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Creating Superhumans, Disrupting Human Nature: Can Genome Editing Endanger Our Species?

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Abstract: Advances in biotechnology will soon enable editing the DNA of our future children, which raises multiple concerns. This paper examines two common concerns: that genetic enhancement may create biologically distinct "superhumans" who might outcompete ordinary humans or cause a societal collapse, and that modifying the human genome might "disrupt human nature", leading to the loss of our humanness. While these concerns appear distinct, both ultimately fear that genome editing may create individuals who can no longer be identified as "human" endangering humanity as we know it, and thus both view genome editing as an existential threat. This paper critically evaluates these concerns by examining the feasibility of the envisioned scenarios, arguing that the emergence of a distinct superhuman species is highly unlikely as it would require reproductive isolation achievable only through strictly controlled reproduction, while the emergence of people with enhanced traits might not necessarily convert into a societal catastrophe. Likewise, human nature is unlikely to be fundamentally altered by genome editing without extreme reproductive control, while the genome alone does not define human nature that has significantly evolved throughout human history. Since both feared scenarios would require a dystopian level of reproductive control rather than the mere availability of genome editing, I conclude by discussing the use of extreme totalitarian scenarios in guiding genome editing policy. This paper contributes to the debate on human genetic enhancement by challenging two common existential concerns and advocating for evidence-based ethical and policy deliberations.

Keywords: Human Genetic Enhancement; Genome Editing; Existential Risks; Bioethics; Philosophy of Biology; Superhumans

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1. Introduction

Humans have been trying to improve themselves and their lives for millennia. With the recent advances in genome editing (A Lea and K Niakan 2019; Villiger et al. 2024), we will soon be able to change the DNA of our future children to our liking. Even if one assumes these procedures to be perfectly safe, the idea of human heritable genome editing and genetic enhancement raises a plethora of ethical concerns (Jotterand and Ienca 2023). These range from warning of the risks of increasing inequality, condemning the creation of "designer babies" and concerns about the violation of the child's autonomy, to fears about the resurrection of eugenics (Savulescu and Bostrom 2009). While many of these concerns focus on fairness and the ethics of the parent-child relationship, some frame genetic enhancement as fundamentally disruptive for humanity as a whole (Kass 2004) and even as endangering our species (Annas, Andrews, and Isasi 2002).

Many of the technological developments that can improve people's lives, such as the ability to obtain energy from nuclear reactions or burning fossil fuels, can bring

unintended catastrophic consequences or even threaten our very existence. Being able to edit the human genome might seem to be one of such threats. This paper addresses two central critiques of genetic enhancement that seem to frame it as a sort of existential risk.

The first critique at the focus of this paper is that human genetic enhancement could lead to the creation of "superhumans". In one of his late essays, Stephen Hawking named such "superhuman race" one of the major threats to humanity:

> *"... some people won't be able to resist the temptation to improve human characteristics, such as size of memory, resistance to disease and length of life. Once such superhumans appear, there are going to be major political problems with the unimproved humans, who won't be able to compete. Presumably, they will die out, or become unimportant. …"* (Hawking 2021)

Across the bioethics literature, the fear of "superhumans" might be split into three somewhat distinct concerns. First, it is argued that genome editing could exacerbate inequality as access to these expensive technologies might be limited to the wealthy. The rich would then not only be financially much better off, they would also become biologically "superior": healthier, stronger, maybe even immortal (Bess 2016). This raises the already pressing problem of inequality to a whole new level. Second, genetically enhanced individuals might become so biologically different that they form a new human species, creating not only a social, but also a profound biological divide between the enhanced and unenhanced humans and disrupting the integrity of our species (Jeungst 2009). The third, most catastrophic, concern is that these "superhumans" might intentionally or unintentionally harm, discriminate or even lead to the extinction of unenhanced humans, as Stephen Hawking's quote suggests.

The second critique of genetic enhancement that points at existential risk suggests that genome editing is meddling with human nature and might change or disrupt it to the point that we are no longer humans. This concern has been raised by several scholars, most prominently by Michael Sandel (Sandel 2007) and Leon R. Kass (Kass 2004).

> *"Human nature itself lies on the operating table, ready for alteration, for eugenic and neuropsychic enhancement, for whole-sale redesign. … For anyone who cares about preserving our humanity, the time has come to pay attention."* ((Kass 2004), p. 4)

Apart from the fundamental unease with altering what is fundamentally and naturally "human", this concern also sees genome editing as a powerful force potentially leading to unforeseen harms or vulnerabilities, and most importantly, the disappearance of what we know to be human. These concerns go in line with the broader critique of transhumanism that envisions modifying humans to the extent that they may become "posthuman" – unrecognizable compared to what we currently understand as human.

The concerns about the emergence of "superhumans" and the disruption of human nature may seem distinct at first. However, I address them together in this paper for an important reason. Both concerns assume that genetic enhancement could create individuals who might no longer qualify as "human" [1] – be it "superhumans" or "posthumans" whose nature has been fundamentally altered. In both cases, the underlying existential concern is that genome editing could lead to the emergence of a new category of beings that would either replace or not be able to peacefully coexist with ordinary humans.

These perceived risks have important implications for bioethics, public policy and the future of human genome editing. Today, heritable human genome editing is banned world-wide, with both safety concerns and the ethical concerns such as those described

[1] The precise definition of what it is to be human is a millennia-long debate in philosophy and is not the focus of this paper, neither is it clearly defined in most of the corresponding literature. Both the human-superhuman distinction and the discussions surrounding human nature seem to understand "being human" as a combination of belonging to our biological species (*Homo Sapiens*) and a set of features commonly seen as "human", with the former leaning towards the species distinction and the latter towards a set of features (see more precise definitions in the corresponding sections below).

above contributing to the ban. But how realistic are those feared scenarios and are they a valid reason to prohibit human genome editing in the future when/if its safety is ensured?

In this paper, I critically evaluate these two existential concerns focusing on their major premises: (1) that genome editing could create a "superhuman" species and (2) that it could disrupt human nature. I argue that neither premise holds up to philosophical or, importantly, biological and practical scrutiny. The first part of the paper analyzes the feasibility of creating superhumans, highlighting the biological and social barriers to creating a new human species and questioning the certainty of the threat from a group of "superhuman-like" people. The second part explores the idea and feasibility of "disrupting human nature". Using a pragmatic definition of "human nature", I argue that the human genome and its modifications only have a limited power to define or disrupt it. I conclude that both feared scenarios are utterly unrealistic as a consequence of simply permitting human heritable genome editing and can only come to life under a totalitarian regime with fully controlled reproduction. Finally, I briefly explore the relevance of such a dystopian scenario for ethical and policy decisions.

This paper does not seek to provide a comprehensive ethical analysis of genome editing and enhancement, and neither does it focus on whether an aspiration to create superhumans or alter human nature are morally acceptable. Instead, this paper provides an *interdisciplinary analysis of existential risks commonly associated with genetic enhancement* and shows the weaknesses of their underlying assumptions. A realistic, evidence-based approach to accessing the risks of emerging technologies is crucial for both ethical evaluation and policymaking. Shifting the focus from speculative fears toward more probable risks will allow for the development of more just, effective, and well-informed decisions about genome editing and enhancement in the future.

2. Brief Overview of Heritable Human Genome Editing

Since the topic discussed here centers around genetic enhancement, it is important to overview how one can create a genetically enhanced (or genetically modified) person. Heritable (or germline) genome editing that is at the core of the genetic enhancement debate is a special type of genome editing that is performed on an embryo at a very early stage. This type of genome editing, unlike genome editing used in gene therapy, leads to the creation of a genetically modified human, that is – every cell of the person's body will carry the altered genome.

Heritable genome editing can only be performed as a part of an *in vitro* fertilization (IVF) procedure (Kim et al. 2024) because the genome modification procedure must be performed on a very early embryo to ensure that every cell is treated and has the same (altered) genome. It is impossible to edit the genome of the embryo conceived naturally, as there is no safe access to the early embryo. Performing genome editing on an already born child can only result in some of their cells having the altered genome - such as achieved when performing gene therapy (Uddin, Rudin, and Sen 2020).

A standard IVF procedure involves egg retrieval, fertilization, embryo incubation, an assessment of embryos' quality/viability and embryo transfer into the uterus. A genome editing procedure would be performed on the early-stage embryo during the incubation period. The genome editing itself is likely to be performed using the CRISPR/Cas9 system that constitutes the simplest and most powerful method of genome editing today [2] (Villiger et al. 2024).

[2] It is crucial to note here that CRISPR/Cas9 facilitated genome editing, while being very widely used in scientific research as well as in the development of gene therapies, is still not safe or robust enough to be applied on real human embryos (Schleidgen et al. 2020; Ledford 2020). It couldn't be approved today even if there were no ethical concerns about it. While there are continuous efforts to improve CRISPR/Cas9 methodology (Lei et al. 2024), it might take many years until it is robust enough to be used on embryos, particularly given an outstanding challenge of how to perform clinical studies on a technology used for assisted reproduction.

3. Creating Superhumans

First, let us define "superhumans" for the purposes of this discussion. While the term "superhuman" is more commonly used in popular culture[3], art (Pisarski 2021) and the media[4] than in academic literature, the three-component concerns described above do center around the concept that can very reasonably be called "superhumans". In this paper, I will use the term "superhumans" to refer to *individuals possessing a set of traits far beyond human average*[5] (Almeida and Diogo 2019). These traits usually involve extremely high intelligence, superior beauty/attractiveness, extraordinary health (up to immortality), and extreme physical strength. These features are pushed-to-the-limit projections of the modifications parents might want to introduce in their children if germline genome editing becomes widely accessible.

It is important to reiterate the core of the superhuman concern: while genome editing might seem beneficial for preventing or fixing genetic diseases, once allowed it might be used by parents for enhancing their kids, which could in turn lead to a world where genetically enhanced individuals form a distinct "race" or "species" of "superhumans". In what follows I discuss the biological and philosophical aspects of this scenario to understand if this concern is valid. The focus of this paper is not whether the existence of "superhumans" would be morally or socially acceptable, but whether genome editing could realistically create a new human species that could endanger ours.

3.1. More than one human species

Currently we, *Homo sapiens*, are the only human species living on Earth. The emergence of a new human species would be a truly outstanding event that many deem disruptive. While we did share the planet with other human species, such as Neanderthals, *Homo neanderthalensis*, and Denisovans, *Homo denisova*, for tens of thousands of years, every single human species except for us is now extinct[6]. Since early and modern humans have been responsible for several waves of massive species extinctions on Earth (IPBES 2019; Ceballos et al. 2015; Svenning et al. 2024), it is reasonable to assume that humans contributed to the extinction of all other human species as well. Interestingly, while it might seem intuitive to assume that humans killed off all Neanderthals, there is so far no substantial evidence of massive direct violence towards Neanderthals that would substantially contribute to their extinction (Villa and Roebroeks 2014). The exact reasons Neanderthals went extinct around 40,000 years ago have not yet been determined and there is a lot of debate, but archeological and genetic research suggests that Neanderthals gradually disappeared because of their lower adaptability to climate change, the competition for resources with *Homo Sapiens*, and the merging of the two populations (Higham et al. 2014; Vaesen, Dusseldorp, and Brandt 2021). Thus, while *Homo sapiens* likely did not directly exterminate Neanderthals, they contributed significantly to their extinction, largely due to their capacity for complex collaboration and innovation (Coolidge and Wynn 2018; Finlayson 2011).

What would be the consequences of the emergence of a new "superior" human species in the near future? Could we share the planet with another human species of likely much higher intelligence[7] and physical strength? And would competition for resources, direct aggression or the superior adaptability of "superhumans" lead to the extinction of ordinary humans? These are fascinating and unsettling questions worthy of rigorous

[3] https://marvel.fandom.com/wiki/Glossary:Superhuman

[4] https://www.redbull.com/gb-en/podcast-shows/red-bull-how-to-be-superhuman-podcast

[5] https://en.wikipedia.org/wiki/Superhuman

[6] https://theconversation.com/were-other-humans-the-first-victims-of-the-sixth-mass-extinction-126638

[7] Similar questions are widely discussed in the context of artificial intelligence (AI) development and superintelligent AI is often thought to bring very high existential risk (Bostrom 2016; Yudkowsky 2007).

philosophical investigation. However, the risks of the emergence of superhumans strictly depend on this fundamental premise – that such an emergence is even possible. Surprisingly, a pragmatic analysis of this possibility is largely absent from the literature[8].

Let us distill the "superhuman" critique of genome editing and enhancement into three major assumptions:

1. Permitting heritable human genome editing will lead to its use for enhancement.
2. Genome editing for enhancement will result in the creation of a separate "superhuman" species.
3. The emergence of the superhuman species will be detrimental, or outright dangerous, for ordinary humans.

Every one of these statements calls for a rigorous evaluation, each deserving an article of its own. Let us primarily focus this paper on the assumption number 2 and then briefly investigate the assumption number 3. To understand the feasibility of the emergence of a separate "superhuman" species, we need to understand what it would take for a group of "superhumans" to really become a species distinct from ordinary humans, and whether this is technically possible.

3.2. How to distinguish two species?

The theory of what a species is, how different species diverge from a common ancestor, and how a group of organisms can be said to belong to one species and not another is quite a philosophical branch of evolutionary biology. Many biologists, not unlike philosophers, discuss whether "species'' is an ontological category or a purely epistemological construct. Is "species" a real property of nature, or do we arbitrarily draw a boundary between different closely related groups of individual organisms and decide to call each group a species (De Queiroz 2007)?

Distinguishing between species seems easy when we compare humans to something distinct like tomatoes. Even before the advent of genetics, this could be easily done because of two major reasons: first, they look and function totally differently, and second - they cannot possibly interbreed, i.e. a tomato and a human cannot produce offspring. With the invention of the microscope, further distinctions became evident - for example, humans and tomatoes have a different number of chromosomes. The development of genomics showed that tomatoes and humans also have vastly different genome sequences. These genetic and chromosomal differences make a hybrid human-tomato embryo technically impossible, even in a Petri dish. The same logic applies to humans and cats, or humans and chimps: striking phenotypic differences and inability to interbreed makes the species distinction clear.

It gets less straightforward when examining two very closely related species. For example, ordinary humans and Neanderthals had the same number of chromosomes and were able to interbreed when they met in Eurasia about 100,000, and then again about 50,000 years ago (Gibbons 2016). Interbreeding was possible despite the two species diverging from a common ancestor about 500,000 years ago and possessing significant genetic differences: any two modern humans differ by approximately 3 million base pairs (about one in every 1,000 base pairs)[9], while a human and a Neanderthal would differ about three times more – roughly three in every 1,000 base pairs (Prüfer et al. 2014). Given such differences, it is possible that not every human-Neanderthal child was healthy and fertile, as observed for crossbreeding of other mammalian species (Adavoudi and Pilot

[8] It has been suggested that from the perspective of trans- and posthumanism, human genome editing resulting in the creation of the super-human species is not only possible but desirable and constitutes the whole point of human enhancement (Rueda 2022). The article however provides no analysis or support of the idea that the transition into the new species is at all *possible* by "radical genetic enhancement" (Rueda 2022).

[9] https://www.ashg.org/wp-content/uploads/2019/09/genetic-variation-essay.pdf

2021). However, some children were clearly viable and fertile as all modern non-African populations retain some Neanderthal DNA in their genomes (Prüfer et al. 2014).

3.3. Can heritable genome editing create a new human species?

We have previously defined "superhumans", quite conventionally, as genetically enhanced individuals with a set of traits far beyond average. What would qualify these "superhumans" as a separate species?

The simplest and most common assumption underlying the "superhuman" discourse is this: germline genome editing can introduce significant changes into the genome sequence and thus can create a new species. In what follows, I will show that this assumption is oversimplified and inaccurate.

Could genome editing introduce enough genetic changes to create a new species, a putative "*Homo superior*" (Mende, Noble, and Sugar 2023)? To explore this, let us take Neanderthals – the (extinct) species most closely related to us – as a reference point. Let us posit that if humans and superhumans reached the same level of genetic differences as that of humans and Neanderthals, we could be certain that the two groups are now distinct human species. Let us now relax this criterion and say that we only require the genetic difference of two per 1,000 base pairs to say that "superhumans" are a separate species. This would amount to a difference between *Homo sapiens* and "*Homo superior*" of roughly 6 million base pairs distributed across the whole genome, which is about twice the average difference between two humans. It is very unlikely that a genetic difference of six million base pairs can be achieved in the context of genetic enhancement.

Moreover, we know that two random humans differ from each other by 3 million base pairs, and we also know that humans are one of the least genetically diverse species[10]. This low genetic diversity is associated with our relatively recent emergence as a species and many bottleneck events in our evolutionary and migration history[11]. Therefore, there must be considerable room for increasing the range of human genetic variation without stretching out to creating a new species, and it might be that even achieving the 6 million base pair difference would not be sufficient for speciation.

Thus, straightforwardly achieving enough genetic differences to form a new species is highly unlikely. Even so, general genetic sequence divergence or specific differences in the genetic sequence are often considered to play a smaller role in speciation than something called *reproductive isolation* (Westram et al. 2022). Reproductive isolation is a situation, in which two groups of organisms can technically interbreed and produce a fertile and viable offspring, but something prevents them from doing that. There are different sources of reproductive isolation (Nosil 2013). The simplest one is space: two reproductively isolated populations can be physically separated – live too far away from each other and thus not be able to meet and interbreed. Such isolation does not necessarily result in speciation: for example, human populations on different continents were separated by distance for many thousand years but did not become separate species or developed any reduced reproductive capabilities. The time of this isolation must be long enough to allow the accumulation of a significant number of mutations: evolutionary biology usually operates in hundred thousand and million years.

There are, however, other sources of reproductive isolation. For example, differences in behavior between two groups can make breeding impossible – different mating rituals or timing can cause two groups to stop interbreeding and eventually diverge into separate species. If some birds start singing songs that are unattractive for the others, they will quickly become unable to interbreed[12] (Turbek et al. 2021).

[10] https://www.ashg.org/wp-content/uploads/2019/09/genetic-variation-essay.pdf

[11] https://news.berkeley.edu/2022/06/23/bottlenecks-that-reduced-genetic-diversity-were-common-throughout-human-history

[12] https://www.aaas.org/news/feather-color-and-song-drive-speciation-nearly-identical-songbirds

Let us return to "superhumans" and try to imagine how a group of genetically enhanced people could possibly form a new species. As outlined above, the speciation between the "ordinary" and the "super" humans requires reproductive isolation: a physical separation, or other interbreeding barriers. The physical separation would have to persist for a million years given only natural evolution is at work, and suppose, by a wild guess, a thousand years given the artificial highly accelerated evolution facilitated by genome editing. A scenario where the genetically enhanced rich and powerful and all of their offspring never "breed" with unenhanced humans by either never meeting them, or by being prohibited from marrying them and producing an offspring, seems unrealistic in the modern world.

However, maybe we do not need a thousand years: there are reports of much faster speciation. For example, this happened to finches on the Galapagos islands: some finches flew from one island to another, interbred with the locals and developed reproductive isolation within just two generations because the hybrids between the local and immigrant birds had much larger beaks, did not attract local mates and would only breed with each other [13] (Lamichhaney et al. 2018). Thus, miniscule genetic changes that result in noticeable appearance changes can create a reproductive barrier between two groups within the same species. We can imagine that enhanced "superhumans" would be so much smarter, stronger and more beautiful/attractive than non-enhanced humans that the latter would become completely unattractive to the former and there would be a reproductive barrier without any space separation or legal prohibition. While this scenario is possible, it is hard to imagine that it would be a strict reproductive separation without occasional "out-of-caste" marriages, unless this is surveilled by an overly totalitarian state.

The most "promising" option for making superhumans reproductively isolated from ordinary humans is to introduce specific genetic changes that would make humans and "superhumans" *reproductively incompatible* (Maheshwari and Barbash 2011), i.e. a "superhuman" and a human would be able to meet and "mate", but this would not result in the birth of a viable and/or fertile child. There are several potential ways to achieve that. For example, one could edit genes responsible for sperm-egg recognition (Okabe 2018) and make sperm-egg recognition and thus fertilization impossible between modified and unmodified individuals. Another method could be to introduce structural chromosomal changes (Bakloushinskaya 2017) large enough to make proper cell division (and thus viability) of the fertilized egg impossible. One could also alter the mitochondrial genome in enhanced individuals so that it cannot interact properly with nuclear DNA from ordinary humans (Telschow et al. 2019).

While it is theoretically possible to achieve reproductive isolation through such genetic modifications, all these targeted methods require a very specific *intent* to do so. Simultaneously, none of these genetic modifications seem to bring any benefit for the genetically modified individual but rather appear to bring health risks. It is difficult to imagine that parents would specifically introduce such modifications in their future children in the context of genetic enhancement. Moreover, it is highly likely that since these modifications make the child effectively infertile, they would be strictly banned as any involuntary sterilization procedures. Enforced introduction of such non-beneficial reproductive incompatibility modifications for the purpose of creating "superhumans" would require there to be a severely totalitarian government holding such intent and controlling reproduction.

3.4. No genetic homogeneity in the superhuman population

Another crucial aspect that should be considered here is that all of the reproductive isolation scenarios described above presuppose that there are two groups of individuals that are more similar within the group than between the two groups. The idea of "superhumans" arising from genetic enhancement, if realistically thought through, would

[13] https://cosmosmagazine.com/science/biology/new-species-evolve-in-just-two-generations/

require that all, or many genetic changes introduced in the enhanced individuals be the same. This is a very strong assumption that seems very unlikely to be true. Even if we assume genetic enhancements to be technically possible, some parents might want to give their children an outstanding musical talent, while others would focus on strength and resilience. Even strength enhancements might come in different versions as we know that outstanding athletes practicing different sports look quite differently. Any summer Olympics is an illustration of the fact that optimal muscle strength distribution varies for different types of sports, and so do body shapes: runners are unusually lean, swimmers have unusually wide shoulders, basketball players are unusually tall. Beauty standards also differ from society to society and from person to person. Some parents might want their children to be pushier and "shape"[14] them to work at Wall Street, some might focus on empathy and kindness. We cannot expect all enhanced children to possess the same set of traits and thus we cannot expect them to have the same genetic modifications. This means that the group of "superhumans", while likely all having good health (as it seems to be a universal wish that parents have towards their children's traits), will be largely diverse in their phenotypes and genotypes making it unlikely that they form a new species.

Finally, despite the uttermost unlikelihood that enhanced humans can become a separate "superhuman" species, there is an important sociocultural aspect to consider. People's worldviews are rarely fully aligned with underlying biological reality or known scientific facts. The history of racism tells us that humans can consider groups of humans to be a different subspecies without any genetic reasons for it. Modern racism shows that even published research on the topic is not sufficient to eliminate such misconceptions. Likewise, while genetically enhanced humans might not biologically constitute a different species, the public can perceive them as such. This perception can cause both idealization and discrimination of the genetically modified people (Savulescu 2009).

In summary, the emergence of a new "superhuman" species as a result of public access to heritable genome editing seems rather impossible, due to three main reasons: large space for increasing human genetic variation, impossibility to ensure reproductive isolation between genetically modified and ordinary humans, and the diversity of genetic modifications introduced. Creating a new "superhuman" species would require a specific intent and powers to enforce certain genetic modifications and massively control human reproduction, i.e. it requires a Brave-New-World-style totalitarian regime of an unprecedented scale.

3.5. Are superhumans a threat to ordinary humans?

One can argue that even if we do not create a whole new species, the emergence of "superhumans" as we defined them – people with a set of traits far beyond average – can still bring serious risks to ordinary humans. In a commonly envisioned scenario, unequal access to expensive genetic enhancement procedures results in that exclusively wealthy people become "superhuman" and the already existing inequalities reach unprecedented levels (Bess 2016). In extreme projections, portrayed in fiction and computer games, these inequalities lead to a societal collapse. Another extreme scenario envisions enhanced humans forming a supremacist movement and actively harming ordinary humans. However, both scenarios seem rather unrealistic.

The scenario of increased inequality is the most realistic of all the envisioned consequences of genetic enhancement discussed in this paper and will clearly need to be addressed by regulatory bodies in the future. However, I would like to question the imagined catastrophic consequences of such development as well as the validity of this scenario as an argument for ethical impermissibility of genetic enhancement. First, the

[14] Elsewhere I argue that the idea of "designing" or "shaping" your future children through heritable genome editing is rather unrealistic and is based on genetic determinism and incomplete understanding of modern human biology.

concern of widening the gap between the rich and the poor can be applied to nearly any other technological and medical advance that improves lives, which makes genome editing just one technology among many others. If we are to use this argument to condemn genome editing, we would need to condemn many widely acceptable practices that cause little to no concern in the bioethics community. Second, socioeconomic inequality already significantly contributes to disparities in the quality of life, health and life expectancy without any need for novel gene editing technologies. For example, there is a ~12-year difference in life expectancy between the richest and the poorest one percent of the US population (Chetty et al. 2016), and a 10-year difference between South and North Korea[15]. I would like to argue that addressing broader systemic issues contributing to inequality and the difference in health and life expectancy seems more productive than opposing genetic advancements. Third, genome editing technology might become much more widely available with time, as we have seen that historically most technologies, even those that are initially only available to the wealthy, eventually become more affordable and widespread, reducing disparities over time. We cannot fully eliminate the possibility that that genome editing will not follow the path of many emerging technologies from the past and will have an unprecedently polarizing effect, but any policymaking as well as risk assessment has to deal with uncertainties. Finally, the use of expensive medical treatments in many European countries provide an encouraging example of how a social system might offer expensive treatments to those who need them most.

The assumption inherent to the second scenario – that "superhumans" might form an organized force with a negative attitude toward ordinary humans – is also questionable. While shared enhanced traits and possibly life experiences, or perceived threats or discrimination from ordinary humans, might create a sense of unity and cohesion, this does not guarantee an emergence of a destructive force. Even if ordinary humans were to stigmatize and exclude enhanced individuals, leading them to form exclusive communities akin to modern elite clubs or schools, this would not inherently pose a danger. Numerous elite organizations exist today, yet they do not normally aspire to actively harm those "beneath them". Moreover, the diversity among enhanced individuals as well as today's societal norms discouraging supremacist ideologies would likely prevent them from forming a dangerous ideological movement.

Furthermore, we already observe the existence of exclusive groups with extraordinary capabilities very far beyond average. For example, academic mathematicians are drastically better at logical reasoning and Math than an average human, while professional basketball players are drastically taller and stronger than an average human. While these outstanding traits and capabilities were not achieved through genetic enhancement nor defined by a specific genetic sequence[16], these groups provide valuable insights if we want to make predictions about the possible social dynamics of groups of "superhumans". If being far beyond average in health or other advantageous traits makes a group of people prone to destructive supremacist ideologies, we might expect to see supremacist movements arising from academic mathematicians or professional athletes. However, no such trends exist despite these people having both outstanding traits and plenty of opportunities to meet and form exclusive communities. On the contrary, the demographics of contemporary supremacist ideologies show an enrichment of rather disadvantageous and undesirable traits, such as poverty, low education and social status, as well as psychological traits associated with the "dark

[15] https://www.worldometers.info/demographics/life-expectancy/, mind the likely unreliability of the North Korea demographic statistics sources, as is common in totalitarian states, that might overstate the life expectancy

[16] Population genetics research on traits like intelligence or height does not provide a reason to think that these traits are determined by the genetic sequence, but rather, like most traits, are influenced by many genes as well as a plethora of environmental and life-history factors (see for example https://en.wikipedia.org/wiki/Heritability_of_IQ).

triad", such as Machiavellianism and psychopathy[17]. This suggests that supremacist ideologies are more commonly associated with socioeconomic disadvantage and certain psychological profiles rather than with groups characterized by exceptional abilities or achievements. Thus, the fear that "superhumans" might inevitably form a supremacist movement does not appear to be properly supported.

In summary, while the societal risks of the emergence of "superhumans" are more grounded than the fear of the emergence of a biologically new species, the former are still likely exaggerated. Scenarios of exacerbated inequalities resemble existing societal structures, while the fear of an aggressive supremacist elite makes a strong and largely ungrounded assumption about the unification and radicalization of genetically enhanced individuals. While it is possible that unprecedented genetic modifications could produce unforeseen social dynamics, enhanced individuals are unlikely to unite into an organized and threatening force.

4. Disrupting Human Nature

Let us now explore the second major existential concern: that by modifying the human genome we modify human nature and may somehow endanger it. Similarly to the superhuman concern, this concern is laden with assumptions and concepts that are far from self-evident. To evaluate whether "preserving human nature" justifies restrictions on genome editing, we should address four foundational questions:

1. What is "human nature", and does it exist?
2. What can be considered a change in human nature?
3. Can genome editing modify human nature?
4. Does modifying human nature threaten humans?

While none of these questions are trivial, the opponents of human genome editing and enhancement rarely touch on them, which they have been criticized for (Caplan 2009). Let us work through these questions to understand if there might be a real threat of starkly altering human nature if the ban on genome editing were to be lifted in the future.

4.1. What is human nature, and does it exist?

"Human nature" is a widely contested concept (Hannon and Lewens 2018) and many philosophers as well as biologists suggest that human nature might not ontologically exist (Lewens 2015). Yet, the term "human nature" is frequently used in academic writings and common language, and philosophers have tried to define it for centuries (Roughley 2023). Some discussions focus on defining the set of human properties that constitute "human nature", while others lean towards philosophy of biology and link the concept of "human nature" to the biological notion of "human species" deliberating whether humans and other species do have a kind of "nature" or "essence" at their core. Interestingly, Tim Lewens dissects several prominent notions of human nature in context of the debate surrounding human enhancement and concludes that the concept of human nature brings no benefit to this debate and should rather be avoided (Chapter 4 in (Lewens 2015)).

Not diving into the centuries-long debate about "human nature", this paper tries to address whether permitting heritable human genome editing could lead to the situation that might be roughly seen as its change or disruption. To do so, we need a workable definition of both "human nature" and its alteration. Norman Daniels offers a very useful analysis of what "human nature" might entail and how we can determine if it has changed (Daniels 2009). In this paper, I will adopt Daniels' pragmatic definition of "human nature" as a set of universal human features. He points out that, similarly to other species, humans exhibit extensive variation in their traits. While some traits are static, most are dynamic and depend on a wide range of environmental conditions at various times through the lifetime, thus forming countless massive clouds of feature ranges.

[17] https://doi.org/10.1146/annurev.soc.33.040406.131752, https://osf.io/preprints/psyarxiv/c9uvw_v1

Daniels also argues that what we consider a species' nature is in reality not a sum of all its traits but only those most important to us. Daniels brings up an example of pigs producing, via a genetic change, human proteins in their organs. While this significantly changes pig biology, and even introduces an element of human "nature" into pigs, it would not make us believe that we fundamentally changed "pig nature". In contrast, if pigs were genetically modified to be able to talk, this would surely be seen as a genuine change in their nature (Daniels 2009). The same can be said about humans: changing human skin or hair color, stomach acidity or the shape of our colon's folds – despite requiring significant genetic modification – would not be seen as changing human nature because these features are not perceived as something fundamental to being human. However, applying the same extent of genome editing to make humans more aggressive, shy or unloving would likely be perceived as modifying human nature as these features are more crucial for us. Roughley also highlights that psychological and behavioral traits are more commonly regarded as parts of "human nature" than physiological or morphological ones (Roughley 2023).

4.2. What can be considered a change in human nature?

As outlined above, the definition of human nature, even if just a pragmatically construed one, is intertwined with the definition of what it is that would qualify as a *change* in human nature. We established before that such a change requires modification of features considered so important that we see it to be part of human nature. The next prerequisite is that this change must be significantly large. For example, if all humans were to become one centimeter taller, we would neglect it. Yet, if all humans were to suddenly become taller than two meters, this would significantly change many aspects of our lives, and we would probably say that our nature has changed. If we were to modify people to have slightly higher social intelligence and empathy, via educational programs or genome editing, we would not claim that human nature has changed (Daniels 2009). In contrast, if we modify humans to be capable of mind-reading, as suggested by Daniels (Daniels 2009), it would be a major alteration that would clearly qualify as a change in human nature. Along these lines, Eberl brings up mind uploading – a concept widely discussed in the trans- and post- humanist literature (Eberl 2023) – as an example of radically altering human nature. Indeed, if we imagine people's minds being uploaded to digital media and human bodies being replaced with robotic ones, we can without doubt say that we dramatically meddled with human nature, to the extent that it is not clear if such beings can still be considered human – thus the "posthuman" label ((Ranisch and Sorgner 2014), p.7-27).

The third crucial factor is the number of individuals undergoing the trait change (Daniels 2009). Modifying a small group of people, even drastically, would not equate to changing human nature. Daniels brings an example of making most people very shy, which could significantly alter society and thus be considered a change in human nature. Yet, if we only make a small group very shy, this, while life-changing for those individuals, will not be a change in human nature. In fact, there are quite a lot of very shy people already: it might be that we did not even outperform natural variation, as each feature comes in a wide dynamic environment-dependent range of values. But even if we perform a radical change, far beyond natural variation, such as mind-reading or mind-uploading, but only on few individuals, such rare individuals will just be outliers, reasons for discussions, but it is unlikely that we would be able to say that human nature was significantly altered if most people stay the same.

Thus, there are three conditions that a transformation, achieved by genetic or other means, must satisfy to qualify as a "change to human nature": it must be in traits that are important to us, the change must be significant in scale and, importantly, the change must be widespread across the population.

4.3. Can genome editing modify human nature?

The first two questions – what human nature is and what qualifies a change to it – are independent of the source of change. However, the question central for this paper is whether human nature, pragmatically defined as a set of important features, can be starkly changed by means of genome editing, or more specifically – as a consequence of permitting heritable human genome editing.

To address this, it is crucial to distinguish between theoretical biological possibilities and practical realities constrained by multiple other factors. For example, it is biologically possible to edit the genome of every child-to-be in a way that they all get sick when they grow up. We could introduce a mutation into the SMN1 gene and make every human on earth develop spinal muscular atrophy (SMA)[18] at some point of their lives[19]. While biologically possible, such a scenario is entirely implausible: no adequate parents would want this, a knowingly harmful medical procedure could not be permitted in a reasonably functional state, and an intentional harm to the child is also rather universally punishable.

Moving to less extreme cases, let us consider a rare genetic condition called congenital hypertrichosis, where affected individuals have excessive hair growth all over their bodies, and, importantly, faces (Pavone et al. 2015). Historically, individuals with this condition were presented as "wolfmen/women"[20]. The genetic basis of this condition is not known for every single case of it, but a few cases allowed identification of the affected genetic loci (Sun et al. 2009). What is important here is that a very small number of genes are involved, and this can be easily reproduced by CRISPR genome editing. If many parents decide to introduce this trait into their children, in just a couple of decades many people would have hairy faces. Having a bald face, especially around the eyes and the forehead, is an important human feature as it allows easily visible facial expressions – a crucial component of communication for humans and other great apes (Kret et al. 2020). Having many or most humans have hair covering their face would likely influence the ways we communicate, our perception of ourselves and, perhaps we can say – human nature.

Thus, it is possible that genome editing can change some important, human-nature-eligible, features of the modified humans to a large enough extent. However, unlike the extreme and unrealistic examples above, the features commonly discussed in the context of genetic enhancement are improved cognitive and physical abilities – for example, strength, memory and logic, social skills, reaction or coordination. Despite these features being more ordinary than hairy faces, they are actually much further from being either determined by the genetic sequence or feasibly manipulated by genome editing. They are also very far from being fully mechanistically understood on a genetic and molecular level.

Let us say that despite the problems described above, we do manage to fulfill the first two criteria for changing human nature, but how can we fulfill the third one – that the change affects most, or at least a very large part, of the population? There would be a need for a somewhat coordinated action by many, ideally the majority of, future parents. Many parents must decide that genetic enhancement is important enough for them that they forgo natural conception and go through IVF, and they must also genetically modify the same trait in their children. Heritable human genome editing is a complicated and stressful procedure that requires determination from parents who are willing to undergo one or several IVF cycles. Currently the only people undergoing IVF are those who cannot conceive a child in a conventional way – heterosexual couples struggling with infertility, homosexual couples and single aspiring parents. It is unlikely that people would prefer IVF to natural conception without a very pressing reason to do so and it is even less likely that this will be a ubiquitous phenomenon.

[18] https://smanewstoday.com/spinal-muscular-atrophy-causes-genetics/

[19] https://smanewstoday.com/sma-life-expectancy/

[20] a clearly immoral practice that is not the focus of this discussion.

We will need to assume that in the very far future, genome editing, and IVF become so cheap and simple, and the social pressure to change your child's DNA becomes so high, that the majority of future parents choose IVF over natural conception. Finally, we can imagine a dystopian world, where the totalitarian government forces citizens to do IVF to produce genetically enhanced children. Daniels also concludes that a significant change in human nature cannot be achieved by genome editing and that the scenarios worth worrying about lie in the realm of science fiction (Daniels 2009).

In sum, while genome editing can theoretically change what we perceive as human nature, this theoretical possibility requires too many unlikely hypotheticals to materialize, especially with regard to the ubiquitousness of the alteration.

4.4. Does modifying human nature threaten humans?

Even if we assume that human nature does exist and that changing the genome can indeed significantly change it, the question remains if the fear of such changes is justified. What is inherently wrong or dangerous in changing human nature? How much change are we comfortable with, and at what point do humans stop being humans? Many of these questions are extensively explored by transhumanist, posthumanist scholars as well as their critics (Kass 2004; Bostrom 2005; Lewens 2015). Here, I will argue that we have never been cautious about changing human nature – a point made by several scholars (Savulescu and Bostrom 2009), and we have remained "human" throughout. Moreover, if there is nothing mystical or sacred about the human genome, the changes in human nature that heritable human genome editing can achieve are rather modest compared to the changes that can be brought by other means.

If we follow human history of the past centuries, we can notice quite a few drastic changes in many of the important human features and behaviors - roughly what we agreed to call human nature above, or at least the manifestation of human nature. Many critiques of genetic enhancements consider the consequences of radical life extension (Lawrence 2021; Haker et al. 2022), yet radical life extension is not unprecedented. Human life expectancy has doubled in the last century alone [21] and tripled compared to prehistoric times. The length of a human life seems to have many dramatic influences on how we perceive ourselves, what we are able to accomplish and how we connect to the world around us and others. Human height increased less drastically, but similarly ubiquitously and significantly - all humans are now about 10 cm higher than just a century ago[22]. These are just some examples of our physiological features.

Our behaviors, our lifestyles, our way of interacting with the world and each other, our perception of others and ourselves have changed even more dramatically. Consider for example the advent of the internet and various digital tools. We have gained a revolutionary possibility to almost instantly answer almost any question that pops in our mind, find ways of solving most of new tasks or contact other members of our species regardless of their location and ours. We are vastly more informed, well-oriented in the surroundings and capable than any previous generation – so much so that *we would appear as "superhumans"* to our ancestors. Our height, life expectancy, resistance (survival) to disease, our knowledge about the world and thinking skills are also far beyond an average human 10,000 years ago. And we have achieved all these drastic changes without genome editing.

This raises an important question: what realistic changes to the genome could compete with the potential of other technological innovations? Take for example, the idea of mind-reading. It is simply unthinkable that it can ever be achieved through genome editing – not only do we lack the molecular understanding of brain function required,

[21] Average life expectancy across the whole world was 34.1 years in 1913 and 71.0 years in 2021 (https://ourworldindata.org/grapher/life-expectancy).

[22] World-average human height increased from 1896 to 1996: 162.5cm->171.3cm for men and 151.2cm->159.5cm for women (https://ourworldindata.org/human-height).

genome editing also cannot, for example, provide the medium for "transmission", it is very fundamentally limited. Meanwhile, the promises, and even early successes, of Neuralink[23] or similar technologies are drastically more powerful than any possible genetic modification. How would we possibly genetically modify an individual so that they can play a computer game with the "power of their mind" (Davies 2024)? Similarly, creating Douglas Adams' Babel Fish – a way to understand all languages – is simply impossible through genetic means. Yet, AI-powered translation tools have already achieved that goal for us. The list of such examples is vast.

Humans are fundamentally techno-social beings. Our tools, societal structures, and institutions are as much a part of our nature (Laland and Brown 2018; Bednar 2020) as our biological features, and even those are not fully determined by our genomes (Resnik and Vorhaus 2006). Unless one assumes that the genome is a magical, God-given essence, genetic modifications cannot pose a greater threat to our nature and our existence than other technologies. Genome editing influences human nature only insofar as it alters the features that are important to us, and even then, its impact is limited by comparison to the societal and technological shifts we have already embraced.

In summary, it seems that the common concern that human genome editing threatens to disrupt human nature does not withstand a closer dissection. While this view is intuitively attractive, it disregards the limited power of genome-editing technology, as well as the adaptability and techno-social component of human nature.

5. The Use of Totalitarian Scenarios

As argued above, both "creating superhumans" and "disrupting human nature" seem to require the establishment of a dystopian totalitarian regime with fully controlled reproduction. While a comprehensive analysis of such scenarios is beyond the scope of this paper, several considerations highlight the problems of using such hypothetical scenarios as a justification for fully banning genome editing rather than developing policies that focus on its potential misuses.

When discussing an installation of a strict totalitarian regime that goes as far as to strictly control reproduction and even enforce assisted reproduction and genome editing, we should critically examine what is actually being envisioned. A scenario often mentioned in the discussions surrounding genome editing and enhancement predicts that a totalitarian government could use this technology to create "superhumans" or, more commonly, "super-soldiers". However, we should ask: which government are we talking about? How, where and when does it emerge? What happens to their local legislation and the international law in the process? Can an international or local ban on genome editing prevent its use by totalitarian governments? These are critical issues often discussed in the context of warfare (Biberman 2021) and they should also be thought through when developing genome editing policies.

Despite the existence of global institutions such as the United Nations, and a number of international treaties, our planet is split into hundreds of governing bodies, i.e. countries, each with their own legislation. This, on one hand, hinders the establishment of a single global totalitarian government, but, on the other hand, complicates efforts to implement unified policies.

Currently, there is a global ban on heritable human genome editing, which reflects both the current lack of safety of the genome editing procedures and the ethical concerns, such as those examined in this paper. In the future, one can envision a more nuanced regulatory framework with heritable genome editing being generally permitted, but with firm restrictions applied to the type and specific uses of genome editing. One can argue that as soon as the international ban is lifted, some government will launch unrestricted human genome editing programs, but the case of the first genetically modified babies born in China in 2018 (Greely 2019) might suggest otherwise. Despite China's tensions with

[23] https://neuralink.com/

many Western Countries, and their often independent stance on global issues, the scientist who performed the unauthorized CRISPR/Cas9 heritable genome editing procedure, was condemned and prosecuted by Chinese authorities (Chen et al. 2020). This suggests that even politically autonomous nations might not support reckless use of human genome editing.

However, one might still suggest that a truly dystopian totalitarian government is yet to appear, and when it does, it could fully exploit genome editing for unethical purposes. This is a big and well-recognized challenge of regulating emerging technologies: rogue actors – be they terrorist organizations, rogue states, or authoritarian regimes – could misuse the technology regardless of international treaties or bans (Rayfuse 2017). This points to a broader problem: no policies can entirely eliminate the risk posed by malicious actors (Katagiri 2021).

To illustrate this issue, let us consider the following hypothetical chains of events:

Scenario 1: heritable genome editing is *permitted*.

1. The public and bioethical discourse concludes that genome editing *can be permitted*.
2. Genome editing is *permitted*.
3. The establishment of a totalitarian regime.
4. -
5. The totalitarian regime uses genome editing to create superhumans.
6. The consequences of the creation of superhumans.

Scenario 2: heritable genome editing is *banned*.

1. The public and bioethical discourse concludes that genome editing *cannot be permitted*.
2. Genome editing is *banned*.
3. The establishment of a totalitarian regime.
4. The totalitarian regime *lifts or simply ignores the ban on genome editing*.
5. The totalitarian regime uses genome editing to create superhumans.
6. The consequences of the creation of superhumans.

While it looks simplistic, spelling out these chains of events highlights that our public discourse and even the policy decisions might not be meaningful to prevent the totalitarian misuse scenarios used to justify the complete ban on genome editing. The question, then, is not whether totalitarian scenarios are theoretically possible but *whether they are practically significant to justify a complete ban on heritable genome editing* and whether unethical uses of genome editing envisioned in the totalitarian scenarios are a justified reason to deem the technology ethically unacceptable.

I argue that it is logically incoherent to extrapolate an ethical condemnation of a misuse of a certain technology onto the technology as a whole. Similarly, since policy decisions often reflect our ethical judgements and in the light of the arguments presented in this paper it seems unjustified to ban genome editing based on the possibility that a totalitarian government might misuse it for malicious purposes. That said, producing a structured and detailed policy specifying acceptable and unacceptable (i.e. permitted and banned) uses of human genome editing, will be possible and necessary in the future.

Finally, even a dystopian totalitarian government might not automatically decide to initiate a program to create genetically enhanced superhumans as its practicality is questionable. The reality one must not forget is that humans are not a quickly breeding species. Even if the technology and the knowledge needed for performing genetic enhancement were already available, producing genetically enhanced "super soldiers" today would only yield the desired result of actually having super soldiers at your service only in 20 years – a very long time in our world of exponential technological progress.

In conclusion, there are two main issues: 1) even if we ban genome editing as a whole to prevent its misuse for e.g. the creation of superhumans, a government, totalitarian enough to control reproduction, will not abide by any of our regulations, 2) even for a

dystopian regime, creating superhumans may be impractical – it is too slow. Thus, even a brief analysis reveals significant weaknesses in using a totalitarian scenario of the misuse of genome editing for threatening practices, such as the creation of superhumans, as a justification for banning regulated practices. Producing a *refined* policy that specifies permitted, and ethically acceptable, uses of genome editing seems to be a more rational way forward than banning the whole technology with a hope to prevent rouge actors from misusing it.

6. Conclusions

In this paper, I critically explored two existential concerns associated with human heritable genome editing: the emergence of "superhumans" and the "disruption of human nature". Although these fears are quite common in both public and academic discourse, they appear largely unfounded when evaluated through biological, philosophical, and practical lenses.

The "superhuman" concern implies that genetic enhancement could create a group of "superior" people that would form a distinct species that would pose significant threats to ordinary humans. In this paper, I argue that the creation of a new human species as a result of lifting the ban on genome editing is biologically unlikely because of the three main reasons: the vast genetic and phenotypic diversity between ordinary humans, the difficulty of achieving reproductive isolation crucial for forming a new species, and the diversity of enhancement modifications. Additionally, regardless of their species status, it is questionable that "superhumans" would become an organized threat to ordinary humans.

The concern that genome editing might "disrupt human nature" assumes that altering the genome sequence significantly changes what it means to be human, and it might change us too much. I argue that this is hindered by the difficulty of achieving ubiquitousness and uniformity of genetic modifications. Additionally, this paper argues that human nature is dynamic and influenced by culture and technology on par with genetics, while the history of profound changes in human traits and behaviors, achieved without genome editing, highlights that the fears of "disrupting human nature" might be exaggerated.

It seems that neither the emergence of "superhumans" nor the "disruption of human nature" is a realistic outcome of permitting heritable genome editing under current or foreseeable conditions. For these feared scenarios to occur, it would require a totalitarian regime with unprecedented control over human reproduction – a scenario much more catastrophic than the feared consequences of genetic enhancement. I suggest that such totalitarian scenarios, while commonly used in bioethical discussions, might not be useful for developing effective policies for regulating genome editing. I argue against extrapolating ethical and policy decisions we make about the potential misuses of genome editing, such as a possible totalitarian aspiration to create "superhumans", onto the technology as a whole.

This paper adds biological and practical perspectives to the bioethical debate surrounding human heritable genome editing and genetic enhancement, challenges exaggerated but common narratives and emphasizes the need for balanced, evidence-based approaches to both the ethical discussions and policy decisions on this topic.

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