The socio-economic importance of personality characteristics

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Summary

This article considers the role of personality attributes (often called non-cognitive skills or talents in the economics literature) in determining various dimensions of well-being in adulthood. In addition to providing evidence of how these attributes are developed and determine individual outcomes, the article presents situations in which public policies – especially within education – can affect non-cognitive development.

1. Introduction

A person's success is largely determined by his or her individual characteristics, and accordingly, the state, in the interest of improving the well-being of its citizens, is committed to formulating policies that help individuals to improve their talents. Concomitantly, the scientific community, particularly psychologists and economists, devotes significant effort to understanding how individual characteristics are developed, how these characteristics influence different dimensions of well-being, and which public policies can encourage these characteristics.

However, knowledge about the development of individual skills has developed unevenly, with significant priority given to the analysis of cognitive skills. The main reason for this imbalance is the relative difficulty of accurately measuring non-cognitive human attributes. Cognitive skills are less susceptible to the context in which we attempt to measure them. For example, an individual who has good logical thinking skills will manifest this talent on both a math test and an intelligence quotient (IQ) test. Non-cognitive attributes, however, are more difficult to measure. Two tests that are designed to measure the same characteristic in the same individual may yield very different results depending on the situation and on how the tests are administered. The tradition of measuring cognitive abilities is therefore older, and the development of these skills throughout the life cycle has been better documented than the development of non-cognitive dimensions. As cognition develops with age, knowledge also accumulates, making individuals more productive and better adapted to their environment. Thus, educational policies that aim to convey new content and facilitate the accumulation of knowledge have long been recommended as a form of state action that can improve the productivity of the workforce and individual well-being.

Recent improvements in techniques for measuring individual characteristics have led to new discoveries related to the development of non-cognitive attributes and their importance in determining individual success and other variables of interest to society.

In a seminal study that began in the late 1960s, the Austro-American psychologist Walter Mischel showed that the results of an experiment intended to measure preschoolers' ability to postpone rewards were an important predictor of various important individual outcomes in adulthood.[1] Mischel's experiment involved leaving one child at a time alone in a room with a marshmallow. The experimenter stated that he would leave the room and that if the marshmallow was uneaten when he returned, a second treat would be given to the child. The child was then filmed, which allowed the

[1] Mischel, Shoda, and Rodriguez (1989), Metcalfe and Mischel (1999), and Mischel and Ayduk (2004).

researchers to measure how much time elapsed before the candy was eaten. Mischel followed the participants of the experiment until adulthood and found that those who ate the marshmallow earliest had the worst results on the SAT exam (similar to the ENEM exam), a higher incidence of drug use, lower education levels, and poorer results on psychological tests. However, controversy persists regarding what attributes Mischel's test[2] actually measures and how the results of a test administered at the end of early childhood can be correlated with adult outcomes.

In two influential studies, Heckman et al. (2001, 2011) found that students who had obtained their high school diplomas via an equivalency examination (GED) had IQ test scores that were distributed similarly to those of students who earned their degrees through regular schooling, a fact that contrasted dramatically with the observed differences in the wage distributions of the two groups (which clearly favored individuals who had attended regular school). This result called into question previous beliefs regarding the mechanism through which schooling might influence earnings. According to the prevailing argument, people who attended more years of school would have further developed their cognitive skills and thus become more productive than those who attended fewer years of school. If this argument were correct, the method by which an individual acquired his or her high school diploma would have no additional effect on wages given that both types of graduates had similar IQ levels. In continuing their research, Heckman and Rubinstein (2001) found that the distributions of some non-cognitive characteristics[3] of GED graduates were more similar to those of individuals who had dropped out of school before obtaining their high school diplomas than to those of individuals who had completed their schooling. This finding suggested that the factor of finishing school may have contributed to the students' productivity through non-cognitive channels and that this difference could explain the observed wage gap between the two types of diploma-holders. In the article, the authors also showed that non-cognitive attributes are at least as important as IQ in determining earnings levels.

Heckman et al. (2010 a-c) also reinforced the importance of school in promoting non-cognitive skills when they conducted an in-depth analysis of the results of the Perry/High Scope preschool program. In 1962, a preschool program that was inspired by Piaget and featured an innovative, high-quality pedagogical structure was implemented in the U.S. city of Ypsilanti, Michigan. This program focused on the development of vulnerable children or of those at risk of vulnerability. The program also included a detailed data collection procedure that rigorously evaluated its impact on the participants into adulthood.[4] The findings showed that the program significantly influenced the participants' ability to generate income, reduced their propensity to engage in illegal activities, and increased their level of education. Because of this powerful impact, the High Scope program has since inspired the development of preschool curricula around the world. Interestingly, Heckman et al. (2010 a-c) showed

[2] Also known as the Marshmallow Experiment.

[3] Rosenberg's self-esteem scale and Rotter's Locus of Control (which measures an individual's beliefs about the control he/she has over his/her destiny and is influenced by the individual's self-confidence, persuasion, and political initiative).

[4] A lottery of eligible children was conducted to determine which would receive treatment, and both the treated children and the untreated participants have been followed consistently through home interviews. The study has enjoyed surprisingly low attrition rates given the long data collection period.

that despite the program's many positive results, the IQ differences between treated and untreated children were short-lived. This finding suggests that even though the program positively affected individual cognitive development, this cannot have been the main explanation for the differences observed in adulthood. In this study, the systematic differences between the two groups with regard to IQ were not evident when the participants were 14 years of age.

The objective of this paper is to discuss this and other evidence of the importance of non-cognitive attributes in determining individual success and collective well-being and to explore the available theoretical explanations for such findings. Additionally, we will present existing empirical evidence related to the formation of these attributes throughout the life cycle and the significant potential influence of public policy in this regard. As previously mentioned, the literature on non-cognitive skills is much more recent than the literature focused on cognitive skills; additionally, research on non-cognitive skills has not yet comprehensively assessed the causal effect of these attributes on individuals' future outcomes or fully determined how these attributes are formed. As we will see, the available evidence originates from research groups with different goals and theoretical frameworks; thus, it is not always possible to reconcile all of the facts in a single coherent explanation. The structure of the paper is as follows. The next section discusses the taxonomies used to define attributes and non-cognitive skills and the theoretical frameworks that underpin them. Section three will present empirical evidence regarding the formation and crystallization of non-cognitive attributes. Section four will illustrate the importance of non-cognitive attributes in determining individual success in the labor market and in educational achievement. This section will also show the impact of these attributes on criminal propensity, their effects on family structure and longevity, and the results of evaluations of public policies that can modify the development of non-cognitive attributes in individuals. The fifth and final section contains comments and concluding remarks on the topics raised throughout the text.

2. Non-cognitive attributes: theory and measurement

Curiosity about why different individuals react differently to the same situation and why different people obtain different outcomes throughout their lives has permeated humanity since its origins. Experience suggests that each of us has intrinsic characteristics that make us unique and that help to explain both of these issues. However, the complexity of human behavior and of the situations in which human behavior is observed make it difficult to characterize all of this diversity with reference to only a few dimensions.

The potential benefits of such a characterization are uncontested. From a clinical standpoint, the ability to identify the factors that limit our success in different contexts would be invaluable because it would make it possible to prescribe treatments that mitigate the negative consequences involved. In addition, from a public policy standpoint, it should be possible to formulate intervention programs that help vulnerable populations to overcome competitive disadvantages, create equal opportunity for themselves in the labor market, and participate in civic life.

The challenge, however, is to evaluate behavior based on a set of determinants that is at once sufficiently precise and sufficiently selective so as not to exceed the investigator's capacity for analysis. Furthermore, most observed behavior is influenced

by multiple characteristics, which makes it particularly difficult to identify the levels of each attribute.[5] For example, it is possible that an individual will behave aggressively in some situations but not others or that he/she might enjoy risk-taking in lotteries that involve little money but not enjoy risking large sums. During the last hundred years, intense debate has continued regarding whether and how one might characterize behavior at a reasonably reduced scale. To a large extent, this discussion has unfolded in parallel with the evolution of systems for measuring human attributes.

As their name suggests, non-cognitive attributes complement cognitive ones, and the best way to define them is to first identify the set of cognitive attributes and then determine how their development is measured and characterized. We also begin this discussion by determining the nature of cognitive attributes because the research on cognitive development is older and because many of the theories of and ways of measuring non-cognitive attributes attempt to mimic cognitive research. Finally, it is significant that throughout this text, both cognitive and non-cognitive attributes are understood as personality attributes, i.e., "relatively stable and enduring patterns of thoughts, feelings, and behaviors that reflect a tendency to respond in certain ways to certain circumstances."[6] This limitation is important because the only attributes considered here are those that vary little after a certain age and can be modified through intervention, producing lasting benefits and thus justifying public policies intended to provide such intervention.

2.1. Cognitive development

Although large-scale mental tests have been conducted since the ninth century, Alfred Binet and Theodore Simon have been credited with developing the first modern intelligence test, the primary goal of which was to identify cases of mental retardation and psycho-neurological diseases and to diagnose mental retardation in school children. The Binet-Simon scale, originally published in 1905, was further developed by Professor Lewis Terman at Stanford University in 1916. Terman's work generated the Stanford-Binet scale, which became the most popular IQ test[7] throughout the twentieth century and is still the basis for many existing scales. The popularity of the Binet-Simon scale (and, later, the Stanford-Binet scale) results from both the consistency with which these scales measure the cognitive development of individuals over time and their high correlation with academic grades and the results of other knowledge tests in different populations.

Conducting research parallel to that of Binet and Simon, the experimental psychologist Charles Spearman developed a statistical method of identifying a limited set of factors that satisfactorily explain the variability in multiple measurements of individual outcomes. Spearman's technique was essential because it enabled a relatively large number of behaviors to be explained by a small number of individual characteristics even when these characteristics could not be directly measured. Moreover, the use of Spearman's method in a knowledge test measurement system[8] showed that one factor alone could explain most of the observed variation, leading

[5] This challenge is essentially the problem of identification raised by Duckworth et al (2011).
[6] As defined by Roberts (2009), quoted in Duckworth et al (2011).
[7] Intelligence Quotient.
[8] A series of cognitive tests used with the same sample of individuals.

Spearman to theorize that in fact, individuals possessed an attribute that could capture the structure of intelligence. This is known as the g factor theory.

The work of Binet-Simon-Terman and Spearman allowed cognitive development to be measured throughout the life cycle and facilitated the generation of theories regarding this type of development. Spearman's findings showed that the chosen cognitive test and the context in which it is conducted do not influence the results sufficiently to invalidate comparisons over time and that the enhanced Stanford-Binet scale is a relatively reliable instrument.

Inspired by the potential to measure intelligence, several authors have theorized about cognitive development, and although there is no complete consensus regarding how learning occurs, scholars generally agree that (i) cognition develops cumulatively with age, with a person's current knowledge used as the input in the next stage of learning; and (ii) certain ages or life stages facilitate particular types of learning.

Though initiated by psychologists, interest in cognitive development has not been restricted to scholars in this area. The cumulative nature of learning and the strong correlation between the results of cognitive tests and an individual's ability to generate income (which suggests that cognitive skills are closely related to worker productivity) have led prominent economists to formulate the theory of human capital,[9] according to which individuals (and families) invest rationally in the acquisition of knowledge and in skill development (particularly through education) to obtain future returns on that investment. Furthermore, several empirical studies suggest that differences in education are among the main determinants of wage differences at the individual level and that some of the trajectories of economic growth observed in various countries can be explained by the trajectories of their educational indicators. In addition to helping to explain why different individuals invest different amounts of resources (financial and non-financial) in their cognitive development, the theory of human capital provides a direct link between this development process and various dimensions of individual success in adulthood.

In neuroscience, significant effort has been made to explain the biological determinants of cognitive development. First, numerous studies[10] attempt to relate the development of certain skills (including verbal, spatial, and memory skills) to the formation of specific brain regions, such as the prefrontal cortex. Furthermore, there is growing interest in investigating the extent to which observed differences in behavior have genetic or environmental origins.[11]

Finally, there are multiple ways of defining which human attributes should be classified as "cognitive." In this text, a rather restrictive definition is used: only the g factor (or IQ tests as a proxy for this factor) will be considered to be purely cognitive. All other measures of behavior are to some extent affected by both cognitive and non-cognitive characteristics. This definition has been used because regardless of whether a particular attribute is classified as "cognitive" or "non-cognitive", all of the attributes have been the object of less research than IQ as determinants of future individual success.

[9] The precursors of these studies were Gary Becker (1962, 1967, and 1966 with Cheswick), Theodore Schultz (1963, 1971), and Yoran Ben-Porath (1967).
[10] See Diamond (2002, 2006).
[11] This debate is known as the 'nature versus nurture' debate.

2.2. Non-cognitive development

The "Big Five" personality model

In the first half of the twentieth century, the most prominent psychologists devoted significant effort to examining the differences among individuals: differences that led to the formulation of the modern concept of personality. The same interest that led to the emergence of the g factor theory motivated many authors to seek to identify individual characteristics that might explain human behavior in cognitive tests in different contexts. The factor analysis techniques proposed by Spearman were critical for the formulation of the Big Five theory because they made it possible to examine the variability in behavior measurements in a focused manner.

The pioneering Big Five theory is attributed to Gordon Allport and his colleagues in the mid 1930s. Influenced by Francis Galton's lexical hypothesis, which states that the most important individual differences should be captured by everyday language, Allport and his colleagues searched English-language dictionaries for all adjectives that could describe personality attributes (e.g., "irritable," "aggressive"), amassing approximately 18,000 words. After eliminating synonyms, they produced a list of 4500 items that describe observable, permanent human characteristics. In the 1940s, Raymond Catell used new research results to reduce the list to 171 adjectives, which were later grouped based on content into 35 clusters (forming what Catell terms the "personality sphere"). The next step was to generate personality tests that examined these multiple dimensions of personality. In the 1960s, in examining large samples from several personality tests, several authors found that five main factors explained most of the variation in the tests. This empirical regularity suggested that the many non-cognitive characteristics of individuals could be grouped into five large generic blocks, which over time were given various different names. Then, through the influential work of Lewis Goldberg (1980, 1981), these characteristics came to be referred to using the acronym OCEAN, which stands for the following categories:

- **O**penness to experience: the willingness to accept new aesthetic, cultural, or intellectual experiences.
- **C**onscientiousness: a propensity toward organization, responsibility, and hard work.
- **E**xtraversion: the inclination to direct one’s interests and energy toward the outer world of people and things (rather than the inner world of subjective experience). Characterized by affectivity and sociability.
- **A**greeableness (cooperativeness, friendliness): the propensity to behave in a cooperative and unselfish manner.
- **N**euroticism (neuroticism and emotional stability): the propensity for psychological imbalance (neuroticism) and the predictability and consistency of one’s emotional reactions (emotional stability).

Each of the above five factors represents a dimension of personality in its most general and abstract form and is subdivided into more specific attributes. In addition, there are other theories of personality that generally resemble the Big Five theory as outlined above. These theories seek alternative ways of dividing and naming classes of personality attributes but share the belief that most differences in the behavior of individuals arise from differences in these attributes or in the combination of these attributes and the relevant environment and stimuli. Given that these attributes are

intrinsic human characteristics, personality theorists typically attribute a high degree of importance to genetic and biological factors in determining the level and development of these attributes, which become relatively stable at a certain age.[12]

Behaviorist critique

Not all psychologists and social scientists agree on the relevance or even the possibility of defining non-cognitive attributes. For behaviorists, the main determinants of human behavior are the characteristics of the environment in which the behavior is observed, not hypothetical constructs such as those suggested by the Big Five. In cases in which such constructs appear to be correlated with behavior, the explanation is that the constructs themselves must result from other behaviors (such as "thinking" and "feeling"), which can also be explained by environmental factors (which, in turn, are ultimately the real causes of both). For these authors, non-cognitive personality attributes either are not permanent and stable or, if they are, play a minor role in determining behavior. They are believed to be mostly the result of life experience and of the situations in which people find themselves at the time of measurement.

In 1968, Mischel (who conducted the Marshmallow Experiment) published a seminal work[13] that changed the dominant paradigm used by psychologists to determine behavior. In that work, Mischel showed that the correlations among the various measurements of the same construct in the same subject were surprisingly low, suggesting either that they were measuring different things, or that the results obtained were predominantly determined by environmental conditions (such as the type of test or questionnaire used to measure the construct or an incentive structure inherent in the test design that encouraged subjects to behave in a certain way). In both cases, Mischel's findings discredited psychological theories of personality and validated the behaviorist perspective.[14]

Mischel's work led contemporary behaviorists (among them B.F. Skinner, the founding father of radical behaviorism) to gain prominence in the debate on personality and the determinants of behavior. In addition, the popularity of behaviorism was further enhanced by the preponderance of state intervention.[15]

As enthusiasm for the Big Five theory decreased, a third school of thought became prominent. Led by psychologists such as Albert Bandura and Mischel himself, supporters of social-cognitive theory argued that personality attributes are not inborn but are instead developed through experience, social interaction, and the individual's cognitive processes. Thus, these theorists differ from supporters of the Big Five theory in that they do not agree that the five groups of characteristics are innate attributes of individuals. In addition, these theorists reject the behaviorist suggestion that

[12] According to the diagnostic and statistical manual of the American Psychological Association, "... personality traits are "enduring patterns of perceiving, relating to, and thinking about the environment and oneself that are exhibited in a wide range of social and personal contexts."

[13] Mischel, W. (1968) *Personality and Assessment.*

[14] In his conclusions, Mischel states that "... with the possible exception of intelligence, highly generalized behavioral consistencies have not been demonstrated, and the concept of personality attributes as broad dispositions is therefore unsustainable."

[15] Unlike the Big Five theorists, behaviorists argued that human behavior was the result of experience, which can thus be modified by interventions. If the main determinants of behavior were individual characteristics that were not significantly affected by the environment, public policy would have little influence.

manifestations of cognition (such as the act of thinking) are simply forms of behavior and as such are entirely a function of past experience and the context in which they are measured. Moreover, social-cognitive theorists argued that the five groups of non-cognitive characteristics result from the processing of previous experience via cognition and from the observation of other members of society and of their behavior.[16] Thus, they argued, it is impossible to distinguish between "cognitive" and "non-cognitive" characteristics because all human characteristics ultimately result from some cognitive process.

2.3. Temperament and executive function

The differences among the supporters of each of the three schools presented thus far have deep philosophical roots in the work of early thinkers who were dedicated to investigating the relative importance of individual characteristics and of the environment/experience in determining a person's destiny. Each of these schools addresses the same empirical evidence and attempts to interpret the evidence in a manner that substantiates its views. Typically, such evidence includes the results of tests and questionnaires (scales and inventories) that measure suggested personality characteristics. Evidence of stability (over time and across different situations) is often viewed as validating personality theories, whereas the absence of stability seems to indicate the role of environment and experience. The contrast between stable measures of intelligence and volatile measures of other characteristics supports socio-cognitive theories. The measures used generally need to be consistent throughout the life cycle to allow informed discussion regarding the empirical content of the different theories and to allow these theories to be challenged.

However, an important branch of the literature is dedicated specifically to the development of certain characteristics during an individual's first years of life (i.e., early childhood). This interest stems both from the observation that most characteristics form or develop rapidly in this phase and the fact that to some extent, children are still developing, which allows us to associate the formation of cognitive and non-cognitive personality traits with physical development. These researchers have produced an important and distinctive body of empirical facts and theoretical explanations that do not always accord with the types of measurement and questions formulated by participants in the debate regarding the three schools of thought described above. In general, the former group includes both those investigating the development of executive function and those researching temperament. Both value the interactions between physical (i.e., biological) and psychological measures, and both emphasize the need to estimate the relative importance of genes and one's environment in examining the observed results (because temporal interrelationships and dependencies are still relatively less complex in this phase of development and are therefore easier to analyze).

Executive Function

[16] The ability to retain information about successful behavior and to identify the actions with the greatest potential for success in new situations was termed "self-efficacy" by Bandura. This idea plays a central role in socio-cognitive theory, as it has been suggested that this ability encourages the individual to choose to perform successful actions, thus determining the behavior observed). In an attempt to combine the various behavioral theories into a single model, Duckworth et al. (2011) conceptualized measures of self-efficacy as reflecting one facet of neuroticism.

Researchers of executive function work within the fields of psychology and neuroscience. According to this theory, the first type of response to stimuli manifested by individuals is purely instinctive and repetitive. For example, if a baby learns to suck a finger, his first reaction to another object is also to suck it; if the baby observes someone performing a particular action, his impulse will be to imitate him. Executive function is the system that inhibits impulsive responses and allows the individual to reflect on context and choose the appropriate action.[17] The development of executive function is generally associated with the development of the prefrontal cortex and occurs very rapidly in various dimensions during early childhood. From one perspective, the development of executive function is what first makes it possible to differentiate between the various behaviors of individuals, whereas in principle, impulsive responses should depend entirely on environmental characteristics. Although several studies have documented the rise and development of executive function in individuals, these findings have not been comprehensively related to other measurements of behavior at older ages.

Temperament

Temperament can be defined as the innate aspects of an individual's personality. (Come authors refer to these characteristics as "crystallized" or stable because they represent the character of an individual.) Although several tests and scales have been created that measure these characteristics, it is difficult to relate these empirical findings to other behavioral theories. First, although these measurements have been developed for application in early infancy, there is no universally accepted way to test whether they actually reflect innate attributes. Second, these tests have relatively low correlations with personality measures obtained at older ages, which makes it difficult to delineate what these tests and scales actually measure.[18] Nevertheless, the stylized facts produced by these modes of thinking deserve special attention because they provide evidence of the relevance of non-cognitive attributes in people's lives.

2.4. Non-cognitive characteristics and economic theory

Modern economic theory is primarily concerned with characterizing the decision-making behavior of economic agents, including individuals. As in psychology, economic theory reflects a fascination with the question of why different individuals respond differently to the same stimulus. The general consensus is that there are two types of attributes that produce heterogeneity among individuals.

First are the characteristics related to individual preferences, such as the "intertemporal discount rate" (which allows the comparison of future benefits and current benefits, both associated with decisions made by individuals), the "degree of risk aversion," which is the propensity of agents to choose actions involving greater or

[17] Norman and Shallice (2000) outlined five types of situations in which impulsive responses are no longer sufficient and more elaborate constructions are necessary: (i) planning and decision making; (ii) the correction of errors and defects; (iii) situations in which the solution involves a sequence of actions or actions for which part of the sequence is unknown; (iv) dangerous or technically difficult situations; and (v) situations that involve resisting some type of temptation versus choosing the easy route (as in the Marshmallow Experiment).

[18] Part of the problem is the arbitrary manner in which both temperament researchers and supporters of the Big Five and other theories of behavior name the constructs that their scales and tests should measure. Often, terms such as "extraversion" and "aggressiveness" are simultaneously used to define areas of temperament and personality, leading researchers to search for correlations that simply may not exist.

lesser risk based partially on the benefits associated with them, and individual "tastes" for different goods, actions, etc. Attributes associated with preferences are generally assumed not to vary across situations. Over time and in most contexts, such stability has often been seen as a prerequisite for the empirical validity of various economic models (because it ensures that they are non-tautological).[19]

Second, some characteristics may vary over time, and this variation often results at least partially from earlier decisions made by the individuals themselves or their families. For instance, the acquisition of the skills necessary to solve specific problems and complete particular tasks is partly a function of the decision to study and work. Some of these characteristics help individuals to improve their future well-being (e.g., through higher wages). Thus, one can compare the decisions that can change these characteristics over time to the investment decisions made by entrepreneurs. This idea is known as the human capital theory.

Conceptualized in the late 1950s and advancing the theoretical work of Gary Becker,[20] T.W. Schultz,[21] and Yoram Ben-Porath[22] and the empirical research of Jacob Mincer,[23] the human capital theory plays a central role in the modern economy and complements psychological theories regarding the formation of attributes and determinants of behavior. In particular, the nature of this theoretical formulation directly links human attributes to improvements in the well-being of individuals and society. This theory also emphasizes the elements of the evolution of individual characteristics that can be modified via action undertaken by economic agents – as opposed to biological processes or even other situational processes in which responses to existing stimuli are described in less detail.

Understanding how an agent's current behavior influences his characteristics in the present (which in turn become important determinants of future behavior) may have important public policy implications. Typically, we believe that a direct influence on behavior can be generated through interventions within an individual's environment. As the human capital theory explains, the environment can have both a direct and an indirect impact on behavior by influencing the characteristics of individuals, which, in turn, affect behavior and well-being.

In its original formulation, the human capital of an individual was regarded as a one-dimensional object that accumulated over time and as the economic counterpart of the *g factor*. Since the late 1970s, following the work of Heckman (1978) and Willis and Rosen (1979), among others, researchers have suggested that the determining skill set at the level of individual well-being may be multidimensional and that individuals who make investment choices that will improve their characteristics evaluate the potential for comparative advantages by investing more in areas that present higher rates of return (e.g., in the form of salaries and other earnings or in terms of health and family stability). As demonstrated by Heckman and Honoré (1990), the fact that individuals consider the question of comparative advantage increases the final heterogeneity of individual attributes but reduces the heterogeneity of the results.

[19] See the discussion in Becker and Stiegler (1977).
[20] 1962, 1967, and 1966 with Chiswick.
[21] 1962 and 1971.
[22] 1967.
[23] 1958, 1974, 1997, and 1974 with Polashek.

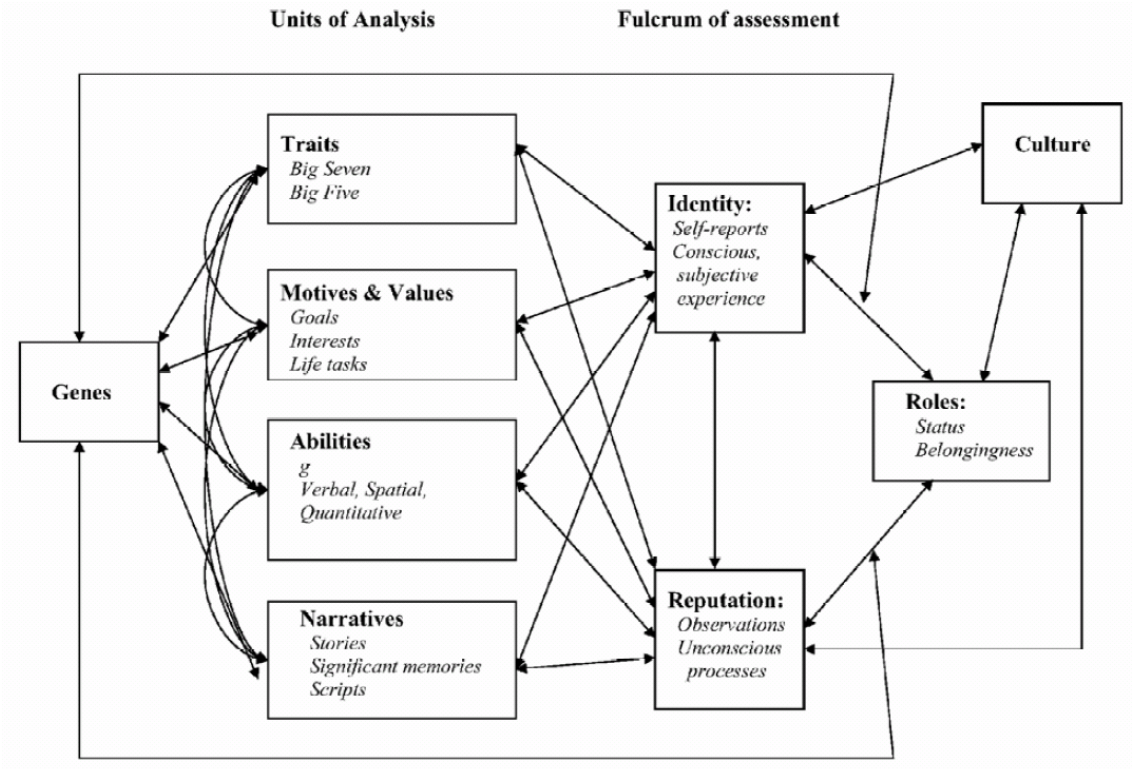
2.5. The Roberts-Heckman model of formation and measurement of cognitive and non-cognitive attributes

In 2006, Brent Roberts proposed a model that could unify the socio-cognitive, behavioral, and Big Five approaches, placing each of these special cases within a broader framework and thus developing a mode of empirical testing that could evaluate the relevance of each approach to human behavior.

In Roberts' model, the personality is the result of a system of three mutually interacting levels. The first level includes the individual's genetics, which directly determine the formation of the various attributes and skills discussed above but also influence the situations, experiences, and other environmental variables that the agents will experience (which, in turn, influence the formation of attributes and skills). Simultaneously, attributes and the environment also affect how the individual's genes are expressed and how they thereby influence the experiences and the environment of the individual (by affecting the opportunities that arise or the person's choices). In short, in terms of causality, the person's genes, attributes, and environment are part of a process of simultaneous determination.

The third level includes identity and reputation, culture, and social roles. Again, a process of mutual determination influences the person's attributes and environment, thus affecting the relevant third-level variables, which in turn influence the former factors. The third level includes all of the observable manifestations of personality, including those measured using tests, inventories, and scales.

Roberts' Model of Personality



Source: Roberts (2006). In the model, personality results from a system of interactions involving biological factors (e.g., genes), environmental conditions and incentives, and characteristics (attributes, skills and social characteristics).

In Roberts' model, some components are relevant to both (stable) personality attributes and environmental variables (e.g., experience and the incentive systems embedded in the measurement context). This commonality reduces the disagreement between those who argue that individual attributes are invariable and the proponents of behavioral theories to the empirical task of establishing the relative importance of these two sets of factors. Additionally, the model allows the development of several attributes to be affected by their original levels, accommodating the idea that non-cognitive characteristics in adulthood are largely determined by cognitive processes (as social-cognitive theorists argue). Again, the model makes the task of establishing the relevance of this mechanism an empirical one.

Finally, Roberts' model clearly distinguishes between personality attributes and observable manifestations of personality. For example, according to this model, the results obtained using a scale that measures self-esteem will be affected not only by the participants' self-esteem levels but also by the overall system that produces personality. Other attributes, the situation, and the environment in general may interfere with the results obtained, yielding the fundamental problem of identification mentioned at the beginning of this section (i.e., making it difficult to infer what levels of various personality attributes influence the observed personality trait). Nevertheless, recent statistical advances have made it possible to address potential measurement error (defined as the difference between the results obtained using a scale or test designed to measure a certain attribute and the true level of the attribute). It has also become possible to examine the parsimony of models that simultaneously characterize the determining attributes of human behavior (see Duckworth et al., 2011).

Heckman et al. have mathematically formalized Roberts' model in several studies. Duckworth et al. (2011) construct a system of equations for use in simultaneously identifying the variables that determine personality; the authors formulate strategies for identifying and estimating personality attributes. Cunha et al. (2010) suggest that cognitive and non-cognitive attributes exert a combined influence, indicating that both biological processes and individual decision-making can influence how various characteristics evolve over time and stabilize at various points in the life cycle (as different attributes can stabilize at different times). The model developed by Cunha et al. (2010) is remarkably nuanced, allowing different attributes to be particularly malleable at certain stages of life. In these phases, relatively small changes in the determinants affecting the development of the attribute can produce large variations in that attribute. Because environmental variables are also determinants (either directly or indirectly via their influence on human capital investment decisions), the model has extremely important implications for public policy because it allows one to conclude that the same resources or policy may yield quite different results in populations of different ages. In addition, this model allows the various attributes to have complementarities of various types during the development process. Attributes may complement each other at a particular point in time; for example, if a disciplined individual made an investment to increase his/her intelligence, his/her sense of discipline might allow him/her to obtain a more substantial increase in intelligence from that investment. Dynamic complementarities may also exist; for example, an investment made today to increase a person's ability to solve equations may not only increase the number of problems that this individual can solve but also improve his/her ability to

make new investments and learn to solve more difficult problems in the future. Again, in principle, the role of each element of the model can be tested and estimated.

3. Possible effects of non-cognitive attributes on individual success and collective well-being[24]

The task of establishing the causal relationships between non-cognitive attributes and economic and social variables is challenging for at least two reasons. First, as previously mentioned, we must confront the problem of identification. For most of the human attributes that determine behavior, there is a natural, universally accepted method of measurement (e.g., there is no 'yardstick' for measuring aggressiveness or shyness, unlike height). Instead, we seek to infer the levels of these attributes via the statistical manipulation of data that reflect observed behavior, e.g., through tests, inventories, and scales.[25] Unfortunately, in most cases, the measurements obtained are influenced by factors other than the characteristics that the researcher wants to measure. For instance, the results of an IQ test that is supposed to measure only intelligence may also be influenced by self-control (a facet of conscientiousness or neuroticism) and perseverance (a facet of conscientiousness). The same is true of most of the existing means of measurement. Therefore, identifying the exact level of each characteristic via indirect measurement is a complex task, particularly because we do not even know how many relevant characteristics we may wish to measure. Indeed, even the five factors emphasized by the many supporters of the Big Five theory were generated via a statistical filter based on the largely unjustified claim that much of the variation in personality can be explained by five factors. There remains no consistent theory of why there are exactly five factors or why those particular factors are the essential ones).

The second fundamental barrier to causal inference regarding the role of non-cognitive attributes in people's lives is the question of reverse causality. In principle, the development processes for the various attributes should be interdependent, and there should be a mutual relationship of influence between those attributes and environmental variables as previously discussed. As a result, for instance, if discipline and educational performance in a particular dataset appear strongly correlated, it may be unclear whether discipline encourages better performance or vice versa. The best studies that attempt to infer the causal effect of individual attributes on socio-economic outcomes seek to minimize the problem of reverse causality by temporally separating the measurement of attributes and outcomes (i.e., by comparing the actual measurements for particular attributes in younger participants with data indicating success and well-being in older age groups).

Finally, it is worth noting that the controversy regarding the intrinsic attributes of an individual and the environmental variables that may serve as situational determinants of behavior (the "person-situation" debate discussed in the previous section) only

[24] This section is inspired by the discussions documented by Duckworth et al (2011).

[25] Tests are interactive tasks that the examiner asks the individual being evaluated to complete. Inventories and scales are questionnaires distributed to individuals that include questions concerning their characteristics (direct or indirect; the latter inquire about situations in which the characteristics of individuals might be apparent). In inventories, the set of questions provided should cover all (or a wide range of) personality characteristics; once the data have been collected, statistical filters (e.g., factor models or principal components analysis) are used to isolate the levels of the different attributes based on the responses. In scales, questions are already constructed to measure specific attributes, and in theory, the result obtained from a questionnaire should provide a direct measure of the level of each attribute.

minimally affects assessments of the causal relationships between non-cognitive attributes and individual outcomes. Essentially, if there are human characteristics that are stable at some point in an individual's life, the question of how these characteristics developed (whether via a purely biological or innate process, through experience or through cognitive processes) is irrelevant to the assessment of those characteristics and of their causal relationships with other variables. Nevertheless, this theoretical debate is of great importance because of its implications for the process of influencing individual character formation and thereby improving the well-being of individuals.

In this section, we will separately analyze the role of different non-cognitive characteristics in people's lives, compiling the available evidence regarding the five dimensions of the Big Five theory. Because many of the empirical studies examined used scales and tests that measure particular aspects of personality, we use the scheme proposed by John and Srivastava (1999) and presented in Duckworth et al. (2011) to situate the particular domains captured by the scales and tests within the five overarching groups from the Big Five theory.

Personality domains and their facets

Attribute (Big Five)	**Description in the APA dictionary ***	**Facets**	**Related attributes**	**Attributes of temperament (child)**
Openness to experience (Incorporating intellect)	The tendency to be open to new aesthetic, cultural, and intellectual experiences	Fantasy (imaginative) Aesthetics (artistic) Sensitivity (excitable) Actions (has broad interests) Ideas (curious) Values (unconventional)	-	Enjoyment of low-intensity activities Curiosity Sensory sensitivity
Conscientiousness	The tendency to be organized, hardworking, and responsible	Competence (efficient) Order (organized) Autonomy (does not expect help) Fights for goals Discipline (is not lazy) Deliberation (is not impulsive)	Strength of character Perseverance Delaying rewards Impulse control Planning and striving for goals Ambition Ethics at work	Attention Concentration Commitment to controlling attitudes Impulse control / postponement of rewards Persistence Activity **
Extraversion	The direction of interests and energy toward the outer world of people and things (rather than the inner world of subjective experiences)	Friendliness (welcoming) Aggregator (outgoing) Assertion (assertive) Activity (energetic) Seeks excitement (adventurousness) Positive emotions (enthusiasm)	-	Social dominance Social vitality Shyness ** Activity ** Positive emotion Sociability / affiliation Sensation seeking
Agreeableness	The tendency to act in a cooperative manner and not	Trust in others (tolerant) Objectivity (direct in addressing others) Altruism	Empathy Looking at problems from different angles	Irritability ** Aggressiveness Good will, availability

	selfishly	Obedience (not stubborn) Modesty Docility (kind)	Cooperation Competitiveness	
Emotional stability (neuroticism)	Predictability and consistency of emotional reactions, the absence of sudden changes in mood	Anxiety (worried) Hostility (irritable) Depression Introspection (shy) Impulsiveness Vulnerability to stress (not self-confident) Optimism Psychopathology (mental disorders) including depression and anxiety disorders	Locus of control Self-esteem Self-efficacy	Fear (intimidation) / behavioral inhibition Shyness ** Irritability ** Frustration Sadness Difficulty calming down

4. American Psychological Association. ** May be related to more than one of the Big Five.

The relevant studies investigate the relative importance of non-cognitive attributes across three levels. Some studies attempt to compare the overall importance of these attributes vis-à-vis cognitive attributes and environmental characteristics. Other studies investigate the role of the Big Five or examine specific categories within that framework, seeking to determine the impact of facets from one or more domains on individual outcomes. In general, studies that attempt to summarize the available evidence regarding the relative importance of cognitive and non-cognitive attributes to various dimensions of adult well-being have found that non-cognitive attributes are at least as important as cognitive attributes in predicting educational performance and performance in the labor market. Additionally, these studies have found that non-cognitive attributes are significantly more relevant to criminal activity or violent behavior and to longevity and healthy habits (e.g., abstinence from smoking, the consumption of a balanced diet, and exercise).

Openness to new experiences and intellect

Because this domain includes curiosity, imagination, and inquisitiveness, it is not at all surprising that many studies characterize openness to experience as strongly related to educational indicators (e.g., final education level attained, school performance, and selection of more difficult courses). In examining final education levels, studies have produced significantly different results regarding the magnitude of the relationship, with the impact of an increase of one standard deviation in openness to experience ranging from zero to 0.2 years of study. Duckworth et al. (2011) indicated that most studies use data that reflect openness and education at the same point in time or within a small time interval. Thus, these studies may be affected by the problem of reverse causality. Moreover, there is evidence that openness is strongly correlated with intelligence. If the effect of intelligence on education is not properly controlled in the study, a portion of the effect that is attributed to openness may actually be due to intelligence. Indeed, the effect of openness on schooling decreases significantly when we control for the effects of intelligence. However, Cunha et al. (2010) examined a dynamic model of cognitive and non-cognitive attribute formation and found that children with higher levels of non-cognitive attributes exhibit more rapid cognitive skills growth (although the opposite does not occur: more intelligent children do not necessarily develop non-cognitive attributes more rapidly than others). Thus, it is possible that the correlation between

openness and intelligence arises from the causal effect of the former on the latter and that openness has both a direct effect on a person's final level of schooling and an indirect effect through its impact on intelligence (and hence on education).

In a methodologically rigorous study, Lounsbury et al. (2004) found that high school students who were more open to new experiences missed fewer classes and opted for more difficult math courses when they were permitted to choose, even though they did not ultimately obtain higher grades than other students. Indeed, of the Big Five, openness is the second most correlated with mean final grades at school (after conscientiousness); however, this correlation is relatively modest at approximately one-third the size of the estimated correlation between intelligence and grades.[26] Nevertheless, it is important to note that the correlation between openness and grades at the start of the educational cycle is higher than at the end, which is consistent with the hypothesis that groups become more homogeneous as the cycle progresses and some of the weaker students drop out. Using the results of standardized tests of language, arts, and mathematics skills as the outcome variables in a New York study of children at the beginning of the cycle, Duckworth et al. (2011) determined that the impact of openness on grades was similar to that estimated for intelligence.

Openness to experience does not appear to be among the major determinants of productivity and wages in the labor market. However, some studies show that openness may be important in the careers of women, reducing absenteeism (Stömer and Fahr, 2010) and increasing the likelihood of their occupying managerial positions (Cobb-Clark and Tan, 2009).

Conscientiousness

Of all of the personality attributes, conscientiousness is undoubtedly the most highly associated with the many researched measures of success. This group of attributes includes characteristics such as perseverance, discipline, effort, and responsibility, which are important in any activity that involves medium or long-term commitment, including study and work. Like other individual characteristics, this attribute has been shown to be an important (and probably a causative) predictor of the outcome variables studied, but little is known about the precise mechanisms by which this attribute affects success.

In education, conscientiousness, along with openness to experience, is the attribute most closely associated with the final education level attained by an individual. The magnitude of the impact of conscientiousness on years of schooling is close to that observed for intelligence (0.2 years of study for each increase of one standard deviation, with a particular impact on men). There is also evidence that data on behaviors related to conscientiousness, such as punctuality, class attendance, and homework completion, can be used to predict a person's final level of education up to ten years in advance (Lleras, 2008). Even temperament characteristics that are measured in early infancy, such as attention, are statistically significant in predicting the completion of high school (Vitaro et al., 2005).

In predicting the grades that a person obtains during the course of his/her education, conscientiousness is the most important personality attribute, rivaling intelligence in the magnitude of is influence. However, unlike intelligence and openness,

[26] According to Poropat's (2009) meta-analysis.

conscientiousness does not become less intensely associated with grades during the education cycle as would be expected given the homogenization of groups. This finding suggests that conscientiousness may be even more important than intelligence. Martin (1989) showed that persistence and distractibility as reported by parents of children still in early infancy are well correlated with grades in school and on standardized tests. Similarly, Mischel et al. (1989) showed that children who waited longer to eat the candy in the Marshmallow Test (described at the beginning of this article) obtained higher scores on the SAT standardized test, which is used for university admissions in the U.S. The correlation between these variables is surprisingly high at 0.42 and 0.57 for language and mathematics tests, respectively. In another study, Duckworth and Seligman (2005) showed that the proportion of variance in the scores of eighth-grade students that was explained by self-discipline measured at the beginning of the school year was more than twice as high as that explained by intelligence. Finally, studies consistently seem to indicate that conscientiousness is more related to academic grades than to performance on standardized tests, suggesting that there are mechanisms besides one's capacity to learn that link conscientiousness to success in school (e.g., the self-control required to perform well on a test under pressure or the discipline and perseverance to successfully address problems posed by the teacher during a course; on a standardized test, because the questions are prepared by external examiners and the students may not know in advance what will be tested, these skills may not come into play to the same degree). Working from another perspective, Jacob (2002) studied the reasons for the increasing gap in the percentage of young men and women who decide to attend college (in favor of the former). Jacob found that the differences between the self-discipline levels of the two groups are among the main determinants of this phenomenon and that self-discipline is far more important than intelligence.

Facets of conscientiousness such as discipline, organization, and responsibility are valued and rewarded in the labor market, as in school, and thus are positively correlated with wages and opportunities for career advancement. In addition to the direct effects of the above characteristics on individual productivity, there are multiple channels through which conscientiousness may affect one's position in the labor market, First, conscientiousness improves educational performance, which increases productivity. Moreover, various facets of conscientiousness help to reduce absenteeism and turnover, which, in turn, serves to improve performance on long-term tasks. Moreover, in the labor market, conscientiousness is the most important non-cognitive attribute and is approximately half as correlated with job performance as performance is correlated with intelligence. However, whereas the association of performance with intelligence is greater for more complex occupations, the association between conscientiousness and performance remains stable across the entire spectrum of occupations (Schmidt and Hunter, 2004).

In addition to identifying the positive effects of conscientiousness on school and work, studies have found that a positive relationship exists between conscientiousness and health indicators. In a meta-analysis by Roberts et al. (2007), conscientiousness was a better predictor of longevity than intelligence (IQ) or socioeconomic characteristics. Hampson et al. (2007) also found that children with good levels of conscientiousness on assessments composed by first-grade teachers exhibited a lower incidence of smoking and a greater likelihood of physical exercise in adulthood. Friedman et al. (2010) also

found that greater conscientiousness in childhood is associated with more social interaction after 70 years.

Another positive effect of conscientiousness appears in studies of potential participation in crime and violence and of the likelihood of juvenile delinquency. John et al. (1994) found that young offenders were 0.75 standard deviations below average with regard to indicators of conscientiousness as reported by their mothers. Of the facets of conscientiousness, self-control is one of the most important and is directly related to involvement in crime (according to Vazsonyi et al. (2001), self-control explained between 10% and 16% of the variance of indicators of theft, drug use, vandalism, and sexual abuse).

Finally, conscientiousness also emerges as an important determinant of marital stability, reducing the likelihood of divorce and increasing the duration of marriage. In this respect, however, the predictive power of conscientiousness is lower than that of agreeableness and neuroticism.

Extraversion

Of all the effects of the Big Five attributes, the effects of extraversion are likely the most difficult to capture in statistical exercises. First, the effects associated with this attribute may not be monotonic in most cases; that is, it may not be true that more (or less) of this attribute always causes more (or less) of a particular outcome. Very shy or very uninhibited people may be at a disadvantage in education and in the labor market as compared to people with non-extreme levels of this attribute. Because most statistical exercises generally assume monotonicity, it is not surprising that the effects of extraversion are rarely visible from measures of individual success. Additionally, extraversion may be one of the attributes that is most influenced by past experiences and the incentives given to individuals, so the issue of reverse causality is particularly important in this case, and studies that fail to strictly control for this problem may produce particularly erroneous conclusions.

In most previous research, the correlations between measures of extraversion and educational and labor market outcomes are statistically null or very low. In studies in which the results are significantly different from zero, the sign is generally negative, but again, it is generally not recommended that these results be interpreted as indicating a causal relationship between the factors in question. The study by Cattan (2010) is one exception that indicates that the effects of extraversion may not be monotonic in many cases. The author shows that individuals with higher sociability in adolescence obtain higher wages in management occupations (+4%), sales (+2%), and administrative office functions (+2%) and lower wages in technical roles (-2%); there was no effect in "mechanical" (blue collar*)* operations.

In a second exception to the rule, Carneiro et al. (2006) found that although extraversion is not particularly important in determining grades or language and mathematics test results during in adulthood, it may be correlated with the decisions of young people who choose to remain in school longer. In the same study, the authors showed that measures of sociability at age 11 significantly predicted a person's chance of being employed in low-income positions. The impact of this attribute is even greater if the individual is more intelligent. Furthermore, the study indicated that as age increases, the impact of intelligence on employment decreases and the impact on pay

increases, whereas the impact of sociability (measured at age 11) remains constant throughout the life cycle.

Regarding health, studies also differ as to whether extraversion is necessarily desirable. Hampson et al. (2007) showed that first-graders who were assessed by teachers as extraverted were less likely to smoke and more likely to engage in physical activity in adulthood. In contrast, Hampson et al. (2010) concluded that young people with high sociability in high school did not smoke more but exhibited more frequent alcohol consumption.

Agreeableness

Characteristics such as aggressiveness, irritability,[27] availability, and affability are associated with agreeableness, which is believed to have a particular impact on group activities.

There is little evidence of a strong relationship between cooperativeness in adulthood and the highest level of education attained. Again, the previously mentioned issue of reverse causality is relevant here. However, Duncan and Magnusson (2010) found that aggressiveness in childhood is an important predictor of completion of high school. This finding suggests that this facet of agreeableness can play an important role in determining educational outcomes. Furthermore, throughout elementary school, there is a correlation between agreeableness and grades that is similar to that obtained for conscientiousness. However, unlike the latter effect, this correlation dissipates as the education cycle progresses (probably due to group homogenization).

Although agreeableness does not have a particularly strong effect on wages and productivity, there is evidence that more cooperative men tend to miss work less (Stömer and Fahr, 2010) and are less likely to become managers or business professionals (Cobb-Clark and Tan, 2009). However, the same effects do not occur for women.

However, the greatest impact of agreeableness manifests in the areas of health, criminality, and marital stability. More cooperative people live longer (Roberts et al., 2007) and better, i.e., they smoke less and exercise more (Hampson et al., 2007). Furthermore, agreeableness and conscientiousness emerge as the main attributes that determine the probability of juvenile delinquency (John et al., 1994). Additionally, with regard to the duration of marriage and the probability of divorce, agreeableness (and particularly aggressiveness) and emotional stability appear to be the main determining attributes.

Neuroticism and emotional stability

Before examining the role of neuroticism, we should recall that the inclusion of scales associated with various facets of this attribute in some of the more important American databases (in particular, scales for self-esteem and control over situations that determine success) has generated a comparatively large volume of studies that investigate the relationship of this attribute with several individual outcomes. Therefore, more associations have been identified between neuroticism and such outcomes, which might lead us to overestimate the relative importance of this attribute vis-à-vis the other Big Five attributes.

[27] Also associated with neuroticism.

Using broad measures of emotional stability, Stömer and Fahr (2010) estimated that one standard deviation more of this attribute is associated with a 12% reduction in absenteeism from work. Duckworth et al. (2011) also showed that this attribute is correlated with work performance at only a slightly lower level than intelligence.

People with higher levels of neuroticism tend to have shorter longevity.[28] Hampson et al. (2010) showed that children with greater hostility as measured in primary school were more likely to use marijuana, drink alcohol, and smoke cigarettes in high school.

Two measures often associated with emotional stability – self-esteem and the Rotter Locus of Control (which attempts to measure the extent to which people believe that success in their lives depends on their own decisions as opposed to chance) -- form the basis for a series of studies by Heckman et al. and other personality researchers. These studies take remarkable care in controlling for the problem of reverse causality and dynamic complementarities in examining the various individual attributes. In the work of Heckman et al., these measures (or the standard indices constructed from them) are used as summary statistics for a broad spectrum of non-cognitive attributes in contrast to measures of IQ (which are used as measures of cognitive attributes). These studies have illustrated that one standard deviation more in the Rotter Locus of Control is associated with an increase of approximately 1.5 percentage points in a student's chance of completing high school. This is especially true for men and for individuals in the lower tail of distribution of this measure. Cunha et al. (2010) also showed that people with higher levels of self-esteem and locus of control find it easier to increase their cognitive indicators, which yields important secondary effects on educational performance.

In other areas, the studies by Heckman et al. showed that the two scales above predicted salaries as accurately as intelligence did. Likewise, in a study that employed German data but used similar techniques, Pinger and Piatek (2010) estimated that if an individual moved from the lowest 10% on the Rotter scale to the highest 10%, his salary would increase by 36%. Gallo et al. (2003) also showed that people with better performance on this scale are more likely to be re-employed if they lose their jobs. Investigating the channels through which locus of control affects performance in the labor market, Caliendo et al. (2010) concluded that this scale is associated with more intensive searching for new positions and greater demands regarding working conditions (as indicated, for example, by the reservation wage, the lowest wage at which an employee will accept a post).

Heckman et al. (2006) showed that locus of control affects the likelihood of daily smoking, particularly for men with low perceived control. Conti and Heckman (2010) showed that self-esteem and locus of control as measured in adolescence are more important than intelligence in predicting depression and obesity at 30 years, particularly for men. Heckman et al. (2006) also found that these scales determine the risk of involvement in criminal activities; indeed, they have the same impact as measures of intelligence in this regard.

Finally, neuroticism and emotional stability appear to be the main characteristics that determine the duration of a marriage and the likelihood of divorce, far outperforming other attributes.

[28] Martin et al (2007), Kern and Friedman (2008), and Boyle et al (2005), among others.

4. The development of non-cognitive and cognitive attributes throughout the life cycle

The discussion of the evolution of personality attributes was polarized for a long period. Some researchers thought that personality attributes should be considered to be immutable individual characteristics because they perceived personality as something unique to each individual; otherwise, such attributes would cease to be intrinsically linked to individuality. Other scholars believed that people were born relatively similar and that all human behavior was largely explained by the personal history of the individual. These researchers suggested that measured personality traits and behaviors were not unique markers of individuality but were instead the result of processes arising from the experiences of each person.

The views that currently seem the most promising are not polarized in this way. First, there are two types of attribute stability: stability over the lifespan and stability across different situations at a given age. It is relatively easy to conceptualize changes in personality attributes over time as unique to each individual by suggesting that the evolutionary trajectory of each individual is unique rather than that each individual maintains unique, static levels of each trait. However, it is more difficult to understand why different scales designed to measure the same attribute may exhibit low correlations during the same period. Nevertheless, the models developed by Heckman and Roberts offer us a way to understand the role of both the innate characteristics of individuals (which may evolve over time) and the experiences and situations that the person may encounter at the time of measurement. Even if human behavior is not exclusively determined by personality attributes, the concept that such attributes have some relevance in determining behavior is sufficient for us to develop a definition of personality that retains the concept of uniqueness.

The evidence discussed in this section describes what might be called the 'typical' evolution of individual attributes in a given society. Typical evolution is understood to result only from biological or adaptive (ontogenetic) processes and/or from typical interactions with other members of society that involve cultural influences and the changing social roles that individuals encounter during their lives (sociogenic processes). Changes in personality attributes resulting from trauma and the results of the proactive behavior by individuals and families who decide to modify their attributes (e.g., changes that result from chemical treatments, investments in human capital, and therapy, among others) fall outside the scope of this analysis.

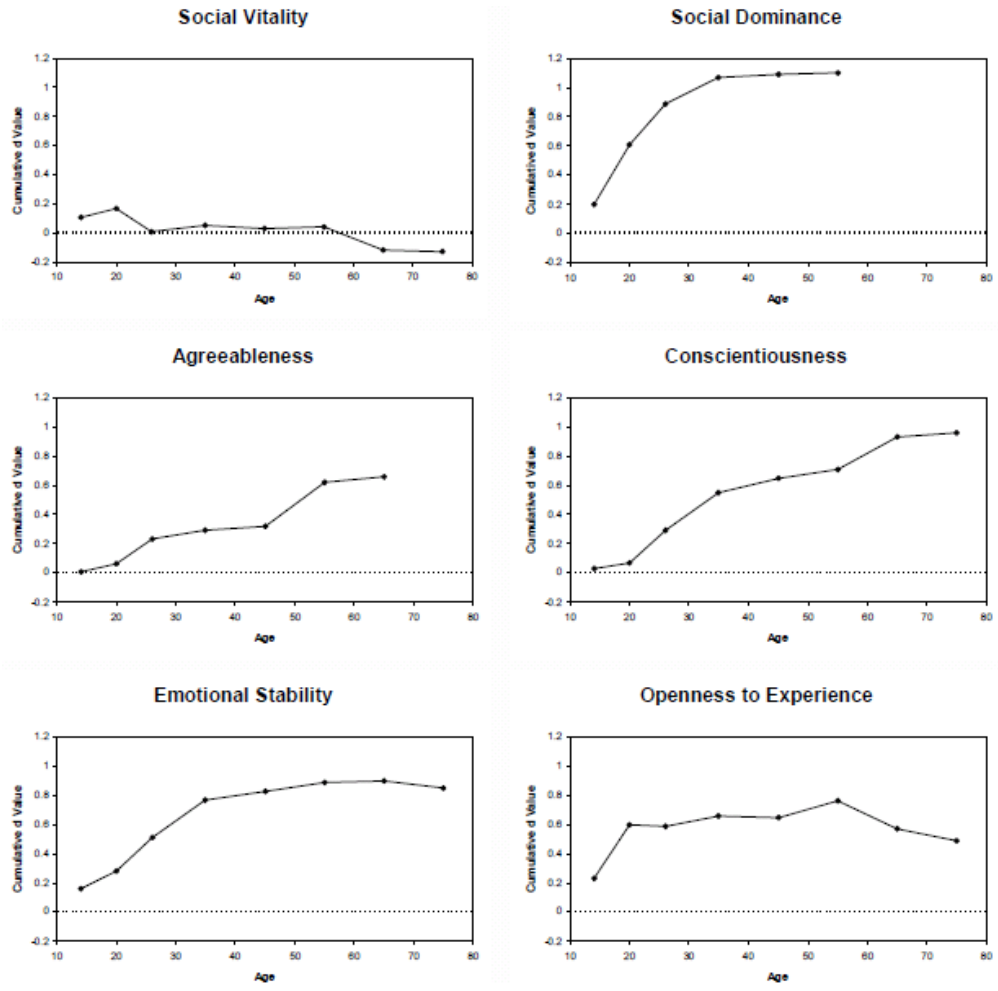
One challenge of characterizing the evolution of cognitive and non-cognitive attributes over time is that most of the measures derived from questionnaires (scales and inventories) have no default unit of measurement. If one wishes to describe the evolution of an individual's height, it is only necessary to use a ruler and to compare the number of inches over time; heights at different ages are comparable. If two questionnaires are distributed to individuals at different ages, the resulting scores are generally not directly comparable, but manipulations can be performed to facilitate such comparisons.[29] In some cases, attempts are made to standardize questionnaire scores so that statistical means can be compared across different age groups.

[29] For cognitive tests, it is common to use factor models or filters generated from item response theory (IRT). Some personality scales are considered to be non-specific with regard to age, and the same questionnaire can be reused with individuals over time (although this method may be compromised by

Methods of measuring the typical evolution of non-cognitive attributes include mean comparison (in which one first chooses a metric that is comparable across ages and then observes the evolution of the mean by age) and comparisons of the typical rankings for every age. Typically, attributes are malleable at some points but also crystallize during the life cycle. Some malleable phases are especially sensitive; at a particular age, an individual may undergo major changes in a particular area in a short span of time. Sensitive periods are typically those in which successful interventions tend to produce the greater effects and are therefore of great interest from a public policy standpoint.

Although there has been a great deal of evidence obtained for the human life cycle more generally, numerous articles focus on early childhood. This phase is unique because be child is malleable in almost all respects and because the study results tend to exhibit high variability both longitudinally and cross-sectionally. Thus, various tests and questionnaires have been specifically designed to measure attribute development in this phase.

Accumulated changes in mean personality levels during the life cycle



test-retest bias; individuals may learn how to respond and seek to provide the desired result, which may affect the quality of the responses).

Source: Roberts, Walton, and Vietchbauer (2006), as cited in Duckworth et al. (2011).
Notes: Extraversion in this figure is divided into social dominance and social vitality. The cumulative value of *d* represents the total change of the attribute in standard deviations from the first measurement.

The above figure is the product of a meta-analysis that was conducted by Roberts et al. (2006) and summarizes much of the work that has attempted to measure the evolution of personality attributes over time. Interestingly, four of the six dimensions listed are particularly malleable in early adulthood, including conscientiousness. Only social dominance and openness to experience are particularly malleable in adolescence. The evolution of personality attributes contrasts sharply with that of cognitive attributes, which tend to crystallize in early adolescence (see Duckworth et al., 2011). This contrast is important from a public policy standpoint because it suggests that only investments in the promotion of non-cognitive attributes can significantly affect well-being after a certain age (consistent with the popular adage "You can't teach an old dog new tricks"). Moreover, it is clear that several non-cognitive domains are still malleable during adulthood.

Psychological studies that sought to investigate the role of innate components (or those manifested in early infancy) and environmental factors in determining the heterogeneity observed in personality within a population have obtained the following results:

(i) Much of the variability in levels of attributes among individuals in the same cohort is explained by the levels of these attributes as measured early in life (which are sometimes interpreted as genetically determined).

(ii) The levels of attributes measured at the beginning of life have a strong hereditary component (approximately 50% according to Bouchard and Loehlin, 2001). The correlation between the attributes of parents and children is greater in the upper tail of the distribution.

(iii) Much of the variability in attributes explained by environmental factors (situations and experiences). However, theoretical models that seek to take neuroscience into account emphasize that some personality changes observed during the life cycle may be biologically programmed and therefore (at least partially) genetically determined.[30]

Working from another perspective in a seminal paper, Cunha et al. (2010) proposed a model of human capital accumulation[31] that was intended to structurally estimate an entire system of equations that, according to their theory, governs the development of cognitive and non-cognitive attributes throughout the life cycle. Due to its complexity, this empirical research is closest in terms of its level of generality to the research by

[30] The preference for risk in adolescence may be related to the restructuring of the brain's dopamine system, whereas the growing risk aversion during the prime of adulthood may be related to changes in the prefrontal cortex.

[31] In economics jargon, human capital is the set of characteristics that people exhibit at any given time and use to perform tasks (working or not) or actions (including socio-emotional tasks), which in turn generate results (producing either a screw or a smile, for example). *Investment in human capital* includes all resources dedicated to the development of the attributes that constitute *human capital*, whether material (e.g., a textbook), temporal (as in parents' time spent providing homework help, inculcating moral values in their children, or creating an environment in which their children feel comfortable), or otherwise. Economists in this field usually consider the terms "characteristics," "attributes," "talents," and "abilities" to be synonyms.

Roberts (2006) as described in the second section. In their model, Cunha et al. propose the existence of functions that describe the evolution of cognitive and non-cognitive skills. For example, in each period *t* of life, individuals with a certain level of cognitive and non-cognitive attributes, A^c_t *and* A^{nc}_t, receive investments from family and school, I_t, and are influenced by the environment in which they live, Z_t, which determines their levels of the various attributes in the next period, (A^c_t, A^{nc}_t). The model thus allows for the distinct influence of innate individual characteristics (A^c_0, A^{nc}_0) and that of environmental characteristics, incentives, and experiences (Z_t) at any time of life. The model also allows all of these attributes to vary over time, influencing each other in a process of simultaneous determination. Thus, the authors circumvent the debate among the Big Five supporters, behaviorists, and social-cognitive theorists, establishing the controversy as an empirical matter.[32] Interestingly, the model developed by Cunha et al (2010) is sufficiently flexible to allow people with higher levels of cognitive attributes to more easily accumulate non-cognitive skills and vice versa. In addition, the model allows investments made at different ages to produce different effects on the evolution of each attribute, consistent with the idea that there are sensitive periods during which certain attributes are more malleable. Among the key findings of the article are the following: (i) that there exist different sensitive ages ("windows of opportunity for cognitive attributes (which crystallize early) and non-cognitive attributes (which remain malleable for longer); (ii) that human capital investments that are made earlier not only are more productive but also increase the productivity of later investments (via dynamic complementarities, as previously explained); and (iii) that higher levels of non-cognitive attributes seem to facilitate the accumulation of cognitive skills but that the opposite does not necessarily occur. In other words, if we compare two individuals with identical initial levels of intelligence and similar life experiences who receive equal investment, we should find that those with higher levels of non-cognitive attributes will exhibit better cognitive skills in the next period. However, individuals who are identical in everything except for their cognitive characteristics will have approximately the same levels of non-cognitive skills in the next period. These results suggest that early investments are most effective in promoting all types of skills but are especially essential for cognitive skills which crystallize earlier. The findings also suggest that investment in non-cognitive attributes is useful even when the objective is only to promote cognitive development. Furthermore, the results suggest that human capital investments are justified even for young people with cognitive deficits after the crystallization phase for these attributes because non-cognitive attributes remain malleable into adulthood and are as important as cognitive attributes in determining individual success.

Finally, the importance of non-cognitive development in the process of cognitive development is well documented among neuroscientists and neuropsychologists. Baumeister et al. (2005) and Twenge et al. (2002) showed in controlled experiments that people with feelings of social exclusion exhibit impaired judgment, decision-making, attention, and persistence in the face of complex problems. Campbell et al.

[32] If those who suggest that personalities are innate and immutable are correct, A^{nc}_0 should be the only significant predictor of A^{nc}_t. If A^{nc}_t is completely determined by experience and by past and present situations, (A^c_0, A^{nc}_0) should not play an explanatory role, and if all supposedly non-cognitive development is actually a manifestation of cognitive processes, A^c_0 should play the central role in determining A^{nc}_t, and A^{nc}_0 should be irrelevant.

(2006) noted reduced activity in the prefrontal cortex among people with feelings of loneliness who were asked to solve math problems (which generally requires executive function). Arnstein (1998) and Cerqueira et al. (2007) found that the flow of dopamine and noradrenaline to the prefrontal cortex changed in people subjected to stressful situations, affecting executive function. There is also evidence that sleep helps the mind to summarize experiences and learning experienced during the day (Stickgold, 2009; Walker and Stickgold, 2010). To the extent that imbalances in non-cognitive attributes (such as emotional stability) affect sleep, such imbalances can impair learning.

5. Policies aimed at promoting non-cognitive development

There have been relatively few impact assessments of policies and programs that are intended to affect the rate of accumulation of human capital and its influence on the personality attributes of individuals. Such impact analyses have not attracted sufficient interest among psychologists, and economists, who traditionally conduct this type of research more often, have only recently begun to recognize the importance of non-cognitive aspects of human development and to attempt to understand and master measurement instruments that were developed mainly by psychologists. Of the relevant studies, most focus on small samples, which makes it relatively easy to obtain control and randomized treatment groups that are arguably similar in all ways except that one under consideration. The problem with these studies is that it may be difficult to replicate their findings in large-scale studies and that the former thus may not be very useful from a public policy perspective.

5.1. Preschool interventions

The most abundantly researched topic is the long-standing question of whether educational interventions focused on social or vulnerable groups of children improve trajectories of both the cognitive and non-cognitive development. Several programs of this type have had a positive effect on non-cognitive attributes. Interestingly, the most successful programs have a relatively temporary impact on cognitive attributes but a long-term effect on non-cognitive characteristics.

One of the programs that has been studied most often is the High Scope/Perry Preschool Project, begun in the American city of Ypsilanti, Michigan in 1962. The program was intended to provide high-quality early childhood education to a group of children who were considered to be at risk of developmental delays. To be eligible, the children had to have IQ scores below 85 at three years old, be of African-American descent, and come from low-income families. Among the main features of the program[33] are the following: (i) an innovative curriculum based on the children's interactions with the objects studied; (ii) a pre-established and predictable activities routine; (iii) a constructive learning environment; (iv) shared adult-child control of the choice of activities, intended to reveal the children's talents and stimulate their ability to solve problems; (v) the use of developmental indicators to monitor the children's progress; and (vi) specific conflict resolution procedures with well-defined stages.

Considered avant-garde when it began, the program was designed to be rigorously evaluated. At the outset, nearly 200 children who were eligible for the program were

[33] The formulators of the program define themselves as "Vygotskians" (i.e., as followers of León Vygotsky, the educator and psychologist), but several authors have classified them as "Piagetian" (i.e., as inspired by the work of Jean Piaget, the psychologist).

randomly assigned to a treatment group (58 children) and a control group (65 children), and both groups have been followed ever since (during the last interview process in 1999, the participants were approximately 40 years old). The success of the intervention rapidly became evident; the IQ of the treatment group was substantially higher than that of the controls only a short time after the intervention. The success of the program attracted the attention of educators worldwide, making High Scope a curricular model for pre-schools around the world, including in Brazil. Although the original program was implemented on a small scale, there have been some successful attempts to adapt the curriculum for public networks. The most successful is the Chicago Child-Parent Centers (CPC) in the city of Chicago, Illinois (U.S.). Among the main results of the program are the following:

- The participants had attained one year of additional schooling by the age of 27
- The participants exhibited an average 1.3-year reduction in the use of continuing special education services (for mental, emotional, phonoaudiological, and auditory deficits)
- They are less likely to have children outside of marriage (57% vs. 83%) and to experience early pregnancy (0.6 vs. 1.2 children/woman)
- They are less likely to be incarcerated (28% vs. 52%) or arrested for violent crimes (32% vs. 48%)
- They enjoy higher wages (approximately 40% higher in the treatment group)

In total, it is estimated that for every dollar spent on the program, at least 16 additional dollars were generated for society, and of this amount, seven dollars were generated through channels other than salary increases.[34] Because the IQ levels of the control and treatment groups became similar by the time they were 15 years of age (which emphasizes the temporary nature of the cognitive benefits obtained), it seems plausible that these excellent returns mainly result from improvements in individuals' non-cognitive attributes. In fact, indirect measures of personality were significantly affected by the program (e.g., the incidence of theft, lies and mistakes, and the use of profanity as reported by the elementary school teachers).

Several interventions similar to the Perry Project were subsequently evaluated, some yielding similar conclusions, though other studies were inconclusive. The Carolina Abecedarian Project (Chapel Hill, 1972) extended the Perry Preschool model for children from a few months old to five years old[35] and had similar effects on non-cognitive dimensions in addition to generating a permanent increase in the participants' IQ (with an annual rate of return for society of 3.4%, only one-third of which was attributable to earnings gains). In the STAR project conducted in Tennessee (U.S.), children were randomly assigned to classes of different sizes in kindergarten. As in the Perry Project, the cognitive benefits were ephemeral (i.e., they had disappeared by the eighth grade) but significant wage gains were obtained in adulthood, and there were significant improvements in behavior according to the participants' fourth- and eighth-grade teachers, who rated the students in terms of effort, initiative, interest in class, and

[34] The annual rate of return of the intervention can be interpreted as approximately 8%, which is high given that the average post-war return on the U.S. stock market is 5.8% per year and the return on government bonds is 1% pa).

[35] A significant change in the Abecedarian project was the generation of very small classes with student-teacher ratios ranging from 1:3 for newborns to 1:5 for five-year-olds.

inappropriate behavior. These facts suggest that the channels through which classroom size may have affected wages were in fact mainly effects on non-cognitive attributes.

5.2. Interventions specifically designed to influence non-cognitive attributes

Educational interventions designed to influence only non-cognitive aspects are more rare. One such program, PATHS[36] is a rigorously evaluated curriculum that promotes the principle that all feelings are acceptable but that not all behavior is acceptable as a response to these feelings. The program is integrated into curricula based on social-emotional learning. Students create representations of possible feelings ("feelings boxes") and outline possible responses, organizing the responses according to an a priori classification system including the categories "stop and calm down" (red), "go slow" (yellow), and "go ahead with your plan" (green). After events, students revisit their boxes and signs and reclassify particular attitudes according to the level of success obtained. The program yielded significant improvements in aggressiveness, prosocial behavior, and engagement in academic activities as well as improvements in grades.

Based on Vygotskian principles and neuroscientific evidence, the Tools of the Mind curriculum attempts to stimulate the development of executive function, which principally involves "inhibitory control" (i.e., the ability to inhibit instinctive, mimicked, or mechanical responses to certain impulses and situations and thereby to achieve the correct or most appropriate response), "working memory" (i.e., the ability to remember a list of possible responses to a given impulse or situation from which one is eventually chosen; our "menu" of possible reactions increases with age, especially during infancy), and "cognitive flexibility" (i.e., the ability to adapt the responses used in other contexts to the current situation or stimulus). This curriculum has also been evaluated in randomized trials and has in many cases contributed to the collective improvement of classroom environments; at an individual level, the curriculum has been successful in promoting executive function.

5.3. Interventions at older ages

Interventions at older ages are less common, but there is at least one example of a successful program designed to affect personality attributes in adolescence. In Portugal, the Businesses for Social Inclusion initiative (Empresários pela Inclusão Social - EPIS) devotes considerable effort to improving performance and reducing the dropout rates of students in the seventh and eighth grades,[37] identifying students at risk of delays, and directing them to sets of individualized activities in accordance with their respective difficulties. Many of the modules focus on promoting non-cognitive attributes and are facilitated by mediators (specialized professionals) in small groups or one-on-one.[38] Initially, the selected participants and their mediators establish performance goals and discuss what they wish to achieve. These meetings occur regularly[39] but are scheduled outside of school hours to avoid stigma. At the time of assessment (2010), 65 mediators funded by 90 large companies served between 50 and 100 students. A scientific

[36] Promoting Alternative Thinking Strategies.
[37] Individual interviews with psychologists and other specialists.
[38] The individual activities include motivational conversations and practice applying self-control and problem-solving techniques. In groups, students learn to study and to work in teams, to practice their social skills and self-control, and to control anxiety and excessive criticism of people.
[39] A maximum of 15 days.

committee assisted with the module design and offered suggestions to the supervisors and the senior members of the management team. In total, 10% of the country's students (approximately 15,000) participated in the program. The results (Martins, 2010) included a reduction in failure rates of 10 percentage points (with cumulative effects of 30 percentage points on the likelihood of one failing grade during basic education); in addition, the students' grades improved substantially, and the cost-benefit ratio was favorable. In another example of an effective intervention program for young people, the National Guard Youth Challenge program, which focused on teenagers who dropped out of school, provided 17 months of counseling and activities that emphasized motivation and discipline.[40] In an evaluation performed after nine months, participants exhibited a greater likelihood of having completed high school and of working full time; they were also less likely to be incarcerated and registered at higher levels on the self-efficacy scale (see nr 15).

Examples of programs that attempt to influence the non-cognitive attributes of adults are even more rare. Gottschalk (2005) evaluated the Self-Sufficiency Project (SSP), in which recipients were given subsidies in the form of unemployment insurance that were intended to help them obtain work. Again, the evaluation procedure involved a strict randomization procedure in which the eligible candidates were distributed into a treatment group and a control group. The study investigated the impact of the intervention on neuroticism and particularly on locus of control.[41] The authors found that the program had a positive overall impact on this facet of neuroticism and that this effect was heavily concentrated in workers under 30 years of age. In another study, Jackson et al. (2010) investigated whether a program intended to promote inductive reasoning in the elderly using games such as crosswords and Sudoku puzzles positively affected IQ and openness to experience. After 16 months, the authors found that compared with individuals on the waiting list, participants exhibited significantly better levels of openness to experience.

Studies that attempt to investigate the role of regular (and large-scale) education on non-cognitive development are generally less rigorous because of the difficulty of conducting randomized experiments and of modifying the design and incentives of the program to facilitate the measurement and interpretation of the impact achieved. Therefore, the results of such studies should be viewed with more caution.

Researchers have long debated the roles of the various types of interventions in human development beginning with early childhood education. Children up to age five develop rapidly across multiple dimensions, and in many cases, it is unclear whether the best way to contribute to this development process is to secure family care for the child or to leave him/her in the care of an early childhood educational institution for part of the day. According to many researchers, there is no single answer; instead, the answer depends on the nature of the family and of the school(s) to which the child has access. Institutions of this type in the U.S. fall into three major groups: (i) daycare centers (DCs) or other centers (usually run by churches and neighborhood associations) in

[40] The program began with two weeks of preparatory meetings and was followed by 20 weeks of residence, usually on a military base; the last part of the program involved one year of tutoring and counseling by a specialist.

[41] The scale measured the extent to which people believe that their individual successes depend only on their attitudes and actions as opposed to attributing them to fate and/or external agents (believing, in the latter case, that their locus of control lies outside them).

which an adult is available to meet the child's basic needs with regard to hygiene, sleep, and eating but that do not offer a general curriculum or specific stimulus activities; (ii) (pre-)kindergartens (K) or small schools with curricula and activities intended to stimulate development, commonly linked to elementary schools; and (iii) compensatory education (CE), in which in addition to the regular activities offered by a (pre-)kindergarten, there are also programs offered that teach parents how to care for their children, nurture them, and provide the resources necessary for their development. This framework can be used to categorize the different programs and schools throughout the world. For children of younger ages, daycare centers are most common, although such institutions are rapidly losing ground to prekindergartens.[42] International evidence indicates the rather heterogeneous impacts of these different types of intervention, with the first (DC) generally exhibiting worse results than the second (K) and the latter performing equally well or more poorly (for children in vulnerable groups) than the third (CE). Sociability and aggressiveness are dimensions that many believe educational institutions can improve better than families. Educational institutions require children to socialize with each other, thereby forcing them to learn how to interact with one another. Interestingly, several studies suggest that a negative relationship exists between day care attendance (although such programs are the norm) and indicators of aggressiveness. This finding is worrisome because, as we discussed in the previous section, aggressiveness negatively affects one's position in the labor market, marital stability, and involvement in criminal and/or violent activities (Sternberg et al., 1991, demonstrate this finding for Sweden; Varin et al., 1994, for Italy; Borge and Melhuish, 1995, for Norway; and Baydar and Brooks-Gunn, 1991, for the U.S.). We might speculate, however, that these results do not necessarily result from a long-term negative effect of attendance at day care but instead stem from the natural aggressiveness of children beginning to make contact with their peers. Supporting this interpretation, Urzúa and Noboa-Hidalgo (2010) showed in a rigorous longitudinal study using Chilean data that although there is evidence of the adverse effects of public childcare centers on various indicators immediately after treatment, participants in this type of program perform better in terms of virtually all dimensions of development in the long run.[43] (In this case, these dimensions include intelligence, both logic and verbal; aggressiveness and socialization; motor skills; and physical development.) Other studies have shown that any adverse effects – even short-term ones – disappear if the school meets certain minimum quality standards (Howes and Olenick, 1986 and Howes et al., 1992).

Using a structural model with longitudinal data for American citizens, Heckman et al. (2006) investigated whether formal education fundamentally influences cognitive and non-cognitive development. The results indicated a significant, high-magnitude impact on multidimensional tests of intelligence,[44] especially at the end of high school,

[42] For example, in Brazil, LDB (1996) initiated a reform process for public day care centers that made them more educational and focused on development. A fast-paced transformation has occurred in which the management of child care has been transitioned from the Department of Social Welfare to the Department of Education. Now, a formal curriculum is provided by the Ministry and Department of Education, and the day care centers are officially included in the education system and are among the programs that receive funding intended to promote education, e.g., through the FUNDEB program.

[43] The only exception occurs in interactions with adults.

[44] Arithmetic reasoning, vocabulary, reading comprehension, mathematics knowledge, and planning speed.

and an even greater impact on self-esteem and on the participants' internal locus of control. For self-esteem, it is basic education that is the most influential; there is little effect after that period. For locus of control, the impact is greater and increases with the participant's educational level.

In examining the influence of the family, it is difficult to separate the effect of parental attitudes from that of inherited characteristics. Parents who are more intelligent, who are more emotionally stable, who are more open to experience, and who exhibit other desirable characteristics are more likely to take a pro-development attitude, and it is not possible to use observational data to determine whether the positive correlation between such attitudes and child development is the result of the attitudes themselves or of the simple transmission of this set of characteristics to the children of such individuals.[45] The studies that attempt to isolate the effect of parental attitudes compare orphans who were adopted by parents with different characteristics and attitudes. Duyme et al. (1999) followed children with low IQs who were adopted between the ages of four and six by different types of parents. In adolescence, those who grew up in households with low socio-economic status gained 9% or more, whereas those who grew up in households with higher socio-economic status improved 2.5 times more. In a famous study of Romanian orphans who had suffered hardships, Becket et al. (2006) showed that children adopted before the age of six months exhibited dramatic gains in IQ but that those who were adopted later exhibited a permanent deficit of 15 points, which was considered to be a high impact. Interestingly, after six months, significant differences between children based on their age at the time of adoption could not be detected. This finding reinforced the idea that there exists an early window of opportunity in which most cognitive skills are formed.

Recently, considerable attention has been paid to the role of computers in children's lives and to their impact on personality. Some scholars argue that the computers facilitate meetings with new people and socialization and that they operate interactively, which helps children to develop their cognitive skills and the ability to solve problems. In contrast, some argue that time spent at the computer competes with other forms of interaction, yielding potentially adverse effects on sociability and neuroticism. Rueda et al. (2005) showed that children ages four to six years who underwent exercises designed to improve their attention showed improved performance on tasks requiring attention as compared to children who simply watched interactive videos on the same topic for the same amount of time. Stevens et al. (2008) showed that a six-week intervention program involving exercises on a computer increased the capacity for auditory attention. Fiorini (2010) also showed that the household use of a computer between the ages of four and seven improves performance on cognitive tests and that this impact is especially pronounced when the computer is used during weekends.[46] Regarding non-cognitive traits, the author obtained mixed results: in promoting prosocial attitudes, computer use was beneficial for children between four and five years of age (especially for the daughters of mothers with higher education levels), but it was detrimental for children from six to seven years of age. In promoting the formation of friendships, the

[45] See the nature vs. nurture debate, which has implications for many areas of knowledge.

[46] The authors argue that during the week, the computer replaces other activities that are potentially stimulating from a cognitive point of view, whereas on the weekend, the computer replaces pure leisure activities. Furthermore, because of parent participation, the software used on the weekends may be more educational in nature than that used during the week. The data are from Australia.

effect was negative between six and seven years of age, especially when computers were used during the weekends. Significant effects on other dimensions were not found.

6. Conclusions

The aim of this paper was to summarize the theories and empirical evidence related to the role of non-cognitive attributes in determining the levels of well-being of individuals and society. Most of the discussion cited herein has emerged from and developed predominantly within the psychological community, which is concerned with explaining the behavioral differences among individuals but which does not particularly emphasize the consequences of these differences on educational performance, participation in the labor market, or quality of life and of family life. Recently, economists, neuroscientists, educators, and psychologists, aided by important methodological developments in their areas and by the increased availability of data, have devoted increasing attention to this topic.

In the present context, we know that non-cognitive attributes as a whole contribute approximately as much as cognitive aspects to academic achievement as measured by grades, dropout rates, and education levels achieved. Non-cognitive characteristics are also rewarded in the labor market in the form of higher wages and shorter periods of unemployment. Although the average impact of non-cognitive attributes is roughly the same as that of cognitive attributes in defining salary levels, for example, the importance of non-cognitive skills is evident in all professions. In contrast, the significance of cognitive skills decreases with the complexity of the task required. In both cases, conscientiousness, which includes responsibility, discipline, and perseverance, seems to be the most relevant. In the other investigated dimensions (health, involvement in illegal activities, instances of violence, and marital stability), the role of non-cognitive attributes surpasses that of abstract intelligence, providing higher levels of satisfaction.

Understanding how non-cognitive attributes are formed and to what extent the state can modify these developmental trajectories through public policy is as important as establishing the relevance of these attributes in our lives. The most helpful studies have shown that both cognitive and non-cognitive skills are most easily influenced during particular ages and life stages and thus that the interventions designed to promote them may be most effective during specific times. Overall, studies show that intelligence and analytic capabilities develop very early, whereas non-cognitive characteristics remain malleable during adolescence and even during adulthood. These findings are especially important because they justify continued investment in the education of people with significant cognitive deficits even after the period in which cognition typically stabilizes (given the strong indications that school makes an equally important contribution to cognitive and non-cognitive development). Moreover, research on subjects with some high school education in the U.S. suggests that learning inside and outside school can yield similar IQ levels (when one compares individuals who obtained their high school diplomas through high school with others who underwent equivalence examinations). However, levels of certain attributes, such as self-esteem and perceived locus of control[47] (which are considered to be fundamental to professional and personal success) proved to be very different for people who completed their formal education and those

[47] This element measures the level of an individual's confidence that success depends only on himself and not on chance, family origin, or socio-economic status.

who obtained equivalent degrees. In another set of studies, several interventions to rehabilitate children with cognitive and non-cognitive deficits or children from vulnerable social groups indicated that a good school can do much to reduce both deficits. However, these studies also indicated that to obtain a lasting effect that results in improvements in adult well-being, school quality must remain steady throughout the whole education cycle and thereby influence cognitive development. Nevertheless, in many cases, attending a good school for only a few years had persistent results in non-cognitive dimensions.

In addition to demonstrating the existence of "windows of opportunity," or ages at which attributes are malleable, recent studies[48] indicated that there are many complementarities at work in the development process for of cognitive and non-cognitive abilities. First, an investment in child development, whether through school or family, produces better results when performed at an early age, when most attributes are still malleable. Moreover, the return on investment at later ages is greater when the initial investment is greater and is made at a younger age. This finding reveals the effect of dynamic complementarities on this type of investment and the importance of investment during early infancy. Second, among children at the same initial cognitive level, better non-cognitive skills generate better cognitive improvement. Interestingly, the opposite has not been proven; children at the same initial non-cognitive level will not experience better non-cognitive improvements based on their level of cognition. These facts show that the attention paid to non-cognitive development is justified even if the ultimate aim is to raise cognitive levels. It should be noted that although the study considered here was relatively rigorous, more evidence must be generated before these findings can be generalizable.

Despite the attention that is currently devoted to this topic, this paper also reveals many gaps in our knowledge that need to be filled if public policies, especially within education, are to become more effective for more individuals. The first problem is the difficulty of measuring both cognitive and non-cognitive personality attributes. The existing measures are based on questionnaires or interactive tasks. Although these methods are designed to measure single attributes (or limited sets of attributes), the participants' responses are affected by all of their characteristics. Even the results of IQ tests are in part determined by motivation, discipline, and other non-cognitive attributes. One problem that remains without a definitive solution is how to filter a set of responses influenced by multiple characteristics to measure a single characteristic. A second methodological problem is the relative scarcity of longitudinal data for particular individuals from long periods. (As previously mentioned, the increased availability of this type of data is partly responsible for the recent boom in research on the subject, but such data are still scarce and are only available for a few countries.) Human development is an inherently dynamic process, and current interventions and episodes may only have a future impact. Alternatively, the opposite can occur, with a significant immediate impact that disappears over time. For both reasons, the relevant findings should be viewed with caution either because results are not yet fully measured or because their validity in a given society may not necessarily be mirrored in other contexts. Both problems exist for both cognitive and non-cognitive attributes.

[48] Cunha et al. (2010).

In addition to the methodological problems cited, there is an unfilled gap in the existing research. Important contributions have been made by economists (through impact assessments) and neuroscientists focused on early infancy and childhood, a period of intense malleability of individual characteristics. However, the former often estimate the average impact of interventions and episodes on individuals' future outcomes without detailing the mechanisms through which the interventions made an impact. Observations of the latter type are necessary to characterize biological development and the connections between this development and personality development, which are still unclear. In both cases, there appears to be a strong relationship between the findings and the effective formation of cognitive and non-cognitive attributes, but this link is tenuous. Psychology requires closer links between theories of human development and empirical results. For instance, the five major domains of personality (the Big Five), which have inspired a significant volume of research, were obtained empirically without a theory that explained why these were the relevant domains or why they should be the only domains to be investigated. (Indeed, the suspicion remains that they appear relevant only because they are the domains that can be measured).

In short, this review suggests that there are at least some non-cognitive dimensions among the main determinants of individual success. This suggestion alone means that such dimensions warrant at least as much attention as is traditionally afforded to cognitive skills. At least one channel of intervention – education policy and compensatory education – has already demonstrated its effectiveness in promoting non-cognitive development, which in turn has proven to be responsible for at least half of the benefits resulting from such intervention. Methodological improvements, data availability, and further studies in this area will be necessary to confirm and generalize the findings so that the mechanisms by which non-cognitive attributes develop and are influenced by intervention can be more fully understood. Such advances, in turn, will lead to more effective investments intended to promote these attributes.

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