**Short title:**

**“Materialism, *Lebenskraft* and the limits of science”**

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**Materialism, *Lebenskraft* and the limits of science**

**Metaphysical vitalism in post-Kantian scenarios**

Author:

Paolo Pecere

University of Roma Tre, Deparment of Philosophy, Communication and Performing Arts, Via Ostiense, 234-236 – 00146 Roma

Email: paolo.pecere@uniroma3.it

Summary:

Kant’s legacy in the history of life sciences has notoriously included a critique of the use of soul and “vital force” (*Lebenskraft*). In this paper I focus on a less-known side of this legacy, i.e. Kant’s late critique of vital materialism and its impact on 19th century German science and philosophy. In § 2, I show that Kant considered materialism as a kind of metaphysical hypothesis since the 1760s and pointed out that it was empirically impossible to distinguish it from different kinds of hypotheses (such as monadology). I focus on Kant’s late essay on Samuel Sömmering (1796), arguing that the critical rejection of materialism and the notion of *Lebenskraft* belonged to an anti-reductive program for life sciences. In § 3, I maintain that Kant’s views influenced Alexander von Humboldt’s turn concerning vitalism in the late 1790s and the anti-metaphysical and physicalist epistemology of Hermann von Helmholtz. In §§ 4-5, I follow this Kantian legacy in the works of Friedrich Lange, Emil du Bois-Reymond and Erich Adickes. In the final section (§ 6), I argue that this tradition provides a vantage point to reconsider contemporary debates over materialism and panpsychism.

Keywords:

Materialism, life, sensation, vital force, Kantianism

1. Introduction

Kant’s legacy in the history of life sciences has notoriously included a critique of the use of soul, “vital force” (*Lebenskraft*) and similar metaphysical notions. Some sides of this story are well-known: Kant rejected “hylozoism” as “the death of all natural philosophy” in the *Metaphysical Foundations of Natural Science* (1786), and replaced the resort to final causes with his transcendental account of the subjective principle of “purposiveness” of organic beings in the *Critique of the Power of Judgement* (1790).[[1]](#endnote-1) However, since the 1790s a number of natural philosophers revived the concept of vital force and the resort to teleology. This anti-Kantian trend characterized a range of different approaches in the development of German biology.[[2]](#endnote-2) This trend, in turn, would be rejected since the 1840s by members of the “Berlin physical society”, notably Emil du Bois-Reymond and Hermann von Helmholtz: these scientists wanted to dispose of vital force as an explanatory principle for organic beings, thus challenging the metaphysical vitalism of their teacher Johannes Müller, and advocated an epistemology of life sciences that restored a number of originally Kantian insights. They defended a thoroughly physico-chemical account of life, based on their groundbreaking discoveries in physics and electrophysiology. Helmholtz would connect physiological research to the formulation of the principle of the conservation of energy, which would establish what was later called the “causal closure” of nature and thus excluded non-physical causes in the explanation of life (and mind). Eventually, these accomplishments played a major role for the development of 20th century epistemology of life sciences, from the Vienna Circle to contemporary cognitive sciences, fostering a physicalist or materialist outlook.

In this paper I want to address a less considered side of this story, focusing on critical rejections of materialism and the notion of *Lebenskraft*. I will argue that there is a historically documented connection between Kant’s accounts of *Lebenskraft* and physiology, grounded on his early engagement to Enlightenment materialism (§ 2), and the theories of 19th century philosophers and scientists such as Alexander von Humboldt and Hermann von Helmholtz (§ 3), Emil du Bois-Reymond, Friedrich Lange (§ 4). I will also highlight an important element of this Kantian legacy, that is the thesis that materialism, rather than being a scientific alternative to metaphysical speculation, can be itself a metaphysical hypothesis which involves an empirically ungrounded characterization of life. Indeed, according to this view, the understanding of life as an essential property of matter cannot be empirically distinguished from the admission of speculative metaphysical kinds of vitalism and from related metaphysical notions such as animism and panpsychism, and therefore it has to be rejected altogether. To be sure, on this Kantian perspective, the study of organisms might involve non-mechanistic notions and methods, provided that this does not introduce concepts of special substances, intrinsic properties and non-mechanical causes.[[3]](#endnote-3) This insight motivated the critique of the notion of vital force in prominent scientists such as Ernst Haeckel (§ 5). As I will finally point out, this Kantian perspective can also provide an interesting vantage point to reconsider a similar conundrum concerning the connection of materialism and panpsychism in contemporary philosophy (§ 6).

2. Kant: monads, matter and critique of vital force

Kant addressed the notions of souls and vital force over his whole philosophical career, dealing with different hypotheses in medicine and life sciences such as Stahl’s animism and Maupertuis’ sentient particles. On the background of these different accounts was Kant’s original elaboration of monadology. In his early works, from the *Thoughts on the True Estimation of Living Forces* (1745) to the *Physical* *Monadology* (1756), Kant wanted to conceive the activity of monads in terms of Newtonian attractive and repulsive forces and this project raised a number of issues, including the distinction of monads from matter.[[4]](#endnote-4) In the mid 1760s, Kant started to wonder whether this separation was possible at all and envisaged the danger that his own metaphysics might be conducive to materialism. Thus in the *Dreams of Spirit-Seer*, *Illustrated by Dreams of Metaphysics* (1766) he praised Stahl’s attempt to “explain animal processes in organic terms [*organisch*]” and argued that Stahl “was closer to the truth” than mechanists, such as Hoffman and Boerhaave, because he admitted “immaterial forces” and the “influence of incorporeal beings” as a condition for the understanding of organic beings.[[5]](#endnote-5) This reference to Stahl, however puzzling, indicates that Kant related his own theoretical problems with the debate on Stahlianism that was initiated by the Leibniz-Stahl controversy.[[6]](#endnote-6) Indeed, in the *Negotium* *Otiosum* we already find a discussion of the problem that anticipates the thesis that materialism can be conflated with alternative theories into a single metaphysical approach. Leibniz argues that Stahl’s account of sensory perception, grounded on the interaction of soul and body, leads to Hobbesian materialism:

“It is held in the same place that sense is nothing other than the reaction of subtle external motions to subtler motions produced by the soul for the sake of perceiving. I fear that in this way the soul would be rendered corporeal and mortal, and would be transformed into that very thing that is called by others “spirits” (to wit, corporeal spirits), especially as the distinguished man denies that spirits of this sort are distinct from the soul. Of course, it was with this approach that Hobbes explained sensation in terms of reaction”.[[7]](#endnote-7)

To deny any interaction between soul and body, as Leibniz does, is presented here as the only antidote to the materialization of the soul. For the same reason, Leibniz also excluded any localization of the soul in the body.[[8]](#endnote-8) In his early metaphysics, Kant disagreed with Leibniz’s critique of interactionism: he wanted immaterial souls that interact with matter in order to explain organic beings. Kant thus believed that his physical monadology, with monads that interact by means of Newtonian forces, could be consistent with solid metaphysical dualism. But this turned out to be the reason of his problem with the intertwining of monadology and materialism.[[9]](#endnote-9) In particular, in the *Dreams*, Kant considers a number of hypotheses on the animation of matter and he focuses on the problem of empirically distinguishing among them. There is an “immeasurable but unknown hierarchy of beings and active natures, in virtue of which alone the dead stuff of the corporeal world is animated [*belebt*].” But “it will, perhaps, forever be impossible to determine with certainty how far and to which members of nature life extends, or what those degrees of life, which border on the very edge of lifelessness, may be.” The alternative theories ranged from “hylozoism,” which “invests everything with life,” to “materialism,” which “when properly considered, deprives everything of life”.[[10]](#endnote-10)

Kant here calls “materialism” the mechanistic materialism of Hobbes and others, while he calls “hylozoism” what we would rather call vital materialism.[[11]](#endnote-11) His favourite example of hylozoist was Maupertuis, who “ascribed the lowest degree of life to the organic particles of nourishment”.[[12]](#endnote-12) Kant respected Maupertuis’ work, which he cited many times in writings of the 1750s and 1760s, but he never endorsed the latter’s organic molecules. One more hypothesis that he takes into account in the *Dreams* is Haller’s “irritability” as a property of nerves and of some plants.[[13]](#endnote-13) It is not clear which was Kant’s favourite hypothesis at this time, but his praise of Stahl and his Newtonianism suggest that he might have liked Haller’s strategy of reconciling soul-body dualism with irritability as a kind of Newtonian force. However, Haller’s theory was famously controversial since La Mettrie had interpreted it in the direction of materialism.[[14]](#endnote-14)

German academic philosophers were aware of these interpretative problems and their possible connection to monadology. Kant’s teacher Martin Knutzen suggested that Leibniz’s thesis of the sensibility of monads might provide “weapons” to the materialist. Indeed, La Mettrie maintained that Leibnizians “with their Monads […] spiritualized matter rather than materialize the soul”, thus suggesting that monadology could be turned into materialism.[[15]](#endnote-15) The tension exploded with the 1746 monad controversy at the Berlin Academy of Sciences, which provided a background for Kant’s early engagement with the problem. Eventually, in the 1764 Prize Essay, Kant realized that the alternative of monadology and materialism was characterized by a fundamental underdetermination with respect to empirical evidence. The possibility or impossibility of representative substances, in this regard, would “likewise remain incomprehensible”. The “flexibility” of hypotheses was an unsurmountable obstacle to establishing the truth. The same problem was raised by “different localization hypotheses”, which “admit only of a very superficial proof, or no proof at all”. If we determine the local presence of the soul in the body, then we lack “any characteristic mark” to discriminate the soul from “the raw elements of matter […] Then the idea jokingly proposed by Leibniz that in drinking our coffee we may perhaps be swallowing atoms destined to become human souls would no longer be a laughing matter”.[[16]](#endnote-16) In the light of these insights, Kant decided to abandon his quest for a monadological metaphysics and start an investigation on metaphysics as a science of the “limits” of human knowledge that would eventually lead to the *Critique*.

In the *Critique of Pure Reason*, “materialism” is listed among the controversial hypotheses of metaphysics, which the critique allows to avoid by severing its “very root”, and rebutted in its psychological version as the doctrine of the materiality of the soul.[[17]](#endnote-17) Hence, it is still conceived as a dogmatic doctrine concerning matter as the ultimate ground of reality in itself. In a radically different way, Kant launched a new “metaphysics of corporeal nature” in the *Metaphysical Foundations of Natural Science* of 1786. In this work, given the empirical concept of matter as the “movable in space”, Kant investigates its properties (e.g. impenetrability) following the guiding thread of the categories and their possible representation by means of mathematical constructions. This new metaphysics was meant to integrate the mathematical physics of Newtonian natural philosophy in the framework of transcendental idealism, and hence did not change the previous, dismissive critique of materialism of any kind.[[18]](#endnote-18)

In the late 1780s, Kant argued for the combination of mechanism with the use of teleological principles in the study of organic beings. In this perspective, he welcomed Johann Blumenbach’s “formative drive” (*Bildungstrieb*). Blumenbach had defined the “formative drive” as the drive “by means of which they [organisms] receive a determinate shape originally, then maintain it, and when it is destroyed repair it where possible” and “the primary cause of all generation, reproduction, and nutrition”.[[19]](#endnote-19) Kant praised the notion in his account of teleological principles in the *Critique of the Power of Judgment* and wrote to Blumenbach that he united “two principles that people have believed to be irreconciliable, namely the physical-mechanistic and the merely teleological way of explaining organized nature” and hence provided a “factual confirmation” of Kant’s idea.[[20]](#endnote-20) Blumenbach responded positively and reframed his notion in terms that suited Kant’s perspective. In the second edition of his book he presented his formative drive in Newtonian style: “The word *Bildungstrieb*, like the words attraction, gravity, etc. should serve, no more and no less, to signify a power whose constant effect is recognized from experience and whose cause, like the causes of the aforementioned and the commonly recognized natural powers, is for us a *qualitas occulta*”.[[21]](#endnote-21) This was one more point of agreement with Kant, who rejected any hypothesis on the principle of “the life of matter (in it, or also through an animating inner principle)” as belonging to “hylozoism”, thus conflating Stahl’s animism with vital materialism.[[22]](#endnote-22) In Kant’s critical perspective, these hypotheses belonged to the past unfruitful attempts of metaphysics. On the whole, Blumenbach’s work seemed to provide a scientific support to Kant’s program.[[23]](#endnote-23)

However, the intellectual context was moving forward in another direction. Herder, in the *Ideas for a Philosophy of the History of Mankind* (1784-1791) brought back into discussion vital forces acting from “living points” and materialism: in fact, he overtly rejected Kant’s critical ban and reconsidered the whole set of hypotheses of Kant’s early speculation.[[24]](#endnote-24) In the 1790s, Johann Friedrich Kielmeyer also revived the psychological interpretation of irritability, claiming that “what was previously irritability develops in the end into the capacity for representation”.[[25]](#endnote-25) Kant’s and Blumenbach’s attitude was widely dropped by many German philosophers and natural scientists. As Zammito points out, “*Lebenskraft* and *Bildungstrieb* became virtually synonymous”.[[26]](#endnote-26)

Kant reacted to this trend in a number of writings, including his essay on Samuel Sömmering’s “On the organ of the soul” (1796). In this book Sömmering – a prominent physician and anatomist educated in Göttingen – argued that his anatomical study of the brain as corroborated the metaphysical hypothesis that the seat of the soul lies in ventricular fluids of the brain. Thus he postulated that “a fluid can be animated [*animirt*]” and maintained that “our spirit, that is the whole force of our developed individual, of our I, is […] contained in a drop of soft liquid”.[[27]](#endnote-27) Sömmering retraced his view back to a series of philosophers, from the antiquity to Leibniz, Stahl, and the materialist interpretations of their views, e.g. in Ernst Platner, i.e. the whole set of hypotheses that Kant had discussed in his works of the 1760s. He also claimed that the anatomical hypothesis on the seat of the soul belonged to a “transcendental philosophy”, suggesting that Kant might have appreciated it.[[28]](#endnote-28)

He was not entirely wrong, but his idea came too late, long after Kant had dismissed Platner’s “eternally futile inquiries as to the manner in which bodily organs are connected with thought” in “physiological anthropology”.[[29]](#endnote-29) Kant’s essay, published as an Appendix to Sömmering’s book, excluded the possibility of localizing the soul in the brain, presenting this task, as formulated by Haller, as “not only unsolvable (…) but also in itself contradictory”. The unity of consciousness, in the perspective of criticism, belongs to the intellect, and to consider this unity in terms of spatial relations between parts of the brain is an impossible task, compared to an “impossible magnitude (√­–2)” – what we would call a category mistake.[[30]](#endnote-30) Nevertheless, as we have seen, Kant had envisioned this kind of theory in the past and he admitted that Sömmering touched a “weak spot”. In a preliminary draft to the essay he presents the topic of Sömmering’s essay as “the principle of the living force in animal bodies and the seat of the soul” and his hypothesis as a “temptation for the metaphysician” to “dare a to dare a step beyond his limit in the field of physiology”.[[31]](#endnote-31) The temptation was aroused from the “dogmatic appearance” of attributing properties of the self to material objects in order to understand the relation between self and nature. As an example of this metaphysical delusion Kant cited Maupertuis’ organic particles, which were mocked by Voltaire in “Doctor Akakia”,[[32]](#endnote-32) and commented on this famous episode with a confession:

“I do not want to conceal that I was myself tempted by such a tendency [*Hang*] to dare a transition from the theory of the soul to physiology (to the nature of living matter) and —besides the mechanical (statical and hydrodynamical) and the more deeply hidden chemical laws— to admit of a special life-force (or irritability, as one otherwise may prefer to call it) in each part of these matters where nerves and their movements are effective, and thereby to admit of a principle of peculiar sensibility of these parts, even though the unification of sensations of so many animated [*belebten*] organs in a consciousness of the soul can only be effected through the nerves that connect the affected organ to the brain”.[[33]](#endnote-33)

Irritability, which Kant had examined in the *Dreams* and connected to the undesired collapse of the immaterial soul into material substance, is now presented as a variant of vital force, which involves sensibility of living tissues. Against this kind of hypothesis, Kant now sketches his alternative program for neurophysiology. He excludes the concepts of the soul and vital force from natural science. With regards to the supersensible ground of matter he had pointed out in the first *Critique* that the ground of inner and outer phenomena “might perhaps not be so different in kind”, but no evidence could be provided in support of such monistic hypothesis, as we “lack the necessary condition for applying the concept of substance” to this ground.[[34]](#endnote-34) In the essay on Sömmering, Kant points out that the “presence” of the soul as “consciousness” – rather than substance – had to be conceived rather as “a virtual presence, which belonged only for the understanding, and which just for that reason is not spatial”.[[35]](#endnote-35) Nevertheless, this exclusion of old metaphysics did not affect empirical investigation. On the contrary, in the light of Sömmering’s anatomical hypothesis, Kant prospected that the *chemical* analysis of brain fluids may allow the understanding of the transformation of nervous stimuli into sensations and the nervous processes underlying “empirical thinking”, that is the connection of sensations. This chemical physiology of “mind” (*Gemüth*)[[36]](#endnote-36) was limited to the synthetic activity of imagination in the association of ideas, and it had to be separated and limited by the philosophical investigation of “pure consciousness” with its rational and a priori principles.[[37]](#endnote-37)

Kant’s program for life sciences has been described as a “defeat”, for vital forces were widely accepted by German scientists.[[38]](#endnote-38) But the impact of the late essay on Sömmering with its threefold strategy has been underestimated. The essay was widely read and Kant’s threefold strategy – rejection of metaphysical hypotheses on soul and vital force, chemical analysis of physiological and mental processes, antireductionism concerning rational principles – left a significant legacy in life sciences. Eventually these Kantian ideas inspired the new physicalist program of the “organic physics” shared by Hermann von Helmholtz and Emil du Bois-Reymond, that is, precisely the rising force in mid-nineteenth-century Germany that advocated once more the banishment of souls and vital forces. A pivotal character for this transition was the great naturalist Alexander von Humboldt.

3. *Kantian legacy and vital force: Humboldt to Helmholtz*

In the first decades of the 19th century metaphysical vitalism and vital materialism were leading alternatives for the explanation of life in German sciences. Johannes Müller, who established the most important school of physiology in Berlin, supported a unification of speculative philosophy and experimental life sciences, where *Lebenskraft* and soul played a major role. In his textbook of physiology, Müller maintained: “Everything that feels and moves itself voluntarily according to its own desires has a soul”, conceived as a “life principle”.[[39]](#endnote-39) By the early 1840s, speculative idealism was losing credit and materialism was rising in scientific circles, due to the elaboration on French ideas in the research and popular essays by Karl Vogt and others. The materialism controversy that started in the 1840s concerned, among other topics, the possibility that life and mind could be reduced to physico-chemical processes.[[40]](#endnote-40) In this context, a physicalist but non-reductive and non-materialist perspective was developed by fellow students of Müller, notably Emil du Bois-Reymond and Hermann von Helmholtz. Helmholtz had subscribed to the program of the “organic physics” formulated by du Bois-Reymond in the early 1840s, whose main objective was the banishment of vital force and the foundation of the experimental study of organism by means of physico-chemical forces or new kinds of attractive and repulsive central forces. Helmholtz connected his views to the tradition of Kantianism, and indeed he revived some of the general tenets of Kant’s strategy that I have outlined above.[[41]](#endnote-41) Helmholtz pointed out that his theory did not belong to “orthodox” Kantianism. Nevertheless, a *direct* connection to this Kantian legacy can be found in the work of Alexander von Humboldt, who was Helmholtz’ and du Bois-Reymond’s first academic protector and arguably an important model for the younger scientists.

Humboldt’s debt to Kantian philosophy has been traditionally limited to natural history, in particular to the historical “idea of cosmos” and possibly to geography. [[42]](#endnote-42) However, I submit, Humboldt owed much to Kant in life sciences too. Originally Humboldt endorsed vital force, conceived as a condition for the preservation of life forms that contrasted the action of chemical affinity. In a 1793 essay on botany he writes:

“We call that matter inactive, brute, or inanimate if its elements are combined according to the laws of chemical affinity. We call those bodies animated and organic that, though they tend constantly to change into new forms, are constrained by some internal force, so that they do not relinquish that form originally introduced […] That internal force which dissolves the bonds of chemical affinity and prevents the elements of bodies from freely uniting, we call vital”.[[43]](#endnote-43)

This view was developed in the context of post-Kantian life sciences. After his studies in Göttingen, Humboldt spent some time in Weimar, where he had important intellectual exchanges with Goethe and Schiller and discussed Kant’s philosophy. In 1795, he published a short story in Schiller’s journal “Die Horen”, defending once more his previous notion of vital force.[[44]](#endnote-44) However, by 1797 Humboldt changed his mind: in his *Experiments on stimulated muscular and nervous fibres*, he decidedly rejects vital force and defends a purely chemical account of physiological processes. This turn in Humboldt’s thought, I submit, was stimulated by the study of Kant’s 1796 essay on Sömmering, which was the object of a very positive account in the book. Humboldt praised Kant’s “very subtle” treatment of the issue of representations and brain matter and he invited the “empirical philosopher” – i.e. the natural philosopher – to follow the idea that “everything that happens in the organic matter can be investigated [*beurteilt*] according to mechanical and chemical laws”. He also maintained that psychological phenomena might be grounded in “something, which is not matter”, but professed ignorance regarding the “transcendental object”, concluding that the scientist can work with the supposition that “something material and simultaneously extant corresponds to sensory processes”.[[45]](#endnote-45) Thus Humboldt accepted Kant’s exclusion of the soul of organisms from the field of life science and Kant’s positive account of the prospects of chemistry, and thereby envisaged a physico-chemical program for electrophysiology.

Kant’s influence is evident elsewhere in the book. Humboldt connects this anti-metaphysical attitude to a critique of vital force: vital force is an “unknown force”, it is “by no means proved”.[[46]](#endnote-46) Another passage connects irritability to Humboldt’s new physicalist stance: “Animal and plant fiber must, as I believe, be regarded not merely as susceptible to irritation but as continuously irritated[…] Light, heat, electricity and the other components of the atmosphere, in which all creatures are bathed, operate upon them at every moment”.[[47]](#endnote-47) Humboldt’s notion of organism is explicitly derived from Kant: “The balance of elements in living matter maintains itself only so long as every part is part of a whole and exists as such”. This new definition of life depends “directly on the idea of that immortal thinker ‘that in an organism every part is mutually means and end.’”[[48]](#endnote-48)

To be sure, Kant’s philosophy of life sciences – in the quoted passages of the third *Critique* and the *Organ of the Soul* – was just one among many influences that drove Humboldt’s research. In the second volume of his *Experiments on stimulated muscular and nervous fibres*, Humboldt pointed out that Johann Christian Reil had empirically disproved his former hypothesis and was arguably influenced by the latter’s physicalism in “On Vital Force” (1796).[[49]](#endnote-49) However, a close examination shows that Humboldt’s view was closer to Kant’s than to Reil’s. Reil maintained that “the ground of animal phenomena, which are not representations” must be looked for in “animal matter”, and that “representations cannot operate without a simultaneous motion of the brain”.[[50]](#endnote-50) Thus Reil defended a material account of life, where life-force corresponds to a “peculiarly formed and mixed matter”,[[51]](#endnote-51) but he left open the issue of mental *representations*. Humboldt agreed with the first part of this account, while his further claim that voluntary motion and thinking suggest a non-material, albeit unknown ground and his warning against reduction reflect Kant’s account.

On the other hand, Humboldt was also greatly influenced by Schelling’s philosophy and found here a further motivation for an integrated account of natural forces, against the introduction of a particular vital force.[[52]](#endnote-52) Nevertheless, it can be argued that Humboldt never accepted the whole metaphysical commitments of Schelling’s transcendental idealism and speculative *Naturphilosophie* in general. In the mid 19th century, he would mention his own turn concerning vital force and take the opportunity of siding with the new empiricist and physicalist trend in physiology against the legacy of metaphysical vitalism. In the first volume of *Kosmos* he writes: “The myths of imponderable materials and of intrinsic life-forces in any sort of organism obscure the view of Nature […] Within the inorganic crust of the Earth lie the very same basic materials from which the frames of the animal and plant worlds are constructed. [....] The same forces dominate […] in conditions that are still unfathomed and grouped by the very vague denomination of *effects of life-forces*”.[[53]](#endnote-53) These theses did not entail any commitment to either materialism or idealism, they were rather a consequence of the “empirical account” of nature, which aimed at arranging phenomena according to “guiding ideas, the generalization of the particular, the search for empirical natural laws”, avoiding the “folly” and the “illusory pictures” of the systems of natural philosophy.[[54]](#endnote-54)

In the 3rd edition of the *Views of Nature* (1849), Humboldt wrote that “consideration and further studies in the area of physiology and chemistry have profoundly shaken my earlier belief in a so-called Life Force […] I no longer use the term intrinsic forces for that which is perhaps only actuated by the interaction of long-familiar individual materials and material forces.” He mentioned du Bois-Reymond’s works on animal electricity as an example of the “further studies” that motivated his turn, thus showing how he found a profound agreement with the “Berlin school” of du Bois-Reymond and Helmholtz, two scholars that he had known and supported, who shared the empirical and metaphysically agnostic, hence non-materialist perspective on the ground of life and mind.

In this perspective, Helmholtz’s account of vitalism and Kantianism can be considered as a realization of Humboldt’s program for life sciences. The background for Helmholtz’s rejection of vital force was the discovery of the conservation of energy, which, as is well known, was the result of investigations on the transformations of mechanical, thermic, chemical and electrical phenomena in animals. Helmholtz questioned the notion of vital force starting from the problem, formulated by Justus Liebig, whether warmth and mechanical motion in animals could be fully conceived as the result of chemical processes. He concluded that plants’ vital processes of plants can be accounted for by means of physico-chemical factors and “animals use a certain quantity of potential chemical forces, producing heat and mechanical forces”.[[55]](#endnote-55) Thus Helmholtz compared the “living body” to a steam engine. To be sure, there was no proof yet “that the work produced by living bodies is an exact equivalent of the chemical forces which have been set into action”, but many experiments pointed towards this general conclusion and Helmholtz considered “extremely probable that the law of the conservation of force holds good for living bodies”. This ruled out “vital principles”, conceived as exceptions to the deterministic laws of nature.[[56]](#endnote-56) In the lecture “On Thought in Medicine” (1877), Helmholtz made clear that modern investigations of physiology disposed of the Stahlian soul, “vis vitalis” and similar notions of “vitalist physicians”, conceived as “ruins of old dogmatism”.[[57]](#endnote-57)

In the *Treatise on physiological Optics* (1867), Helmholtz accommodated this conclusion in the framework of the post-Kantian epistemological strategy that I have introduced above. First, in books 1 and 2, Helmholtz considered sensation as rooted in physical stimuli and bio-chemical processes. In book 3, on the other hand, he posited a “psychological activity” as a condition for turning of sensations [*Empfindungen*] – conceived as nervous states – into perceptions of objects [*Wahrnehmungen*], e.g., he detected the activity of the “intellect” in the application of the “pure logical law” of causality to the representation of external objects. Such observations belonged to a “pure psychology”, dealing with “the laws and nature of mental activities”, to be separated from physiology.[[58]](#endnote-58) This antireductionist approach excluded any metaphysical commitment to spiritualism and materialism, which were conceived as examples of “equally ungrounded metaphysical speculations or hypotheses”, not be me mistaken for “dogmas”.[[59]](#endnote-59) While the first hypothesis belonged to speculative idealist philosophers, such as Schelling and Hegel, whom Helmholtz considered responsible for the estrangement of science and philosophy, the second was envisaged by many physiologists (including fellow students of Müller such as Carl Ludwig and Rudolf Virchoff). To limit between science and metaphysics was thus an urgent need in life sciences too.

4. Materialism misunderstood: Lange and du Bois-Reymond

Helmholtz’s critique of materialism can be read in the context of the materalism controversy that raged in Germany since the 1840s. Lange produced a philosophical assessment of the controversy in the *History of Materialism* (1866, 18752), which agreed on many substantial points with Helmholtz and du Bois-Reymond. Lange’s general thesis was that materialism is an unstable doctrine, which can be interpreted in contrasting ways, and the main objective of his book was to develop a “consequent materialism” against its mistaken interpretations. Lange argued that materialism can be understood either as a maxim of scientific investigation or as a “comprehensive worldview” about self-existent material objects as the ultimate ground of reality (materialism in a “metaphysical sense”).[[60]](#endnote-60) In Kantian terms, materialism as a scientific maxim concerned the investigation of phenomena (“materialism of the phenomenon”)[[61]](#endnote-61) rather than things in themselves, and entailed the exclusion of the supernatural, while it encouraged the search for the physical correlates of biological and mental processes. But once we ask “what is matter?”, we realize that material objects are representations of our senses and the “consequent materialistic view thus changes round [...] into a consequent idealistic view”.[[62]](#endnote-62)

However, materialists from the Antiquity to the French Enlightenment (and beyond) often conflated the two notions. In this regard, Lange also claimed that, once materialism is taken in its metaphysical sense, it becomes undistinguishable from other non-materialistic hypotheses and thus loses its original meaning. This transformation appears inevitable in the attempts of explaining sensations in organisms. Since the ancient atomistic formulation, materialism was unable to explain sensory qualities unless it turned into something else: “The atoms have no *qualities* except size, figure and weight […] With the assumption of intrinsic qualities the atom has already become a monad, and we pass on into Idealism or into pantheistic naturalism” (Lange 1866, 28). As soon as materialism tries to explain sensations it grants the status of attributes of matter to sensory qualities, and that is the point where “materialism, however consequently it may be developed in other respects, always, more or less avowedly, leaves its own sphere” (Lange 1866, 48). Thus the alleged materialistic explanation of sensations always ends up in a kind of substance-predicate metaphysics, which may be idealistic or realistic, depending on whether consciousness is attributed to a noumenal reality grounding phenomena (as in Leibniz’ monadology or in Spinoza’s “idealistic pantheism”) or to matter itself (as in Bruno’s “realistic pantheism” or Toland’s pantheism). In general, materialists “take naively the unknown matter as the only substance”. In contrast to this substantialism, Lange praised Helmholtz’s epistemology, that inferred forces from empirically given effects and avoided any further determination of the underlying stuff.[[63]](#endnote-63)

Thus Lange gave anti-materialist twist to an argument on the empirical underdetermination of hypotheses on living beings that belonged to the Kantian legacy. He was reacting particularly to the German context, where the progresses of empirical science were intertwined with the rise of materialism and an abundance of speculative claims in the tradition of *Naturphilosophie*. This was evident in the Preface to the first edition of the *History of Materialism*, where Lange discusses the actuality of the problem – mentioning Gustav Fechner – and points out that “pantheistic naturalism […] is often lumped together with materialism” (p. ix). In the second edition, Lange lists a number of occurrences of this fallacy, including Schopenhauer’s conflation of “will and impulse to motion”, Philipp Spiller’s “cosmic ether”, Friedrich Überweg’s “sentient matter”, Friedrich Zöllner’s thesis that sensation is the “most general property and the condition for the understanding of natural phenomena” (Zöllner 1872, 321, cf. Lange 1875, 162ff).

Those were not isolated cases. More prominent scientists, such as Wundt and Ernst Haeckel, presented an intertwining of experimental science and metaphysics concerning the explanation of life and sensation.[[64]](#endnote-64) In contrast with metaphysical investigations, Lange argued that Helmholtz’s physiology of sense organs might produce a scientifically updated version of Kantianism, showing that our representations essentially depend on the “organization”. Hence Lange did not accept Kant’s original argument for transcendental idealism and found new scientific grounds for pleading ignorance about the “transcendent basis” of the world and defending a kind of phenomenalism, which ruled out materialism as a hypothesis on reality in itself (while it can stay as a maxim of empirical investigation).[[65]](#endnote-65)

Against this background, Lange positively appraised contemporary scientific accounts of the brain correlates of thinking. Notably Lange praised Kant’s neurophysiological account in the essay on Sömmering, taking once more the opportunity to criticize the hidden speculative side of materialism. Instead of localizing representations in a material *element*, “as carps in a fish pond”, Kant conceived them as functions of the whole brain, thus suggesting that sensory processes might be conceived in terms of “numerical relations and the kinds and ways of the joint action of organic processes” (1866, 458). Kant’s “*formalist* formulation” was opposed to Sömmering’s “materialistic” one (459). Again, Lange here identifies materialism with a theory which hypostatizes all kinds of properties of organisms in a material substratum, which, however, is merely an “unknown” ground of the world.[[66]](#endnote-66)

Lange’s account anticipated du Bois-Reymond’s arguments in his lecture “On the Limits of Natural Science” (1872), which Lange praised and discussed at length in the second edition of the *History of Materialism*. Du Bois-Reymond argued for the possibility of an “analytical mechanic of living process” and hence rejected vital forces since his early *Investigations on Animal Electricity* (1848), in the Preface that he would later reprint with the title “On Life Force”: “So called life force, as it is commonly conceived as acting in any point of living creature, is an absurdity [*Unding*]”.[[67]](#endnote-67) Indeed, du Bois-Reymond maintained that forces in general are functional notions that do not exist beyond material particles, hence there was no reason to separate forces of inorganic and organic matter. This approach was connected to the principle of the conservation of energy.[[68]](#endnote-68) In the “Limits”, du Bois-Reymond would defend a broader epistemology drawing on notions of Kantian philosophy: he argued that natural phenomena can be explained exclusively by means of “propositions of mechanics”, which he conceived as “apodictic” after the model of Kant’s *Metaphysical Foundations of Natural Science*. Then he introduced a first limit of natural science in the explanation of the “essence of matter and force”, arguing that hypotheses like physical monadology and the like could never find empirical support.[[69]](#endnote-69) This anti-metaphysical attitude concerning natural science was arguably the reason why du Bois-Reymond did not commit himself to materialism either. Besides excluding vital materialism, he engaged with contemporary physicalist materialism of Vogt and others, which considered “mental” properties such as sensation as material. To be sure, du Bois-Reymond argued that monism in general was “the easiest solution” to connect physical and mental properties, and the knowledge of the nature of matter would provide an understanding of “how the underlying substance senses, desires and thinks,” but since we couldn’t cross the limits of scientific knowledge he concluded that it was “idle” to dwell on the hypothesis. Thus he praised Karl Vogt’s materialism for connecting mind and matter, but he pointed out that the flaw of Vogt’s famous simile of thought and urine – which “represents mental activity as being the result of material conditions in the brain” – was suggesting “that the soul’s activity is in its own nature as intelligible from the structure of the brain, as is the secretion from the structure of a gland” [i.e. the kidney].[[70]](#endnote-70) Knowledge of structural elements of matter and lawful connections among the motion of material particles would never allow to cross over into the determination of matter itself. The model of scientific inference and its limits was the law of the conservation of energy: “the mechanical cause passes completely into the mechanical effect. Hence the mental phenomena, which in the brain appear in company with material phenomena, are, so far as our understanding is concerned, void of sufficient basis*”.* This lack of possible evidence determined the conclusion that the facts of sensation cannot be *explained* by material grounds, although mind can be considered as a “product of material conditions”.[[71]](#endnote-71) On the whole, neither life processes nor sensation could motivate the extension of scientific knowledge beyond the field of mechanical concepts.

Du Bois-Reymond has been described as a “non-reductive materialist”, but his theses that matter itself is inscrutable, and we can merely connect natural properties with matter and dispose of supernatural causes of life and mind, are closer to what Lange described as a materialist maxim of investigation.[[72]](#endnote-72) Indeed he seems to reject precisely the kind of metaphysically laden, substantialist materialism that Helmholtz had already ruled out as unscientific. This explains the way du Bois-Reymond reacted to the resort to material vital forces among fellow scientists such as Ernst Haeckel.

5. Haeckel and “metaphysical materialism” (again)

After the publication of his speech, du Bois-Reymond was attacked by many fellow scientists for his position of (allegedly) unsurpassable limits of science, including Carl Nägeli and Ernst Haeckel. In particular, Haeckel – a fellow student of Müller – presented du Bois-Reymond’s views as a reactionary defense of “obscurantism”.[[73]](#endnote-73) In his popular book *The Riddle of the Universe (die Welträtsel)*, Haeckel responded to the challenge of du Bois-Reymond in the speech *The Seven World Riddles* (1890), where the origin of motion in the universe, the essence of matter and the rise of sensation, and “consciousness” in general, were presented as “transcendent” problems that natural science could never solve. Haeckel argued that there were no limits of natural science: consciousness was a “function” of the neurons of the brain cortex, just as life was a function of the cells.[[74]](#endnote-74) But this analogy between the explanation of life (which du Bois-Reymond admitted as a scientific problem that could be solved by chemistry) and the explanation of sensation was not meant to support a kind of reductive materialism. Haeckel maintained that the explanation of life processes entailed that simple organisms and even atoms were endowed with cognitive capacities:

“Without the admission of an atomic soul [*Atomseele*] the most common and general phenomena of chemistry are unexplainable. Pleasure and displeasure, desire and aversion, attraction and repulsion must be common to every atom, since the formation and dissolution of any chemical bond can only be explained by sensation and will”.[[75]](#endnote-75)

Du Bois-Reymond quoted this passage in the *Seven World-Riddles*, commenting that this sort of speculation was “in full coherence with the spirit of a false philosophy of nature” and that Haeckel was resorting to “anthropomorphic phantasies of the childhood of science”.[[76]](#endnote-76)

To be sure, Haeckel’s position was not isolated in German biology of his time, as the legacy of early 19th century natural philosophy from Goethe to Schelling was still widespread. The development of cell theory had prompted the return to the idea that particles of living matter display intrinsically different properties from particles of inorganic matter, and that the whole organism – e.g. a human being – is but a composite of living individuals. Rudolf Virchow, notably, argued that the new theory disposed of the soul of ancient vitalism, but at the same time entailed the existence of a “vital force”, different from physical molecular forces, in order to explain cellular motions.[[77]](#endnote-77) This problem was also raised by discussions on evolution and the hypothesis that primitive forms of organism might contain a substance named “protoplasm”, which concentrated in it all the basic functions of cells. Haeckel was a prominent defender of Darwinism in Germany and participated to these discussions on cell theory and original organisms, focusing on a number of amoeboid organisms – which he calls “Monera” ­– displaying life functions that “flow immediately from formless organic material”. In works of the 1860s, Haeckel notably doubted whether “irritability” might entail proper “sensation” in simple organisms. Eventually he developed a double-sided thesis: on the one hand, he maintained that the distinctive properties of life, including consciousness and thought, arise from chemical elements with no need for further “forces”. On the other hand, he combined this physicalism with a broader panpsychist claim that he borrowed from Spinoza, Goethe, and more recently from the work of the astrophysicist Friedrich Zöllner (whom we have mentioned above): a mental element had to be present in any part of matter.[[78]](#endnote-78) This is the ground of Haeckel’s claim, in *The World-Riddles*, that mind is a “function” of the brain and, at the same time, physical objects have mental properties down to atoms.[[79]](#endnote-79)

Although Haeckel was also not alone in connecting a kind of monism to Darwinian biology, this metaphysical position attracted several critiques. Haeckel apparently confirmed Lange’s claim that vital materialism tends to turn into panpsychism. In 1901 another neo-Kantian philosopher, Erich Adickes, replied in the essay “Kant contra Haeckel” attacking the latter’s “scientific dogmatism”, and defending the Kantian view of philosophy as a “theory of knowledge”. According to Adickes, Haeckel’s “official” reprise of Spinoza was but an “apparent monism”, which actually reduced mental properties to properties of atoms and boiled down to materialism.[[80]](#endnote-80) Adickes agreed with Lange’s phenomenalistic critique of materialism. Thus his critique of Haeckel can be seen as part of the series of post-Kantian controversies that we have considered starting from Kant’s essay on Sömmering.

6. Coda: Does Materialism entail Panpsychism?

The theoretical tensions that I have documented in post-Kantian scenarios did not disappear in the 20th century. While the logical empiricists’ critique of the metaphysical hypotheses, such as materialism and pantheism, persistently influenced epistemological debates, metaphysical revivals regularly occurred, notably the rise of Bergsonism in France and the metaphysical investigation of consciousness in late 20th century analytic philosophy. The post-Kantian scenarios that I have sketched, I submit, provide a valuable vantage point to reconsider these revivals.

For example, the thesis that materialism is unstable and tends to panpsychism has been notably revived by David Chalmers in his discussion of the “hard problem of consciousness”. Chalmers has argued that, given the existence of consciousness, the fact that consciousness does not logically supervene on material properties and the causal closure of the world, materialism, conceived as a theory that admits the epistemological difficulty with mental properties, cannot stand as a metaphysical hypothesis: if coherent at all, it “must plausibly eventually reduce to some more specific view”.[[81]](#endnote-81) Chalmers, concludes that materialism has to collapse into Russellian monism or a kind of dualism. A monistic view of the problem solution has been defended by Galen Strawson, who defines Materialism – or “physicalism” – as “the view that every real, concrete phenomenon in the universe is […] physical”. Given that consciousness is “the fundamental given natural fact” and “nothing is more certain than the existence of experience”, Strawson claims that materialism entails panpsychism, as “the view that the existence of every real concrete thing involves experiential being”. A crucial premise for this conclusion is the inscrutability of matter. Our ignorance of the intrinsic properties of matter entails that there is “no good reason to think that we know anything about the physical that gives us any reason to find any problem in the idea that experiential phenomena are physical phenomena”.[[82]](#endnote-82) These examples are not representative of a standard view in natural science, and they have been criticized by means of a provocative comparison with the old theories of vital force.[[83]](#endnote-83) Yet this kind of metaphysical revival is one of the trends of contemporary cognitive sciences. Some philosophically inclined scientists – notably Damasio – have endorsed ideas such as “proto-cognition” and “proto-feelings” of particles or cells, reviving ideas of Spinozism and Enlightenment vitalism.[[84]](#endnote-84) From this point of view, the Kantian legacy that I have introduced represents an interesting case study, for it shares most of the premises of the above quoted philosophers on the epistemic limits of natural science, but rejects their conclusions, and the very possibility of establishing any truth about this kind of hypotheses.

1. *Kant’s gesammelte Schriften* (ed. Royal Prussian Academy of Science) (Reimer, Berlin 1900–), vol. 4, pp. 544; vol. 5, p. 391 and *passim*. [↑](#endnote-ref-1)
2. For a general reconstruction see John H. Zammito, *The Gestation of German Biology* (University of Chicago Press, Chicago 2018). [↑](#endnote-ref-2)
3. For the notion of ‘vital materialism’, which I will use in this article to address figures like Maupertuis, see Oswei Temkin, ‘Materialism in French and German Physiology of the Early Nineteenth Century’, in *The Double Face of Janus and other Essays in the History of Medicine* (The Johns Hopkins University Press, Baltimore, 1977), pp. 340–344. On materialism as “metaphysics” and its connection to natural science in the modern times see Charles T. Wolfe, *Materialism. A Historico-Philosophical Introduction* (Springer, Cham, 2016). For the distinction of metaphysical or “substantival” vitalism from the epistemologically motivated “functional” vitalism see Id., “Il fascino discreto del vitalismo settecentesco e le sue riproposizioni”, in  
   In *Il libro della natura*, vol. 1: *Scienze e filosofia da Copernico a Darwin* (ed. Paolo Pecere) pp. 273–299 (Carocci, Rome 2015). On vitalism and its distinction from panpsychism also see id., ‘Vitalism and the Metaphysics of Life’, in *Life and Death in Early Modern Philosophy* (ed. Susan James), pp. 292-313 (Oxford University Press, Oxford, 2021). [↑](#endnote-ref-3)
4. On Kant’s early project see Martin Schönfeld, *The Philosophy of the Young Kant: The Precritical Project* (Oxford University Press, Oxford 2000). [↑](#endnote-ref-4)
5. *Kant’s gesammelte Schriften* cit., vol. 2, p. 331. [↑](#endnote-ref-5)
6. On Kant’s account in the *Dreams* see: Philippe Huneman, *Métaphysique et biologie: Kant et la constitution du concept d’organisme* (Kimé, Paris, 2008), pp. 171–174; Paolo Pecere, ‘Stahl was often closer to the truth’: Kant’s second thoughts on animism, monadology, and hylozoism’, *HOPOS*, 11(2) (2021), https://doi .org/10.1086/715879. [↑](#endnote-ref-6)
7. Th*e Leibniz-Stahl Controversy* (ed. François Duchesneau and Justin E. H. Smith), p. 49 (Yale University Press, New Haven CT, 2016). [↑](#endnote-ref-7)
8. “To fix it [the soul] to a point, to diffuse it all over many points, are only abusive expressions, idola tribus” Georg Wilhelm Leibniz, *Die philosophischen Schriften* (ed. K. Gerhardt) 7 vols. (Weidemann, Berlin, 1875), vol. 7, pp. 365­–366. [↑](#endnote-ref-8)
9. On Kant’s problem with monadology and materialism see Paolo Pecere, ‘Materialism, monadology and Newtonian forces: The Turn in Kant’s Theory of Matter’, *Quaestio*, 16 (2016), pp. 167–189. [↑](#endnote-ref-9)
10. *Kant’s gesammelte Schriften* cit., vol. 2, p. 330. [↑](#endnote-ref-10)
11. On ‘mechanistic’ and ‘vital materialism’ see Falk Wunderlich, ‘Varieties of Early Modern Materialism’, *Br. J. Hist. Philos*. **24**(5) (2016), pp. 797–813. [↑](#endnote-ref-11)
12. *Kant’s gesammelte Schriften* cit., vol. 2, p. 330. [↑](#endnote-ref-12)
13. *Kant’s gesammelte Schriften* cit., vol. 2, p. 331. [↑](#endnote-ref-13)
14. Zammito, *The Gestation* cit., p. 81. [↑](#endnote-ref-14)
15. Martin Knutzen, *Philosophische Abhandlung von der immateriellen Natur der Seele* (Hartung, Königsberg, 1744), p. 38. Julien Offray de La Mettrie, *L’Homme-Machine* [1747] (Engl. tr. Princeton University Press, Princeton NJ, 1960), p. 148. [↑](#endnote-ref-15)
16. *Kant’s gesammelte Schriften* cit., vol. 2, pp. 323, 327, 341 (“flexibility”). [↑](#endnote-ref-16)
17. Ivi, vol. 3, 21, 273–274. On the issue of “materialism” in German philosophy from Leibniz to Kant, including an account of its different meanings, see Paola Rumore, *Materia cogitans.* *L'Aufklärung di fronte al materialismo*, Olms, Hildesheim 2013. [↑](#endnote-ref-17)
18. For a detailed analysis of this work see Michael Friedman, *Kant's Construction of Nature: A Reading of the. Metaphysical Foundations of Natural Science*, Cambridge University Press, Cambridge 2013. Cf. P. Pecere, *La filosofia della natura in Kant*, Edizioni di pagina, Bari 2009. [↑](#endnote-ref-18)
19. Johann Friedrich Blumenbach, *Über den Bildungstrieb und das Zeugungsgeschichte* (Dietrich, Gottingen, 1781; repr. Fisher, Stuttgart 1971), pp. 12–13. [↑](#endnote-ref-19)
20. *Kant’s gesammelte Schriften* cit., vol. 5, p. 424. Kant to Blumenbach (5 August 1790), in *Kant’s gesammelte Schriften* cit., vol. 11, p. 185. [↑](#endnote-ref-20)
21. Johann Friedrich Blumenbach, *Über den Bildungstrieb* (2nd ed., Johann Christian Dieterich, Göttingen, 1789), pp. 25–26. Blumenbach repeated this claim in successive books, including the second edition of his *Handbuch der Naturgeschichte* (Johann Christian Dieterich, Göttingen, 1788), p. 14. [↑](#endnote-ref-21)
22. *Kant’s gesammelte Schriften* cit., vol. 5, p. 392. [↑](#endnote-ref-22)
23. On Kant’s influence on Blumenbach see Timothy Lenoir, ‘Kant, Blumenbach, and Vital Materialism in German Biology’, *Isis,* **71** (1980), pp. 77-108. Peter McLaughlin, “Blumenbach und der Bildungstrieb: Zum Ver­hältnis von epigenetischer Embryologie und typologischen Artbegriff” *Medizinhist. J*., **17** (1982), pp. 357–372. Lenoir coined the term “teleomechanism” to define Kant’s and Blumenbach’s shared approach. This view has been questioned by Robert Richards, ‘Kant and Blumenbach on the *Bildungstrieb*: A Historical Misunderstanding’, *Stud. Hist. Phil. Biol. & Biomed. Sci.*, **31**(1), (2000), pp. 11–32. Zammito has similarly questioned this account, arguing that Kant’s notion of the “supersensibile substratum” was objective after all and that the picture of Kant’s philosophy was often confused in German science, hence Blumenbach’s “affiliation with Kant is best understood as a misunderstanding”, while *Herder* should be considered as a closer philosophical model for Blumenbach’s biology (*The Gestation of German Biology* cit., pp. 235–237, and chaps. 8–10). [↑](#endnote-ref-23)
24. Johann Gottfried Herder, *Ideen zur Philosophie der Geschichte der Menschheit* [1784], in *Sämtliche Werke*, vol. 13 (Olms, Hildesheim,1967), pp. 169, 172, 199–201. [↑](#endnote-ref-24)
25. Carl Friedrich Kielmeyer, 1993. *Über die Verhältnisse der organischen Kräfte unter einander in der Reihe der verschiedenen Organisationen, die Gesetze und Folgen dieser Verhältnisse* [1793] (Basilisken, Marburg, 1993), p. 37. [↑](#endnote-ref-25)
26. Zammito, *The Gestation of German Biology* cit., p. 280. [↑](#endnote-ref-26)
27. Samuel Sömmering, *Über das Organ der Seele* (Nicolovius, Königsberg, 1796), pp. 37–42. [↑](#endnote-ref-27)
28. Ivi, p. 156. [↑](#endnote-ref-28)
29. Kant to Markus Herz, toward the end of 1773, KgS X, 145. See Thomas Sturm, *Kant und die Wissenschaften vom Menschen* (Mentis, Münster 2009), p. 265 (and the whole chapter on “The Critique of Physiological Anthropology”). [↑](#endnote-ref-29)
30. *Kant’s gesammelte Schriften*, vol. 12, 34, 35. [↑](#endnote-ref-30)
31. Ivi, vol. 13, p. 398 (manuscript draft of the essay on Sömmering). [↑](#endnote-ref-31)
32. Ibid and cf. Ivi, p. 414. [↑](#endnote-ref-32)
33. Ivi, pp. 398–399. [↑](#endnote-ref-33)
34. Ivi, vol. 3, 278. [↑](#endnote-ref-34)
35. Ivi, vol. 12, p. 31. [↑](#endnote-ref-35)
36. *Gemüth* – translated with “mind” in the Cambridge Edition – is literally the “faculty (animus)” of unifying “given representations”, that is, the faculty of empirical thinking as opposed to “pure consciousness” (ivi, vol. 8, p. 178; cf. vol. 12, p. 34). [↑](#endnote-ref-36)
37. Ivi, vol. 12, pp. 33–34, 32n. On Kant’s perspective and arguments in this essay see Paolo Pecere, ‘Kant’s Über das Organ der Seele and the Limits of Physiology’, in *Kant’s Shorter Writings* (ed. R. Hanna *et al*.), pp. 214–30 (Cambridge Scholars Publishing, Newcastle upon Tyne, 2016). [↑](#endnote-ref-37)
38. Zammito, *The Gestation of German Biology* cit., p. 237. [↑](#endnote-ref-38)
39. Johannes Müller, *Handbuch der Physiologie des Menschen*, vol. 2 (Coblenz, Hölscher, 1840), pp. 506–507. [↑](#endnote-ref-39)
40. See Frederick Gregory, *Scientific Materialism in Nineteenth Century Germany* (Dordrecht, Reidel, 1977); *Weltanschauung, Philosophie und Naturwissenschaft im 19. Jahrhundert* (eds. Kurt Bayertz, Myriam Gerhard, and Walter Jaeschke), Bd. 3. *Der Ignorabimus-Streit* (Hamburg, Meiner, 2007). [↑](#endnote-ref-40)
41. On du Bois-Reymond and his legacy see Gabriel Finkelstein, *Emil du Bois-Reymond: Neuroscience, Self, and Society in Nineteenth-Century* *Germany* (The MIT Press, Cambridge, MA/London 2013), in particular at p. 62 for the program of the “Berlin Physical Society”. On Helmholtz and the Kantian legacy in physiology see Paolo Pecere, ‘“Physiological Kantianism” and the “organization of the mind”: a reconsideration’, *Intellectual History Review* (2020), <https://doi.org/10.1080/17496977.2020.1784596>, pp. 3-4, 7-9. [↑](#endnote-ref-41)
42. On Kant’s “universal history” and Humboldt see Hans Beck, *Alexander von Humboldt*, vol. 2 (Steiner, Wiesbaden, 1961), pp. 225–227. On geography see Richard Hartshorne, “The Concept of Geography as a Science of Space, from Kant and Humboldt to Hettner”, *Ann. Assoc. of American Geographers*, 48(2) (1958), pp. 97–108. On Humboldt, life sciences and vital force (with a mention of the importance of Kant) see Robert J. Richards, *The romantic conception of life: science and philosophy in the age of Goethe* (Chicago University Press, Chicago, 2002), pp. 316–321. [↑](#endnote-ref-42)
43. Alexander von Humboldt, *Florae Fribergensis specimen, plantas cryptogamicas praesertim subterraneas exhibens* (Rottman, Berlin, 1793), pp. 133–135 (n. 1, 2). [↑](#endnote-ref-43)
44. Alexander von Humboldt, “Die Lebenskraft oder der Rhodische Genius. Eine Erzählung”, *Die Horen*, 1, 1795, pp. 90–96. [↑](#endnote-ref-44)
45. Alexander von Humboldt, *Versuch über die gereizte Muskel-und Nervenfaser, nebst Vermuthungen über den chemischen Process des Lebens in der Thier- und Pflanzenwelt*, vol. 2 (Decker, Posen and Rottmann, Berlin, 1797), pp. 43, 48–49. [↑](#endnote-ref-45)
46. Ivi, p. 433. [↑](#endnote-ref-46)
47. Ivi, pp. 59–60. [↑](#endnote-ref-47)
48. Ivi, p. 434. [↑](#endnote-ref-48)
49. Ivi, p. 433 and see Richards, *The romantic conception* cit., pp. 257–259. [↑](#endnote-ref-49)
50. J. Ch. Reil, “Von der Lebenskraft”, in *Archiv für Physiologie*, 1, 1796, p. 11. [↑](#endnote-ref-50)
51. Ivi, p. 50. [↑](#endnote-ref-51)
52. Richards, *The romantic conception* cit., p. 292. [↑](#endnote-ref-52)
53. Alexander von Humboldt, *Kosmos, Entwurf einer physischen Weltbeschreibung,* 5 vols. (Cotta, Stuttgart, 1845–58), I, p. 367. [↑](#endnote-ref-53)
54. Alexander von Humboldt, *Kosmos* cit., I, pp. 68-69, 83; vol. II, p. 10. [↑](#endnote-ref-54)
55. Hermann von Helmholtz, “Über die Erhaltung der Kraft”, in *Wissenschaftliche Abhandlungen*, vol. I (Barth, Leipzig, 1882), pp. 65-66. Helmholtz’s result was first presented in the paper “Ueber den Stoffverbrauch bei der Muskelaction" (1845). See Leo Koenigsberger, *Hermann von Helmholtz*, vol. 1 (Vieweg, Braunschweig, 1902), pp. 58–59. [↑](#endnote-ref-55)
56. Hermann von Helmholtz, “On the Application of the Law of the Conservation of Force to Organic Nature”, *Not. Proc. Meet. Memb. R. Instn Gt Br.* **3**, (1861), pp. 347–357; repr. in Id., *Wiss. Abh.* cit., vol. 3, at p. 579: “There may be other agents acting in the living body, than those agents which act in the inorganic world; but those forces as far as they cause chemical and mechanical influences in the body, must be quite of the same character as inorganic forces, in this at least, that their effects must be ruled by necessity”. This popular lecture was read at the Royal Society in London. See David Cahan, “Helmholtz and the British scientific elite: From force conservation to energy conservation”, *Notes Rec. R. Soc.***66 (2012),** 55–68. [↑](#endnote-ref-56)
57. Königsberger, *Helmholtz* cit., vol. I, p. 81. Cf. Hermann von Helmhotz, “Das Denken in der Medizin” (1877), in *Wiss Abh* II, 178–9. [↑](#endnote-ref-57)
58. Hermann von Helmholtz, *Handbuch der Physiologischen Optick* (Voss, Leipzig, 1867), pp. 430, 447, 454. [↑](#endnote-ref-58)
59. Ivi, p. 796. Cf. Id., ““Das Denken in der Medizin” cit., pp*.* 186–187. [↑](#endnote-ref-59)
60. Friedrich Lange, *Geschichte des Materialismus und Kritik seiner Bedeutung in der Gegenwart*,2nd ed., 2 vols. (Iserlohn, Baedeker, 1873/1875), vol. 1, pp. 60, 440. [↑](#endnote-ref-60)
61. Ivi, vol. 2, p. 398, [↑](#endnote-ref-61)
62. Friedrich Lange, *Geschichte* cit.,1st ed. (Iserlohn: Baedeker, 1866), 493, 496. [↑](#endnote-ref-62)
63. Ivi, pp. 150, 214, 217. [↑](#endnote-ref-63)
64. Wundt argued that materialism has the “immanent requirement” to decide whether to deny psychic phenomena or to endorse them as “original properties”, thus turning into dualism or Spinozian monism (Wilhem Wundt, *Grundzüge der physiologischen Psychologie*, 2 vols (2nd ed., Leipzig, Engelmann, 1880), vol. 2, p. 444. On Haeckel see below § 5. [↑](#endnote-ref-64)
65. Friedrich Lange, *Geschichte* cit., 2nd. ed., vol. 2, pp. 165, 408ff.. On Lange’s physiology of the senses see (most recently) Scott Edgar, “The Limits of Experience and Explanation: F. A. Lange and Ernst Mach on Things in Themselves.” *British Journal for the History of Philosophy*, 21(1), pp. 100–121; Id., “The Physiology of the Sense Organs and Early Neo-Kantian Conceptions of Objectivity: Helmholtz, Lange, Liebmann”, in *Objectivity in Science* (ed. F. Padovani, A. Richardson, J.Y. Tsou) (Heidelberg *et al.*, Springer, 2015), pp. 101-122; Id., Pecere, “Physiological Kantianism” cit. I thank an anonymous reviewer for prompting me to clarify the difference between Kant’s original idealist account and Lange’s in this passage. [↑](#endnote-ref-65)
66. This contrast between a relational and phenomenalistic theory of knowledge, on the one hand, and a substantialist and transcendent one (including vitalism), on the other hand, was appreciated by Bertrand Russell in his Preface to the English translation of the *History of Materialism* (London, Kegan Paul, 1925), pp. vi, xvii, xix. It served as a model of the anti-metaphysical philosophy, which, in turn, would be questioned at the end of the 20th century (see below § 7). [↑](#endnote-ref-66)
67. Emil du Bois-Reymond, “Über die Lebenskraft”, in Id., *Reden*. vol. 2 (Leipzig, Veit, 1887), pp. 9, 13. [↑](#endnote-ref-67)
68. Ivi, pp. 17–18 and cf. 6 on “function” as basic concept of natural science. [↑](#endnote-ref-68)
69. Emil du Bois-Reymond, “Über die Grenzen des Naturerkennens”, in Id., *Reden*, vol. 1 (Leipzig, Veit, 1886) pp. 106, 111-112. [↑](#endnote-ref-69)
70. Ivi, pp. 128–129. [↑](#endnote-ref-70)
71. Ivi, p. 127. [↑](#endnote-ref-71)
72. “Non-reductive materialist”: see Neil Tennant, “Mind, Mathematics and the Ignorabimusstreit.” British Journal for the History of Philosophy, 15(4), 2007, pp. 745–773, in part. at p. 748. On du Bois-Reymond’s position and its Kantian elements see Paolo Pecere, “Reconsidering the *Ignorabimus*: du Bois-Reymond and the hard problem of consciousness”, *Science in Context* 33 (2020), pp. 1–18. Also see Michael Hagner, “The soul and the brain between anatomy and Naturphilosophie in the early nineteenth century”, *Medical History*, 36(1), pp. 1–33. [↑](#endnote-ref-72)
73. Ernst Haeckel, *Antropogenie oder Entwickelungsgeschichte des Menschen* (Leipzig, Engelmann, 1874), pp. xiiff.. [↑](#endnote-ref-73)
74. Ernst Haeckel, *Die Welträthsel. Gemeinverständliche Studien über monistische Philosophie*, A. Kröner, Stuttgart, 1899, 11. [↑](#endnote-ref-74)
75. Ernst Hackel, *Die* *Perigenesis der Plastidule oder die Wellenzeugung der Lebenstheilchen. Ein Versuch zur mechanischen Erklärung der elementaren Lebensvorgänge,* 1876) [↑](#endnote-ref-75)
76. Emil du Bois-Reymond, “Die Sieben Welträtsel”, in Id., *Reden*, vol. 1 (Leipzig, Veit, 1886) pp. 388, 413 n. 8. On the “*Ignorabimus* controversy” initiated by du Bois-Reymond’s speech see Kurt Bayertz, Myriam Gerhard, and Walter Jaeschke (eds.), *Weltanschauung, Philosophie und Naturwissenschaft im 19. Jahrhundert*, Bd. 3. *Der Ignorabimus-Streit* (Hamburg, Meiner, 2007). [↑](#endnote-ref-76)
77. *Die Vorlesungen Rudolf Virchows über Allgemeine Pathologische Anatomie aus dem Wintersemester 1855/56 in Würzburg* (Jena, Fischer, 1930), p. 30. [↑](#endnote-ref-77)
78. On these aspects of Haeckel’s thought see Robert J. Richards, *The tragic sense of life: Ernst Haeckel and the struggle over evolutionary Thought* (Chicago, The University of Chicago Press, 2008), pp. 47-8, 123, 314, 400. Also see Trevor Pearce, “‘Protoplasm Feels’: The Role of Physiology in Peirce's Evolutionary Metaphysics”, *HOPOS* 8, (2018), pp. 34-37. Pearce points out that Haeckel’s turn to full-fledged panpsychism happened in the mid 1870s. [↑](#endnote-ref-78)
79. Ernst Haeckel, *Die Welträthsel, gemeinverständliche Studien über Monistische Philosophie* (Bonn, Emil Strauss, 1899), p. 11 and chap. 12. [↑](#endnote-ref-79)
80. Erich Adrickes, *Kant contra Haeckel. Erkenntnistheorie gegen Naturwissenschaftiche Dogmatismus* (Berlin, Reither & Reichard, 1901), pp. 10–12 and passim. [↑](#endnote-ref-80)
81. David J. Chalmers. *The Conscious Mind. In Search of a Fundamental Theory* (Oxford, Oxford University Press, 1996), p. 162. [↑](#endnote-ref-81)
82. # Galen Strawson, “Realistic Monism: Why Physicalism Entails Panpsychism”, in Id., *Real materialism and other essays* (Oxford, Clarendon Press, 2008), pp. 53–54, 57.

    [↑](#endnote-ref-82)
83. Daniel Dennett, *Consciousness Explained* (New York, Back Bay Books, 1991) p. 314–315. [↑](#endnote-ref-83)
84. Antonio Damasio, *Self Comes to Mind. Constructing the Conscious Brain* (New York, Pantheon, 2010), pp. 252, 258. [↑](#endnote-ref-84)