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Fine-tuning nativism: the 'nurtured nature' and innate cognitive structures

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Abstract S. Oyama's prominent account of the Parity Thesis states that one cannot distinguish in a meaningful way between nature-based (i.e. gene-based) and nurture-based (i.e. environment-based) characteristics in development because the information necessary for the resulting characteristics is contained at both levels. Oyama as well as P. E. Griffiths and K. Stotz argue that the Parity Thesis has far-reaching implications for developmental psychology in that both nativist and interactionist developmental accounts of psychological capacities that presuppose a substantial nature/nurture dichotomy are inadequate. We argue that well-motivated abandoning of the nature/nurture dichotomy, as advocated in converging versions of the Parity Thesis in biology, does not necessarily entail abandoning the distinction between biologically given abilities necessary for the development of higher psychological capacities and the learning process they enable. Thus, contrary to the claims of the aforementioned authors, developmental psychologists need not discard a substantial distinction between innate (biologically given) characteristics and those acquired by learning, even if they accept the Parity Thesis. We suggest a two-stage account of development: the first stage is maturational and involves interaction of genetic, epigenetic and environmental causes, resulting in the endogenous biological 'machinery' (e.g. language acquisition device), responsible for learning in the subsequent stage of the developmental process by determining the organism's responses to the environment. This account retains the crux of nativism (the endogenous biological structure determines the way the organism learns/responds to an environment) whilst adopting the developmentalist view of biology by characterizing environments as distinctly different in terms of structure and function in two developmental stages.

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The Parity Thesis and liberal interactionism

Oyama's (2000a, b, 2001) formulation of the Parity Thesis states that one cannot in principle distinguish between the nature-based (i.e. gene-based) and nurture-based (i.e. environment-based) characteristics in development because the information necessary for the resulting characteristics is contained both at the level of the environment and at the level of the genes. Thus, the genes (i.e. the DNA molecules) are only part of the developmental process, and the nature/nurture dichotomy collapses as 'nature' represents a developing phenotype, not an independent causal determinant. And the phenotype is only part of the developmental construction. Hence, genetic information is never transmitted from a master molecule in the isolated germ, but is always constructed in development. The biologist's task then is to decipher the ontogeny of such information and evolution is "a change in the distribution and constitution of developmental (organism−environment) systems" (Oyama 2000a, p. 77), not simply a change in gene frequencies as genocentrism of Modern Synthesis of Darwinism and genetics has it.[1]

Oyama, the most vocal advocate of the Parity Thesis, thus emphasizes that phenotypes are always developmentally constructed in stark contrast to the genetic programme approach to development. Furthermore, this does not allow one to simply partition genes and environment as two necessary but independent components of development (as well as morphogenesis) that can be analysed as such (where the precedence of the genes could be established in some cases). In her words, "the parity thesis does not lead to conventional 'interactionism' that accepts traditional categories of nature and nurture, biology and culture even if both are 'important', and 'interact'" (Oyama 2000b, p. 342). Thus, the consequence of her characterization of the distinction between acquired and innate biological characteristics is intended to make a much stronger point than even a very liberal version of interactionism, which, unlike conventional interactionism in psychology, treats nature and nurture on par.[2] She writes that "*there is no intelligible distinction*

[1] A brief account of the origin of the Developmental Systems approach in light of its relation to the Central Dogma of molecular biology, and germ-centrism of Modern Synthesis of Darwinism and genetics, is provided in the Appendix.

[2] Conventional interactionists in psychology maintain that the genetic programme results in, for instance, the biological centres necessary for psychological development (the main topic of our paper to be discussed shortly), albeit more minimally than the biological devices presupposed by nativists (see, e.g., Elman et al. 1996; Karmiloff-Smith 1992). Liberal interactionism eliminates the genetic programming altogether and invokes the environment/biology interaction throughout the process. This is a novel general (parity) thesis which, unlike conventional interactionism, does not explicate what exact, if any (developmentally produced), biological devices are needed for psychological development. It is not simply a weaker interactionist account: we will, in effect, argue that it is plausible to reconcile a nativist claim about the substantial biological devices necessary for psychological development with liberal interactionism as a general parity thesis, if the former is divorced from genetic determinism. However, nativism, even when divorced from genetic determinism, cannot be reconciled with conventional interactionism because of the disagreement as to the kind of biological devices needed for the realization of psychological abilities, not to mention the interactionists' commitment to genetic determinism.

between inherited (biological, genetically based) and acquired (environmentally mediated) characteristics…. Once the distinction between inherited and the acquired has been eliminated, not only as extremes, but even as a continuum, evolution cannot be said to depend on the distinction" (Oyama 2000a, p. 138; emphasis added).

Parity thesis, as summarized by Oyama, has been present in the developmental biology and developmental psychobiology for some time. Like Oyama developmental biologists, such as Lewontin (1980), Gottlieb (2003), Meaney (2001), Bateson (2003), to name just a few, are reluctant to accept the distinction between the nature-based (i.e. gene-based) and nurture-based (i.e. environment-based) characteristics. One of the main reasons for abandoning such distinction comes from their worry that the basic assumption of behavioural genetics applies only to a very limited domain: the assumption that a quantitative analysis of the genetic and environmental contributions to the development of individual traits is possible.

Behavioural geneticists have developed several standard methods for studying nature-based (or gene-based) and nurture-based traits. These include twin studies (or adoption studies)[3] in humans and breeding, transgenesis[4] and gene knockout[5] studies in animals. The general idea behind them is that manipulation of genotypes and/or environments on large numbers of individuals of a species, analysed by statistical methods, tells us which traits are due to genes and which are due to the environment. The assumption is that genetic and environmental factors operate independently, and these methods can successfully capture the functional roles of both.

Developmental biologists (e.g. Lewontin et al. 1984, Gottlieb 2003; Meaney 2001; Bateson 2003) have pointed out, however, that statistical methods currently used in behavioural genetics do not illuminate the developmental processes characterizing individuals. Thus, if we are analysing individual variance (by keeping genotype and/or environments constant), this will give us a very general picture of genes and environment involved in development, but not the specifics of the environments and genotypes, and their interactions, involved in the trait development of particular individuals. Nor will it indicate under which conditions and to what degree this happens in the individual. In other words, it does not provide a causal explanation of how the development of an organism's traits unfolds in terms of distinct environmental and genetic causes. So it would be a mistake to infer from statistical analysis that some traits are caused by genes whilst others are caused by environmental factors, nor is it possible to infer which percentage of a trait in a given case is due to genes and which percentage is due to the environment.

[3] The main idea behind studying monozygotic or identical twins is that their overlapping genotypes (almost 100%) makes them ideal for teasing apart innate (inherited) traits from those that are environmentally acquired. Such studies seem indispensable for research on inheritable diseases and pathological conditions running in families, but they have been (mis)used in studying the inheritability of the IQ or aggressive behaviour as well.

[4] This is the process of introducing the new gene into the organism. The organism will then exhibit a novel trait and transmit it to its offspring.

[5] This technique makes certain genes inoperative. The goal is to cast more light on their role in the development of a trait.

For developmental biologists arguing for the Parity Thesis, this limitation is not merely a 'statistical limitation'. It turns out that the interactions between genes and environment in individuals are much more complex than these studies assume and that accordingly, the underlying account of genes and environment in the experiments that enable the researchers to keep genes or environments constant is sketchy, at best. Therefore, we should not draw conclusions about the ratio of genetic and environmental factors from such studies. When developmental biologists study development in individuals, they understand that it is almost 'logically indefensible' to describe and explain the development of an organism and its characteristics in as rough terms as the aforementioned studies do (Gottlieb 2003, p. 338). Developmental biologists admit that the goal of developmental biology (and developmental psychobiology) is to study the variety of causal factors involved in the development of an organism—factors coming from genes, cytoplasm, hormones, physiology, anatomy and a plethora of physical and social stimuli external to the organism—but we should abandon all hope of quantifying such factors in the aforementioned sense. Based on what we know, it is not clear even what kind of methods or instruments would enable developmentalists to measure and quantify these factors in the manner required by behavioural geneticists' methods.

A number of studies have shown that the gene−environment interaction is far more complex than the studies in population and behavioural genetics assume (see, e.g. in Nijhout 2001; Müller and Newman 2003). The extensive research on gene expression has shown that genes always operate (i.e. are activated or inactivated) in a particular context; furthermore, the two are so entangled that the gene's functional role cannot be studied, or even defined, independently from that context. They also show that the context or the environment in which genes operate cannot be understood in general terms as a typical or standard environment whose role is to trigger or activate gene expression, and such an understanding is indispensable in the kind of studies required by behavioural geneticists. Environment needs to be conceptualised on multiple levels from the immediate surroundings of DNK molecules (which sometimes includes other genes!), to cytoplasm, tissues, and the external physical and social stimuli of the organism.

For instance, the complexity of 'gene expression' has been demonstrated in a study of the effects of glucocorticoids, a class of steroid hormones (Diamon et al. 1990). The production of these hormones increases when the organism is under stress. Their main function is to regulate changes in blood sugar, heart rate and neural activity in stressful situations. But how they affect cells (and regulate the aforementioned changes) is mediated by changes in gene expression. Thus, on the one hand, glucocorticoids bind to intracellular receptors that regulate gene activation. On the other hand, intracellular receptors are able to do that by binding to the regulatory sequences of the gene essential for gene transcription. This study has shown that when glucocorticoids bind to intercellular receptors, they can increase or decrease gene transcriptions. Which they will do depends on the presence or absence of other intercellular transcription receptors. However, the number of other intercellular transcription receptors depends on whether a person is in a stressful situation. Given such interdependency of external factors, intercellular factors and gene activation, it is not clear what would it mean to study the effects of these factors independently from each other or what keeping one of them constant

would achieve in terms of the insights sought by behavioral geneticists.[6] One can talk about the trait only as an overall product of multiple factors.

Furthermore, when we take a closer look at the developmental process, it becomes clear that it is impossible to reach the goal of capturing and quantifying purely genetic causes of the traits and behaviours of an organism. This is primarily because DNK molecules are inert and require activation. As 'gene expression' is determined by "other levels of the system" (Gottlieb (2003), p. 349), the immediate surroundings of the genes, i.e. cytoplasm, must impact gene expression. In turn, cytoplasmic factors are frequently influenced by external stimuli of the organism, depending on the particular behaviour of the organism. Gottlieb calls such interdependence of gene expression, cytoplasmic factors, behaviours and external stimuli in the development of the traits of the organism 'coation' or 'relational causality'.

Within such a framework, genes become a part of the developmental manifold and cannot be singled out as independent causes or even as independent contributors to the development of the traits or behaviours of the organism. More precisely, by themselves, genes do not produce a neurological structure in a linear fashion, nor do they produce behaviour of an organism (contrary to explicit suggestions by behavioural geneticists). There are simply no such unidirectional causal links between genes, neural structure and behaviour:

> Environment regulates the actions of genes, and genes via changes in the nervous system influence the sensitivity of an organism to changes in the environment. The two causes are not separable developmentally. Statistical procedures that appear to separate variance according to genetic and environmental causes do not provide a valid representation of physiological reality. (Wahlsten and Gottlieb 1997, p. 178, as cited in Meaney 2001, p. 53)

One worry about the Parity Thesis defined in this way is that if we dissolve a substantial distinction between genes and environment—as independent kinds of causes—it seems that we cannot satisfyingly discriminate between them so that we can determine their particular role in the developmental process (Kitcher 2000). Thus, Kitcher argues that there is no need to radically reconceptualize our current developmental biology and abandon the dichotomy between environmentally based and genetically based developmental factors. In order to overcome the problems faced by genocentrism, the argument goes, it will suffice, first, to acknowledge methodological problems of studies in population and behavioural genetics along with their hasty conclusions that some traits are due to genes whilst others are due to environment. Second, we need to develop more precise methods to determine

[6] "Yamamoto and colleagues found that glucocorticoids could either positively or negatively regulate proliferin, depending on the context. If intracellular levels of another transcription factor, cJun, were elevated, then the glucocorticoid receptor bound to a regulatory region of the proliferin gene and increased transcription. In the absence of cJun, activation of the glucocorticoid receptor was without effect on proliferin expression. But the story becomes increasingly complex. If intracellular levels of cJun as well as another related transcription factor, cFos, were elevated, then the glucocorticoid receptor did indeed regulate transcription, but negatively. Thus, without cJun there was no glucocorticoid effect, with cJun there was an increase in gene transcription, and with high levels of both cJun and cFos there was a glucocorticoid receptor-induced decrease in gene transcription" (Meaney 2001, p. 53).

genetic causes as well as environmental ones (when environment is understood in the broadest sense to include the immediate environment of DNK molecules) and accept that both kinds of causes are equally important in the development of the organisms and their characteristics. Kitcher labels this position 'liberal interactionism', indicating that a core distinction remains intact, even though it is defined in a more minimalist way. It should permit us to use the main arguments of the proponents of the Parity Thesis (when they are arguing against genetic determinism) whilst allowing us to avoid obscurity prompted by negating the distinction between genetic and environmental contributions to development. Finally, within the framework of liberal interactionism, we could talk about genetically based diseases—at least in some sense. In other words, when we identify a role played by certain genes in the onset of certain diseases, we could say that such diseases are genetic whilst acknowledging that genes never operate in isolation and bearing in mind all the complexity of environmental factors involved in such a process (as the proponents of the Parity Thesis would have it). This could be of great use in the studies of inheritable diseases.

Whilst Oyama and other developmental biologists and psychobiologists maintain that the Parity Thesis implies that the classification of traits into gene-based and environment-based as well as the study of genetic/environmental causes as if they function independently of each other is not viable, they also argue that "our emphasis on causal interdependence doesn't mean that everything is so connected to everything else that analysis is impossible, or that in order to study anything, you must study everything" (Oyama 2000b, p. 344). Instead, they think that the Parity Thesis enables far more refined discriminations among developmental causes by abandoning the nature/nurture dichotomy. Thus, developmentalists like Oyama would not deny the role genes play in development, but they would deny that genes could play such a specific role outside a specific context or environment. So in order to study what genes do, we need to study what their specific environment does. But this does not seem to be something with which Kitcher would necessarily disagree, given that he understands environment in its broadest sense and given that he acknowledges the importance of environment in the process of gene expression (Kitcher 2000, pp. 403, 405).

The point where the Parity Thesis and Kitcher's liberal interactionsim seem to diverge lies in Kitcher's view that we should maintain the notion of 'genes for traits' in our developmental theory even if we acknowledge the complexity of the developmental process and the multiple roles genes play in it. By keeping the notion of 'genes for traits', Kitcher may be implicitly suggesting that with some better measurement devices and methods, we would be in a position to determine more precisely in what way and to what extent genes contribute to development, i.e. such devices would be able to isolate, clearly identify and quantify the role and the contribution of genes to the development of a trait, behaviour or disease. In other words, it seems that Kitcher is suggesting that better measurements would enable us to determine the independent contribution of genes to the development of an organism. But, again, given that Kitcher acknowledges the complexity of the developmental process and the importance of context and environments for gene expression (Kitcher 2000, p. 406), it is not clear what it would mean to determine the independent contribution of genes and/or environment to the development of a trait.

Whilst with finer measurement devices we could potentially identify a multiplicity of causes and get a better picture of their causal roles in development, it would still not make much sense to retain the distinction between genetically based and environmentally based traits, given that they are necessarily the result of both.

Therefore, as traits, behaviours and diseases are always the result of multiple interrelated factors involved in the bidirectional causal process, it is not at all certain what kind of technology would allow for the quantification of the contributions of each factor (if this is what Kitcher suggests by endorsing 'genes for traits'). That is, if we accept the thesis that we need to study the context in which genes function in order to study gene expression—and Kitcher seems to accept this—we end up with the Parity Thesis and its conclusion that genes and environment are interdependent and that to study the former necessarily involves studying the latter. This implies that we should abandon all talk about genetically based traits, behaviours or diseases.[7]

With these clarifications in mind, the next question to examine is whether the Parity Thesis, as described in this section, has clear implications for developmental psychology, particularly for nativism, and, if it does, to what extent. The following section deals with this question.

Nativism in psychology and the Parity Thesis

Oyama and others (see, e.g. Griffiths and Stotz 2000) argue that the Parity Thesis has far-reaching implications for developmental psychology in that any developmental account of motor, cognitive, affective, social and linguistic capacities that presupposes the nature/nurture dichotomy is inadequate. Nativism (as well as conventional interactionism), the argument goes, implicitly and/or explicitly subscribes to the neo-preformationist understanding of development. And a genetic programme is responsible for innate features of the organism (i.e. the features given by nature), whilst the development of the more advanced cognitive, affective, social and linguistic capacities unfolds through interaction between innate nature and culture. Yet, if we instead abandon the idea of genetic programmes and accept Oyama's suggestion that nature is always nurtured, this renders misleading the claim that "psychological development is due to interaction, whilst the body is programmed, or that some modules are in the genes whilst others must develop" (Oyama 2000b, p. 341).

Now, even if the point concerning the collapse of the distinction between gene-based and environment-based traits is plausible in biology (i.e. if there is no master molecule or genetic programmes), it is not immediately clear whether or how this

[7] To be fair, near the end of his article dealing with the issue (Kitcher, p. 409), Kitcher seems to say that the notion "genes for traits" should be kept for pragmatic reasons (for instance, when we study inheritable diseases), but we should be much more cautious when we use it in some studies, for example, on the inheritance of aggressive behaviour. This means that it would be useful in identifying certain genes that reoccur in the onset of a disease; these genes could be called "genes for" this disease. However, because they are only provisional, we should keep in mind all the causally interdependent factors involved. Kitcher's final remarks on the pragmatic use of the notion "genes for X" indicate that the dispute between his liberal interactionism and Oyama's parity thesis could be settled; their disagreement does not run as deep as it might appear at first glance.

threatens nativism in psychology or, to be more precise, how it threatens even a particularly strong version of nativism in psychology (explained in detail below).

For example, even if nativists do not deny that most mechanisms which result in psychological traits, capacities and behaviours of organisms are developmentally constructed (i.e. that they are due to the interaction of genetic, epigenetic and external factors), their core understanding that there is a substantial and well-defined set of capacities or predispositions (often interpreted broadly to involve the existence of specific modules and devices) necessary for the development of higher cognitive capacities (such as language) could conceivably remain intact. Whether such a position could remain viable depends on whether, as Oyama seems to be claiming, the complexity of the developmental biological processes collapses not only the distinction between nature and nurture but also the one between biologically given and learned. It also depends on what exactly are these necessary capacities and predispositions, i.e. what kind of nativism one advocates.

In fact, nativists have substantially different views on the exact nature of the capacities or predispositions necessary for development. Historically, innateness has been ascribed not only to predispositions and capacities but also to traits and behaviours, as well as to full-fledged knowledge.

Thus, in the history of pathology, we find a view that a particular state of the body (its constitution) predisposes it to acquire certain diseases; this is called the diathesis. Whilst the disease is contracted or developed due to the environment, it is also contracted because of the weak constitution of the body inherited from the parents (Olby 1993).

In the weakest forms of nativisim regarding capacities of the mind, as in empiricism and behaviourism, we inherit mechanisms of learning readiness that do not contribute content to the output of the learning process. What is learned depends entirely on the culture in which the learner grows, but if she is to learn successfully, she must inherit the right predisposition (the learning readiness mechanism).

Mental and physical character traits have also been considered as inherited. One of the first to argue that through empirical research and strict measurement we can determine which traits are due to nature and which are learned was F. Galton, Charles Darwin's first cousin. Galton believed that nature, at birth, offers a potential for development. Whilst neither nature nor nurture is self-sufficient for development, "no carefulness of nurture can overcome the evil tendencies of an intrinsically bad *physique*, weak brain or brutal disposition" (Galton 1875, pp. 9–10, italics in the original).[8]

In contemporary evolutionary psychology (see, e.g. Cosmides and Tooby 2000), some instincts and behaviours, such as fear of snakes, incest avoidance, altruistic and mating behaviour and the like, are considered innate. What kind of cognitive mechanism, if any, needs to be innate to generate such behaviours remains to be seen (Cosmides and Tooby 2000).

[8] Galton was the father of the statistical twin studies accepted and used by behavioural geneticists. Obviously, if we accept Oyama's parity thesis along with developmentalists' critique of the methodology and the conclusions of such studies, Galton's concept of innateness needs to be abandoned. However, whether the same applies to other notions of innateness is to be examined on a case-by-case basis. Our goal is to consider the notion of innateness developed in cognitive revolution, particularly by Chomsky and his followers. We turn to this issue shortly.

Stronger versions of nativisim regarding mind emerged with the cognitive revolution of the 1950s and the subsequent rise of the computer metaphor for the mind. Whilst nativists of the cognitive revolution continued the tradition of seventeenth century rationalists who argued for innate ideas and innate knowledge, later, twentieth century nativists conceptualized innate knowledge as domain-specific learning mechanisms, including the language acquisition device (Chomsky 1959, 1968; Pinker 1994), the theory of mind module (Baron-Cohen 1995), mind modules for physical reasoning (Spelke and Kinzler 2007; Cosmides and Tooby 2000), the recognition of faces (Cosmides and Tooby 2000) and the like. The main difference between stronger versions of nativisim that posit domain-specific leaning mechanisms and weaker versions that postulate innate dispositions for learning lies in the fact that the former ascribes some innate content (knowledge) to the process of learning whilst the latter denies such knowledge and postulates elaborate learning mechanisms devoid of content.

Let us, however, focus on the strong version of nativism as it applies to language. There are two components of such nativism and two sets of arguments that reinforce each other: first, arguments that purport to demonstrate why language cannot be learned by induction through the interaction between the subject and the environment and, second, arguments concerning the biological location of such a device.

By developing the theory of transformational grammar in the 1960s and 1970s and the theory of principles and parameters in the 1980s, Chomsky articulated several arguments for the innateness of language acquisition device (LAD) or universal grammar (UG). These arguments had both logical and empirical force. According to Chomsky, the main feature of all human languages is that they are structure-dependent and are finite systems of words and rules that allow for an infinite number of sentences.[9] Starting from this feature of all human languages, Chomsky concludes that children, in order to learn language, need to have basic rules for the combination of words. A general learning device (say learning by induction) that is not based on such set of rules simply does not suffice if they are to master the use of linguistic phrases and rules in a short period.[10] Chomsky goes on to explain why these basic rules and categories are not learned: by and large, they do not occur in child-directed speech (or 'motherese'), i.e. in the language that the child hears. This means that parents do not correct their children consistently when children make grammatical mistakes. Moreover, child-directed speech or motherese is deficient, full of hesitations, ill-formed sentences and self-corrections.[11] Hence, these rules must be innate.[12]

[9] These arguments for the innateness of language are usually called arguments from structure dependency and creativity.

[10] By the age of three, children are able to form fairly complex grammatical sentences.

[11] This is usually referred to as poverty of stimulus and degeneracy of data arguments.

[12] Chomsky's arguments for innateness of LAD or UG have been challenged in various ways. Some developmental psychologists focused on the nature of child-directed speech and showed that it is far more informative (in terms of positive and negative evidence) than Chomsky thought (for a summary, see Sokolov and Snow 1994). Other developmental psycholinguists aimed to explain the learning of linguistic rules by invoking simpler learning mechanisms from which such rules could be extracted (for a summary, see, e.g., Michel and Moore 1995.

However, the question is what exactly does it mean that certain domain-specific knowledge such as LAD is innate or hardwired in the context of a naturalist explanation (the one that most people now expect) of the origins and development of mind?

Pinker (1994) establishes that language capacity is localized in a particular part of the brain[13] and moves on to illustrate how this particular network of neurons, localized in a particular brain area, can process certain linguistic rules.[14] Pinker next considers how neurons responsible for the processing of certain linguistic rules form a neural network with the required pathways. He invokes a simplified version of the genetic programme in order to explain the formation of the pathways: he notes that the molecules that guide, connect and preserve neurons are proteins, and genes specify proteins. Within this framework, the 'grammar genes' are stretches of DNA that code for proteins or trigger the transcription of proteins at certain spatial and temporal points in the brain. The proteins, in turn, guide, attract or glue neurons into networks necessary to compute the solution to some grammatical problem.

After explaining Chomsky's initial arguments for the innateness of language acquisition device and after laying out possible genetic and neurological mechanisms that could be responsible for language acquisition, the next question to consider is whether nativism of this form can be reconciled with the Parity Thesis.[15] It is clear that nativism and the Parity Thesis cannot be reconciled as long as the former is predicated on the genetic programme approach to development. But can Pinker and other modular theorists who subscribe to genetic determinism continue to argue that the mind is a set of hardwired modules if genetic determinism is implausible? Prima facie, it seems that they can as long as the distinction between biological structure (such as LAD implemented in the brain) and the process of learning is maintained. Even if genes do not carry privileged information about protein transcription and proteins are a result to great extent or predominantly of epigenetic and similar processes, nativists might still maintain that there are brain centres necessary for the development of language, theory of mind, and so on and that the structure and function of these centres result from environmentally shaped and (not merely genetically programmed) biological processes. The 'nature' can be equated with the biological structure, an 'organ' necessary for the development of language and various psychological capacities, even though it (the biological structure) is a result of biological processes which are not genetically determined by an information carried by the germ. For nativists such as Chomsky and Pinker, the biological/neurological structure necessary for language acquisition could be the result of genetic, epigenetic and other processes, as long as it is not the result of learning.

[13] There is a long history of arguments against the concept of localization. For some current arguments, see Michel and Moore (1995).

[14] The neural network is supposed to carry the information in a way similar to the programmed Turing machine that processes information while doing addition. Pinker is speculating that some pathways in this neural network are responsible for processing particular grammar rules such as inflection or verb tense. When the child is born, many neural pathways in the centre for language are open (and thus the child can learn any language), but they are also constrained in that they are devoted to processing linguistic rules universal to all languages. As the child is exposed to her mother tongue, some pathways are strengthened more than others.

[15] We are examining the strongest version of nativism, in part, in order to preempt the objection that nativism as we understand it is too weak. Indeed, as we will argue, once we disentangle the key aspects of strong nativism concerning cognitive structures from the underlying biological account of their origin, it turns out that even the strongest versions are reconcilable with Parity Thesis.

However, as we will discuss shortly, the issue is somewhat more complicated. The main problem for nativists willing to give up genocentrisim is that most of the brain centres to which they refer are not ready or even present at birth. To account for the postnatal development of these centres, nativists usually invoke the concept of maturation that presupposes a genocentric view of development. It turns out that the concept of maturation forces nativists to embrace the view of genetic programming of traits and that the reconciliation of the Parity Thesis and strong nativism hangs on this issue. We will turn to this central problem and the way in which nativists can address it in "Moving on the debate: maturation, development and non-genocentric nativism".

But first, it is important to clarify that the Parity Thesis as sometimes presented by Oyama and others seems to demand more than abandoning genetic determinism. Nothing can save nativism about higher cognitive structures in the face of the Parity Thesis if it demands that we abandon both the nature/nurture distinction in a very specific sense (i.e. there are no gene-based and environmentally based traits) as well as the distinction between biologically given structure and the process of learning. At times, Oyama seems to suggest exactly this. Along with others, she says: "[O]pposition between genes (*or biology*) *and learning*, or between genes (or biology) and culture, are endemic to many fields but are miserably inadequate for capturing the multitude of causal factors needed for any reasonable treatment of ontogeny and phylogeny" (Oyama et al. 2001, p. 2, italics added). If this is the case, there cannot be a moderate abandoning of genetic determinism to leave intact the distinction on which nativism in psychology (nativism of the Chomskian kind, for instance) is grounded. Given that nature "is always a nurtured nature" (Oyama 2000b, p. 341), the nature–nurture discriminations can never, at any level, be clear-cut and studied independently from each other. And "the discriminations must stand on their own if they are to stand at all" (Oyama 2000b, p. 339). In other words, we have to be able to study, at least in principle, the traits as purely nature-based or environment-based if the opposition between these two categories is to be conceptually justified and potentially empirically useful. The implication is that such clear-cut distinctions are possible only within a genocentric view of development and that if we give up genetic determinism, we should abolish such distinctions altogether. That "there is no intelligible distinction between inherited (biological, genetically based) and acquired (environmentally mediated) characteristics" seems to undercut the foundations of any sort of nativist analysis.

The consequence of this attitude with respect to developmental psychology is severe: it implies rejection of the nativist emphasis of the existence of innate biological mechanisms as responsible for the development of advanced psychological capacities in the appropriate environment, at least in the case of the nativism advocated by Pinker. Thus, psychological capacities and traits cannot be defined in (non-dynamic) non-developmental terms that analyse these capacities—irrespective of their developmentally and environmentally constructed nature that the nativist might acknowledge—in terms of biological predispositions.

Oyama reluctantly admits, however, that "if one really is interested in abilities that are present at birth, for instance, one can certainly study them" (Oyama 2000b, p. 340). She adds that "the point is not that all notions of nature are meaningless, but that their meanings are often unclear" (Oyama 2000b, p. 340).

But how are we to interpret Oyama's position and put it in the context of the nativist aspirations?

The underlying (albeit substantial) distinction between biological nature on the one hand and the process of learning on the other hand is an indispensable ground for formulating any explanatorily meaningful questions regarding biologically given structures necessary for the development of higher cognitive capacities, in the first place[16]—even if one clarifies that 'nature' (biological structures) are not merely in genes but are developmentally constructed.

Thus, typically, developmental psychologists are interested in understanding how certain advanced psychological capacities occur in development. For instance, empathic understanding is considered to be a fairly late product of cognitive and affective development, and a question asked in the nativist spirit is which developmental processes and more basic capacities are its precursors. Whilst many abilities, such as gaze following, joint attention, social referencing, and the like, are usually cited as necessary for the normal development of empathic understanding, the ultimate question is whether a child needs to have a neurological basis enabling most primitive automatic empathic reactions if she is to develop advanced empathy later in life. If there is such a neurological basis, it is considered to be innate (see Preston and de Waal 2002). Now, if we abandon entirely the distinction between biological nature, the process of learning and environmental causes that jointly contribute to the emergence of an advanced psychological capacity like empathy, can we even ask questions about a neurological basis that the child must have as part of her biological makeup in order to develop such capacity?

Oyama's comment then must be suggesting that the Parity Thesis tolerates a weaker sense of the concept of the nature present at birth than the one on which Pinker's analysis is predicated. The problem is that if we interpret Oyama's remark that it allows as meaningful the search for the neurological basis that is responsible for later development of, e.g. empathy, and given that such a search requires the basic distinction between nature and nurture in very specific sense as biologically given capacities and learned capacities, it is not clear how her view that we need to abandon all nature/nurture distinctions could generalize to all the senses of nature and nurture and apply to this particular distinction (i.e. biologically given capacities and learned capacities).

In other words, if Oyama argues that all the talk about the nurture-based and nature-based traits should be abolished in every possible sense (nature/nurture, nature/culture, innate/acquired, as well as biologically given/learned) and it seems that she does, it is hard to see what the question concerning "biological abilities necessary for the development of higher cognitive capacities" could possibly mean. Any clarification of the notion of 'nature' in answering such a question seems predicated on a substantial nature/nurture distinction at least in a specific sense, i.e. biological (neurological, physiological) structure/learning distinction, as we have noted. The problem is, then, that either Oyama's thesis, without additional clarifications, implies that it is meaningless to study a biological predisposition necessary for the development of complex psychological capacities. Or she needs to accept that the Parity Thesis has its limits and some distinctions are here to stay even if other, similar, distinctions need to be abandoned given new insights in developmental biology and developmental psychobiology.

[16] It is indispensable, at least for some developmental psychologists, including not only nativists like N. Chomsky or S. Pinker but also figures like M. Tomasello who argue that simpler biological mechanisms for language acquisition need to be innate.

Nativism has been a persistent force in the twentieth century developmental psychology and cognitive science primarily because of the explanatory need to differentiate between capacities and/or knowledge that result from learning and those that emerge fairly early in development and are unlikely to be learned. Thus, traditionally, nativists have asked what kind of biological and psychological capacities are necessary for the development of psychological mechanisms. Conceptually, this seems a valid question, and if Oyama insists (and she sometimes seems to) that we cannot talk about the bottom-line capacities/constraints necessary for development, which would strike at the heart of nativism, she needs further conceptual and empirical arguments to substantiate this claim.[17]

Moving on the debate: maturation, development and non-genocentric nativism

Let us return to the question of the relation between nativism and the alternatives to the view of genetic programming of traits. As pointed out, it seems possible for the advocates of strong nativism of Pinker's type to abandon genetic determinism, embrace the mechanisms of the formation of neurological centres (and modules) as accounted for by the Parity Thesis, and still ask the meaningful questions in the spirit of nativism concerning biological (neurological, physiological), as opposed to environmental (e.g. linguistic, cultural), pre-conditions necessary for the subsequent development of certain psychological capacities. The nativists will only need to refine their notion of innateness by pointing out that it captures primarily the causal significance of biological structures, even though such structures develop through the interaction with environmental factors. The Parity Thesis, when we understand it to claim that the distinction between gene-based and nurture-based traits is not viable but not that all the distinctions between biologically given and learned must disappear with it, does not deprive the nativists' questions of meaning; rather, it provides a more detailed and perhaps more refined background for it.[18]

[17] This is not to say that such arguments could not be found. On the contrary, there is a vast literature on dynamic systems providing both conceptual and empirical arguments against the use of so-called structural explanations (of the Chomskian kind) in developmental psychology. Thus, the proponents of dynamic systems usually argue that it would be misleading if not wrong to explain development by relying on biological structures that need to develop before the process of learning can begin. They argue that we should shift our attention to dynamic kinds of explanations of the development where both basic and higher cognitive capacities emerge through the organism−environment interaction (for the dynamic explanation of motor development and empirical evidence that this explanation is better suited for such development, see, e.g., Thelen and Smith 1994). For the application of dynamic systems to higher cognitive capacities, see, e.g., Thompson (2007). Indeed, there are those like Clark (2001) who leave open whether dynamic systems approach could be useful for higher cognition while they admit that it could be of great importance for more basic capacities. However, these arguments differ from Oyama's and are not solely derived from the critique of genetic determinism and the nature/nurture distinctions.

[18] It is certainly not necessary for somebody who embraces the Parity Thesis, understood in this way, to accept the nativist view of substantial biological devices (such as language acquisition device). Thus, developmental biologists and developmental psychobiologists could choose to accept the existence of minimal biological devices as prerequisites for psychological development. But our main point is that there is nothing preventing them from embracing a kind of explanation suggested by strong nativism either.

Yet the path to the reconciliation of the Parity Thesis, on the one hand, and strong nativism, on the other, may not be as smooth. There is a jarring aspect of nativism that, we think, critically blurs the relation between nativism, genetic determinism and the alternatives. Although we see it as critical for the marriage of genetic determinism and nativism, this aspect has not been explicitly recognized in the literature.

Most capacities treated as innate are not exhibited by just-born infants.[19] For instance, first words occur in the second year of life and complex grammatical constructions do not occur before the child is 3 years old. Therefore, if there is an innate language acquisition device, as Pinker (1994) or Chomsky (1959) would have it, such a device is a result of prenatal as well as postnatal development. In addition, understanding others as intentional beings, which is sometimes identified as the main precursor of social cognition, does not emerge before the infant is 9 months old (see, e.g. Tomasello 1999). The theory of mind module, often posited as a necessary requirement for the normal development of social cognition (see, e.g. Baron-Cohen 1995), does not fully kick in before the third or fourth birthday. Such psychological abilities occur relatively late in development as a result of innate biological capacities enabled by biological structures that emerge well into the postnatal period.

In order to explain these psychological capacities as innate rather than learned, nativists usually invoke the concept of maturation. The idea is that the neurological and physiological structures necessary for the emergence of the abovementioned abilities which require some postnatal time to develop are entirely directed or prescribed by inner genetic programmes and, as such, are not a result of learning, experience or any environmental causes. Pinker, for one, is committed to such a view and provides a detailed account (Pinker 1994).

Thus, even though it seems prima facie that nativists of Pinker's type can embrace non-genoncentrism in the form of epigenetic or similar mechanisms, and thus potentially reconcile their view with the Parity Thesis, the problem is that they feel compelled to reinforce the concept of maturation by defaulting to genetic determinism and the genetic programme approach to development. The key question is then whether maturation and genetic determinism are inextricably linked.

We believe that nativists could explain the postnatal development of neurological structures that they hold to be necessary for language learning, social cognition, and alike without invoking maturation married to genetic determinism.

Nativists believe that the view that learning explains the emergence of biological devices such as language acquisition device is implausible, as elaborated earlier. Actually, developmental psychologists (or, more generally, cognitive scientists interested in psychological development) usually equate the notion of learning with the notions of the early experience of the infant and with the development of neurological centres (if they treat them as shaped by environmental factors). Given this conflation, nativists feel compelled to introduce the maturation period which minimizes (or, in effect, eliminates) the role of environmental causes in the biological formation of neurological centres (devices) in order to distinguish it from learning as the developmental process that starts once the maturational period is over. Thus, in order to avoid learning as an (implausible) environmental cause of the

[19] Nor are all capacities present at birth are treated as innate and inherited for that matter (e.g., foetal alcohol syndrome).

capacities and devices, they embrace genetic determinism to account for maturation as an innate endogenously directed process. For them, learning begins once the necessary biological structure has matured and can enable the biological capacities as a pre-condition for psychological development rather than at birth with the exposure of the child to the outside environment, that is, presumably, why learning happens suddenly and more or less uniformly among the individuals of the species.

Now the first step in disentangling nativism and genetic determinism is a realization that this maturation/learning distinction may be unnecessarily strong. Nativists can hold that the learning process is simply a result of certain suitable environmental influences (triggers) such as proper linguistic environment exerted on the maturated neurological centres whilst at the same time accepting that the neurological centres necessary for learning have been shaped by environmental influences (along with the genetic ones) as long as these are different from learning. Given the nature of the processes at stake, a nativist might be better off talking about (a) the maturational segment of the developmental process, where the biological processes interact with the environment to produce fully developed neurological centres (thereby eliminating crude genetic determinism), and (b) learning, as the segment of the developmental process that starts once the maturational development has reached the threshold when a whole other group of environmental factors (that we could label social) becomes dominant.

Thus, the environmental causes make a significant contribution to the maturational segment of the developmental process—a point emphasized by the advocates of the Parity Thesis. It is, however, meaningful (and necessary if we are nativists) to ask what kind of neural centres an infant needs and to consider what kind of maturational (developmental, i.e. genetic, epigenetic and environmentally caused) process must take place for the infant to be capable of learning. Also, the maturational segment of the developmental process remains analyzable in terms of tangible distinctions between biological, albeit not purely genetic, causes on the one hand and environmental causes (primarily tied to child care practices) on the other. And even though biological processes are always causally entangled with the environment, the nativist can treat the threshold reached by such a process in static rather than dynamic terms, as a biological 'machinery' or structure required for learning processes to take place. Even if nature is always nurtured, one should not conflate different environmental factors (environmental/biological and environmental/social factors) as their relevance changes with respect to the segments of the developmental process.

Thus, for example, nativists could say that everyday activities and routines in which a caregiver regulates child's eating, sleeping, levels of arousal, and the like are environmentally as well as biologically based processes necessary for the development of brain centres responsible for language learning or social cognition. Such social environmental causes are as indispensable for the development of the brain structures after the child is born, as are the inner genetic and epigenetic (biological/environmental) processes in the prenatal period. Even so, the brain structures necessary for learning are not a result of the learning process, which is virtually nonexistent before the development of these centres is finalized.

Oyama is right to argue that in some sense, traditional distinctions between nature and nurture or innate and acquired have to be abandoned. But developmental

psychologists need not give up these distinctions altogether if they are careful in distinguishing between the kinds of environmental causes and genetic or epigenetic causes that work together to build the neurological and physiological structures necessary for language learning, social learning or any other kind of learning. In other words, the distinction between biological prerequisites, the learning processes (that take place only if these biological prerequisites are in place), and the advanced linguistic, cognitive, affective and social capacitates that presuppose both can be made even if we give up genetic determinism.

Furthermore, the advocates of nativism such as Pinker do not need to appeal to a rather simplistic notion of language genes and the concept of maturation married to it.[20] Pinker can instead argue that a language acquisition device is not an outcome of language learning but rather a biological prerequisite for normal language acquisition, even though it is developmentally constructed rather than genetically determined as such, both in the pre- and postnatal period. His argument, presumably, would not lose any of its nativist appeal (however, whether Pinker and Chomsky are correct in their explanation of language acquisition by means of a language acquisition device can only be decided by further theoretical clarifications and empirical research in the field of developmental psycholinguistics).

In short, if it turns out that genetic determinism and the genetic programme approach to development is unsatisfying, nativists can adjust their view of what constitutes innate physiological and psychological structures so that it makes biological sense.[21] In the end, the nativist position in psychology does not stand or fall with genetic determinism in biology, nor does the Parity Thesis necessarily dispose of the distinctions that constitute the substance of this particular kind of nativism in psychology. Ultimately, other conceptual and empirical criteria, some of which are cited above, should decide its fate.

In a way, this might be a triumph of developmentalism that provides a sensible general framework and also absorbs the key features of nativism whilst shedding its less essential and more ideological aspects. Or it could represent a synthesis of the two, a nativist developmentalism of sorts, where the key is not genetic determinacy and biologically endogenous traits but a subtle distinction between various functions played by the environment in biological and cognitive development.

[20] To some extent, Pinker seems to be trying to refine his biological account of the growth of the "language organ" by invoking a more developmentalist-minded story in his recent work. But he still does not seem to be convinced that the inherently developmentalist account of the underlying biology can provide a good enough explanation of a very specific device such as the language acquisition device. One way to expressing our main point is that nativists, including Pinker, can certainly benefit from employing already available subtle and elaborate developmentalist strategies of explaining biological capacities needed for the development of specific psychological capacities.

[21] It is possible that this two-stage developmentalist account of innate capacities applies only to very specific devices needed for the higher-level cognitive abilities and that some basic cognitive capacities can be explained with some basic learning mechanisms involving a social component (see, e.g., relevant experiments with the chimpanzees; Kawai 2006) that does not require a very sophisticated "learning devices." Even though the answer to this question will ultimately come from the empirical research, it might be that even in such simple cases the less complicated devices need to developmentally maturate prior to learning. We are grateful to Collin Alen for this critical remark.

Appendix: Parity Thesis in the context of modern biology

The advocates of the so-called central dogma of molecular biology, often perceived as an indispensable aspect of the Modern Synthesis of Darwinism and genetics, regard non-genetic factors as merely constraints on genetic expression and the variations which result in the characteristics of organisms. The environment, or everything external to the molecules that supposedly carry the genetic information (i.e. external to the germ), which extends from the cell, to somatic processes, all the way to social interactions and culture, is as necessary as genes in terms of selection and inheritance, but it does not contain information that controls the development of the traits. Thus, even though there might be disagreement as to the exact nature and role of the environment, the course of development is predominantly a result of the information contained in genes (DNA). This information can be changed at the level of DNA molecules and passed on to offspring. DNA controls the synthesis of proteins and their activity in developmental and morphogenetic processes. The role of the environment in these processes is secondary.

Dawkins (1989), a zealous advocate of the Central Dogma, insists on the indispensability of information language to characterize gene-centric (i.e. DNA-centric) views and on the causal asymmetry between genes and the environment where only genes are causally effective.

A more refined position (Maynard Smith 1998) allows that developmental and morphogenetic processes can be affected, even severely, by non-genetic constraints. Neo-Darwinism does not prohibit this as the basic premise of the Modern Synthesis that only those changes inherited by the DNA can be passed on to offspring is not challenged.

One could argue that the environment might be as important as genetic information, given that what the gene codes for is enabled by and perhaps determined by the structure of the environment. However, Dennett (1995) argues against this view, noting that the causal asymmetry is preserved because genes contain explicit information and the environment contains implicit 'matching' information. In effect, environment is a passive condition that enables genetic information to be realized (as a resulting trait). One could add that an inheritance is due to a variation at the molecular level which produces a new trait under the right conditions in the environment (i.e. when the genetic information is found in the 'right' environment).

Although we cannot provide an exhaustive list of the challenges of the gene-centric view and its variations, it is important to note their breadth and depth. Many criticisms cannot be convincingly dismissed by a mere regurgitation of, or the application of superficial changes to, the postulates of the Modern Synthesis.

One such criticism challenges germ-centrism, stating that the role of proteins in development and morphogenesis has to be reconsidered significantly in light of the studies of protein structures and interaction with DNA and RNA molecules. The notorious problem of protein folding has been attacked successfully by those who argue that the proteins play an active role in the process (Godfrey-Smith 2000). Others point out that in some species, somatic embryogenesis does not establish a germline that provides for the continuity of DNA information. As a matter of fact, other cells participate on par with those carrying DNA in the formation of gametes (Buss 1987).

Drastic evidence for the virtual obsolescence of gene- or germ-centrism is structural inheritance in ciliate protozoa where molecules of DNA and RNA play no significant role (Frankel 1989). Here, a morphogenetic cellular field controls both inheritance and morphogenesis. Similarly, some non-genetic structures are inherited by epigenetic mechanisms (Sterelny and Griffiths 1999). As the cells might differ in terms of phenotype whilst having identical genotype in such cases, the mechanism of DNA replication is an insufficient explanation of either development or inheritance (Jablonka and Raz 2009).

Conceptually speaking, the metaphor of information has become central to biology. Dawkins went so far to claim it "is not a metaphor, it is a plain truth" (Dawkins 1986, p. 111). Yet many feel that it narrows understanding of development and heritability and prevents an adoption of some more subtle points concerning the role of proteins and other key elements.

Although these and other challenges have resulted in the dissatisfaction of many biologists and philosophers of biology with the dominant account grounded in Central dogma one way or another, it is hard to avoid using it as at least a starting point or even as a working hypothesis for biological studies and explanations of evolutionary and genetic processes and their interrelation. Thus, this framework remains an indispensable heuristic tool (Michod 1981), even defining, albeit implicitly, the working premises of many studies attempting to undermine it.

The Developmental Systems Theory predicated on the Parity Thesis attempts to offer a comprehensive alternative by drawing on diverse challenges to it, some of which we have just outlined, and by offering a novel conceptual framework.

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