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THE EVO-DEVO AND ITS EPIGENETICS— "A NEW BIOLOGY FOR PSYCHOLOGY"? THE CASE OF INHERITANCE OF THE ATTACHMENT STYLE

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ABSTRACT

The Evolutionary Developmental Biology (in abbreviation Evo-Devo) gains in popularity among psychologists. It would be a "synthesis of development and evolution" which would finally allow a rapprochement of psychology and biology. The Evo-Devo redefines epigenetics and opposes it to the (alleged) genetic determinism, genetic reductionism and preformationism of the Modern Synthesis (MS), proposes the concept of the extended inheritance and a mechanism of inheritance of acquired characters, which are claimed to be (neo-) Lamarckian, fuses the three questions separated by the MS: the origin of variation, fate of variation and inheritance of variation. These points of the Evo-Devo's programme particularly resonate with psychologists' expectations: genes alone do not explain the question of transgenerationality, the ontogeny of the attachment, e.g. early experience with caregivers (e.g. separation and loss) have a long-term effects on adult development can span a person's lifetime, can even span generations. However, in the paper I show that the inheritance of acquired characters is indeed impossible, that Lamarck never proposed a theory of the inheritance of acquired characters and that it is a confusion rather than fusion to link the question of the origin of variation, the question of development and the one of inheritance. If the Evo-Devo is so appealing to psychologists, it is not because there is "a new biology for psychology." I show that psychologists' attitude towards monism was ambivalent and such was the relationship between psychology and biology. The paper is a standpoint of a philosopher of biology interested in psychology.

Keywords: Evo-Devo; epigenetics, extended inheritance, transgenerationality, attachment style, dualism, mind-body problem.

1. INTRODUCTION

Psychology as a distinct branch of science originated when the "psyche" started to be considered as something that can be examined and explained in terms of laws of nature. Since then many psychological approaches have benefited from various branches of biology. Yet, the rapprochement between psychology and biology has always been a complex issue. Recently Evolutionary Developmental Biology (in abbreviation Evo-Devo) and its interpretation of epigenetics has become increasingly more and more popular among psychologists. Some consider it even "a new biology" for psychology (Hofer, 2014). According to the author, if psychology (and psychoanalysis in particular) grew away from biology, it is because the biology of "the century of the gene" did not lend itself to the rapprochement with psychology: "... throughout the twentieth century, biology became identified with the 'nature' side of an endless argument that forced a choice between 'nature and nurture'" (Hofer, 2014, p. 17). Biology of the Modern Synthesis (hereafter MS, alias Neo-Darwinism) would assume genetic determinism, ontogeny and development would be in the shadow of evolution and given that for the MS "the transmission of genes from one generation to the next was the (only) mechanism for heredity" the inheritance of acquired characters would not be possible:

"In a very few years, between 1900 and 1910, there came a paradigm shift in biology. The rediscovery, in 1900, of Gregor Mendel's work on heredity in pea plants (Mendel, 1865 (1966)) and a growing appreciation of the cellular research of August Weismann (1895) lead to the strong conclusion that the units of heredity were discrete entities, soon named "genes," that were isolated from the environment in special germline cells until they were passed over unchanged to the next generation. The very idea of transgenerational effects, presumed to act only on germline cells, soon became "heresy" to biologists. [...] However, it was the discovery and naming of the "gene," its location, molecular structure, and finally its mechanism of action that was to dominate our understanding of evolution in the twentieth century" (Hofer, 2014, p. 3).

Yet, for most psychologists we are not reduced to genes. The childhood matters. Early experience (e.g. separation and loss) have a long-term effects on adult development, can span a person's lifetime, and can even span generations:

"Child-caregiver interaction patterns are internalized early in life and guide the infant's expectations, and evaluations, of relationship experiences. [...] They continue to influence relationships throughout childhood, across the lifespan, and even into the next generation" (Bowlby, 1973; 1980;

(Fonagy et al. 1991, pp. 891–892). For psychologists, genetics alone do not explain the question of transgenerationality, of "the making and breaking of intergenerational links" (Quinton, Rutter, 1988). In the context of the abused-abusing cycle almost half the convicted perpetrators of child sexual abuse have been sexually victimized as children (Craissati et al., 2002). The 70% of abusive parents were themselves abused. The 20–30% of abused infants are likely to become abusers themselves (Chapman, Scott, 2001; Egeland et al., 1987). Transgenerationality in this context is more a matter of ontogenetic experience than of faulty genes. Finally, would the famous psychoanalytic "repetition," "the search for an absent ancestor which continues to act in the present" (Laufer, 2006: "*rechercher l'ancêtre absent continuant à agir dans le present*") makes anyhow sense in the light of evolution (to paraphrase Theodosius Dobzhansky (1973)?

For many psychologists, the Evo-Devo is a new biology, a "synthesis of development and evolution" which finally allows a synthesis of psychology and biology. Here are points of the Evo-Devo's program, which seems to particularly resonate with psychologists expectations. These are also the points which according to Evo-Devo's partisans constitute a "revolution" and overturn the going neo-Darwinian paradigm. Indeed, some partisans of Evo-Devo postulate a modification and some others even a departure from the Modern Synthesis (e.g. Williams, 1966; Dawkins, 1976; 1982) in favour of the Extended Synthesis (hereafter ES, Muller, 2007; Pigliucci, 2007; 2009; Pigliucci, Muller, 2010).

Evo-Devo goes against (the alleged) genetic determinism of the MS: "genes do not have a unique or privileged role in determining the phenotype" and further: "the term »epigenetics« is increasingly being associated with the hope that we are more than just the sum of our genes" (Heard, Martienssen, 2014, p. 95). According to the philosopher and biologist Michel Morange, epigenetics wants to contradict the inevitability of genes (Morange, 2014). Evo-Devo puts "epigenetics" to a new context, where it becomes opposed to genetics (while in the original sense of Waddington (1942 (2012)), epigenetics was complementary to it (Morange, 2014). Thus, Evo-Devo creates around genetics the specter of preformationism. In the relatively recent history of ideas the latter was a conviction that organisms develop from miniature versions of themselves (in one of the most literal versions it was a conviction that inside a sperm or egg there is a tiny person, the famous homunculus from which grow individuals). "Epigenesis" in Evo-Devo's sense is the denial of preformationism—as if the MS embodied the latter. Evo-Devo clearly rekindles the perennial debate and reenters the opposition between nature or nurture, predestination and free will. In the Evo-Devo's framing genetics ends up on the side of determinism (phenotypes would be encoded in genes, genes would decide about what happens with us, would control phenotypes) and epigenetics end up on the side of develop-

mental plasticity (genes are no longer our destiny, epigenome has power over genes, power mediated by the environment we live in and shape through our will and actions).

Evo-Devo adds to "epigenetics" also the question of inheritance, while, again, in the original sense of epigenetics there was no such question. Evo-Devo talks about the inheritance of phenotypes and of all factors which participate in the development and the reoccurrence of a phenotype across generations (the extended inheritance potentially spans from epigenetic, cellular processes, to the inside of the womb to familial, social and cultural environment—under the condition, that the environment contributes to development, fitness and recurrence of a phenotype across generations (Jablonka, Lamb, 1989; 1998; 2005; 2007; Odling-Smee, Laland, Feldman, 2003). The potential role of the Evo-Devo for psychology in general, and the potential role of the concept of extended inheritance for the question of transgenerationality in particular, was flagged up by Karola Stotz (2014); in the title she coins the term "the extended evolutionary psychology"). Evo-Devo tends to make the synthesis of development and evolution through the synthesis of the question of development and of inheritance. Evo-Devo talks even in favor of inheritance of acquired characters:

> "With the rediscovery of genetics, conventional wisdom had it that selection acts on phenotypic variation via genetic variation that is itself blind to environmental cues. Further, according to Weismann's principle of the germplasm (1895), somatic cells are separated from germ cells, and thus, no mechanisms were thought to exist for germ cells to be modified by the environment. Over the last few years, the 'rediscovery' of epigenetics and its underlying mechanisms has reopened this old debate, giving rise to the concept of transgenerational inheritance of epigenetic variation and even of acquired traits" (Heard, Martienssen, 2014).

Evo-Devo credits Lamarck with the theory of acquired inheritance:

> "… the epigenetic modification of DNA through maternal care leading to transgenerational effects on offspring behavior provides evidence for the inheritance of acquired traits. The Lamarckian theory that traits acquired in response to the environment experienced over the lifetime will be transmitted to offspring was initially overlooked as a potential mechanism of inheritance. However, current research on the role of epigenetic modifications in mediating environmentally induced changes in maternal care that are transmitted across generations provides a mechanisms through which Lamarckian inheritance is possible" (Champagne, 2008).

This "new biology" appeals to many psychologists. "Now, for the first time since the fall of Haeckel and Lamarck at the close of the nineteenth

century, there is an opportunity for a dialogue on the subject between psychoanalysts and biologists that can benefit both fields" (Hofer, 2014). Psychologists' reading of the Evo-Devo postulates is that they provide one more link between mental and physical health, another "mechanism" through which "the psyche" has an influence on the soma (cf. *The Impact of Emotions on the DNA* by Nathalie Zammatteo (2014), or "new biology of intention" on how genes are triggered within a few seconds by thoughts or emotions, (Church, 2007). For psychologists epigenetics in the sense of Evo-Devo would be the final proof that the mental can kill and the mental can heal. The "talking therapies" and mental health would get that way their full legitimacy. Church coins even the term "epigenetic medicine," talks about "healing techniques with epigenetic effects" or "epigenetic medical therapies," etc... Some researchers study differences in DNA methylation between young adults who have a history of chronic aggression compared to those who have normal development. These authors use epigenetics to back the importance of early intervention programs supporting parents during pregnancy or teaching children to control their affect and aggressive behavior (see e.g. Checknita et al., 2015; Galéra et al., 2014; Lacourse et al., 2014; Herba et al., 2013; Hall 2014).

In the present paper, on the case of attachment style I show that all the above listed points are at least excessive. Some already pleaded Evo-Devo for holding back, among them there are biologists (see especially (Dawkins, 2004) a direct reply to Evo-Devo's main contributors), philosophers of biology (Morange, 2014) who talked about hubris in the context of revolutionary ambitions of Evo-Devo and epigenetics) and science writers (cf. Farrel, 2011, *Epigenetics: The Revolution That Wasn't*; or Kaiser, 2014, *The Epigenetics Heretic*). I will say after Jerry Coyne that Evo-Devo and epigenetics do make "a stream of surprising discoveries. But they've done nothing to alter the going paradigm of neo-Darwinian evolution" (quoted in (Farrel, 2011)). The MS is not based on genetic determinism; the inheritance of acquired characters is indeed impossible in sexually reproducing multicellular organisms such as we are, that Jean-Baptiste Lamarck never proposed a theory of the inheritance of acquired characters and that it is a confusion rather than fusion to link the question of the origin of variation, the question of development and the one of inheritance.

I choose the attachment style as an example for three main reasons. The first one is that for many decades Bowlby's attachment theory has been "a point of convergence" between psychology and biology (Schore, 2002, p. 67). For instance, the attachment processes have been already studied at neurophysiological level as emotion regulation mechanisms used in social situations, such as re-appraisal and suppression (Gross, 2002; Mikulincer, Shaver, 2007; Vrtička et al., 2012). As we now know rather well the neuroendocrine correlates of attachment style and how it develops during ontoge-

ny it will be easier to evaluate what the concept of the extended inheritance actually offers. The second reason is the importance of the attachment style and emotion regulation in psychology. It has been hypothesized for last decades that maladaptive affect regulation is one of the main pillars of most psychopathological conditions diagnosed by current clinical standards (ICD-10 and DSM-5), a fundamental feature of major psychiatric disorders including borderline personality disorder, major depressive disorder, bipolar disorder, generalized anxiety disorder, social anxiety disorder, eating disorders, alcohol-related disorders and substance-related disorders (Aldao et al., 2010). Finally, the attachment style is a good example to study how Evo-Devo's propositions work for the question of transgenerationality in psychology. The similarity across generations in relationship patterns has a distinguished history across many psychological fields, from psychoanalysis (from Freud, 1940 (1964); Bowlby, 1969; 1973; 1980; Fraiberg, Adelson, Shapiro, 1975) to developmental psychology (Main et al., 1985; Sroufe, 1985, for more see Fonagy et al., 1991). What is more, comparative studies based on the assumption of common phylogenetic relatedness brought evidence for transgenerationality of attachment style in human as well in non-human primates. In humans there is evidence for the transmission of attachment style from mother to daughter (Fonagy et al., 1991) and grand-daughter (Stroufe, 2005). Van IJzendoorn (1995) found that 75% of mothers and infants had matching a secure versus insecure attachment style. A mother's own attachment to her mother is a good predictor of her infant's attachment (Benoit, Parker, 1994). In non-human primates infant abuse also "runs in families" (Maestripieri et al., 1997). Over 50% of offspring of rhesus macaques who had received abusive parenting during the first 6 months of life would then exhibit abusive parenting themselves as adults (Maestripieri, 1998).

At the end I explain that there was a place for psychology in the MS, but not all psychologists were ready to take it. For a reason that precedes by centuries the origin of both psychology and biology, namely mind-body dualism. I show that psychologists attitude toward monism were ambivalent and such was the relationship between psychology and biology. The paper is a standpoint of a philosopher of biology interested in psychology.

2. WHAT EPIGENETIC INHERITANCE IS AND WHY IT DOES NOT APPLY NEITHER TO NEURONS, NOR TO PHENOTYPES

For the MS inheritance is genetic and refers to the nucleotide sequence in nucleic acids (typically DNA). Alternatively, the Evo-Devo proposes many kinds of inheritance: behavioral, symbolic and ecological (niche construction theory, Odling-Smee, Laland, Feldman, 2003). This is because the Evo-

Devo calls hereditary all factors which contribute to the recreation of parental developmental conditions, so they range from hormonal and neural conditions, to the transmission of symbionts and parasites (e.g., gut bacteria) to behavior (e.g. maternal care), language, culture, ecological environments, etc. The epigenetic inheritance occurs when environmentally-induced and developmentally-regulated variations are transmitted to subsequent generations of cells or organisms (Jablonka, Lamb, 1989; 1995; 1998; 2005; 2007). In the original sense of epigenetics (Waddington 1942 (2012)) there was also no question of inheritance or that phenotypes would be transmitted to next generations. Epigenetics was the study of how genes and epi-genetic factors (the Greek prefix "*epi*" which means "around," "outside") give rise to phenotypes: "the branch of biology which studies the causal interactions between genes and their products which bring the phenotype into being." Evo-devo defines epigenetics in a new, different manner: it is "the study of heritable phenotype changes that do not involve alterations in the DNA sequence" (Dupont et al., 2009; cf. Russo et al., 1996). Epigenetic inheritance occurs through mitotic cells and through meiotic cells (transgenerational heredity of DNA methylation, (Jablonka, Raz, 2009)). Epigenetic inheritance is about how environmental influences changes gene expression (usually put into "off" position) and how these changes pass on to daughter cells. DNA methylation is a process by which a chemical, a methyl group, is attached to a promoter, or to some nearby proteins surrounding DNA. The result is that transcription factors (e.g. proteins) can no longer access or bind to the promoter. It does not change the DNA sequence, but it changes (usually repress) gene transcription. This silencing effects are reversible, yet sometimes relatively stable, last days to lifetimes, and according to Evo-Devo, can span generations: "DNA methylation patterns are maintained after cell division and thus passed from parent to daughter cells and it is through this form of epigenetic modification that cellular differentiation occurs" (Champagne, 2008). How does epigenetic inheritance work in the case of transgenerationality of attachment style at the level of neuroendocrine mechanisms of emotion regulation?

First of all, there is no evidence that the neuroendocrine effects of maternal care across the lifespan are mediated by DNA methylation (Champagne 2008). Given that this is what the author report herself in the paper, it is hard to understand why she concludes anyway that

> "... current research on the role of epigenetic modifications in mediating environmentally induced changes in maternal care that are transmitted across generations provides mechanisms through which Lamarckian inheritance is possible" (Champagne, 2008).

However, epigenetics is a developing field, thus let us suppose that some neuroendocrine effects of maternal care across the lifespan mediated by

DNA methylation will be discovered in the future and that theses changes will be maintained after cell division. There are two kinds of cell division: mitosis and meiosis. In the first case it would not apply to neurons. In the second case its effects would be limited in humans as well as in other sexually reproducing multicellular organisms.

2.1. Epigenetic modification inherited by daughter cells following mitotic cell division

It would not apply to neurons: neurons do not pass on their acquired characters to any neuronal progeny. Neurons do not replicate and the longest neurons may live is the lifespan of the individual (just like phenotypes). Epigenetic modification inherited by daughter cells would not apply to postmitotic, permanent cells, such as neurons, simply because they do not reproduce. Here is why. Some cells keep the mitotic activity and divide continuously throughout life, like skin cells, cells in the gastrointestinal tract, and blood cells in the bone marrow. They are called premitotic, labile cells. The rest are postmitotic cells, which lose the ability to divide through mitosis. Among them some can be stimulated to enter the cell division cycle when needed (they are called stable cells and they compose the liver, the proximal tubules of the kidney and the endocrine glands), but some definitely lose the ability to undergo mitosis and never divide. The latter are called permanent cells. Neurons are permanent cells (like the skeletal and heart muscles cells). Neurons do undergo the mitosis (that is, the division of one cell into two), but only during the prenatal and early postnatal period and then they lose the ability to replicate. That is why neurons are famous from being incapable of regeneration. Neurogenesis is of course still possible in adults, but it does not occur through cell division. Instead, new neurons come from neural stem cells in two regions of the brain: the adult subventricular zone (SVZ) of the lateral ventricles, and the dentate gyrus of the hippocampus. Scientists do not know why exactly the cessation of mitotic activity occurs in neurons, but perhaps if we understood this, we might be able to make cancer cells stop dividing. However, the fact is that neurons do not reproduce and that the longest neurons may live is the lifespan of the individual (Alvarez-Buylla, Lim, 2004). Thus, the argument of evo-devo would not apply to neurons, as they do not pass on their acquired characters to any neuronal progeny.

2.2. Epigenetic modification inherited by daughter cells following mitotic cell division

Would it apply to cells other than neurons? After all, there are dozens and hundreds of other body cells—other than postmitotic, permanent cells, such as neurons—which do reproduce, like skin cells, but also most glial

cells (non-neuronal cells in the central and peripheral nervous system) are capable of mitotic division (Ludwig, Das, 2020). Well, it would apply if we were unicellular organisms, like amoebas. In amoebas there is no division into somatic cells and germline cells. However, we are sexually reproducing multicellular organisms. Somatic cells do not participate in fertilization and are not source of gametes and thus do not transmit to the offspring the mutations they have undergone. When these dozens and hundreds of body cells reproduce, *they create an environment* in which originate another body cells and they build up a phenotype. Yet, these body cells, although they divide, they do not participate in fertilization and in making-up of a new organism. Other kind of cells, namely germline cells, give rise to ovum and sperm, and only these cells reproduce, fuse during fertilization and produce a zygote cell, which afterwards divides and differentiates into the cells of an embryo.

Darwin's concept of pangenesis accounted for the inheritance of acquired characteristics precisely, because he assumed that in every cell there exists tiny invisible material particles called "emmules," which participate in fertilization and in making-up of a new organism (Lamarck never proposed any theory of inheritance. Would Evo-Devo's researchers ignore the fact? I will come back to the question below.) Darwin's concept of pangenesis assumed "gemmules" are subject to environmental alterations during ontogeny and in this altered form were transferred to the offspring. The way the transmission takes place is that the gemmules are continually shed by every cell into the blood stream and afterwards are assembled in gonads: by "mutual affinity for each other, leading to their aggregation into buds or into the sexual elements" (Darwin, *Variation*, 1875 (2016), vol. 2, p. 370). In this form they were somehow (Darwin was not specific on that matter) transmitted by sexual reproduction to the offspring, where they formed the new organism. About twenty years later it became obvious that Darwin's hypothetical mechanism of pangenesis is not defendable, as is not defendable any theory of inheritance of acquired characters, precisely because in sexually reproducing multicellular organisms such as we are, only genes from germline cells participate in fertilization and in making-up of the offspring (Weismann 1895). Shortly speaking, somatic cells (e.g. skin cells or connective tissue) are not source of gametes (only germline cells are). That is why somatic cells do not transmit to their descendants the mutations they have undergone.

Here is an obvious example of the consequences of the Weismann's barrier: if a broke my legs in a car accident and then I get pregnant, my child will not be born with broken legs, or if s/he does it would not happen because my own legs were broken. It does not mean that the fact that I have broken legs will not affect my child's development. *This will create the environment* in which my child grows up. Perhaps I lose my job because of it, get

depressed, anxious about driving, etc. Perhaps there even will be an across generation similarity and my child will "inherit" my fear of driving. Yet, it has nothing from Evo-Devo's concept of epigenetic inheritance, which is a direct inheritance. It has something from Aristotle's view on similarity across generations, which seems naive given how complex is now the picture we have of the inheritance:

> "… children are born with a likeness to their parents not only in congenital but also in acquired characteristics, for before now, when the parent have had scars, the children have been born with a mark in the form of the scare in the same place, and there was a case at Chalcedon where the father had the brand on his arm and the letter was marked on the child only confused and not clearly articulated. That is pretty much the evidence on which some believe that the semen comes from all the body" (Aristotle, *Generation of Animals*, 721b29–35).

Weismann then made the distinction between soma cells (body cells) and germline cells in 1895. Soon after the term "gene" was coined (Johannsen, 1909) and the distinction between phenotype and genotype: the longest a phenotype may live is the lifespan of the individual and what happens in the ontogeny does not change the genes which are passed to the next generation. A half century later it was confirmed that the genetic code, whereby nucleotide sequences are translated into amino acid sequences, is irreversible: "… the transfer of information from nucleic acid to nucleic acid, or from nucleic acid to protein may be possible, but transfer from protein to protein, or from protein to nucleic acid is impossible" (Crick, 1957). The famous direction DNA → RNA → proteins. "Once information has passed into protein, *it cannot get out again*." (Crick, 1958). This is still generally valid (except for retroviruses and prions) and Evo-Devo did not change that (see especially Dawkins, 2004).

On the basis of Weismann's and further discoveries, the Modern Synthesis reject/exclude any transmission-like theory of inheritance of acquired characters in humans as in any sexually reproducing multicellular organisms. However, the MS does not reject that ontogeny matters and that there is a similarity and causal continuity between generations. It says that somatic cells develop afresh, *de novo* in each generation. (Even already Weismann says that environments, e.g. temperatures can influence butterflies' traits). The Evo-Devo's *epigenetic* opposes to preformism, but the MS is not preformist. The MS only says that whatever may happen to body cells is not directly transmitted to the next generation. It does not mean that what happens to somatic cells does not affect the next generation, or that there is no causal continuity between generations. It is just that it is not direct and transmission-like as Evo-Devo claims. Today "Weismann's barrier" means barrier to the transmission-like inheritance of acquired characters, because

if only germline cells participate in fertilization, then cells that derive from all other parts of parents' bodies (soma cells) cannot directly transmit from parents to offspring. This is valid for sexually reproducing multicellular organisms such as ourselves. The barrier is not there in amoebas, unicellular microorganisms, where one cell division would be equivalent to reproduction, to the origin of a new organism. There are organisms were Darwin's proposition of the inheritance of acquired characters works: in sponges where non-differentiated somatic cells form the germline or in Cnidaria (like Jellyfishes) were differentiated somatic cells are the source of the germline. It does not work that way in us.

Evo-Devo refers also to the fact that we have known for a few decades that the epigenomic changes such as e.g. DNA methylation, are not completely erased in eggs and sperm, thus can be passed on by both (Anway et al., 2010; Way et al. 2014; Siklenka et al., 2015). However, it does not constitute a possible mechanism for transmission-like inheritance of acquired characters, because the genome-wide erasure of DNA methylation occurs in preimplantation embryos (reaching a low point during the blastocyst stage, that is, around the 5th to 7th day of life of the zygote). Not long after implantation, DNA methylation is *de novo* methylated during later stages of development (Hajkova et al., 2002; Santos et al., 2002).

Finally, besides epigenetic facts concerning e.g. the DNA methylation processes to which the Evo-Devo refers and which can look complicated for psychologists, we should not lose sight of the most basic reason why phenotypes do not replicate and why the longest a phenotype may live is the lifespan of the individual: the fact of genetic recombination. The process happens during meiosis and leads to a novel set of combination of genes in the offspring, different from the one of its parents. That is why genetically each of us is different.

3. THE THEORY OF INHERITANCE OF ACQUIRED CHARACTERS IS NOT LAMARCKIAN

Evo-Devo credits Lamarck for the theory of inheritance of acquired characters. Yet, Lamarck never proposed any theory of inheritance. Lamarck did not even use the term, as did not "most of authors to whom we ascribe the concept of heredity of acquired characters from Antiquity to 1840" (Gayon, 2006, 105, e.g. the above-mentioned Aristotle did not use the Greek equivalent of the word heredity, *klêros*). Instead, Lamarck devoted much of his work to discredit Cuvier's thesis about the catastrophic origins of species, which were considered miraculous rather than natural events. Lamarck's thesis that species are mutable with no clear boundaries between them was sulfurous one given the institutionally established creationist view on the

origin of species. Lamarck lived in the context of the French Revolution, in times when geological discoveries brought by Napoleonian Wars were irreconcilable with biblical narratives of Creation. Yet a version of creationism, namely catastrophism, was ferociously defended by Georges Cuvier, who claimed that there is evidence for cyclical creations and destructions of species by global extinction events such as deluges. Lamarck was engaged in the dispute with Cuvier ideologically and personally (Grimoult, 2019). Thus, Evo-Devo wrongly credits Lamarck for the theory of inheritance of acquired characters, who was not preoccupied by the question of *similarity* through generations, but was focused on the question of *change* through generations. Lamarck's original contribution concerns precisely the evolutionary, gradual nature of that change. The modern theory of evolution begins precisely with Lamarck. Darwin praised Lamarck that "He [Lamarck, A.G.] first did the eminent service of arousing attention to the probability of all change in the organic as well as in the inorganic world being the result of law, and not of miraculous interposition" (Darwin, 1861, p. xiii).

4. A SYNTHESIS OF DEVELOPMENT AND EVOLUTION OR A CONFUSION OF DEVELOPMENT AND INHERITANCE?

Why do not the Evo-Devo's authors refer to Darwin, who, contrary to Lamarck, did propose a theory of inheritance of acquired characters? A reason for that might be that Lamarck made no distinction between factors which contribute to the origin of variation, to the fate of variation and to the inheritance of variation. The three are separated by Darwin and the Neo-Darwinism. Two hundred years later, the Evo-Devo attempts to (con) fuse them back. Let us first consider the first pair: the origin of variation and the fate of variation.

Lamarck's main contribution was that species get adapted to the environment through evolution and not through a miraculous interposition. He did not posit the existence of natural selection, which would explain the adaptive character of variation. For Lamarck the origin of variation was obviously adaptive, given that it was induced by the environment. Lamarck's contemporary Étienne Geoffroy Saint-Hilaire held adaptation for a passive, externally imposed process through a direct action of the environment. In case of organisms with a nervous system, Lamarck considered adaptation to be an active process occurring through the organisms "unconscious volition" (Gayon, 2006, IX). In that sense the variation was "directed" (fr. *dirigés*), was an answer to environmental changes and challenges. It was Darwin's main contribution that species get adapted to the environment through natural selection. Darwin introduced thereby the distinction between the origin of variation, which is a matter of chance and the fate of variation, which is

a matter of natural selection. The Neo-Darwinism keeps the distinction but here, although the origin of variation is also a matter of chance, the fate of variation is already a matter either of natural selection or of chance (Beatty, 1984). However, what it crucial in the context of the Evo-Devo's proposition to make a synthesis of development and evolution, neither for Darwin nor for Neo-Darwinism, variation is adaptive at the moment it originates—as it is for Lamarck. Contrary to Lamarck, Darwin and the Neo-Darwinism distinguish between conditions of variation and conditions of selection (Lewontin, 2003), origin of variation and fate of variation (Beatty, 1984), sources of variation and consequences of variation (Gottlieb et al., 1990) or arrival of the fittest and survival of the fittest (Gilbert, 2006). The distinction is fundamental for the MS and is related to the concept of evolutionary chance: that the origin of variation is a matter of chance means that there is no causal relation between the potentially adaptive values of variation *at the moment it originates*. For instance, "Heat-induced mutations do ot produce phenotypic change related to heat tolerance." (Simpson, 1953, pp. 86–87; Simpson, 1953, pp. 86–87, after Merlin, 2011, p. 90). What it implies for psychologists is that although it absolutely makes sense to think in terms a continuity between generations, the causal link between what happens in the ontogeny and what happens in subsequent generations is not as straightforward as it was for Lamarck or as it suggests the Evo-Devo.

To the considerations upon the above pair of: the origin of variation and the fate of variation, let us now add the inheritance of variation. The Darwinism and the Neo-Darwinism distinguish the question of what influences fitness (the fate of variation) and what is inherited. In other words, Neo-Darwinism distinguishes what is selecting and what is selected. Evo-Devo tries to fuse them back, as if it was possible after all what happened after Lamarck. In Evo-Devo's concept of the *extended inheritance* what is considered to be inherited is everything which contributes to the reliable reoccurrence of alternative phenotype persisting for several generations and to its fitness value. The inheritance here is not only a replication of genes, but is extended to the replication of phenotypes and all factors which contribute to the development and to the adaptedness of phenotypes and spans several generations in time (Jablonka, Lamb, 1989; 1995; 1998; 2005; 2007; Odling-Smee et al., 1996; 2003).

> "Darwin understood that natural selection can only affect traits in which there is variation that is transmitted from parents to offspring; namely, traits that are heritable. Since then, the merging of Darwinism with genetic into modern synthesis has led to a semantic shift, resulting in the tendency to assume, that only the DNA sequence is inherited across generations. However, evolution acts on any phenotypic differences that are stable across generations. According to this view, phenotypic variation should be partitioned into

> its transmitted versus non-transmitted components rather than into its classical genetic and environmental components" (Danchin et al., 2011).

In my opinion it is not a question of "a semantic shift," but of understanding of fundamentals of the Neo-Darwinism. Although genes are selected for their phenotypic properties, only genes are inherited (Dawkins, 1982). Natural selection is indeed instantiated, among others, by phenotypic differences in the sense that natural selection is composed of all factors which contribute to the reproduction. One of these factors are phenotypic traits. What is inherited, is what results. Not what is a selecting cause. Instead, Evo-Devo proposes that all that selecting factors are inherited. What result from it, is that Evo-Devo inflates the inheritance from epigenetic, cellular processes, to the inside of the womb to familial, social and cultural environments. In this light, language is inherited, ecological niche is inherited, and even intestinal bacteria are inherited. Perhaps this could work in a folk sense, as Lamarck used it in a rough sense of the similarity across generations, of the fact that parents resemble their parents and grandparents. However, Evo-Devo claims a scientific and not folk sense to the word.

The Evo-Devo introduces into epigenetics the question of inheritance and extends the latter in order to overcome (the alleged) determinism and reductionism of the MS:

> "As it stands, the Modern Synthesis reduces inheritance to genes and considers the development of forms as the consequences of variation in the DNA sequences of structural genes. [...] many arguments proposed by advocates of the extended synthesis have consequences that need to be formalized in terms of inheritance [...] in order to incorporate all non-genetic inheritance as participating to the development and inheritance of the phenotype" (Danchin et al., 2011).

Yet, Evo-Devo seems to fall into determinism and reductionism itself. Here is why.

In the original sense (Waddington, 1942 (2012)) of epigenetics not only was not opposed to genetics but complementary to it (Morange, 2014), as I mentioned above. There was also no question of the genetic determinism or the inheritance of phenotypes. In the original sense epigenetics was clearly about causal interaction between genes and their environment and not against the supposed causal primacy or of self-sufficiency of genes. The genes determinism is a conviction that phenotypes arise out of genes which are necessary and sufficient for a phenotype to develop. Like in the made by philosophers of biology analogy to "matches determinism:" determinism in that case would be a conviction that striking a match is *the* cause it lights up, i.e. is the necessary and sufficient condition, while background conditions (such as an appropriate oxygen rate in the atmosphere, etc.) are just neces-

sary conditions (Sterelny, Kitcher, 1988). Yet, the MS never claimed that „genes are *necessary and sufficient* for a trait to develop." The genetic determinism the Evo-Devo imputes to the MS owes much to preformationist: here there are genes, away in a nucleus, separate from its closest cellular environment, like was the homunculus at a control panel, sit there controlling development and omnipotently decide what you do. As if genes were not part of the cell and would operate independently, outside the causal universe. The MS statements that "genes are necessary for a trait to develop" does not equal (es Evo-Devo seems to read them) that "genes are self-sufficient for a trait to develop" or that "genes are enough for a trait to develop" or that "the environment does not matter if you have that gene." It is not genes *or* environment. For instance, the probability that a disease will be expressed really is greater in an individual bearing a gene x than in another who lacks the gene x (e.g. probability that mongolism will develop is greater in individual bearing a supernumerary chromosome, than in a bearing diploid chromosome number). Yet, sometimes really it is enough to have one particular gene to develop a disease. For instance, if on the first chromosome one has a mutation on one single gene coding for a glycoprotein (called the extracellular matrix protein 1, ECM1), the person will suffer from the Urbach-Wiethe syndrome. Besides other symptoms of the disorder, in 50±75% of cases there are bilateral calcifications in the anterior medial temporal lobes, especially in the amygdalae, crucial in emotion mechanism of the central nervous system. However, precisely because genes alone are necessary, but not sufficient for reliable predictions (because for the MS gees are necessary but not sufficient for a trait to develop), in some cases, like in phenylketonuria, we can prevent the pathological development and mental deficiency by introducing an appropriate diet. In the case of the Urbach-Wiethe syndrome we do not (yet) know what we could do in order to prevent the disorder, but it does not mean that the gene in question is "a master molecule." The MS never assumed that development is not a complex and complicated process or that DNA does not depend on those developmental factors. The MS does not assume genetic determinism, but genetic selectionism and understands inheritance in *statistical* terms (Dawkins, 1976; 1982; 2004).

Ironically, the alleged Neo-Darwinist reductionism and genetic determinism Evo-Devo brings into discredit, Evo-Devo itself proclaims. The latter focuses on the gene *expression* but seems to obscure the fact that it is *gene* expression. This can be seen already in the new way the Evo-Devo defines the epigenetics as "the study of heritable phenotype changes that do not involve alterations in the DNA sequence" (Riggs et al., 1996; cf. Dupont et al., 2009). The same goes for the distinction between intergenerational and transgenerational effects. According to the Evo-Devo, the intergenerational effects encompass all nonsequence-based effects that can be transmitted

from one generation to the next, e.g. parental effects, such as the impact of in utero exposure to particular nutritional, hormonal, or stress/toxin environments on the developing embryo. Only the second kind are "truly transgenerational effects" and these are "found in generations that were not exposed to the initial signal or environment that triggered the change (Heard, Martienssen, 2014). It looks like "epigenetics is the new 'gene for'" (Buchanan, 2013). Only why would psychologist exchange genetic reductionism for somatic reductionism? "These epigenetic findings may well set off a new round of somatic reductionism because research is confined largely to the molecular level" (Lock, 2013).

5. CONCLUSION. FOR PSYCHOLOGISTS: IS EVO-DEVO THE MATTER OF THE SYNTHESIS OF DEVELOPMENT AND EVOLUTION OR THE MATTER OF THE RAPPROCHEMENT OF PSYCHOLOGY AND BIOLOGY?

Why Evo-Devo's proposition, despite its careful reception among biologists, is so appealing for psychologists that some call it "a new biology for psychology"? The Evo-Devo complain is that the MS focuses on the science of evolution and neglects the science of development. As we have seen, although the Evo-Devo's makes great discoveries, their enthusiastic project to "modernize the modern synthesis" (Danchin et al., 2011) is already to be moderated. However, it is biologists' concern. The interesting question is what is psychologists concern and why did they identified with someone else complain? What is it that psychologists heard behind Evo-Devo's claim to make a synthesis of development and evolution so that they made it their own claim? The rapprochement between psychology and biology is clearly in the spirit of the times (Panksepp, Panksepp, 2000; Panksepp, 2010; Solms, Saling, 1986). But why to do it through Lamarck? "Now, for the first time since the fall of Haeckel and Lamarck at the close of the nineteenth century, there is an opportunity for a dialogue on the subject between psychoanalysts and biologists that can benefit both fields" (Hofer, 2014).

Perhaps one reason for that precedes by centuries the origin of both psychology and biology, namely mind-body dualism. The latter is a conviction that what is mental is opposite to material, not physically determined and therefore contra-causal. Lamarck (and after him the modern theory of evolution) made a step toward monism in his thesis that species do not result from a creation, but from the laws of nature. Let us recall once more "He [Lamarck, A.G.] first did the eminent service of arousing attention to the probability of all change in the organic as well as in the inorganic world being the result of law, and not of miraculous interposition" (Darwin, 1861, p. xiii). The very idea lies at the origin of psychology. Indeed, psychology as

a distinct branch of science originates when psychology becomes part of natural science. The "psyche" finally starts to be considered as something that can be examined and explained in terms of laws of nature. From the point of view of philosophy, this naturalization of the psyche, this bringing it back to the nature, means in fact taking position regarding the mind–body problem. Philosophically interpreted, the enterprise to create a science of psychology is a step toward monism. However, although in the 20th century the meaning of the psyche as the soul in psychology started to be mostly repudiated, the problem of mental causation which is "at the heart of the mind-body problem" (Shoemaker, 2003) has not gone away. Instead, it shifted to mental (conscious, volitional) and to the questions of how, if ever, mental is causally relevant to bodily behavior (Robb, Heil, 2019). From the beginning psychologists drew on biology of their time (starting by Wilhelm Wundt in Germany, Théodule Ribot in France, Alexander Bain in Great Britain and William James in United States), psychologists take position toward biology (even if it is rejection). Yet, their attitude toward monism remained ambivalent and such was the relationship between psychology and biology. My claim then is that is in not, as Hofer says, that the Evo-Devo changes biology so that at last the rapprochement between psychology and biology is possible. Rather psychologists are now ready for the rapprochement.

With Freud's psychoanalysis made a step toward monism, although not without ambivalence. Freud wrote in 1895 *The Project for a Scientific Psychology* (first published in 1950), which was an attempt to bridge mind and body (as it bridged his early career as a neurologist and his later career as psychologists): "What Freud attempted in the 'Project' was a monumental effort, an attempt to overcome the dualism that plagued and still plagues psychology and neurology" (Solomon, 1974, p. 39, after Schore, 1997). Freud expected that "we shall have to find a point of contact with biology" (Freud, 1913, after Schore, 2009). Yet, soon after Freud abandoned the project. Perhaps he did so because biology was not advanced enough to be helpful to psychoanalysis, but it was also premature to bring the two together. Freud's desire to create "a psychology which shall be a natural science" (Freud, 1895, after Schore, 1997) was quite ambivalent, associated with a fear that psychology will eventually be reduced to biology. Indeed, Freud talks about psychological ideas as "provisional," "artificial" over which the biological will in the future gain the upper hand: "we must recollect that all of our provisional ideas in psychology will presumably one day be based on an organic substructure" (Freud, 1914, after Kandel, 1999) and that physiology "will blow away the whole of our artificial structure of hypothesis" (Freud, 1920, after Kandel, 1999) as if Freud assumed that biological was less artificial, more true. In other words, it may be that for psychoanalysis it is "biology [that] grew ever more distant from psychoanalysis" (Hofer, 2014, p. 11) but

it may also be that it is "psychoanalysis [that] have cut its ties to the rest of the scientific world" (Holt, 1989, p. 340).

Psychology in its initial period did not overcome dualism. Some psychologists considered the mental without the biological and some other considered the biological without the mental. For instance, psychoanalysis gave the explanatory primacy to the mental and continued without appeal to biology. To this day some psychoanalysts dress the question "whether biology is at all *relevant* to psychoanalysis" (quoted by Kandel, 1999). "… psychoanalysis has not evolved scientifically" (Kandel, 1999, p. 505), paid the price of not being considered scientific and met skepticism whether "talking therapy" can be anyhow efficient (whether the work on the mental could anyhow change the physical, e.g. the brain). On the other hand, the behaviorism gave the explanatory primacy to the biological and continued without appeal to the mental (tried to get rid of descriptive mentalism, e.g.: "s/he feels angry" and explanatory mentalism referring to psychological states, such as beliefs, desires, thoughts, convictions, feelings, e.g.: "she abandoned him because she thought he did not love her" (Zuriff, 2003). The behaviorist attitude toward mentalist explanations was reductionist and at times derisive, since for some its main proponents the mental was still referring to an immaterial substance, to agents endowed with contra-causal free will, and to homunculi within bodies (Skinner, 1971; see Graham, 2019). The dualistic thinking played out in the difference between patient's attitude toward suffering from physical and mental suffering: usually not hesitating to take care of broken legs or cancer, but reluctant to ask for help when it comes to mental suffering, even when it is their own.

In recent decades the mind–body dualism fades. Many psychological approaches benefit from various branches of biology and the mental gains particularly from the rapprochement of psychology and physiology. Our attitude toward mental disorders changes as we gain knowledge of their neurophysiological underpinnings. For instance, depression or addiction started to be considered "real," that is, "physical" illnesses. Psychiatrists are the less often considered as "lesser physicians" compared to other medical doctors. People are more likely to ask for help a psychotherapist. Long-term follow-up studies confirm that, e.g. 8 years of mentalization-based psychotherapy for borderline personality disorder achieve a remission (Bateman, Fonagy, 2008) and treatment gains are maintained over the subsequent years. It means we gained the monistic conviction that the work on the mental changes the physical (that is, the brain) and their effects extend over a longer time that the effects of pills. Probably psychologists' saw in the Evo-Devo claims one more link between mental and physical health, another "mechanism" through which "the psyche" has an influence on the soma, one more way to overcome the residue of dualism.

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