Natural Things and Non-natural Things. The boundaries of the Hereditary in the 18th century

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1.

Hereditary transmission of bodily (physical) and behavioral (moral) features from parents to offspring became an independent subject of scientific theorizing only in the mid-decades of the nineteenth century. Only then did it become clear that the questions around the stability of species and the question about the contingent similarities responsible for family resemblance were tightly intermingled, and that both could be explained in a unified way. The problem of how transmission is effected became central issue for biologists[1]. Until then the issue of the conservation of type within a genealogical line was considered a major biological problem, whereas the phenomenology of hereditary communication of accidental traits within the lineages was normally seen as of secondary importance, except in a few local contexts, such as among animal and plant breeders and particularly among some physiologists and medical men, whose interests guided them towards considering the possibility of a regularity in the transmission of traits from ancestors to offspring within a genealogical line.

Elsewhere I defended the view that the appearance of the word *Heredity*, after the decade of the 1830's, first in French and then in other European languages, signals the turning point, as the shift from an adjectival use (in which there always was a peculiarity that was called *hereditary*) to the nominal use (*Hérédité*) reveals a growing awareness of the existence of a causal pathway responsible for observed regularities, and irregularities.[2]

I have also contended that before that period there existed among medical men and naturalists a set of accepted phenomena associated with the use of the adjective *hereditary* which were explained (or explained away) in different fashions during the different epochs.

A rather modest tradition of paying attention to how hereditary accidents are communicated through lineages can be followed from Antiquity to modern times. One can find within it a growing number of descriptions, and of attempted explanations of how the phenomenom occurs and why it can be responsible for similarities of physical and moral characters within such lineages. Some well known examples are Aristotle's mixed (cultural-hereditarian) explanation of the "Longheads"[3], Aristotle's complex physiological (dynamic) explanation of resemblance of the offspring to both parents[4]. Hippocratic and Galenic appeals to dual-seminal models of reproduction in order to account for resemblances in general.[5] Medieval astrological accounts of children's peculiarities of feature. Paracelsian influential dualistic theory, in which the

1 López-Beltrán (1992), Idem. (1994), Churchill (1987).
2 López-Beltrán (1992), Idem. (1994).
3 See Glacken (1967).
4 See Coles (1995).
5 See Boylan (1984); Idem. (1986); Jacob (1970); Lloyd (1983); Coles (1995).

imagination could induce both resemblances and monstrosities[6]. The medical attempts (after the Renaissance) to account for hereditary transmission of disease within family lines under different theoretical frameworks[7].

In 1775 I. Kant proposed an analytical distinction that can be of use in our descriptions. He suggested that hereditary variations should be called "resemblances" if "they agree with their derivations" (the offspring "takes after" one or both parents, or some ancestor), and be called degenerations (or "expeciations" according to one translator) if they moved away from the norm in such a way "that the original stem-formation cannot be restored"[8]. By the mid-eighteenth century a more or less stable set of phenomena were usually included in this peculiar category of the hereditary. Be it *resemblances* or *degenerations*, the fact that inessential peculiarities of feature not shared by all the members of a species or lineage, managed to be re-produced with some fidelity in the descendants, was considered a stumbling block for descriptive and explanatory systems in both Natural History and Physiology. It can be said that a special relationship was forged during the 17th and 18th century between such set of hereditary phenomena and the theoretical models of generation that were vehemently discussed. Resemblance to both parents, the mixed peculiarities of mules, the origins and transmission of monstrosity, etc. became a probing, evidential ground for the dispute.

What I call the *hereditary* constituted thus, from the mid decades of the eighteenth century on, a set of heterogeneous phenomena that anyone had to "save" in order to consolidate his view on generation. Chamber´s Dictionary (1738) for instance, in his entry for "Generation" mentions that Sir John Floyer "starts a difficulty which seems to press equally against each system (ovism and animalculism), taken singly"... the fact that mules partake of the characteristics of both horse and ass, and that the defenders of both systems capriciously choose the characters that favor their view as the important ones for the determination of the origin of the foetus, having the characters conveyed by the opposing sex as secondary[9]. When Diderot was preparing in the 1750´s his *Élemens de Physiologie*, he assigned a special weight the hereditary facts for the evaluation of the several systems of generation he intended to describe. The difficulty that preformationist views had in dealing with "maladies héréditaires; resemblance des parens; mules et mulets qui engendrent" was particularly highlighted by him in those notes[10]. At the beginning of his *Considérations sur les Corps Organisés*, Charles Bonnet posed some of the challenges his preformationist stance had to face:

> Si les germes sont contenus originairement dans les ovaires de la femelle, et si la matiere séminale n'est qu'une espece de fluide nourricier, destiné à devenir le principe du développement, d'où viennent les divers trait de resemblance des enfans avec ceux qui leur ont donné le jour? Pourquoi les Monstres? Comment se forment les Mulets?[11]

6 See for instance Glacken (1967) and Radl (1930).
7 See López-Beltrán (1992).
8 See Kant (1775) In Chukwade (1997). Chukwade uses the term "expeciation" to translate Kant's expression which covers similar semantical grounds as Buffon's "dégénération". Though Kant's appeal to the *original stem-formation* shows, I believe, an attempt to a generality influenced by Bonnet and Blumenbach that Buffon´s concepts lacked, I will keep "degeneration" as the adequate translation.
9 See "Generation" in *Chamber's Dictionary*, vol. I, 2nd. edition (1738).
10 See "Génération", chapter XXIV. in Diderot ([1875] 1964), pp. 182–185.
11 C.Bonnet ([1778] 1985), p. 31.

In his *Primae Linae Physiologiae*, written in the period when he still sided with epigenesis, Haller outlined the facts that pushed him *necessarily* in that direction. That organisms, especially hybrids, resemble both parents, simply "rules out" he wrote, any possibility that the new being is preformed in one or the other parent[12].

Diderot, in his adjudicator's stance, knew well that even if the dual seminal (pangenetical)[13] models could account with more ease for the hereditary transmission of features by both parents, they had serious problems of their own when facing actual anatomical observations, and detailed physiological questioning. In his *Élemens de Physiologie* he writes "Dans ce sisteme (pangenesis) placenta, et envelopes impossibles a expliquer". This kind of criticism was of course made forcefully by Haller and Bonnet against Buffon[14].

An important difference to point out concerns the character of the empirical facts that posed problems for each competing approach to generation. While detailed observation of the organs of generation, and of the development of the embryo, backed strongly preformationist (specially ovist) positions, dual seminal (pangenetic) accounts were favored by what may be called "genealogical" observations (or pedigree following); that is the following of patterns of similitude and difference within lineages. While the first set of facts depend on a focus on single individual development, the second set imply a higher level, comparative perspective, that needs the observation of many individuals belonging to several generations. The kind of features that, due to curiosity or a special interest, were followed through the generations varied widely. From very vague family resemblances to precise weird characters like an extra digit, a spectacular mole or a snub nose, or on the pathological side from general tendencies to ill health to precise ailments that develop in exactly the same manner at a particular age.

The "genealogical" approach to evidence and observation, I believe, opens up the possibility for setting external limits to physiological speculation[15], in contrast with the interior limits set by dissection and microscopy. The gathering of convincing cases of hereditary transmission of a wide range of different features, the progressive closure of different causal avenues for dealing with them[16], was one main theme of 18th century debates around generation. Important aspects of Bonnet's increasingly sophisticated ovism (in which he strategically adopts several explanatory resources from the rival dual seminal theories) were no doubt a consequence of the strains put on preformationism by hereditary facts.

It was not however an all powerful set of facts. The *hereditary* was an unstable domain, plagued with irregularities and exceptions. Not everybody agreed to grant it some reality. The fact of hereditary transmission itself could be put into question. When reviewing Buffon's theory of generation, Haller considered that the hereditary posed a challenge important enough, to go to the

12 Haller collected a series of hereditary facts in his miscelaneous collection *Similitude Parentum*. In this period he was convinced that only a new formation could acccount for them. See Roe (1981), p. 25 and Guyenot (1957), p. 295.

13 Whereas when discussing generation theories the main opposition between systems seems to be between preformation and succesion (say, epigenesis), in the case of hereditary transmission a crucial issue is the origin of the "information" concerning details (snub noses), and the opposition preformation vs. dual semen (or seed) is more relevant.

14 See Haller (1752).

15 By considering for instance the changing sets of conditions under which herediatary transmission occurs, when and with what regularity some features are preserved within a lineage.

16 For example explaining them away by ascribing them to chance ocurrences or calling them irrelevant.

extreme of denying its reality. “I prefer simply to deny to Mr. Buffon that offspring resemble their parents... the offspring are no longer images of their parents” (“et le reste de l’édifice tomberá de lui même”). Haller bases his belief in the greater number of exceptions than positive cases, and especially on the fact that internally (anatomically) there is never a shared pattern of nerves or veins between parents and offspring[17]. When commenting this extreme denial by Haller, Duchesneau writes that it illustrates with particular clarity the “individual” character of generation, in the eyes of the savants of the first half of the 18th century[18]. I believe this statement deserves some clarification. Rather than “individual” the act of generation was considered the result of natural (or divine) laws that produced each individual separately. This made the consideration of genealogical links rather irrelevant for all the fundamental issues. What however remained under dispute was if generation was to be given responsibility for all the features, both general and paticular, of the individual, or only for the former. The latter option left the door open for the all things individual, accidental, to be affected by influences from both external and ancestral (hereditary) influences, somehow independently from how generation occurred.

A denial similar to Haller’s was made in 1747 by the French physician Antoine Louis in a notorious discussion on hereditary disease[19]. What Louis was keen in establishing there is the impossibility that any anatomical (“solid”) feature of the parents can serve as the origin of a similar feature in the offspring. Any similitude has to be due to common, external causes. What is singular, individual, is the acquisition of peculiarities by each new being. Generation is entirely another question. About the possibility of hereditary disease Louis writes:

> les desordres de l’oeconomie animale doivent s’acquerir particuliérement par chaque homme: toutes les maladies seront individuelles puisqu’elles doivent être postérieures a la formation des germes qui n’ont reçu aucune alteration dans leur principe.[20]

Causal boundaries of the hereditary were drawn in a very different manner than the one we have become habituated after the instauration of our nature-nurture distinction. The explanation of individual bodily peculiarities was still closely linked to complex and open-ended medical notion such as constitution, temperament, etc. where an interaction between external and internal elements was responsible for idiosyncratic features of form and (dis)function.

The restrictive view that Haller and Louis (in their different projects) put forward for the notion of hereditary transmission of individual peculiarities somehow strangles (squeezes) the possibility of such transmission by closing the gap between two causally independent domains. The internal of the generation (or reproduction) of the germ (the first formation), and the external, circumstantial, influences, on the body. Among other things, what was being blocked by their arguments is the possibility that external influences (climate, nutrition, etc.) became somehow integrated into the lineages and eventually adopted in a non-accidental manner. For such authors, there is no conceivable way in which accidental variations of any kind could be inherited from

[17] Haller (1752), p. 32. The English translation by Phillip Sloan (“Reflections on the theory of generation of Mr. Buffon”, p.318) insists that the resemblances whose existence Haller is denying are “exact” replications, but that modification is not to be found in the French.
[18] Duchesneau (1982), footnote 132, p. 539.
[19] For a discussion of this dissertation see López-Beltrán (1994).
[20] Louis (1749), p. 35.

parents to offspring with any regularity. Even if for instance family resemblances were caused by a transmission of peculiar features from parents to offspring, they would be unimportant. For them the hereditary belonged to the domain of anecdote.

2.

A particularly suitable and surprising approximation to the conceptual frame under which hereditary matters were conceived within the medical tradition in the 18th century is given by the Galenic distinction between *natural things* and *non-natural things*. The boundary between body and environment, between physiology and milieu, for 18th century physicians can be neatly outlined with these concepts. Arnulfe D'Aumont writing for the *Encyclopédie* defined the (six) non-natural things|

> on appelle donc choses non-naturelles (d'aprés Galien[21]) celles qui en composent pas notre nature ou notre etre, mais dont l'économie animale éprouve des grands effects, des grands changémens, des grandes altérations.[22]

The list of the six non-naturals is somehow surprising for a modern eye: "l'Air, les Alimens, le Travail et le Repos, le Somneil et la Veille, les Excrétions retenues ou évacuées, et les Passions de l'Ame"[23]. Galenists contrast these external factors with those called the (seven) natural things, and which are essential part by nature of the individual's bodily constitution:

> "les élemens, les tempéramens, les parties, les humeurs, les esprits, les facultés et les actions: ce sont celles qui concurrent à former le physique de notre être".

The coherence, logical and explanatory power of this conceptual framework has been studied and discussed in several papers by William Coleman. He writes for instance that in the 18th century "the doctrine of the non-naturals provided a concise, flexible, and widely accepted framework for articulating the primary demands imposed by the conditions of existence upon men and women who sought seriously to preserve their physical well-being". (...)"The non-naturals became an integral part of a new and largely secular moral order."[24]

I believe we can also deploy such conceptual frame to focus on the way the boundary between internal and external determinations of bodily features and constitution were delineated in the period, in order to raise the question of the permeability, and , in some sense, the fluidity, between the internal (natural) and the external (non-natural) actions.

The ancient notion of the body as both a product of a mixture of humors (*crasis, temperament*) and a constant subject to multiple humoral influences played an important role in this kind of issues. Questions linked to the individuality of temperament, and to the possible explanatory role

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21 Galen inspired the concept of the six non–naturals, but did not really coin it himself. From a few suggestions he gave about which external influences were important to check in order to promote a healthy life, his followers ended up establishing a narrow list of six determinant factors. For historical studies of the concept see Nyebil (1971), Rather (1968), D'Aumont (1765), Nutton (1971).

22 D'Aumont (1765).

23 See Louis (1747), p. 18; D'Aumont (1765).

24 Coleman (1974), p. 406. See also Idem. (1984).

that geography ("airs, waters, and places") and genealogy (family, tribe, nation) could play on some of its aspects. Taking Antoine Louis' analysis again as an example of a radical view, he insisted in the extreme individuality of the body:

> Le tempérament des enfans qui naissent d'un même pere, et d'une même mere est presque tojours différent; les un son bilieux, les autres sanguins; les uns son guais, les autres sérieux, pésans: ces différences d'humeur, de caractere et d'inclination dans les freres et soeurs, sont des suites de la différence des tempéramens; et elle depend peut-être moins de la constitution primitive ou radicale, qui paroît devoir être la même dans tous les enfans; que d'une diposition acquise par la combinaison infiniment variée de toutes les choses extérieures[25].

Among the external influences Louis mentions are the weather at birth, the suffering during birth, the amount of blood in vessels at birth, the quality of the nurse's milk, the thickness of the air that was breathed during the first hours, etc. ("on ne finiroit à faire l'enumeration"). The earlier external influences have the more lasting effects on the individual's temperament. Future illnesses (or dispositions to them) are often acquired at very early stages. Louis was adamant that this acquisitions (pathological or not) were not however transmitted to the next generation

> (si la) diversité des tempéramens n'est point héréditaire, comment les maladies qui ont les suites pourroient-elles se transmettre par les parens[26] (...) les variations décident donc rien en faveur de la question des maladies héréditaires, puis quelles en vienent d'un principe interne et des dispositions inhérentes et immuables; mais qu'elles dependant uniquement des choses non-naturelles qui sont toutes extérieures[27]

As I have shown elsewhere[28], most of Louis' critics, a few decades later, focused their attack on his "unbelievable" argument against the reality of hereditary transmission on what they saw as the false assumption that temperaments are all in all individual, secondary and accidental. A considerable proportion of medics believed that the possibility of transmitting bodily peculiarities through the family line was just impossible to deny. Contrary to Haller's and Louis' attitude, they claimed, facts should be given precedence over theory.

To understand the differences on this issue among 18th century physicians an important "theoretical" division should be considered (one that to my knowledge has not been sufficiently discussed). The one which separated solidists from humoralits. The latter is of course the older tradition, and is responsible for the main conceptual scheme for Hippocratic-Galenic medicine[29]. Its rationale for a unity and diversity of human bodily and spiritual propensities turns around the balance of its fluid (humoral) constituents and their relation to the environment[30]. As Vivian Nutton wrote "the advantages of this logical scheme can best be seen in the development within humoralism of the theory of the six non-naturals"[31]. Solidism is a medical outgrowth of modern

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25 Louis (1747), p. 35.
26 Ibid., p. 37.
27 Ibid., pp. 74/75. Further on he writes: "Les hommes sont soumis a cette regle generale comme les plantes et les animaux, leur caractère et leur tempérament dependent d'une infinie des choses extérieures qui peuvent être variées a l'infini: c'est une verité recinue en médecine."
28 López-Beltrán (1994).
29 About the history of these medical doctrines and its links to hereditary disease see Portal (1808), and Adams (1814).

mechanicism. It is tied to the search for mechanical, structural causes within the body. Theoretical stances like iatromechanics and the physiology of fibers are expressions of its main contention: disease and/or normality should be found in the physical properties of organization. Lesions (not a bad mixture of humors) are the causes of diseases.

Over the issue of the permeability of the boundary body and environment these two theoretical positions worked under different presuppositions. If under a mechanical stance the solid parts (fibers, tissues, organs) are given causal (etiological) primacy over the fluid portions in the body[32], then it becomes (as Louis argues) much less likely that external presences (air, efluvia, waters, food, climate in general) could *irreversibly* affect the body's properties; specially if the origin of the main features of the solids (organization) is thought of as preformed. In other words, the solid parts of each new being , ultimate bearers of all functional responsibility, will not receive any kind of regular, permanent influence, physiologically normal, from the equivalent solid parts of its ancestors; nothing acts at the first formation of the new being that deserves the name of heredity. On the other hand, if primacy is given to humoral mixtures (and if solids are thought of as product of a solidification or condensation of humors after fecundation), then the possibility arises that at the first formation of the new being its organizational plan acquires "original" alterations due to the peculiarities (the qualities) of the materials contributed by the parental seeds. It also becomes possible that those alterations acquire some "permanence" within the lineage, so that any causal influence that can find its way, through air, water, food, etc., and that dramatically changes a person's humoral balance will alter his physical constitution. This will happen because such alteration in turn will affect the next generation's reproductive humors like semen, blood, milk[33].

In the context of hereditary traits (*resemblances, degenerations*) then, I believe that the distinction between naturals and non-naturals, and the conception of their interactions, can be illuminating. A traditional explanatory resource for variation within biological species, especially in the human case, is the appeal to external influences. The climatic (geographic) explanation is ancient[34]. During the 18th century the action of the sun, the air, the water, etc. was again given a central role in the explanation of diversity of bodily constitution (and of *moeurs*) by important theorists as

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30 As Vivian Nutton defines it: "Humoralism is a system of medicine that considers illness to be the result of some disturbance in the natural balance of the humours, within the body as a whole or within one particular part. It stresses the unity of the body and the strong interaction between mental and physical processes. It is at one and the same time highly individualistic, for each person and each bodily part has their own natural humoral composition (also known as *krasis*, mixture, or temperament), and universal, for the range of variation is limited and the same patterns of illness (diseases) can be seen to occur in many individuals. The natural balance of health is always pecarious, for it is constantly subject to potentially harmful influences from one's diet, life-style and environment." "Humoralism" in Porter and Bynum (1993), p. 281.

31 Nutton (1993), p. 288.

32 Louis writes "l'action des fibres plus ou moins forte et vigoureuse, façonne et modifie différemment les humeurs de notre corps; ces huneurs agissent suivant leur quantité sur les solides dans lequels elles sont contenues, et elles en determinent diversement les actions: de-là viennent les complexions particulieres qui mettent tant de différence entre les hommes, tant par rapport aux dispositions du corps qu'aux caracteres de l'esprit." Louis (1747), pp. 37/38.

33 The capacity that one is willing to concede to a humor was a point in dispute. Haller was very critical of the way humoralists were willing to accept that amorfous fluids could by themselves produce any sensible order.

34 Its locus classicus is the Hippocratical *Airs, Waters, Places.*

Arbuthnot, Falconer, Montesquieu, Buffon, etc.[35]. This external origin of difference was often combined with discussions concerning resemblances and *degenerations*. What could be called the "staying power" of externally induced alterations was often a point of both empirical and theoretical discussion. Competing systems (or models) of generation had to adapt themselves to collected facts and consensus opinion around this issue.

It will be of interest to notice that conceptions of hereditary transmission associated with French vitalism tended to side with a more permeable view of the link between body and environment. This open position, that saw in (complex) equilibria between internal and external elements of the body the only plausible realistic approach to health (and to natural history) allowed for the eventual conception of a Hygienic approach to both health and the physical betterment of humanity. A crucial difference between French and British hereditarianism in the course of the 19th century was due exactly to this permeability allowed by the French. As Coleman clearly showed, the notion of the *non-naturals* was the antecedent to the hygienic programs in the post-Napoleonic years. Elizabeth Williams has followed brilliantly the influence of vitalism throughout the 19th century approaches to the link between body and environment by French physicians[36].

Humoralists on the whole were prone to what we could call a holistic view of the links between the body and the environment, and found it conceivable that a kind of a flux (or flow) of externally induced characters could travel (trough physiological means) within the family lines and conform a peculiar bodily heritage for families, tribes, races. On the other hand, solidists (à la Louis), given that no possible route of influence can be imagined that connect the parent's initial, solid bodily frame, with that of its infant's, and that every single case of variation and resemblance can be explained (away) using external factors, hereditary attributions become just a "façon de parler".

What I want to discuss then is the question of the permeability of the (possible) hereditary causal routes to the external factors during the 18th century. The task should be to show how the two levels of analysis, the influence of external factors on bodily constitution, and the hereditary influence of the parents bodily constitution on the bodily constitution of the child could be (and were) coordinated by different authors with different viewpoints.

The specific discussion around the hereditary transmission of disease in the frame of eighteenth century views of physiology and generation provides a privileged access to the evasive conceptualization of the possible routes through which the environment could affect, in dramatic and more or less permanent fashion, the constitution of individuals and lineages.

3.

It seems to me that a useful way to frame the discussion of heredity in the 18th century is to be found in Peter McLaughlin's proposal[37] to make a "distinction between the two types of inheritance – the law-like transmission of species form and the contingent disturbance or supplementation of this transmission by individual traits." I believe however that such distinction

[35] See relevant chapters in Glacken (1967).
[36] See Coleman (1984), Williams (1994).
[37] McLaughlin (2000).

should be made in another fashion, and more care should be taken in the choice of words. For the most, during the eighteenth century, what McLaughlin refers to as the first type of inheritance was considered outside the domain of the hereditary. Generally speaking, all theoretical positions about generation did not refer to inheritance when dealing with a lawful transmission of form; that is a notion that was adopted well into the 19th century. Authors in the 18th century, both preformationists and succesionists[38], thought that the transmission of form from generation to generation was due to a constant, invariable cause (or fact) that gave the species its fixity and stability, and which had nothing to do with the contingencies of genealogy. Both the idea of the preexistence of the germ, and that of a lawful (successive) production of the new being driven by a mould, or by a generative force, or some other epigenetic principle, shared the notion of a basic common structure for each species, over which the singular, accidental characters of the ancestors had no permanent influence. A shared attitude towards hereditary characteristics (the peculiarities of individual, family, or major lineages) was thus to confine them to the domain of the accidental. While accepted and discussed in both Hippocratic treatises and Aristotle's works, the facts of hereditary transmission of physical and moral resemblance, deformation and disease, were seen both as undeniable (though bothersome) factual givens that had to be explained away. Perhaps only in the medical tradition, with its preoccupation with the singularity of disease and patients had more room for thinking about the peculiarities of individual temperaments and their transmission through the family line. For that period the distinction that MacLaughlin is aiming at should in my view be refered to as that between type vs. accident, and only the latter should be seen as linked to the hereditary.

The type-accident distinction allows for a careful following of the place that the hereditary received in different theoretical frameworks. For instance, Hippocratic-Galenic medics were content with the fact that dual seminal, pangenetic, solidification of fluids, model could among other explanatory virtues, account for the facts of hereditary recurrences. At the same time, the more theoretically sophisticated model of generation devised by Aristotle was seen to generate some puzzles difficult to sort out in regards to this kind of facts[39]. There is in fact an ongoing discussion among Aristotelian scholars about how to understand his proposal of explaining (away) in his scheme, the hereditary fact of resemblance to both parents, and sometimes to previous ancestors.

As is well known, in Aristotle's scheme of generation male seed was responsible for form and female matter for individual peculiarities[40]. In an illuminating recent piece, Andrew Coles provides a complex physiological analysis of the origin and function of the male seed (semen) in Aristotle, so that the main difficulties that arise with hereditary facts are overcome. Contrary to widespread belief, according to Coles it is by rescuing the Cnidian (Hippocratic) notion of

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38 Succesionist, as I said, is a label that includes both epigenetists and the partisans af dual seminal rapid formation of the germ or first rudiment.

39 At least since Empedocles, for anybody in the business of giving an account of human, (or animal) generation, the paradoxes of *the hereditary* were a serious stumbling block: Aristotle's view of the male seed as the only causal contributor to the form (shape) of the body of the offspring had to by-pass the empirical evidence of female transmitted characteristics (resemblances, mules). The most convincing account of of the irregular mixtures of resemblances to both parents was given by dual seminal theories.

40 The question then (as Sharples poses it) is, if it is supposed that the father imparts form and nothing else, why snub-nosed fathers tend to have snub-nosed children. See Sharples (1985).

pangenetic origin of the semen that he manages to do the trick: "It is in Aristotle's conception of the physiological origins of semen, and more particularly of its hereditary properties, that the links between his biology and that of the Cnidian's are the closest"[41]. Apparently, the view that the (male) semen is the product of a special process of separation from the blood, and that in its passing through all the different parts of the father's body, it acquires particular kinds of secondary movements (*dunamis*) which can be responsible for carrying on the offspring hereditary resemblances. The result from the (part by part) struggle of these paternal *dunamis* with similar movements that oppose them and that come in the mother's generative matter defines the side that the offspring's different parts are going to take after[42].

Aristotle's acute perception of the thorny causal problems that hereditary resemblances posited was progressively diluted by his interpreters, so the aspects of his system specifically designed for coping with them seem to have been lost. Galen for instance was convinced that there was no way in which Aristotle could account for female transmitted resemblances, and for that reason made a forceful argument in favor of the existence of a female seed (semen), with equivalent physiological powers to transmit hereditary peculiarities[43].

Harvey believed he was being Aristotelian when he limited the influence of material physiology to the action of male spirits in the production (conception) of form in the new being, and pushed out the hereditary influence (resemblances, etc.) to the Paracelsian domain of the action of the mother's imagination[44].

As McLaughlin points out, the conflict between pangenetic (dual seminal) models of generation (with their hereditary support) and the epistemological (and theological) demands that promoted preformationist views an the 17th century produced different attempts at "mixing" the virtues of both accounts, as Aristotle had apparently done.

At the beginning of the 18th century Bourguet proposed one such synthetic model. A preformed germ affected after fecundation by a pangenetic, dual seminal influence, responsible for all things hereditary.

As has been said, Haller first used the hereditary as a weapon for epigenesis, and later changed sides, denying emphatically its reality when criticizing Buffon.

Bonnet eventually adopted and deepened Bourguet's strategy separating clearly the origin of form (in the germ) from the external origins of resemblances[45] which were due to the incorporation (*intussusception*) of accidents in the nutritional growth-development process where (pangenetically gathered) particles from both origins could play a role. Although succesionist authors like Maupertuis and Buffon insisted that the manner of the (new) production of the germ in each fecundation is important, several authors (including McLaughlin) have argued that there is a common structure between their hypothesis and elaborate preformationism such as Bonnet's. More than a hundred years ago, in an insightful historical essay called "Evolution in

41 Coles (1995), p. 50.
42 See Coles (1995), pp. 70/76.
43 Coles (1995), p. 76, Boylan (1984).
44 See Harvey ([1651] 1981).
45 Though in his later versions of his theory of generation Bonnet came closer and closer to a quasi-epigenetical scheme, in which organised structure is not actually present in the preformed germ but somehow "preprogrammed". See Huxley ([1878] 1896), and Bonnet ([1769] 1985).

Biology"(1878), T.H. Huxley arrived at the conclusion that if we set aside around the time and manner of the production of the germ (Harvey's rudiment), most 18th century theorists of generation, preformationists or succesionists, supported some form of the doctrine of evolution or development, which considers a dual phase in the production of the new being's body; first the creation or reproduction of the basic structure in the germ, and second the growth and development of this rudiment.[46] Huxley sees in Bonnet's description of such process the common "exemplar" for the period. For the case of the hen's egg, Bonnet in his *Considérations*... states that:

> fecundation and incubation simply cause the germ to absorb nutritious matters, which are deposited in the interstices of the elementary structures of which the miniature chick, or germ, is made up. The consequence of this intussusceptive growth is the "development" or "evolution" of the germ into the visible bird. Thus an organized individual is a composite body consisting of the original, or *elementary* parts and of the matters which have been associated with them by the aid of nutrition; so that if these matters could be extracted from the individual, it would, so to speak, become concentrated in a point, and would thus be restored to its primitive condition of a germ.[47]"

Further modifications to his notion of germ made Bonnet's position even more general and inclusive[48].

> Ce mot (germe) en designéra pas seulement un corps organisé reduit en petit, il désignera encore toute espèce de préformation originelle dont un tout organique peut résulter comme de son principe immédiat[49]

Huxley's conlusion is eloquent:

> But thus defined, the germ is neither more nor less than the "particule genitalis" of Aristotle, or the "primodium vegetale" or "ovum" of Harvey; and the "evolution" of such germ would not be distinguishable from "epigenesis"[50].

So even something as obtuse as Buffon's "moule interieur" could somehow become equivalent to Bonnet's generalized "germ". Notwithstanding important subtleties that stand in the way of Huxley's coarse integration of these concepts, he is no doubt making an important point. Most 18th century theorists shared the idea of a deep conceptual hiatus between the explanation of organization (taxonomic similarities), and that of accidental individual peculiarities (variations, resemblances).

For our purposes, the similarity Huxley sees between the generation models of the kind

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46 Huxley added that even Cuvier, in following century, adopted a very similar scheme. Huxley ([1878] 1896), p. 190.
47 Ibid., p. 191.
48 Huxley writes: "Bonnet... in his later writings and at length ... admits that the germ need not be the actual miniature of the organism, but that it may be merely a "original preformation" capable of producing the latter." (Huxley [1878] 1896, p. 193. he quotes from Bonnet, 1769, X., ch. ii).
49 Bonnet (1769), X, ch. ii. quoted by Huxley ([1878] 1896), p. 193.
50 Huxley ([1878] 1896), p. 193.

Bonnet-Haller, and of the kind Buffon-Maupertuis, turns around the fact that both deliver a germ that suffers a process of growth and transformation under the influence of a fluid milieu that provides the elements that become *incorporated*. This milieu is responsible for hereditary influence. The origin, qualities and manner of action becomes the question for hereditary analysis. The typological, essential, permanent features of organization are identified with the solid frame, whereas accidental, ephemeral features come into play through humoral (fluid) influences. The dialectics of solid-humoral interaction have a crucial role in the split between structural stability and individual deviations. The solid organization (given for instance by the germ or driven by a solidifying force) receives constant influences, and matter from the fluid environment. These alter and shape the bodily frame.

Aggregation or intussuseption of particles of different origins (paternal, maternal, external) are processes indifferent with regards to the hereditary route. Both a succesionist and a preformationist account of generation can equally explain (away) hereditary transmission through the incorporation of elements during growth or development.

There is an important difference to keep in mind about the consequences of the acceptance of a preformationist account and that of a succesionist account of the origin of the germ (or the "first formation"). Although some hereditary facts can in both cases be accounted for through external supplements[51] to the first formation during "evolution", or growth, the preservation of a clear-cut split between the (causal) origin of form and the (causal) origin of resemblances or *degenerations* becomes more problematic for the succesionist. In a Maupertuis-Buffon kind of model, for instance, some of the more dramatic, important hereditary variations (*degenerations*) could up to a point be incorporated into the essential genealogical sequence. Six-digitism, or other *degenerations*, become susceptible of being transmitted or "copied" by the generation process[52] responsible for the first formation in a similar fashion as the more basic characteristics of the species. In fact, for some defendants of the preformation, like Haller, this vagueness about the limits of the individual (resemblances) and the formal (type) became one of the main reasons for their opposition to succesionist schemes. At the same time the failure of preformation to make sense (by itself) of preexistence within genealogical lines of accidental features made the subsequent appeal to a supplementary dual pangenetic influence methodologically suspicious[53]. Again, the permeability or impermeability of the specific form to external, accidental influences is one of the issues at stake within these discussions.

Though it must be remembered that hereditary facts could, during the 18th century, still have alternative non-physiological explanations (v.gr. a constancy or repetition of some external climatic influences or an appeal to the action of imagination or other "mind over matter" interventions) the search for a regular, stable physiological source was increasingly seen as the only sensible explanatory strategy. For such a strategy one important question turned around the origin, kind, and qualities of the material particles that were incorporated (through generation,

51 Dual seminal, plus maternal blood, plus other sources of nourishment.

52 For example through the modified *moule interieur*, or Maupertuis' material memory. There seems to be evidence both for a possibility of modification of the moule interieur, and for its inalterability in Buffon's writings. See Aréchiga (1996).

53 In his 1878 work Huxley concludes that it was only with the careful observation of development of the chick by C.F. Wolff that the speculative impasse ended and embriology could take a progressive route.

nutrition, development and growth) into the different parts of the body. The notion of a strict ontological boundary between organic and inorganic particles, as proposed for instance by Buffon, provided another boundary to take into account. The access of external influences to the peculiar bodily features of each individual could clearly be limited by such considerations. Climatic, nutritional and other sources of bodily variation, captured eloquently by the label of the *non-naturals* can have very different capacities to alter the constitution according to the continuity or discontinuity postulated between bodily constituents and external matter (air, water, places, etc.). The medical frame of natural and non-natural, and of solid vs. humoral influences was the main available resource for coping with these questions. It was undoubtedly at the root of Buffon's speculations concerning the influence of climate and food in the production of degenerations (*degenerations*), which begin as individual variations and are progressively generalized within a lineage as they are hereditarily transmitted ("like diseases are communicated from fathers or mothers to the children")[54].

A further question, not often formulated clearly is the "staying power" (which makes them more or less permanent or ephemeral) of the peculiarities incorporated by environmental and nutritional routes, within the genealogical succesions. This question can become crucial in a succesionist account, if there is a dilution of the difference between individual and specific organization[55]. The question presented itself to Maupertuis and Buffon, and also to Blumenbach. They all allowed for a semi–permanent transformation of the type due to the conservation of accidental variation within the lineage[56]. It is probably in the extensive discussions of Buffon on the notion of degeneration that the intricacies of this issue began to be sorted out. The belief in a strict and widespread correlation between climate and bodily temperament in human groups was heavily questioned in the course of the 18th century. The tenacity or the feebleness (i.e. differences in "staying power") of accidental racial features had both evidence and testimonies in their favor[57]. The issue of establishing how and when external influence on the physical characteristics became "rooted"[58] in a lineage acquired a progressive importance after Buffon's work[59]. This French author always maintained that a limit existed to the amount and kind of variation accepted by the interior mould[60].

Kant for instance believed in the feebleness of accidental acquisitions. He writes:

> "Gradually and at last the constitution of the soil (moisture or drought), and food, also, induce a hereditary difference or strain among animals of one and the same stock and race, especially

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54 See Buffon ([1749] 1971). See also Aréchiga (1996), p. 74.

55 The process of using the complete bodily constitution or temperament of a parent as an original pattern or mould for the production of the new being (at the moment its first formation) has even induced a paradoxical talk of the conservation of an individual type(!): See Duchesneau (1982), p. 539, and López-Beltrán (1992), chapter V, and Borie (1985).

56 John Hunter arrived at a similar view, influenced by Blumenbach. See López-Beltrán (1992), chapter IV.

57 "such is the difference of this effects – writes Blumenbach – (some) are preserved unimpaired by a sort of tenacious constancy through long series of generations, or by some power of change withdraw themselves again in a short space of time". (Blumenbach [1795] 1865).

58 He metaphor of depth, of rootedness, taken I believe from iatrochemical speculations of the seed or material cause of disease, was frequently invoqued in this context.

59 See Roger (1989), Aréchiga (1996), Glacken (1967).

60 Blumenbach himself wavered in front of the evidence. Compare Blumenbach ([1775 and 1795] 1865). See also López-Beltrán (1992), chapter IV.

> in stature, proportion of limbs, and also in the temperament; which later hybridizes when mixed with another kind: but on another soil and in the presence of other food (even without alteration of the climate) disappears but in a few generations" [61].

Blumenbach wavered in front of the evidence. After first having also dismissed the view that what Buffon called degenerations could become a stable hereditary part of an animal's (or a person's) constitution, he came to accept what he called "hereditary peculiarities of animals from diseased temperaments":

> An hereditary disposition to disease would seem at first sight rather to belong to pathology than to natural history of animals. But when the matter is more carefully looked into, it is plain that in more ways than one it has something to do with those causes of degeneration we are concerned with.[62]

Blumenbach later writes that when some of these (constitutional diseases or disorders)...

> are propagated by hereditary causes for a long series of generations it shades sensibly away into a sort of second nature and in some species of animals gives rise to peculiar and constant varieties[63].

4.

Blumenbach's analogy between hereditary disease and hereditary variation, and his blurring of the distinction is to my mind revealing, in that within medical tradition (as I said) there existed a frame that allowed a way of dealing with the issues of the link between the body (temperament, constitution) and the environment. A complex, and mutually dependent set of causal factors could be considered as working over the same product (the body) in such a way that the final result could not be attributed wholly to one or another particular influence. The notions of crasis (mixture), fluidity, individuality, allowed the imagination to both conceive a given outcome as determined and caused, and as complex product of an un-analyzable and variable set. On the other hand the distinction between the *natural things* (bodily frame, temperament) and the *non-natural things* (that affect and change the former) allowed for a separation of causal spaces, that is however very different from the modern nature-nurture split we have become habituated to. The fact for instance that passions, dreams, and other psychological elements were placed on the same grounds as the air, or food, or water, reveals a very different conception of the boundaries, and of the causal dependencies that are implied. Organisms (bodies) were not seen diachronically as we see them, that is as being in a dialectical sequence of expression of a hereditary information within succesive environments, but were rather seen as embedded in, open to and intimately dependent on its physical surroundings. The complex web ob influences that acted over each individual (human) body was a main preoccupation of the medical tradition, and the physical and moral inheritance that was passed on from parents to offspring through generation was only a small portion of such web.

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61 Kant (1775), in Chukwudi (1997).
62 Blumenbach ([1795] 1865), p. 202.
63 Ibid., p. 259.

The *natural things* (humors, elements, temperament) can be equaled for the sake of our story with the bodily elements that are put in place by typical generation. That is to say, those which constituted the germ, and/or the preordered set of elements that get together to form the organized new individual are product of the *natural things*.

The *non-naturals* (air, food, dreams, passions, etc.) are the set of "external" influences that somehow come into contact with, and/or determinantly, affect the body as it grows, lives and decays. From a superficial analysis the two sets of causes are disconnetced. They were treated for instance in two different Hippocratic treatises[64]. But of course the link between them is powerful, and as Arnulfe D'Aumont writes, it is when these interactions (*natural/non-natural*) goes wrong that the *praeter-natural* (diseases) appear[65]. As we saw in Antoine Louis' argument above, the six non-naturals can readily play a part in the discussion concerning external causes of degeneration, and the "staying power" they acquire according to their origin and moment of influence[66]. The possibility that external influences could become more or less permanent through generation within a genealogical line was seen as more or less open by differently oriented physicians.

A privileged access to how these matters were dealt with, and into the details of physiology and etiology, during the18th century is gained when we look at discussions of hereditary disease[67]. Through them we can clarify the different consequences for the phenomenology of the hereditary that medical men could see if they were to accept certain openness (permeability) or closure to external, accidental influences at the moment of the first formation. According to different physiological views, different boundaries could be drawn. The question can again be posed: are accidental hereditary bodily features induced by the *six non-naturals*(?) and are these transformations of such an order that the family lineage is affected in a permanent way? I will attempt in the following paragraphs a short summary of several positions that can be found among physicians during the second half of the 18th century.

A strict solidist position can readily drive to an anti-hereditary stance. We have seen that with Louis[68]. The impossibility of the incorporation (at the required depth) of anything external or accidental into the body's frame (i.e. the original germ). This is Louis' main argument. If diseases have a solidist *root*, any lesion would have to be local, isolated, and its effects would end with the death of the bearer. In contrast a humoralist view incorporates the hereditary to a choreography of internal and external influences. Within them there is no clear-cut separation between external and internal humors. The hereditary cause does not have a special ontological status. It is more a consequence (a "side effect") of the flux of succesive generations irregularly acquiring (not only through generation) physical (and moral) peculiarities and transmitting them (through generation) to their offspring. At the most, the adjective "hereditary" refers to a possible route of transmission

64 "Airs, Waters, Places" and "The Nature of Man".

65 D'Aumont (1765).

66 The division we described between humoralists and solidist becomes relevant. In an humoralist view the balance among humors is crucial, and there is a continuous flow of materials, mixtures, in and out of the body, carried by air and liquids and food. The solid parts of the body are always changing according to these interactions. In a solidist view the root of the disease is in a lesion or malformation at the level of the organs or solid parts. It is the solids and their properties who master a control the humors.

67 I have made a thorough study of the disputes around this issue that happened in France between 1745 and 1810. See López-Beltrán (1996).

68 Louis himself locates the thrust of his antihereditary argument in the older work of Luis Mercado, where apparently all solid to solid influence is also denied. See Louis (1749), footnote, p. 14.

of influences that may also operate through other routes.

An important theoretical development occurs among medical men when committed solidists, uncomfortable with humoral, proteic explanations of hereditary disease, nevertheless accept the reality of the fact of hereditary transmission, on the base of the accumulated evidence provided by the accumulation of cases were features, traits and diseases were seen to travel through lineages. A new kind of speculation about the possibility of solid to solid hereditary influence is then developed, and as a consequence a distinction between properly hereditary transmission and parallel congenital influences is proposed[69].

We could also summarize the different "models" of hereditary disease transmission according to which notion of generation is presupposed by physicians. Under preformation: the germ is invaded by the "seed" of disease[70], and its humoral balance is disturbed. Or it is damaged by an external influence (v.gr. a fluid) during its development *and* the alteration can then be somehow transmitted to the following generation through parental semen (pangenetically for instance). The transmission then is not necessary and is avoidable. In a clear-cut succesionist account something analogous can happen. After the "first formation", heritable alterations can be suffered. Humors are responsible for idiosyncracies. There is not an important etiological distinction between receiving the evil action for the first time in the lineage (by an environmental cause) or receiving it through the liquids of the parents during growth and development, or even during nursing.

Towards the end of the 18th century a very different notion of hereditary transmission is adumbrated by solidists that is only possible in a succesionist scheme. A form or other of a copying mechanism is proposed as responsible for producing, each generation, the solid parts of the new being[71]. The latter can be framed (as for Buffon and Maupertuis) under the analogy of crystallization, or not. The (solid) bodies of the parents are taken to be the *source* (or mould) that is used as a base for the new production of organization in the offspring. Both essential and non-essential features can be thus candidates for copying. The hereditary act (transmission) occurs always at the moment of the "first formation" of solid parts (the production of the germ). Bodily variations due to external influence can become hereditary only if they originate at the moment of the "first formation". Besides, not every feature is transmitted identically. There is rather a different tendency among them to be transmitted according to their properties. Essential features are transmitted with more constancy, and accidental features have less chance to be copied. Similarities have the way more open than degenerations. The older an accidental feature has been running in the family the stronger will its propensity to be communicated due to a sort of rootedness it has developed. What we have been calling the "staying power" of a variation is thus linked to its propensity to be carried along to posterior generations by the "copying" mechanism. Variation within the offspring is thus explained. The bodily organization of the new being is a version of the parent's organization, in which both essential and accidental features are copied from them. Even deformities can be transmitted if their origin is an accident at the moment of the first formation. What can be called a "frozen accident" explanation of hereditary transmission of accidental variation due to external causes. This kind of thinking can be traced to the model of

69 For a detailed discussion of this conceptual innovation, and its consequences in both French and British discussions of the hereditary see López-Beltrán (1992), idem. (1996).

70 In a iatrochemical wording.

71 See Pujol (1802), Prichard (1813) and idem. (1824).

Maupertuis' generation theory and was used by John Hunter and his followers. The clear-cut distinction it aims at establishing between hereditary and non-hereditary transmission within lineages was used by French medics, and also by Hunter and his followers, to establish a difference between congenital and connate transmission of disease[72]. What is often discussed is, I repeat, if the depth of the incorporation of the hereditary variations into the normal flux driven by the reproduction mechanism. Usually, among medics, the question attended to is how, if in any way, can hereditary disease be eliminated. The answer to such question reflects the view held by the physician[73].

5. (Conclusions)

We can talk of the existence during the 18th century of two kinds of limits or boundaries to hereditary transmission. The "channelization" of hereditary influences through the physiological "line of production" of the new beings can be seen, during that period as being limited by an internal and an external boundary. The internal boundary is given by the separation between the re-production (generation after generation) of the specific form, and the acquisition and transmission of peculiar accidents of constitution first by individuals and later by lineages. Both preformationist and epigenist views of generation accepted the challenge of explaining (away) the facts of hereditary links between parents and offspring. And in both their positions a tight boundary was placed in order to preserve the integrity and stability of the form. The accidents could not be incorporated *definitively* into the essential organizational features or *form*. Each new being when first constituted as a germ was free from accidental variations produced by external influences, including hereditary ones.

The external boundary is given by the physiological facts of growth, development, nutrition. The amount of isolation they were thought to have with respect to the physical milieu made the outcome of growth and development (the mature individual's temperament) more or less variable, and the depth of the changes could also vary. The belief that only those modifications of temperament by the *non-naturals* that could find their way to the flux of pangenetic chain of transmission was shared by many. The mystery of course was how this could actually take place. What exactly had to be modified by external influences? The mould or the particles? The bodily features of the parent and the particles that integrated them. Buffon, Blumenbach and other 18th century thinkers conceived mechanisms by which physical modifications induced by the environment could be preserved hereditarily and give rise to varieties within species. The reversibility by external influences was always an option, as was the idea of betterment through hygienic measures[74]. The vitalist program in France preserved this attitude throughout the 19th century, allowing the notion of hereditary determination of physical and moral characters to be balanced by a hygienist counterpart.

Though the notion of hereditary transmission was restricted and had a minor importance in the 18th century. The breaching of what I just called of the internal boundary is responsible for the hardening of heredity, and its progressive transformation during the 19th century into a central

72 See Pagès (1798), Pujol (1802), and Adams (1814).
73 See López-Beltrán (1996).
74 Changing the climate, the food, the way of life.

cause in physiological thought. The permanence and transcendence of "accidental" variations needed a new conceptualization of the hereditary. Towards the turn of the century (18th to 19th), as can be seen in Blumenbach's changing views, and more prominently in Lamarck's use of hereditary (and in a sense "accidental") modifications as the source of species transformation, the narrow boundaries between which hereditary transmission could be conceived to occur, became progressively breached, and blurred. The outcome of this opening was that external climatic and psychological causes could be now seen to affect and modify in the long run the essential form of organisms, and of their descendants. Deeply embedded in the organism's constitution, some *degenerations* with considerable staying power could be conceived as witnesses to the power of both environment and heredity to shape bodies (and minds). Resemblances, *degenerations* and the transmission of form through generation could be now seen as having similar causal dependencies.

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Almost certainly this work prompted Joseph Adams' famous treatise on the subject, in which he tried to claim for John Hunter, and himself, the "modernization" of the concept of hereditary transmission of disease (see below). The English (edited) version of the piece was published in two installments in Adam's *London Medical and Physical Journal*, volume 21, in Dec. 1808 and June 1809, pp. 229-239, and 281-296.

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