

**Epigenetics and Its Influence on
Mental Health:**

How does epigenetics affect mental health across generations?

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Chapter 1: Introduction

Imagine an infinitesimal bump on a DNA strand. One of 20,000 or more, this particular gene contains the power to weather emotional stress with resilience. Along comes a chemical cluster that surrounds and encapsulates the gene, inhibiting its ability to function and leaving a legacy of dire physical, psychological, and emotional consequences. This phenomenon forms the essence of a recent branch of science focused on activity that takes place “above” the gene, or “epi-genetics”. The focal point of Epigenetics is how environmental influences, such as traumatic experiences in both children and adults, can actually affect the expression of one's genes.

Nature vs. nurture has been a long since debated topic between embryologists. Epigenetics seems to be the bridge to aid in understanding this complicated field. Dr. Conrad Waddington, the father of epigenetics, provided further insight into gene-environment interactions that influence development beginning with embryology, at a time when his colleagues did not believe that genes were crucial to human development. Dr. Waddington dismissed and disproved the assumption that genes are unchangeable, and that in fact both nature and nurture play a part of how DNA is configured. It is to be noted that epigenetics as we now understand it describes a wide range of reversible modifications such as DNA methylation, histone modifications, chromatin remodeling, and microRNA (miRNA). This paper will focus primarily on the DNA methylation modification.

Another more recently understood aspect of epigenetics is the range and variety of epigenetic programming, and when it occurs. This literature review highlights the range of epigenetic modifications by structuring its findings according to different stages of human life from prenatal and gestational (the period when the fetus is developing) through childhood and finally adulthood. Using chronological order helps to clarify the ways in which environmental factors experienced in utero and early childhood can trigger epigenetic changes, causing mental, physical, and other life altering disorders that adversely affect human life at each stage of development. In addition to epigenetic programming, it is believed that gametes (male and female reproductive cells) may also be affected by these unhealthy environmental factors passed along from mother to child during the gestational period. It is possible that in this way, an embryo may be affected by its grandmother's epigenetic information, resulting in phenotypes

(observable traits) in areas such as appearance, behavior, stress response, disease susceptibility, and longevity.

While changes to the DNA are irreversible, epigenetic alterations of genes have been shown to respond to healthy changes in biological and environmental conditions. Descriptions of programs geared toward helping mothers replace unhealthy factors such as maltreatment and malnutrition with a range of positive parenting skills are a critically important part of this paper. Three such interventions address relieving stress during gestation, ways of bonding with infants, and proper diet for babies and young children.

Learning that factors such as maltreatment and malnutrition faced by disadvantaged children can lodge in their biological makeup and actually change their DNA so that the resulting emotional, behavioral, and possibly learning issues may be passed along to future generations was found to be shocking and unsettling. Finding that outreach by trained psychiatrists, psychologists, social workers, and teachers to parents and others in the community held out hope that changes could be affected over time in at least some of the families and children.

Two important criteria in the writing of this paper were choosing a selection of articles that encompass a variety of disciplines, and conveying a range of perspectives. Researchers who met those specifications are briefly noted below.

Prenatal and Gestational:

Psychiatric nurse practitioner Janiece DeSocio, recognized leader in her field and pioneer in interventional strategies that teach mothers parenting skills ranging from healthy nutrition to meeting the emotional needs of infants and babies

- Australian researcher Tony Mansell, collaborator in investigation of the influence of maternal mental distress on 481 infants and babies as corroborated by the presence of glucocorticoid in cord blood.
- Hungarian geneticist György Kosztolányi, specialist in the effect of harmful environmental, nutritional, social, emotional, and behavioral factors on embryonic and

fetal development, as well as the transgenerational aspect of such diseases as cancer, mental retardation, psychosis, and neurodegenerative disorders.

Childhood:

- Tufts University president and geneticist Anthony Monaco focuses on the treatment of parental anxiety and depression linked to their own experiences of childhood adversity, and leading to the transmission of physical and mental health issues to their children.
- Dutch researcher Patricia Dashorst finds parental traits such as poor attachment quality, low self-esteem, and lack of trust exhibited by Holocaust survivors mirrored in their offspring.
- In a study of approximately 250 children who have been subject to maltreatment, developmental psychologist Dante Cicchetti finds a significantly higher degree of genetic alteration than in the control group, putting the children at risk for physical and mental disorders that could be transmitted across generations.
- Assistant professor David Jones familiarizes counselors with epigenetics and its effects on school age children from troubled backgrounds, training counselors to provide parents with interventions that could offset the difficult factors in children's home environments and reduce the possibility of negative outcomes.

Adulthood:

- University of Leicester author/researcher John Cromby discusses the recent connection between epigenetics and schizophrenia. He feels discouraged that in spite of the commonly acknowledged influence of psychological, social, and emotional factors on disease-causing epigenetic alterations, researchers continue to consider schizophrenia as a biomedical rather than a biosocial phenomenon. Instead of treating schizophrenia only as a medical disease, Cromby advocates bringing our knowledge of hereditary, environmental, and interpersonal factors to bear on the treatment of patients with schizophrenia.

- Knowing that the brain is capable of creating new pathways to compensate for injuries to original pathways, genetic psychologist and professor Robert Kumsa introduces psychotherapy as a tool to reduce the influence of epigenetic mechanisms caused by mental stress early in a child's life.
- Australian researcher Natasha Woods investigates the relationship between chronic stress in childhood and children's socioeconomic position as adults.

The work of these researchers will be discussed more fully under developmental stages in chronological order in Chapter 2: Literature Review. Each of their articles contributes to a better understanding of my research question: How does epigenetics affect mental health across generations?

Chapter 2: Literature Review

Recently, a growing body of research in the field of epigenetics has been suggesting that the influence of epigenetics on mental health may be transgenerational. It is unclear whether or not epigenetic mechanisms negatively affect mental health across generations. Evidence on this subject is still inconclusive. How can current research establish a correspondence between mental health disorders and the presence or absence of transgenerational epigenetic inheritance? This literature review examines how trauma may adversely affect mental health across generations through epigenetic mechanisms such as methylation. Additionally, it will address the negative effects of epigenetic modifications on the well-being of infants and older children, possibly into future generations. In order to gain an understanding as a psychology student aiming toward working with families and children, a mix of articles was selected involving children and occasionally adults from varying points of view, including an article focused on epigenetics and schizophrenia, a topic that is new to research.

The Research Question is: How does epigenetics affect mental health across generations?

Understanding Methylation:

Cicchetti

Author Dante Cicchetti clarifies DNA methylation, an epigenetic phenomenon that holds a prominent place in each of the following articles. He describes methyl as a chemical normally present in the body to keep biological processes working as they should. Cicchetti goes on to explain that in epigenetics, methylation refers to methyl groups attaching themselves to selected genes, thereby inhibiting those genes from expressing themselves. This may diminish the functioning of genes essential to physical and mental wellbeing.

Methylation During Gestation:

DeSocio

Mansel

Kosztolányi

In “Epigenetics, maternal prenatal psychosocial stress and mental health”, psychiatric nurse practitioner and recognized leader in her field Janiece DeSocio focuses on the perinatal

period (the stage preceding and immediately following birth). She describes the process by which maternal anxiety, depression, and stress affect the flow of oxygen and nutrition to the placenta and from there to the fetus. In this way, the mother's negative physiological and emotional environment are shared with the developing baby. DeSocio refers to the perinatal or gestational period through the earliest weeks of an infant's life as the developmental window during which the neurodevelopmental foundations of language and cognition are being established. Emotional regulation, which determines whether a child will be vulnerable or resilient in responding to life's challenges, also has its roots in this stage.

DeSocio echoes Monaco's ardent wish for translating academic knowledge into practical ways of intervening in the methylation process, with the goal of preventing mental health disorders from being passed from generation to generation. She has made it her priority to minimize or eliminate psychological, social, and biological stress in the environment of the womb and early in infants' lives by instituting the training of psychiatric nurses to carry out home visiting programs from early pregnancy through age two. In gathering information from articles that served as the basis of her literary review, DeSocio notes a study of mothers who experienced prenatal psychosocial stress, 90% of whom had a psychiatric diagnosis. It was found that the 3-1/2 to 4-year old children whose mothers had poor parenting abilities demonstrated negative cognitive abilities. In contrast, when mothers exercised positive parenting skills, the correlation became close to insignificant. Similarly, DeSocio's programs that teach mothers and families interventions such as stroking infants and meeting babies' emotional and nutritional needs have yielded evidence of improved infant outcomes in the form of lessened maternal prenatal depression and reduction of premature births.

DeSocio's article communicates an understanding of the way maternal stress transmits itself to the fetus, and how this may trigger epigenetic modifications that not only put infants' physical and emotional development at risk but may well be passed along from one generation to another.

Hungarian medical geneticist György Kosztolányi brings his specialization in the transgenerational and developmental aspects of diseases to his research on neonatal development as author of "Hypothesis: epigenetic effects will require a review of the genetics of child development". Kosztolányi, like Monaco and DeSocio, sees genomes as most likely to be

susceptible to the harm as well as to the regulation of environmental factors during the earliest stages of embryonic and fetal development. It is during this period that epigenetic activity may turn on or inhibit the expression of genes. By environmental factors, Kosztolányi is referring to nutrition, tobacco smoke, and certain chemicals found in the body, as well as emotional, social, and behavioral factors that include maternal care. The author is hopeful that research in this area will lead to identifying and regulating risk factors leading to disease during pregnancy, infancy, and children's early years. Kosztolányi looks beyond the earliest stage of neonatal development to studying disturbed regulation in older children and adults. Resulting pathologies include cancer, mental retardation, psychosis, and neurodegenerative disorders.

Learning from a specialist in the transgenerational aspect of epigenetics provides a valuable starting point to understanding more about the regulation of disturbed genes that lead to cancer and other diseases.

Dr. Tony Mansell of Australia's Murdoch Children's Research Institute joins DeSocio in emphasizing the link between epigenetic mechanisms and the gestational period. "Maternal mental well-being during pregnancy and glucocorticoid receptor gene promoter methylation in the neonate", is a collaborative primary research project by 13 scientists representing infant study programs in different parts of the world. Numerous smaller studies (involving fewer than 100 neonates) have supported the association between maternal depression and anxiety during pregnancy and the presence of methylation in babies. Mansell's investigation, the largest of its kind at the time, seeks to determine whether this connection is corroborated by the presence of glucocorticoid in newborns' cord blood. His study indicates that the influence of methylation is balanced by the presence of this hormone, secreted by the adrenal gland, which serves to restore balance during stress.

Unlike smaller studies, this highly technical piece of research, based on 481 participants, concludes that the influence of mothers' mental distress on their babies was so slight as to be insignificant. The difference in findings between this and smaller research projects rest partly on sophisticated technology that is not likely to be available to researchers in smaller projects. Mansell himself suggests that rigorous statistical control minimizes false positive findings. how to better evaluate source material. It is surprising and eye opening to have found a highly

credible study that contradicts the conclusions of other studies, and reveals the need to better understand how to evaluate sources. The possibility that depression and anxiety during pregnancy do not necessarily lead to the negative consequences of methylation offers a ray of hope to mothers-to-be.

Hungarian medical geneticist György Kosztolányi views the harm caused by environmental factors in the earliest stages of embryonic and fetal development as a specialist in the transgenerational and developmental aspects of diseases. Author of “Hypothesis: epigenetic effects will require a review of the genetics of child development”, Kosztolányi singles out environmental factors such as nutrition tobacco smoke, and certain chemicals found in the body, as well as emotional, social, and behavioral issues that include maternal care. The author is hopeful that research in this area will lead to identifying and regulating risk factors leading to disease during pregnancy, infancy, and children’s early years. Kosztolányi looks beyond the earliest stage of neonatal development to studying disturbed genetic regulation in older children and adults. Resulting pathologies include cancer, mental retardation, psychosis, and neurodegenerative disorders. This article provides a starting point for understanding more about disturbed genes that lead to cancer and other diseases.

Methylation during childhood development:

Monaco

Dashorst

Cicchetti

Jones

Concern about the dramatic increase in mental health disorders in children and adolescents over the past two decades, explores factors that contribute to this phenomenon. In “An epigenetic trans-generational model of increased mental health disorders in children, adolescents, and young adults’, Tufts University president and geneticist Anthony Monaco observes that childhood stress, trauma, malnutrition, and obesity have been linked to the rise of ADD, ADHD, depression, and anxiety. His research focuses on topics such as treatment trends for anxiety and depression, chronic social instability, and the intergenerational transmission of childhood adversity in parents. While changes to DNA are known to be irreversible, Dr. Monaco

concludes that epigenetic transgenerational alterations due to methylation are responsive to biological and environmental changes. He emphasizes the urgency of creating interventions that negate the effect of exposure to trauma in parents as well as in offspring at risk for mental health and other health disorders.

In comparison to Monaco's broad overview of childhood mental health disorders, Dutch researcher Patricia Dashorst narrows her focus in "Intergenerational consequences of the Holocaust on offspring mental health: a systematic review of associated factors and mechanisms". Her article analyzes characteristics found in Holocaust survivors and their children. Epigenetic mental disorders in children were found to replicate those of their parent or parents, and to correlate with parenting issues such as poor attachment quality. Outlooks on life such as pessimism, low self-esteem, and lack of trust were documented as being passed from parents to children. Mothers who survived the Holocaust were better able to contribute to their children's well-being than were fathers. Offspring having two survivor parents were at higher risk for mental health problems than those with one survivor parent. The studies on which Dashorst bases her findings also take into account other traumatic life events and genetic predispositions. Dashorst's compilation of the findings of fellow researchers furthers understanding of the passing on of mental health issues to future generations.

Whereas Dashorst investigates possible effects of unspeakable parental trauma on children of Holocaust survivors, developmental psychologist Dante Cicchetti focuses on methylation in a study of children who themselves have been subjected to maltreatment. Cicchetti's large scale primary research project, "An investigation of child maltreatment and epigenetic mechanisms of mental and physical health risks", studies the degree of methylation in a group of 548 low-income school age children, roughly half of whom have experienced maltreatment while the other half have not. Using a variety of sophisticated graphs to illustrate his findings, Cicchetti notes significantly higher methylation percentages in maltreated children than in the control group. This points to the possibility, if not likelihood, that these children may exhibit physical and/or mental disorders which could be passed along to future generation. By clarifying the way in which these disorders may be transmitted from one generation to the next, Dr. Cicchetti has given a solid basis for comprehending other research articles related to epigenetic alterations.

In “Mental Health Epigenetics: A Primer with Implications for Counselors” by David Jones speaks to the needs of school age children. Jones offers counselors basic, yet not commonly known information related to epigenetic mental health research. He lists anxiety, depression, addiction, and schizophrenia as often stemming from adverse early experiences in the psychological and social spheres. Jones addresses cognitive behavioral therapy, mindfulness, diet, and exercise as factors that may tilt the balance toward mental health in children’s lives. The article consists of clearly and understandably explained topics such as genetics, transcription, translation, and epigenetics including DNA methylation and histone modification. Jones gives examples of environmental factors such as the Dutch famine during the Nazi occupation of Holland that impacted the health of children born during that time into adulthood and across generations. He elaborates on mental health disorders rooted in childhood maltreatment and emphasizes that effective strategies on the part of parents, counselors, and others, especially during the first five years of life, may prevent the emergence of mental health disorders.

Professor Jones targets counselors for three reasons. First, because of counselors’ close ties to children and their families; second, because Jones and his colleagues recognize that counselors are likely to be under-informed about the topic of epigenetics and the possibility that methylation may disable genes that contribute to strengthening mental health; and third, because trained counselors are in a position to be able to provide parents with social, emotional, and nutritional interventions that have the potential to avert the negative outcomes due to difficult psychological, social, and biological factors in children’s home environments. Jones ‘outreach to counselors provides the knowledge they need to put research into practice in ways that may change children’s lives.

With this article, Jones and his academic colleagues join what appears to be a growing group of researchers who are reaching out to non-scientists with close ties to children. His outreach to counselors provides the knowledge they need to turn research into practice in ways that may change children’s lives.

Methylation during adulthood:

Cromby

Kumsa

Woods

In his article, “Reviewing the Epigenetics of Schizophrenia”, John Cromby moves beyond epigenetics as it affects children from pregnancy through later childhood to a study of the possible effects of epigenetics on a specific adult population. His research on schizophrenia is based on selected articles published between 1958 and 2012.” Cromby and his colleagues note that earlier studies centered around intracellular changes affecting the DNA, as well as the addition of methyl to a gene sequence, which silences that gene when it duplicates. These changes may be passed from generation to generation. More recently biology, medicine, psychiatry, and psychology have taken their place in the field of epigenetic research.

Cromby’s intention is two-fold: first, to examine the connection between epigenetics and schizophrenia as it has developed over time; second to voice his conviction regarding the direction research needs to take at this point. Schizophrenia has been at the forefront of many recent studies. Although factors such as famine, nutrition, abuse, and neglect are known to be associated with schizophrenia, the emphasis continues to be on the biomedical aspects. While Cromby fully embraces epigenetics, he expresses disappointment that its proponents have fallen short of making use of its full potential. He wonders that epigenetic researchers have chosen to pursue a biomedical approach to this illness, rather than changing their emphasis to a biosocial approach that centers on known hereditary, environmental, and interpersonal factors. Cromby is hopeful that bringing epigenetics and mental health together will advance our knowledge of both. When treating people in psychological distress, he avoids limiting himself to the biomedical model and rigid diagnostic categories. He prefers, instead, to gain an understanding of his patients from their own perspective, contained partly in their subjective anecdotes. Cromby’s holistic approach makes a valuable contribution to exploring the link between epigenetics and schizophrenia.

In “The role of epigenetics for understanding mental health difficulties and its implications for psychotherapeutic research”, German professor Robert Kumsa joins fellow researchers Mansell, DeSocio, Cicchetti, Monaco, and Cromby by advocating for interventions that reduce or eliminate the power of methylation.” Just as the brain is malleable in that it is

capable of creating new pathways to compensate for injuries to the original pathways, Kumsa has undertaken to investigate whether psychotherapeutic intervention may have the potential to mitigate genetic alterations caused by mental stress early in life. Pilot studies reveal small but measurable changes in post-therapeutic subjects, suggesting that continued exploration of this possibility is warranted. The possibility that psychotherapy may be added to existing approaches that reduce the influence of methylation is exciting to contemplate.

“In “Scars of childhood economic stress: A systematic review”, Natasha M. Woods, like Kumsa, brings a new perspective to the possible influence of epigenetic alterations on adults. Along with two fellow Australian researchers, Woods gathered and evaluated 32 publications on the relationship between methylation in subject children and their socioeconomic position later in life. “Allostatic load”, the biological cost of chronic stress, is a known factor in depression, anxiety, PTSD, and antisocial behavior. Woods refers to “DNAm” as a mechanism that has the potential to weaken the methylation that prevents a given gene from expression itself, thereby restoring the function of that gene and the mental health of the individual. Learning more about whether socioeconomic deprivation also remains part of children’s genetic make-up once they enter adulthood is the focus of this project. It was difficult for the researchers to draw conclusions due to the fact that no uniform means of measuring the results of the impact of mechanisms such as DNAm had yet been established. Addressing methodological issues will open the door to further research in this area.

This research project was conceived before the existence of technology essential to its evaluation. Learning that such a project may need to be pursued in multiple stages expands an understanding of the research process.

Conclusion:

Eight of the ten primary or literary research articles on which this thesis is based suggest a positive connection between methylation and the transmission of mental and/or physical disorders across generations. The exceptions are an article in its early stages, and the group of researchers who found at most a slight correlation, given the presence of good parenting in children’s lives. This study was also based on a large number of participants and carried out by a multidisciplinary team of professionals with access to highly sophisticated tools and methods

which smaller studies could not be expected to have at their disposal. Five researchers illustrate what seems to be a growing trend by strongly advocating teaching parents and others ways of minimizing stress associated with methylation. Of these, two have turned theory into practice by creating and/or implementing programs designed to reduce or eliminate the adverse effects of methylation with encouraging results. The fact that epigenetics is a relatively new branch of science is likely to account for questionable results that may become clearer as time goes on.

Two important issues have not been addressed in these ten articles. First, whether it may be possible now or in the future to reverse methylations that suppress the ability of genes to resist the development of cancer and other diseases, some of which are known to be handed down from one generation to the next. Second, whether there are ethical concerns specific to the science of epigenetics.

Chapter 3: Methods

This study of epigenetics and the ways in which it affects mental health across generations is a secondary paper, in that it is a literary review that extracts data from other literary reviews. It is qualitative in nature because the facts, opinions, and insights expressed in the thesis largely grew out of the written aspect of these research projects, rather than from the charts and graphs that accompany some of the articles. Using a qualitative approach to deriving data from the ten articles selected to shed light on my thesis question led to deeper knowledge and understanding gained from experts in their fields. The source of data was peer reviewed articles located in the Purchase College Library. Key words used to search the database include psychiatry, psychology, neonatal, infancy, childhood, and adulthood as related to epigenetics. Data was selected from articles that address multiple aspects of epigenetics as they pertain to the sequential stages of human development. The knowledge contained in these articles was originally obtained either through primary research, or by reviewing the writing of other authors/researchers.

In the course of arriving at a well rounded selection of articles, several were rejected. An article whose title drew my attention was so poorly written that it was nearly impossible to understand. Another was rejected because the highly advanced technology and graphics at the heart of the author's research were not balanced by text that could be understood by less knowledgeable readers. Two more were reluctantly set aside because, while informative, they duplicated the topic and point of view of several articles that had already been reviewed.

After a significant number of articles had been reviewed or were in the preliminary stage of being reviewed, a pattern began to emerge. Methylation during gestation and childhood was the original focus of this study. This was reflected in the choice of articles, whose researchers represented a variety of backgrounds and points of view. At some point, it felt important to bring new aspects of epigenetics into this review. Four articles focusing on the impact of epigenetics in adulthood provided the breadth and diversity that enriched this literary review in unexpected ways.

Comparing and contrasting data from different articles made it possible to access commonalities among researchers, as well as patterns and trends. A trend of great significance is the creation and implementation of programs that provide guidance to mothers and other care givers with child rearing skills that have the potential to reverse harmful epigenetic changes. As research progressed, a single contradiction was uncovered. A limitation of the review concerns the evaluation of this contradictory finding vs. commonly accepted findings. The limitation is related to not yet having the knowledge required for the kind of analysis that involves highly sophisticated technology. In its place, this contradiction is brought to light as food for thought for readers.

Chapter 4: Results

The ten articles that provided insight into my research question from a variety of viewpoints led to two main findings: eight of the studies affirm the likelihood that the epigenetic mechanism methylation causes genetic alterations that are capable of being transmitted from one generation to another, while two studies find little evidence to support this hypothesis. Three of the studies that affirm that transgenerational transmission exists, as well as two studies that do not, acknowledge that the negative effects of methylation may be reversed or eliminated by positive changes in the environments of babies and young children. Researchers of these five articles strongly advocate for new and existing programs that offer intervention to mothers and families of at-risk children, from the neonatal stage through infancy to early childhood and possibly beyond.

DeSocio's study showed that 3-1/2 to 4-year children, whose mothers had benefitted minimally from the interventions they had been offered, demonstrated cognitive issues. In contrast, she found no significant cognitive impairment in children whose mothers were able to take advantage of the parenting skills they had learned. This finding highly supports my hypothesis that methylated genes can be passed along from one generation to another in the absence of interventions that reduce or eliminate methylation mechanisms.

Dr. Tony Mansell seeks to establish whether the presence of glucocorticoid in babies' cord blood is a reliable indicator of maternal anxiety and depression, known stress factors that can trigger methylation. He focuses on glucocorticoid, a hormone secreted by the adrenal gland, because it is known to balance stress. Mansell's investigation indicates that the influence of methylation is balanced by the presence of this hormone, and that maternal anxiety and depression do not carry over to babies as a result of the hormone glucocorticoid. In spite of this finding, Mansell's commitment to increasing knowledge of negative effects of the methylation process does confirm my hypothesis.

Three researchers support my hypothesis while at the same time advocating for interventions that diminish the effects of methylation. György Kosztolányi details biological and psychological environmental factors that he views as leading to the intergenerational transmission of genes affected by methylation. Dr. Anthony Monaco seeks to treat causes of

epigenetic changes that negatively affect children. Professor David Jones reaches out to guidance counselors, training them to provide parents with a basic understanding of epigenetics, along with introducing interventions that will strengthen their children's mental, physical, social, and emotional health to counteract the effects of genetic methylation.

Patricia Dashorst notes that children of Holocaust survivors display traits such as pessimism, low self esteem, fearfulness, and lack of trust. These traits mirror those of their parents, and are exacerbated by poor parental attachment skills. In attributing these characteristics to the passing along of mental health issues from one generation to another, Dashorst's research supports my hypothesis.

Developmental psychologist Dante Cicchetti finds that children who have been subjected to maltreatment have significantly higher levels of methylation than the control group. He concludes that it is likely that these children may evince physical and mental disorders ascribed to intergenerational transmission of compromised genes as time goes on. This finding is consistent with my hypothesis.

John Cromby, staunch proponent of epigenetics, specializes in schizophrenia. Rather than a biomedical approach, Cromby favors an interpersonal approach while interacting with patients with schizophrenia. Cromby believes that bringing epigenetics and the mental health disciplines together will strengthen our understanding of both. His views support my hypothesis.

Professor Robert Kumsa investigates whether psychotherapeutic intervention may be a viable path toward reducing genetic alterations and their long term negative effects. Kumsa's understanding of this possibility supports my hypothesis.

Natasha Woods studies DNAm, a mechanism that may weaken methylation. Her goal is to research a possible correspondence between childhoods lived with deprivation, and those children's socioeconomic status later in life. Woods' knowledge of methylation and the need to minimize it reveals her understanding of epigenetic alterations. Her work supports my hypothesis

Chapter 5: Discussion

Each of my articles is based on a question that is important to the researcher or research team. Observation, in this case of mothers and mothers-to-be who experience biological or psychological stress, helps researchers formulate their hypothesis. The hypothesis is the researcher's question in need of exploration and clarification. Experiments, a major part of the scientific method, bring researchers closer to concluding whether their hypotheses are true. The scientific method proves or disproves a hypothesis by generating knowledge and insight. It paves the way to putting findings into action, though it does not take this step itself. For that reason, this kind of research is called "theoretical research".

A second type of theoretical research is social science research. These researchers use polling in the form of questionnaires, as a means of gathering data. Libraries are a social science resource for discovering what has already been documented about a given topic. This may inform secondary researchers (those who research the research of others) that they would benefit from approaching their topics from a different angle. Statistical analysis is another tool used in social science research. In contrast to theoretical research, practice or empirical research is primary research. Empirical research observes and experiments with the subjects being studied. An article that identifies itself as a literature review with a research hypothesis is an example of theoretical research. It is possible for a given study to represent both types of research.

This study was undertaken with a very limited understanding of epigenetics. It was known that unhealthy psychological, social, emotional, and behavioral issues at home and in the neighborhood can cause a negative change in young children's genes, predisposing them to mental health issues and possibly learning disorders. Learning more about the certainty or uncertainty of altered genetic information being passed down to future generations was expected. Feeling unprepared for the flood of concepts and findings contained in research in this field was unexpected. The task of selecting ten articles on which to base this project was initially overwhelming. In the beginning, these articles grouped themselves into long vs. short, easy to understand vs. highly academic. Not being able to comprehend academic writing was frustrating. Extracting pertinent information from more understandable writing led to being able to skim more difficult articles, identifying concepts that supported the thesis question. Understanding highly sophisticated technology essential to several of the research articles was a challenge that could not be overcome at this moment.

Another important limitation was not having the tools and experience essential to evaluating research findings, as opposed to taking them at face value. Several internationally acclaimed institutes connected with large scale studies stood out as being credible beyond doubt, but evaluating the findings of smaller research projects is something yet to be learned. Overall, being exposed to new knowledge and challenges has been exciting and worthwhile, a real introduction to becoming part of the field of psychology.

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