes' writings and an analysis of the secondary related literature shed the light on the voluntary anatomical approximations aiming to build an ad hoc neurophysiology that allows Descartes' soul–body theory.
Conclusion: By its central position within the brain mass and its particular shape, the pineal gland raised diverse metaphysical theories regarding its function, but the most original theory remains certainly its role as the seat of soul in René Descartes' philosophy and more precisely the organ where soul and body interact. The author emphasizes on the critics raised by Descartes' theories on the soul–body interaction through the role of the pineal gland.

> "We see clearly that it is just this problem before which philosophers have taken refuge in the fortress of immanence. . .Even if one of the most prominent representatives of the view [Ernst Mach (1838–1916)] had not explicitly stated this to be the case, we could readily see that all forms of the immanence idea arise from a desire to escape the psychophysical problem."
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> Moritz Schlick (1882–1936), *General theory of knowledge (Allgemeine Erkenntnislehre)*, Translated by Albert E. Blumberg. Springer-Verlag. 1974. p.199–200

1. Introduction

Until the end of the 16th century, the definition of the soul (*psukhè* or *anima*) used in occidental Europe was the one enounced by Aristotle [1]. He defined the soul as the first actuality of a natural body that is potentially alive. It therefore represents a veritable principle of life authorizing the fulfillments of the body's potential. According to Aristotle's conception, the soul is not conceivable without the body and it is essential to the proper core activities of all living beings: vegetative (reproduction, nutrition and growth), motor and sensitive, and rationale functions.

During the 17th century and particularly under the impulse of René Descartes (1596–1650), the interactions between the soul and the body arouse several debates. With his Platonic and anti-Aristotelian posture considering the soul as an immaterial thought without any connection with life, Descartes distinguishes the corporeal substance (*Res extensa*), incapable of thought and subject to the laws of nature, and the mental substance (*Res cogitans*) totally immaterial and unsolvable by physics or mathematics. Using this dichotomy, Descartes raises the issue of the soul–body interaction. He hypothesizes that the pineal organ is the seat where the soul and the body interact. His theory mainly relies on the fact that the pineal gland is the unique organ of the brain that is not double and that has a central position within the brain:

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> My view is that this gland is the principal seat of soul, and the place in which all our thoughts are formed. The reason I believe this is that I cannot find any part of the brain, except this, which is not double. Since we see only one thing with two eyes, and hear only one voice with two ears, and in short never have more than one thought at a time, it must be necessarily be the case that the impressions which enter by the two eyes or by the two ears, and so on, unite with each other in some part of the body before being considered by the soul. Now it is impossible to find any such place in the whole head except this gland; moreover it is situated in the more suitable possible place for this purpose, in the middle of all the concavities; and it is supported and surrounded by the little branches of the carotid arteries which bring the spirits into the brain.
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> Letter to Meyssonnier, 29 January 1640 – page 143, vol. 3 [2]

In a preliminary reading of Descartes' *De Homine* [3], we can be surprised facing the obvious neuroanatomical errors and approximations in the book's illustrations at a moment when Andreas Vesalius [4] (1514–1564) and Caspar Bauhin [5] (1560–1624) academic anatomical works were already diffused in occidental Europe. However in order to avoid any basic purely anatomical critics of Descartes' theory on the pineal gland, it is paramount to replace his neuroanatomical conception into his dogmatic and rationalist methodological context. We recall that the Cartesian method implies that the reason is considered as the unique and decisive source of knowledge, and therefore pretends to the truth only by its a priori principle.

The aim of this work is to expose in a first part the ancient pre-Cartesian assumptions on the pineal gland before describing the neuroanatomical and neurophysiological basis of the Cartesian dualism. The last section emphasizes on the reactions to Descartes' theory on the substantial union of the soul and the body, both through anatomical, metaphysical and theological perspectives.

2. The pineal organ before Descartes

Numerous publications have stressed out the theories about the pineal organ before Descartes [6–11]. The first comprehensive descriptions of the pineal gland are found in Galen's *On the usefulness of the parts of the body, eight book* [12]. Galen (ca 130–210) named it pineal (*kônarion* in greek, *glandula pinealis* in latin) because of its particular shape resembling a pine cone (*kônos, pinus pinea*). At that time, a gland was considered to have a purely mechanical support role to vessels particularly veins:

> Coming back, then, to the subject of the parts behind the middle [third] ventricle, let us examine the body [the pineal body] which lies at the beginning of the canal connecting the middle ventricle with the posterior encephalon and which is called conarium [little pine cone] by those versed in anatomy, to see for what usefulness it was formed. This body is a gland to judge by its substance, but in shape it very closely resembles a pine cone, and from this it takes its name.
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> Pages 419–420 [12]

To better understand Galen's notion of the pineal gland, we must remind his physiology and particularly his conception of the nervous system. Based upon a classical Hippocratic tradition, Galen defines health as an equilibrium between the four bodily humors: the blood, the yellow bile, the dark bile, and the phlegm. These four fluids are composed of a mixture of the four fundamental elements associated to their respective qualities: fire/hot, water/humid, air/cold, and terra/dry. According to Galen, human temperaments result from the combination and the dosage of these elements. In the brain, he considered two lateral ventricles as a unique cavity forming the anterior ventricle, a middle ventricle (3rd ventricle) and a posterior ventricle (4th ventricle). He described the ventricles filled with a volatile airy substance he named the *psychic pneuma*, intimately linked to the substance of the soul, i.e. the *sensus communis* [13].

Before Galen, the pineal gland was described as a purely mechanical valve, such as the pylori between the stomach and the duodenum, regulating the flow of the *psychic pneuma* between the middle ventricle (3rd ventricle) and the posterior one (4th ventricle). Galen pointed out this misconception [13]:

> Some think it has the same usefulness as the pylorus of the stomach; for they say that the pylorus too is a gland and prevents the nutriment from being taken over from the stomach into the thin intestine before it is concocted, and that this gland, the pineal body, standing at the beginning of the canal that transmits the pneuma from the middle [third] ventricle to the one in the parencephalis [fourth ventricle] is a guardian and housekeeper, as it were, regulating the quantity that is transmitted.

Galen argued his rejection of the ancient pineal theory on the anatomical data he collected during his experience as physician of gladiators having examined dozens of cranio-cerebral injuries but also on dissections of pigs and monkeys. By this way, he described the venous complex surrounding the pineal gland, known nowadays as vein of Galen:

> I, myself, however, have told earlier what opinion we should hold concerning the pylorus of the stomach, and I believe that this gland resembling a pine cone and filling up the bifurcation of the large vein [vein cerebri magna] from which nearly all the choroid plexuses of the anterior ventricles arise was formed for the same usefulness as other glands that support veins as they divide. . .

According to him, the pineal gland cannot regulate the flow of *psychic pneuma* between the middle and posterior ventricles because the gland is situated outside the brain. He explained that the pineal gland does not have any possibility of movement because of its morphology. As a possible valve to regulate the flow of *psychic pneuma*, he rather proposed the cerebellar vermis he named *vermicular appendix*:

> The notion that the pineal body is what regulates the passage of the pneuma is the opinion of those who are ignorant of the action of the vermiform epiphysis [vermis superior cerebelli] and who give more than due credit to the gland. Now if the pineal body was a part of the encephalon itself, as the pylorus is part of the stomach, its favorable location would enable it alternately to open and close the canal because it would move in harmony with the contractions and expansions of the encephalon. Since this gland, however, is by no means a part of the encephalon and is attached not to the inside but to the outside of the ventricle, how could it, having no motion of its own, have so great an effect on the canal? . . .Why need I mention how ignorant and stupid these opinions are?

Since Galen, many assumptions on the role of the cerebral ventricles and particularly the mechanisms of regulation of the *psychic pneuma*'s flow have been imagined. During the second half of the 4th century, Posidonius of Bysance theorized a ventricular somatotopy placing the imagination in the anterior ventricle, the reason in the middle one, and the memory in the posterior ventricle. A Lebanese physician, Qusta Ibn Luca (864–923) applied Galen's idea of the vermicular appendix to the ventricular somatotopy described by Posidonius of Bysance: by raising the head and opening the vermicular appendix, one allows the access to the posterior ventricle where memory is stocked, while by bending down the head, souvenirs are isolated in the posterior ventricle and one can concentrate to have clear unpolluted ideas [13]. During the middle