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Abstract

This paper reviews literature in human epigenetic research as a case study in order to examine and critique the dominant framework of embodiment as unidirectional or bidirectional and mechanistically driven. We identify three major critiques to this approach: 1) A treatment of epigenetic traits as a mechanism of embodiment, rather than one of the multidirectional components of the dynamic and ongoing embodiment process; 2) A tendency to view changing epigenetic traits as both the cause and solution for embodied social inequalities rather than examining the need for systemic change; and 3) A loss of the complexity of varied lived experiences within epigenetic studies. We suggest weaving in humanistic frameworks and expanding towards a multidirectional definition of embodiment in the field as a way forward.

Introduction

In biological sciences, embodiment often focuses on the mechanistic aspects of how lived experiences impact biology, usually through biomarkers (Worthman and Costello, 2009; Strimbu and Tavel, 2010). Central to this study of mechanism is the concept of plasticity, or a biological organism's ability to change in response to environmental context. Understanding and naming the mechanisms of embodiment is vital work, especially when it comes to utilizing biological anthropology to counter claims of biological determinism (i.e. without evidence for the biological mechanism, a trait cannot be classified as biological or heritable). However, the combination of the broad definition of embodiment (how lived experiences impact the body) and the narrow focus on mechanism and/or measurement, leads to unidirectional thinking around how the environment and the body interact, which we argue is especially evident in epigenetic

research on embodiment. In this paper we consider environment to be comprehensive, including not just physical environment but the sociocultural systems which shape our material, social and economic conditions, including, for example, race, class, gender, sexuality, and citizenship.

Embodiment is used in different ways across the anthropological subdisciplines and outside anthropology, as well, with varying definitions approaching a theory net, or a term or concept that brings together many elements that constitute a core understanding (Kimmel, 2008). Outside of biological anthropology, embodiment refers to the process of a person or group incorporating, internalizing, and reproducing the material and sociocultural world around them (Csordas, 1990; Kimmel, 2008). This process is multidirectional, meaning that embodying does not act on only on a passive object; a subject embodies and in turn recreates and changes that which they are embodying (Csordas, 1990). When interpreted through this lens, embodiment is an interpersonal and social process rather than only occurring between a singular person/group and the outside world (Csordas, 1990; Kimmel, 2008). People can embody their world and lived experiences through dance, vocalization, movements, behaviors, clothing, and physiological changes, consciously or subconsciously (e.g. Jones, 2002; Reed, 1998; Rees, 2017; Weidman, 2014; Zimman and Hall, 2009). Counter to these definitions, within human biology and public health disciplines, including epigenetic research, the definition of embodiment refers primarily to physiological changes, with an emphasis on the mechanism. Krieger (2005) defines embodiment as:

> A concept referring to how we literally incorporate, biologically, the material and social world in which we live, from in utero to death; a corollary is that no aspect of our biology can be understood in the absence of knowledge of history and individual and societal ways of living… ‘‘embodiment’’ for epidemiology is best understood: (a) As a construct, process, and reality, contingent upon bodily existence; (b) As a multilevel phenomenon, integrating soma, psyche, and society, within historical and ecological context, and hence an antonym to disembodied genes, minds, and behaviours; (c) As a clue to life histories, hidden and revealed; and (d) As a reminder of entangled consequences of diverse forms of social inequality (p.352).

Krieger’s (2005) definition of embodiment is one of the most widely accepted definitions of embodiment in human biology and health research. Krieger’s model is expansive, as it explicitly names embodiment as a multilevel process and emphasizes the need for human biology research to consider sociocultural and environmental context. The use of Krieger (2005) as a definition of embodiment in epidemiology is taken up by epidemiologists and human biologists in ways that emphasize a specific biological mechanism through which embodying occurs, narrowing the

scope of embodiment research, and further emphasize disease or negative health outcomes. This concentration on disease outcomes can imply that embodiment is only negative. Case in point, in biological anthropology, the phrase "getting under the skin," which is itself a phrase used to describe something annoying and conjures images of unwanted incorporation, is common. In order to move away from more limiting connotations of embodiment, which view the process as solely negative or occurring only through biological means, we draw from sociocultural anthropology, as well as humanistic, queer, and feminist scholarship on embodiment to conceptualize embodiment more holistically.

Anthropologists have been working towards more interdisciplinarity, and acknowledging the ways epigenetics research could further bioreductionalist frameworks if we do not begin incorporating more ethnographic and critical research into biological anthropology (Lock, 2015; Niewöhner and Lock, 2018; Meloni, Moll, Issaka, et al., 2022). Here, we build on prior research to bring a multidirectional framework to human epigenetics, and at a more existential level, highlight the ways we broadly, conceptualize embodiment in biology. By using human epigenetics as a case study, we hope to present a big picture critique of embodiment frameworks in biology, and present incorporating humanities approaches as a way forward.

Epigenetics as a case study

Much of the emphasis in biological anthropology is on contributing to the understanding of potential mechanisms for embodiment, and changes in epigenetic traits are often highlighted as a way for lived experiences to affect the body biologically (e.g. McDade et al. (2019), Mulligan et al. (2012), and Thayer and Non (2015). Epigenetics refers to the ways gene expression can be modified without changing the DNA sequence, and, in human biology research, often involves examining the relationship between environment and gene expression modification, usually through methylation, histone modification, and chromatin accessibility.

Here we use human epigenetic research as a case study to examine the use of embodiment ideology as unidirectional and mechanistically driven. Taking a holistic approach to four-field anthropology, we identify three major critiques of this approach and utilize humanistic frameworks to propose expanding towards a multidirectional definition of embodiment in the field.

Our major critiques of current human epigenetic research are:

1. A treatment of epigenetic traits as a mechanism of embodiment, rather than one of the multidirectional components of the dynamic and ongoing embodiment process
2. A tendency to view changing epigenetic traits as both the cause and solution for embodied social inequalities rather than examining the need for systemic change
3. A loss of the richness of varied lived experiences within epigenetic studies

A treatment of epigenetic traits as a mechanism of embodiment, rather than one of the multidirectional components of the plastic and ongoing embodiment process

Positioning epigenetic traits as the mechanism of embodiment overemphasizes only one possible pathway of embodiment, a unidirectional framing, which we term *the environment to biological mechanism (like epigenetic modifications) to outcome pathway* (Figure 1A). Studies of epigenetic traits and environmental/social context incorporate this pathway into study design by positioning biomarker data as the variable of interest. While this design is useful, it often leads to interpretations that construct a narrative in which the biomarkers are acted on, and in turn cause disease (or some other outcome of interest).

{~?~IM: insert Figure 1A here.}

Figure 1A: A visual model of a unidirectional framing of embodiment

The tendency towards a unidirectional framing can be sensationalized, and further construed by researchers and the public alike as determining specific phenotypes or health outcomes. Even as researchers acknowledge the drawbacks of epigenetic work, specifically the issues in proving causality, having large enough sample sizes, and the lack of understanding of longitudinal effects the sensationalization in popular sphere, such as tech and TEDx spaces as well as the media remains (Juengst, Fishman, McGowan, et al., 2014; Joly, So, Saulnier, et al., 2016; Liu, Shen, Barfield, et al., 2022; Yousefi, Suderman, Langdon, et al., 2022; Thayer and Non. 2015). A common example of sensationalization is found in Richardson et al. (2014) who critiques the ways epigenetic research has been harnessed as a new cultural tool to blame mothers for offspring outcomes. While many researchers are not explicitly arguing for a deterministic conceptualization of epigenetics, by using unidirectionality and focusing on mechanisms of embodiment, the patterns seen in the results of epigenetics research are often read as unchangeable. A deterministic interpretation can lead to blaming individuals for epigenetic

changes due to structural and social inequalities and move the focus from these inequalities to the individual (Müller, Hanson, Hanson, et al., 2017a; Saldaña-Tejeda and Wade, 2019).

This biological reductionism often leads to instances of misplaced causality. For example, the idea that high levels of adrenaline in the brain (often a result of a stressful or aggressive situations) causes extreme behavior attributes causality to the biomarker (adrenaline level) rather than the circumstance (Rose, 2007). Epigenetic association studies may lead to this type of interpretation, especially due to the tendency to treat epigenetic traits as both modifiable and static within the same study, while presenting definitive conclusions. Egorova points out, in her work on GWAS studies in India, how multiple conflicting scientific stories can be presented in the same paper, with the same data. Epigenetic studies are particularly sensitive to multiple narrativizations, due to the sensationalization of epigenetics in the media (Egorova, 2009). In epigenome-wide association studies, a lived experience (or phenotype) is explored in relation to an epigenetic trait, like gene methylation. By nature of the experiment, this association is not directional. The lived experience cannot be concluded to result in an epigenetic change any more so than the methylation difference can be concluded to result in that lived experience. There is a relationship, but more information is needed to provide evidence of causality.

Epigenome-wide association studies often focus on understanding disease or finding methylation biomarkers (relevant CpG sites) for non-communicable disease. This focus theorizes methylation (a specific epigenetic mark) as simultaneously changing due to environment, and static over time (in terms of 'health'). However, the sensationalization of epigenetics has led to epigenetics being lauded as the primary "how" of embodiment. In this framework, quick fixes can alter your epigenome and change your body. Sometimes touted as the way to "overcome your genetics" (Feinberg, 2013), or "become healthy" (Weber, 2019), these overblown views of epigenetics, popular in "wellness spaces," highlight how the focus on epigenetic marks as the sole, linear, mechanism for embodiment rather than part of an interconnected multidirectional process can lead to misunderstandings between researchers and the public. This issue is only intensified, as the replicability of many epigenetic studies comes into question (Sugden, Hannon, Arseneault, et al., 2020). Although this phenomena is not the fault of researcher producing epigenetic work, sensationalization is a huge motivator for embodiment focused biology, and part and parcel of the frameworks we aim to move away from

in this paper.

That is not to say that epigenetic studies do not provide us with valuable biological information. Studies have provided evidence that life experience impacts the epigenome (Denhardt, 2018; Cavalli and Heard, 2019). Some of these impacts are relatively stable (Gallego-Paüls, Hernández-Ferrer, Bustamante, et al., 2021) and these epigenetic differences result in changes to RNA activity (Tsai, Glastonbury, Eliot, et al., 2018). However, as Gravlee points out in his 2009 work, "…the construct of embodiment does work that plasticity alone does not." In particular, Krieger's model reflects an emerging consensus that the next wave of research needs to integrate 1) multiple levels of analysis with 2) developmental and life-course perspectives and discussions over time. The causal implications emphasized in media portrayals and popular understandings of epigenetic studies move away from Gravlee and Krieger's call, instead focusing attention on the unidirectional model of embodiment, glazing over important unknowns such as the difference between short-term and long-term changes, the effects of differential gene expression, and the impact of epigenetic changes on the body as a whole. Again, that does not mean that work focused on mechanisms is bad, in fact certain historically marginalized groups have been able to utilize epigenetic work to regain some political power (Warin, Kowal and Meloni, 2019; Müller and Kenney, 2021). Nonetheless, embodiment is more complex than the unidirectional model suggests, and as we will expand on in the discussion, we require creative frameworks to think about how the body and environment interact multidirectional way.

A tendency to view changing epigenetic traits as both the cause and solution for embodied social inequalities rather than examining the need for systemic change

As a part of the dynamic and ongoing embodiment process, epigenetic traits can remain responsive to environmental stimuli, send internal and external signals, and act within a suite of bodily responses to dynamic embodied environments (Gravlee, 2009; Thayer and Kuzawa, 2011; Müller, Hanson, Hanson, et al., 2017b; Richardson, 2017; Denhardt, 2018; Cavalli and Heard, 2019). By overemphasizing the unidirectional *environment to biological mechanism to outcome pathway* and more specifically, the mechanism, human epigenetic research also positions the epigenetic trait of interest as the panacea to understanding the cause of, and also the solution to, embodied social inequalities. Additionally, the emphasis on the mechanism in human epigenetic

research (and its position as a dependent variable or variable of interest in scientific design) deemphasizes the human lived experiences that are so valuable for contextualizing embodiment in all its dimensions and directions.

The unidirectional thinking that frames epigenetics as the primary mechanism for embodiment also creates conditions in which many scientists assume the best way to repair negative impacts from epigenetic marks must be through chemically reversing those marks. This limiting worldview, which is compounded by the over-sensationalization of epigenetics in the media, is a major problem when discussing how social inequalities may be embodied. As epigenetics becomes more widely studied, we see an increase in concerted efforts to "reverse" epigenetic marks (Abhimanyu et al., 2021; Duggirala, 2018; Topart et al., 2020). This prevalent movement to biochemically shift epigenetic marks ignores the (potentially environmental, social, and/or systemic) conditions that led to people gaining epigenetic marks that are negatively associated with health in the first place. These logics avoid the root causes of social inequalities and instead move to treat symptoms, rather than demanding a change in the status quo. Although these root causes range widely from systemic racism (Smith, 2016) and colonialism (Evans-Campbell, 2008; Bombay, Matheson and Anisman, 2014; Loomba, 2015) to environmental toxicity (Barouki, Melén, Herceg, et al., 2018), none of them will be solved through biochemical changes in an individual. When scientists talk about the applications of their epigenetic research, using biomedical treatments to reverse epigenetic marks should not be seen as a benefit to society; it is dangerously close to eugenics.

As we discuss how researchers use embodiment as a framework for epigenetic research, we should not forget the eugenic baggage that comes with genetic and epigenetic research. The vocabulary of eugenics is the vocabulary we use today in scientific research (Bashford & Levine, 2010, p.2). The division of people into "fit" and "unfit" groups and the "nature-nurture" debate link to eugenic impulses as well as popular understandings of genetics (Turda, 2012). There is a concern that determinism, both biological and environmental, is permeating epigenomic research and interpretations (Müller, Hanson, Hanson, et al., 2017b). Müller and colleagues point out that environmental epigenetics stems from a long history of work concerned with "denigration," which culminated in 20th century eugenics movements that held the explicit goal of preventing people deemed "biologically inferior" from reproducing (Müller et al., 2017). Although epigenetics and embodiment through epigenetics are lauded as leftist ideas that counter genetic

determinism, they are susceptible to reenact it through environmental determinism mediated by the body, thus biological determinism with a new mask (Weasel, 2016; Richardson, 2017). As feminist science scholars and anthropologists have discussed, it is vital to shape the dialogue around epigenetics to counter the essentializing impulse in order for these frameworks to challenge harmful reductionism and reach their feminist potential (Richardson, 2017; Niewöhner and Lock, 2018; Meloni, Moll, Issaka, et al., 2022).

Eugenics already frames popular discussions about epigenetics and embodiment. We, as researchers, generally focus on studying the embodiment of trauma, social inequality, and stigmatization. In a PubMed database search for biological anthropology papers on embodiment, almost all focused on marginalized populations (Supplemental Figure 1). Marginalized people are "othered"; to be "healthy" you must fit into normative structures, which reflects the eugenic baggage our conceptions of "health" carry. "Healthy" (white, able-bodied, thin, middle-class, cisgender, heterosexual, etc.) people are not seen as having anything "embodied," yet their lived experiences influence their bodies just as much as anyone else. The emphasis on the negative traces back to eugenic research that focused on the Victorian poor (Mazumdar, 1992). Our systems view white supremacy as natural, positioning whiteness as the 'normal' baseline of comparison (Clancy and Davis, 2019). Our argument build on Eve Tuck's work on the harms of damage-centered research, and her call to appreciate complex personhood (Tuck, 2009). The focus on negative life experiences in marginalized communities can and will be used by bigots to make environmentally deterministic arguments that paint people who have embodied negative life experiences as "broken," "sick," or in need of a biochemical "cure." Instead, researchers need to focus on how radically changing social systems can provide a better quality of life for everyone.

Epigenetics research can shift away from a focus on biochemical reversal of determined "negative" epigenetic traits towards a nuanced view of how changing social systems can provide a better quality of life for all. Currently, epigenetic studies focus on health and disease in the individual at the expense of structural views that look at social, political, and economic determinants of health (Müller, Hanson, Hanson, et al., 2017b). It is better to prevent harmful life experiences than it is to try to biochemically erase the physiological impact those experiences have had. Recent studies demonstrating how proper nutrition can impact the epigenome show how social change (such as ensuring everyone has access to nutritious food) can lead to positive

embodiment (Park, Yoo and Park, 2017). As we have shown throughout this paper, overly emphasizing a unidirectional and mechanistic understanding of embodiment only highlights the way epigenetic marks change, which misdirects focus to solutions which treat the symptoms and not the cause of systemic and structural inequalities.

A loss of the richness of varied lived experiences within epigenetic studies

Finally, the unidirectional and mechanistic framework of embodiment in epigenetic studies focuses on aspects of lived experience that can obscure the diversity of these experiences, or that position what is a snapshot of one's experience in a singular moment in time as static. Studies that follow an "*environment to biological mechanism to outcome*" unidirectional framework often identify and quantify lived experiences into measures that can be compared statistically to the biomarker outcome. This quantification smooths over much of the nuance inherent in all of our lived experiences and *assumes* that certain lived experiences are more impactful than others (for example, negative lived experiences like those highlighted above). Additionally, research focusing on the biological impact of how individuals perceive their own lived experience is beginning to demonstrate to the scientific community that how people feel about their reality plays a larger role in molecular embodiment than many external or supposedly objective measures of stress or health (Cole, Nagaraja, Lutgendorf, et al., 2015; Kitayama, Akutsu, Uchida, et al., 2016; Riestra, Gebreab, Liu, et al., 2017; Lee, Rittschof, Greenlee, et al., 2021). With or without an epigenetic study, people know their experiences have impact. When measuring embodiment, biological anthropologists run the risk of obscuring or even removing lived experiences in favor of a measurable data point. In doing so, the data loses the depth and detail of lived experiences. We end up silencing individuals and erasing context in an attempt to understand general trends.

This critique is not new. Even with the use of epigenetics as a linking mechanism, there is recognition of the complexities inherent in understanding the relationship between embodiment, epigenetics, and studied phenotypes. Benn-Torres et al. (2019) notes, "because of the way that humans interact with and within their environments, where environment is broadly defined and inclusive of both physical and psychosocial elements, in practice, gene-by-environment interactions are very difficult to accurately account for in human quantitative genetics. As a

consequence of this, there remain significant challenges in accounting for embodiment in biomedical/genomic studies of human disease." The knowledge that popular frameworks of biological embodiment minimize the importance of lived experience, including the lack of accounting for gene-by-environment interactions, does not prevent researchers and funding institutions from emphasizing the broader impact that they feel quantitative genetics and epigenetics have to offer. This leads to a cycle of valuing quantitative data, statistics, and institutional ways of knowing over lived experience. This systemic focus on quantitatively measurable variables pushes researchers to fit lived experiences into limiting frameworks to make them easier to measure through standard scientific practice.

Anthropological work on biological embodiment tends to focus on the embodiment of negative lived experiences. According to a PubMed search, almost all of the papers focused on epigenetics published in *American Journal of Physical Anthropology*, *Human Biology*, and the *American Journal of Human Biology* since 2002 concerned the embodiment of marginalization (Supplemental Figure 1). This tendency, combined with the overvaluing of quantitative data often leads to a smoothing of complicated, often traumatic, life experiences into workable data points. Variation in life experience gets simplified into static measures that lack nuance. As a direct result of the so-called objective standard scientific system, the dynamic, interconnected ways lived experiences interact with the body are erased.

Researchers are working to demonstrate the value and complexity of lived experiences (Bombay, 2008; Gravlee, 2009; Kuzawa and Sweet, 2009; Thayer and Kuzawa, 2011; Clarkin, 2019). Brody et al. (2015) conducted research on experiences of African American youth in Georgia, USA, focusing on the relationship between experiencing racial discrimination and advanced epigenetic aging. Advanced epigenetic aging suggests that a person is aging faster biologically compared to their chronological age. Rather than simply highlight the link between discrimination and advanced epigenetic aging, the authors further showcase that supportive familial environments buffer the relationship between discrimination and advanced epigenetic aging. In this example, understanding the diversity within similar lived experiences helped reveal different outcomes. Mixed-methods approaches that value qualitative data, ethnography, and participant input are extremely vital to moving the field forward (Mertens, Bledsoe, Sullivan, et al., 2010; Tashakkori and Teddlie, 2010; Karasz, Patel, Kabita, et al., 2013; Bombay, Matheson and Anisman, 2014; Claw, Anderson, Begay, et al., 2018). Studies like these acknowledge the

complexity of lived experiences, which will further improve with the addition of humanistic frameworks.

Discussion

In order to better address these three critiques, we draw from humanistic, feminist, and critical theories as a way of reconceptualizing embodiment beyond the unidirectional and mechanistic. First, we expand on previous definitions of embodiment by drawing from Michael Rothberg's work *Multidirectional Memory*, to suggest that embodiment is a multidirectional process. Rothberg describes memory as multidirectional, meaning he views memory as "subject to ongoing negotiation, cross-referencing, and borrowing; as productive and not privative" (Rothberg, 2009, pg. 3). Embodiment, the relationship between the environment, lived experiences, the perception of lived experiences, and the biomarkers we measure as evidence of the mechanisms of embodiment are equally entangled. The body, the experience, and the environment are all interrelated and in flux. Embodiment is a multidirectional process that is constantly subject to negotiation, cross-referencing, and borrowing from internal and external signals. Embodiment does not stop at the mechanism. Multidirectionality is one of many alternatives to paradigms that rationalize embodiment as a unidirectional, or even bidirectional chain of events and instead helps frame embodiment as a complex process that is constantly ongoing (see Figure 1B). By incorporating this model of embodiment into future epigenetic research, we can directly address our first critique. Theorizing embodiment as multidirectional in human epigenetic studies will provide researchers with a framework to better discuss the nuance and fluidity of epigenetic traits. This framework should be used throughout the research process, from conceptualizing research questions, to study design, interpretation and dissemination of results. By thinking of embodiment as multidirectional throughout the research process, we can propel our work beyond current models which focus on the unidirectional flow of social inequality to epigenetic change to negative disease outcome.

{~?~IM: insert Figure 1B here.}

Figure 1B: A visual model of multidirectional framing of embodiment

In addition to multidirectionality, feminist scholars have voiced a need for interdisciplinary work and definition-building in studying embodiment. For example, Donna Haraway's work on situated knowledges embraces partial perspectives and presents an honest

viewpoint of the messy processes that allow us to understand how multiple situated knowledges work together to build reality. According to Haraway embodiment "resists fixation and is insatiably curious about the webs of differential positioning" (Haraway, 1988, pg. 36). Agarwal et al. (2011) calls for blurring the boundaries between humanities and social science scholarship, and as a bioarcheologist, calls for social scientists to consider more humanistic definitions. Agarwal and Glencross describe how social theory and emphasizing contextualization has helped bioarcheologists understand skeletal embodiment and move away from reductionist theories often associated with biological anthropology. In cultural embodiment work, qualitative research methods identify patterns in lived experiences in ways that situate bodies in plastic environments, recognize "local biologies," and recognize dynamic bodies in motion (Agarwal, 2016 citing Lock, 1993; Ingold, 2013; Ingold & Gísli Pálsson, 2013; Niewöhner, 2011). In other words, the local environments people encounter, the embodiment of these environments, and the ways people interact within environments are dynamic. Biological anthropologists have much to gain, especially in terms of contextualizing their work, from worldviews that see embodiment as being-in-the-world and in a state of multidirectional movement.

Feminist scholars focused on the social studies of science have also argued that the social and the natural are not binary or oppositional (Weasel, 2016). Weasel positions epigenetics as the intersection of the social and material; while Weasel's work focuses on social theory, this positioning also looks at epigenetics as a mechanism for embodiment. Weasel uses Van De Vijver and colleagues' broad definition of epigenetics to entangles epigenetics and embodiment inextricably. By viewing epigenetics as individual embodiment this definition on one hand limits the capacity of embodiment, bringing it into the purview and vocabulary of biological science, and on the other, demonstrates why interdisciplinary multidirectional approaches to understanding these complex processes are necessary. They advocate for using multiple fields to understand what acts as a "determinant."

Drawing on multidirectionality, along with queer and feminist theories, we can move embodiment away from binaries (ex: environment versus body; before versus after embodying; social versus natural). Additionally, utilizing humanistic frameworks, like multidirectionality and situated knowledges, allow us to integrate lived experiences into our analyses. Currently, although there is a marked interest in how lived experiences become embodied, measurement remains at the center of analyses. While incorporating a multidirectional framework may not

solve ongoing issues of reproducibility, effect size, or other common statistical-driven concerns (Lappalainen and Greally, 2017; Liu, Shen, Barfield, et al., 2022; Yousefi, Suderman, Langdon, et al., 2022), working with humanistic frameworks can help center the lived experiences of participants. As academics, we engage in a storytelling process about our data. Scientists often view so-called empirical, quantitative approaches as universal Truth, or the "right" story. Attention to frameworks that center lived experiences can help move us away from the universalizing impulse. Drawing from the humanities can help us frame the story differently, providing multiple perspectives with which to understand complicated processes. Humanities and cultural scholars have extensive frameworks with which to understand embodiment (Csordas, 1990; Weiss and Haber, 1999; Kimmel, 2008; Sutton and Williamson, 2010; Kiverstein, 2012).

We argue that everything we experience has the potential to be embodied. How we can embody these experiences is only confined by what a body can be/do/experience/become, which can change over time. This kind of conceptualizing of embodiment is expansive, opening up seemingly infinite ways to embody and study embodiment. For us, biological embodiment refers to the dynamic, fluid, physiological, cellular, chemical, and molecular processes taking place, consciously, subconsciously, or unconsciously, within our bodies. The biological mechanisms we as biological anthropologists are interested in are just a few of the ways a researcher can study embodiment, but they are by no means the only or most important way. Utilizing a multidirectional and interdisciplinary approach will strengthen anthropological explorations of the fluid process of embodiment through acknowledging the impact of diverse lived experiences and moving away from simplistic, sometimes harmful, framings.

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Figure Captions

Supplemental Figure 1: A PubMed search of the papers containing “embodiment” in the title or abstract of the paper in the *American Journal of Physical Anthropology*, *Human Biology*, or the *American Journal of Human Biology* yielded the results in this references list. Only 2 of the 8 are about something other than the negative embodiment of marginalization.

Figures

Figure 1A

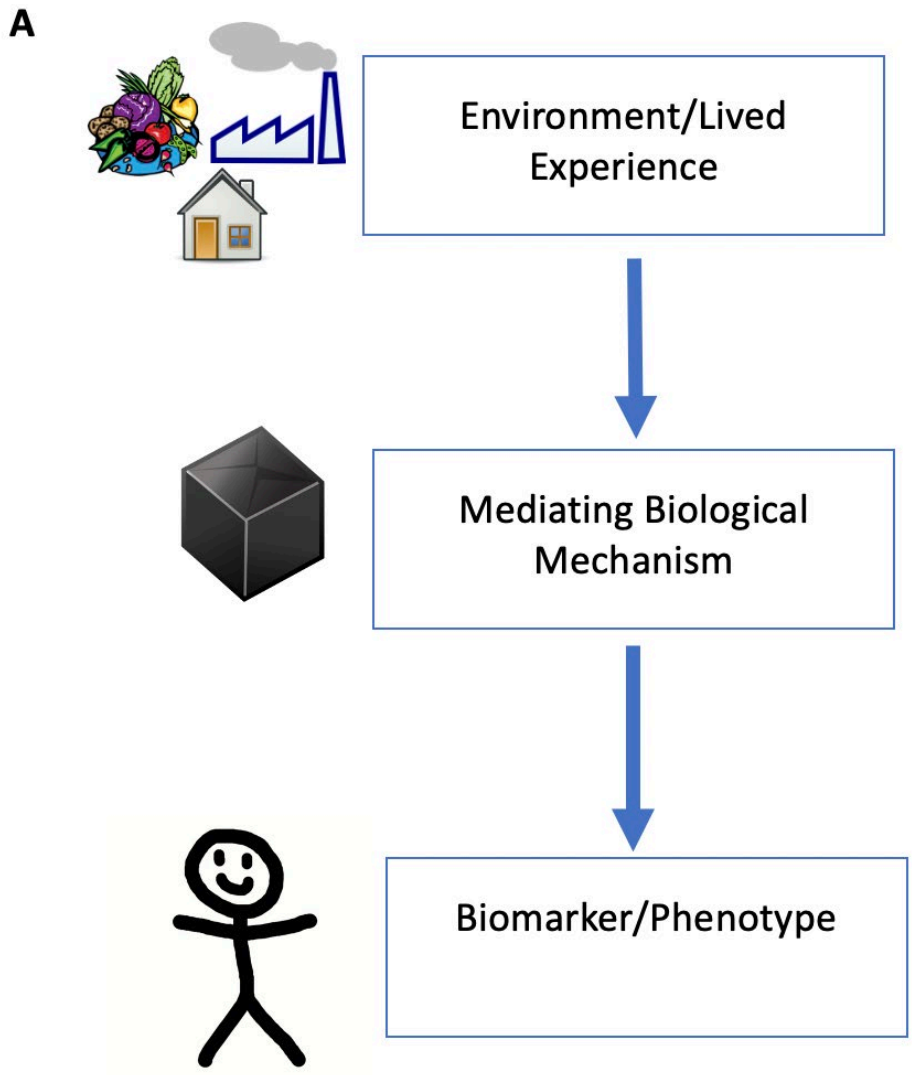
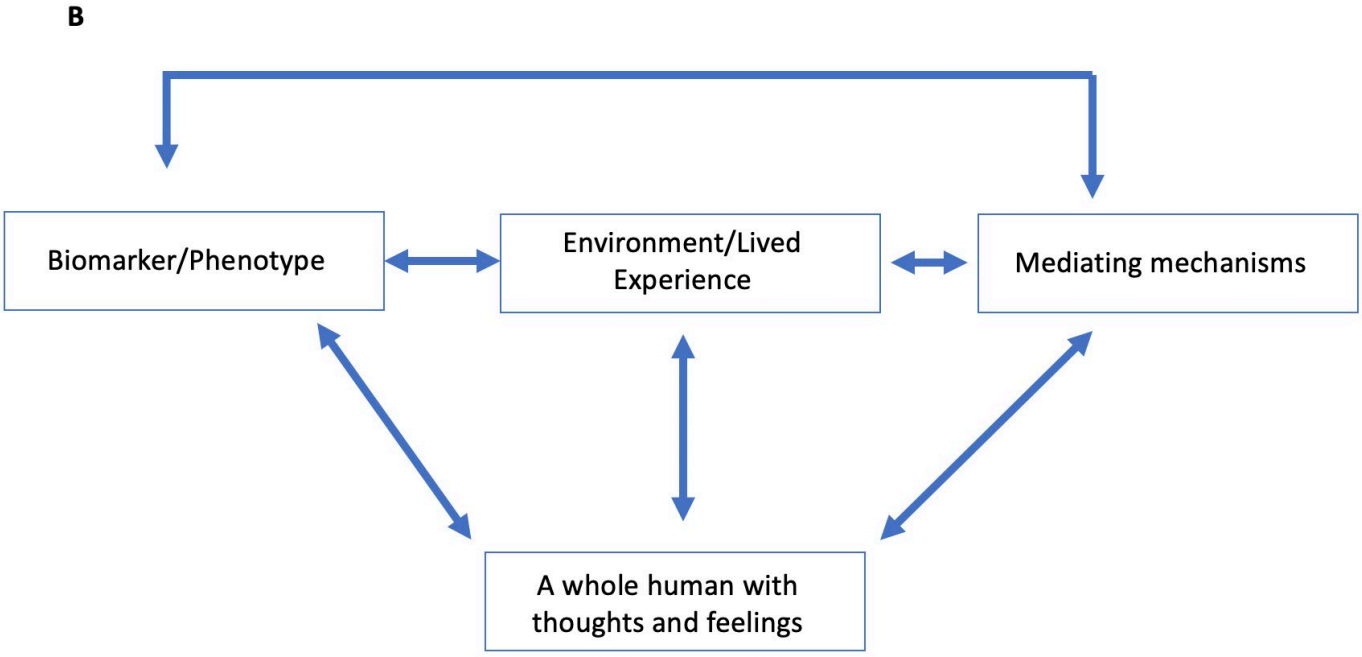


Figure 1B


B
Biomarker/Phenotype
Environment/Lived Experience
Mediating mechanisms
A whole human with thoughts and feelings

Supplemental Figure 1

Dent, Sophia C. "Interindividual Differences in Embodied Marginalization: Osteological and Stable Isotope Analyses of Antebellum Enslaved Individuals." *American Journal of Human Biology: The Official Journal of the Human Biology Council* 29, no. 4 (July 8, 2017). https://doi.org/10.1002/ajhb.23021.

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