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AN INTERDISCIPLINARY ANALYSIS OF BEHAVIORAL GENETICS: Bridging Philosophy and Science

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Abstract

This thesis examines the historical but ongoing nature vs. nurture debate, tracing its roots from ancient Greek philosophy through the latest advancements in behavioral genetics. From a philosophical perspective, it examines the interplay between genetics and environment in shaping human behavior, analyzing the conceptual foundations, methodologies, and findings of behavioral genetics. This work also considers how research in behavior genetics, which aims to explore the constitutive forces of nature and nurture, is constructed interdisciplinarily, highlighting the epistemological challenges of understanding the development of human psychological differences. By integrating insights from various disciplines, this work aims to connect science with philosophy to enhance the conceptual clarity of behavioral genetics and demonstrate its relevance to broader philosophical and scientific discussions.

Keywords: Behavioral Genetics, Philosophy of Science, Philosophy of Biology, Nurture vs Nature

Resumo

Esta dissertação examina a histórica e contínua discussão sobre natureza versus criação (*nature vs nature* debate), examinando suas raízes desde a filosofia grega antiga até os mais recentes avanços em genética comportamental. De uma perspectiva filosófica, o presente trabalho examina a interação entre genética e ambiente na formação do comportamento humano, analisando os fundamentos conceituais, as metodologias e as descobertas da genética comportamental. Este trabalho considera que a pesquisa em genética comportamental, que visa explorar as forças constitutivas da natureza e criação, é construída de forma interdisciplinar, destacando os desafios epistemológicos de entender o desenvolvimento das diferenças psicológicas humanas. Ao integrar insights de várias disciplinas, essa dissertação visa conectar a ciência com a filosofia para aprimorar a clareza conceitual da genética comportamental e demonstrar sua relevância para discussões filosóficas, científicas e sociais

Palavras-chave: Genética Comportamental; Filosofia da Ciência; Filosofia da Biologia, *Nature vs Nurture*

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Introduction

Background and Significance

In the first chapter of this thesis, we initiate an exploration of the foundational philosophical theme that underlies all of the questions addressed by behavioral genetics: the nurture vs. nature debate. The chapter begins with a panoramic view of the historic and philosophical origins of this long-lasting opposition. We analyze how the nature vs. nurture dispute manifests itself in various scientific disciplines, being a background theme that permeates different realms of human endeavor and scientific research.

Importantly, the presence of this dispute is sometimes implicit and often not obvious to detect, especially if one does not compare scientific traditions in a historical and panoramic way. One of the main ideas that will be advanced is that the nurture vs. nature debate, while extremely pertinent to scientific discussion, is a dispute extremely sensitive to political shifts. Any political view, as we will see, is predicated on a conception of human nature, and on how this nature is malleable to the influences of the environment. As a conclusion to the first chapter, following philosopher Jesse Prinz' suggestion, we summarize this debate into three distinct aspects, identifying and analyzing themes that have intrigued scholars from ancient philosophers to contemporary thinkers.

In the second chapter, transitioning into a much more technical realm, we explore the notion of heritability – a key concept in behavioral genetics – shedding light on important limitations of this measure, especially those highlighted by Turkheimer in his works about the heritability of general cognitive ability (IQ). The work then continues with a presentation of the contemporary methodologies employed in behavioral genetics research. To do so, we delve particularly into twin and adoption studies, examining their respective roles in trying to disentangle the constitutive forces of genetics and environment. This endeavor will also cover the current methodological controversies in behavioral genetics, which highlight certain considerations we should bear in mind regarding its research outcomes. Finally, this chapter ends with a scrutiny of the major replicated findings (also known as "Big Findings") in the domain of behavioral genetics, which lay the groundwork for a better understanding of the dynamics between genetic constitution and behavioral

outcomes. To the extent that it fulfills these examinations, the second chapter lays the foundation for a holistic investigation into the philosophical implications and complexities of behavioral genetics to be explored in the following chapter.

In the third and final chapter, we shift our attention to the epistemic implications arising from the intersection between the previously examined behavioral genetics' findings and the scientific and philosophical knowledge, considered in a broad sense. The exploration touches on the complexities of the notion of causality in human psychological traits and behavior, aided by the philosophical perspective of Emergentism. The philosophical viewpoint serves as a valuable tool to better understand the intricate dynamic of genetic and environmental influences on human behavior. Furthermore, this exploration also extends into how the seminal ideas of Darwin illuminate the relationship between genetics and evolution and how they are indispensable for a comprehension of the fundamental aspects of our being.

Amidst these interdisciplinary explorations, we include, with special attention, the discussion about emerging models in psychopathology, exploring the dynamic interplay between genetics, environment, and mental health conditions. Summarizing, the last chapter delves into epistemic implications of the most important findings of behavioral genetics, showing that they permeate several realms of human knowledge: cognitive science, evolutionary theory, social sciences, and psychopathology. It aims, with the assistance of philosophy, to better understand the interplay between genetics, behavior, and the broader fabric of human development and existence.

As our final remarks, we make a brief retrospective summarization that encapsulates the key insights obtained throughout this interdisciplinary and philosophical exploration of behavioral genetics. This begins with a condensation of findings, distilling the essence of behavioral genetics insights on the intricate interplay between genetics, environment, and behavior that has unfolded in the preceding chapters.

In the final word, we comment on the value of approaching the scientific and philosophical perspectives on the investigation of reality. The constant and fast evolution of genetics, aided by the deepening of our philosophical and scientific insights, means an unparalleled perspective of scientific discovery and understanding. The conclusion of this thesis marks a juncture where philosophical

inquiry and empirical study can converge, emphasizing the crucial importance of interdisciplinary engagement in the pursuit of comprehending human behavior.

Research Questions and Objectives

Research Questions:

(1) How can interdisciplinary engagement between philosophy and science, circumscribed to the field of behavioral genetics, help us identify the epistemological challenges associated with studying the interaction between genetics and environment?

(2) How have research methodologies that aim to disentangle nurture and nature, particularly twin and adoption studies, evolved in the field of behavioral genetics, and what methodological controversies have arisen?

(3) To what extent this knowledge can contribute to the development of a framework that guides theoretically sound and effective interventions in the fields influenced by behavioral genetics research?

(4) What epistemological challenges arise from the complexities of causality and Emergence in the context of behavioral genetics, and how can philosophical insights contribute to addressing these challenges?

(5) How does behavioral genetics research intersect with Darwinian evolutionary theories, and how does it inform philosophical discussions on human nature and identity?

Research Objectives:

The primary objective of this interdisciplinary thesis is to comprehensively investigate the conceptual foundations, methodologies, and epistemic implications of behavioral genetics, fostering a holistic understanding of the interplay between genetics, environment, and human behavior. The thesis aspires to:

(1) Provide a comprehensive historical overview of the nature vs. nurture debate and its philosophical foundations, contextualizing the emergence of behavioral genetics as a scientific discipline;

(2) Analyze the progression of research methodologies in behavioral genetics, focusing on twin and adoption studies, while addressing the methodological controversies that have emerged;

(3) Investigate the epistemological challenges posed by the complexity of causality and reductionism in the study of human behavior, while exploring how philosophical insights can enrich scientific understanding; and

(4) Assess the implications of behavioral genetics research in diverse fields — especially in psychiatry and clinical psychology — highlighting the importance of philosophy to better grasp the meaning of behavior genetics findings in such fields.

Chapter 1: The Nature Versus Nurture Debate

The fundamental issue that underlies every question that this thesis addresses — the *nature vs. nurture debate* — has an extensive history that reaches back to ancient Greece. It concerns the extent to which the development of human phenotype[1], especially of mental traits, can be attributed to biological constitution (nature) or environmental factors (nurture). This discussion has persisted for millennia; recent advances in the empirical field of *behavioral genetics*, however, have provided new insights that could have important philosophical implications about how we think about ourselves and the roots of our differences. In the next chapter, we will explore some of the major advancements in this discussion, which are largely due to the unprecedented investigative benefits delivered by recent developments in molecular genetics. Nevertheless, attention to an historical perspective of the discussion, especially for this thesis's philosophical purposes, is essential.

To accomplish this, the chapter begins with a historical overview of the nature versus nurture debate. The primary goal of the subsequent discussion is to uncover and elucidate the widespread, but also sometimes subtle and implicit, influence of the nature vs. nurture debate, demonstrating its pervasive impact across diverse fields of scientific research and human endeavor. Then, to summarize what has been examined, the concluding section of this chapter outlines the three major theoretical disputes that can be identified as the essential aspects of the nature vs. nurture debate.

1.1 A Brief Overview of the Nature versus Nurture Debate

The nature vs. nurture debate has been an extensive philosophical discussion that attracted many scholars since ancient Greece. Since its beginning, the debate has been about the fundamental question of whether human character was primarily shaped by nature (innate constitution) or nurture (environmental influences). Extremely influential philosophers such as Plato argued that individuals possessed

[1] "Phenotype" refers to observable characteristics or traits of an organism, resulting from the interaction of its genetic makeup (genotype) with the environment. In the context of mental traits, phenotype encompasses psychological characteristics such as personality traits, behavioral dispositions, and cognitive abilities, which, as we will uncover, arise from the complex interplay between an individual's genetic constitution and their environmental influences.

many inherent qualities, suggesting a nativist perspective; Aristotle, on the other hand, proposed that external experiences and education played the key role in shaping human behavior. This is an early instance of the nature vs nurture debate. As we will discuss throughout this thesis, this ancient divergence of viewpoints laid the foundation for a centuries-long exploration of the complex interplay between nature and nurture in shaping human behavior (Prinz, 2012).

Throughout all of its history, the nature vs. nurture debate evolved and resurfaced at different moments, and each generation of thinkers added new perspectives to the discussion. During the Enlightenment era, for instance, the philosopher John Locke emphasized the role of experience and environment in shaping the individual, contending that the mind was a "blank slate" or "tabula rasa" (Locke, 1689); conversely, Jean-Jacques Rousseau argued for a more innatist view, proposing that humans were naturally good but corrupted by certain societal influences (Rousseau, 1762). Every time they emerged, these contrasting perspectives stimulated the philosophical attempt to understand the dynamic between innate predispositions and environmental interactions in human behavior.

Crucially, in the modern era, the nature vs. nurture debate was hugely affected by the advent of behavioral genetics. This new development, along with its important philosophical implications, will be the main issues addressed in the second and third chapters of this thesis. As will become apparent, the emergence of twin and adoption studies in the mid-20th century offered a novel approach to what is referred to as the *disentanglement* of genetic and environmental factors (Plomin, 2018). This tradition of research builds upon the work conducted by pioneers like Francis Galton, who explored the heritability of many traits and behaviors, contributing to a body of compelling evidence supporting the importance of genetic factors in shaping human characteristics (Galton, 1869).

The first chapter will function as a philosophical introduction to the exploration of behavior genetics. It will walk us through important philosophical insights that can be abstracted from an historical analysis of the nature vs. nurture debate, particularly in the 20th century. These insights will then maximize our ability to grasp the productions of Behavior Genetics as valuable material for philosophical inquiry and discussion.

1.1.1 Philosophical Pertinence

Before initiating with our investigation, a question that lurks in the background must be attended: why does the *nature vs. nurture* dispute remain as a relevant philosophical issue? Nowadays, after all, stating that our characteristics are shaped by both nature and nurture may strike some of us as a truism. It is easy to observe the widespread scientific stance of assuming that both nature and nurture are relevant to our development (Prinz, 2012).

Aside from any findings from behavioral genetics, empirical research drawn from other fields had already demonstrated that this is the case. It is well documented in the field of biology, for instance, the fact that even the most basic organisms are capable of learning and therefore do not act determined by genetic constitution alone (Sapolsky, 2017). Tiny, microscopic creatures can learn fundamentally in the same sense as we do, even if they do so in extremely rudimentary ways. They can learn, for example, the right places to search for food, showing preferences for environments with certain chemical characteristics that become associated with the presence of nutrients (Rankin, 2004). So, even if the preference for food of these microorganisms is genetically determined, the activity of pursuing it can undoubtedly be shaped by learning.

When faced by examples such as this one, it may seem to us that there is no sense in asking if we are a product of nature or nurture: a simple reflection on basic biology should inform us that the correct answer is both. What happens, unmistakably, must be a combination of genetic constitution and the influence of the environment. So, taking this into consideration, if in contemporary science there is a consensus about the mutual and indissociable role of nature and nurture, why should we still bother about this issue in a philosophical sense?

Firstly, this issue preserves its relevance, as philosopher Jesse Prinz (2012) notices, because between the extremes of nurture and nature there is an enormous spectrum of possibilities. And, crucially, for each point at this continuum, one can conceive of radically different philosophical and practical implications. So, even if in the scientific community there is a consensus that the process of human development lies not in the poles of learning or innatism but in between them, the strong philosophical dispute associated with the debate still persists (Paris, 2022).

Furthermore, recent research on behavioral genetics reveals that the nature of the interplay between genetic constitution and environment is much more complex

than one might initially assume. As we will elaborate in the second chapter, the notion of Gene-Environment Interplay, provided by behavioral genetics to understand it, is of great value for philosophical reflection.

But to really grasp the fundamental philosophical importance of the nature vs. nurture debate, we must understand *how* it permeates a great number of scientific disciplines. This will later prompt us to see nurture vs. nature debate as something that cannot be settled entirely inside the scope of a given scientific discipline; instead, a great chunk of the nature vs. nurture debate is implicit as a set of presuppositions that, in various scientific fields, organize the research itself (Prinz, 2012; Paris, 2022).

1.2 The Nurture vs. Nature Debate Across Various Disciplines

The nature vs. nurture debate is a theoretical dispute that permeates various scientific disciplines (Paris, 2022). As already suggested by the few historical examples presented so far, there is no shortage of instances where it emerges as an explicit form of contention. More frequently, however, the debate exists as a set of underlying presuppositions that orient different realms of human endeavor and research (Prinz, 2012). In this sense, the presence of the debate — implicit in scientific theories and human activities — is broader in scope but also less straightforward to detect (Paris, 2022).

This difficulty to grasp the essence of the nature vs. nurture debate is heightened when scientific disciplines are not examined from a historic, panoramic perspective (Prinz, 2012). As philosopher of science Thomas Kuhn (1962) has argued, an image of science derived without regard for historical context is bound to be both incomplete and misleading to us. History enables us to observe the evolution of scientific paradigms over time and their contrasts with one another in a way that would be impossible otherwise (Kuhn, 1962). Crucially, as observed by Jesse Prinz (2012), the historical pattern of the nature vs. nurture debate over time appears to be more influenced by political intentions than by empirical evidence alone.

1.2.1 Nurture vs. Nature in Psychology

Among the various scientific disciplines it permeates, the nature vs. nurture debate, not surprisingly, is a particularly relevant theme in psychology (Paris, 2022). To examine how this debate manifested in the history of psychology, our focus will be directed to two extremely influential but radically different scientific paradigms in

psychology: psychoanalysis and behaviorism. We will notice that, despite their extremely divergent theoretical foundations, these paradigms share a key commonality from the nature vs. nurture debate standpoint. Both are, if considered from a contemporary perspective, nurturist traditions (Harris, 1998; Bloom, 2023). This means that they both place experience as the central factor in promoting individual differences. This exploration will briefly describe the particular characteristics and ideas of each paradigm, while, on the other hand, noticing how they share their emphasis on environmental factors shaping human behavior. Let us initiate this endeavor with psychoanalysis.

To grasp the magnitude of the cultural impact of psychoanalysis, it is worth to remember, as psychologist Paul Bloom (2023) remarks, that there is no psychologist more famous than Sigmund Freud. Freud was a neurologist born in the middle of the 19th century, who spent most of his life in Vienna. He was the eminent figure behind a method of investigation and treatment of mental conditions called psychoanalysis. His extremely influential ideas are likely familiar to us: the existence of the unconscious; the possibility to access to contents of this unconscious mind through the interpretation of dreams; or the idea that certain unconscious tendencies manifest themselves in jokes, writing or speech errors (Bloom, 2023).

But what is most pertinent, regarding the problems considered in this thesis, is Freud's development of a deeply influential developmental theory. His theory was formulated to explain the reasons behind individuals developing mental illnesses and certain psychological tendencies. These ideas, since their inception by Freud nearly a century ago, have become profoundly entrenched in Western culture (Bloom, 2023).

Freud proposed several developmental stages in psychoanalysis, each predominantly associated with certain body parts and their sexual investment by children. He advanced the idea that certain experiences during these stages could lead to an individual becoming psychologically fixated at a certain stage. This concept of fixation, as Freud himself termed it, could play a crucial role in understanding one's later psychological development. According to his theory, an individual fixated at a particular developmental stage would, influenced by unconscious motivations and mechanisms, seek pleasure and relief in ways reminiscent of that earlier life period. These ideas were unparalleled in their influence to the realm of psychotherapy and in general western culture (Bloom, 2023).

But what concerns us the most is the fact that this model of psychological development is, by contemporary standards, considered a nurturist one (Paris, 2022). This is due to the model's almost exclusive focus on the experiential factors shaping personality and psychopathology. Something experienced, rather than something inborn, would be the key to understanding the diversity in psychological characteristics. In other words, Freud's approach sought explanations in the different instances of experiences, rather than in innate, natural differences between individuals (Harris, 1998).

With this knowledge at hand, we can more effectively explore the previously mentioned implicit nature of the nature vs. nurture debate. Nowadays, for the reasons just presented, the psychoanalytical model of psychological development can be labeled as "nurturist". But this is only due to the readiness with which it contrasts with other contemporary theories or models that emphasize innate dispositions as significant in driving individual differences (Prinz, 2012).

For a trained and committed psychoanalyst, particularly in Freud's time, the dichotomy of nature versus nurture as it is understood today would not have been an issue. The debate over the relative importance of innate versus environmental factors was not explicitly addressed in Freud's writings (Harris, 1998). It is the absence of focus on innate differences in Freud's approach that indicates to us that the complexities of human psychology were assumed to be adequately addressed just by looking into environmental influences (Paris, 2022). In other words, the centrality of environmental experiences in shaping psychological traits was an implicit presupposition of his model, not an explicitly formulated hypothesis to be empirically sustained or challenged (Harris, 1998).

Another way to put it is that an early psychoanalyst focused on *how* specific experiences of children with their parents — such as the dynamics of the Oedipus Complex — would shape their psychological differences, particularly in cases of clinical psychopathology. However, the question of *if* this specific set of factors was sufficient to understand such issues was not itself considered. As we will explore in detail in the following chapter, there is compelling evidence from behavior genetics suggesting that this presupposition kept the psychoanalytic paradigm theoretically limited in highly problematic ways. And just the same observation can be made regarding behaviorism.

Continuing from the earlier discussion about psychoanalysis and its nurturist aspects (i.e. its almost complete interest in environmental occurrences rather than innate differences), we now turn our attention to behaviorism, which is another extremely influential school in psychology. Some of the most essential ideas of Behaviorism do exemplify the nurturists notions prevalent in 20th century psychology (Paris 2022). One of the key figures in behaviorism, especially during the mid-twentieth century, was B. F. Skinner. His influence on western thinking was wide: in terms of his influence, he was often considered the American equivalent of Freud. He brought a distinct and highly influential approach to the understanding of human behavior (Bloom, 2023).

Born in 1904, he achieved a very high level of fame and academic recognition for a scientist of his time. But Skinner's approach in psychology was, in many ways, the very antithesis of Freud's. Unlike Freud, who was largely the originator of psychoanalytic theory, Skinner entered a field where the groundwork of behaviorism had already been laid by eminent psychologists such as Ivan Pavlov, John Watson, and Edward Thorndike (Bloom, 2023). While Freud was the pioneer of psychoanalytic thought, Skinner expanded the established principles and epistemological precepts of behaviorism to the scientific community and the general public.

As just discussed, Freud's work delved into the complexities of the unconscious mind, interpreting dreams and slips of tongue or writing to access hidden psychological truths. In a strikingly sharp contrast, Skinner focused completely on the observable and measurable aspects of behavior. A notorious epistemological assumption of behaviorism was that the mind — by its own abstract nature and subjective access — could not be taken as an object of scientific scrutiny. He sought, therefore, to strip psychology of its focus on internal mental states, proposing instead a framework where the distinction between human and animal behavior was minimal. Crucially, just as Paul Bloom (2023) notices, this is a second fundamental assumption of behaviorism: *innate differences are unimportant in the study of behavior*. In fact, behaviorism's approach in this regard was so radical that even differences between species were often considered irrelevant. The behavior observed in one species was, unless there was a specific reason to think otherwise, assumed to be applicable to others (Bloom, 2023).

So, central to the behaviorism framework are several key ideas. The most interesting of them, given the scope of this thesis, is the focus on learned behaviors over innate traits. This belief can be found in its purest and most distilled form in a famous quote by John Watson, a foundational figure in behaviorism:

> Give me a dozen healthy infants, well-formed, and my own specified world to bring them up in and I'll guarantee to take any one at random, train them to become any specialist I may select—doctor, lawyer, artist, merchant-chief, and, yes, even beggar-man and thief, regardless of his talents, pensions, tendencies, abilities, vocations, and race of his ancestors. (Watson, 1924, p. 104)

This statement, obviously, is the epitome of nurturism, revealing the sheer conviction in the power of environment and experience to shape any individual, irrespective of their genetic background. We certainly find it hard to imagine psychological schools as distinct from each other as Psychoanalysis and Behaviorism. But, exploring Behaviorism and its emphasis on environmental factors shaping human behavior, we observe a clear nurturist orientation, akin to that of Freud's psychoanalysis, yet remarkably distinct in both methodology and conceptual stance.

This is exactly what the psychologist J. R. Harris argues in her influential book "The Nurture Assumption" (1998): when arguing against the nurturist presuppositions in psychology, she identifies them in both behaviorism and psychoanalysis. She perfectly summarizes what has been just discussed:

> The behaviorists rejected almost everything in Freud's philosophy: the sex and the violence, the id and the superego, even the conscious mind itself. Curiously, though, they accepted the basic premise of Freudian theory: that what happens in early childhood — a time when parents are bound to be involved in whatever is going on — is crucial. They threw out the script of Freud's psychodrama but retained its cast of characters. The parents still get leading roles, but they no longer play the parts of sex objects and

> scissor-wielders. Instead, the behaviorists' script turns them into conditioners of responses or dispensers of rewards and punishments. (Harris, 1998, p. 54)

In her book, Harris highlights that the entire tradition of developmental psychology was massively influenced by the nurturism springing from both Freudian psychology and behaviorism. Going even further, a core message of her book is that the nurturist approach in developmental psychology research had an extremely far-reaching and profound influence on the general public, shaping and permeating our cultural understanding of individual differences (Harris, 1998).

In the second chapter of this thesis, we will delve into an extensive array of findings from behavioral genetics that contest such an overly nurturist perspective on the origins of individual differences. However, one might assume that psychology's apparent inattention to innate differences during certain periods reflects a broader neglect of genetics and heredity. It could be thought, for instance, that the absence of major public genetics research projects, like the Human Genome Project, which greatly popularized the field of genetics, might have contributed to this nurturist bias in psychology.

A closer look at historical developments, however, might suggest a different perspective. Studies focusing on heredity were, in fact, profoundly active and influential in the early 20th century, contrary to any notion suggesting a general disregard for genetics during that time (Prinz, 2012). A prime example of this early focus on heredity can be seen in the works of Francis Galton, whose publications in the initial years of the 20th century played a significant role in shaping the scientific research on genetics and heredity at the time.

Galton's 1904 publication in the American Journal of Sociology is an excellent example of this. Galton was one of the main figures in eugenics, which he defined as "the science which deals with all influences that improve the inborn qualities of a race" (Galton, 1904, p. 1). This definition by itself, contrasting with what we just saw with psychology, highlights the period's emphasis not only on innate qualities but also on the idea of improving society through genetic selection. Galton openly argued that the aim of eugenics was not only to improve inborn qualities through selection, but also to develop them to their utmost advantage (Galton, 1904). This perspective — and its widely favorable reception at the time — reflects the period's inclination towards hereditary factors as key determinants in both individual character and

societal advancement. Galton thought that the improvement of the human lineage was of utmost importance, and his sentiment was widely prevalent in early 20th-century scientific discourse (Prinz, 2012).

Galton's work sheds light on the strong political implications of different stances on the nature vs. nature dispute. As naturists, he and his peers discussed how eugenics could potentially raise the average quality of a nation, improving various aspects of life, from domestic to political affairs (Galton, 1904). The naturist idea that genetic enhancement could lead to societal improvement was a cornerstone of early 20th-century thought on heredity (Prinz, 2012).

Given the scope of our discussion, the main thing to be abstracted from this examination of Francis Galton's 1904 publication is the significant emphasis placed on hereditary factors in the early 1900s. His ideas on eugenics and genetic improvement reflect the period's naturist perspective in understanding human qualities and societal development. This allows us to grasp something crucial. As philosopher Jesse Prinz (2012) argues, *the shift away from the naturist viewpoints advanced by Galton and his contemporaries was not merely a result of the scientific rise of psychoanalysis or behaviorism, nor was it primarily driven by any scientific challenges that similar theories posed to naturism.*

Instead, a significant factor in the decline of eugenics was its association with Fascism. Both fell after the conclusion of World War II. This historical context reveals an obvious connection between the nature vs. nurture debate and broader political movements (Prinz, 2012). In other words, prevailing naturist or nurturist ideologies are inextricably connected to the political climates of their respective regions and moments. Eugenics, which emerged and gained prominence in Victorian Britain, extended its influence across Europe, until it found fanatic support in regimes such as Nazi Germany.

In this geopolitical landscape, the “nurturists” — Americans, who largely embraced behaviorism, and Jewish intellectuals, many of whom contributed significantly to psychoanalysis — stood in opposition to the Germans during the war. This opposition reflects the broader context in which scientific theories, particularly those concerning human nature and its susceptibility to environmental influences, evolve and compete within specific historical and cultural contexts. This dynamic interaction between scientific production and political power structures highlights the first key aspect of the nature vs. nurture debate that makes it a subject of critical

philosophical inquiry. *Despite being rooted in scientific inquiry, the debate appears more responsive to shifts in political and societal power than solely to empirical or scientific data.* The second characteristic, as we will explore in the next section, is its ubiquity across many scientific disciplines.

1.2.2 The Case of Linguistics

Linguistics, especially within the topics of language acquisition and development, can provide something that indicates another important characteristic of the nature vs. nurture debate: its ubiquity among different realms of scientific production. The field of linguistics, as it happens, also oscillated between these two major viewpoints: innatist perspectives, advocating for a genetic predisposition to language learning; and environmentalist views, stressing the role of social interaction and linguistic exposure (Prinz, 2012).

In the mid-20th century, the famous and pivotal debate between psychologists Noam Chomsky and Skinner epitomized this divide (Prinz, 2012). Skinner, as just discussed, was a leading figure in behaviorism who proposed also that language acquisition operates through the same principles that govern behavior — namely reinforcement and punishment (Skinner, 1957). Contrarily, Chomsky challenged this view, positing that language comprehension and use are governed by an innate, latent mechanism. He argued that while the specific words of a language are not genetically transmitted, the inherent ability to recognize and learn language is innate (Chomsky, 1959). This includes grammatical constraints and language usage patterns. This seminal dispute between Chomsky and Skinner not only mimetizes the contrasting approaches within psychology but also exemplifies the surprisingly large scope of the nature vs. nurture debate.

This linguistic case study is an illustration of the pervasive nature of the nurture vs. nature debate. In fact, it extends beyond the boundaries of psychology or linguistics, holding its important presence in various scientific fields. As we proceed, it becomes increasingly clear that this debate is not limited to a single domain; rather, it is a recurrent theme in all sciences concerned with human behavior and development, including those related to healthcare. The following sections will further demonstrate how this debate continues to shape and influence multiple disciplines.

1.2.3 Epistemology

We have just examined how the nature vs. nurture debate, often in an implicit manner, manifests across scientific disciplines. Psychology and Linguistics, selected here arbitrarily for argumentative purposes, are merely two examples. This debate is equally relevant in disciplines such as sociology, pedagogy, political science and even in some instances of medicine. The reason for this is that each of these fields needs to operate with a set of beliefs about human nature to guide both research and interventions. Fundamental questions of this kind are unavoidable: are neurological diseases predominantly explained by genetic or environmental factors? Is intellectual giftedness innate or acquired through learning? Are certain aspects of social organization, such as power hierarchies, inborn, or are they entirely cultural constructs? These questions could be multiplied here *ad nauseam.* And they often lie at the heart of scientific investigations, forming the core of various research programs (Prinz, 2012).

But a distinctively remarkable and important dispute within the nature vs. nurture debate is of an epistemological nature, involving questions about how we acquire our knowledge. In this dispute, the opposition between nature and nurture translates also into an opposition between Rationalism and Empiricism.

The first crucial question in this realm, as Prinz (2012) notices, was posed clearly by the ancient Greeks: *are there innate ideas*? An innate idea would be an idea or belief that we have without learning from the environment by experience. They could arise within us without observation or instruction. This was a possibility defended by Plato, who was a notorious defender of the existence of innate ideas. These ideas do not need to be ready at birth: naturally, we will not expect newborns to give a speech about justice or geometry; the idea — just as much with linguistics — is that there is a decisive innate latent ability that can manifest itself at a certain time or condition. Among these dispositions could be an inclination to the understanding of ideas of love, religion, ethic, mathematics and essentially any other epistemic domain (Prinz, 2012).

Notoriously, Aristotle, Plato's student, antagonized this hypothesis, arguing that only experience could be the true source of knowledge (Prinz, 2012). To a surprisingly large degree, a great chunk of the history of western philosophy, particularly epistemology, can be thought of as a continuation of this seminal ancient debate.

For instance, let us consider a famous work by the English philosopher John Locke about the nature of human knowledge. It is titled "An Essay Concerning Human Understanding" and dates back to the seventeenth century. Here, Locke's account of the mind is unmistakably nurturist and even gets close to what one would call a "blank slate" stance (Prinz, 2012). The mind is blank and would be later filled with experience. His thesis denies the existence of any "innate principles". As he wrote:

> If we will attentively consider new-born children, we shall have little reason to think that they bring many ideas into the world with them. [...] they get no more, nor other, than what experience, and the observation of things that come in their way, furnish them with (...). (Locke, 1689, p. 36)

This was undoubtedly revolutionary, since Locke's work was influential and the prevalent view in the context of his publication was Rationalist. His philosophical predecessors regarded innatism to be central as the source of knowledge. The nurturist work of Locke about human nature was decisive to the development and later success of British Empiricism, which in turn was crucial to the development of general western thought and science (Prinz, 2012). This passage highlights how notions regarding human nature, beyond scientific disciplines, also integrate the epistemic foundation of numerous philosophical positions.

1.3 Sociobiology

Another major dispute related to the nature vs. nurture controversy — one that has many philosophical implications — springs from the revolutionary theory proposed by Galton's famous cousin, Charles Darwin (Prinz, 2012). Darwin's theory of evolution is undoubtedly among the most important intellectual productions in the history of humanity; it sheds an unparalleled light on our understanding of our own nature. Impressively, despite its unmatched relevance to biological science and human knowledge in general, it only describes the consequences of the interaction of three basic elements (Sapolsky, 2017).

The first element is the condition that there has to be, among organisms, a number of biological traits that are inherited by the descendants of a biological lineage; secondly, the occurrence of mutations and random gene recombination must

produce variations in those traits; and lastly, some versions of these traits should grant more chances for an organism to successfully reproduce and therefore to preserve these traits in existence. Given these conditions, over time, the frequency of adequate or "fit" gene variants tends to increase in a given population. This process is called "*natural selection*" (Sapolsky, 2017).

However, despite the simplicity of the natural selection mechanism, as we will elaborate, the proper interpretation of the natural selection dynamic is a subject of major controversy (Sapolsky, 2017). The philosophical and theoretical controversies around evolutionism and natural selection — and how they connect to what we can conceive of human nature — will be thoroughly examined in the following sections.

1.3.1 Frequent Darwinian Misconceptions

Darwin's theory of evolution, being simple as it is, unfortunately, in its public reception, has always suffered from major misapprehensions. First misconception is the idea that evolution points toward the "survival of the fittest". This, as we will consider, is a deeply misleading idea. Evolution, in darwinian terms, is about the preservation of what was successfully reproduced: what is relevant is not survival, but the replication of copies of genes to the next generations. An organism that lived for centuries but failed to pass his genetic contents to the next generation would be evolutionarily invisible (Sapolsky, 2017).

This frequent confusion between survival and reproduction can be permanently undone once one understands the case of "antagonistic pleiotropy". "Pleiotropy" (from Greek "*pleion*", which means "more", and "*tropos*", "way") is an important concept in genetics and it means the case when one gene influences, simultaneously, seemingly unrelated phenotypic traits. "Antagonistic Pleiotropy" always refers to a conflict in evolutionary fitness — a tradeoff —; for example, the increase in reproductive capacities to the expense of decreasing life span (Sapolsky, 2017).

Primate postates, for instance, have an extremely high metabolic and functional rate. This, of course, has the great evolutionary upside of enhanced fertility and increased average number of offspring. This is a very meaningful and straightforward advantage in a darwinian sense. But the downside is dreadful: increased risk of prostate cancer. In salmon, for instance, one can find another striking case of Antagonistic Pleiotropy. They journey to spawning grounds in order to

reproduce, and then die there. If evolution were about survival, none of this tradeoff would ever occur. Survival matters only to the extent it enhances reproduction (Sapolsky, 2017).

The second major misconception is that evolution can select traits "in advance", planning and accumulating useful tools for the future. This never happens, because natural selection exerts its pressures only at the immediate time. For that reason, there is nothing in evolution that can justify a philosophical claim that the living species are better or more special than others that were extinct. What happens is that the species that were extinct were just as well adapted as any other, until environmental conditions changed radically enough to put an end to them (Sapolsky, 2017).

Lastly, there is the philosophical misconception that there is some kind of teleology of biological richness or complexity behind evolution by natural selection. One might conclude, reflecting upon the fact that there were once only single celled organisms in the biosphere, that the average complexity in life has increased. This in fact seems to be the case; however, it does not represent a fundamental, unequivocal direction in evolution. Bacteria and viruses can decimate entire populations of extremely evolved and complex mammal species, producing a change in the genetic pool that runs contrary to the supposed arrow of complexity growth (Sapolsky, 2017).

With misconceptions addressed, we can better appreciate the intricate genetic foundation that underpins our behavioral tendencies. It was Darwin's idea that human psychological traits might be explained by the same mechanism of natural selection that elucidated the evolution of observable phenotypes (Prinz, 2012).

1.3.2 Evolutionary Biology and Psychology

This particular idea was hugely elaborated by 20th century Harvard entomologist E. O. Wilson, which led to the influential publication of "Sociobiology" in 1975. While much of Wilson's book discusses animal behavior, an especially inflammatory chapter of his publication delves into human behavior. He attempted to understand societal dynamics through the lens of evolution by natural selection. Wilson proposed that human psychological inclinations, such as altruism, aggressiveness, social hierarchies, and the sexual division of labor, have a deep biological constraint. Building upon Wilson's groundwork, an influential group of

scientists, known as evolutionary psychologists, have further elaborated and updated this perspective (Prinz, 2012).

Evolutionary psychology, which as a research paradigm was much less influential in the 20th century than psychoanalysis or behaviorism, can be seen as an endeavor to articulate observations of human behavior or hypotheses about cognitive structures with predictions harmonious with the Darwinian paradigm (Prinz, 2012). Again using the lens of philosopher Thomas Kuhn's (1962) conceptual framework, this resembles a puzzle-solving endeavor typical of established scientific disciplines: attempting to reconcile specific observations (identified mental traits and psychological regularities) with a broader theoretical prediction (in this context, the prediction that such regularities must augment fitness because of natural selection) (Kuhn, 1962).

However, if carefully examining Kuhn's philosophy, one might contend that Evolutionary Psychology has not quite achieved the consensus-driven stature that characterizes normal science (well-established research disciplines oriented by paradigms). As it was said before, genetic constitutions that grant more fitness increase in a population over time as a result of natural selection. This is the essence of Darwinian predictions. But a basic problem stands as follows: if something as complex and intricate as a psychological trait is prevalent in a population, does that necessarily mean that it is present because it is adaptive? The evolutionary psychologists typically assume this to be the case. But, while their hypotheses and models are admittedly built over this presupposition, there is no plain scientific consensus regarding its validity (Prinz, 2012; Sapolsky, 2017).

This ongoing debate and lack of consensus regarding the interpretation of adaptationism — which has raised critical questions about the foundational premises of evolutionary psychology — can be traced back several decades. This idea was notoriously criticized in the mid-20th century by Harvard professors Stephen Jay Gould and Richard Lewontin. They argued that the problem was that Evolutionary Psychology explained too much and predicted too little. What they were doing — the authors accuse — was just to observe some trait or behavior, and coming up with a story that assumes adaptation in darwinian terms. The author with the most convincing story would win. So, in their view, these naturist frameworks of evolutionary psychology or sociobiology deeply lacked scientific rigor (Prinz, 2012).

1.3.3 Spandrels

It was in this context that Lewontin and Gould introduced the famous concept of "spandrels" in their 1979 landmark paper called *"*The Spandrels of San Marco and the Panglossian Paradigm: a Critique of the Adaptationist Programme*".* A "spandrel" is a term that refers to the space that exists between two arches in an architectural set up. The authors argue as follows: someone contemplating the magnificent art on the spandrels could look at such structures and conclude that they were built with the purpose of providing space for paintings. They were built for this reason, along with the rest of the structure. But that conclusion would be wrong. They did not evolve for any purpose. The authors argue:

> The design [of the spandrels] is so elaborate, harmonious and purposeful that we are tempted to view it as the starting point of any analysis, as the cause in some sense of the surrounding architecture. But this would invert the proper path of analysis. (Gould & Lewontin, 1979, p. 148)

What really had a purpose were the arches, which exist with the real purpose of holding up the weight of the dome. The spandrel, which is the space between them, is nothing but an inevitable geometrical byproduct. They have no functional meaning (Gould & Lewontin, 1979).

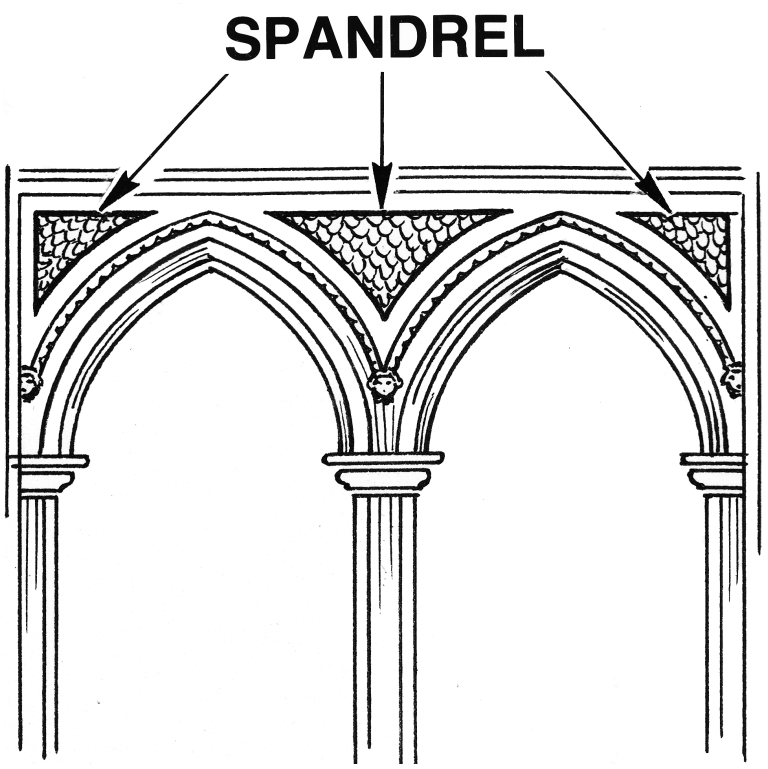


Figure 1.

Illustration of a Spandrel

One cannot find evolutionary meaning in male nipples, for example. They are spandrels. They serve an obvious reproductive role in females and are present also in males because there is no significant selection pressure for males not having them. So, Gould and Lewontin argued that many traits that were being subject to the construction of "adaptive tales" are present just as spandrels, without adaptive meaning behind them (Sapolsky, 2017).

The Darwinian paradigm remains open to different attempts of articulation with human issues (Prinz, 2012; Sapolsky, 2017). Sociobiologists or evolutionary psychologists, being naturists, attribute or interpret most of our behaviors in terms of what is biologically constituted. But in this particular issue, it becomes clear that they also have an inclination to believe that the biological constitution itself is both more meaningful and more logical than it might really be. Some of our biological characteristics or propensities may not have an evolutionary or adaptive meaning. They could be the byproducts of an imperfect and complex phylogenetic trajectory; one that creates structures over existing structures and leaves spandrels.

We should notice that Gould and Lewontin's analysis fundamentally is not a critique of naturism as a concept. It leaves room for the possibility that a majority of our significant social characteristics or individual distinctions are inborn. Yet, if a substantial number of these traits turn out to be spandrels – incidental byproducts rather than direct evolutionary adaptations – then interpreting the subtleties of human nature purely through the lens of evolutionary theory becomes significantly less straightforward. This perspective suggests that while some traits may have deep evolutionary roots, others could be the result of complex, non-adaptive processes. Therefore, understanding the full spectrum of human nature can require more than just a straightforward application of evolutionary principles; a much more complex and careful consideration of the intricate and sometimes coincidental pathways of our development is most likely necessary.

Considering this discussion, one of the most important tasks is to highlight certain instances that can justify a degree of skepticism when it comes to interdisciplinary efforts. While, as the title implies, the interdisciplinary approach is highly valued in this thesis, it often encounters an issue: essential theoretical aspects

of the theories being combined are frequently neglected. Researchers go for the data and forget the nuances of the theory. Let us consider this important case of darwinism again. It now garnered significant interdisciplinary interest, as seen in the recent growth of the field of Evolutionary Psychology in the past decade (Sapolsky, 2017). However, authors in this field frequently fail to debate the foundational elements of the theories that inform their models.

Creating intricate models based on Darwinian principles of adaptation while disregarding the ongoing debates surrounding adaptationism might render the effort pointless. As discussed, it is questionable whether every trait can straightforwardly be considered a direct outcome of adaptations. This uncertainty raises legitimate doubts about the foundational principles on which many interdisciplinary approaches are built. While interdisciplinary work is certainly valuable, even more scientific caution is due when delving beyond our areas of expertise.

1.3.4 A Political Bias Consideration

There is yet another layer of investigative caution that we must hold, one that was already introduced in a previous section. When examining the extensive nature vs. nurture debate, we came across several reasons to believe that it is not an exaggeration to state that all political stances are in an active interplay with conceptions about human nature.

When emphasizing the rigidity or regularity, as opposed to the plasticity and plurality of possible manifestations of human nature, one might be more inclined to sympathize with conservative political stances. Persuaded by a heavily naturist work, such as Wilson's Sociobiology, one might be more prone to accept that gender differences in labor or political power are a natural phenomenon that occurs following a biological determination. In the face of political turmoil, one might resign, thinking that perhaps we should not fight against our nature; that economic inequalities or unjust social hierarchies are inevitable and consistent with a biological destiny. Inversely, if one believes, suggested by the overly nurturists, that our genetic constitution does not impose meaningful boundaries or restrictions on how we should organize our ethical efforts and social expectations, one can end up amid serious theoretical mistakes and relativism. When it comes to healthcare, resources can be wasted in uninformed therapies that neglect the naturist evidence of genetic forces. Biology is never irrelevant to a complete medical, psychological, ethical or political

discussion. The denial of human nature seems to be, as Pinker (2002) pointed out, implicitly present in many prevalent theories in the humanities.

If one seeks a deeper psychological outlook for some features of this debate, considering the concept of Cognitive Dissonance, as proposed by Festinger (1957), is paramount. Cognitive Dissonance is an important concept in cognitive psychology and refers to the aversive psychological state that arises from the perception of contradictory cognitive information. People suffer from psychological discomfort when they perceive that some new information clashes with their identity or worldview (Festinger, 1957). And, because the nature vs. nurture debate can have implications that get too close to themes that are basic to our social worldview, such as the nature of gender roles, intelligence differences and economic inequality, people, consciously or not, are deeply motivated to select theories that justify their own personal activities and social position. This could be a route to explaining the previously examined association of the nature vs. nurture debate with political contexts.

Looking upon the conflict between nurturist and naturists, especially now in the case of sociobiologists and their critics, there is a remarkable fact that corroborates the existence of an underlying, tacit political agenda. As professor Robert Sapolsky notices, the first generation of sociobiologists in the United States, including E. O. Wilson, Bob Trivers and Sarah Hrdy, were all southerners and white. In opposition, their greatest critics were mostly Northeartens and all urban and leftist: Gould, Lewontion, Beckwith, Hubbad, Kamim and Chomsky (Sapolsky, 2017).

And if one extends the political reflection further in time and moves it from the United States to Europe, one might also notice that modernity was a period when European powers were aggressively expanding on colonization. New populations were discovered and studied by then. Naturally, there was great public curiosity as to what explains the differences observed in such populations.

"This difference between us and them is attributable to what?" This line of questioning provided a favorable context for the first naturist scientific endeavors that later inspired Sociobiology. But, even more importantly — beyond the satisfaction of mere curiosity —, anthropology and biology most likely, at the time, collaborated in the function of providing the colonizers the psychological justification to expand their power with innocence. If the Europeans were thought to be superior, there would be less perceived harm or incongruences in colonizing others and imposing rule on them. Again, Festinger's idea of cognitive dissonance could serve us as a powerful

theoretical resource to understand the early history of naturism in science and perhaps also its current development. In any case, we are safe to assume that the closer the subjects of science are to issues that can affect our worldview, the more skeptical we should be about the objectiveness of the discussions and the more certain we can be that we are entering a field deeply contaminated by bias.

1.4 The Three Aspects of the Debate

Now we have sufficient information to grasp both the philosophical relevance and the wideness of the nurture vs. nature debate. In an attempt to summarize it, Prinz (2012) dissects three distinct aspects that were particularly important in shaping the contemporary debate. One can certainly find a degree of thematic overlap over these issues; nevertheless, historically speaking, these three facets of the nature vs. nurture debate have been mostly independent (Prinz, 2012).

The first dispute one might recognize as a nature vs. nurture confrontation includes the persistent epistemological debate about innate ideas. This particular issue, as we examined, traces back to ancient Greece (Prinz, 2012). It is essentially a debate about the influence of innate inclinations versus the effects of learning in producing our characteristics.

The second aspect of the debate is about the attempt to expand the evolutionary paradigm of darwinism to psychological issues, which culminated in the controversial fields of sociobiology and evolutionary psychology (Sapolsky, 2017). This dispute is in a sense similar to the epistemological debate about innate ideas, because it also pertains to the nature of our shared predispositions. We must notice that this debate, however, has incorporated contents of greater amplitude: it includes topics such as innate emotions, gender differences, social dispositions, and the nature of sexual preferences (Prinz, 2012).

The third debate centers on whether — or to what extent — significant phenotypic differences between individuals or groups are rooted in genetics. This aspect of the nurture-nature debate will receive our attention the most. This is where behavioral genetics is circumscribed (Prinz, 2012).

1.4.1 Individual and Group Differences

This aspect of the nature vs. nurture debate, that concerns the innate origins of individual differences, will be thoroughly discussed in the next chapter of this

thesis. As already pointed out, scientific disciplines like psychology, medicine or linguistics frequently have questions that pertain to this aspect of debate. They often ask, for instance, why some individuals develop certain conditions and others do not. And, as we discussed, some perspectives, like psychoanalysis and behaviorism, place most of the explanation in differences in what is experienced. To the extent they do so, they position themselves in this aspect of the nature vs. nurture debate (in this case, as nurturist perspectives). The next chapter will be an examination of behavioral genetics. We will notice that, while some of the questions posed by these scientific disciplines touch on this aspect of the nature vs. nurture debate, all of the questions posed by behavioral genetics are inherently linked to it.

People vary significantly in almost every measurable trait, including psychological ones: some individuals are notably more intelligent than others, while some display greater compassion, energy, aggressiveness, and so forth (McCrae & Costa, 2008). Moreover, disparities in mental health are also evident across individuals. Should we attribute these psychological variations to genetics? Or is the environment the real culprit? To what extent our differences in phenotype are attributable to differences in our innate constitution? Behavioral genetics seeks to address such questions.

As presented so far, some philosophers throughout history have highlighted the influence of the environment in shaping individual differences. This idea was also prevalent in psychology, particularly in the second half of the 20th century. Conversely, as we will examine, others adopted a naturist stance, attributing differences in character to different innate forces. Notably, however, during the nineteenth century, this latter conjecture gained credibility as a serious scientific hypothesis, advanced at first by Francis Galton. Besides his connection with eugenics, Galton was the pioneer of many statistical techniques and formulated concepts that are widely in use in contemporary science: the notion of correlation, the usage of structured questionnaires, and — importantly — the idea of monozygotic twin studies to estimate the heritability of traits. These twin studies are a cornerstone of behavioral genetics and will be thoroughly analyzed in the next chapter. Interestingly, it was Galton himself who popularized the phrase *nature versus nature*; he was interested in the human mind and believed that many of our psychological tendencies were determined at birth (Prinz, 2012).

The quest to determine to what extent we can attribute our differences to genetics and how genes connect to behavior is the trade of behavioral genetics. Following the delineation offered by Prinz (2012), it is inscribed in the "individual and group differences" aspect of the nurture vs. nature debate, and its methods and findings will be carefully examined in the next chapter.

Chapter 2: Behavioral Genetics and the Notion of Heritability

As a field grounded in empirical research, behavioral genetics encompasses an array of methodologies designed to investigate the complex interplay between nature and nurture in the shaping of human diversity (Plomin, 2018). Its origins trace back to the early 20th century (Prinz, 2012). This chapter delves into the historical controversies and contemporary breakthroughs of behavioral genetics. It aims to provide a comprehensive overview of its evolution and its pivotal role in our current understanding of the shaping of individual differences.

In his recent book "Psych: The Story of the Human Mind", released in 2023, the psychologist Paul Bloom highlights the contributions of behavioral genetics as some of the most relevant in psychology. His work points out a profoundly significant change in how psychology understands both mental disorders and general personality traits based on behavioral genetics contributions. This change stemmed from the recognition of the crucial role played by inherent differences in influencing mental traits. According to him, behavior genetics findings have now been widely recognized and integrated into the core of both developmental psychology and psychopathology. To really grasp the complexities of individual differences in our phenotypes, he argues, a psychologist needs to consider the evidence of the constitutive effects of inherent variations in our genetic makeup (Bloom, 2023). In this chapter, we will examine the nature of this evidence.

If we are to examine the foundational insights of behavioral genetics and its profound impact on psychology, it is important to acknowledge the general historical context of genetic research. Long before the discovery of DNA or chromosomes, the role of inheritance in shaping who we are was evident, since phenotypic similarities among relatives stood out when compared to the general population (Sapolsky, 2017; Plomin, 2018). Our efforts in this chapter will take us through the evolution of understanding regarding these genetic influences, tracing back to these early observations and then reaching up to contemporary research.

The first naturist belief related to the advent of behavioral genetics was the rudimentary idea that if some particular behavior is done by every member of a family, then it must be due to a shared innate disposition. This is the opposite of the nurturist presuppositions examined in the previous chapter. This early naturist position can be formulated as follows: *certain behavioral tendencies or mental traits*

are empirically found to be clustered in families, and what explains it must be genetics. However, this assumption was quickly challenged by the realization that cultural influences and other environmental factors also tend to be shared within families. A subsequent and subtler proposition suggested that the more a trait was prevalent among closer relatives within a family, the more likely it had genetic origins. Yet, this argument was also flawed for similar reasons, since closer relatives often share more similar environments. For instance, siblings, compared to cousins, typically grow up in more comparable settings. It became evident that simple observation of phenotypic patterns in families was not enough to disentangle nature from nurture: more methodological sophistication was needed to properly understand the constitutive effects of such forces (Sapolsky, 2017).

To conduct research that yields meaningful results in this sense, the methodological aim should be to assess variations in traits accounting for genetic similarity and controlling for the environment. As we will learn when advancing into the subsequent sections of this chapter, the study of monozygotic twins offers a crucial window into this line of inquiry: they are born from the same sperm and egg, which means they share all of their genome (Plomin, 2018). If more similarities are found in these pairs of individuals, and that particularly high similarity does not appear to be explained by shared environmental conditions, then this serves as evidence of a genetic contribution (Plomin, 2018). Galton recognized this natural opportunity for scientific exploration and was a pioneer with this methodology (Prinz, 2012). We will return to the issue of twin studies later, examining how they are still employed today in one of behavioral genetics most powerful research tools, the "Classical Twin Design" (Hagenbeek et al., 2023).

So, in the endeavor to disentangle nature and nurture and to *quantify* the genetic influence in the development of our traits, the field of behavioral genetics emerged. But, before delving into crucial methodological topics such as study designs and implicit theoretical presuppositions, the first thing to be understood in behavioral genetics is the general quantitative score that it aims to produce. The quantification of the "gene influence" in trait differences is expressed in a score called "heritability" (Sapolsky, 2017); a concept that, for the theoretical and philosophical purposes of our discussion, ought to be examined meticulously.

2.1 Heritability

Studies in all scopes of behavioral genetics typically produce a "heritability" score, which nowadays can be found in a myriad of scientific literature, especially in medicine and psychology (Plomin, 2018; Hagenbeek et al., 2023). If someone interested in psychiatry consults general literature on psychopathology, such as the 2022 revised fifth edition of the highly influential Diagnostic and Statistical Manual of Mental Disorders (DSM-5-TR), they will very frequently find information about the heritability of many mental disorders. For instance, for the highly prevalent Major Depressive Disorder, heritability is now estimated at 40% (American Psychiatric Association, 2022).

For psychological traits related to antisocial behavior, resilience after psychological traumas and even complex traits like leadership potential, the score typically ranges from 40% to 60% (Sapolsky, 2017). And for any researcher active in those areas, it does not take time to notice that these scores are very widespread in contemporary research literature. But, while they certainly appear to be impressive or revealing, one must be aware of the common misconceptions about these measurements. Understanding with precision what heritability scores are really about is indispensable to our discussion.

As Stanford neurobiologist Robert Sapolsky (2017) puts it, "what is an heritability score" and “what does a gene do" are different matters. The first misconception relates precisely to that: there is a difference between a trait being strongly *inherited* and having high *heritability*. If genes strongly influence the average levels of any trait — say, the average male human height — that is a case of a trait strongly inherited (Saposlky, 2017). Assessing this is not the trade of behavioral genetics. Behavioral genetics is about what promotes the differences between individuals, not what is common (Plomin, 2018). But, differently, if genes are shown to strongly influence the amount of *variability* around that average level, then that trait has high heritability. By its correct meaning, heritability *is in essence a population measure and it estimates the percentage of a variation inside it that covaries with genetics* (Sapolsky, 2017).

One of the most frequent confusions that we must be aware of, therefore, is to think that if a trait is strongly inherited, it has high heritability. To avoid this misapprehension, it suffices to remember, once again, that heritability is about the genetic influence in the variability in traits, and not about average level. To further

elucidate this, if one were to measure the heritability of, say, the number of fingers a man has in his hand, this percentage would be extremely low. This is because most of the discrepancy in this measurement in a population would be due to fingers being chopped out by accidents. Having five fingers is a highly inherited trait, but it has low heritability, since it is most commonly changed by the environment as opposed to forces springing from differences in genetics (Sapolsky, 2017).

Demonstrating a general degree of fragility of heritability estimates, Sapolsky (2017) offers the hypothetical example of a plant that grows in a desert. In this scenario, only one gene, say, gene 3127, regulates the plant's growth. Gene 3127 has 3 alleles (different gene versions): A, B and C. Plants with version A always are observed with one centimeter of height; B, with always two centimeters, and C, with three centimeters. Knowing every plant's height and also their genetic constitution, one could ask: what factor has the most power in predicting its height?

And the answer here, obviously, would be the genetic factor: whether it has the allele A, B or C explains all the variation between different plants. This means, therefore, 100% heritability for height: phenotypic variation (or trait variation) completely matches genetic variation. But now, let us consider the same observation made in a radically different environment, say — a rainforest — where another geneticist is studying a perfect clone of this plant. In this environment, plants with genes A, B and C reach 101, 102 and 103 centimeters respectively. This other scientist also concluded — correctly — that the trait "plant height" has 100% heritability. After all, even if the average values are different, the variation remains the same, and it is still matching genetic variation in the same way. But the situation changes dramatically if they combine their data sets.

What is relevant now, if the question is about predicting the height of this plant anywhere in the world? Which is more useful now, to know its genes or its environment? Beyond any doubt, it is to know its environment. When these two data sets are combined, heritability plummets and becomes negligible. A plant growing in the rainforest with the gene associated with minimal height (gene A) would still be much taller than the plant with the gene associated with the most height (gene C) growing in the desert.

This leads us to a crucial point that pertains to measurements on human traits: *if a behavioral genetics study is confined to only one environment, we are blind to the effect that other environments could exert upon the differences we are interested in*

studying (Sapolsky, 2017). The philosophical implications of this are crucial and will be discussed later.

As the renowned behavioral geneticist Robert Plomin (2018) puts it, heritability is not a natural constant like the gravitational constant or the speed of light. It is, by essence, a statistical measure that expresses what was found in a certain population at a certain time. Any population has a particular mixture of genetics and environmental influences. This will be decisive to the later philosophical discussion but already allows us to anticipate an important conceptual commentary over the notion of heritability*:* it indeed says something about *how things are* in a population; it says much less, however, about how they *could be* given different conditions*.* Another set of individuals at a different location, or even the same population at a future time, can exhibit a significantly different dynamic of genetic and environmental influences.

2.1.1 An Example of Overestimated Heritability: Turkheimer and IQ

What has been exposed so far suggests caution when interpreting heritability scores in general. But now we turn to a specific example which highlights the deep political implications these studies might engender. What follows also showcases how poor study designs to assess heritability can lead us astray in trying to estimate the influence of genetic factors for a particular psychological trait. It regards the heritability of general cognitive performance: namely, IQ scores.

Since the beginning of heritability measures of psychological traits, IQ was particularly thought to be highly heritable in kids and this was a belief widely sustained throughout the 20th century (Prinz, 2012). But then it was argued by Turkheimer et al. (2003) that only if one restricts the study sample to kids of high socioeconomic status does IQ heritability becomes high (sometimes very high, reaching ~70%); contrastingly, if one conducts the same investigation in low socioeconomic status families, the percentage can drop, much impressively, to nearly 20%. This means that the importance of genetic constitution to intelligence development is proportional to one's socioeconomic status. The more one is facing the harsh adversities of poverty, which configure a greater heterogeneity and magnitude of developmental problems, the less important is what comes from the genes (Turkheimer et al., 2003).

Inversely, to the group free from the obstacles of poverty, the genetic potential each one has innately has a higher chance of flourishment, and therefore heritability becomes higher. Similarly, as another instance of context dependent heritability, one can reflect upon the heritability of alcohol abuse. Heritability, in this case, is significantly lower for religious groups (Prinz, 2012). This means that the shared cultural restraints on drinking associated with religion can be much more relevant than individual genetic dispositions. But, naturally, this effect is only visible if such restrictions are present in the sample group studied. Only when these powerful cultural restraints are absent, does heritability become high and truly useful to make predictions about alcohol abuse (Sapolsky, 2017).

These examples showcase that heritability — while at many times being a very useful measurement — has in its essence an inherent degree of fragility from a theoretical standpoint, particularly if interpreted absolutely and without due consideration for the context of its determination. Shifts in study delineation, population sample selection, and the cultural characteristics of those studied can have huge impacts on heritability scores (Plomin, 2018). This, naturally, leaves the field more open to the bias of the researchers. One has more ways to alter the study parameters and find different results, trying to confirm his own preferred hypotheses. Also, we are in danger of naively believing in some kind of absolute truth about these scores, and assuming too readily that some conditions — as important as intelligence level — are mainly determined by genetics.

Science, if not revised thoroughly in its methodology, can also misinform social political and pedagogical precepts; teachers or policy makers, faced with scientific information suggesting a high level of heritability for a trait as important as intelligence, can conclude that there is not so much to be done about cognitive impairments. This is one of the reasons that justify the philosophical efforts in this thesis. "We should simply accept that we are dealing with some feature determined at birth" — one might think. We ought to maintain a critical perspective to these studies. Numbers, particularly the ones associated with the humanities, have a tendency to appear to be more objective than they really are.

2.2 Contemporary Behavioral Genetics Research Methodology

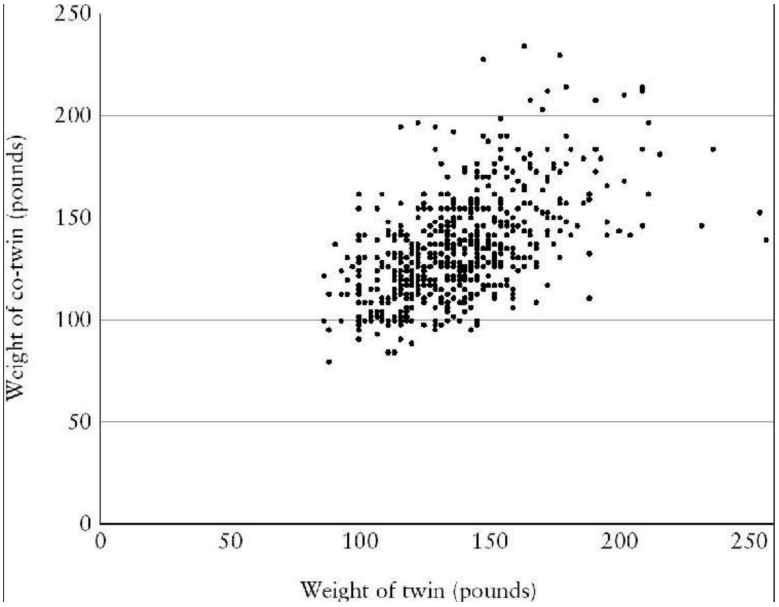
Having conducted a brief overview of the heritability concept and addressing some of its potential interpretational pitfalls, we now direct our focus towards the

methodological approaches encompassed in behavioral genetics to promote its estimation. To achieve this, we will start with an examination of the important twin studies before delving into the realm of adoption studies.

2.2.1 Twin Studies

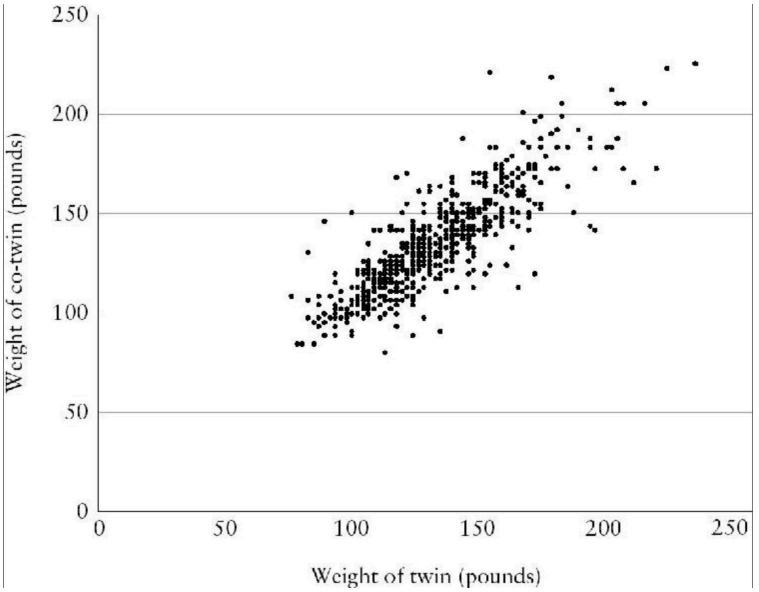
In the tradition of twin studies, the first method of research to be examined is what is known as the Classical Twin Design. The Classical Twin Design is a specific type of twin study in behavioral genetics that essentialy compares the similarities in traits between monozygotic (MZ) twins and dizygotic (DZ) twins. This method is predicated on the fact that MZ twins are genetically identical — a genetic clone —; while DZ twins share, on average, only 50% of the genome (Plomin, 2018). We can call "rMZ" the correlation coefficient of a given trait between a group of monozygotic twin pairs, and "rDZ" the correlation coefficient for the same trait between dizygotic twins.

Those scatterplots presented in Plomin's work demonstrate the differences in weight correlations between monozygotic (MZ) and dizygotic (DZ) twin pairs. In these visual representations, we can compare the weight correlation of 600 MZ twin pairs with that of 600 DZ twin pairs, both groups aged 16 years (Plomin, 2018).



(Plomin, 2018, Figure 2)

First scatterplot, showing correlation of weight for 600 DZ twin pairs.



(Plomin, 2018, Figure 2)

Second scatterplot, showing correlation of weight for 600 MZ twin pairs.

The first scatterplot represents the weight correlation of DZ twins, who share on average, 50% of their genetic makeup. The second scatterplot illustrates the significantly different correlation for MZ twins, who are genetically identical. These plots reveal a notable and crucial difference: MZ twins show a much higher correlation in weight compared to DZ twins. Specifically, the correlation coefficient for MZ twins (rMZ) in this case is 0.84, indicating a very strong similarity in weight between these twins. In fact, this correlation is almost equivalent to the correlation observed when the same individual's weight is measured twice, a year apart. In contrast, the correlation for DZ twins (rDZ) stands at 0.55, demonstrating a significantly less pronounced similarity.

Naturally, this difference in correlation between MZ and DZ twins highlights the genetic influence on weight. The higher correlation in MZ twins, who share their entire genome, compared to DZ twins, who share only half, strongly suggests that genetics plays a significant role in determining weight. To quantify this genetic influence, we can use the Classical Twin Design's formula, that subtracts the rDZ (DZ twins share 50% of genome) from the rMZ (MZ twins share the whole genome) and then multiplies the result by two. This calculation gives us an estimate of the genetic covariation in weight, reinforcing the argument for a strong genetic component in this trait, as demonstrated in the scatterplots (Plomin, 2018).

Thus, the formula for heritability in twin studies can be expressed as:

$$\textbf{Heritability}(h^2) = 2(r_{MZ} - r_{DZ})$$

Expressed beyond quantitative terms, this means that, if we have reason to believe that both types of twin pairs share similar environments but MZ twins show greater resemblance in a trait when compared to DZ twins, then we have evidence that genes play a role in the shaping of this trait (Plomin, 2018). This is the basic logic of the Classic Twin Design, which stands as one of the most important research methods in behavioral genetics (Hagenbeek et al., 2023). As mentioned earlier, Francis Galton was the first one to conduct studies on twins to investigate the heritability of various characteristics, such as intelligence and personality. However, it was not until the mid-20th century that the Classical Twin Design, as we know it today, was formally structured (Bouchard & McGue, 2002).

The Classical Twin Design became popular as a research method for several reasons. As Sapolsky (2017) highlights, one of the most remarkable studies in behavioral genetics was a twin study conducted by Thomas Bouchard of the University of Minnesota. Rather than comparing groups of MZ and DZ pairs, Bouchard became especially interested in twin studies when he discovered in 1979 a pair of MZ twins who were separated at birth and adopted into different homes, having no knowledge of each other's existence until they were later reunited as adults. To illustrate the strength of genetic influences on behavior that this occasion suggested, it helps to think of what would be an ideal twin pair for study: A and B, MZ twins, sharing all of their genome, but raised in dramatically different environments. The more dissimilar the environment of the separated MZ twins, the more one can assess the extent of genetic influence when comparing them.

Indeed, Bouchard did come across a remarkable MZ twin pair born in 1933 in Trinidad that grew in deeply contrasting environmental backgrounds. The twins were separated at six months of age, with one raised as Jack Yufe, an observant Jew in Israel, and the other as Oskar Stohr, a Hitler Youth fanatic in Germany. On the occasion of their reunion and study, Bouchard observed an array of shared behavioral and personality traits, including extremely striking habits like flushing the toilet before use (Bouchard & McGue, 2002). The significance of these similarities prompted scientists to be enthusiastic about studying MZ twin pairs, as they present an unique opportunity to investigate the forces of genetics and environment. By

examining over a hundred pairs of such twins, Bouchard reached the conclusion that the significant level of similarity observed among these numerous sets of MZ twins unveiled a substantial influence of genetic factors on our development (Sapolsky, 2017).

Studying such MZ twin pairs fueled the interest in the comparative Classical Twin Design, and since Bourchard's findings, behavior geneticists have published numerous studies in specialized journals, such as Genes, Brain and Behavior, Twin Research and Human Genetics, consistently demonstrating that genetics plays a significant role in various domains of behavior and mental characteristics (Sapolsky, 2017). These domains include IQ and its subcomponents; psychopathology such as schizophrenia, depression, eating disorders, autism or ADHD; and general personality measured with the Five Factor Model (extroversion, agreeableness, conscientiousness, neuroticism, and openness to experience) (Plomin, 2018).

Additionally, studies in the American Journal of Political Science — which now also incorporate the Classical Twin Design — suggest genetic influences on political involvement and sophistication, regardless of political orientation (Plomin, 2018). While twin studies help to establish that genetic contributions to behavior are evident, it is crucial to note, as it will be later discussed, that behavioral genetics also tells us that specific behaviors are never completely determined by a single gene. Instead, the relationship between genes and behavior is always complex and frequently indirect (Sapolsky, 2017).

2.2.2 Adoption Studies

Adoption Studies are another tool employed in the investigation of the constitutive roles of genetics and environment in shaping human traits. The research logic with this method is very straightforward: by observing adopted children — who share genetic similarity with their biological parents but did not receive their upbringing — researchers take advantage of a situation that, to a considerable extent, disentangles the influence of genetics from the environment (Plomin, 2018).

If variance in traits like body weight are predominantly influenced by genetics, then adopted children should exhibit similarities in weight with their biological parents rather than their adoptive parents. Deduction based on this hypothesis creates a clear prediction to what it is expected to occur; therefore, it also defines a case that would falsify such a hypothesis. This adds scientific qualification to behavior genetics

findings: falsifiability, as notoriously argued by philosopher Karl Popper (1959), is at the core of sound research.

On the other hand, adoption studies also offer another angle to test the impact of nurture: conversely, if environmental factors play the key role in body weight differences, then adopted children should resemble adoptive but not biological parents. Adoptive parents, after all, are those who provide a family environment, dietary habits, and many other relevant lifestyle choices (Plomin, 2018).

Researchers also compare genetically unrelated adoptive siblings within the same family environment. These siblings are not genetically related but grow up together in a similar environment. If family environment, rather than genetics, is the decisive factor in promoting individual differences for a given trait, then adoptive siblings should exhibit similarities for that trait, not differing too much from biological siblings who also share more of their genes aside from environment (Sapolsky, 2017).

The adoption design is therefore a powerful tool for untangling the forces of nature and nurture, because it can encompass comparisons with biological parents (the genetic parents of adopted-away children), adoptive (or environmental) parents, and also "genetic-plus-environmental parents" (the typical case of parents who share both genetics and environment with their children). This large amplitude for study designs enables researchers to derive robust estimates of genetic and environmental influences on various traits (Hagenbeek et al., 2023).

According to Plomin (2018), both twin and adoption studies were crucial in revealing the roles of genetics and environment in behavioral genetics. Comparatively, twin studies usually benefit from a larger and more representative sample, which enhances the generalizability of the findings to the broader population. On the other hand, adoption studies provide a distinct qualitative advantage, as they configure a natural experiment to disentangle genetic and environmental effects. The control over family environment in adoption studies allows for a better understanding of the independent impact of environmental factors. However, a comparative disadvantage of adoption studies lies in the limited sample size relative to twin studies, which could reduce the statistical power to detect genetic effects accurately (Hagenbeek et al., 2023). Additionally, selective adoption processes and potential biases in adoptive parent selection may introduce confounding factors (Plomin et al.,

2016). The next section will delve into these methodological issues in detail, examining what is assumed in the background of both twin and adoption studies.

2.2.3 Assumptions of the Classical Twin Design

As pointed out by Hagenbeek et al. (2023), the Classical Twin Design is only meaningful to the extent that certain assumptions are true. As we will see, such assumptions do not necessarily have to be taken as objections; they are simply conditions implied in the methodology. The first one is the random mating assumption: the studies assume that the parents of twins have mated randomly, meaning that there is no specific selection of mates based on their genetic profile or other traits related to the studied trait. Secondly, there is the Equal Environment Assumption (EEA): twin studies also assume that the environmental factors influencing a trait are homogeneous for MZ and DZ twins pairs, meaning there are no systematic environmental forces particularly applicable to MZ but not to DZ pairs. This assumption implies that any systematic differences in the similarity of traits between MZ and DZ twins can be primarily attributed to genetic factors, as the environmental factors are assumed to be equally influential for both.

Beyond this, as pointed out by Plomin (2018), another assumption in twin studies is that twins are inherently representative of the overall population for which heritability and other estimates are thought to be applicable. This means that there should be no exclusive characteristics in twins that could hinder the inference of generalizing the findings by induction. As it turns out, as noted by Hagenbeek et al. (2023), that seems to be precisely the case, and therefore the issue does not constitute a controversy in current debate: despite being born with fewer days of pregnancy on average and growing up with a same-age sibling, twins share striking similarities with singletons. As the authors remind, both MZ and DZ twins show equivalent biomarker profiles, disease patterns, cognitive functions, personality traits, and psychopathology in relation to singletons. Although twins may have lower birth weight, the same genes influence birth weight in both twins and singletons (Sapolsky, 2017). Due to these similarities, data from twins can be combined or compared with other population-based findings to broaden representation. Twins are considered highly representative of the general population, making their study valuable for understanding the influence of genetics and environment on traits (Hagenbeek et al., 2023).

As for adoption studies, the following assumptions were highlighted by Sapolsky (2017) and Hagenbeek et al. (2023): the first is the Environmental Independence Assumption. Adoption studies naturally assume that the environmental influences experienced by adopted children are largely independent of their genetic relatedness to their adoptive parents. This means that, by studying children raised in different families from their biological parents, researchers aim to isolate the impact of the adoptive family environment on behavioral outcomes (Sapolsky, 2017).

Secondly, they depend upon the Assumption of Random Assignment of Adoption. To ensure the methodological validity of adoption studies, it is assumed that the placement of children with adoptive families is based on a random or relatively unbiased process. Naturally, if random assignment is the case, then the likelihood of systematic differences in the adoptive family environment based on the child's traits or background is minimized. Thirdly, adoption studies assume that the sample of adopted children is representative of the broader population. A diverse and representative sample enhances the generalizability of findings and strengthens the validity of conclusions drawn from the study (Hagenbeek et al., 2023).

2.3 Methodological Controversy in Behavioral Genetics

Some scientists have criticized the aforementioned assumptions in twin and adoption studies, arguing that many of them are probably false and tend to overestimate the role of genes in influencing traits (Turkheimer et al., 2003). While many behavior geneticists acknowledge these issues, they generally argue that the overestimates are minimal and do not hinder the studies' scientific potency (Hayden, 2013). This section delves into the various facets of this controversy.

One of the major controversies in twin studies is the Equal Environment Assumption (EEA) in the Classical Twin Design. The EEA proposes that both MZ (identical) twins and same-sex DZ (fraternal) twins experience their environments in sufficiently similar ways for the studies to be meaningful. However, there is a case to be made against this. Some authors believe that MZ twins, because of their often extremely similar appearance, might be treated more similarly than DZ twins.

If that extra environmental similarity is not accounted for, this would lead to an overestimation of the genetic influence. Some behavioral geneticists addressed this issue by aiming to measure the actual similarities in childhood experiences among

twins. Some researchers even found cases where parents mistakenly believed their DZ twins were in fact MZ, thereby treating them as if they were identical. Robert Sapolsky, in 2017, summarized the findings from these types of studies. He argued that, even after accounting for the potential environmental similarities between MZ twins, genetic factors still held significant influence (Sapolsky, 2017).

Another area of significant concern revolves around the insufficient examination of periconceptional and prenatal variables in behavioral genetics. Hagenbeek et al. (2023) emphasize that this scarcity hinders a holistic comprehension of early life influences on an array of traits and outcomes. This research gap naturally conveys the constraints in fully considering the early interplay between genetic and environmental factors, thereby limiting the clear understanding of the intricate genetic-environmental dynamic. Part of this concern regards the fact that MZ twins experience more similar conditions from their prenatal time as fetuses. Unlike DZ twins, who develop in separate placentas, 75% of MZ twins share one placenta, making them "monochorionic". This means that most MZ twin fetuses share maternal blood flow, resulting in exposure to more similar levels of maternal hormones and nutrients. If this difference is not considered, then the greater similarity observed in MZ twins may be wrongly attributed to genes (Sapolsky, 2017). A research effort was made to examine the chorionic status in various MZ twin pairs and its impact on cognition, personality, and psychiatric conditions. As stated in one review by Prescott et al. (1999), the overestimation of genetic factors due to these influences is considered to be "small but not negligible".

The next important objection to Behavioral Genetics methodology also pertains to prenatal conditions, but it is specifically related to adoption studies. As previously highlighted, adoption studies are predicated on the fact that children adopted shortly after birth share a similar genetic profile with their biological parents but not the same family environment. However, this might overlook potential prenatal environmental effects (Hagenbeek et al., 2023).

Throughout an entire pregnancy, a newborn spends on average nine months exposed to a certain biochemical profile in virtue of sharing the circulatory environment with their biological mother. As Sapolsky (2017) asserts, this can significantly influence their neurological development. He also points out that epigenetic changes can be carried by eggs and sperm into the next generation, potentially impacting a child's traits. There is no shortage of compelling evidence that

prenatal and epigenetic effects from the mother can be substantial, as shown by cases like the Dutch Hunger Winter, where third-trimester malnutrition drastically increased the risk of adult diseases (Sapolsky, 2017). We will delve more into the realm of epigenetics — and its relevance to Behavioral Genetics — in the next chapter of this thesis.

However, there is a simple method to account for the potential influence of the prenatal environment: comparing traits between children and both of their biological parents. Since an individual inherits roughly half of their genes from each parent, a pattern of similar traits between a child and one parent more than the other can indicate the presence of non-genetic influences. Specifically, if a trait is more similar to the biological mother than the father, this suggests the influence might not be purely genetic, as genetic expectations would predict equal similarity with both parents. Using this logic, studies investigating the potential uneven genetic influence of schizophrenia in twins indicate that prenatal factors might not be of significant concern. Nonetheless, it is crucial to recognize and consider the possible effects of prenatal and epigenetic factors, especially in adoption studies (Hagenbeek et al., 2023).

Moving on, as pointed out earlier, adoption studies operate on the assumption that a child and their adoptive parents share an environment but do not have a particular genetic similarity. However, this might sometimes be false. Kamin and Goldberger (2002) pointed out the issue that adoption agencies have a tendency to place children with adoptive families that resemble their biological parents in terms of ethnicity. This can lead to a methodologically problematic degree of genetic similarity between the adoptive parents and the child. If researchers fail to consider this, they might mistakenly conclude that observed similarities stem from the environment rather than shared genetics.

Another problem to consider is that adoptive families often have a much higher level of education, wealth, and mental health when compared to biological parents in general. Hagenbeek et al. (2023) refer to this as "range restriction", meaning they are more uniform in terms of these characteristics than the general population. The authors also notice that certain groups, like African, Arab, Hispanic, and non-European populations, are underrepresented in twin research. This lack of diversity makes it harder to discern and comprehend the influence of environmental factors on behavior. The authors point out that, despite recognizing the potential

impact of selective placement in adoption studies, there is ongoing debate about its importance (Hagenbeek et al., 2023).

As a concluding remark to this unavoidably technical section, while researchers have extensively tried to address issues such as the prenatal environment, epigenetics, selective placement, range restriction, and assumptions about equal environments, most experts in the field recognize that these challenges are inherent to the study of behavioral genetics. However, many studies indicate that these challenges may not be as hindering as critics initially believed (Sapolsky, 2017; Plomin, 2018).

In summary, adoption and twin studies have undeniably enriched our understanding of behavioral genetics. Yet, these methods have their set of limitations and theoretical problems. The knowledge derived from twin studies, as highlighted by Hagenbeek et al. (2023), has been indispensable for behavioral genetics, deepening our insight on the interplay between human behavior and genetics. And while measures have been taken to account for potential pitfalls, determining the exact influence of these factors remains a subject of debate.

2.4 Behavioral Genetics Major Replicated Findings

After understanding the debated elements in behavioral genetics research, we turn to exploring the reasons that give it a solid and respected foundation in the scientific literature. To thoroughly understand them, again, it is essential to look into contextual information.

What is now known as the Replication Crisis in psychology refers to a widespread concern over the inability of scientists to consistently replicate findings of previous empirical studies. This problem has raised important questions about the general reliability of research in psychology, pointing to critical issues such as publication bias, questionable research practices, and low statistical power (Pashler & Wagenmakers, 2012). When further delving into this issue of lack of replicability, one finds that this concern also affects other areas of research.

An extremely influential paper titled "Why Most Published Research Findings are False" offered a critique that, to some degree, was pertinent to virtually all contemporary empirical research. In this paper, information gathered from influential medical research revealed that out of 49 widely referenced medical papers, only 34 had faced replication testing. Impressively, among these, when subjected to

replication trials, 14 were definitively proven to be inaccurate. Furthermore, for every 6 studies with designs lacking randomization, 5 did not replicate successfully (Ioannidis, 2005).

A number of subsequent studies checking the replication of medical and psychological findings have shown equally negative and discouraging outcomes (Begley & Ellis, 2012; Prinz, Schlange, & Asadullah, 2011). In the field of medicine, replication attempts also yielded widely negative results, even leading to the strong claim that 85% of research resources are wasted (Macleod et al., 2014). Similarly, in psychology, a more recent systematic effort to replicate 100 studies found that only 36% of them yielded considerable replication (Open Science Collaboration, 2015).

In the face of this context, a publication in behavioral genetics titled "Top 10 Replicated Findings from Behavioral Genetics" by Plomin, DeFries, Knopik, and Neiderhiser (2016) received significant attention (Plomin, 2018). In this paper, the authors present a compilation of the ten "big" repeatedly replicated findings in behavioral genetics, highlighting the special scientific significance of these findings in providing robust and reliable scientific insights. Because it identifies and summarizes such findings, the publication serves as a very useful resource for researchers seeking to prioritize scientifically solid results amid the replication crisis. Naturally, what is presented is of special value in the context of skepticism about research results, because the statistical robustness of the findings suggest a reliable foundation of established knowledge (Bloom, 2023).

Authors in behavioral genetics describe these findings as "big" for two reasons. Firstly, they exhibit a high effect size, which reflects the magnitude or strength of a relationship between the variables under study. This statistical characteristic serves as an indicator of the practical significance and impact of a particular effect observed in a study. Secondly, these findings stand out in the context of the replication crisis, carrying significant implications for the fields of psychology, psychiatry, and philosophy (Plomin, 2018) – all of which are under scrutiny in this thesis. In the remaining enterprise of this chapter, our goal is to highlight the "big" findings that bear the utmost significance in our understanding of human differences. This will enable us to identify the relevant cutting-edge revelations within behavioral genetics, laying the foundation for our subsequent philosophical discussions.

2.4.1 The First "Big" Finding: Between Nurture and Nature

As we have seen so far, the study of individual differences in behavioral genetics has employed genetically sensitive methodologies, such as the Classical Twin Studies. It was pointed out that this approach, which assesses the comparative similarity between pairs of MZ and DZ twins, has been extensively utilized across various psychological domains (Plomin, 2018). Those domains include, for instance, cognitive abilities, psychopathology, personality traits or substance abuse. Importantly, what emerges from those studies is a consistent pattern of significant genetic influence on these traits, leading to the establishment of what is often referred to as the "first law" of behavioral genetics (Plomin et al., 2016).

The first thing to be noticed is that, while it is now widely accepted in psychology that genetic influences are a key factor in shaping mental differences, this was not always the case. As psychologist Steven Pinker (2002) pointed out, just a few decades ago the idea of genetics playing a significant role in psychological differences promoted an inflammatory battleground among scholars. Despite this, a recently formed consensus acknowledges the massive evidence of the genetic underpinning of various psychological traits (Plomin, 2018), reinforcing the importance of considering genetic influence when discussing matters that relate to human behavior.

Let us consider, again, the case of intelligence heritability. A comprehensive review of intelligence literature involving more than 10,000 pairs of twins found that MZ twins exhibit significantly greater similarity in intelligence compared to DZ twins (Haworth et al., 2010). This pattern of substantial heritability holds across diverse geographical locations such as the United States, Europe, Russia, East Germany, Japan, and India, which indicates a generalizable genetic impact on cognitive abilities. Subsequent studies, with even larger samples, continue to corroborate these findings, strengthening the evidence for genetic influence (Plomin et al., 2016).

Similarly, within the domain of psychopathology, the Classical Twin Design was extremely influential, because it has consistently pointed out that conditions like schizophrenia exhibit substantial higher concordance rates among identical twins, reflecting a very strong genetic component; other psychological traits, such as specific cognitive abilities or mental disorders like autism or ADHD, also consistently exhibit genetic influence (Plomin et al., 2016). For personality traits, numerous twin studies spanning decades have consistently pointed to significant genetic influence.

Scores from self-report questionnaires, meta-analyses, adoption studies, and data from twin pairs all converge pointing to the genetic underpinnings of personality (Turkheimer et al., 2014; Loehlin, 1992).

Analyzing heritability estimates, which as we saw are the key metric in behavioral genetics, we can further illuminate the degree of genetic contribution to psychological traits. For example, recent studies on General Intelligence, delineated after Tukerheimer's important critiques, generally estimate heritability at around 50%, while personality traits also tend to show substantial heritabilities, although with greater deviations, typically ranging between 30% and 50% (Plomin, 2018). Other psychological traits only recently studied in behavioral genetics, such as subjective well-being, also reveal substantial heritability (Bartels, 2015).

To summarize, a wide array of studies in behavioral genetics consistently reveals a significant genetic influence on psychological traits, pointing to the crucial role of genetics in the heritability of psychological makeup. This pattern is observed across diverse areas, including intelligence, personality, psychopathology, and subjective well-being. Despite important debates over the precise accuracy of heritability estimates and the methodological intricacies involved, the evidence of a profound and widespread genetic impact on psychological differences is virtually undeniable. Consequently, the importance of genetic factors in shaping psychological characteristics is now considered an established principle within the field of psychology (Bloom, 2023).

2.4.2 Heritability is Caused by Many Genes of Small Effect

Until this point, we have seen that heritability, which aims to reflect the extent to which genes are associated with the variation of a trait, has been repeatedly estimated using different research methods. Two prominent approaches — twin and adoption studies — have shown that genetics plays an important role in shaping complex traits such as mental disorders. However, these methods shed no light on the crucial question of how many genes are involved in heritability, exerting influence on the etiology of a given trait.

To shed light on this matter, researchers in the 1970s first reasoned about the population dynamics of phenotypes observed in nonhumans. We should notice that this is another instance of interdisciplinary efforts contributing to substantial advancements in behavioral genetics. The reasoning goes as follows: if only one or a

small number of genes were responsible for the heritability of any given phenotype, then populational lines selected for this trait would quickly stabilize with different phenotypes after a few generations and then would not diverge further. Instead, selection studies of complex traits in animals, including behavioral tendencies, demonstrated a linear response to selection even after dozens of generations, indicating the involvement of many genes in shaping differences in these traits (DeFries, Gervais, & Thomas, 1978).

But the decisive insight into this issue comes from the modern Genome-Wide Association (GWA) studies, which analyze hundreds of thousands or even millions of genetic variations across the genome (Plomin, 2018). GWA studies have successfully detected associations between specific genes and traits, and the effect sizes of individual genes were found to be extremely small (Gratten et al., 2014). In fact, even the largest effect sizes detected by GWA were minuscule, suggesting that no single gene, considered individually, has a substantial impact on any behavioral trait (Plomin et al., 2016).

Instead, it appears that heritability is caused by the cumulative effects of many genes pointing toward the same direction in a behavioral sense, each one contributing with a small, stackable effect. This crucial discovery, that points toward a polygenic model in psychological etiology, suggests that numerous genes work together to influence complex traits like mental disorders (Bloom, 2023).

To summarize, this second "big" finding of behavioral genetics come from the combination of selection studies in animals with recent GWA studies, which strongly supports the idea that heritability in complex traits is a product of many genes of small effect, rather than a few major genes (Plomin et al., 2016). This polygenic nature of heritability is of key importance for understanding the genetic basis of complex traits and opens new avenues for future research.

2.4.3 Heritability of Intelligence Increases With Age

The third "big" finding of behavioral genetics that we will consider certainly ranks among the most surprising. It seems obvious that we are continuously shaped by our surroundings. The longer we live, the more we are shaped by the cumulative influence of our parents, peers, instructors, as well as unfortunate circumstances such as health issues. However, this third "big" finding of behavioral genetics challenges this intuitive notion: certain genetic influences may actually become more

decisive to our shaping as we age. Impressively, *no psychological characteristic studied by behavioral genetics becomes less influenced by genetics over time*, and certain hereditary factors seem to become significantly more influential during development. There is considerable evidence that this is the case of cognitive abilities (Plomin et al., 2016).

Cognitive abilities are dissected in psychology and psychometry in many ways, such as the subtypes of verbal or spatial skills. However, these distinctions are questionable in their distinction from a measurement perspective, because if someone excels or scores poorly in a given area, they are more likely to have a similar score in others (Bloom, 2023). For instance, those with strong memory are likely to perform well in executive functions; similarly, those with good calculation skills usually have good verbal skills. Thus, in psychology there is a concept of General Intelligence, which — at least in theory — encompasses a general ability that various specific cognitive tests share sensitivity to measure. IQ tests aim to measure this General Cognitive Ability (also commonly represented by "g") and usually include a range of verbal and non-verbal assessments; they express performance as an IQ score, short for "Intelligence Quotient" (Prinz, 2012).

Despite the initial expectation that the impact of experiences would accumulate over time increasingly affecting our intelligence, as it proposed by various developmental theories (Baltes, Reese, & Lipsitt, 1980), research from over three decades in behavioral genetics consistently reveals a linear increase in the heritability of intelligence throughout an individual's life-span (McGue et al., 1993). This holds true for both longitudinal and cross-sectional analyses, as well as both twin and adoption studies (McGue et al., 1993; Plomin & Deary, 2015).

For instance, one study examining data from 11,500 twin pairs — larger than all prior twin studies combined — illustrated this linearly escalating heritability pattern. The heritability of intelligence climbs significantly from 41% in childhood (age 9) to 55% in adolescence (age 12), and then further to 66% in young adulthood (age 17) (Briley & Tucker-Drob, 2013; Haworth et al., 2010).

How can the heritability of intelligence, challenging our intuition, increase during human development? We just saw how twin studies provide support for the validity of this finding, but advancements in GWA research could offer clarifying insights on its reasons. Researchers are trying to identify genes that correlate with performance in cognitive tasks (Plomin, 2018). Also, we have learned from

neuroscience that the frontal lobe, which is associated with cognitive functions, is that last brain region to fully develop, getting fully matured on average only at 25 years of age (Sapolsky, 2017). This means that some genes relevant to cognitive functioning can become fully active only at a later age, shedding light on why MZ twins have a more similar performance pattern as they age.

Another part of the explanation might resides in what will lead us to the next finding: the concept of Genetic Amplification. Certain environmental experiences are selected in a manner that amplifies previously held genetic tendencies. For instance, children with a genetic inclination towards higher intelligence are more likely to engage in activities like reading and choose friends and hobbies that stimulate their cognitive growth. So, because they select and approach certain life experiences biased by their genetics, they become more of what they "are[2]" genetically, rather than more different as they age (Plomin, 2018). This aligns with the concept of an active experience model that will be thoroughly explored in our discussion about the next "big" finding.

2.4.4 The Environment is Also Heritable

This particular finding, besides being philosophically interesting, is methodologically pertinent because it prompts us to think about the nature of every measure of the environment in developmental psychology research. In behavioral genetics, "environment" is defined negatively, being the set of forces that encompasses everything that influences behavior other than genetics (Plomin, 2018). Various aspects of this innumerably large set of influences called "environment" can be specified: parenting styles, social support, exposure to toxins, or the occurrence of certain life events such as financial ruin. These circumstances are widely measured in psychological research. These measures, as they assume to reflect only external influences, would ideally demonstrate minimal or no genetic correlation. However, a notable revelation emerged from a review conducted in 1991, which examined the first 18 studies using these environmental measures in genetically sensitive studies.

[2] Preserving the conceptual rigor of this thesis, we should notice that, of course, there is no such thing as what someone "is" genetically. Individuals develop the way they do through a complex interplay of gene-environment interactions. There is no "genetic" self that can be conceived detached from its environment. The use of "are" in this context is intended to suggest that certain stable genetic factors may become more influential as people age, rather than implying a deterministic or absolute genetic identity.

Surprisingly, these measures consistently demonstrated evidence of significant genetic influence on environmental measurements (Plomin & Bergeman, 1991).

This unexpected genetic influence on environmental measures is of unparalleled importance for understanding human development. As we will see, it can be attributed to the intricate interplay between genetics and environmental shaping. What happens seems to be the following: rather than assessing an external environment truly independent from the individual's genetic constitution, these measures capture the interaction between a person's genetic constitution and their environment-shaping behavior. The idea is powerful, yet simple: *as individuals, we tend to select, modify, and even create environments that align with our genetic inclinations, including our personality traits and psychopathological tendencies* (McAdams, Gregory, & Eley, 2013). This interaction leads to situations where seemingly environmental factors become entwined with genetic influences. Several studies in Behavior Genetics have shown that parenting practices can reflect variations in children's genetic characteristics like temperament and psychopathological tendencies (Avinun & Knafo, 2014; Klahr & Burt, 2014; Plomin, 1994).

This finding has been deeply influential in shaping contemporary research. Since its initial discovery, more than 150 research papers have explored the genetic impact on environmental measures using genetically sensitive designs (Plomin et al., 2016). These investigations have consistently pointed to significant genetic influence across a wide range of environmental domains. A comprehensive review of 55 independent genetic studies revealed an average heritability estimate of 27% for 35 diverse environmental measures (Kendler & Baker, 2007). A 2014 meta-analysis of the issue of parenting styles, which, as we discussed in the first chapter, is now a frequently studied environmental domain, has shown that variation on parenting styles (such as authoritarian or hyper protective) is driven not only by the parent's genetic characteristics but also by the child's genetic characteristics (Avinun & Knafo, 2014; Klahr & Burt, 2014).

This means that, since our infancy, we are constantly participating in shaping the environment that surrounds us. This even includes, to a degree, the treatment we are likely to receive from our parents. Naturally, when life events are categorized as uncontrollable (such as the death of a spouse by accident) as opposed to those that are sensitive to our actions (such as financial problems), the former tend to show

nonsignificant genetic influence (Plomin et al., 2016). Additionally, cross-cultural analyses have highlighted variations in the heritability of some environmental aspects. Touching on the inherent context sensitivity of heritability measures discussed in the beginning of this chapter, studies of parenting in Japan point to more genetic influence when compared to Sweden, probably reflecting cultural differences in parenting approaches (Shikishima et al., 2012).

To summarize, this finding is about the important revelation that numerous environmental measures show significant correlation with genetic constitution. This frontally challenges the traditional understanding of the environment as a set of independent external factors. Behavioral genetics findings demonstrate that our behaviors and choices — which from our perspective might appear to be guided by sheer free will — are in fact constantly influenced by our genetic differences, which explains the evident genetic influence on environmental measures. This highlights the complexity of the Gene-Environment Interplay.

2.4.5 Abnormal is Normal

Now we shall consider the last "big" finding in behavioral genetics, which is extremely pertinent to psychiatry and clinical psychology. A fundamental question in psychopathology pertains to whether mental disorders are in essence an extreme instance of normal psychological traits (dimensional model), or if there is something about mental disorders that justifies them being considered qualitatively distinct entities (categorical model) (Paris, 2022). One of the ways of approaching this issue is to look at what genetics can inform us.

While many rare single-gene disorders, like Phenylketonuria (PKU), have genetic roots that are clearly distinct from those that build normal phenotypes, this distinction becomes blurred when examining the genetic underpinning of mental disorders such as Major Depressive Disorder, Schizophrenia, Autism or Attention Deficit Disorder (Paris, 2022). The genes associated with mental disorders are found to be correlated with normal personality dimensions, and vice versa. Moreover, the focus on polygenic scores in genetic research has revealed that these scores, which as we noticed are derived from the aggregation of many genes with small effects, follow a normal (Gaussian) distribution (Plomin, 2018). Since almost all measurable dimensional phenotypes in nature — like weight or height — follow the Gaussian distribution, this observation supports the idea that what inclines people in certain

contexts to develop mental disorders are actually just quantitative extremes of normal genetic variations. In other words, what is labeled as the "abnormal" is, from genetics standpoint, the expected extreme of a normal variation. The essence of mental illness is, in an important sense, a quantitative one; not a qualitative distinct (Plomin, 2018).

Summarizing, this "big" finding is about the cumulative evidence from quantitative genetic methods and DNA research strongly suggesting that, from a genetics standpoint, mental disorders are not qualitatively distinct from normal psychological variation; rather, they represent an expected extreme end of the same genetic tendencies that influence the entire distribution of behaviors.

As a final remark to the second chapter, it is essential to explore the broader epistemological ramifications that these findings can hold. Also — and this will be one of the main issues of the following chapter — how we view and interpret the interplay of genes and behavior is deeply rooted not just in the contents of the evidence we gather, but also in the manner we understand, examine, and give meaning to this evidence. This is essentially the matter of the next chapter of this thesis. How do these revelations challenge or reshape our existing paradigms to comprehend human nature and development? And in what ways our approach to gathering and interpreting pertinent evidence might evolve based on such insights?

Chapter 3: Behavioral Genetics Epistemic Implications

Since contemporary research questions increasingly transcend the conventional and traditional boundaries of individual disciplines, there is a growing recognition in science of the value of interdisciplinary collaboration. Behavioral genetics stands as a model example of this interdisciplinarity: it merges psychology's exploration of human behavior and mental processes with the study of genetics, which primarily focuses on objects such as the DNA and phenomena like genetic inheritance or mutations. Furthermore, as our discussions from the previous chapter emphasized, behavioral genetics also integrates knowledge beyond these two disciplines: it frequently draws insights from other fields such as population dynamics in biology and advanced statistical methods employed in meta-analysis.

In this chapter, we will explore how the behavioral genetics findings can affect other disciplines; conversely, how other disciplines can illuminate the way we interpret behavioral genetics findings. While the movement towards collaborative exploration is obvious in contemporary scientific endeavors, it is worth noting that such interdisciplinary spirit is not a recent idea at all. Actually, it has its roots in ancient philosophy. And this notion forms the foundational basis for our discussion in this chapter.

Despite the absence of the modern scientific categorizations prevalent today, incipient versions of interdisciplinary thought trace back to the Classical Period. Plato, for instance, posited that the evolution from ignorance to enlightenment is possible through a type of education that encompasses different subjects such as mathematics, music, physical education, and philosophy. This suggests that Plato, and perhaps also his contemporaries, recognized that a comprehensive education should not be solely oriented toward specialization. They noticed that valuable insights for addressing specific issues could emerge from diverse and even remote fields of inquiry. This approach reflects an early instance of interdisciplinary thinking, through which diverse fields of knowledge contribute to offer a deeper perspective that is greater than the sum of the individual contributions (Godfrey-Smith, 2003).

Beyond the contribution from the ancients, recent developments in Philosophy of Science, like the already mentioned Thomas Kuhn's notion of paradigm shifts, shed light on the natural and intrinsic limitations of scientific research. In his seminal book "The Structure of Scientific Revolutions", Kuhn (1962) argues that scientific

revolutions result from a particular view toward nature's insufficiency to explain certain observations, which he termed "anomalies". He argued that normal scientific activity is based on a previous and widely acknowledged scientific achievement — a paradigm. Scientific revolutions, which happen only occasionally, occur when one paradigm replaces another. An example thoroughly discussed in Kuhn's book is the case of Einstein's general relativity supplanting Newton's theory of gravitation. Kuhn emphasizes that Einstein's work was not merely the proposal of an additional theory; it redefined the most foundational concepts in physics, such as time and space (Kuhn, 1962).

Even if Kuhn's concept of paradigm shifts does not encompass all significant scientific progress, it does illuminate the idea that crucial advancements in science sometimes arise from novel perspectives on phenomena, rather than the mere accumulation of research within an established framework. What stands out from this is that, in certain circumstances (in our case, the investigation of human development or the origins of individual differences), it becomes more important to reevaluate concepts and presuppositions than to merely amass additional data. This proposition serves as the guiding principle behind this thesis. So, for instance, in the context of behavioral genetics, the shift it suggests from a simplistic naturist/nurturist opposition to a dynamic and more complex understanding of Gene-Environment interactions exemplifies a rethinking of basic thought parameters. Additionally, given the sensitive and complex nature of heritability measurements, language precision and refinement prove to be crucial in Behavior Genetics research and interpretation.

After Kuhn, the philosopher Paul Feyerabend (1975), in his book "Against Method", questioned the concept of a singular and universally applicable scientific method. In this regard, Feyerabend's perspective was notoriously radical. He advocated for what he termed "investigative anarchism", suggesting that diverse disciplines with fundamentally different rationales contribute unique perspectives to the overall pursuit of knowledge (Feyerabend, 1975). While assessing the quality of Kuhn's or Feyerabend's philosophies is surely beyond the concerns of this thesis, their perspectives support the idea that the significant developments in behavioral genetics we discussed would continue to benefit from interdisciplinary collaboration. Insights combined from genetics, psychology, evolutionary biology, neuroscience and other fields would further illuminate the intricate interplay producing human behavior,

and prevent scientists from becoming narrowly entrenched in their own established and rigid frameworks.

These philosophical perspectives find appreciation in the ongoing discussions of the field (Bloom, 2023). The convergence of advancements in genetic technology, combined with insights from psychology and neuroscience, enables researchers to explore the interactions between genes, behavior and brain functioning in novel ways (Plomin, 2018; Hagenbeek et al., 2023). For instance, the integration of behavioral genetics with neuroscience has yielded a deeper understanding of the neural mechanisms underlying certain behavioral traits (Turkheimer & Waldron, 2000; Hagenbeek et al., 2023). In this chapter, we will explore how this fusion is crucial in contemporary psychopathology, providing a more comprehensive view of the complex dynamics between genetic factors and neural networks. Considering this all together, behavioral genetics exemplifies the profound relevance that interdisciplinary collaborations can have not only in advancing specific domains but also enriching our general understanding of the complexities of human constitution.

3.1 Complexity, Causality and the Simplicity Bias

An interesting way to initiate the interdisciplinary analysis of behavioral genetics and explore its epistemic implications comes from insights abstracted from Cognitive Psychology. The field of Cognitive Psychology studies the nature and patterns of human perception and thinking (Pinker, 2002). It could offer us, therefore, useful insights into the biases we are likely to encounter when dealing with considerably obscure themes such as psychological development.

As we delve into the discussed intricacies unveiled by behavioral genetics, it is crucial to understand the nature of our cognitive inclinations, which often push us towards simplistic explanations. One particularly compelling observation arises from our known propensity to establish stereotypical connections between phenomena, often leaning toward oversimplification in thought and superstition. The cognitive inclination toward superstition has received broad recognition in psychology since Skinner's (1948) groundbreaking research involving pigeons. What Skinner initially uncovered in behaviorism has resonated within the realm of cognitivism, since the nature of our cognitive processes is connected to the existence of stereotypes and simple associations (Pinker, 2002).

As Pinker (2002) argues, this human disposition to think linearly, to establish superstition in thought, and by extension illusory connections between phenomena, is an extremely harsh bias to overcome (Pinker, 2002). Thinking in terms of complexity or multivariate thinking — exactly what behavioral genetics findings prompt us to do — may be both less satisfactory and more challenging to carry out. Embracing complexity entails acknowledging that we lack the capacity to foresee results for countless subjects of our interest, either due to incomplete knowledge of all variables or the sheer inability to accurately calculate them (Gibb et al., 2019).

A historical outlook can once again enrich our discussion: it appears to support the observation that theories of a simpler nature often gain popularity more effortlessly and with less demand for rigorous empirical justification (Prinz, 2012). As psychiatrist Joel Paris (2022) notes, the notion of a "gene for" every condition or trait, as well as linear effects of childhood abuse — namely, univariate theories — still attract many followers, even though they strongly contradict the vast body of empirical evidence discussed so far. To clearly understand the underlying factors of deeply intricate processes, such as the emergence of behavioral traits, one needs to adopt perspectives and models that mirror the inherent complexity of certain issues and accept the impossibility of achieving perfect predictions (Paris, 2022).

Humans, as a social species, are deeply motivated to understand and predict the behavior of others (Bloom, 2023). The challenge of making accurate predictions, however, increases dramatically when a discipline deals with phenomena heavily influenced by multiple factors. This undoubtedly characterizes both psychology and psychopathology, especially when accounting for the previously discussed insights from behavioral genetics (Pinker, 2002).

In fact, as Gibb et al. (2019) point out, the difficulty in predicting an outcome when multiple factors are active is so overwhelming that it also extends to more basic (in terms of variable complexity) fields of science such as classical mechanics. In astronomy, for instance, a notable example lies in the formidable challenge of accurately calculating orbits when the gravitational interactions involve three or more celestial bodies (Gibb et al., 2019).

Rather than attributing this challenge to a lack of knowledge about the gravitational force's behavior, the complexity arises from the intricate interplay of well-known and established forces. This specific epistemological constraint arises, therefore, from the complex interaction of the influence of various elements, rather

than from a lack of understanding of the inherent nature of these forces in isolation. Even within the sharp and rigorous realm of the hard sciences, there is a consensus that linear models centered on isolated causes and effects lack effectiveness in fully understanding numerous situations (Paris, 2022). There is simply no compelling reason to assume that this scenario would differ in the context of human development.

In examining all of this, two distinct dimensions are evident. Epistemologically, we are constantly accompanied by the primitive urge toward predicting and comprehending human behavior (Bloom, 2023). However, from an ontological viewpoint, the subject matter — our own nature, motivations, and the underlying factors of our variances — proves to be extremely complex. This abyssal disparity between our strong epistemic aspirations and the ontological complexity of our interests might bias us to adopt oversimplified theories about human behavior. In certain areas of scientific investigation, it might be better to acknowledge and accept a degree of inherent uncertainty than to be satisfied with theories that pretend to explain it all. In many investigative circumstances, the relevant variables are simply too numerous to yield meaningful predictions. Crucially, the exploration of interactions among multiple factors not only entails merely challenges in variable computation, but also frequently uncovers surprising properties that arise from the combination of individual factors in certain situations. This adds a new layer of epistemological challenge: it is known as Emergence (Gibb et al., 2019).

3.1.1 Emergence

Bridging philosophy and science proves its importance to the degree it allows for a deeper appreciation of the complex phenomena that surround us. One concept that certainly demonstrates the significance and usefulness of this interdisciplinary effort with philosophy is called "emergence". This concept, which is now indispensable to the development of many fields of empirical research, also has its roots in ancient philosophy. Aristotle (ca. 350 B.C.E./1924) in "Metaphysics", gave one of the earliest known descriptions of what we now call emergentism: "*things which have several parts and in which the totality is not, as it were, a mere heap, but the whole is something beside the parts*" (Book VIII, Part 6). This philosophical foundation, set by Aristotle, paved the way for many thinkers to better explore the notions of emergence and complexity.

So, similar insights emerged in more recent philosophical works. Among the numerous scholars who have brilliantly explored this topic, John Stuart Mill stands out. In "A System of Logic, Ratiocinative and Inductive", Mill (1858) observes: "The chemical combination of two substances produces, as is well known, a third substance with properties entirely different from those of either of the two substances separately, or of both of them taken together" (Mill, 1858, p. 211). This statement from Mill emphasizes the crucial distinction between mere aggregations and the surprising properties that arise from certain combinations of elements in nature. This idea of unexpected properties stemming from combinations has indeed intrigued many thinkers.

Advancing even more our comprehension of this notion, the philosopher G.H. Lewes introduced the term "emergent" in 1875, differentiating it from the simpler notion of "resultant". He stated:

> Every resultant is either a sum or a difference of the co-operant forces: their sum, when their directions are the same – their difference, when their directions are contrary. Further, every resultant is clearly traceable in its components, because these are homogeneous and commensurable. (Lewes, 1875, p. 369)

This perspective aligns, for instance, with typical cases in classical mechanics when two or more forces can be summed (e.g. gravity and downward propulsion) or subtracted (e.g. gravity and drag) to produce a resultant. However, when Lewes delved into the concept of "emergence", he proposed a different and more complex idea:

> It is otherwise with emergents, when, instead of adding measurable motion to measurable motion, or things of one kind to other individuals of their kind, there is a co-operation of things of unlike kinds. [...] The emergent is unlike its components in so far as these are incommensurable, and it cannot be reduced to their sum or their difference. (Lewes, 1875, p. 369)

This delineation clearly underscores the distinctiveness of emergent phenomena as compared to mere resultants. The concept of emergence holds

significant relevance in numerous facets of psychological development, especially when trying to understand it from a neurological or genetic perspective. It underscores the nature of mental disorders as well as normal psychological characteristics: *both neural and psychological development carry a chaotic nuance; what occurs at foundational levels — like that of individual neurons or genes — does not straightforwardly manifest in observable behavior* (Bloom, 2023).

In other words, *it is impossible to predict behavior by solely examining individual genes or isolated neurons* (Paris, 2022). As Sapolsky (2017) points out, there is no fundamental distinction between the human brain and that of a fly. *The perceived fundamental qualitative difference is essentially rooted in emergence*, due to the scale and number of active neuronal networks. Behavioral genetics also seeks to shed a light comprehension of mental processes. But instead of delving into the intricate inner workings — which are extremely complex — it begins by emphasizing the statistical correlations between genetic makeup and behavioral outcomes (Plomin, 2018). The fact that the human brain is composed of almost 100 billion neurons is the ultimate testament to this complexity (Damasio, 1999).

Summarizing, emergence, in the context of contemporary neuroscience, illuminates how interactions between billions of individual neurons and brain networks give rise to emergent (and unpredictable) properties at various levels of organization, shaping both cognitive and emotional processes. By embracing a degree of uncertainty, acknowledging the role of genetics elucidated by behavioral genetics, and considering the invariably intricate mechanisms underlying mental health conditions, we are better positioned to understand the etiology of human behavior in a theoretically sound model (Paris, 2022).

Expanding on this very issue, the psychiatrist Joel Paris (2022) highlights the substantial degree of ignorance we have when it comes to the etiology of mental conditions. Developmental psychopathology had long noticed an intricate relationship between risks and outcomes. Such connections, notoriously, can exhibit both *multifinality* and *equifinality.* These terms, in essence, refer to the known pathways of convergence and divergence between risks and mental health outcomes. *Multifinality* refers to the fact that the same risk factors in psychopathology do lead to very different outcomes. *Equifinality*, inversely, means that the same type of psychopathology can emerge from different developmental risk factors of both genetic and environmental nature. Risks and outcomes are clearly not bound by

straightforward, linear trajectories; instead, evidence suggests they follow paths that can both converge or diverge in various directions (Paris, 2022).

Similar risk factors lead to different kinds of psychopathology in different patients or even to no symptoms at all (Paris, 2022). Why does this occur? Addressing the specificities of why these varied outcomes occur, unfortunately, lies beyond the scope of this thesis. However, the recognition of the complexity inherent in the answer is within our scope and crucial to our discussion. Such complexities in developmental paths reinforce the idea that, while we can speak of a pattern of regularity and tendencies, linear predictions based on risk factors or genetic constitution will always be elusive to a degree in the field of psychopathology.

3.1.2 Implications for Research Methodology

This notion of complexity, fostered by contemporary behavioral genetics, holds significance not only in shaping perspectives on human development and other intricate issues but also is proving to be decisive in shaping the methodologies employed in psychopathology research. Historical research in psychology often relied on univariate statistical tools such as t-tests and chi-squares. Today, however, the approach to methodology is fundamentally different. Presently, multivariate statistics have become a prerequisite for the acceptance of studies focusing on psychopathology, and this is also due to the acknowledgment of the importance of genetic factors (Paris, 2022).

Of course, as Paris (2022) highlights, this shift implies practical difficulties. Due to statistical reasons, to conduct multivariate analysis properly requires a much larger sample. And since the cost of research increases with sample size, if the research funds remain the same, researchers might search for a more convenient albeit less representative sample, such one composed only of, say, students of a single university course. This is clearly problematic, as undergraduate students are not representative of the population of any given territory, not to mention other regions of the world (Henrich, 2020).

To sum everything up, in our quest for understanding, we often seek, maybe for our own psychological comfort, straightforward explanations and readily identifiable patterns, even in matters of evident complexity. As Steven Pinker (2002) elucidates, this cognitive proclivity to oversimplify and categorize means a cognitive bias that influences how we perceive and interpret the world around us. This

inclination, while probably expedient in many everyday life matters, may hinder our capacity to accurately comprehend multifaceted issues, such as the interplay between genetics and development. Moreover, embracing complexity is certainly in a sense frustrating: as already pointed out, it implies the sheer impossibility of making perfect predictions.

Consequently, this all prompts a shift in our vocabulary, requiring us to replace expressions like "caused by" and every sort of rigid notions of cause and effect with a nuanced and sometimes probabilistic perspective. Particularly in the context of genetics and development, where multiple variables interact, more suitable terms encompass a probabilistic framework, such as "influenced by", "context-dependent inclinations" and "context-dependent risk factors" (Sapolsky, 2017; Paris, 2022). When acknowledging this nuanced interplay and the deep limitations of deterministic language, it becomes vital to delve into realms where these complex interactions manifest most vividly. One such realm is known as Epigenetics.

3.2 Epigenetics

Epigenetics, broadly defined, refers to modifications in gene function that do not involve changes to the underlying DNA sequence. Instead, they involve changes in how genes are expressed, often as a result of environmental influences (Sapolsky, 2017). The allure of epigenetics from the behavioral geneticists standpoint lies in its potential to explain individual variability. Even MZ twins, which as we discussed are a genetic clone (they share 100% of their genome), do exhibit differences in behavior and manifestation of mental conditions (i.e. heritability is never 100%), and epigenetics offers a mechanism for understanding these discrepancies (Plomin, 2018). Epigenetic marks, such as DNA methylation or histone modifications, can be influenced by external factors like stress, nutrition, or exposure to toxins, which can in turn affect gene expression and subsequently behavior (Sapolsky, 2017).

One of the things that is especially important, given the scope of this thesis, is that the examination of epigenetics compels a reevaluation of the traditional nature versus nurture dichotomy. A clear-cut distinction between what is innate ("nature") and what is environmental ("nurture") becomes problematic when considering epigenetics. As discussed in the second chapter, traditionally, "environment" has been defined negatively: it encompasses all external factors influencing behavior, aside from the innate ones. However, epigenetics blurs this sharp distinction by

showing how environmental factors can directly influence gene expression. If we take the findings of epigenetics into account, then what is innate is different from what is genetic.

While genes certainly form a fundamental part of our biological makeup, epigenetics suggests they do not exclusively define all innate characteristics. Due to epigenetics mechanisms, the same genetic sequence can lead to different effects, influenced in its expression by certain environmental factors, including those of prenatal circumstances. Therefore, innate dispositions are not solely dictated by genes; they are also shaped by the mechanisms controlling gene expression, which, in turn, are themselves affected by the environment (Sapolsky, 2017).

This leads to a challenging conceptual question: when considering an epigenetic profile that a person is born with, how should we categorize it – as part of their "nature" or "nurture"? For instance, let us consider the epigenetic phenomenon of transgenerational trauma, the possibility of effects of trauma experienced in one generation manifesting in subsequent generations (Sapolsky, 2017). Should the inheritance of trauma effects through epigenetics be classified as someone's "nature" because it is something inborn; or does it fall under the category of "nurture", because it was something ultimately produced by the environment and exterior to the genetic sequence?

To address this issue, it is important to understand that epigenetics, by its own nature, is about the interplay of genetic makeup and environmental influences. This concept implies that our inherent traits are not rigidly pre-determined but are rather a flexible set of entities that responds to external stimuli. Therefore, epigenetics acts as a connecting point between innate qualities (nature) and external shaping factors (nurture), highlighting that human development is a complex, inherent and continuous interaction between our genetic foundation and the environments we encounter.

In sum, the contributions of behavioral genetics and epigenetics are certainly complementary, each shedding light on different aspects of human development. Behavioral genetics quantifies genetic influence, while epigenetics reveals how environmental factors can modify gene expression. This interplay challenges our traditional understanding of nature and nurture, suggesting a much more integrated model of human development where genes and environment are inextricably linked. This complex interplay underscores the importance of considering both genetic and

environmental factors in understanding human behavior and development (Plomin, 2018; Hagenbeek et al., 2023).

3.3 Behavioral Genetics and Darwinism

Behavioral genetics and evolutionary theory represent two distinct but in an important sense complementary fields that, if integrated, can further contribute to understanding the complex nature of human behavior and its evolution. Behavioral genetics, as examined, investigates the role of genetic factors in shaping individual differences; darwinism, on the other hand, as we discussed in the first chapter, is an evolutionary theory, pertaining to the adaptive mechanisms that drive genetic evolution (Sapolsky, 2017). The integration of these fields could allow for a comprehensive exploration of the interplay between genetic inheritance and natural selection in the development of behavioral traits.

As previously presented, one of the "Big" findings in behavioral genetics is that all complex traits, including personality traits and cognitive abilities, have substantial heritability (Plomin, 2018). This means that variations in genetic makeup corvary with differences in mental makeup, which in turn have consequences for survival and reproduction. This genetic basis of variation can be considered the raw material upon which natural selection acts, with advantageous traits being more likely to be passed on to subsequent generations, leading to the evolution of behavior over time (Sapolsky, 2017). This may help to elucidate why the human brain has evolved so efficiently: if variation in mental capacities were not heavily influenced by genetic variation, natural selection would not have material to work its influence.

This is a simple but powerful example of how association between these two fields can offer insights into the origins and evolution of human behavior. Darwinism, grounded in the principle of natural selection, elucidates the evolutionary processes that have shaped the genetic constitution of biological organisms. Recognizing the evolutionary origins of our genetic structures deepens our understanding of the hereditary influences of behavioral traits. Darwinism, as discussed in the first chapter, offers us the idea to reflect on how specific behaviors have been naturally selected as beneficial traits over time. And this is the fundamental process that shapes the genetic tendencies that modulate our reactions to our surroundings (Sapolsky, 2017). Combining this evolutionary perspective with the insights of behavioral genetics offers a comprehensive lens to dissect the intricate relationship between our inherited

genes and environmental stimuli (Plomin et al., 2016). In understanding these evolutionary principles — and being vigilant to their frequent misconceptions — we are better equipped to interpret the findings of behavioral genetics and its real-world implications, ensuring that we remain theoretically accurate while exploring the nature of the genetic influence on behavior**.**

3.4 Behavioral Genetics and Emerging Social Sciences Frameworks

Advancing our interdisciplinary explorations, the growing intersection between Behavioral genetics and social sciences represents another significant advancement that has implications for understanding human behavior — but this time considered under social circumstances. The contribution of behavioral genetics for social sciences frameworks once again highlights the complexity of human behavior, because it emphasizes the combined influence of genetic predispositions and environmental factors in shaping traits and behaviors that manifest in social circumstances. The acknowledgment that genetic factors interact with culture and other environmental factors to influence behavior has prompted researchers in social sciences to adopt a more nuanced perspective and new frameworks for understanding social behavior (Plomin & Daniels, 2011).

The renowned psychologist Steven Pinker (2002) argues that the neglection of the role of genetics in the realm of social sciences has promoted a myriad of theoretical problems, deeply hindering the basics of our understanding of human behavior and societal dynamics. Pinker, as a prominent cognitive psychologist and author, is one of the main figures that criticize this absence, highlighting the significance of genetics in shaping various aspects of human nature. Pinker's works, such as "The Blank Slate: The Modern Denial of Human Nature" (2002) and "How the Mind Works" (1997), emphasize the interconnectedness of genetics and social phenomena. The backlash against Eugenics, which, as we discussed, was a political project supported and advanced by Galton, produced the problematic outcome of banishing the field of genetics and heredity from the humanities (Prinker, 2002).

Galton's political projects were certainly reprehensible, but our solution for his ethical shortsightedness should not be to avoid biology or genetics but to better understand these fields and how their findings connect to human behavior (Paris, 2022). Acknowledging the relevance of genetics is much different from embracing genetic determinism or eugenics. Neglecting genetics in social sciences ignores the

powerful evidence that was brought forward by behavior genetics. This can later translate into oversimplified or misguided explanations for complex social phenomena, most likely reducing our capacity for effective policies or interventions.

The Gene-Environment Interplay model accounts for how genetic predispositions can interact with certain environmental contexts to produce particular outcomes (Plomin, 2018). This was pointed out previously in the second chapter, when the "big" finding of the heritability of the environment was discussed. But in this section we should address the fact that behavioral genetics has extended its reach beyond traditional biological and psychological domains to encompass socio-behavioral phenotypes. These phenotypes, which are in essence behavioral patterns, include complex behavioral traits that have social and cultural implications, such as political attitudes, religious beliefs, and interpersonal behaviors (Plomin, 2018). The integration of behavioral genetics with social sciences frameworks could allow for a deeper exploration of the origins of these traits, considering both genetic contributions and the sociocultural context in which they emerge (Hatemi et al., 2014). Researchers are increasingly adopting interdisciplinary approaches that combine genetic analyses with sociocultural investigations to elucidate the multifaceted origins of human behavior (Sapolsky, 2017).

In conclusion, the relationship between behavioral genetics and emerging frameworks within the social sciences attests to the ontological interdependence of biological and environmental factors in shaping human behavior. The integration of genetic insights with social sciences perspectives offers a more holistic understanding of individual and collective behaviors that match such an interdependence. New models could emphasize the importance of considering both heredity and environment in the study of human behavior (Plomin, 2018).

As a final word on this matter, neglecting biology in the social sciences is an epistemological blunder for the same reason that studying chemistry without considering the fundamental principles of physics would be. Let us imagine a chemist attempting to understand chemical reactions, molecular structures, or the behavior of elements completely restricted to the lens of chemistry, knowing nothing about the underlying physical forces that govern these phenomena. In this scenario, crucial insights about the nature of chemical reactions would be missed, leading to incomplete and sometimes completely mistaken conclusions.

Similarly, biology serves as a foundational framework that underlies, in a very important sense, all aspects of human behavior and societal dynamics. Just as physics provides insights into the electric forces that fundamentally govern all chemical reactions (i.e. the changing in atomic bondings and electron states), genetics provides the fundamental basis for understanding human traits, cognitive abilities, and innate inclinations. *This does not entail that either chemistry or psychology should be reduced to fit the concepts and language of physics or biology*. *Nor does it mean that thinking about our biology is more important than thinking about our culture or environment*. Behavioral genetics findings reveal that culture, along with any other environmental aspect, does not stand in contrast to our nature but intertwines with it. That said, disregarding biology in the social sciences inevitably results in a narrow viewpoint, hindering a thorough understanding of the intricate interplay between nature and nurture that molds human behavior and thus the whole fabric of society.

3.5 Behavioral Genetics in Psychopathology: Dimensions and Categories

Besides the broader discussion of the inherent interdependence of biology and environmental factors in human behavior, it becomes pertinent to examine how this interplay manifests in specific areas of psychological research. One such area is the study of psychopathology, where the intersection of behavioral genetics with traditional psychological frameworks has led to deeply transformative insights.

The essence of the influence of behavioral genetics in psychopathology can be seen as the acknowledgement of the fundamental principle that psychological phenotype is a product of both genetic and environmental factors (Plomin, 2018). Just as the study of chemistry at some point cannot be divorced from the principles of physics, the understanding of psychopathology cannot be fully realized without considering the genetic underpinnings of mental disorders. The categorical approach, as established by the DSM-III in 1980, has provided a valuable structure for the diagnosis and treatment of mental disorders (American Psychiatric Association, 1980). Yet, the evolving insights from behavioral genetics suggest that this approach might be overly simplistic, potentially overlooking the complexities and nuances inherent in the genetic basis of psychopathology (Paris, 2022).

Behavioral genetics, as examined in the second chapter of this thesis, offers a new perspective to the understanding of mental disorders. We saw that supports the

view that mental disorders are not discrete entities entirely separate from normal psychological functioning. Building upon the previously discussed findings, it posits that these disorders exist on a continuum with normal behavior, influenced by both genetic and environmental factors (Plomin, 2018). This perspective aligns with a dimensional approach, which considers mental disorders as extensions or exaggerations of normal psychological traits, influenced by a combination of genetic predispositions and environmental experiences.

As we move forward, we will uncover the importance of integrating these insights from behavioral genetics into the study of psychopathology. This integration not only promises a more comprehensive understanding of mental disorders but also aligns with the broader theme of this thesis: the intricate and inseparable connection between our genetic makeup and our environmental interactions. In this section, we will explore how this integration challenged and reshaped the influential categorical framework of the DSM-III, highlighting the role of genetics in the continuum of mental health and illness (Plomin, 2018; Paris, 2022).

The study of psychopathology, which encompasses the understanding, classification, and treatment of mental disorders, has changed significantly in recent years due to its intersection with behavioral genetics (Plomin, 2018). As already mentioned, a crucial aspect of this transformation is the debate over the categorical versus dimensional approaches to classifying mental disorders. Since the revolutionary release of the DSM-III in 1980, psychiatric diagnostic systems have followed a categorical structure, which define mental disorders as separate entities based on specific criteria (American Psychiatric Association, 1980). However, behavior genetics research, as discussed earlier, has revealed a more nuanced understanding of the etiology and nature of mental disorders, bringing attention to the role of genetic factors (Plomin, 2018).

This categorical versus dimensional dispute, fueled by behavioral genetics discussions, has prompted the emergence of novel models that seek to reconcile these perspectives (Paris, 2022). The DSM-5 introduced an alternative model for personality disorders, which explicitly acknowledged the influence of behavioral genetics findings on the elaboration of the dimensional approach. This model includes the "Personality Disorder Trait Specified (PDTS)" category, which assesses personality traits on a spectrum of severity rather than adhering to the categorical definitions proposed in the DSM-III. This shift aligns with behavior genetics insights

and demonstrates its current relevance in psychiatric literature, acknowledging the inherent complexity of the etiology of personality traits (Plomin, 2018). Indeed, one might assert that the recent contribution of behavioral genetics in reshaping psychopathology has been more profound than most contributions of neuroscience. Furthermore, the International Classification of Diseases (ICD-11) model, advanced by the World Health Organization (WHO), also exemplifies the integration of behavioral genetics and emerging models within the context of personality disorders. This model also proposes a dimensional assessment of certain mental disorders. By considering the contributions of genetic factors in conjunction with environmental influences, the ICD-11 model acknowledges the multifaceted nature of personality disorders while trying to preserve clinical applicability (Mulder, 2021).

3.5.1 Behavioral Genetics in Psychopathology: Network Models

The preceding discussion highlighted how the integration of behavioral genetics into the study of psychopathology has influenced the evolution from a categorical to a dimensional approach for mental disorders. This conceptual shift, which acknowledges the genetic underpinnings of mental health conditions, opens the stage for a further exploration of psychopathology from different standpoints. This section of this thesis aims to delve into an alternative perspective that challenges traditional views in mental health, one that is increasingly supported by findings in behavioral genetics (Hagenbeek, et. al, 2023).

Since the early works of Freud (1900), there has been much allure in thinking of mental health conditions in a similar manner as modern medicine typically views the relationship between diseases and symptoms — that is, through the lens of cause and effect and the investigation of underlying problems. The western biomedical paradigm is largely predicated on the separation of pathological conditions from their symptoms. The highest goal in medicine is to remove the cause, not merely the symptoms (in latin: "*Tolle causam"* or "remove the cause"). But this is only possible because in medicine symptoms usually can be differentiated from causes. For instance, one might have a cerebral tumor (cause or underlying condition) without headaches (symptom) and vice-versa (Hyland, 2011).

In contemporary psychopathology, however, the validity of a delineation between mental disorders and their symptoms is far from obvious. That is, unlike the direct and usually clear causal relationship observed in medical conditions, the

existence of mental disorders as discrete entities distinct from their symptomatic expressions remains obscure and difficult to sustain (Hyman, 2010). Importantly, emerging research in psychopathology suggests that mental health symptoms might not be merely the outcome of mental disorders but could also be themselves a causal role in their onset, preservation and progression.

To elucidate what this means, we can think of a series of stressful events that lead someone to experience symptoms such as insomnia, fatigue and sadness. These symptoms, in turn, could prompt other symptoms like decreased appetite, anhedonia, concentration deficits and negative thinking to emerge. This network pattern of symptoms that mutually cause and reinforce one another could be the essence of the mental disorders such as Major Depressive Disorder (MD) (Cramer et al., 2012; Keller, Neale, & Kendler, 2007).

Methodological advancements have aimed to map these intricate symptomatic networks. As an early effort in this sense, Kim and Ahn (2002) asked experienced clinicians to intuitively sketch networks of causal relationships between symptoms of disorders like Anorexia Nervosa or Major Depression based on their clinical experience. Also, extending this pioneering endeavor to cybernetics frameworks, some researchers posited that an individual’s symptomatic network might influence and be influenced by another's (Patzold et al., 1998; Hoffman et al., 2008). In this sense, networks of mental health symptoms can extend across individuals.

This network approach, as outlined by Cramer et al. (2012) and Schmittmann et al. (2013), was then further developed, proposing a fundamental shift in understanding psychopathology. This approach contrasts with the traditional interpretation of symptoms as messengers of underlying conditions. This new perspective treats symptoms as active components within the mental disorder itself, challenging the conventional notion of disorders and their ontological separability from symptoms. This perspective can be distilled into two fundamental premises. Firstly, there is a recognition that symptoms are not uniformly caused by a single psychological or biological condition. Secondly, is the idea that psychopathology symptoms causally influence one another to a significant degree, which challenges the notion of symptoms as mere passive outcomes of an underlying condition. Rather, in this approach, symptoms are seen as active contributors to the disorder's manifestation (Fried & Cramer, 2017).

However, advocating for the theoretical validity of network models comes with a substantial set of challenges. The absence of clear criteria for determining the completeness of networks and replicability issues pose significant problems (Forbes et al., 2021; Fried & Cramer, 2017). Moreover, network configurations can exhibit considerable variability across different patients and even for the same patient at time points, thereby questioning the generalizability and reliability of network approaches (Fried & Cramer, 2017). Amidst this complex scenario, behavior genetics, particularly with twin studies, offers a promising contribution for resolving these challenges. By assessing the twin resemblance for network parameters, especially in MZ twins, researchers can enhance the robustness of their findings from a genetic perspective (Bullmore & Sporns, 2009; Borsboom & Cramer, 2013; Olatunji et al., 2020).

As Hagenbeek et al. (2023) point out, twin studies have emerged in the last decade as a crucial tool for illuminating the genetic contributions to the idea of symptom networks, which potentially could provide decisive empirical support to the model. The way these networks are built seems to be strongly influenced by our genetic constitution. Crucially, in these networks of symptoms, there are specific symptoms or traits termed as "nodes", since they form many more connections than the rest (i.e. the presence or degree of these particular characteristics is associated with the presence of a large number of other symptoms). These crucial symptoms that are found to be "nodes" are also more strongly influenced by genetics (i.e. they have greater heritability). This fact could provide more empirical support to the network model. However, there are many challenges with these studies. It is not trivial to tell if the authors have mapped everything relevant to the network, and, as it was already pointed out, these networks can look different between people or even change over time. In any case, behavioral genetics is proving to be useful in advancing the most cutting-edge models in psychopathology (Hagenbeek, et. al, 2023).

Reiterating a prior point from the first chapter, it becomes clear that certain biases or presuppositions in scientific thought — such as the emphasis on cause and effect or the pursuit of underlying factors — deeply influence our perspective on mental disorders and human nature. It certainly may be the case that biases or blindspots are intrinsic to any science or belief system. Any particular way of thinking can aid in understanding certain phenomena but may also prevent us from seeing other facets of nature and how it works. In any case, one of the major efforts of this

thesis is to illustrate that it is essential to identify and understand these foundational philosophies and thought patterns. After acknowledging them, we are in a better position to formulate robust theories about the origins of mental conditions, transcending the current frameworks that may be hindering our advancement.

In summary, building on the latest insights from behavioral genetics, it is evident that our understanding of mental health and psychological development is undergoing a significant change (Plomin, 2018). The findings in behavioral genetics not only challenge our preconceived notions about the impact of the environment on human development but also question the traditional models of cause and effect that have long dominated psychological theory (Paris, 2022).

Behavioral genetics research reveals a complex interplay of genetic predispositions and environmental influences, suggesting that there are no straightforward, linear cause-and-effect relationships in psychological development. And to go further in this discussion about cause and effect in human development, we can consider again that parenting styles were traditionally viewed as a primary environmental factor shaping a child's development; but behavioral genetics shows that children's innate characteristics also influence parenting styles (Harris, 1998). This bi-directional nature of the influences indicates a dynamic interplay where both genetics and environment mutually reinforce and shape each other.

This perspective is crucial in rethinking psychopathology. As we discussed, psychological conditions have been traditionally viewed in a linear fashion, where certain causes (be they innate, cultural, or environmental) were thought to lead to specific characteristics or phenotypes. However, behavioral genetics suggests that this relationship is far more intricate. For example, an anxious temperament might lead to behaviors that heighten stress in one's environment, which in turn exacerbates the anxiety, creating a *feedback loop that is simultaneously the cause and the effect* (Paris, 2022).

Moreover, the findings from behavioral genetics imply that mental health conditions cannot be entirely attributed to either genetic or environmental factors (Plomin, 2018). Instead, these conditions emerge from the complex and, as discussed, often unpredictable interactions between these factors. This understanding also challenges the traditional dichotomy of nature vs. nurture, since it suggests a more integrated understanding where innate characteristics and environmental influences continuously interact and shape psychological outcomes. In

essence, behavioral genetics reshapes our understanding of psychology to the degree it highlights the intricate network of influences that contribute to mental health and human behavior. It emphasizes the importance of considering both genetic predispositions and environmental factors in a holistic manner, moving beyond simplistic and intuitive notions of causation.

3.6 Conceptual Cautions

In many philosophical works, especially within the analytical tradition, the emphasis on conceptual and language clarity is paramount. This tradition, rooted in the works of philosophers like Bertrand Russell and Ludwig Wittgenstein, holds that many philosophical problems arise from misunderstandings or misuses of language, and that by clarifying the language used to discuss these problems, we can make significant progress in understanding them (Godfrey-Smith, 2003). The analytical tradition asserts that precise language and conceptual clarity are essential tools for dissecting complex problems, enabling a deeper and more accurate understanding of the issues at hand.

This approach is particularly relevant to both the nature versus nurture debate and a proper interpretation of behavioral genetics. The previously discussed intricate interplay between genetic predisposition and environmental factors in shaping human behavior and mental conditions demands a rigorous use of language and a clear understanding of concepts. The frequent inaccuracies or ambiguities in describing genetic influences, such as the misuse of heritability statistics or the oversimplification of gene-environment interactions, can lead to misconceptions and hinder our comprehension of these complex phenomena (Paris, 2022).

As the philosopher of science Godfrey-Smith (2003) points out, the clarity and precision in our descriptions and theories not only shape our understanding but also guide our interpretations of data. By applying the analytical tradition's emphasis on linguistic precision and conceptual rigor, we can more effectively explore the extremely nuanced territory of the nature versus nurture debate, avoiding simplistic conclusions and acknowledging the multifaceted nature of human behavior and mental health.

The analytical tradition's insistence on clarity and precision takes on an important role. It enables us to delineate the boundaries of our knowledge and to identify the limitations of our current understanding. In this way, being vigilant on

language and conceptual rigor not only aids in the advancement of scientific inquiry but *also ensures that the discourse surrounding these complex issues remains grounded* in reality and informed by a thorough understanding of the underlying principles (Godfrey-Smith, 2003).

We now proceed to address some prevalent misconceptions about what behavioral genetics really conveys regarding the genetic influences on mental conditions. As we have already established in the second chapter, heritability is a population measurement that aims to reflect the proportion of variance in a trait attributable to genetic factors (Plomin, 2018). And while this measure offers important insights into the genetic foundations of many psychological traits, comprehending its actual implications can be intricate. Let us consider the heritability of Agoraphobia, which is a specific type of anxiety disorder. The DSM-5-TR, which is currently the most influential manual in psychiatry, presents the claim, without providing any contextual information, that the "Heritability for Agoraphobia is 61%" (American Psychiatric Association, 2022, p. 220). This calls for some considerations.

Reiterating a prior point, heritability, as emphasized by Plomin (2018), paints a picture of the present state of a given population; it is not an indicator of what could be true in other circumstances. By its inherent meaning, heritability should never be treated as a natural constant. By declaring that "the heritability for Agoraphobia is 61%", we might inadvertently imply a sense of permanence to this value, completely neglecting the inherent context-sensitive nature of the measure.

The previously discussed methodological nuances of heritability also allows us to detect another issue besides. Apart from being presented in the DSM-5-TR as a fixed percentage, which is an important misapprehension, it is presented with a precision of 1%, which also attests for a lack of comprehension of its meaning. As we previously observed, Tukerheimer et al. (2003) demonstrated that alterations in study parameters could swing heritability values drastically. Even the more recent studies for the heritability of personality traits, with much more methodological refinement and sample size, typically show a variation margin in findings as large as 15-20% (Plomin, 2018).

Having this in mind, offering an estimate of heritability with a relative specificity of 1/100 reflects both a conceptual imprecision and an unequivocal misunderstanding of its essence. This is the same as weighing human body weight in grams rather than kilograms. Saying "João Weighs 75543 grams" is no more informative than saying

"João weighs 75 kilograms". Despite initially appearing more precise, measuring body weight in grams instead of kilograms is actually misleading for most purposes.

If one concedes that someone's daily weight can vary by as much as 2 kilograms due to factors like fluid consumption, then such a scale becomes meaningless and unrepresentative of what it is supposed to measure. If we push for precision beyond a certain threshold, our measurements lose their relevance and start yielding nonsense. "75kg" provides real information about someone's overall weight, composed by tissues such as fat, muscle, or bone mass. In contrast, the additional information, "543g", is absolutely meaningless for any typical purpose, because it tells us only about someone's fluctuation in fluid intake. Similarly, in the realm of behavioral genetics, if the heritability estimates for mental traits historically fluctuate more than 10% across different studies, a "1%" variation in heritability for mental traits speaks only of the statistical nuances of specific studies, but nothing about the meaningful genetic correlations with phenotype we are aspiring to understand. This also wrongly suggests to the reader that our knowledge of behavior genetics is much more precise than it actually is.

Another issue besides is that many publications in the field of psychiatry still fail to make clear that a high heritability does not mean that certain genes are *causing* the trait (Paris, 2022). Since every trait or condition emerges from the interplay between genes and environment, no trait's "cause" can be isolated from the gene-environment interplay. We should remember that "heritability" essentially measures how much a trait's variance within a population can be attributed to genetic variance. The greater the covariance between a trait and genetic constitution, the higher the heritability (Plomin, 2018). Thus, what can be validly derived from a high heritability is a nuanced understanding: within a specific studied environment, individuals with certain genetic constitutions are at an elevated risk for developing certain traits or conditions.

Given that heritability is fundamentally a context-specific measure with an intrinsic level of significant imprecision, it would be more accurate to express it as "the heritability estimate for Agoraphobia, measured in the population P at time T is approximately 60%" rather than a definitive, simplistic and misleading "the heritability of Agoraphobia is 61%". This nuanced change of expression is not trivial and underscores both the dynamic and conditional nature of heritability, reflecting a more precise understanding of its application and limitations. Embracing such clarity and

precision in scientific communication is far from trivial, as it embodies the true spirit of scientific inquiry. It is vital in science to not only understand the essence and boundaries of our concepts and methodologies but also to communicate the extent of our knowledge with transparency.

Moving beyond heritability scores, the philosopher Jesse Prinz (2012) criticizes the prevalent notion of "genetic predisposition" in psychiatry. Despite being very intuitive and avoiding genetic determinism, he argues that this notion disregards Gene-environment Interplay and implies a false teleology inside the genes themselves. Through a rigorous deduction from behavior genetics principles, we are not justified in speaking of a predisposition for Agoraphobia or any other phenotype. What can be rigorously stated is only the following: behavioral genetics reveal that, within specific studied populations, variations in the occurrence of Agoraphobia were largely associated with certain genetic differences between individuals.

Notice that this is insufficient to imply a predisposition in the genes themselves. The reasoning here is straightforward: under different environmental conditions, this trait might not manifest at all, irrespective of an individual's genetic makeup. It is essential to understand that heritability provides insights into how traits correlate with genes within the conditions we have studied; it does not pretend to state an absolute truth about the roots of any trait that we are studying.

The crucial thing to be understood is that genes are very relevant in promoting individual differences but they do not operate in isolation. They are never solitary actors producing effects independently. Genes are only correctly apprehended when they are thought of as biological entities that react to certain environmental conditions (Sapolsky, 2017).

Most of the effort in behavioral genetics is to study the correlations between genetic constitution and phenotype (Plomin, 2018). But since correlation is different from causation, behavioral genetics will never be able nor does it aim to quantify the extent to which a trait is "caused" by genetics. Posing the question "How much of this trait is genetic?" is itself a conceptual blunder: genes and environment are always intertwined. It follows that their influence cannot be considered individually in a way that transcends the context of a studied population. The "causes" of mental disorders are to be found in problematic instances of Gene-Environment Interplay, never in genetic forces alone. Misunderstanding heritability, especially confusing it with causation, can have serious detrimental consequences. Oversimplifying the

causative factors of mental disorders by misinterpreting heritability statistics can lead not only to weak treatment strategies but also to problematic beliefs about one's genetic destiny (Paris, 2022).

Such beliefs can fundamentally affect individuals' perceptions of their own conditions, agency and prognosis. Naturally, this can reflect in treatment engagement, leading them to mistakenly believe that their fate is solely determined by their genes. Moreover, this reductionist perspective obscures the aforementioned multifaceted nature of mental disorders. All mental disorders arise from an extremely complex interplay of genetic and environmental factors (Paris, 2022). Crucially, a narrow focus on genetics at the expense of other contributing elements risks neglecting essential preventative environmental measures.

Summarizing, it is paramount to always approach behavioral genetics with a discerning and critical mindset, recognizing the conceptual pitfalls and the profound implications of our interpretations. The intertwining of genetics and environment is a complex phenomenon, and we must be permanently careful not to fall into the highly seductive trap of oversimplification.

3.7 Implications for Psychotherapy

As it was pointed out several times, research in behavioral genetics has profound implications across various domains of human endeavor. Notably, the field of psychotherapy can benefit from reassessing its methods or theoretical assumptions based on its findings. However, as noted by psychiatrist Joel Paris (2022), things regrettably stand in a pronounced dichotomy when it comes to mental health interventions. Paris's observation once again reinforces the notion that professionals are still seduced by simplistic explanations, failing to acknowledge Gene-Environment Interplay and consequently a more nuanced perspective of nature vs. nurture disputes. He argues that, regarding mental health interventions, things persist in antagonism and simplism, fueled by both naturist and nurturists perspectives (Paris, 2022).

Paris argues that the majority of psychotherapists lean towards nurture (environmental factors) as the primary cause of mental disorders; and most psychiatrists, on the other hand, regard nature (innate factors) as the key determinant of mental well-being (Paris, 2022). Once again this polarized divergence

in theoretical beliefs reappears and the typical lack of nuanced understanding frequently translates into problematic practical approaches.

Psychiatrists typically engage in brief outpatient interactions, sometimes focusing exclusively on medication adjustments; psychotherapists, on the other hand, sometimes venture too narrowly into the terrain of patients' life histories, investing almost all their time in detailed narratives and meticulously exploring life events and traumas. Paris argues that a substantial fraction of psychotherapists still neglect the discussed evidence of genetic forces on mental health (Paris, 2022). This ties back to our initial observations about the nature vs. nurture debate in the first chapter: at the core of any psychotherapeutic model lies an inherent premise or presupposition about human nature.

Some theorists, inclining towards the naturism and gene-centered perspectives, view human personality as virtually unchangeable and biologically determined. On the other hand, those leaning toward nurturism envision it as almost infinitely malleable by the environment. To refer to the extreme version of this nurturist position, which approaches something that would be the very denial of human nature, the psychologist Steven Pinker (2002) highlighted the "blank slate" notion, which he found to be prevalent in social sciences.

He argued that this belief infiltrates psychotherapy models as well (Pinker, 2002). As highlighted in the first chapter, seminal works, like Freud's Interpretation of Dreams, while certainly groundbreaking, did not acknowledge the possibility of genetic makeup influencing mental conditions (Freud, 1900). For that reason, many therapists overlook inherent predispositions and operate under the false presumption that children, like blank slates, are entirely molded by their familial environments (Paris, 2022). Naturally, the emerging evidence from behavioral genetics analyzed so far challenges this oversight as a major theoretical flaw.

Such theoretical orientations then lead to tangible repercussions in clinical practice. The denial of innate dispositions may prompt patients to attribute their mental suffering solely to upbringing, suggesting them to grow resentment against their parents or caretakers. Furthermore, if one operates under the nurturist belief of boundless human adaptability, they could set unrealistic therapeutic goals, or persistently attempt to alter inherently resistant traits (Paris, 2022).

In psychotherapy, it is paramount to establish empirically-grounded goals. This means that therapists should move away from the idea of achieving an idealized

level of mental well-being (Paris, 2022). Instead, many therapists are coming to the conclusion that the objective should be to help patients craft a life that aligns with their unique personalities — accentuating the positive attributes influenced by genetics and reducing the problems brought about by detrimental ones (Bloom, 2023).

By adopting such evidence-informed and grounded goals, patients will find themselves in a better position when they relinquish the pursuit of assigning blame or radically changing all of their personality traits. Associating faults with external factors, particularly upbringing, is linked to increased neuroticism and unfavorable clinical outcomes (Paris, 2022). Furthermore, persisting with this approach not only misaligns with contemporary theoretical insights but also fosters counterproductive behaviors. Embracing a robust sense of personal agency, as highlighted by esteemed psychologist Albert Bandura (1977), is foundational to mental well-being. Paris (2022) argues that patients who shift their focus away from laying blame are better equipped to adopt a proactive stance and to reclaim control over their lives. A heightened sense of control is associated with reduced neurotic tendencies (Paris, 2022).

This section, naturally, aims not to revolutionize psychotherapy principles but to highlight the inherent connection between psychotherapy formulations and beliefs about human nature and its potential for change. Behavioral genetics findings, revealing the important constitutive influence of genetics over mental traits, suggest a need to critically examine therapeutic approaches that overly focus on traumatic events. Such methods may inadvertently lead patients to assign blame, embarking on a relentless "detective hunt" for the root causes of their struggles. Paris (2022) notices that this approach often proves futile, as it is based on the empirically ungrounded idea that uncovering past traumas will instantly resolve current issues. Alternatively, a more constructive approach would encourage patients to enhance their current functioning, regardless of past experiences (Paris, 2022). This perspective values understanding the past only to the extent that it helps patients recognize their biases and problematic behaviors, equipping them to process new information and face life's challenges effectively. In any case, notions about human nature are deeply intertwined with the concepts and treatment strategies in psychotherapy, and behavior genetics findings can advance our knowledge in this sense.

However, because of the typical polarity of the nature vs. nurture disputes, the reception of behavioral genetics findings by mental health professionals, as pointed out in the beginning of this section, is varied. Sometimes these findings are just readily rejected or ignored; while other times they are misused to justify genetic determinism, or notion of a genetic "causation" of mental disorders (Paris, 2022).

Behavior genetics model's suggest that mental disorders can be understood as problematic instances of gene-environment interplay. As discussed in the second chapter, since the development of certain psychological traits or mental disorders significantly correlate with genetic makeup, any attempt to understand these issues without considering both the genes and the environment would be incomplete. However, the question about the "causation" of mental disorders inevitably ties us to a complex philosophical problem (Prinz, 2012).

In the field of mental health, a seemingly fundamental task is identifying the origins of mental health issues. But this task is, in a sense, only partially achievable through empirical methods. Research in psychopathology, for instance, enhances our understanding of the risk factors for mental illness, which, as we discussed, encompass both genetic and environmental elements. However, the manner in which we interpret and address these risk factors will always remain an open question, regardless of the empirical evidence. We have learned that a comprehensive understanding of mental disorders will emerge only if we consider the interplay of inherent and environmental factors. But, when considering the vast and intricate array of elements in this interplay, we can approach or interpret them in an almost unending number of perspectives.

Considering the notion of Gene-Environment Interplay, to what extent can we *attribute* mental disorders to problems in genetic makeup as opposed to the prevalence of environmental triggers or stressors? Are our current diagnostic categories, including those employed in behavioral genetics research, objective, or do they inherently reflect an arbitrary lens through which we view mental pathology? Can a society itself be considered mentally ill, perpetuating and normalizing pathological or destructive behaviors in a way akin to individuals? Knowing what we know about genetics, are we justified in focusing our attention or interventions primarily on the individual level, or instead should we consider broader societal changes as the primary and most intelligent targets for intervention?

As Bloom (2023) points out, there are no straightforward answers to such questions. Those are issues that intersect empirical, philosophical and ethical dimensions. This once again highlights this thesis's philosophical efforts. *Behavioral genetics alone cannot fully unravel the complex origins of mental health issues*, nor can it restrict these origins solely to genetic factors (Bloom, 2023).

Advancing on these problems, Bloom (2023) notices the philosophical aspects of the problems regarding the nature of mental pathology. He considers someone displaying symptoms of major depressive disorder following a traumatic event, like the loss of a child. While psychiatric treatment, including medication, might be beneficial, this type of depression would not be classified as a mental illness by psychiatry; it would instead be regarded as a normal response to a catastrophic event. Clinical psychologists and psychiatrists are flexible in their categories to some extent, as evidenced by the "bereavement exclusion" in earlier versions of the Diagnostic and Statistical Manual (DSM) and the careful consideration of grief in the latest DSM versions. Unless it persists after a certain amount of time, the experience of grief will not qualify as pathological depression (American Psychiatric Association, 2022).

But this all seems to be both artificial and arbitrary. Why is the justification or rationality of depression restricted only to the loss of a loved one? Why other significant life events, like a long-term marriage ending or enduring a meaningless job, are not also considered valid triggers for a reasonable depressive response? Depression, as Bloom (2023) argues, regardless of its associated with a certain genetic constitution, might be a form of grief for our lives not being as they should be (Bloom, 2023). Maybe society fails to create, organize or distribute the necessary conditions for mental health. These questions are not trivial and open room for much skepticism about overly naturist notions of mental health, proposing that sometimes our focus should be on the outside world rather than solely on the mind or genes.

In a way that resonates with all the discussions in this chapter, Bloom (2023) takes a balanced perspective on the nurture vs. nature debate. Throughout his book, he highlights that both the environment and genetics matter in mental health. But he also notices, as we should by now, that several fundamental questions surrounding mental health interventions and diagnosis are of an intrinsically philosophical nature (Bloom, 2023).

Concluding Remarks

In the preceding chapters of this thesis, we have examined the intricate and multifaceted field of behavioral genetics, exploring its significant findings and their implications for our understanding of human behavior and development. These concluding remarks will, at first, summarize these findings. Then, we will reflect about the indispensable role of philosophy in enriching and guiding our interpretation of such scientific insights. Philosophy, with its critical and reflective nature, has not only complemented but profoundly shaped our approach to the complex interplay of genetics, environment, and behavior.

A Brief Summarization of Behavioral Genetics Findings

Behavioral genetics, through its integration of various disciplines, has provided profound insights into human behavior and mental processes. This interdisciplinary field has transcended traditional academic boundaries, merging behavioral analysis with genetic science to offer a new understanding of complex human phenomena. Drawing from both ancient philosophical questions and modern scientific advancements, the field highlighted the significance of interdisciplinary collaboration in unraveling the complexities of human nature.

We examined how key findings in behavioral genetics had revealed that traits were influenced by both genetic and environmental factors, challenging simplistic naturist or nurturist views. Studies had consistently shown that traits like intelligence and personality possessed substantial heritability, indicating significant genetic components. Yet, these studies also emphasized the critical and indissociable role of the environment, as heritability was found to vary across different contexts. This variation had underscored the dynamic nature of the Gene-Environment Interplay, a pivotal concept in comprehending human development.

Moreover, behavioral genetics had established the polygenic nature of heritability, where many genes of small effect contribute to the development of complex traits. This insight, emerging at first from animal selection studies and then corroborated by Genome-Wide Association studies, supported the notion that heritability results from the cumulative effects of numerous genes.

Additionally, one of the field's most striking findings was the increasing heritability of intelligence and other traits with age, countering the intuitive

assumption that environmental factors grow more influential over time. Genetic influences on intelligence were shown to become more pronounced from childhood to adulthood, a phenomenon explained to a degree by the concept of Genetic Amplification.

We also discussed how behavioral genetics significantly influenced psychopathology, contributing to debates over the classification of mental disorders and informing emerging models that integrate genetic insights. The field had clarified the nature of heritability as a context-dependent measure, not an absolute indicator of genetic determination, thus aiding in dispelling naturist myths like genetic determinism. Furthermore, the intersection of behavioral genetics with social sciences has brought new perspectives to understanding social behavior. The integration of genetic findings with sociocultural research had enabled a more comprehensive exploration of human behavior, considering both inherited and environmental influences.

In sum, behavioral genetics exemplifies the necessity of an interdisciplinary approach in scientific research, revealing the intricate interplay of genetics, environment, and culture in shaping human behavior and development. This understanding had opened new pathways for effective policies and interventions, rooted in a nuanced comprehension of the multifaceted nature of human existence.

The Role of Philosophy

In the search for knowledge, the convergence of different approaches is often what produces the most profound insights. The philosopher Bertrand Russell, in his notorious publication "Mysticism and Logic", expresses something that connects with this idea:

> But the greatest men who have been philosophers have felt the need both of science and of mysticism: the attempt to harmonize the two was what made their life, and what always must, for all its arduous uncertainty, make philosophy, to some minds, a greater thing than either science or religion. (Russell, 1917, p. 1)

This excerpt, though originally referring to the combination of the logical and mystical intellectual inclinations, also resonates deeply with the integration of

philosophy and science. It emphasizes that the fusion of diverse perspectives can lead to a more comprehensive understanding of complex phenomena.

Just as Russell (1917) praised a harmonization of logic and mysticism, we must consider the connection between philosophy and science as something deeply desirable. Philosophical reflection can accompany scientific inquiry to prevent the pitfalls of over-reliance on theoretical presuppositions or in empirical data alone. Empirical data, as Thomas Kuhn (1962) points out, is never gathered at random in nature; rather, it is inevitably sought by science with a number of presuppositions at hand, both about where this data is to be searched and also about how it should be interpreted.

Through our examinations in the first chapter, we learned how implicit these presuppositions can be and also how connected they are to political settings. When scientific theories gain acceptance, they seem utterly objective. Their underlying presuppositions, such prevailing notions about human nature, have a tendency to stay invisible and unchallenged, unless we engage with a philosophical and broader perspective (Kuhn, 1962).

Overall, we have learned a crucial aspect of scientific development, particularly when it comes to examining the nature of human differences. The long-standing nature vs. nurture debate, which, as we examined, is pervasive across many scientific disciplines, appears to undergo significant shifts more due to political influences than solely based on empirical evidence gathered from scientific research. The steep decline of eugenics after World War II, considering its association with Fascism, highlights how some scientific theories can be invisibly but decisively influenced by societal beliefs and power structures. Philosophy is what provides us the tools to notice and investigate those kinds of connections.

And, as another philosophical conclusion regarding the nature vs. nurture debate, there is still another consideration besides: when putting everything we examined together, particularly in the third chapter, our understanding of human development need not be confined to strictly naturist or nurturist perspectives. The amount of "naturism" or "nurturism" adequate in an explanation is not absolute; it depends upon the questions being asked. We can recognize that certain innate abilities, such as the latent capacity to acquire and use language, are natural and inherent to us; but the refinement and effective application of this language, in a way

that creates achievements we regard as meaningful or valuable, is undoubtedly contingent upon the appropriate cultural and educational contexts.

Similarly, innate differences may be key to understanding why some individuals develop mental illnesses and others do not; but this susceptibility is restricted to certain contexts, and the societal interpretation of what is considered pathological, or even the broad perception of individual qualities and flaws, is certainly shaped by cultural and social forces. Both the forces we call "nature" and "nurture" are essential in shaping and understanding human behavior: innate differences and potential always coexist with environmental influences, each playing a significant role in the dynamic interplay of human existence.

Advancing on this topic, in the last chapter, we have identified a prevalent "simplistic bias" across various schools of thought. Many scholars, driven by the profound desire to understand and predict human behavior, frequently lean towards reductive explanations, favoring either excessively nurturist or excessively naturist perspectives. *This thesis has emphasized the imperative of transcending such limitations*. An inspiration for such transcendence can be drawn from Thomas Kuhn's concept of "essential tension" in scientific research (Kuhn, 1962). This tension is not a static methodological ideal; it is a continuous philosophical effort that prevents stagnation in presuppositions or conceptual frameworks.

When discussing the epistemological dichotomy between rationalism and empiricism in the first chapter, we connected these philosophical stances to the nature vs. nurture debate. And our examinations in this thesis suggests that, while empirical methods — such as the ones employed in behavioral genetics research — are undoubtedly foundational in our overall quest for knowledge, we must remain vigilant against the powerful realm of our own abstract presuppositions and concepts.

We must also be open to the idea that different perspectives can contribute to illuminating our understanding of complex phenomena. A complex process such as the development of human behavior can be studied in a number of angles or perspectives that do not contradict or invalidate one another. Some of these angles can focus on aspects of development more affected by "nature" or innate individual differences; others might emphasize what is most changed by "nurture" or environment. This vigilance in our epistemological or investigative stance is the essence of a positive "essential tension": a dynamic transition between different ways of looking into reality and the avoidance of oversimplification.

This thesis posits that the integration of philosophical effort into scientific disciplines transcends mere benefit; it is, given science's ultimate investigative goal toward reality, indispensable. Philosophy should not just complement empirical research on complex phenomena; it should interpenetrate and refine it, maximizing the awareness of our underlying theoretical assumptions or recondite intentions. Such awareness is sometimes the only possible antidote to both theoretical oversimplification and practical shortsightedness, no matter how sophisticated the empirical methods get.

Some authors, maybe invigorated by the passion of their strong convictions, readily declare themselves to be "naturists" or "nurturists". Others, trying to be more moderate, advocate for a "balanced" approach when it comes to such issues. This is certainly an advancement. But maybe our discussion can allow us to go even further, without having to settle for any of these positions.

After all, trying to answer questions related to human development by declaring oneself as "naturist", "nurturist" or "balanced" is essentially the act of reducing extremely complex issues to fit an unidimensional language. Maintaining a proper investigative stance is not about just balancing contrasting viewpoints or imagining ourselves somewhere near the middle of a spectrum. It is about nurturing a critical, dynamic and conceptually precise intellectual landscape, where transformative ideas originate from different perspectives, such as the historical analysis of scientific disciplines or the recent breakthroughs in behavioral genetics. The questions posed in the nature vs. nurture debate are complex in essence, and so are the answers.

As a final word, the insights from behavioral genetics unequivocally demonstrate that understanding the diverse development of psychological characteristics in individuals requires attention to genetic variation. Both genetic and environmental factors are inherently associated, and both play a crucial role in human development. To fully grasp human development and what is behind the origins of our differences, *it is essential to explore influences springing from radically different domains.*

The *world* of genes and chromosomes may seem too far apart from, say, the world of parenting styles and interpretation of dreams. Maybe some psychologists believed that talking about genes was something out of bounds for them. *Nature, however, does not care on how we shape or give boundaries to our scientific*

disciplines. In an ontological sense, these are not different worlds at all; boundaries in scientific disciplines are artificial and serve only for our own epistemic purposes. For this reason, the key to understanding complex issues often lies beyond the limits of our current research methodologies.

The integration of genetic and environmental factors is essential for a comprehensive understanding of human development, just as bridging scientific approaches with philosophical efforts is crucial to grasp the subtleties of complex phenomena. The history of the longstanding nature vs. nurture debate teaches us that scientists who rely solely on empirical methods, while neglecting the nature, limitations or the precise meaning of their concepts, risk hindering their investigative progress. Moreover, without a degree of the philosophical spirit, they are more likely to be blind to the effect that political atmospheres can exert upon the direction of their scientific research fields. Any researcher or student delving into the fascinating field of behavioral genetics, beyond attention for methodological issues like sample size or selection, must carry out a significant degree of philosophical effort in order to properly grasp what these findings truly entail.

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