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Two types of genetic reasoning in contemporary psychology and their relevance for education[1]

Csaba Pléh

Central European University Department of Cognitive Science

Abstract
The paper shows how arguments based on genetics came back in the 1960s. The universalist claims started from the innatism of Chomsky, and gradually extended the idea of preconfigured cognitive systems to several areas. This resulted in the development on new methods towards studying preverbal infants, but also in proposing much leaner prewired core systems. The other revival of genetic ideas in psychology was mainly reraising to classical nature/nurture debates regarding IQ. The new epigenetic theories propose a new synthesis in the frames of developmental science: environmental enrichment fosters the unfolding of genetic based individual differences.

Keywords: psychogenetics, universal inheritance, innatism, core systems, IQ, epigenetics

In order to understand the present fate of genetic ideas within psychology, we have to go back to the 1960s. The popularity of notions related to genetics changed drastically during the last half century. Genetic determination that became a specific issue of the psychometric tradition, with the debates on intelligence in the 1920s-1930s, was lost to theoretical psychology in the 1950s, only to reappear in American psychology of the 1960s, but in two rival and different forms, as summarized in Table 1 as two theories about the determinants of development. One was the universalist innatism proposed by Chomsky (1959, 1965, 1968), mainly on analogy with ethology and other European inspirations, suggesting that complex human behaviors may be under genetic control (see Pléh, 2019). The other trend was the reemergence of genetic interpretation of individual differences, that was mainly interested

[1] Chapter parts of my forthcoming new book *The formation of modern psychology*. (Routledge, 2023).

in the unfolding of variation, and not in the general genesis of the mind. differences.

Table 1
New biological ideas about the determination of development in the 1960's

Type of innovation	Key novelty	Opponents	Leading representatives
Universal nativism	Cognitive structures are *a priori*	Learning theories	Chomsky, Fodor
Inheritance of differences	Individual differences are heritable	Differences based on nurture	Hans Eysenck Arthur Jensen
Critical periods	Experience is efficient only at certain times	Cumulative experience	Konrad Lorenz Eric Lenneberg

The psychological interests remain divided. Some people are mainly interested in the generic, species-specific, supposedly innate determination of certain functions, while others look for the genetic components of individual differences. The real future would be to connect these two interests in comprehensive theories of development.

Generic inheritance

The work of the 'generic innatist' group followed the argumentation initiated by Chomsky and applied it to psychology in a universalistic manner. Innatism was one way to overcome the "empty organism" and "black box" metaphor of the behaviorists. Innate organizing principles of language and other complex human achievements belong to "species-specific behaviors." In the hand of his followers, this general innatism claim has usually been transformed into the specific innatism claims of the modularists. The critical period theories were an accommodation of the innatist theories. Before the formation of recent epigenetic theories of development, they allowed for the influence of individual experience factors supplementing the innate mechanism, usually talking about species-specific stable environmental factors in the sense of Donald Hebb (1949, 1958).

Most of the research was interested in the early development of some particular abilities, or *domains* as they preferred to call them later on, like numbers, face recognition, language, and the like. The main arguments for a generic genetic determination were based on early and universal developmental manifestations, cross species comparisons, content specific developmental disorders, and less frequently, real cross-cultural comparisons.

Pinker (2002), is his book criticizing the environmentalist position, exposed this universalistic innatist attitude as a positive social program. He showed that for many people, the Darwinian commitment to an image

of human nature was usually accompanied by a rather liberal egalitarian social philosophy. Even very famous naturalists and geneticians like Stephen Jay Gould (1996) made some historical errors due to their left wing social commitments, when they equated the role of modern genetics in psychology with eugenics and selectionist social Darwinism. This socially left wing group preached that while our bodies are Darwinian creatures, at the same time, regarding our mind, we are open universal learning machines. According to Pinker, and the entire universalist-innatist group, this combination was a mistaken path. The starting point for the genetic optimists should be a postulation of a rich human nature, and acceptance of the very rich human universals listed by David Brown (1991). It should be accompanied by accepting the large individual differences at the same time. Pinker also spelled out that in our folk psychology we hardly ever believe in the "blank slate" of the human condition. "I suspect that few people really believe, deep down, that boys and girls are interchangeable, that all differences in intelligence come from the environment, that parents can micromanage the personalities of their children, that humans are born free of selfish tendencies, or that appealing stories, melodies, and faces are arbitrary social constructions" (Pinker, 2002, p. 422). According to Pinker, the difficult task is to accept differences and at the same time belief in equality. We should stand for equality on a moral basis. At the same time, with all the genetic variations acknowledged, we should see clearly that these variations, compared to other primates, are relatively small.

Interestingly, in his take on evolutionary psychologists, the cognitive philosopher Jerry Fodor highlighted the built-in social tensions as well in evolutionary psychology. There is a tension between the innatism of the new evolutionists and the cultural relativism of most social sciences. "Cultural relativism is widely held to be politically correct. So, sooner or later, political correctness and cognitive science are going to collide. Many tears will be shed and many hands will be wrung in public. Be that as it may, if there is a human nature, and it is to some interesting extent genetically determined, it is folly for humanists to ignore it" (Fodor, 1998, pp. 207–208).

Innatism and the smart babies

With the innatism background, and the ongoing social debates, during the last generation, a new *developmental science* has been taking shape. It is reminiscent of pedology a good hundred years earlier. The similarity is due both to interdisciplinary methodology, and due to an aim to base education on the knowledge of children. Developmental science is an interdisciplinary enterprise that tries to understand child development with a combination of the methodical and conceptual tools of the genetics, biology and psychology of development. The new trend brings many real conceptual novelties as well. It is open to challenging new theoretical ideas, again not unlike pedology a

hundred years ago. This is related to the generalist innatism claims started half a century earlier. One implication of innatism was that innate components of mental life should be present very early on. These efforts resulted in conceptions of the *competent infant*. The usual starting point is the mocking of an idea of William James (1890, p. 487) about the disordered sensory confusion of objects in the sensations of babies. "The baby, assailed by eyes, ears, nose, skin, and entrails at once, feels it all as one great blooming, buzzing confusion," and the babies would take a long time to learn to differentiate these sensory impressions to be parts of objects. This image was prevalent in all empiricist theories of child development, including behaviorism and Piaget. The earliest efforts to question this entirely constructed image were proposed by psychoanalytic theories of ego development in the 1930s, such as Mélanie Klein in the 1920's and René Spitz in his theory of hospitalization. These psychoanalysts were not taken seriously by mainstream developmentalists. The real innovation and the discovery of smart babies has come with the factual, psychological interpretation of theoretical innatist claims. The new proposals emphasize what complex achievements regarding the world of objects and the world of communication are available even for neonates, and these hidden competencies are domain specific. Infants acquire very early on commplex skills, such as getting tuned to the phonological system of the mother tongue, after starting with a broader innate sensibility (Mehler & Dupoux, 1994).

There were two crucial inroads for this new vision.

Development of infancy research technologies. It is impossible to give verbal instructions to babies, and to ask them about their experiences. Infancy research has taken indirect routes, from the time of John B. Watson, with his controversial study of fear conditioning in little Albert, an infant. From the 1970s on, new, refined technologies for the indirect study of baby preferences, like habituation and selective looking and the like played a crucial role in developing the conception of "smart babies." One central technique has been the use of *habituation*. Habituation has been a central tool in studying animal learning, perception, and attention. You can study discrimination with repeated stimulation until boredom (habituation), and changing one aspect of the stimulus afterwards to see if it still evokes the habituated response (Sokolov, 1960). This research tool was extended to babies from animals. The first method still in use was introduced by the team of Peter Eimas (1934–2005) at Brown University. He made babies listen to repetitive syllables, like *da, da, da* while their sucking frequency was measured by a pacifier provided with a sensor. In general, babies react with increased sucking frequency to new stimuli. After a while, as a result of habituation, the reaction to the repeated [da] syllable decreased. When the stimulus was changed to [ta], the sucking frequency increased again. Thus, babies could differentiate between voiced [d] and voiceless [t], and showing signs even of categorical phoneme perception, where discrimination of the

same acoustic difference is better when it spans the boundary between two phonemes, compared to when it falls within the same phoneme category (Eimas et al., 1971). This technology has been extended to many areas, including human infant and animal comparisons, developmental effects of early exposure, etc. (Gervain & Mehler, 2010 summarize the evidence).

Another frequently used technology is the measurement of *looking times* with a peculiar double presupposition. With very elaborate stimulus procedures, the researchers either suppose that children look more at familiar stimuli, or in other arrangements, that they look more at the unexpected, surprising stimuli. For example, children look at targets speaking their environmental language, showing a familiarity effect (Gervain & Mehler, 2010). At the same time, children look more at unfamiliarly arranged face targets, because they have an expectation for the face arrangement. With much setting elaboration, the two interpretations can be differentiated. Looking times and selective turning towards one source are useful measures for discrimination here. With looking time technologies one can study for example understanding of words in preverbal children. The baby listens to the word *apple,* and is shown an apple on the left, and a banana on the right. If the baby looks more frequently to the left, this implies the baby 'understands' the word *apple* (Bloom, 2005).

Another class of technologies uses brain evoked potentials and imaging. Csibra et al. (2000) for example, showed that a change in object perception might be detectable between 6 and 8 months old by a more regularized gamma band activity around 40 Hz in the infant brain. Or to take another example, research using the so-called *near infrared spectroscopy* of infant brain imaging compared different reactions in newborns to "repetition-based AAB (e.g., *babamu, nanape*) and ABB (e.g., *mubaba, penana*) patterns as compared to random ABC controls (e.g., *mubage, penaku*) in the bilateral temporal areas, with a somewhat stronger response in the left hemisphere, as well as in the left frontal regions. The processing of structural regularities thus appears to be clearly left-lateralized at birth" (Gervain, 2013, p. 212).

A literal interpretation of innatism. The innatist claims forced psychologists to look for early signs of preparedness for many cognitive and emotional achievements. Innatism was not interpreted by them as a mere general philosophical self-explaining doctrine, but something that has to be checked empirically, possibly on very young children.

Very young children, like humans in general, started to be interpreted – following the way Chomsky (1968) introduced grammatical knowledge into the mind of every speaker – not merely as knowers, but also as theory builders, little scientists and philosophers. They started to be assumed to form general theories of the physical and social environment and test these theories by observation and active experimentation. Jean Mandler (1992) called the non-propositionally organized perceptual starting principles *conceptual primitives.* Later, the smart babies started to be assumed to be

philosophers of knowledge and social life (Gopnik et al., 1999; Gopnik, 2009). The original linguistic innatism proposed by Chomsky in the 1960s was generalized from the 1980s on into a general "cognitive innatism."

A special version of these 'babies as theoreticians' idea is the *core knowledge* vision promoted by Sue Spelke at Harvard University (2000; Spelke & Kinzler, 2007). According to this innatist model, the innate ideas do not relate to specific concepts as Fodor (1983) proposed, but only to some basic systems of knowledge. The theory proposed by Susanne Spelke assumes some content specific modular systems, but they are presented as a compromise between the general cognition and the overmodular conceptions. "The human mind is not a single, general-purpose device that adapts itself to whatever structures and challenges the environment affords. Humans learn some things readily, and others with greater difficulty, by exercising more specific cognitive systems with signature properties and limits. The human mind also does not appear to be a 'massively modular' collection of hundreds or thousands of special-purpose cognitive devices [… but it is] built on a small number of core systems." (Spelke & Kinzler, 2007, pp. 91–92).

The first core system is *object representation*. It centers on the spatio-temporal principles of cohesion, continuity, and contact (ibid., 89). The second one is *agency.* "The intentional actions of agents are directed to goals, and agents achieve their goals through means that are efficient. Numerosity and geometry, and maybe social representation of others make the list full.

Core systems do give us strong constraints, they are peculiarities of our everyday naive thought. At the same time, their limited scope can be overcome through the history of human knowledge, especially science. For example, though our core geometry is Euclidean, we could develop other geometries, as well as create numbers that are not part of our natural system of numerosity. The constraints of the social core system are still hard to overcome. "A predisposition for dividing the social world into *us* vs. *them* may have evolved for the adaptive purpose of detecting safe and trustworthy social partners, but it can be misemployed in modern, interconnected and multicultural societies. It even may support the ravages of discord, violence and warfare among individuals, groups and nations" (ibid., 93)

Thus, a central message of new developmental studies is the postulation of smart babies. At the same time, the new developmental studies have also shown, that several procedures in many areas, which seemed to develop very early, do take much more time. Visual integration, for example, develops until rather late, into early puberty (Kovács, 2000, 2004). Related to these timing issues, several practical questions are also integrated into contemporary developmental science, like the reopening of the issue of sensitive periods. Some practically interesting issues are what remain relatively open throughout our entire life, such as learning new words, or recognizing and storing new faces. The crucial age in the consolidation of value systems and self-regulation, the specific importance of a 'second critical period,' is adolescence.

Inheritence of individual differences

The study of individual variation was labeled as the 'other type of scientific psychology,' i.e. psychometry (Cronbach, 1957). The two main areas for psychogenetics in this domain studied were personality differences like the origin of temperamental variations following the traditions of Galen (Kagan, 1994), and (on the footsteps of Galton, 1869, 1893), genetic differences in general intellectual abilities (MacKintosh, 1998). Socially, the latter interest in the genetics of intelligence was often linked to a conservative social philosophy and to a belief in a stable social order. It remained true for the late 20th century as well.

The inheritance of intelligence issue is the most telling and most visible one. This is the issue where the social embedding continues to be seen most clearly, and that is where the entire issue was discussed for most of modern psychology, for over 100 years.

Heredity of intelligence: Galton reloaded

The issue of genetic determinism of human behavioral and intellectual individual differences became the focus of increasing scientific attention again in the 1960s. This reemerging view also started as a criticism of behaviorism. The new psychogeneticians denied that the behaviorists' simple life history empiricism could be a possible way to explain individual differences. To explain individual differences, they referred to the Galtonian paradigm that proposed heredity to be crucial in determining individual differences in behavior, and basically presupposed an additive role of nature (genetic) and nurture (environment). The followers of Galton did not consider the possibilities of substantial proactive visions of interaction, where human agents as environmental factors factually enter the causal chain, in changing schooling patterns for example (for critical surveys, see Richardson, Spears & Richards, 1972; Sternberg, 2018).

There is a further important aspect of the revival of Galton's theory, namely, that it assumes *one single feature of excellence*, which is in clear contrast to the modular ideas. "In psychology Darwin's theory has taken two competing forms for more than a hundred years. The first is a conservative, deterministic approach based upon the theory of natural selection and the survival of the fittest. It stresses the need to reduce the dimensions of psychological variability by finding a small number of traits in which individuals differ from each other. If someone excels in these traits, he is considered to be fitter than others. The second approach is more tolerant, emphasizes development, and considers variability itself as an evolutionary asset" (Kovács & Pléh, 2000, p. 1).

A hot new debate regarding the validity of the Galtonian paradigm started half a century ago when Arthur Jensen (1923–2012), a Berkeley based educational psychologist published a paper claiming the genetic

intellectual inferiority of African-Americans (Jensen, 1969). Jensen claimed that intellectual differences are inherited and it is hardly possible to raise intelligence by interventions. *Table 2* shows the basic arguments promoted by this much discussed review and program paper, and the opponent opinions.

Table 2
Some value choices of the claims about the genetic determination of intelligence promoted by Arthur Jensen (1969)

Jensen's thesis	Consequences	Opponents
IQ is a key for social differences	Cognitive structures are unified	Multiplicity of cognitive differences
IQ differences inherited	Key to schooling. IQ cannot be raised.	IQ-differences results of early experience
Social differences inherited	No social injustice in schooling	The school and social cult of IQ is unjust

Jensen's paper started intensive debates that lasted for two generations. The paper by 2019 had over 5,000 references. The leading evolutionist, paleontologist and science popularizer of the egalitarian group at Harvard University, Stephen Jay Gould was a key player in the field with an emotionally committed antiracist environmentalist attitude, who openly claimed that scientific objectivity should not mean a lack of preferences. In his frequently cited (11,000 references!) and published book on the *Mismeasure of man,* where he surveyed all the allegedly distorted use of intelligence testing for social discrimination and related racist psychology, he expressed his opinion in emotional terms, that he kept later on as well, even in his criticism of evolutionary psychology. «We pass through this world but once. Few tragedies can be more extensive than the stunting of life, few injustices deeper than the denial of an opportunity to strive or even to hope, by a limit imposed from without, but falsely identified as lying within» (Gould, 1981, pp. 61–62).

The intervention issue was historically crucial, since in the presentation of Jensen, the crucial indirect social argument for a genetic determination of IQ levels was specifically the lack of success of the social intervention programs initiated in the United States as part of the Great Society efforts, the so-called Head Start program to raise IQ levels. Jensen (1969) already with his title – *How Much Can We Boost IQ and Scholastic Achievement?* – was challenging the idea of these compensatory interventions. The interventions relied on the notion of "impoverished environment" taken over from animal studies and proposed by J. M. Hunt (1906–1991). The book of Hunt (1961) on the importance of early experience was central in several regards. Hunt, who was by training and experience a Freudian developmental psychologist and was originally interested in early childhood to explain pathology,

gradually became interested in the impact of early experience on cognitive development. He did not rely on the 60-year-old psychometric tradition of intelligence, rather, in the new cognitive atmosphere, Hunt tried to interpret intelligence as an information processing ability. Hunt also postulated that this information processing ability was profoundly influenced by early experience, in line with the idea of critical periods.

As he summarized in a review paper two decades later, the first three years of life are crucial for both intellectual and emotional development. They are "highly important for the achievement of initiative (or roughly the opposite of learned helplessness), of trust (or readiness and skill in eliciting help from adults and others), of compassion […] of curiosity […] and of various still poorly understood attainments (or learning sets) that seem to be important for the later development of competencies" (Hunt, 1979, p. 136).

Hunt's book was significantly influential in setting the stage for the social intervention programs in the U.S. initiated in the mid 1960s. He served in presidential committees under Lyndon B. Johnson, was one of the authors of a policy document *The Children's Bill of Rights*, and even acted as a promoter of educational television programs, such as *Sesame Street*. The logic underlying the interventions, based on his book of 1961, had several limitations or problems, however. They were not sophisticated enough in an educational sense, and treated some social groups in a rather condescending manner, such as lacking culture or even lacking a proper language, like the depraved ideas regarding Black English in the U.S. In their hasty design, compensatory education proposals were not based on strategic intervention plans in an educational sense. As many social critics saw it, the entire idea that a program was successful only if it raised the IQ of the participants, was socially questionable as well. There might be other gains, like in learning motivation, strategic life planning, and so on.

Around the same time, when Jensen published his provocative paper, Richard Herrnstein (1930–1994), a Harvard psychologist, who was an old style pigeon psychophysicist and historian of psychology, published a paper in the *Atlantic* magazine spelling out the social aspects of the genetic argumentation (Herrnstein, 1971). In searching for the bases of meritocratic society, Herrnstein claimed that (inherited) IQ was a determinant of social success in America. Therefore, social distribution of wealth, power, and so on was becoming more and more based on IQ. Interestingly, the *Atlantic* magazine where Herrnstein published his ideas was already involved in the abolition of slavery issues as early as the 1860's (!), and the IQ debates of the 1920's (!), and was read by a wide variety of people, including many liberal intellectuals. Thus, the paper of Herrnstein created a sizeable secondary social literature. The logic of this paper was straightforward that later resulted in a book on meritocracy (Herrnstein, 1973). This was shocking especially from someone who himself had come to Harvard as a child of uneducated, poor Jewish migrants in New York. This was similar to the background of Gould, his basic liberal left wing opponent of

hereditarian ideas, also from Harvard, who dedicated his book on intelligence measurement to his Eastern European immigrant Jewish grandparents, who came through selective US immigration screenings.

The essence of the conservative social proposition of Herrnstein was summarized as a series of statements.

– differences in mental abilities are inherited;
– social success requires those abilities;
– earning and prestige depend on success;
– social standing will be based on inherited differences among people;
– social differences shall increase because IQ will be more and more inheritance determined;
– all of the above brings modern social intervention programs into question.

There was a wider context to all of these debates that was raised at the time by Noam Chomsky (1978). Chomsky as a representative both of the generic innatist group, and a radical left wing social thinker questioned several issues in the reasoning of Herrnstein in a rather radical manner, as well as some of the naive liberal criticisms directed against Herrnstein. First, Chomsky expressed his puzzlement why the possible inheritance of any trait is such a disturbing social issue. "The question of heritability of I.Q. might conceivably have some social importance, say, with regard to educational practice. […] It is, incidentally, surprising to me that so many commentators should find it disturbing that I.Q. might be heritable, perhaps largely so. Would it also be disturbing to discover that relative height, or musical talent, or rank in running the 100 yard dash, is in part genetically determined? Why should one have preconceptions one way or another about these questions, and how do the answers to them, whatever they may be, relate either to serious scientific issues (in the present state of our knowledge) or to social practice, in a decent society?" (Chomsky, 1972, p. 44). He moved on to more basic and disturbing social issues, to question the very distribution of social rewards. "It is alleged that in our society remuneration correlates in part with IQ. But insofar as that is true, it is simply a social malady to be overcome much as slavery had to be eliminated at an earlier stage of human history. […] The standard arguments for 'meritocracy' have no basis in fact or logic" (Chomsky, 1978, p. 122). Only capitalist society distributes rewards in a meritocratic manner. "Herrnstein recognizes that his argument will collapse if, indeed, society can be organized in accordance with the 'socialist dictum,' 'From each according to his ability, to each according to his needs.' […] If […] society can be organized more or less in accordance with the 'socialist dictum,' then nothing is left of Herrnstein's argument." (Chomsky, 1972, p. 34).

According to Chomsky, another misleading factor is related to the very notion of intelligence. Differences in intelligence between groups are measuring the wrong thing. "We have to study less complex issues. An inquiry into such questions as race and IQ appears to be of virtually no

scientific interest. […] race and IQ, each an obscure amalgam of complex properties. Rather, he would ask whether there is a correlation between measurable and significant traits, say, eye color and length of the big toe. It is difficult to see how the study of race and IQ can be justified on any scientific ground" (Chomsky, 1978, p. 132).

Chomsky also arrived to the same conclusion as Pinker (2002) a generation later: social equality of opportunity is not an issue of abilities, but an issue of principle. "Human talents vary considerably, within a fixed framework that is characteristic of the species and that permits ample scope for creative work, including the creative work of appreciating the achievements of others. This should be a matter for delight rather than a condition to be abhorred. Those who assume otherwise must be adopting the tacit premise that a person's rights or social reward are somehow contingent on his abilities. [...] in a decent society opportunities should confirm as far as possible to personal needs, and such needs may be specialized and related to particular talents and capacities" (Chomsky, 1978, p. 127).

This was rather much in line with later developments in postindustrial societies. From the 1980s on, the sometimes paternalistic programs of 'elevating the oppressed' and compensatory education typical of the late 1960s, are replaced in American universities and elsewhere with "multiculturalism." 'Studies programs' like 'Black studies, Minority Studies, and Women's Studies' representing the recognition of alternative cultures and values were created, where what was at stake was no more the denial of differences and compensation, but the acceptance of differences. These processes were not necessarily decreasing social inequalities in access to education and jobs.

The interesting controversies between the two camps had an assumed opposite causal chain in their social argumentation. The macro sociological level relations between social status and intelligence were accepted by both camps. The politically left wing 'environmentalists' claimed that these differences are caused by cumulative effects of the environment, from childhood undernutrition to intellectually unchallenging environments. For the researchers claiming inheritance, the social differences in intelligence would be a result of a long history in liberal societies of social class position becoming tied to inherited intellectual differences. Due to an assumed equal opportunity schooling in liberal societies, social stratification would be more and more stabilized, and would historically mirror inherited individual differences in general intellectual ability. We know, however, that there are overlaps in intelligence between social strata.

The next wave of the debate on the inheritance of intelligence started with the publication of a book by Herrnstein and Murray (1994) that claimed that many variations on social success and failure in American society, the unequal distribution of merit, are basically caused by inherited differences in intelligence. (For Herrnstein, who was by then a veteran of the intelligence

debates, this was already a posthumous book, with over 10,000 citations). In an interesting way, as the analysis of Weidman (1997) clearly showed it, their argument fired up the cultural war between progressives and conservatives in psychology and in social science again. The first group stood for nurture, the second for nature. One aspect of the hereditary determination group's claims was almost forgotten. They did claim that with economic growth, there was a standardization of the environment, including cultural environment, with things like universal education, reading, and numeracy – which actually raises heritability. This last point is especially important in modern societies, with their intense efforts *to equalize opportunity.* As a general rule, as environments become more uniform, heritabilities rise. "It is the central irony of egalitarianism: uniformity in society makes the members of families more similar to each other and members of different families more different. This assumption proves to be the crux of Herrnstein's and Murray's argument. Yet it has not attracted commensurate attention from the book's critics. The flaw in its logic is obvious: it is impossible for Herrnstein and Murray to prove that our society presents a 'uniform' environment to all people" (Weidman, 1997, pp. 142–143). As the anthropologists, Richerson, Boyd and Henrich (2010, p. 8990), summarized there is a paradoxical effect of culture here. "Human genetic variation for behavioral traits may be large because cultural variation shelters much genetic variation from selection." The new review of Tucker-Drob and Bates (2016) showed interesting cultural differences here as well. The higher effects of heritability in higher status were especially true in societies with a socioeconomically unequal access to schooling.

As Dickens and Flynn (2001) showed in a formal model, high heritability and environmental influences are not contradictory. People select environments that correspond to their IQ the same way as they selectively chose partners, fitting to their own intelligence (assortative mating). These influences increase the effect of heredity in a peculiar way. "The picture that emerges suggests a powerful role for environment in shaping individual IQ. However, we wish to stress that the way environment plays its role is very different from the traditional characterization. It appears that most environmental effects are relatively short-lived. At least for young children, experiences much more than a year old influence today's IQ only because of their effect on past IQ and the effect of past IQ on today's environment. Even then, the effects of environment decay, leaving only a narrow window in which transient environmental effects may influence IQ. […] improving IQs in childhood is not the way to raise the IQs of adults. Adult IQ is influenced mainly by adult environment. Enrichment programs may nonetheless be worthwhile because at least some seem to have long-term effects on achievement and life outcomes, and the temporary IQ boosts they provide may mediate those effects. […] such programs would be most likely to produce long-term IQ gains if they taught children how to replicate outside the program the kinds of cognitively demanding experiences that

produce IQ gains while they are in the program and motivate them to persist in that replication long after they have left the program" (Dickens and Flynn, 2001:366). Thus, the success of interventions depends on the success of motivational changes.

As Anastasi (1958, p. 197) pointed out two generations ago, the real issue was not addition of variance, following the Galton model, but explaining the mechanisms of effects. "Rather than seeking to discover *how much* of the variance was attributable to heredity and how much to environment, a more fruitful approach is to be found in the question '*How?*" There is still much to be learned about the specific *modus operandi* of hereditary and environmental factors in the development of behavioral differences." In the middle of behavioristic environmentalism, she claimed that the crucial issue is the directness of the influence. Among environmental influences there are direct ones like brain damage, and indirect ones, like richer environment. "Environmental factors of an organic nature vary along a 'continuum of indirectness.' The more indirect their connection with behavior, the wider will be the range of variation of possible outcomes." (ibid.)

Bronfenbrenner and Ceci (1994) proposed a framework along these lines, by distinguishing systematically between proximal and distal influences. This was one of the last papers of the famous cultural developmental psychologist, Uriel Bronfenbrenner (1917–2005). He was one of the intellectual moving forces of the Head Start movement in the 1960s. A generation later they concluded that the better environmental conditions in fact provide for a fuller development of genetic potential, thus in a paradoxical manner, there is more observed heredity effects under good developmental conditions. That is an argument for social improvement and intervention in their view. "When proximal processes are weak [ie. in poverty, Cs. P.], genetically based potentials for effective psychological functioning remain relatively unrealized but that they become actualized to a progressively greater extent as proximal processes increase in magnitude [..] unrealized capacities might be actualized through social policies and programs that enhance exposure to proximal processes in environmental settings […], can provide the stability and resources that enable such processes to be most effective" (Bronfenbrenner & Ceci, 1994, p. 569, 583).

Thus, the debate that continued for two generations has two interesting messages. First, to interpret the effects of genetic and environmental differences, a sophisticated developmental theory is necessary. Second, both progressive and conservative theorists agree that the impact of the genetic potential increases in better and/or homogenous environments. These differences regard social policy implications: the conservatives think that these better environments are already attained, while the liberals and progressives argue for interventions to achieve these favoring environments.

The idea about general intelligence had an old-time neuroscience support. The proposals of Lashley (1929) about mass action and equipotentiality in

his rat studies implied that intelligence may be dependent on the amount of cortical tissue rather than on any specific brain areas. Recently, the challenge is how to relate modularity of function to the psychometric claims regarding general intelligence. Gary Marcus and his colleagues made an interesting secondary reanalysis of the many – over 200 – available brain imaging studies of general cognitive functions (Cabeza & Nyberg, 2000). They proposed that basically there is always an overlap between the different brain areas which is supposed to be responsible for a given task. This is due to the fact that even simple looking cognitive tasks would involve different modules. As a matter of fact, if this general intelligence would be real, it would be the result of the overlap between real world tasks and the need to involve different modules for each task. "We suggest a potential way of reconciling a central finding in human individual differences, both with modern conceptions of neural function and with some forms of modularity and functional specialization in cognitive science. […] any given task will most likely necessarily call upon the operation of hypothesized modules" (Rabaglia et al., 2011, p. 301). Thus, they basically propose something like what was proposed by the neuropsychology of Luria (1966) in the 1960s: complex human function involves an entire array of brain regions. Kovács and Conway (2016) made an even more detailed region overlap analysis, showing that *g* might be related to prefrontal functions. During this process, the two separate modern psychogenetic traditions, the universalist and individual differences trends start to be reconnected.

Determining factors of development

The traditional nature/nurture issue had become complex due to the self-conscious development of the modern natural sciences of development. William Stern proposed already a 100 year ago a convergence theory of development. According to the convergence theory, nature and nurture not merely interact in determining development, but they determine development in a convergent manner, somehow relying on common proximal causal mechanisms. For Stern, this joint integrating field was the concept of personality where environmental and genetic factors do relate to each other (Stern, 1914, 1938). As a matter of fact, some modern developmental theories that criticize as a starting point the separation of inheritance and environment can be taken as followers of Stern (Oyama, 2000). This more dynamic attitude means that embryology should not be entirely replaced by genetics as an inspiration for psychological studies of development. Development should not be interpreted as a realization of an essentialist blue print, where all results and varieties would be contained in the genome interpreted in an archetypical manner. "Organic form […] is not transmitted in the genes, neither is it contained in the environment. [… rather] it is constituted in a developmental process" (Oyama, 2000, p. 26).

The novelties due to the Human Genome Project did overwrite former simplistic systems of psychogenetics relying on a direct, blueprint-read-out metaphor.

Limitations of the genome. Psychologists themselves have been challenged in their psychogenetic models by the fact born out of the Human Genome Project, where the basic issue is how so few genes (numbers were moving from 32,000 down to 23,000 over the decade) can be responsible for so many cognitive adaptations (Marcus, 2006).

The limitations related to the size of the gene pool question the early visions of evolutionary psychology, that abundantly postulated over a 1,000 elementary minor psychologically interpreted genetic changes merely to differentiate between humans and other apes (Cosmides & Tooby,1992). It is also difficult to accommodate the small number of genes with those conceptions that interpreted certain peculiarities of human grammar such as number agreement be genetically determined, together with certain taste or, face preferences, and so on. Both in behavior genetics and in the genetic interpretation of psychological processes, we have to forget the idea of a biunique correspondence between genes and preferences or species-specific behaviors. Most behavioral and cognitive features must have a polygenic determination, supplemented by epigenetic mechanisms (Grigorenko, 2018).

Fostering regulatory genes. These do play trivial roles in organic development, like in the development of body symmetries, but they may as well be crucial in neural development and therefore in determining sensitive developmental periods (Johnson et al., 2011; Charney, 2012).

Genetics in an open system. Philosophers have emphasized for centuries that man is an open project. Nowadays, research on mental development also realized the centrality of this issue. The most characteristic human processes such as language or culture, though they do follow interesting universals, do assume an adjustment during individual lifetime (Slobin, 1985, 2004). Thus, when looking for genetic determinants of behavior and cognition we have to look for genetic models that entail the existence of environmental interactions as a sort of species wide expectation, which have a stabilizing role for example for the sound system of the mother tongue, kinship relations and so on.

The classical discussions of how genetics and "embryology" contribute to the unfolding of psychological individuality are also highly relevant to the developmental theories. For the psychologists, this concept supports a possible new interpretation of their own classical doubts regarding straightforward genetic determinism. Evolution paves the way for individual development, where genetics and ecology, such as the cultural environment of primary and secondary socialization, determine the way of 'choosing individual' routes made possible by the evolutionary landscape. The intense study of epigenetic unfolding as shown by Charney (2012) indicate the implications of the still relevant landscape metaphor proposed by

Waddington (1942, 1957) to illustrate the concept of epigenesis. Jablonka and Lamb (2002) present the history of this concept as an intersection of evolution, development, genetics, and ecology. They claim that both the traditional idea entertained by Waddington and the novel postgenomic ideas allow for multiple developmental pathways. "Epigenetics [is] associated with the interaction of genes, their products, and the internal and external environment. […it focuses] on alternate developmental pathways, on the developmental pathways underlying stability and flexibility, and on the influence of environmental conditions on what happens in cells and organism" (Jablonka & Lamb, 2002, pp. 88–89).

Epigenesis as a term has several meanings. In some of its loose psychological usage, it merely means the idea that environment driven development is important. It is also used to refer in an evolutionary sense to gene-culture co-evolutions, such as lactose tolerance in human adults and cattle breeding. It is often used in the interpretation of genetic vulnerability and environmental interactions in the genesis of different psychopathologies. In the modern genetic interpretation, however, the very term epigenesis also implies a definite genetic notion, namely that the activation of the genome, or more precisely parts of the genome are experience dependent as well (Charney, 2012).

Epigenesis has several meanings regarding behavioral development as well. It does imply some kind of intricate sensitivity to environmental effects, in the form of sensitive periods or the like. Grigorenko (2018) summarized how this concept might be useful in understanding some puzzles of the assumed inheritance of intelligence. Epigenesis can be interpreted, as the famous image of Waddington (1942, 1953, 1957) suggested, a picture where evolution and genetics determine only possible pathways of development but development itself depends on many environmental factors as well.

It is hard to imagine a simple Mendelian genetics for (supposed) modular cognitive organizations. In addition, we have to recognize that there are not only opponent systems in cognition, but supplementary systems as well, such as nighttime and daytime vision, or grammar and the lexicon. Finally, specific cultural learning mechanisms show up in humans as a procedure that is prepared to acquire relatively unmotivated, arbitrary systems in a flexible manner (Csibra & Gergely, 2009).

The newer approaches started off with a theoretical critique of a simple blue print image of genetic determination. In a way, as presented among the first ones by Gary Marcus (2001, 2004) of New York University and by the edited volume of Ellis and Bjorklund (2005), the new aim was and is to relate proximal mechanism of development with distal mechanisms of evolution. This has been the eternal dream since the time of Haeckel and J.M. Baldwin through evolutionary epistemology of Karl Popper and Donald Campbell. The new approaches have two basic novelties. They are not merely looking for analogies, but for causal relations connecting the two changes, and they

rely on clear notions of modern genetics. There are interesting analogies between developmental processes of psychology and biological processes regarding the 'preparedness' of organisms for change. "Evolutionary biology possessed not only an analogue to trial and error learning, but also an analogue to cognitive psychology in the theory of developmental constraints! Cognitivists insisted that trial and error was mediated by complex internal states that could speed up, slow down, or channel the effects of environmentally mediated learning. Advocates of developmental constraints said the same thing about the operation of natural selection. Embryological development biased the set of 'options' that were available to selection. […] the criticisms of cognition and constraints were very similar. Behaviorists scorned cognitive states as 'mentalistic,' while neo-Darwinians scorned *Bauplans* as 'idealistic'" (Amundson, 2006, p. 10).

As Gary Marcus (2001) emphasized, nativism can be reconciled with the effect of experience. The brain can be assumed to have an initial structure, at the same time emphasizing that during development there are factors such as gene expression, interaction between cellular structure, chemoaffinity, and gradual differentiation that all play a role in the unfolding of the genetic make-up. The last 10–15 years have witnessed the appearance of a new synthesis, whereby innate mechanisms, learning and experience, perception, as well as social factors have all been acknowledged to play important roles in the development of higher order cognition and language. In this new perspective, the question is shifted from a simple *nature versus nurture* dichotomy to exploring the mechanisms that are responsible for aspects of cognitive development and their interaction with one another.

The new issues raised at the turn of century are nevertheless embedded into classical issues of nature/nurture, and the role of genetics in contemporary psychological theories. The reemergence and reanalysis of the whole issue of genetic components of behavior is a striking feature of the last half century, from two different angles.

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