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From parental responsibility towards mutual understanding: reimagining the employment of epigenetic knowledge



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Abstract

This paper is interested in normative translations of findings in intergenerational epigenetics. Particularly, what role can and should epigenetic knowledge play in our normative thinking about parenthood and relationships such as those between individual parents and broader society or between parents and their children? How should epigeneticists engage in science communication to ensure that knowledge of intergenerational epigenetic effects is useful rather than harmful to parents and children? Much of the existing literature on the ethical aspects of epigenetics points out worrisome tendencies of epigenetic knowledge inspiring policies and discourses that lead to blaming and stigmatization of individual parents and women in particular. While such warnings are important, they are not the only shape ethical discussion of intergenerational epigenetics can take. Firstly, this paper claims that it is also worthwhile and necessary to imagine potential positive effects of epigenetic knowledge on parents and their children. It will be argued that an approach that focuses on empowerment of individual parents and children rather than general responsibility distributions fits will with a nonideal approach to normative theory that takes into account the unequal distributions of social, economic and material resources among parents. The second part of this paper explores whether narrative identity is a useful concept to imagine such a positive framework for the employment of epigenetic knowledge. It argues that integration of epigenetic knowledge in a shared narrative identity may benefit mutual understanding and self-knowledge, and perhaps also have an empowering effect on parents, children and families. After discussing the risks of (1) attaching too much weight to etiology and (2) any epigenetics discourse playing into 'bionormativity', the paper concludes that epigenetic knowledge can and should be used in a framework that goes beyond deterministic etiologies but embraces the complexities and interrelatedness of all factors influencing the health of future generations.

Keywords Intergenerational epigenetics, Ethics of epigenetics, Narrative identity, Procreative autonomy, Nonideal theory, Parental responsibility

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Introduction

The ways in which individuals and collectives act upon (or fail to act upon) knowledge about the epigenetic connections between exposures and health outcomes has an impact on multiple generations. Intergenerational human studies provide increasing evidence for the inheritance of epigenetic marks by the first generation of male offspring and the first and second generations of female offspring [1, 2]. This paper is interested in issues of intergenerational ethics in the context of such findings in epigenetics. What role can and should epigenetic knowledge play in our normative thinking about parenthood and relationships such as those between individual parents and broader society or between parents and their children? How should epigeneticists engage in science communication to ensure that knowledge of intergenerational epigenetic effects is useful rather than harmful to parents and children?

Normative claims can never be unequivocally derived merely from biological findings about the workings of epigenetic mechanisms.¹ Epigenetic knowledge itself cannot simply be regarded as either a burden or a blessing, but at best as a "double-edged sword" [3 (212)]. The translation from epigenetic knowledge into moral and political realms can happen in a variety of ways, depending on the values, commitments, priorities and biases, of those doing the translating. As Müller and Kenney note, "biosocial narratives are neither inherently liberatory nor inherently oppressive" [4, (2)]. Political values are decisive in the uptake of scientific theories [3].

That being said, it has been argued that findings on epigenetic inheritance give rise to a 'temporal expansion' of our normative discussions [5–7]. Much of the literature on ELSA (ethical, legal and social aspects) of epigenetics points out how the lifestyles, behaviours, circumstances and exposures of people who are planning to have a child, or are already pregnant, are subject to intense normative scrutiny in both scientific and popular discourse. Thus, most of this work focuses on the question: 'who is responsible for the health of future generations?'. Since epigenetic changes sustained even before conception can be transmitted to offspring, matters of parental responsibility arguably become more acute, with some authors wondering to what extent we can blame parents for choices they made before they may have even considered that they might ever become a parent [8].

The existing literature on the ethical aspects of epigenetics almost unanimously points out worrisome tendencies of epigenetic knowledge inspiring policies and discourses that lead to blaming and stigmatization of individual parents and women in particular [9, 10]. Moreover, social determinants of health and the complex causality behind epigenetic mechanisms pose a challenge for conceptualizing the relationship between epigenetic knowledge, autonomy, and responsibility [2, 11, 12].

While such warnings are important, they are not the only shape ethical discussion of intergenerational epigenetics can take. Firstly, apart from formulating and scrutinizing claims about the epigenetic responsibilities of individual parents and their communities alike, we may also be interested in other normative issues, concepts or relationships. For example, we could be concerned about the privacy of parents when epigenetic markers can potentially give us some insight in elements of their past. Or we may worry about the risk of 'epieugenics' [13] that arises when epigenetic findings are employed to intensify societal pressure on individual parents (and especially women) to adhere to ableist norms of what counts as a healthy baby [14]. Secondly, since epigenetic knowledge is a 'double-edged sword', in addition to *cautionary* approaches we may also try to develop more optimistic approaches that try to imagine positive employments of epigenetic knowledge that benefit both parents and children.

This paper claims that it is worthwhile and necessary to imagine potential positive effects of epigenetic knowledge on parents and their children. First, this claim will be explained in light of both cautionary and optimistic contributions to the literature. Specific attention will be paid to the critiques of several conditions for responsibility that have been formulated by other scholars, arguing that those difficulties warrant an additional alternative normative approach to the epigenetic health of parents and children that does not hinge on responsibility. Additionally, it will be argued that an approach that focuses on empowerment of individual parents and children rather than general responsibility distributions fits will with a nonideal approach to normative theory that takes into account the unequal distributions of social, economic and material resources among parents.

In the second part of this paper, we explore whether narrative identity is a useful concept to imagine such a positive framework for the employment of epigenetic knowledge. It will be argued that epigenetic knowledge can contribute to the construction of the narrative identity of children and families. The integration of epigenetic knowledge in a shared narrative identity may benefit mutual understanding and self-knowledge, and perhaps also have an empowering effect. Following an explanation of this approach is a substantial discussion of its potential complications, particularly the risks of (1) attaching too much weight to etiology and (2) any epigenetics

¹ Distinguishing epigenetic knowledge from the responsibilities that may be derived from it, does not necessarily mean that epigenetic knowledge is an 'objective' or value-neutral starting point for such normative translations. The process of scientific knowledge creation is itself already an endeavour imbued with different kinds of values, and choices made in this process are context-dependent.

discourse playing into 'bionormativity'. We will conclude that epigenetic knowledge can and should be used in a framework that goes beyond deterministic etiologies but embraces the complexities and interrelatedness of all factors influencing the health of future generations.

Imagining positive effects of epigenetic knowledge

Why is it necessary that more of the literature on ELSA of intergenerational epigenetics explores potential positive effects of epigenetic knowledge dissemination? In this section, two arguments for exploring new positive approaches are discussed.

Obstacles to epigenetic responsibility suggest a pragmatic approach

Recent years have seen an important rise in criticisms of individualizing epigenetic responsibility in ELSA literature on epigenetics in general [10], with parental responsibility claims being one of the most scrutinized kinds. Researchers have warned against the premature translation of research findings in animal experiments [13–16]. Rushed and simplistic science communication that attaches normative implications for human behaviour to research in animals is not only epistemologically problematic but also risks making "impossible demands on prospective parents" [13 (427)]. Another concern is the personal nature of procreative and parenting decisions. Although dealing with the inequities that significantly impact the lives of individuals and their children requires societal change and collective action, there is disagreement as to which amount of state influence should be allowed [8, 13].

Perhaps more fundamentally, various authors have formulated astute critiques of various kinds of epigenetic responsibility assignments based on the conditions for moral responsibility. Three such conditions we generally expect agents to fulfill in order to be appropriate subjects of responsibility relations are the knowledge condition, the capacity condition, and the (closely related) causality condition. We generally tend to hold agents responsible for an outcome only if 1) they know (or could reasonably have known) the effect of their actions; 2) they are capable of acting on that knowledge to produce a desired outcome and 3) there is a (or an expected) causal connection between their behaviour and the outcome. It is generally agreed upon that more knowledge only benefits agents if this knowledge is actionable to them. This means that having agency, the power to act in the world, is a necessary condition for responsibility: a classic way to put this is that 'ought' implies 'can'.² Knowledge needs to be actionable, and not merely in an abstract, *prima facie* sense: it depends on the context of the receiver of this knowledge whether they can act on it. A fair responsibility ascription requires (among other things) that the intended agent has sufficient autonomy, i.e. is sufficiently free to act on their own motives and free from external control, to take up this responsibility (in a forward-looking sense) or be truly liable to blame or praise (in a backward-looking sense).

In the context of epigenetics, political scientist Maria Hedlund asserts that many structural conditions related to epigenetic health may be beyond the capacity of individual agents to influence. She argues that this also has implications for the knowledge condition in epigenetic responsibility claims. This condition, which she terms 'cognizance', presupposes that an individual agent has access to a broad range of relevant information and risk estimates "of the epigenetic effects of nutrition, smoking, habits, physical exercise, and other factors possible for the inidivudal to decide upon herself" [17 (180)]. Given the complexity of this information, she suggests that acting in an epigenetically responsibility way "would be a rather demanding task" (ibid.) for any individual agent.

With regards to the capacity and causality conditions, an emphasis on individual epigenetic responsibility is also often criticized because it is believed to be unfair in light of the complex and limited causal connection between individual choices and changes to the epigenome. For example, epidemiologists Bastiaan Heijmans and Jonathan Mill bring up a variety of biological, technical, and methodological issues that plague those in their discipline trying to determine the effects of individual behaviour and living conditions on the epigenome [18-19]. Charles Dupras and Vardit Raditsky share the concern that "some scholars, the public, and the media are at risk of too hastily and simplistically assigning most epigenetic responsibilities to individuals" [20 (6)]. However, they are equally wary of simplistic prospective and state-focused solutions, instead proposing a 'diversity of types' of epigenetic responsibility that takes into account the nuances regarding the definition of a 'normal' or healthy reference epigenome in a specific context (epigenetic normality) and the dynamic nature of epigenetic modifications (epigenetic plasticity). They argue that defining the normal epigenome is a challenging endeavour for many reasons. For example, according to the mismatch model of epigenetic disease development, "an adverse phenotype does not depend merely on the presence or absence of a specific epigenetic variant, but rather on the mismatch between the previously programmed variant and the individual's lifestyle or living conditions" [20 (3)]. The full impact of epigenetic alterations can only be assessed contextually, by taking into account someone's lifestyle and their environment more broadly conceived.

² Moral responsibility can only be ascribed to moral agents, but whether a particular moral agent should take up specific responsibilities may depend on many other considerations than just the capacity to do so.

As Luca Chiapperino summarizes it, many critics have pointed out that "appeals to individual responsibilities to protect one's epigenome overestimate individual capacities of bearing such backward- and forwardlooking types of responsibilities" [11 (20)]. Chiapperino himself provides another version of this critique based on the influence of moral luck on individual agency. Moral luck designates "the import that factors beyond one's control have on the justification and cogency of normative claims such as responsibilities" (ibid., 2). He goes a step further, however, by showing that much of the critiques of individual responsibility in the context of epigenetics also apply to collectives. He argues that it may be unwarranted to exempt collectives "from a consideration of how intrinsic limitations and deficiencies, trying and unwanted circumstances, as well as imperfectly predictable results, temper their blameworthiness for failing to act responsibly to protect our epigenomes and health" (ibid., 12). In other words, the conditions of knowledge, causality and capacity are just as difficult to fulfill, if not harder, for collective agents. For instance, it may be hard to determine the contributory liability or backward-looking responsibility of individual members of a collective. Furthermore, it is often far from clear to what extent past and present members of a collective have contributed to its actions leading to certain epigenetic effects.

Although debates on the appropriate subjects (if any) of epigenetic responsibility claims have been most prominent, various scholars have also pointed out that identifying an *object* or goal of responsibility relations is far from straightforward. For example, difficulties regarding epigenetic normality complicate epigenetic responsibility issues, because arguably some notion of a 'reference' genome "is required prior to determining personal and collective goals regarding epigenetic health" [11 (1)]. Furthermore, the line between preventing harm and optimizing or enhancing an outcome is not at all easy to draw, especially in the context of parental responsibility [8]. Epigenetic findings might be employed to intensify societal pressure on individual parents (and especially women) to adhere to ableist norms of what counts as a healthy baby [14], leading some authors to worry about the risk of 'epi-eugenics' [13]. Various authors point out that expecting (prospective) parents to prevent disease or suboptimal epigenetic transmission in their offspring by minimizing every possible risk factor seems to ignore the extent to which exposures, diets and stressors are partly shaped by socioeconomic and political factors [5, 13, 16, 21]. Some conclude by emphasizing the importance of collective responsibility for the well-being of future generations, for example by pointing out that many people in the environment of a child, not just the parents, may causally contribute to a child's epigenetic profile [22].

In summary, most of the literature on the potential ethical and social implications of epigenetic discoveries for procreation and parenthood takes a cautionary approach [9]. The warnings and nuances in this body of work are important and should be taken into account by policy-makers, clinicians and researchers alike. However, since many of those contributions have pointed out considerable difficulties with ascribing responsibility in the context of epigenetics, it may also be worth to explore approaches that do not hinge on the concept of responsibility.

To be clear, this paper does not suggest that normative work on epigenetics in terms of moral responsibility cannot or should not continue. In spite of many criticisms of responsibility discourses, we may still want to use them to hold accountable certain agents whose involvement in environmental harms is relatively clear (say, a polluting company or a negligent government). For example, Luca Chiapperino and Martin Sand suggest that we may try to vindicate some residual collective epigenetic responsibility by referring to the 'moral worth' of a collective. We can take up an 'aretaic perspective' and judge the moral blameworthiness of collectives on the basis of their proper function in society, even if the exact extent to which they have contributed to an outcome is unsure [23]. Another avenue to be explored further might be that of forward-looking collective responsibility in the context of epigenetics. As argued by Emma Moormann, this concept can be an integral part of a normative account that conceptualized epigenetic injustice as a historical-structural wrong and strives towards epigenetic justice instead [24].

This work needs to continue, but given the recurring difficulties it faces, it may also be worthwhile to explore other normative paths simultaneously. Thus, this paper suggests that work on the ELSA of epigenetics can take a two-pronged approach, in which continued work on responsibility issues is supplemented by novel searches for other, particularly positive and emancipatory, ways of science communication and dissemination.

In the same vein, we offer a pragmatic argument for the suggestion to put more research efforts towards imagining positive employments of epigenetic knowledge. Epigenetic research is progressing quickly: its various subdisciplines continue to produce new findings on a very broad variety of exposures, mechanisms, diseases and conditions at a rapid pace. Although calls for 'slow science' and against hasty science communiction may have some impact, this high pace of output and dissemination is to a great degree a reality that ethicists are confronted with. Given that understandings of epigenetics influence societal and political debates, and that popular science articles offer advices based on findings in epigenetics, what can ethicists do? Firstly, they can urge for caution and point out dangers of simplistic or wrong translations of this knowledge, as was discussed extensively before. But ideally, those concerned with the normative aspects of epigenetics offer not only critiques, but also suggestions for positive alternatives. What counts as 'positive' depends on the moral and political commitments of researchers. More about the commitments of this paper will be said in the next section. But the more abstract point we wish to make here stands regardless: there is a difference between the goal of avoiding harmful science communication and the goal of working towards producing positive results with it, and ELSA scholarship should ideally be engaged in both.

Existing inequalities require a nonideal approach

Because we know that in most if not all current societies the burdens of (prospective) parenthood and procreation are not equally shared, we may worry about responsibility claims 'adding insult to injury' [25]. We should avoid unjustly burdening with individual responsibility those for whom epigenetic knowledge may not be available or, when available, be actionable at all. Indeed, this includes all of us to various degrees, since no one can be said to have full and fully actionable knowledge of epigenetic mechanisms. However, some are more disadvantaged than others. Epigenetics has the potential to paint an increasingly clear picture of how social determinants of health play a role in shaping the health of (prospective) parents and their children. Such factors and conditions are distributed rather unequally, and although they are certainly not set in stone, they are hard to change for any individual parent or couple. General statements about responsibilities of all parents risk ignoring the sometimes stark differences in control between privileged and underprivileged individuals and communities. For example, consider that pregnancies are often unintended³; gender inequality still means that women often bear (or are expected to bear) most of the responsibilities surrounding the health of future generations; and the means of people to secure a healthy food intake or a healthy physical environment can be seriously limited by e.g. socioeconomic and geographical conditions. Most parents do not need reminding of their responsibilities, but they might lack the means to fulfill their role as well as they want to. In other words, it is the capacity condition of moral responsibility that is often insufficiently fulfilled in nonideal situations. Thus, we need to take a nonideal approach to intergenerational ethics in the context of epigenetics. In contrast to ideal theory, such an approach does not assume just background conditions and tries to avoid idealization or abstractions that misrepresent or exclude all aspects in which our moral and political reality are currently not ideal [27–30].

What might a positive nonideal approach to employing findings in intergenerational epigenetics look like? Can epigenetic knowledge potentially be employed to benefit parents and children, and especially those in the most vulnerable communities? One way to think positively about knowledge on intergenerational epigenetics in an unequal society might be to see it as a tool in striving toward the empowerment of parents, children and families. As philosopher Iris Young notes, "empowerment is like democracy: everyone is for it, but rarely do people mean the same thing by it" [31 (48)]. For our purposes, we can distinguish at least two kinds of empowerment that may be relevant to intergenerational epigenetics. A first sense sees autonomy as a purely individual matter of being free from external control, often connected to traits such as self-control or confidence. In a bioethical context, authors have pointed out that such an understanding risks ignoring the biosocial influences that connect an individual to their communities. For example, Luca Chiapperino and Giuseppe Testa are critical of the role of empowerment in a personalized medicine discourse as legitimizing a neoliberal project of individualizing responsibility for health [32]. They warn us that language of empowerment can be used to serve such a political project that seeks to devolve responsibility for health from the state to individual citizens and expects this move to make the healthcare system more economically sustainable (ibid., 207).

Another meaning of empowerment exists. As Young explains, empowerment can also be seen as having both a personal and a collective component. She defines this meaning as "a process in which individual, relatively powerless persons engage in dialogue with each other and thereby come to understand the social sources of their powerlessness and see the possibility of acting collectively to change their social environment" [31 (50)].

Chiapperino and Testa also do not rule out the possibility of using empowerment as part of a more emancipatory discourse. They refer to a radical history of the concept, for example in the tradition of liberatory pedagogy [33]. As such, epigenetic knowledge might contribute to the empowerment of parents, children and family units if it manages to show agents how social determinants and environmental exposures of themselves and/ or other family members affect their health. What an empowerment discourse should be mindful of, then, is that agents also need to be sufficiently free from financial, social and material constraints to act on this knowledge.

In the context of procreation and parenting, such an empowering project could also be served by a sufficiently refined concept of procreative autonomy, that pertains to the right and capacity of people to decide whether, when

³ Nearly half of all pregnancies worldwide are unintended [26].

and under which circumstances to procreate, as well as to the social and political recognition of this right [34, 35]. To heed the calls for awareness of the social structures that impact procreative and parental autonomy, we should understand autonomy not as something strictly individual, but in an inherently relational sense. The idea of autonomy as something relational fits well with a nonideal approach, as it is premised on the belief that persons are "shaped by a complex of intersecting social determinants, such as race, class, gender, and ethnicity" [36 (4)].

The next section of this paper proposes a novel positive approach to epigenetic knowledge in the context of procreation and parenthood. It proposes a way of employing epigenetic knowledge that may strengthen the narrative identity of the child and the family. Thereby, it might empower parents and children in the Youngian sense: through dialogue and increased self-understanding, people might collectively seek to change their circumstances. Admittedly, the proposed approach developed here does not provide solutions for the financial and material constraints that members of the most vulnerable communities may find themselves in. However, it does situate itself in the context of the stigma and social pressure that has historically affected, and continues to affect, pregnant women and young mothers.

Gestation, and thus women's bodies and behaviours, seem to have become the main target of intervention suggested in epigenetic literature on intergenerational effects [6, 37]. While epigenetics expands the temporal window of potential influence, the emphasis of maternal influence on the health of a fetus, baby or child is itself nothing new [13, 15, 38–40]. There seems to be a growing consensus among commentators that such an emphasis on maternal influences in epigenetic risk messaging places excessive blame on women. Richardson and colleagues have compellingly shown how narratives about epigenetic findings risk perpetuating "a long history of society blaming mothers for the ill health of their children" [16 (131)]. They warn us that although the scientific findings underpinning those blaming practices are often rather moot or have been proven to be plain wrong, women still experience harmful effects to this day.

The attention and resources that have been directed toward scientific research on maternal influences, specifically in the perinatal period, should also be critically questioned [38]. Sharp and colleagues highlight how the focus of DOHaD (developmental origins of health and disease) research (including epigenetics) on maternal exposures around and during pregnancy is based on some "implicit assumptions about the 'causal primacy' of maternal pregnancy effects" [41 (20)]. However, epigenetics offers an opportunity to strike a new balance in parental responsibility between contributors, because it helps to show how not only influences in utero play a role in offspring health. For example, a recent shift has been noticeable towards research of paternal influences, for example by creating a POHaD paradigm (paternal originals of health and disease) that researches the impact of paternal lifestyle and exposure and their impact on for example sperm quality [37, 41, 42]. Translation of these new findings could reduce some of the burden currently placed on mothers, but attention is needed to ensure that the discourse about paternal influences does not simply replicate the stigmatizing and blaming tendencies that are currently present in maternal influences discourse [37].

The approach in the next section was developed with this nonideal reality in mind. As such, while not offering solutions for material and economic disparities, it more modestly suggests that epigenetic knowledge can help to mitigate some social constraints that may be experienced by this group of people. As we will see, conversations between parents and children that include discussions of potential epigenetic effects may lead families and individuals to construct a nuanced sense of identity that challenges simplistic notions of maternal behaviour as the source of all problems and solutions.

Can epigenetic knowledge contribute to narrative identity?

Can knowledge of epigenetics be beneficial to parents and/or their children? And if so, can it be beneficial in such a way that it has an empowering effect? Before answering those questions, some remarks on the term 'epigenetic knowledge' are in order. As has become clear, the complexities of epigenetic mechanisms and disease etiologies call for a sufficiently nuanced understanding of the term. Such epigenetic knowledge does not only pertain to information about epigenetic mechanisms that play a role in connecting environmental influences to specific health outcomes. Rather, it should ideally also reflect a refined understanding of the complex causal nature of diseases and conditions. When this paper talks about people having or needing epigenetic knowledge, it generally has in mind lay people, whose own health (or that of their offspring) is the object of discussion, rather than experts such as epigenetics researchers. The paper also assumes that this knowledge includes at least an elemental awareness of the fact that 1) there is always a multiplicity of factors involved in causing a disease and 2) epigenetic changes generally do not directly cause a certain health outcome, but rather predispose one to it or increase chances of developing a certain condition. In practice, having epigenetic knowledge can for example mean that someone is aware of at least some of the complex and interconnected associations between the lifestyles and exposures of (future) parents and the phenotype of the child.

First, let us consider whether children could, at some point in their life, benefit from knowledge about the choices and circumstances of their parents before they were conceived, and about the ways in which those may have affected them. We might imagine that children at some point have conversations with their biological parents about the decisions they made and the circumstances they had to deal with before their birth. It is conceivable that it would be valuable for them to learn more their parent's considerations about family planning, prenatal testing, and a host of other issues, such as food intake and changes in exposures and habits (or a lack thereof) such as smoking. Although we might imagine that some information could make children angry or upset, such conversations might also strengthen parentchild relationships due to increased mutual knowledge and understanding. Moreover, such conversations might help children to understand their biological makeup better knowing some of the in-utero influences they were exposed to. Although epigenetics need not necessarily play a role here, knowledge of epigenetic mechanisms might provide some added insights.

To think about whether or not this line of argument holds any plausibility, consider the following case.

Alex and his mother Farah Farah is a postdoc researcher at a prestigious university. She loves her job and considers being an academic an important part of her identity. At the same time, various elements of her job are causing her quite some stress. For example, she worries about only having temporary positions and is working hard to improve her chances of securing a tenured position. When Farah gets pregnant, she decides to continue working her stressful job, even though she is aware of the potential influence that the stress she experiences (as well as that she has experienced before) might have on her offspring.

Ten years later, her child Alex receives a diagnosis of ADHD after experiencing some difficulties in home and school settings. Although he sometimes continues to struggle with some aspects of his ADHD, throughout his teenage years Alex starts to consider this diagnosis as an integral part of his identity that he would not want to change.

Epigenetic research on ADHD is growing, and some evidence exists that epigenetic mechanisms play some causal role in the connection between stress during pregnancy and ADHD in offspring [43–45]. Suppose that Alex learns about these studies, for example when he is in college, and talks with his mother to learn more about the decisions she made, the experiences she had and the obstacles she faced before and during her pregnancy. What might his reaction be? And how, if at all, might that reaction be impacted by the knowledge that his mother's past exposures may have made some contribution to his ADHD through epigenetic mechanisms?

A possible response Alex might have is to blame his mother for letting herself, and once pregnant her fetus too, be exposed to the stress she experienced. But it is at least conceivable that Alex might (also) have a different reaction, one of increased understanding. Getting to know more about Farah's reasons and values behind the choices she made may provide Alex with information that he could use when facing similar situations later in life. Learning about the circumstances that may have constrained Farah in making a truly free choice might help him to understand her even better. After all, even if Farah considers this a choice she made freely, social and economic constraints such as financial circumstances and career prospects may have played a role in her decision. Furthermore, the fact that the knowledge about epigenetic mechanisms leads to a few honest conversations between mother and son may (admittedly, in ideal circumstances) also be valuable to the parent-child relationship itself. Moreover, knowing that there may be some connection between the life story of his mother and his ADHD, which he considers important to his identity, may contribute to his developing narrative identity. We will come back to this later.

First, we can try to expand this line of thought back in time even further. Alex and his mother talked about the actions and environment of Farah during her pregnancy. Might there be any value for the child or the parent-child relationship in having shared knowledge of elements of the lives of parents before they were even thinking of conceiving, but that nonetheless may have impacted the child's biological make-up? Consider the following example related to environmental pollution to think about this.

Jenn and her parents Two people who together intend to have children have both grown up in a poor neighborhood close to a polluting factory. They are aware of this pollution and its potential health effects on themselves and their future offspring. Although this is far from easy, they manage to move to another part of their city with relatively clean air. There, they conceive and later become the parents of Jenn. However, the marks of them having lived in the polluted neighborhood may to a certain extent still have been inherited by Jenn.

Would it be valuable for Jenn to know this? And if so, how might she react? Jenn might be thankful that her parents decided to move away from a place that they were very attached to for her sake. She might gain a better sense of appreciation of their considerations, although it is not unthinkable that she might also feel guilty for being the reason they made such a drastic and costly change. Moreover, knowledge about epigenetic mechanisms might help Jenn understand why she is more prone than others to certain conditions such as asthma than others. Conversations about how both social determinants of health and individual actions affect Jenn and her parents may lead to a sense of mutual understanding. In this sense, epigenetic knowledge can play a contextualizing role, suggesting that aspects of the child's health or personality are not isolated from actions, behaviours or exposures of their parents in the past.

In short, a beneficial effect of adequate epigenetic knowledge might be that it can help people to integrate their biography and their biology. Epigenetic knowledge can serve as a 'biological interface' [6] that may help people such as Jenn and Alex to construct a 'somatic sociality' to make sense of their 'embedded body' [46]. In the context of intergenerational justice, such sense-making has already been taking place with regards to various kinds of ancestral traumas. For example, some Indigenous people have found environmental epigenetics to be a helpful framework to link the slavery experienced by their ancestors to their own bodies and communities [47]. It has also been argued that the descendants of Holocaust survivors may still be affected by inherited epigenetic marks that could be represented as a kind of 'biological memory' of experiences [48].

Another way to put this is that parent-child conversations on such topics help the child to create their own narrative identity. A narrative identity can be understood as an "internalized and evolving story of the self that a person constructs to make sense and meaning out of his or her life" [49 (99)]. So-called 'life stories' or 'personal myths' explain how someone is the person she currently is [50]. They primarily explain this to herself, but a person can in turn also use this narrative to explain why she is who she is to others. Narratives lie at the heart of autobiographical thinking because they "elaborate on connections between past events and current self-understanding" [51 (328)]. Kate McLean argues that storytelling is something in which families usually engage often, thereby helping the child to build its earliest and most lasting understanding of self [52]. Although Sally Haslanger convincingly argues that acquaintance with biological kin is not necessary for a healthy narrative identity, information about the lives and circumstances of biological relatives may be one source of such a story [53, 54].

The benefits of epigenetic knowledge for narrative identity formation might not only accrue to the child, but also to their parent and the parent-child relationship or family unit as a whole. Interestingly, McLean describes how stories that parents tell their children about their personal experiences and choices might shape not only the identity of their children but also that of themselves. By narrating how events in their past may have impacted both themselves and their child, they (re)construct elements of their sense of identity. Sharing personal stories such as those in the examples above may thus affect everyone involved in the parent-child relationships [51,52].

What epigenetic knowledge adds explicitly to this project of narrative identity formation, compared to other biological knowledge, is that it broadens the scope and the timeframe in which potentially relevant factors can be found. Inter- and transgenerational epigenetics offer increasing evidence for the heritability of some epigenetic marks that have been sustained (long) before conception and may sometimes even remain present across multiple generations. Thus, people may look not only at experiences during their lifetime as potential candidates for integration in their sense of identity. Similarly, the rapidly growing body of knowledge on environmental epigenetics may open up the scope in which elements of identity can be found. For example, not only tangible objects in a person's immediate surroundings, but also less visible influences such as stress may contribute to their biological make-up in more ways then was previously assumed. This increase of potentially relevant aspects on the 'menu' of narrative identity formation may at times feel overwhelming. However, creating and sustaining a sense of identity always already relies on selecting some elements, and rejecting others. To an important extent, people can choose what they want to include in the narrative of who they are, and they can make edits to this story throughout their lives. Similarly, they may want to pick out some aspects of how their parent's exposures may have contributed to their biology, while rejecting others.

Of course, as has been pointed out by many authors cited above, claims about epigenetic mechanisms often come with high degrees of uncertainty. It is very difficult to isolate the contribution of specific causal factors from each other, and this may never become fully possible. Science communication should emphasize this to ensure that epigenetic knowledge of people is nuanced enough to avoid very simplistic or exaggerated causal claims. But for the construction of a narrative identity, absolute certainty is not required for the person or family who constructs it to find some value in it. Leni Van Goidsenhoven, for example, convincingly summarizes that we need a broad notion of narrative that allows for departures from traditional, coherent linear stories if we want to do justice to all kinds of life stories [55]. An example is thinking about your heritage across multiple generation: you may find it valuable to link some information in your family tree (such as the occupations of your greatgrandparents) to your own identity, even though you are aware that there is maybe only a very limited connection between this person and yourself. David Velleman, in describing his own family narrative, also admits that "it's all imaginative speculation. But such speculations are how we define and redefine ourselves" [54 (377)]. Alex may not need to know the exact contribution of each individual factor, nor a very detailed account of the extent to which his mother Farah truly made a free decision, in order to appreciate what she tells him about this. Since stories we tell about ourselves are always speculative to some extent, the epigenetic component we might add to our biographies does not need to be quantified or absolutized either.

Moreover, parents and children can use insights from epigenetics as opportunities to appreciate more fully how their health and life stories are not individual matters, but rather socially embedded. Perhaps this could have implications for their practices of responsibilizing and blaming, as they might appreciate better how people are often influenced by factors beyond their control. Conversely, they may identify actors that they previously had not considered as influencing their health in a negative way. While a nuanced understanding itself of epigenetics cannot give definite answers to questions of responsibility distributions, it may contribute to an attitude of mildness towards individual parents.

Until now, we have argued that sharing epigenetic knowledge might be beneficial in various ways to parents, children and their relationship. Could we also understand this sharing, and its contribution to a narrative identity formation, as having an empowering effect on them? If we return to empowerment in the sense proposed by Iris Marion Young, we can indeed argue that this might be the case. She explicitly understands empowerment as something that arises as the result of a dialogical endeavour. It is through conversation and the mutual sharing of knowledge that people come to a better understanding of their own agency as well as their social and material environment. If conversations between Jenn and her parents give Jenn a better sense of the potential health effects of air pollution, she might be inclined to take action. Perhaps she even finds others with similar biologies and/or biographies who are willing to take collective action to limit the emissions of the factory in case.

Conversations in which epigenetic knowledge is shared can lead to increased self-knowledge and a fuller sense of identity for those involved. When faced with decisions and situations in the future, this can help people to contextualize their experiences and perhaps strive for collective improvement of their somatic socialities. For example, in a final speculative step, suppose that Jenn and her fellow activists succeed in their goals, and Page 9 of 12

that through a collective effort of activists, NGO's, public health organizations and political work, her country issues laws that drastically limit the allowed amount of industrial pollution, particularly in residential areas. Then, this achievement might become part of the narratives they and future generations tell themselves. Perhaps cultural and social values, such as the value that a society attaches to health compared to economic gains, can also be part of someone's narrative identity.⁴

Complications

After reading this exploration of a novel way to employ epigenetic knowledge to benefit parents and children, one might have some reservations about this approach. Two worries will now briefly be discussed: (1) attaching too much weight to etiology and (2) playing into bionormativity.

Firstly, one could argue that the arguments above attach too much importance to etiology, which is exactly what much of the ELSA of epigenetics literature rightfully argues against. Is knowing more about the causes of their diseases or conditions really necessary for people such as Jenn and Alex to act on them or improve their lives? Does Alex really need an explanation of a causal chain of events in order to be able to live well with his condition? In general, knowing the cause of something may be a first step towards either preventing it or developing a cure, but this is not always desirable. Autism is just one example of a condition for which more and more researchers and neurodiversity scholars advocate moving away from simplistic searches for biological causes or biomarkers, favouring a multi-layered approach that primarily looks to improve people's daily live instead [56]. Yet, many autistic people still welcome the search for biological certainty as a basis of diagnosis [57]. Thus, although knowledge of causes can be valuable, we cannot simply assume that it is meaningful for everyone. This worry might be mitigated if we focus not on the potential of epigenetic knowledge to provide insight into the exact extent to which each factor played a contributory role. Indeed, Luca Chiapperino and Giuseppe Testa point out that this potential may be fundamentally limited, as it is "debatable whether epigenomics will actually be able to disentangle the contribution of lifestyles to health from that of other environmental factors" [32 (214)]. But as we saw before, insights from epigenetics and postgenomics more generally can be regarded as opportunities to appreciate how the health and life story of every individual is embedded in a broad biological and social context. As we saw before, a healthy sense of narrative identity does not need to rely on exact or absolute etiological

⁴ I thank the editor for this suggestion.

claims, nor does it require a neat separation of biological and social influences.

A second set of worries pertains to the risk of drawing normative conclusions from biological knowledge. This paper agrees wholeheartedly with the assertion of philosophers of education Harry Brighouse and Adam Swift that "nothing important need be lacking, from the child's point of view, if she is raised by an adult without this [biological] connection" [58 (79)]. But tensions arise when we extend our argument about narrative identity to the prenatal stage. For example, it is important to note that discussions of paternal and maternal epigenetic influences are crucially limited in scope. An exclusive focus on biological influences does not do justice to a wide variety of family arrangements in which one or more parents of the child are their social, but not their biological parent. Simplistic talk of paternal and maternal factors risks glossing over the wide variety of assisted reproductive technologies in which multiple people might be involved in reproduction in various ways. In surrogacy, for example, the maternal genetic material and the gestating environment do not belong to the same person. By introducing an argument that rests in part on (molecular) biology, this paper in no way wants to downplay the relationship that adoptive parents, stepparents etcetera can have with children, and the influence on their upbringing and understanding of self that they can have. However, there is no reason to believe that for Alex or Jenn to develop a healthy identity it is always necessary to have the knowledge of their parents' past choices and circumstances and the epigenetic mechanisms that may have connected those with their biological make-up. The argument in this paper is rather that 'epigenetic self-knowledge' may be of some added value in constructing one's narrative identity.

Still, we may worry that the 'epigenetic narrative identity argument' made in the previous section unintentionally taps into a sense of bionormativity or "culturally dominant biologism" [53 (93)]. As Megan Warin and her colleagues warn, employing epigenetic knowledge in an emancipatory way may even be understood as a kind of 'strategic biological essentialism'. When people use epigenetic knowledge to identify with 'a history of biosocial deprivation, this may have unwanted side-effects such as intensified biopolitical attention from the state or a more essentialized (and less nuanced) view of the environment [47]. But maybe, as Daniela Cutas points out, epigenetic knowledge can instead help us see that the category of biological parenthood may need to be broadened: it seems safe to assume that everyone who is closely involved in raising a child influences their environment and experiences and also modulates their molecular biology in doing so [22]. She suggests that those people may not have parental or procreative responsibilities, but based on their epigenetic contributions they might be said to have contributed to shaping someone. She argues:

"If contributing biologically to a child's identity is parenthood, and raising a child contributes to their gene expression in significant ways that are inheritable – which means contributing biologically – then raising a child is (one kind of) biological parenthood. If it is not parenthood, it is in any case biological contribution." [22 (106)]

Seen from that perspective, epigenetic knowledge production "brings closer together or altogether blurs the margins between parental, non-parental, primary, secondary, individual and collective responsibilities for children" (ibid.). Thus, the arguments in this paper do not apply exclusively to relationships between biological parents and children; although perhaps in a lesser degree, they can be expanded to all kinds of close interpersonal relationships.

Conclusion

The majority of existing ELSA literature on intergenerational epigenetics points out the dangers of employing epigenetic knowledge in such a way that it overburdens (prospective) parents or blames them unfairly or disproportionally. While this is important work, this paper has argued that we also need to explore potential positive effects of epigenetic knowledge dissemination. Given the moral and epistemic obstacles that any attempt at responsibility distribution encounters, it may be worthwhile to simultaneously explore other paths. Since epigenetic research is progressing quickly and already influences societal debates, ethicists would do well to formulate not only warnings but also suggestions for positive alternatives.

Starting out from the observation that epigenetics communication needs to take into account the complexities of our nonideal world, this paper explored a specific novel way to think about more positive employment of epigenetic knowledge. The paper considered the potential benefits of shared (epigenetic) knowledge between parents and children that points to a potential causal connection between the choices or exposures of parents before conception and the health of their children. Sufficiently nuanced epigenetic knowledge can contribute to the narrative identity formation of children, parents and families. As such, an understanding of how epigenetic mechanisms connect one's biology and one's biography may be beneficial in terms of self-knowledge, a better appreciation of one's social embeddedness, and mutual understanding. Furthermore, we also suggested that a dialogical sharing of epigenetic knowledge may have an empowering effect on its participants, since it might be a

first step towards collectively striving for improved environments and lives.

We wish to conclude with a call for creative research. When looking for improved methodologies that truly take 'a biosocial perspective' into account [59], we should not be afraid to do so in unusual ways or by looking for insights in research fields that we might not quickly consider relevant to the ethics of epigenetics. Philosophy of parenting and childhood and psychological theory are just two of the many possible sources of inspiration. Another suggestion would be to engage in empirical research reporting on the experiences and attitudes of people with regard to issues such as the relationship between epigenetic knowledge, agency, and responsibility. Novel qualitative research on the attitudes of people toward potential epigenetic influences in particular could include questions that address the worries of bionormativity (e.g. 'How do children in non-traditional families think about how their biological parents may have shaped them not only genetically, but also epigenetically?') and etiology (e.g. 'Do people value knowing causes of their conditions, and if so, in which circumstances? How do people deal with the fundamental complexity of epigenetic influences?').

Finally, the communication of our research findings should not easily allow for exaggerations, and perhaps even pre-emptively address existing social injustices and biases that might otherwise influence their translation into moral and political claims. Moreover, if we want epigenetic findings to reach a diverse audience, we may want to be creative about the ways in which we try to encourage narrative identity. For example, story-telling podcasts or artistic methods might be ways to disseminate epigenetic findings in a nuanced, multi-layered, yet accessible way. As researchers in epigenetics and its ethical and social implications, we should all play our role by heeding the calls for nuanced, compassionate and empowering science communication.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Competing interests

The authors declare no competing interests.

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