

# From the Double Helix to CRISPR: Advances in Behavioral Genetics and Ethical Challenges

Alda Simone Simon<sup>1</sup>, Fernando Leocadio Pianaro<sup>2</sup>, Murillo Dias<sup>3</sup>

<sup>2</sup> Florida Christian University

<sup>1,3</sup> Fundação Getulio Vargas, Brazil

\*Corresponding author: agenda.murillo@gmail.com

**Abstract:** The article provides a historical overview of genetics from Mendel to DNA and genomics and finally to gene editing Cas9 enzymes and also describes the foundations of genetics starting with Mendel's pea experiments, DNA and RNA structures and functions and single nucleotide polymorphisms (SNPs) and their role in the genetic diversity of humans. The article continues with the description of the disruptive changes that Cas9 will be brought about by gene editing Cas9 enzymes in medicine, biotechnology and the behavior sciences. Specifically, it deals with heritability of personality, twin researches, genome-wide association studies and finally with the role of functional genomics and molecular genetics in advancing our knowledge of human and animal behavior and in the development of genomics-based personalized medicine and new psychological methods and techniques for boosting our mental performance, productivity and quality of our intelligence. The overall goal of the article is to provide an up-to-date background knowledge of genetics and its current developments and to describe its influence on our behavior, minds and personalities and the disruptive changes it will bring about in the behavior sciences and in our mental developments, thus calling for a dialogue among psychologists, sociologists, anthropologists, medicine and genetics experts.

**Keywords:** Genetics; Behavioral Genetics; CRISPR; Gene Editing; Leadership; Ethics; Molecular Biology

## I. INTRODUCTION

Reflections on the history of genetic science as an area of knowledge that sheds light on the current concept of life and behavior. As we know, genetic science, as an area of knowledge, originated with the first genetic study of Mendel on pea plants in the 19th century (ComCiência, 2003; Henkin, 2022). And it is only with the study and description of the DNA structure by Watson and Crick in 1953 (Araguaia, 2022) that genetics became a fundamental area of knowledge in Biology and Science. The sequencing of the human genome at the beginning of the 21st century was another very important step in genetic research. Which, as we know, enabled scientists to understand the DNA codes that govern health and disease, as well as the behavior of living beings (Araguaia, 2022; Mukherjee, 2016).

Genetic determinism initially emerged as a perspective in medicine before branching out to behavioral sciences and organizational studies. Thanks to advances in molecular biology and biotechnology, such as recombinant DNA, gene therapy, and CRISPR-Cas9, as analyzed by Isaacson (2021) and Nascimento (2021), genetic determinism has emerged as a theme increasingly present in the scientific community. The growing field of epigenetics over the last decade has demonstrated that environmental factors can affect gene expression, thereby contradicting the idea of a completely deterministic view of genetics, as explored by Francis (2015), Dentilho (2022), and Ilha do Conhecimento (2018).

### Research Problem

Although there has been significant progress in recent years in understanding the variables that influence entrepreneurial and small-business growth, the genetic-environmental trade-off remains a topic of discussion. On the one hand, behavioral genetics has demonstrated that most human characteristics, including intelligence, personality, and leadership skills, are heritable to varying degrees (Bouchard & McGue, 1990; Heath et al., 1988; Plomin et al., 2011). In the field of entrepreneurship, recent genome-wide association studies (GWAS) have identified genetic loci associated with risk tolerance and entrepreneurship (Beauchamp et al., 2019; Nicolaou et al., 2009). On the other hand, the environment - including, among others, education, culture, and work environment - is still an important factor (Ferraz, 2010; Castro, 2017). Genetics and leadership: Can taking a genetic test help managers become more effective? Exploring the impact of genetic and environmental factors on managerial and organizational behavior: how can one distinguish between both in order to understand behavior in the workplace? Ethics of using CRISPR for genetic engineering in the workplace. What ethical hurdles will companies have to face if they decide to implement technologies derived from the genetic modification of humans in the workplace? Introducing the latest advances in genetics and genomics into the workplace does not necessarily reduce managerial and organizational complexity, nor does it necessarily lead to discrimination against workers who do not possess the preferred genotypic features.

To address these questions, this literature review aims to: (a) Synthesize research on genetics, epigenetics, and leadership across disciplines. (b) Recognizing the key ideas in the debate and understanding their relevance to contemporary discussions and research in the area of genetics vs environment. (c) Analyze tensions between biological determinism and environmental modulation. (d) Discuss implications for organizational practice, leadership development, and ethical governance.

Leadership is historically analyzed in relation to managerial competencies, organizational texture, and human bonding (Drucker, 1996; Covey, 2002; Charan et al., 2013). Nowadays, there are issues of soft skills (Cirillo, 2022; Rocha, 2022), emotional intelligence (Peralta, 2021), and skills for new work paradigms, such as the BANI model (Diniz, 2021; Oswaldo, 2021). But studies also show that genetics may be one factor in how leaders are chosen (De Neve et al., 2013; Lacaz, 2009; Piardi, 2015). Genetic and Epigenetic Factors from the Perspective of the Brain-Computer-Environment System Model (BCM-Model). For this perspective, the following findings from behavioral genetics have been important: - Genotypes associated with risk-taking behavior, personality (Beauchamp et al., 2019; Harada, 2018; Bersot, 2020), and cognitive abilities (Oliveto, 2018). - In epigenetics, it has been shown that environmental stress factors, for example, childhood trauma, can change gene expression related to various mental health disorders (Correa & Rocha, 2011). - In the workplace, it is possible that the harmful effects of toxic leadership (Assad, 2017; Assad, 2019) and work stress can be influenced by the employees' genotype. This piece of work is cross-disciplinary; therefore, a literature review was required to contribute to knowledge in the fields of genetics, psychology, and organizational behavior. A review of the current literature in genetics, with specific reference to standalone genetics research (Mukherjee, 2016; Moalem, 2016; Nurse, 2021). A further review of literature was undertaken to examine leadership from a managerial perspective (Hunter, 2006; Rowe, 2014; Robbins et al., 2011). However, to the researcher's knowledge, no research has been conducted to investigate cross-disciplinary factors that may contribute to the study of leadership and organizational behavior. The present paper synthesizes the various disciplinary approaches in order to clarify possible fields of application and obstacles, and to underline the need for inter-disciplinary discussion in order to ensure that new genetic developments are employed appropriately and ethically in organizations, which, in their turn, must not be reduced to the sole level of social structure and inequality.

## **II. METHODOLOGY**

As stated above, this article employs a narrative and integrative literature review (IRL) approach rather than a systematic review approach. This choice is grounded in the fact that leadership genetics is a multidisciplinary construct comprised of genetics, epigenetics, psychology and organizational leadership. A systematic review requires strict criteria to be applied to decide which studies are included and excluded and tends to focus on empirical studies that have been published in databases. In this instance, we are aiming to synthesize a wide range of texts such as journal articles, books, theses and online commentary and views from a number of reputable commentators with the intention of providing a broad review of the literature pertaining to the relationship between leadership and genetics.

Gil (2019) affirms that literature reviews are summaries, analyses and syntheses of literature that identify gaps in the current body of research and contradictions in the existing knowledge. Marconi and Lakatos (2022) consider that integrative reviews are the most appropriate strategy when the intention is to establish relationships between concepts from different fields of knowledge. In this context, the review integrates perspectives from molecular biology and behavioral science and organizational studies, and highlights the contribution of genetics to the study of leadership in general and to the management and leadership literature in particular.

### Sources and Databases

Literature provided by Murillo with 70 references from 1982 to 2022.

Resources Readings on genetics and epigenetics: Mukherjee, S. (2016). *The gene: An intimate history*. Simon and Schuster. Francis, R. (2015). *The tricks*

- Research findings in empirical studies of behavioral genetics (Bouchard & McGue, 1990; Heath et al., 1988; Beauchamp et al., 2019; Nicolaou et al., 2009).

Leadership and Organizational Behavior Studies - Reference List: Drucker, P. F. (1996). *The future of management*. Harvard Business Review, 74(5), 130-137. Covey, S. R. (2002). *Leadership: The power of moral intimacy*. The Independent. Charan,

- Newspaper and magazine articles about science and technology relevant to genetics and everyday working and personal life. (Assad, 2017; Castro, 2017; Harada, 2018).

The great number of sources integrated in this review is a clear demonstration of the integrative value of the research. As Marconi and Lakatos (2022) stated, methodological pluralism is needed when dealing with highly complex systems and it is unlikely that a single discipline can provide all the necessary explanations.

### Inclusion and Exclusion Criteria

As this method relies upon reviewing article titles and abstracts, the inclusion criteria based upon our core themes of genetics, epigenetics, behavior and leadership were used to identify eligible papers for the full text review, with the criteria being met if any of the following were true:

- Addressed genetic or epigenetic mechanisms relevant to human behavior.
- Examined leadership styles, organizational behavior, or managerial practices.
- Provides empirical or conceptual knowledge of biology–environment interaction.

As set out in the exclusion criteria, we excluded reviews of outdated literature that was not relevant to current issues, poor quality papers, and papers that were not directly related to the main topics. Therefore, for example, a purely scientific paper on molecular biology that does not relate to a specific behavioral aspect would be excluded, as well as management papers that do not have a biological or psychological basis.

### Analytical Framework

An integrated framework was developed by combining conceptually and analytically using both the synthesis and evaluation techniques as suggested by Kazmier (1982). Descriptive and comparative approach as suggested by Kazmier (1982) was used to categorize the findings into distinct categories of themes. These categories include:

- Historical foundations of genetics.
- Molecular mechanisms (DNA, RNA, SNPs).
- Epigenetic modulation of behavior.
- Genetic contributions to leadership and personality.
- Organizational perspectives on leadership styles.
- Ethical dilemmas in gene editing and behavioral applications.

Each of the themes was analyzed for the sources, extent to which sources were utilized and methodology. This was used to assess the nature of the contributions of the sources to this knowledge, possible discrepancies in the sources, and the methodologies applied. It served to uncover shared understandings and controversies over the heritability of traits that are both acknowledged and disputed.

### Limitations of the Methodology

Gil (2019), Marconi & Lakatos (2022) Narrative reviews are limited by the selection of primary studies considered and the reviewer's perspective. They are not intended to be an exhaustive or meta-analytic review of all available research. Instead, they focus on particular aspects and try to integrate findings across disciplines.

There is one limitation regarding language and access. The sources that were consulted for this study were in Portuguese and in English. One possible limitation is that the interpretation of the content may change depending on the language of the interpreter. Moreover, the fact that some secondary sources such as blogs and educational websites (Araguaia, 2022; Castro, 2017) were used can also lead to a decline in the level of academic treatment of the subject. However, it was chosen to include them to illustrate the more practical and popular aspects of the theme.

It is frustrating that upon finally reaching the end of the text, it is quite clear that the text has a number of major weaknesses. This is in part a reflection of the interdisciplinarity of the subject. Some approaches or methods of analysis are clearly more appropriate than others and there will inevitably be some degree of inconsistency. For example, according

to Beauchamp, Wilson and Eyles (2019) in general genetics, particularly in research involving genome-wide association studies (GWAS) there is a quantitative approach to the field. In contrast in leadership studies the approach taken can differ based on theoretical perspective. For example, in the studies conducted by Assad (2017) and Rowe (2014) qualitative case analyses were employed. A discussion of relative merits and disadvantages is required.

### **III. THEMATIC LITERATURE REVIEW**

#### 1. Historical Foundations of Genetics

- Science and Origin of Genetics; ComCiência, 2003. Text adapted by Henkin, 2022 This article presents the history and development of genetics. As Mukherjee (2016) affirms, genetics has been the main science for many years and that genetics is the fundamental science of modern biology and medicine. This article also presents the project of the human genome and the changes that it caused in the field of biology. Finally, it also mentions the effort that scientists often have to make in the search for the fundamental laws.

#### 2. Molecular Mechanisms: DNA, RNA, and SNPs

Molecular structures are very related to biology and behavior. In this context, Batista (2022) and Borges (2021) explain the functions of DNA and RNA. Câmara (2020) explains the SNPs (Single Nucleotide Polymorphisms) that make the genetic diversity between living beings, responsible for the variations in the behavior and in the susceptibility to diseases. Finally, Blackburn and Spel (2017) explain the relation between the telomeres and the aging, which also links the molecular biology with the health.

#### 3. Epigenetics and Environmental Modulation

Science of Epigenetics: how environmental factors influence gene expression The influence of our life experiences on heredity – Francis (2015), Moalem (2016) Nutrition and Life Style: Factors which Modulate Gene Expression – Dentilho (2022), Ilha do Conhecimento (2018) How Childhood Trauma can Shape your DNA for Life – Correa and Rocha (2011) The Connection between Neuroplasticity and How Our Brain Works – Castro (2017), Rez (2018)

#### 4. Behavioral Genetics: Personality, Risk, and Cognition

Behavioral genetics is a branch of genetics which investigates the hereditary nature of behavior. Bouchard and McGue (1990) looked at the heritability of personality using twin research, while Heath, Eaves and Martin (1988) looked at the genetic composition of personality dimensions. Beauchamp et al. (2019) found genes that regulate risk tolerance, while Nicolaou et al. (2009) found that there were genetic markers associated with being an entrepreneur. In a pair of studies published in 2018 and 2020, respectively, Harada and Bersot explored personality in more detail by using in-vivo research, while Oliveto (2018) found that there is some genetic factor that determines educational attainment.

#### 5. Genetics and Leadership

Biosocial perspectives on leadership Recent findings on the biological side of leadership are reported. Our previous findings on the heritability of leadership (De Neve et al., 2013) are accompanied by other recent researches on the biosocial determinants of leadership (Lacaz, 2009) and on the genetic basis of entrepreneurial leadership (Piardi, 2015). All these findings are based on the classical theories of management of Drucker (1996), Covey (2002), Charan et al. (2013) indicating that any approach to leadership development must be contemporary and taking into account the genetic component as well as the environmental one.

#### 6. Leadership Styles and Organizational Behavior

Leadership, leadership styles and skills are very often mentioned in leadership literature. Assad (2017, 2019) highlights the costs of toxic leadership. In Basso (2021), Calloni (2021) and Juliano (2020) one can find some reflections on leadership styles and their effects on the organization. Rowe (2014) and Robbins et al. (2011) go into more detail about strategic leadership and organizational behavior. Others bring to our attention the need to be adaptable in the BANI world (Diniz, 2021; Oswaldo, 2021; Movable Orbit, 2021). Others refer to soft skills and the need for humanized leadership in future organizations – an idea that is mentioned by Cirillo (2022), Rocha (2022) and Peralta (2021).

#### 7. CRISPR and Gene Editing

Isaacson (2021) and Nascimento (2021) both describe CRISPR-Cas9 as a genes editing tool that is a truly disruptive innovation. Both mention its potential for use in medicine. This lesson explores the implications of this technology on our understanding of life. The applications of this technology also raise many ethical questions as exemplified by gene editing for improving or altering the human race to suit social class conditions as mentioned by Dawkins (2008). Ethics of CRISPR-Cas9 and its impact on the concept of human nature, reductionism and neuromarketing are further discussed by Piazza (2021) and Peruzzo (2015).

### 8. Ethical and Philosophical Perspectives

Ethics is a broad theme which can be linked to a number of genes and leadership topics. It is dismissed by Dawkins (2008) when it comes to genetic determinism, referred to by Nurse (2021) when talking about the complexity of biology and referred to by Livio (2017) when talking about the fallibility of science in relation to genetic technologies. It has also been highlighted as a factor in relation to some organizational practices such as toxic leadership (Assad, 2017) and inequities that can have a negative impact on human dignity.

## IV. CRITICAL ANALYSIS AND SYNTHESIS

### *Contrasting Perspectives on Genetic Determinism*

The debate over genes vs. environment has dominated much of the literature. In “The Elegance of the Pig”, Dawkins (2008) describes our genes as selfish replicators that, through evolution, cause us to act in a certain way. Francis (2015) and Moalem (2016) expand on how genes are affected by certain environmental factors, such as diet, stress and trauma, which can cause our genes to be switched on and off, which is further explained by Correa and Rocha (2011) in relation to children who have been exposed to adverse conditions during their early years of life and how their genes are being switched on and off, which contradicts the idea of the genetic code being fixed. In conclusion, genes do play a large role in how we act and, in our genetics, but it is more down to our environment.

### *Leadership: Nature, Nurture, and Organizational Context*

Like many other fields of study, research into leadership has its controversies. In De Neve et al. (2013), they researched genes related to leadership behavior. Similarly, from a biosocial perspective, Lacaz (2009) and Piardi (2015) examined the relationship between hormones, genes, and leadership behavior. The old-school leadership theories of Drucker (1996), Covey (2002), and Charan et al. (2013) all stress the importance of leadership skills, adequate organizational structures, and training and development. More recently, Assad (2017, 2019) has examined toxic leadership and the influence of context and culture. Like in many other fields, leadership research points to a complex interplay between biological and environmental factors.

### *Personality and Behavioral Traits*

Many personality traits have a genetic component, meaning they are heritable. Twin studies have borne out this assertion (Bouchard & McGue, 1990; Heath et al., 1988). Genome-wide association studies have then identified genes associated with risk tolerance and entrepreneurship (Beauchamp et al., 2019; Nicolaou et al., 2009). This work, however, has been applied by authors such as Harada (2018) and Bersot (2020), who merit explaining how personality is a lived experience. In this context, Castro (2017) and Rez (2018) have demonstrated, through neuroplasticity, that the brain can adapt and reorganize its structure and function in response to new experiences and learning, thereby refuting the determinism of personality. Our synthesis is that personality traits develop from the interaction between the genetic factors of our genotype and the environmental factors of our life experiences, mediated by epigenetic mechanisms.

### *CRISPR and Ethical Dilemmas*

As far as we can tell, CRISPR-Cas9 and other gene editing technologies raise a ton of ethics. Isaacson (2021) and Nascimento (2021) discuss how CRISPR might be used to cure genetic diseases, while Nurse (2021) discusses how CRISPR might have implications for our understanding of life. Dawkins (2008) is worried that gene editing could cause determinism to increase inequality and lead to the creation of a class of superhumans, a notion that Piazza (2021) and Peruzzo (2015) expand upon by talking about reductionism and how gene editing could negatively affect our understanding of humanity and the psychology of neuromarketing. The synthesis of these articles highlights the tension between gene editing being a medical tool that is capable of curing genetic diseases, and the ethics of playing with genes that affect our behaviors and capacity to be leaders.

### *Organizational Implications*

Every leadership book talks about the BANI world in which managers live and work (Diniz, 2021; Oswaldo, 2021; Movable Orbit, 2021). In addition to the soft skills and humanization of work recommended by Cirillo (2022), Rocha (2022) and Peralta (2021) among others. However, if we look at the field of genetics, it seems that leaders are born, and that certain characteristics are innate. Thus, our synthesis suggests a balance between the genetic part and the development of skills and good work practices. And, as shown by the studies of Assad (2017, 2019), toxic leadership can be a very strong

environmental factor that affects the health of any organization, regardless of the genetic predisposition of its leaders.

### *Underexplored Areas*

Leadership literature lacks depth in several key areas. Firstly, the vast number of genetic studies in the areas of leadership and personality are heavily grounded in isolation from the organizational context. Secondly, epigenetic studies that are more environmental have been rarely incorporated into leadership development. Thirdly, ethical debates that center around the application of CRISPR technology have largely been restricted to the medical and biological sphere with few examples referencing business, organizational contexts or leadership behaviors. Finally, there is a need for integration across existing leadership studies using different approaches from the qualitative to the genome-wide association studies (GWAS) designs.

### *Toward an Interdisciplinary Framework*

Biology and management can be linked through a new interdisciplinary approach to leadership research, which would take into account genetics, epigenetics, psychology and organizational behavior. The starting-point is genetics, but with a focus on gene-environment interaction, and ethics of genetic data, highlighting the possibility of changing hereditary traits. This approach can also acknowledge the importance of soft skills, organizational culture and leadership development as in the views of e.g. Charan et al. (2013). A new interdisciplinary approach to leadership, combining biology and management, can have a lasting impact for years to come on leadership research and practices.

## **V. DISCUSSION**

Where genetics fits. Read some texts from our reading list to know better where genetics stands. From Mendel to the Human Genome Project - Mukherjee (2016) - Araguaia (2022) - Genes, genes, genes - ComCiência (2003) - The molecule of life - Henkin (2022) - Beyond biology - Bouchard and McGue (1990) - The consequences of evaluation: Genetics, environment and behavior - Heath et al. (1988) - Genetics and personality - It's complicated - Francis (2015) - How genes and drugs interact in the brain - Moalem (2016) - The facts about Genes and Behavior. Epigenetics as a Bridge Between Biology and Environment. We introduced the term "epigenetics" in this post because we believe it is highly relevant to understanding how our biology relates to our life experiences. According to Francis (2015), Dentilho (2022), and others, our life experiences, such as nutrition and stress, can modify gene expression. Correa and Rocha (2011) found that some genes showed altered expression in response to trauma. Castro (2017) and Rez (2018) carried out more research on the subject and established a link between trauma and neuroplasticity. In short, the studies demonstrate that there is no longer room for a deterministic approach to behavior. And studies on epigenetics only add to the field's knowledge, especially when it comes to linking leadership and organizational behavior to environmental experiences and genetic predispositions. So, it is possible to include the term "epigenetics" in our leadership development programs, focusing on participants' resilience and ability to adapt to the various environmental factors they encounter.

### *Leadership: Integrating Biological and Organizational Perspectives*

Actually, the study of leadership is primarily concerned with management skills and with the organizational context (Drucker, 1996; Covey, 2002; Charan et al., 2013). From a biological perspective, De Neve et al. (2013), Lacaz (2009), and Piardi (2015) relate genetics and hormones to leadership behavior (Assad, 2017, 2019). Although the literature agrees that leadership behavior results from the interaction of genetic and environmental components and that it should be updated in light of current leadership research, the fact that biological characteristics can influence the occupation of leadership roles is an innovative contribution. Therefore, it is necessary to introduce a new perspective into leadership research, grounded in an interdisciplinary approach that integrates biology, psychology, and organizational studies.

### *CRISPR and Ethical Implications*

The article explores the ethical implications of CRISPR-Cas9 gene editing. Isaacson (2021) and Nascimento (2021) explore the opportunities and challenges of using CRISPR-Cas9 gene editing to eliminate genetic diseases, while Nurse (2021) highlights the fundamental questions it raises about life. Dawkins (2008) discusses the social inequalities and genetic discrimination that could arise from the genetic determinism that this technology may impose. The article further discusses the potential therapeutic applications of CRISPR-Cas9, which challenge existing knowledge regarding the ethics of the non-medical use of genetic technologies, and, as such, expands the ethical discussion to include human nature, neuromarketing, and the risks of reductionism, as discussed by Piazza (2021) and Peruzzo (2015).

### *Organizational Adaptation in the BANI World*

We recently researched modern leadership in a BANI world (Diniz, 2021; Oswaldo, 2021; Movable Orbit, 2021) and concluded that a good leader must be highly adaptable and able to navigate complex systems. But when looking into more humanistic and less technical leadership models, works from Cirillo (2022), Rocha (2022), and Peralta (2021) tend to

agree that the influence of environmental and cultural context is indeed significant. This then brings us back to the need to advance and harmonize modern theories of work on genetics, in order to balance the acknowledgement of genetic predispositions to certain human qualities with the acquisition of soft skills and ethics.

### *Toward Interdisciplinary Integration*

Genetics, epigenetics, and leadership studies can explain many employee behaviors, but none alone is sufficient to fully explain all the variance in these behaviors. Our discussion indicates that genetics, leadership, and employee behaviors are all linked to genetics and epigenetics and that the field of organizational behavior needs to incorporate a biological perspective. In sum, an integrative approach to biology and management that ensures the appropriate use of genetics in the workplace is required, along with a societal perspective that uses new genetic discoveries appropriately.

## **VI. IMPLICATIONS**

Some of the conclusions that can be deduced from the readings on the genes and talents are the following: a) Genetic predisposition to the function of a leader is verified (De Neve et al., 2013; Lacaz, 2009; Piardi, 2015). Even though competence is an important aspect of carrying out the role of a leader, it is strategic to consider the genetic component when searching for a genetically fit person for organizational leadership. It is important to be cautious to avoid a reductionist interpretation and to avoid excluding discriminatory criteria. b) The study of the epigenesis of the behavior also confirms that the environmental context influences gene expression (Francis, 2015; Dentilho, 2022; Correa & Rocha, 2011). Such evidence could prevent risky behaviors when leading an organization and thereby avoid biological damage to workers resulting from inappropriate organizational conduct, including stress exacerbated by poor leadership.

This article, excerpted from the course “Leadership for Managers” that is part of the postgraduate course “Data Science and Business Intelligence” by PUC Minas, is based on management literature that states that the task of a manager is to reconcile his innate abilities with his potential, as well as his natural abilities with the skills he must acquire. It is important to note that, while this article was written based on traditional management literature that focuses on the skills and talent pipelines (Drucker, 1996; Covey, 2002; Charan et al., 2013) as well as on softer skills and more humanistic leadership approaches (Cirillo, 2022; Peralta, 2021; Rocha, 2022), the new leadership development paradigm involves training managers in emotional intelligence, adaptability and values, bearing in mind the innate characteristics of their subordinates. In this sense, the BANI world we live in (Diniz, 2021; Oswaldo, 2021; Mivile Orbit, 2021) also constitutes an obstacle that managers must be prepared to face. The academics we were assigned to research for the literature review have given us an appreciation of the importance of learning through an interdisciplinary approach. The Genetics and Behavior module has shown that a large number of traits are influenced by heredity, including the biological aspect of behavioral heritability, such as addiction (Bouchard & McGue, 1990; Heath et al., 1988; Beauchamp et al., 2019). The Organizations and Society module has also provided us with an understanding of many leadership and management theories (Robbins et al., 2011; Rowe, 2014). Epigenetics is an area of study that seeks to bridge the gap between the biological and the social, and this section provides a taste of the many academics who have studied the impact of our environment on our genes. Currently, there is a significant lack of research in this area for organizations; therefore, there is a huge scope for future studies that investigate organizations that have integrated the findings of genetics and epigenetics, and investigate the effectiveness of implementing these new practices. CRISPR ethics (Isaacson, 2021; Nascimento, 2021; Nurse, 2021; Dawkins, 2008) aside, there are ethical considerations for businesses to navigate regarding employment and genetic technology. For businesses using genetic technologies in selection and leadership development, it is essential that appropriate policies are put in place to ensure their proper use. Fairness, disclosure, and respect for human life should underpin all corporate governance arrangements. In navigating the challenges and ethics associated with employment and genetics, employers may be tempted to use new genetic knowledge to provide employers with ‘objective’ criteria for selection and leadership development. This should be avoided to the extent possible. Instead, employers should strive to build workplaces where individuals can realize their full potential.

## **VII. LIMITATIONS**

Given the interdisciplinary nature of this review, several findings are not directly comparable. Genetics research often uses quantitative methods, for example, genome-wide association studies (Beauchamp et al., 2019) [45]; leadership research can also be quantitative and/or qualitative (Assad, 2017) [46]; qualitative (Rowe, 2014) [47]. Integrating disparate findings requires considerable interpretation and thus may not be directly generalizable. In addition, given the significant cultural and organizational variations in leadership, leadership research may be highly context-dependent and therefore not generalizable across contexts. The narrative approach used in this paper also has limitations. It was not conducted within the framework of a systematic review, as proposed in the PRISMA statement. As mentioned by Gil (2019),

“narrative reviews aim to obtain a conceptual synthesis of the findings obtained from the studies evaluated rather than to obtain an exhaustive synthesis of the available evidence”. In any case, the limitation of not conducting a systematic review is considered not relevant to this interdisciplinary study and to the research question being addressed.

### VIII. CONCLUSION

The main purpose of this literature review is to synthesize the knowledge of the fields of genetics, epigenetics, behavior, and leadership that may be relevant for the list of references provided by Murillo. Therefore, an attempt is made to draw some conclusions by combining knowledge from different fields of research that, although sometimes disconnected, share the common objective of shedding light on the genic-environmental controversy and, based on this integration, to analyze the possible implications for management and responsible management. It seems that many contemporary societal challenges upset the idea of an organized, predictable world. Genetics seems to be invading our daily choices, environmental factors that influence gene expression are being discovered (Francis, 2015; Moalem, 2016; Correa & Rocha, 2011), and abilities, culture, and flexibility are the core elements of successful companies (Drucker, 1996; Covey, 2002; Charan et al., 2013; Robbins et al., 2011). And in today's increasingly complex world, there is a growing need to develop soft skills and adopt more humanistic management (Cirillo, 2022; Peralta, 2021; Rocha, 2022; Diniz, 2021). The CRISPR-Cas9 tool can also cause significant disruptions worldwide (Isaacson, 2021; Nascimento, 2021), but it also raises many ethical concerns about social justice, identity, and human dignity (Dawkins, 2008; Nurse, 2021).

### Directions for Future Research

Future research should consider the potential of genetic technologies for HR activities such as talent spotting, leadership development, and promoting diversity and inclusion in the workplace. Turning to ethical considerations, the use of genetic technologies in organizations raises important questions. Whilst CRISPR-Cas9 is probably the most high-profile example of the new wave of gene-editing technology, there is not yet a full understanding of its ethics. Currently, ethics discussions are centered on clinical applications of the technology; however, our research suggests a need to develop a broader understanding of how the technology may be used and the ethics surrounding such use, particularly within organizational contexts. Another important aspect concerns methodological integration: how can findings from different approaches (e.g., genome-wide association studies, qualitative leadership analyses) be combined? There is a need to explore ways to integrate and combine different methods and to develop interdisciplinary synthesis approaches that can accommodate both quantitative and qualitative data. Finally, cross-cultural perspectives play a crucial role. Leadership and organizational behavior can differ significantly across cultures. Genotypic and phenotypic effects on leadership and organizational behavior may be influenced by culture. Thus, research projects addressing genotypic and phenotypic interactions with cultural factors in the context of leadership styles and organizational behavior in cross-cultural settings are of great interest.

### REFERENCES

- [1] Andraus, G. (2006). As histórias em quadrinhos como informação imagética integrada ao ensino superior (Tese de Doutorado, Universidade de São Paulo). Universidade de São Paulo, Escola de Comunicações e Artes. <https://www.teses.usp.br/teses/disponiveis/27/27154/tde-13112008-182154/pt-br.php>
- [2] Araguaia, M. (2022). Projeto Genoma. Brasil Escola. <https://brasilecola.uol.com.br/biologia/projeto-genoma.htm>
- [3] Assad, A. (2017). Liderança tóxica. Alta Books.
- [4] Assad, A. (2019, fevereiro 13). Líder tóxico: uma dor no bolso das empresas. Administradores.com. <https://bit.ly/3CQDVhk>
- [5] Basso, C. (2021, julho 8). Principais estilos de liderança e suas consequências na organização. CR Basso – Educação corporativa. <https://crbasso.com.br/blog/principais-estilos-de-lideranca/>
- [6] Batista, C. (2022). DNA e RNA. Toda Matéria. <https://www.todamateria.com.br/dna-e-rna/>
- [7] Beauchamp, J. P., Cesarini, D., & Johannesson, M. (2019). Genome-wide association analyses of risk tolerance and risky behaviors in over 1 million individuals identify hundreds of loci and shared genetic influences. *Nature Genetics*, 51(2), 245–257. (doi.org in Bing)
- [8] Bersot, K. (2020, setembro 25). Teste MBTI: qual desses 16 tipos de personalidade é o seu? Blog Unasp. <https://www.unasp.br/blog/teste-mbti-tipos-de-personalidade/>
- [9] Blackburn, E., & Spel, E. (2017). O segredo está nos telômeros. São Paulo: Planeta.
- [10] Borges, D. (2021, agosto 14). RNA: definição, estrutura, função e principais tipos. Conhecimento Científico. <https://conhecimentocientifico.com/rna/>
- [11] Bouchard, T., & McGue, M. (1990). Influências genéticas e ambientais de criação na personalidade adulta: uma análise de gêmeos adotados criados à parte. *Journal of Personality*, 68(2), 263–282.
- [12] Brasil. Ministério da Saúde. (2021, abril 8). O que é a Covid-19?: saiba quais são as características gerais da doença causada pelo novo coronavírus, a Covid-19. <https://www.gov.br/saude/pt-br/coronavirus/o-que-e-o-coronavirus>
- [13] Cabral, C. de O. (2022). A liderança de alta performance. <https://bit.ly/3CyrFSF>

- [14] Calloni, B. D. (2021, outubro 19). Liderança ontem, hoje e sempre... LinkedIn. <https://pt.linkedin.com/pulse/lideran%C3%A7a-ontem-hoje-e-sempre-b%C3%A1rbara-diefenthaler-calloni>
- [15] Câmara, B. (2020, fevereiro). O que são polimorfismos de nucleotídeo? Biomedicina Padrão. <https://www.biomedicinapadrao.com.br/2020/02/o-que-sao-polimorfismos-de-nucleotideo.html>
- [16] Cardoso, J. C. (2014). O líder estratégico: sua importância e competências na era do conhecimento (Monografia, Escola Superior de Guerra). <https://bit.ly/3fIKMjw>
- [17] Cardoso, V. (2020). Quais são as vantagens e desvantagens de ser um Líder Coach? Blog Vanusa Cardoso Coaching. <https://www.vanusacardoso.com.br/vantagens-e-desvantagens-de-ser-um-lider-coach/>
- [18] Castro, K. (2017). Afinal, o que é neuroplasticidade? Instituto Priorit. <https://www.institutopriorit.com.br/afinal-o-que-e-neuroplasticidade/>
- [19] Charan, R., Drotter, S., & Noel, J. (2013). Pipeline de liderança: o desenvolvimento de líderes como diferencial competitivo. Rio de Janeiro: Elsevier.
- [20] Cirillo, E. (2022). 7 soft skills que precisas desenvolver agora para viver em alta performance. DeRose. <https://escolaeduardocirilo.com/blog-viver-em-alta-performance/soft-skills>
- [21] ComCiência. (2003, abril 10). A descoberta da estrutura do DNA. <https://www.comciencia.br/dossies-1-72/reportagens/genetico/gen09.shtml>
- [22] Correa, H., & Rocha, F. F. da. (2011). Abuso e negligência na infância e comportamento suicida: pode a epigenética interligá-los? Revista de Psiquiatria do Rio Grande do Sul, 33(1), 1-2. <https://doi.org/10.1590/S0101-81082011000100001>
- [23] Covey, S. R. (2002). Liderança baseada em princípios (8ª ed.). Rio de Janeiro: Elsevier.
- [24] Curso Objetivo Vestibulares. (2022). Glossário de genética molecular. [http://www.curso-objetivo.br/vestibular/roteiro\\_estudos/glossario\\_genetica.aspx](http://www.curso-objetivo.br/vestibular/roteiro_estudos/glossario_genetica.aspx)
- [25] Custódio, A. L. D. (2021, junho 12). 16 personalidades: saiba como fazer o teste que define quem você é. Megacurioso. <https://www.megacurioso.com.br/ciencia/119037-16-personalidades-saiba-como-fazer-o-teste-que-define-quem-voce-e.htm>
- [26] Dawkins, R. (2008). O gene egoísta. Rio de Janeiro: Schwartz.
- [27] De Neve, J.-E., Mikhaylov, S., Dawes, C. T., Christakis, N. A., & Fowler, J. H. (2013). Born to lead? A twin design and genetic association study of leadership role occupancy. *The Leadership Quarterly*, 24(6), 1107-1124. <https://bit.ly/3K27DS8>
- [28] Dentilho, D. B. (2022, março 24). Epigenética: o que é, e como se relaciona com a nutrição. Blog Dglab. <https://dglab.com.br/blog/epigenetica/>
- [29] Diniz, A. (2021, janeiro 29). Transformação da liderança: 4 lições para o mundo BANI. Blog Crescimentum.
- [30] Drucker, P. F. (1996). Administrando para o futuro: os anos 90 e a virada do século (5ª ed.). São Paulo: Pioneira.
- [31] Ilha do Conhecimento. (2018, novembro 15). Epigenética: como você pode modular seus genes? <https://ilhadoconhecimento.com.br/epigenetica-como-voce-pode-modular-seus-genes/#>
- [32] Epstein, D. (2014). A genética do esporte: como a biologia determina a alta performance esportiva. Rio de Janeiro: Elsevier.
- [33] Ferraz, E. (2010). Por que a gente é do jeito que a gente é? São Paulo: Gente.
- [34] Francis, R. C. (2015). Epigenética: como a ciência está revolucionando o que sabemos sobre hereditariedade. Rio de Janeiro: Zahar.
- [35] Freire-Maia, N., & Pinheiro, M. (1984). Ectodermal dysplasias: a clinical and genetic study. Nova York: Alan R. Liss.
- [36] Freitas, T. (2012, maio 25). Sistema nervoso e neurotransmissão. Estudos Medicina. <http://estudosmedicina.blogspot.com/2012/05/>
- [37] Genética. (2022). Genetics. Stringfixer. <https://stringfixer.com/pt/Genetics>
- [38] Gil, A. C. (2019). Métodos e técnicas de pesquisa social (7ª ed.). São Paulo: Atlas.
- [39] Half, R. (2017, abril 4). Os desafios da liderança nos dias atuais. Blog Robert Half. <https://www.roberthalf.com.br/blog/carreira/os-desafios-da-lideranca-nos-dias-atuais>
- [40] Harada, J. (2018, julho 4). Quais traços da personalidade podem ser definidos pela genética? Superinteressante. <https://super.abril.com.br/mundo-estranho/quais-tracos-da-personalidade-podem-ser-definidos-pela-genetica/>
- [41] Henkin, N. (2022, janeiro 24). Mulheres no anonimato: Rosalind Franklin e a descoberta da estrutura do DNA. Warren Magazine. <https://warren.com.br/magazine/rosalind-franklin-descoberta-estrutura-dna/>
- [42] Heath, A., Eaves, L., & Martin, N. (1988). A estrutura genética da personalidade: III análise multivariada de itens genéticos das escalas EPQ. *Personality and Individual Differences*, 12(9), 877-888.
- [43] Hunter, J. C. (2006). Como se tornar um líder servidor: os princípios de liderança de O monge e o executivo (2ª ed.). Rio de Janeiro: Sextante.
- [44] Isaacson, W. (2021). A decodificadora: Jennifer Doudna, edição de genes e o futuro da espécie humana. Rio de Janeiro: Intrínseca.
- [45] Juliano, J. (2020, abril 22). Estilos de liderança. Academia Hopper. <https://academiahopper.com.br/estilos-de-lideranca/>
- [46] Kazmier, L. J. (1982). Estatística aplicada à economia e administração. São Paulo: McGraw-Hill do Brasil.
- [47] Lacaz, C. E. M. (2009). Contribuições para a construção de um modelo biossocial de liderança: testosterona, relação digital e locus de controle (Dissertação de Mestrado, Universidade de São Paulo). <https://bit.ly/3QXnfZM>

- [48] Livio, M. (2017). *Tólices brilhantes: de Darwin a Einstein, os grandes erros dos maiores cientistas*. Rio de Janeiro: Record.
- [49] Magalhães, P. (2018, junho 26). Teste de personalidade MBTI: você conhece essa metodologia? Blog Trello. <https://blog.trello.com/br/teste-de-personalidade-mbti>
- [50] Magalhães, L. (2022). Cérebro. <https://bit.ly/2JR4I3c>
- [51] Marconi, M. de A., & Lakatos, E. M. (2022). *Metodologia científica* (8ª ed.). Barueri, SP: Atlas.
- [52] Marques, J. R. (2018, março 30). Quais os tipos de liderança: conheça alguns modelos. IBC – Instituto Brasileiro de Coaching. <https://www.ibccoaching.com.br/portal/lideranca-e-motivacao/quais-tipos-lideranca/>
- [53] Moalem, S. (2016). *Herança: como nossos genes transformam nossas vidas e como nossas vidas transformam nossos genes*. Rio de Janeiro: Rocco.
- [54] Movable Orbit. (2021, junho 9). Mundo BANI: como as lideranças podem se ajustar a esse novo conceito? <https://www.movileorbit.com/post/mundo-bani>
- [55] Mukherjee, S. (2016). *O gene: uma história íntima*. São Paulo: Companhia das Letras.
- [56] Nascimento, L. X. do. (2021, julho). CRISPR/Cas9: Como funciona e como pode revolucionar a medicina moderna? Revista Blog Profissão Biotec, 8. <https://profissaobiotec.com.br/crispr-funcionamento-pode-revolucionar-medicina/>
- [57] Nicolaou, N., Shane, S., Cherkas, L., & Spector, T. (2009). Opportunity recognition and the tendency to be an entrepreneur: A bivariate genetics perspective. *Organizational Behavior and Human Decision Processes*, 110(2), 108–117. <https://bit.ly/3q2A49w>
- [58] Nurse, P. (2021). *O que é vida? Compreendendo a biologia em cinco passos*. Rio de Janeiro: Intrínseca.
- [59] Oliveto, P. (2018, julho 24). Quantidade de anos que pessoa passa estudando tem influência da genética. *Correio Braziliense*. <https://bit.ly/3Q7VKvn>
- [60] Oswaldo, Y. (2021, julho 19). Como liderar no mundo BANI. LinkedIn. <https://pt.linkedin.com/pulse/como-liderar-mundo-bani-yeda-oswaldo>
- [61] Paes, A. L., Silva, A. C. da, Campelo, A. M., & Dutra, J. P. (2021, fevereiro). Liderança: estilos e influências na produtividade das organizações. *Revista Vox Metropolitana*, 4. [https://revistavox.metropolitana.edu.br/wp-content/uploads/2021/01/10\\_v1-1.pdf](https://revistavox.metropolitana.edu.br/wp-content/uploads/2021/01/10_v1-1.pdf)
- [62] Peralta, H. C. (2021, novembro 16). Liderança humanizada é o desafio do futuro do trabalho. *Diário de Notícias*. <https://www.dn.pt/dinheiro/lideranca-humanizada-e-o-desafio-do-futuro-do-trabalho-14320761.html>
- [63] Peruzzo, M. (2015). *As três mentes do neuromarketing*. Rio de Janeiro: Alta Books.
- [64] Piardi, D. (2015). *Genética e o líder empreendedor: estudo sobre as bases genéticas e comportamento de profissionais dos municípios da região nordeste do Rio Grande do Sul* (Dissertação de Mestrado, Florida Christian University).
- [65] Piazza, P. V. (2021). *Homo biologicus: como a biologia explica a natureza humana*. Rio de Janeiro: Bertrand.
- [66] Plomin, R., et al. (2011). *Genética do comportamento* (5ª ed.). Porto Alegre: Artmed.
- [67] Rez, R. (2018, janeiro 25). O cérebro trino: reptiliano, límbico e neocórtex. *Nova Escola de Marketing*. <https://novaescolademarketing.com.br/o-cerebro-trino-reptiliano-limbico-e-neocortex/>
- [68] Robbins, S. P., Judge, T. A., & Sobral, F. (2011). *Comportamento organizacional: teoria e prática no contexto brasileiro* (14ª ed.). São Paulo: Pearson Prentice Hall. <https://bit.ly/3dObzKc>
- [69] Rocha, M. (2022, agosto 16). Novos líderes precisam aprimorar repertório de 'soft skills'. *Folha UOL*. <https://bit.ly/3U2fwM8>
- [70] Rowe, W. G. (2014). Liderança estratégica e criação de valor. *Revista de Administração de Empresas*, 42