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**Journal name**: Biosemiotics

**Title**: Weismann’s Barrier and Crick’s Barrier Still Preclude Two Kinds of La-marckism

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**Weismann’s Barrier and Crick’s Barrier Still Preclude**

**Two Kinds of Lamarckism**

**Abstract**

In his target article ‘The Illusions of the Modern Synthesis’, Denis Noble argues that the Mo-dern Synthesis is undermined by the major findings of molecular biology. The supposed falsi-fication of Weisman’s Barrier and of standard interpretations of Francis Crick’s Central Dogma has paved the way for Lamarckian forms of inheritance which are prohibited by that theory of evolution. I argue that August Weismann postulated two barriers against two kinds of Lamar-ckism. However, his second barrier was speculative. It was made more concrete through the articulation of Francis Crick’s Central Dogma. These two barriers still preclude Lamarckism or Lamarckian forms of inheritance, as understood by Weismann.

**Keywords:** August Weismann, Lamarckism, Barrier, Central Dogma, Francis Crick

**Introduction**

Referring to Tønnessen’s (2015) thesis that human language is internal to our *Umwelt*, Noble (2021) calls the language of the Modern Synthesis (henceforth MS) its *Umwelt* and claims that it is highly problematic. Furthermore, the findings of molecular biology have undermined the MS on its central assumptions or motivations, “i.e., the Weismann Barrier, the isolation of the genome from the organism and the environment, and the exclusion of Lamarckian forms of in-heritance (…)” (Noble, 2021: 21). As he explains elsewhere (Noble, 2016, pp. 232-238), the MS cannot be amended but should be replaced with a new, Integrative Synthesis. This new theory of evolution is based on the principle of Biological Relativity and avoids the dogmatic exclusion of the inheritance of acquired characteristics, a highly problematic and “central fea-ture” (Noble, 2016, p. 238) of the MS. In what follows, I will argue that it is Noble’s own lexi-con that is problematic and that, properly understood, the Weismann Barrier is intact, the Cen-tral Dogma (i.e., Crick’s Barrier) still stands and Lamarckian forms of inheritance which are prohibited by the MS (i.e., Lamarckism sensu Weismann) are still precluded by these two bar-riers. That does not mean that there are no problems with the MS but it is less undermined than Noble claims it to be: it should not be replaced but can be amended and extended.

**Lamarckism**

Noble (2021: 8) claims that Lamarck did not believe in the inheritance of mutilations and that what he “really thought was that changes developed during life that were a *functional advan-tage* to an organism could be inherited *precisely because they were a functional advantage*.”[[1]](#endnote-1) However, we should distinguish between Lamarck’s general belief in the inheritance of acqui-red somatic characters and the specific use he made of that, at the time, self-evident belief (Zirkle, 1946) in his theory of evolution. As an evolutionist, he used the doctrine of the inheri-tance of acquired somatic characteristics to explain functional evolutionary changes or adapta-tions: new environments sometimes induced new habits (use or disuse), which altered the con-stitution of an animal in a functional way (in plants, the alterations were caused by changes in their nutrition). These changes were then transmitted to the offspring and became part of the race. However, the general doctrine that we now know as ‘Lamarckism’ implied that even mu-tilations might be inherited. As Lamarck himself put it in his *Histoire naturelle*: “All that has been acquired or altered in the organization of individuals during their life is preserved by generation, and transmitted to new individuals which proceed from those which have under-gone these changes” (quoted in Zirkle, 1946: 91).

 Ironically, this is also how Noble implicitly defines the phrase ‘Lamarckian forms of inhe-ritance’ (he doesn’t use the term ‘Lamarckism’), for example when he says that the Weismann Barrier (against Lamarckism) excludes the “inheritance of acquired characteristics” (Noble 2021: 7). This still popular definition was unproblematic in the mid-19th century but has in the meantime become completely inadequate (i.e., hopelessly vague). It is not difficult to under-stand why: Lamarck and his contemporaries only knew two biological dimensions: the somatic and the cultural or ‘episomatic’ dimension (Tanghe, 2019). He believed in the *somatic* inheri-tance of specific, *somatically* acquired biological characters. Of course, we now know that life counts not two but four dimensions and four kinds of inheritance systems: somatic, episomatic, genetic and epigenetic (Jablonka and Lamb, 2005; Tanghe, 2019). The genetic inheritance sys-tem is generally considered to be the main inheritance system, though. Consequently, after the discovery of genes, Lamarckism became, strictly speaking, the *genetic* inheritance of *somati-cally* acquired characters or variations (Hull, 2000). One might also distinguish between strong Lamarckism (i.e., the *genetic* inheritance of somatically acquired variations) and weak Lamar-ckism (i.e., the *non-genetic* inheritance of somatically acquired variations).

 That is certainly how Weismann interpreted Lamarckism. Winther (2001: 518, n. 4) puts it as follows: “Weismann used ‘inheritance of acquired characters’ to mean *only* ‘inheritance of acquired *somatic* characters’.” Or, more accurately: Weismann used the phrase ‘inheritance of acquired characters’ to mean only ‘*germ-plasm* inheritance of acquired *somatic* characters’. One thing is certain: the *somatic* inheritance of *somatically* acquired variations, the *genetic* inheritance of *genetically* acquired variations (i.e., mutations) and the *epigenetic* inheritance of *epigenetically* acquired variations (i.e., epimutations) do not constitute Lamarckian forms of inheritance or Lamarckism in the Weismannian or strong meaning of the term and are not pro-hibited by genetics or the MS (Tanghe, 2019).

 Evidently, that does not necessarily mean that we cannot agree to subsume all these kinds of transmissions of acquired characters (somatic or not) under the general heading of ‘Lamar-ckism’. Indeed, that is exactly what Noble seems to do with his general ‘inheritance of acquired characteristics’ definition: it implies that even the inheritance of environmentally caused muta-tions in germline DNA constitutes a problematic, Lamarckian kind of inheritance. In a similar vein, Jablonka and Lamb (2005: 229) argue that most modern biologists and scholars identify Lamarckism with Mayr’s soft inheritance: the genetic inheritance of genetic material that was modified by the soma or its environment (see Mayr, 1982: 687). However, if that is Lamar-ckism, Weismann himself was also a Lamarckist, since “he held that acquired germ-plasm va-riation was inherited” (Winther, 2001: 517) and that the germ-plasm could be modified through somatic or environmental influences (see below). In these broad but popular meanings of ‘soft inheritance’ or ‘the inheritance of acquired characters’, the general term ‘Lamarckism’ is al-most meaningless. It should, at the very least, be restricted to the (genetic or non-genetic) in-heritance of somatically acquired variations.

**Weismann’s Barrier**

Noble defines Weismann’s Barrier as “the supposed isolation of the sperm and egg cells” (Noble, 2021: 17-18), although the aforementioned enumeration of the (undermined) central assumptions of the MS seems to contradict that definition: “the Weismann Barrier, the isolation of the genome from the organism and the environment, and the exclusion of Lamarckian forms of inheritance (…)” (Noble, 2021: 21). In any case, defining Weismann’s Barrier in terms of an isolation of germ cells is, in several ways, problematic. Firstly, Weismann himself didn’t even use the metaphor of the barrier. Secondly, there can be discerned not one but two anti-Lamarckian barriers or ‘barriers’ in his work: in this sense too, a reference to ‘the’ Weismann Barrier is highly misleading. Thirdly, these barriers refer to statements about the germ-plasm, a molecular substance, not about germ cells. Fourthly, and most importantly, Weismann did not believe at all that the germ-plasm was perfectly isolated from the soma and its environment.

 Weismann did indeed not use the metaphor of a barrier. It belongs to the doctrine, called Weismannism, which dates from the early twentieth century, rather than to Weismann’s own theory (see, e.g., Winther, 2001). Modern biologists use the phrase in several ways. For ex-ample, Nilsson et al. (2020) distinguish between the original or strong Weismann Barrier and a later, weaker version of it. The former barrier claims that somatic cells do not contribute to the germline (i.e., germline cells) whereas the latter holds that hereditary information is only transmitted from germline cells to somatic cells, not from somatic cells to germline cells. These two definitions correspond, broadly, with the two anti-Lamarckian barriers that can be discer-ned in Weismann’s work.

 His main idea was that heredity is based on the so-called continuity of germ cells and, later, germ-plasm: the hereditary material is not derived from the soma, as Charles Darwin and many other naturalists had assumed, but from ancestral germ-plasm.[[2]](#endnote-2) He spoke in this respect of “‘blastogenesis,’—or origin from a germ-plasm” (Weismann, 1893: xiii) and opposed it to Dar-win’s theory of “‘pangenesis’—or origin from all parts of the body” (ibid.). The phrase ‘Weis-mann Barrier’ is a metonymy whereby, in this case, the idea of the continuity of the germ-plasm is metaphorically referred to by its *effect*: the continuity of the germ-plasm acts as a bar-rier against the genetic transmission of somatic characters that were acquired by the parent or-ganism(s). Consequently, it should not be confused with real, physiological barriers, as Noble does in his section on Barriers and Boundaries (Noble, 2021: 10-11). Physiological barriers are indeed permeable, but the metaphorical barriers that can be attributed to Weismann are not.

 Bowler (1989: 38) explains why acquired somatic variations could easily be transmitted to subsequent generations under Darwin’s pangenesis theory: “Once it is assumed that inheritance is a direct transmission of the parents’ adult characters to their offspring, it seems obvious that any changes to the parents’ bodies must affect the generative process and may thus be passed on.” By contrast, if the germ-plasm is exclusively derived from germ-plasm and not (partly) from the soma, changes to the parents’ bodies will not be passed on. This indisputable fact that genes are exclusively derived from ancestral genes (and not from the soma) is still the main reason why somatically acquired characters or variations cannot be genetically transmitted to subsequent generations.

**Crick’s Barrier**

Weismann already realized that there was yet a second way in which acquired somatic charac-ters might be transmitted to subsequent generations via the germ-plasm: not through the *pro-duction* of germ-plasm by the adult soma (vertical or inter-generational Lamarckism) but through the *translation or transmission* of acquired somatic variations into germline germ-plasm of the parent organism (horizontal or intra-generational Lamarckism). He believed that this second kind of (strong) Lamarckism was also somehow precluded, but he could not iden-tify or clarify the mechanism (‘barrier’) in question. He merely argued that it was not clear how specific acquired somatic changes might, during the life of an organism, be translated into *equi-valent* changes in its continuous germ-plasm (i.e., the germ-plasm that would give rise to the next generation) and thus be transmitted to the next generation. In this respect, he used the me-taphor of an English telegram, sent to China, that would miraculously be received in the Chi-nese language: the primary constituents in the germ cells were quite different from the body parts themselves, which implied that a transmission of an acquired somatic change to the germ-plasm would require the primary constituents in the germ cells “to vary in quite a different way from that in which the finished parts have varied; which is very like supposing that an English telegram to China is there received in the Chinese language” (Weismann, 1904, 2: 63).

 However, he did not at all claim that this mysterious second barrier against the second, ho-rizontal kind of Lamarckism *implied that the germ-plasm was completely isolated from the body and its environment* (Winther, 2001). In his essay ‘The continuity of the germ-plasm as the foundation of a theory of heredity’ (Weismann, 1891: 172-173), he put it as follows:

The nutrition and growth of the individual must exercise some influence upon its germ-cells; but in the first place this influence must be extremely slight, and in the second place it cannot act in the manner in which it is usually assumed that it takes place. A change of growth at the periphery of an organism, as in the case of an ‘Exercierknochen,’ can never cause such a change in the molecular structure of the germ-plasm as would augment the predisposition ‘Excierknochen,’ so that the son would inherit and increased susceptibility of the bony tissue or even of the particular bone in question.

Put differently: he only claimed that *specific* changes in the soma could not generate *equivalent* modifications of the germ-plasm.

 This second barrier was rather speculative, though. It was Francis Crick who, in 1957, ex-plained its exact nature (i.e., realised why, exactly, horizontal Lamarckism is impossible): even information about the (altered) sequence of amino acids flows in only one direction, from DNA and RNA to proteins, not the other way around, let alone information about more complex acquired somatic characters. As Mayr (1982: 824) later put it: thanks to the discovery of the molecular structure of DNA, “the last nail could be hammered into the coffin of the theory of the inheritance of acquired characters.” Jokingly, Crick called his statement about the unidi-rectional flow of sequence information the Central Dogma, which he later regretted. With the benefit of hindsight, he might better have called it Crick’s Barrier.

 Noble’s statement that this barrier is not the new embodiment of Weismann’s Barrier, as so-me scholars claim, is only correct if we follow his definition of that phrase or if we identify it with the idea of the continuity of the germ-plasm. However, it can (contra Noble) indeed, be interpreted as the new embodiment of Weismann’s second, speculative and unidentified bar-rier. Noble’s claim that Crick modified his original statement of the Central Dogma is also problematic: in 1970, he merely repeated what he had stated in 1957 (Cobb, 2017). It is Wat-son’s version of the Central Dogma that proved to be inaccurate, not Crick’s version. Lastly, it may be correct that so-called extra-cellular vesicles (EVs), little particles that transmit various molecules, including nucleic acids, between cells, can carry information to the germ cells, that does not mean that they “pass straight through Weismann’s so-called barrier” (Noble 2021: 10) since they do not transmit information about (altered) amino acid sequences to germline DNA, let alone contribute to the production of that germline DNA. Put differently: these vesicles only pass through Noble’s imaginary Weismann Barrier, not through the real anti-Lamarckian bar-riers that can be discerned in his work.

 Of course, Weismann’s claim that the germ-plasm is not completely and perfectly isolated from its (somatic) environment has proven to be correct. That mutations are not always com-pletely random would, nonetheless, have surprised him. However, contrary to what metaphors like ‘genetic engineering’ (Shapiro, 2011) and ‘the wisdom of the genes’ (Wills, 1989) suggest, genomes or organisms cannot at will generate *adaptive* genetic mutations, let alone insert in the genetic code somatically acquired variations.

**Why the MS is still standing**

The kind of Lamarckism that Weismann attacked and that is prohibited by the MS (i.e., strong Lamarckism) remains as impossible as ever: specific somatically acquired variations cannot be genetically inherited because (1) DNA (or RNA) is only derived from ancestral DNA (or RNA), not from the adult soma (Weismann’s Barrier) and because (2) information about the sequence of amino acids cannot flow (back) to DNA (or RNA), let alone information about more complex acquired somatic variations (Crick’s Barrier). If we follow Weismann’s defini-tion of the word, the sporadic transgenerational inheritance, in certain species, of epimutations cannot be called Lamarckism either, even if this inheritance system reproduces, in subsequent generations, somatic variations (since it does not modify the DNA). Noble says that we can all be taken in by our linguistic illusions without realizing that is what they are. He refers specifi-cally to metaphors and analogies that are taken literally. As we saw, ‘Weismann’s Barrier’ is an example of such an illusion: it is a metaphor that Noble takes literally. Often, we also use common terms and phrases in a very careless and thoughtless way and/or in ways that suit our narrative (‘straw men’). Noble’s attack against the MS seems to me to be largely based on such all too human, sloppy and self-serving semantics.

 Of course, that does not mean that the MS is flawless and that Noble’s criticism is entirely baseless. Historically, it crystallized around one preparadigmatic approach of evolution, that of population genetics (Tanghe et al., 2018, 2021).[[3]](#endnote-3) Or, as Müller (2017: 2) puts it: “The for-malized core of the MS theory was—and still is—population genetics, a mathematical account of gene frequency dynamics in populations of organisms.” This resulted in a very genecentric theory and an approach of evolution that does not sufficiently take into account the evolutio-nary role of the three other, aforementioned dimensions of life (somatic, episomatic and epige-netic). Hence the relentless criticisms, levelled at this theory, by Noble and other organismic biologists, now and in the past. Nonetheless, the genetic dimension of life remains the main one, as even severe critics of the MS like Jablonka and Lamb (2005: 5) admit, whereas natural selection is clearly the main sculptor of new species (which explains why each species excels in specific and exquisite adaptations to a specific way of life). That is probably the reason why the MS is still standing, in spite of all the criticism that it has received: it contains an important kernel of evolutionary truth.

**Notes**

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1. This claim is a classic reaction to Weismann’s famous experiments with mice: he cut off their tail without transgenerational effect. The idea that these experiments disproved “what the French biologist, Jean-Baptiste Lamarck, thought” (Noble, 2021: 8) is an illusion because La-marck did not believe in the inheritance of mutilations. However, contrary to what Noble sug-gests, Weismann’s experiment was not intended as an *experimentum crucis* against Lamar-ckism. Weismann distinguished between three kinds of somatically acquired characters: func-tional features that were acquired through the use or disuse of specific body parts or organs, features that were acquired through the influence of the environment and mutilations. His ex-periments merely suggested that mutilations were not inherited, they did not prove that the other two categories of acquired somatic characters could not be inherited. Lastly, as Mayr (1982: 699-700) points out, Weismann’s main weapon against Lamarckism was showing that the physiological mechanisms by which it was supposed to operate, did not exist (or that they were not very plausible). [↑](#endnote-ref-1)
2. As Jablonka and Lamb (2005: 38) point out: “Contrary to common belief, Weismann did not believe in the complete segregation and continuity of the germ *cells*; he knew from his own work on hydroids that germ cells can originate from somatic tissues quite late in development.” [↑](#endnote-ref-2)
3. Noble’s claim that the MS developed from a fusion between, on the one hand, the neo-Dar-winism of Alfred Russel Wallace and August Weismann and, on the other hand, Mendelian genetics (or between the Weismann Barrier and Mendelian genetics) is not correct. Neo-Darwinism and Mendelism were never fused. Historically, the MS developed from the popula-tion genetic approach of evolution (Tanghe et al., 2021).

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Zirkle, C. (1946). The early history of the idea of the inheritance of acquired characters and of pangenesis. *Transactions of the American Philosophical Society*, *35(2)*, 91-151. [↑](#endnote-ref-3)