Ideas, hopes, and fears: what young adults think about genome editing, nature, and society

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Abstract
Gene technologies are developing at a high speed. Yet, the understandings and ethical conceptions about these developments are not sufficiently scrutinized and reflected. Our qualitative analysis examines everyday myths of younger generations about genome editing; these contribute to a complex fabric of rationally and intuitively justified opinions on genome editing. We argue that current thought patterns and social ways of thinking co-constitute the everyday myths. On the basis of group discussions with teenagers and students about genome editing, we reconstruct their topical views of humanity, the world, science and technology, value orientations, fears, hopes, and desires that are connected to genome editing. Our focus is on everyday myths about health and nature (particularly the nature–culture dichotomy) as well as their implications for social developments in the times of genome editing. Among these developments feared by the young generations are first and foremost conceptions regarding population density, environmental destruction, family relationships, normalization processes, and nature as a fundamental normative authority. The juveniles and students also reflect abstract ideals, e.g., perfection and health, within their contexts, and demystify these ideals.

Keywords Genome editing · Nature · Health · Everyday myths · Young adults

This study aims to reconstruct information about the complex modes of thinking and the views of young generations on genetic engineering technologies and to include young people’s understandings in the discourse of genome editing.

As Francoise Baylis (2017) and others demand, we offer insights into the intuitive perceptions of gene technology by the public, particularly by young adults in Germany. Genome editing simplifies and radicalizes all processes of genetic engineering in medicine, plant and animal breeding. Societal discourses on genetic engineering affect
human self-concepts and are underpinned by pictures, metaphors, and ideas which add the required depth to the discourses, and which may also lead into fundamental aporias. Genome editing discourses are qualitatively different than other discourses on science and technology. Compared to discourses on the ecological crisis or nuclear power, for example, genome editing raises questions about human nature and its role in nature. Genome editing involves not only technological knowledge, responsibility, and ethics, but also a response to the (according to Kant) crucial question: “what is it to be human?”. Within these genome editing discourses, reflections on the relationship between humans and nature are more pertinent as the technological modifications of genes not only represent the scientific control of nature but at the same time affect human nature and hence human self-concept. In society, genetic engineering is a key technology regarding multiple aspects: scientific, economical, and—what is of particularly interest here—attitudes on techno-scientific developments, and this concerns the core of our question.

There is a lot of information about genome editing in the German public, with a full package of media coverage and popular science articles. Nevertheless, in Germany “so far, the public opinion about genome editing undertaken using CRISPR/Cas9 only plays a minor role in scientific and juridical debates and is almost unknown.” (BfR 2017), p. 5 translation by the authors. Some research has been conducted about how to involve public views on genome editing (Baylis 2019) and how the public is conceived in genome editing discourses (Meyer 2020). These studies do not particularly examine the understandings of genome editing among young generations. A few studies on school children have primarily examined pre-instructional conceptions on genes with the aim to develop educational methods and models that promise better learning success (Lewis, Leach, and Wood-Robinson 2000). Developing technologies like genome editing harbor profound opportunities as well as wide-ranging threats, and deeply concern the future of younger generations. Therefore, our study addresses the understandings and attitudes of young adults to genome editing. In light of the central role of genome editing for interpretative patterns with respect to the technical and scientific development of modern societies, the insights of our study are not only significant for attitudes on genetic engineering itself, but also for the assessment and acceptance of technosciences more generally.

Our analysis of young adults’ everyday myths is concerned with the recent procedures of genome editing. Based on sociocultural theories, we reconstruct topical understandings of humanity and the world, value orientations, fears, hopes, and desires as well as current thought patterns and social ways of thinking that co-constitute these everyday myths and hence contribute to the complex fabric of rationally and intuitively justified opinions on gene technology. Our attention is focused on everyday myths concerning health and nature and related implications for social developments at a time of genome editing, such as conceptions regarding population density, environmental destruction, family relationships, and normalization processes. Other ideas we reconstructed, such as changing moral values, human rights, the autonomous self, egoism and altruism, humility, and compassion, will be put aside in this paper. A pivotal point will be the nature–culture dichotomy and its partial disintegration.

We compare aspects of our findings to results of an earlier study by Ulrich Gebhard on everyday myths in order to find out if young people express the same everyday myths after more than 10 years of public debates on genome editing, if everyday myths shift, or if we find new ones. At the beginning of the twenty-first century, the promise of salvation, to create a “healthy humanity” using gene technology, was a key part of the implicit views of humanity and the world held by adolescents (Gebhard 2004). Connected with this promise of salvation were the topics disease and death as well as nature and religion.
technology also posed moral challenges to the adolescents and presented at times irresolvable contradictions, arising from the dichotomy of nature and culture as perceived in the minds of the adolescents.

**Theoretical framework**

**Everyday myths**

Gene technology triggers a wide range of ideas, fantasies, hopes, and fears that may be conscious as well as latent. In order to investigate students’ and adolescents’ understanding of and their thinking about genome editing, we adopted the concept of “everyday myths,” which is based on culturally imparted ideas of humankind and the world (Gebhard 2000a, b). Gebhard (1999) established this concept in 1999 by combining the concept of everyday ideas (Barthes, 1964) with social intuitive approaches as well as moral, social, and cultural psychological concepts. It also includes didactic studies and proposes a method to integrate intuitive ideas and beliefs into learning processes. In our study, we analyze everyday myths as spontaneously available background knowledge that underlie our daily practices (Wagner 1994) and that feed routinely on latent images, similar to what Levi-Strauss (1966) called “savage mind.” As “impulsive thinking” (Strack and Deutsch 2004), it activates memory contents directly at the time of perception and leads to intuitive judgments. We believe that everyday myths play an important role in technology assessments. Genome editing, for example, can instantly evoke the idea of a sacrosanct nature that results in an attitude that refuses gene technology without conscious reflection upon it (Gebhard 2000a, b). Everyday myths are somewhat intuitive or unconscious cognitions. They are closer to emotions than conscious representations but are not identical to emotions.

According to the social-intuitionist approach, intuitive ideas shape moral judgments in a crucial way (Haidt 2001). Moral judgments are justified on a rational basis only after intuitive ideas and associations have already triggered them. Jonathan Haidt’s model of moral judgment rejects the equation of moral judgment with the ideal of unaffected truth-searching. Human beings do not judge as isolated individuals. Embedded in the social context of the subject and the object of judgment, the reasons for the judgment often have an indirect origin and effect: Humans possess a comprehensive pool of culturally passed-on convictions and automatically draw on “a priori causal theories” (Haidt 2001, p. 822) when they are asked to justify their intuitions. Haidt also states that judging a situation or an issue has to be understood as a socially influenced process.

The concept of everyday myths suggests understanding rational scientific concepts and everyday ideas as complementary rationalities. Following Roland Barthes (1957), Gebhard regards everyday ideas as everyday myths (Gebhard 2004) which feed on pre-rational sources, on collective cultural pictures (Grize 1989), and on latent thinking structures. According to Grize, these pictures are the mainstays of discourses and convey cultural and social concepts, implicit images of the world. Everyday myths have been proven to affect learning processes as well as opinion-making (Oschatz 2011).

We assume that everyday myths function as an implicit, preconscious source, co-constituting the ethical reasoning and assessment of techno-scientific developments. On a symbolic level, genome editing carries different meanings that activate diverse ideas, hopes, and fears about science and technology. In our analysis, we empirically reconstruct everyday myths about genome editing and argue that they affect the discourses of
genome editing. Hence, these culturally produced images have to be considered in public discourses.

**Nature and culture**

Gene technology touches the core of life and of nature; in particular, genome editing raises questions about the relation of nature and people. It evokes the bipolar structure of nature and culture, a classic antinomy of Western societies (Eser and Potthast 1999) and well-documented, diverse, and ambivalent relationships of humans with nature. For example, Ernst Oldemeyer argued in the light of a diverse understanding of nature for a perspective that conceptualizes nature as always already defined by humans (Oldemeyer 1983). Gernot Böhme argued 30 years ago for a timely philosophy of nature by developing an aesthetic of artificial nature (Böhme 1992). Smillo Ebeling found ambivalent concepts of nature as pristine, wild, and undisturbed as well as manufactured and culturally mediated (Ebeling 2017).

Based on the Habermasian conjecture on “The Future of Human Nature,” human nature has become an important point of reference for self-interpretation of humanity. Jürgen Habermas points to “the inconspicuous normative interplay between the inviolability of the person, which is imperative on moral grounds and subject to legal guarantees, and the natural mode of the person’s physical embodiment” (Habermas 2001, p. 41; translation by the authors). According to Helmuth Plessner, humans are able to develop and invent things, and thus, they naturally change nature and themselves. Humans’ “natural artificiality” results in them being only “half natural,” and thus, they are “in need of supplementation” through culture (Plessner 1965, p. 321; translation by the authors). Concerning the topic of genetic engineering, the antinomy of humans’ “natural artificiality” was already identified by Gebhard in 2004, where the participants conceptualized people in an established dialectic way as a part of nature and as distinct from nature (Gebhard 2004): Humans exist within a double nature as biological beings rooted in evolution on the one hand and as cultural and spiritual beings on the other. However, within this understanding of humankind, another aspect became effective: nature functions as a norm, providing orientation (see also Gebhard 2000a, b, 2015).

One interesting question is whether the antinomy will dissolve or whether it will be even more difficult to deal with in the context of recent debates, in which nature and culture are no longer oppositional concepts. Historian of science Donna Haraway argues that nature and culture are in confluence and suggested the term “naturecultures” (Haraway, 2003). From a range of perspectives, other scholars conceptualize “the age after nature” (Böhme 2017). Art historian Frank Fehrenbach (2018) argues that human civilization took over nature completely; there is not a single spot of unspoilt nature left on Earth.

One crucial aspect within this dialectic understanding of nature and culture is the practice of reading moral order from natural order. According to science historian Lorraine Daston, there is not even one good philosophical argument to reason from natural order to moral order. Despite the knowledge about this so-called naturalistic fallacy, people have established nature as a prefiguration of values. Daston argues that this practice is due to human rational tendencies and capabilities: Humans are prone to orders, norms, and normalizations, because these are strong vehicles for helping prevent chaos. Hence, the core of human intuition is a drive to identify order. Since people experience order at most in contact with natural phenomena, the quest for order and values in nature is one of the deepest human intuitions (Daston 2018).
In modern times, DNA represents an inherent natural order of living beings. In accordance with the twofold meaning of a “norm,” DNA determines the characteristics people have and how things are and also the characteristics things shall have (Daston, 2018). Natural genetic order offers a variety of (contradictive) norms. For example, genetics is used to advocate for social Darwinism as well as for human rights. Violations of natural order may cause nature’s revenge and chaos. Consequently, genome editing is understood as a violation of nature’s order (Daston 2018).

If this was true for the participants in our study, genome editing may trigger a fear of chaos. We analyze what happens to the dialectic relation of nature and humans and to the practice of reading moral norms from nature in the context of genome editing.

**Methods**

We reconstructed everyday myths about genome editing using the qualitative method of group discussions. We conducted and audio-recorded 20 group discussions between April 2017 and August 2019, which varied in duration from 18 to 44 min. Eight group discussions were conducted with university students in biology, bioinformatics, history, language, medicine, and psychology, and 12 group discussions with secondary school pupils. In total, 40 students in the age range of 20–24 years, who had completed their first semesters, and 57 pupils in the age range of 16–18 years took part in the discussions. We consulted these participants as a group of young adults and didn’t differentiate between pupils and university students. We are aware that our group discussions took place under specific conditions, namely involving adolescents with good levels of education in Germany, a rich and industrialized country in Central Europe. The groups were heterogeneous in the sense that the participants expressed different religious beliefs, cultural backgrounds, and family structures. Since we presume that everyday myths are culturally produced, our findings are not intended to generalize for young adults in general. They are only valid for the mentioned sociocultural frame.

To stimulate these discussions, we read a short dilemma story about genome therapy in germ cells to the participants prior to their discussions. In this story, an 18-year-old woman and a 20-year-old man discuss their divergent, but justifiable positions on genome editing controversially and without agreement. They are talking about her aunt, who has a hereditary predisposition for leukemia and is frightened of bequeathing this predisposition to her children. The woman and the man exchange some arguments for and against genome editing, which allows to eliminate the predisposition for leukemia in the embryo’s genome. Their arguments range from the successful elimination of a genetic disease versus irresponsible changes to human DNA and possible side effects.

After presenting this dilemma to the participants, they talked about whether they would use genome editing or not and thereby discussed their own opinion on this dilemma. The discussions followed the criteria of “Selbstläufigkeit” (“self-regulation”) and of non-directive conversation techniques (Loos and Schäffer 2001). In other words, the moderators structured the discussion as little as possible and only intervened when the participants veered way off topic. The benefit of this method is that the discussion resembles everyday communications and that the participants are free and able to express personally significant and intuitive thoughts.

Group discussions have been proven to be a particularly useful method to inquire into contradictions, social negotiations, and personal issues (Billmann-Mahecha and Gebhard
The discussions were transcribed and the data analyzed according to the Grounded Theory Methodology (GTM) (Glaser and Strauss 2008). GTM is applicable for our study, since it allows researchers to understand basic (social) phenomena and behavior patterns. GTM does not only recover already known phenomena in the scrutinized data, but its openness allows the reconstruction of new understandings and “theories.” Another crucial reason for using GTM in our study is that it refers to the basic presumptions of pragmatism und symbolic interactionism. It considers reality as a process that emerges by performative actions (Corbin and Strauss 2015) and it does not assume only rational and purposeful action of individuals but takes non-rational routines into account. In our first step, we analyzed the recorded group discussions by indicating the participant’s ideas and concepts with codes, which we grouped into categories (open and axial coding). Therefore, we identified everyday myths about genome editing. We conducted this procedure in multiple cycles up to the point of theoretical saturation and subsequently analyzed the everyday myths of genome editing. All group discussions were analyzed twice, and the findings were put into correlation. We did not determine an interrater reliability.

Data description and interpretation

In this section, we will describe and interpret some of the everyday myths we found in our data. We organized them according to themes.

Everyday myths about health, disease, death, and immortality

The participants adopted in all group discussions the idea that genome editing will be a biomedical technical device against genetically caused diseases. For this reason, we took the notion of a healthy humankind as a starting point for this paper and analyzed the everyday myths with the question: What imaginations about humankind, nature, and society unfold in the participants’ statements when they think about genetically engineered health?

Health and diseases In Gebhard’s (2004) study, participants understood genome editing as a promise for “healing all diseases,” i.e., a secular promise of salvation, to be accomplished by science, technology, and administration (Gebhard 2004). Our data confirm Gebhard’s insight that health serves as a positively associated complex for the acceptance of modern biotechnologies: In every group discussion, health signifies a high standard of living and to accomplish it by genome editing is understood as a desirable Utopia; genome editing is assessed to be a good and valuable tool to erase disease. For example, one student said: “I really like this possibility. Because diseases like these, that are hereditary, could be eliminated.”

Very often, the participants confine their own positive statements about genome editing by adding counterarguments that they introduce with a “but”—and this is also a novel

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They do not take the promise of absolute health as a detached category but bring in diverse contexts such as unknown risks, abuses of genome editing for political or economic reasons, or acting against nature. These contexts confine the promise of health and transform the utopian idea of a healthy humankind into dystopian imaginations. The participants express this structure so often that we regard it as a fundamental way of arguing. Here is one example—more can be found throughout this paper: “I would like the possibility to fight or to avoid those diseases […] but design children are not acceptable.”

The ideal of health is an abstract concept that does not succeed in practice in the participants’ views. They deconstruct the promise of health achieved by genome editing, while discussing this abstract ideal in its social, cultural, and everyday life contexts. Throughout the paper, we will see more of such demystifying arguments.

### Immortality and death

Life without disease consequently leads to immortality—an old Western utopia. In 2004, the adolescents discussed immortality as a positive feature and release from death. Yet, they imagined it simultaneously as a spell, a burden of an insecure endless future (Gebhard 2004). In our recent data, many participants describe genetically induced immortality also in a negative way, though differently. They question the utopian idea of a healthy and immortal humanity by arguing that disease and death are part of life given by nature: “I feel too that death is something natural […] I feel that death simply belongs here” and “[…] then you just get to the point where people are immortal […] and that is no longer natural.”

Here, immortality does not stand for the Christian idea of humans’ triumph over nature. Instead of a proud victory, it is perceived as a sinful breach of a fundamental taboo. The participants deprive the ideal of immortality of its mystique by arguing with nature as an irrefutable authority that decides on disease and death. It is more important to accept nature than to overcome it by superseding death, which, according to social psychologist Luigi di Marchi (1988), is the origin of culture. The participants explicitly regard genome editing to be a cultural technology that represents progress and that may be helpful in general, but, on an implicit level, genome editing represents an offence against nature.

Since the idea of nature as a powerful authority seems to be crucial for the participants’ thinking of genome editing, we will take a closer look at their everyday myths about nature.

### Everyday myths about nature

Inevitably, genome editing raises questions about the relation of nature and people. In all discussion groups, the participants raised the central issue: “Does genome technology act against nature or is it part of nature?” and linked it to the question as to whether it is morally legitimate for people to change nature by abolishing disease. This illustrates the participants’ struggle with the bipolar structure of nature and culture.

### Nature as a sacrosanct authority

Here, we focus in detail on how the adolescents conceptualize nature in a twofold way as an authority that describes the status quo of things and, simultaneously, as a morally indiscernible authority.

As we have seen above, the participants understand disease and death to be given by nature. Even if disease and death may be cruel, humans are at the mercy of nature and have to accept and follow its rules. This fits Daston’s argument that nature always provides order and that nature always simultaneously determines what is and what has to be (Daston
In this regard, one participant stated, for example, “[…] illnesses are just part of life. And they belong to it so that one sometimes gets kidney failure or something and dies of it, because that is nature, that is what happens and you can’t do much about it.” This understanding is very frequently expressed in every group discussion. Another feature of nature in most participants’ minds is that nature arranged everything in the best way. She is perfect, puts all living beings in a natural balance of healthy and sick organisms. For this reason, humans are not allowed to interfere in nature, not even to erase diseases or to prevent death and suffering: “[…] that [evolution] has functioned well and so we were created. And why do you then want to interfere in a process that functions so well in nature that there are such complex beings as we are?”.

Since nature creates a perfect world, humans emulate nature by seeking perfection when they try to eliminate diseases by genome editing. With respect to the question about the significance of nature, participants often explain in different words that “it would just mean that we would play the role of the creator and then make the world perfect, just as we would like it.”

Many participants also assign natural, necessary functions to disease and death. They understand diseases as a tool of selection, as nature’s device. To heal and to prevent diseases means eliminating natural functions. Human interventions into natural laws, like natural selection, will destroy natural balances. Since genes are understood as nature’s core unit, genome editing intervenes at a very basic level in nature (see also section “Everyday myths about genes”). For example, one participant stated:

I think that humankind should not go so far as to somehow intervene into the basic module, somehow genetically or so […] there is natural selection and there are natural behaviors that somehow ensure that humans decrease in numbers and that there are diseases which are meaningful.

Nature is also frequently depicted as “omniscient in every group discussion:” Nature cannot be fooled. She is able to sense all transformations made by humans and does not tolerate those changes. People may not recognize nature’s knowledge; its wisdom is invisible to humans: “But it could also be that a woman’s body says that it is not natural and is aware that there could be complications with the birth or during pregnancy and that could then also perhaps be dangerous.”

The idea of an omniscient nature is combined with the fear of nature’s revenge for violations of its will. According to Daston (2018), the idea of nature’s revenge only makes sense in those cases in which people are guilty due to specific reasons, such as hubris, greed, or sloppiness. Since a lot of our participants blamed people for those and other reasons (like selfishness), the idea of an avenging nature fits precisely. It implies that nature has its own will, to which people should not object. People must respect nature, and it would be damnable to assert the human will (Daston 2018). Here are two examples from our group discussions: […] we should not meddle with nature […] if we continue to meddle, this could perhaps lead sometime to serious consequences” and “But we know anyway that nature will eventually fight back.”

In our data, this reasoning is mediated by the traditional Western image of nature as female. The above-mentioned quote (“But it could also be that a woman’s body …”) is one of a small number of expressions that depict the female body as a representation of nature and subverts genome editing. Here, the fundamental bipolar structure of female and male supports the divide of nature and culture. This bipolar structure is a crucial conceptual framework for the participants’ thinking about genome editing and requires them to position humankind within or outside of nature.
The participants also often claim that natural selection, diseases, and death are a matter of fate. Destiny is something the participants seem to be willing to accept: “It is simply fate. We should not meddle with people’s fate, just because we want to do so.”

In contrast, most participants believe genome editing enables parents, rich people, companies, and governments to design humans according to their own wishes:

[…] one is designed for farm work perhaps, built more sturdily, able to work longer hours, etc., already with agricultural knowledge and another can work in a mine for instance, while the next can be a good researcher and so on.

Genome editing transforms fate into an individual agenda. By designing children, soldiers, or specialized workers, people act in a targeted manner, according to their own selfish interests, and thereby move nature’s principle of fortuity into one of design and control. Self-interest and arbitrariness seem to be crucial for the participants in every group discussion. They seem to be more likely to accept severe diseases, as long as they are due to natural chance instead to individual interest. Nature, a lot of them argue, provides everyone with the same chances. The moral values of justice and equality are provided by nature’s principles: “[…] it is simply fate how you are borne. […] It is exactly the same with a disease. It is destiny.”

In various images, nature is depicted as being stronger than people are and invincible. Whatever humans do, nature will be stronger than humans—as one participant explained: “And now there are already super-resistant [antibiotic bacteria]. Nature always keeps up.”

Some participants regard nature not only as an abstract category, but also as the physical planet Earth. In their minds, the Earth is overloaded and suffers from overpopulation and its impacts. They believe that genome editing will enhance the damages and dangers to planet Earth and imagine a destructive humankind that will devastate Earth and consequently humankind too. Since genome editing would transform humankind into a burden for planet Earth, it would even be an environmental solution to extinguish the human race. Genome editing, they argue, disturbs the equilibrium of a decent population and will result in an imbalance: “[…] this natural scheme, death and birth will be out of balance […], if we could cut out diseases in genes […] the population will increase even stronger.”

In the shape of the harmonic, self-regulating planet Earth, nature takes its revenge for violating the “local natures” (Daston 2018) and humans may then even deserve to go extinct: “[…] the whole planet is fundamentally suffering already under our influence. […] If we eliminate ourselves completely from the gene pool, perhaps it would not be such a bad thing.”

Intermediate result All these ideas of a given nature provide nature with the status of a sacrosanct authority. Nature reigns according to its own will, it knows everything, and does everything perfectly. Nature is like an invisible force that cannot be grasped; it acts from nowhere. It presents itself in diseases, evolution, animals, and genes. People have to respect and accept nature and have to devotedly follow its rules; otherwise, nature will take its revenge. These ideas resemble a religious understanding of nature: Nature is given by God and represents His will. Therefore, it is not so much nature’s, but God’s authority that people have to follow (Daston 2018). According to such a metaphysical understanding of nature, acting against nature’s rules and norms has a threatening character.

In 2004, the participants also expressed this metaphysical understanding of nature. In our recent study, we reconstructed their everyday myths concerning nature in more detail and found that genome editing implies imitating and violating nature as well as substituting
nature’s will by people’s will, for personal interest. Against this background, it seems difficult for the participants to express a distinct positive attitude to genome editing. One consequence of altering genes and mimicking or taking over nature’s role is that people lose nature as an authority. According to Daston (2018), such a tremendous loss of the main source for norms and values would make way for instability and chaos. These strong dimensions of nature might inform the participants’ basic mindsets about genes and genome editing.

**Everyday myth about genes**

The gene and the mind were two key elements in every group discussion. As we have seen, genes represent a core element of nature and to edit genes means to violate nature’s inert order. The human mind is understood as a result of evolution that enables humans to develop gene technologies. In this regard, genome editing is natural and legitimate. But the participants also argue that the mind allows people to interfere with nature and thereby leave the natural realm. We will take a closer look at these ambivalent understandings of genetic editing.

The participants’ opinion that nature is represented by physical structures, like genes, fits Daston’s (2018) argument that DNA represents the old idea of an inert, naturally given order, a “specific nature” that defines what things are and how they behave. Genes are regarded as very special representatives of nature. Many participants describe them as “basic elements” of life. For example, one participant said “[…] but to tamper with a child’s genetics is really so profound that it is no longer only a slight alteration but it physically changes the basic human structure.”

Along with this understanding of genes as the “natural” basic realm, genetically caused diseases are perceived as part of natural selection. From this perspective, interference in a given genetic makeup is equal to crossing a border. This border separates acceptable and forbidden practices as well as nature’s and people’s spheres of action. Crossing this border means entering a forbidden realm of nature. It seems to be a frightening act that will result in boundlessness and uncertainty. People will lose their structures to hold onto. One participant’s statement may illustrate this idea: “[…] changing a person’s DNA is really something profound and it is a really major border that is crossed and that is just the start, then you really don’t know what will come next—that’s quite frightening.” Daston (2018) suggests that looking for order and norms in nature is one of the deepest and strongest intuitions of people. Hence, genome editing is an act against this intuition and will take away the natural order.

As seen above, within the interpretation frame of a bipolar concept of nature and culture most participants conceive humans simultaneously as biological, natural beings and as historical, cultural, and spiritual beings. Related to this understanding is the image of a human being torn between liberating curiosity, self-enlightenment, and the quest for knowledge and power on the one hand and sacrilegious border crossing on the other. The quest for knowledge and the attained perceptions transcend humans from their natural background to a historical and cultural being. As some participants imply, the human mode of existence is a result of a natural development, i.e., their practical intelligence, their ability to change nature, and their position in the biological taxon Homo as a sagacious human:

[…] one can even say that it is almost a part of evolution that humans have developed to such an extent that it is possible to intervene. Then it is not even interfering with evolution, but simply a necessary step.
Hence, it seems “natural” that people are not helplessly at nature’s mercy, but able to change natural processes. Due to the naturally evolved human mind and culture, people’s ability to eliminate diseases by gene technologies and to change nature is morally legitimate. Here again, the participants simultaneously imply that people are separate from nature by frequently speaking of “interventions into nature.” They very often conceptualize both as distinct parts: “Well, I believe that the world, the Earth, simply has a system for life and death and illness and death that all belongs to it. And I do not think we should interfere with it.”

Fittingly to the idea of an intervention into nature on the genetic level, genetically transformed people are, as some participants express it, excluded from nature and even lose their affiliation to humankind: “[…] for me, such a genetically engineered child is not a real human being, […] not a natural human being conceived naturally.”

The ideas about the mind and the genes associate the Christian narrative of Adam and Eve’s expulsion from paradise. Our results contain an ambivalent understanding of the desire for knowledge as a sin and as relatable. In the bible, the banishment from Paradise ends the harmonious human nature relationship. Similarly, the participants interpret humans’ exclusion from the natural cycle as a result of uncovering the genetic structure and—even more so—of the intervention in the genetic structure. Against this background, biting into the “genetic apple” has, at least in the fantasy of the young adults, consequences similar to the Fall from Grace. Ironically, it is the human mind, the highly appreciated and valued feature that leads to the exclusion of genetically transformed people from nature.

So far, the participants’ understanding of genes and genome editing is informed by overlapping biological, nature-religious, Christian, environmental, and sociocultural discourses: expulsion from Paradise, nature as a balanced system, humans destroying the Earth, and humans as part of nature. The last aspect was already reconstructed by Gebhard (2004). Genome editing transgresses these fundamental ideas of nature and triggers further implications for nature.

**Everyday myths about genome editing and implications for society**

In this section, we scrutinize implications of the participants’ understanding of genome editing for societal units, structures, and relations, all of which are new aspects compared to Gebhard (2004). These effects will have consequences for the nature-culture divide, i.e., culture absorbs nature, and nature and culture merge.

**Overpopulation** In the participants’ view, genome editing promises a healthy humanity. However, if humans become immortal, planet Earth and people would suffer from overpopulation. As seen above, the abstract concept of immortality has a positive dimension, but frightens the participants in the face of practical aspects. Immortality would strain limited natural resources on Earth. Diseases naturally deter overpopulation. These ideas imply a social Darwinist perspective, about which the participants in every group discussion feel bad because it is cruel to sick people and because it opposes medical ethics. Their fear of overpopulation is inspired by contradictory evolutionary, environmental, and ethical discourses, for example:

[…] there is this overpopulation […] now we can be mean and say that humans generally have a right to live. Yes, that’s right but one has to say that ultimately there is a reason why there are things like diseases.
Money and utility maximization  The fear of amplifying overpopulation is informed by evolutionary theories. People will have to compete financially for genome editing, and rich people will therefore be at an advantage and “the fittest.” Very often the participants state that money will become the crucial resource and together, money and genome editing become part of the evolutionary mechanism. One participant said, for example: “[…] only the richest of the rich will be allowed to have children.”

In many group discussions, we found that Homo economicus operates by natural mechanisms, too. Here, nature and culture come together in the sense of Haraway’s “naturecultures.” Genome editing operates as a function of a natural mechanism and money is a part in the “survival of the fittest.” People’s directions of economic interest and profiteering (utility maximization) are turned into nature’s principle of the “survival of the fittest.” Darwin’s evolutionary theory was inspired by the economic theories of British political economist Thomas Robert Malthus; now the evolutionary theory informs societal developments. Money is the crucial criterion for people’s decisions and wins over moral values. Money and nature conflate and rule the world. Since, as many participants state, in times of genome editing Homo economicus will broaden the gap between sick and healthy, poor and rich, neediness and abundance, low and high quality of life, genome editing will increase injustice. For example, one participant said:

[…] a tremendous progress […] that will only attract rich people […] there will be an even more blatant division of society into poor and rich than we have now. Since the rich will be better and better and will get constantly better physical conditions, they will get smarter just by genes.

Moreover, a lot of the participants are concerned that the anticipated revenge for interfering in nature will hit poor people first; rich people might be touched indirectly in the case of civil wars or a collapse of the Earth. Some participants vaguely suggest overpopulation triggers images of floods of negative societal developments; in more specific ideas, it will harm the retirement system, broaden the gap between rich and poor, lead to state birth control, or end in civil war. Two statements document this idea:

Now with pensions too. We already have far too many old people and too few young people who can finance it. If everyone lives longer and then with fewer children, as is recently the case, that will also lead to a certain amount of poverty, at least for the middle class

and:

That would probably lead to a civil war […].

Unequal conditions and social structures The participants mention the broadening gap between rich and poor very often. Their idea is based on unequal conditions and fostered by overpopulation due to genome editing: Only rich people will be able to afford genome editing, and hence, only “the rich” will be healthy and immortal, will enhance their physical and mental traits and the abilities of their children, and will make themselves more beautiful, strong, efficient, and intelligent. Poor people will be used by the rich people, who will cultivate specific types of workers by genome editing, such as farmers and mineworkers or fearless and painless soldiers ready to fight. In the long run, genome editing will foster unequal economic conditions and unfair societal structures. Many participants imagine an impoverishment combined with abuse of genome editing by rich
people: “[…] the rich would be genetically modified and the poor completely relegated to simply being workers. […] The gap between poor and rich would become even bigger.”

**Parental care and love, kinship, and family bonding** Many participants regard the wish to have children as well as a specific type of parental care as self-evident, natural features. In order to raise understanding and sympathy for using genome editing, they argue with the parents’ wish to do everything for their children, as if the parents’ feelings for their genetically related children are naturally given. Implicitly, these parental feelings seem to be commonly accepted, so that everybody has to understand and to agree to genome editing. One participant stated, for example, “[…] when you know, as a parent, that your child is in any way sick, then you try everything to save the child […]”

In the face of this concept of parental care, dystopian societal developments due to genome editing seem to be less important. Moreover, the participants’ reasoning about parental feelings implies that the desire to have genetically related children is of such a high societal value that it serves as a strong argument for genome editing. Some participants even use parental feelings as a rhetorical device to underline the argument for genome editing: They ask other participants to think in the shoes of affected people and hence address their deepest convictions. They build on the persuasiveness of compassion and understanding: “When you will become a father, what I hope for you, you may be able to understand the opinion [that genome editing is helpful].”

The idea of an unconditional parental love is often conceptualized to be biologically given by many participants. It is connected to the moral value that every person has to be loved as she/he is born and hence as they are made “by nature.” These established common grounds and values based on nature will change in times of genome editing. Many participants fear that parents would no longer love their children unconditionally for their natural personality or individual character, regardless of their features and capabilities. Instead, parents would emotionally distance themselves and value their children only for specific features and the children would have to be exactly like their parents “ordered” them. Genome editing will commodify the desire to have children, which will finally result in dehumanization and the disappearance of the natural parental drive to care. Two participants said, for instance:

[…] I find it a little sad to pick your children like you want them to look like in a catalog

and:

It would somehow be like buying shoes online and then at some point you don’t like them any longer […] now you want something else.

Genome editing would transform a naturally given, bio-genetic kinship into a performance principle. The participants fear that they would not satisfy the parental expectations of perfection—aspects that have often been part of parent–child relations, but not yet in this commercial manner:

parents will have too high expectations, they know, we have edited this smart child and enroll it in various classes […] that it may not be able to live […] they will patronize it from the beginning […] the child has to be sensible, that’s what I paid for.
It seems that the “naturally given” bio-genetic kinship and unconditional love threaten to lose force in the face of the commodification of children. All group discussions suggested that, separate from commodification, the technology of genome editing itself would eliminate the concept of bio-genetic kinship. Along with this shift, the reliability and commitment of kinship would shrink. Nature no longer irrevocably provides any foundations for kinship and family bonding. Nature is worn out. Many participants seem to regard the shrinking of a biologically founded family bonding as a great deprivation:

[…] then you are actually no longer the child of X and Y, but you are what was in the Petri dish. So, because you are no longer a part of […] but you no longer have your father’s protruding ear […] you can no longer say: I can identify somehow with my parents. […] You don’t know: am I adopted? Do I belong to my parents? I can’t see any similarity. Perhaps I can’t identify myself with them.

The participants dislike the idea that genome editing would enable parents to gene-edit their children for a variety of different features they want their children to have. This may be external features, like eye color, hair color, and body size, or intelligence, and sportiness. They often find it dangerous and abusive that parents “play nature” by designing children and are apprehensive that parents won’t have to accept and love their children any longer as nature made them: “It would have to be very strictly controlled as there are certain people who would misuse this, the law and then make an elite baby […]”

Many participants link their rejection of gene-edited children with the idea that parents would treasure beauty features and external attributes more than inner values and declare this practice as superficial and abusive. The ability to change inborn features threatens them. Moreover, changing the valuation from personal characteristics to superficial beauty features is even more threatening, because to a certain degree people are already used to changing beauty aspects or to enhancing their physical appearance. “Inborn” personalities and inner qualities are in the words of the participants simply as they are, the last bastion that is not subjected to changes. Nature is responsible for these traits. Two statements document this understanding: “Parents should love their children as they are” and “Everybody is like he/she is and nobody should change this.”

For some participants, genome editing will make people responsible, not only for their health conditions and physical appearance, but also for their personalities. Parents would genetically alter and equip their children with physical and intellectual traits and hence would get a new responsibility and duty that previously belonged to nature. Parents take over nature. Participants commented: “[…] but if the eye color is to be changed, that is superficial and would also be a sort of misuse. I fear for the future.”

By quoting blue eyes and blonde hair in this combination, which happens often in the group discussions, the participants implicitly underline their negative implications of genome editing with associations of the German National Socialist regime. Some participants explicate that it is dangerous for society to change and homogenize natural human traits by genome editing:

It could, for example, also be misused by ideologies like the Third Reich, the Nazi regime. Hitler himself also tried to create a homogenous generation. […] And that, for instance, would have been possible with this. Naturally, it would have had fatal consequences because society would have been destroyed.

They associate genome editing with genocide, crime against humankind, world wars, dictatorship, and mass delusion. These associations function like a warning to be careful about such crimes and disaster and not to follow the wrong ideals.
Childhood Some participants explicitly worry about changes in their concept of childhood: This seemingly naturally given time of development, maturation, and play would also change, since children would be expected to be perfect in every regard from the day they are born. Childhood would lose its eligibility and culture would overrule nature:

But the child will perhaps have no more childhood [...] and then if you can already walk when you are born [...] then somehow a piece of childhood is lost [...], if you can no longer be a child because you must always be able to do everything perfectly straight away [...].

So far, the participants imagine a society in which genome editing transforms nature and naturally given things into cultural products. In their imaginations, culture transforms, substitutes, and takes over nature. The lost natural dimensions are unconditional parental love, the love for people’s personality, the genetically rooted family, a childhood with time to play and develop, and inner qualities. Hence, fundamental societal units, values, and emotional bondings would be strongly affected by genome editing. By understanding these units as naturally given, the participants conceptualize them as providing safety and certainty, all of which would disappear in times of genome editing. The only stable natural dimension would be the desire to have a child and the drive to take care for it by every possible means. According to the participants, these natural emotions legitimize genome editing.

Individuality, uniqueness, and perfection In every group discussion, the participants appreciate individuality and diversity as natural human features and as important values. This collides with the culturally informed parents’ wishes to have “the best” and a unique child. To get such a child, parents paradoxically follow socially and culturally accepted ideal types and norms—sometimes mediated by medicine—that inform the ideas of what is “the best” and “unique” child instead of choosing the unique features of their children by themselves. Hence, parents’ desires for unique children ironically result in homogeneous children. Genome editing, as some participants state, would enable parents to design their “best child” and threaten to cause the natural uniqueness of a person as well as the natural diversity of humankind to vanish. Hence, there are two naturally given and precious values at stake. One participant said, for example:

It can lead to a time when all people are very similar. I mean, everyone will want the best child. No one will want a child who has problems or faults. Then at some point everyone will be the same and the individuality that we have will be lost.

The loss of individuality and uniqueness is entangled with two different meanings of perfection expressed by the participants. One concept of perfection states that nature arranged everything best, including flaws and weakness, which are necessary for the natural balance (see above). Many participants value those natural flaws and appreciate the concept of “natural perfection.”

The other concept refers to people’s idea of flawless perfection. Genome editing helps to create this kind of perfection and eliminates natural flaws. Most participants neither really share the economic ideal of perfectly adapted workers and employees and of a life without diseases, nor the abstract concept of perfection. On the contrary, they imagine negative developments for society, for example, a societal gap, exclusion and degrading, loss of childhood, boundlessness and voracity, and homogenization. As in the cases of the promise
of salvation and of immortality, the abstract concept of perfection turns negative when put into practice. Perfection is disenchanted. For example, one participant said:

[…] then there will perhaps also be a two-class society—the perfect and the not perfect—and I can imagine this would be really, really bad […] and that there would really be a dividing line between the two. Something like it is now between humans and animals.

**Normality** The participants describe a shift in what counts as “normal.” They position “normal” and “artificial” people as opposites. Nowadays, “normal” people are those who develop naturally and by chance and who are flawed and unique. In the future, the participants imagine, genetically engineered humans will be created at the whim of people with decision-making power. Those people would be perfect in their outwardness, cognitive, and physical traits, and also uniform. Genome editing will become the new normal norm, and “naturally developed” people will be degraded and discriminated against—and become the “abnormal.” The essential feature of “normal” will no longer be naturalness, but an arithmetic one. This feature will establish itself by social mechanisms of exclusion and inclusion, i.e., by social pressure and habituation, as well as by natural selection. Nature and culture normalize. A participant stated: “[…] if everyone becomes genetically altered, then it will become normal again.”

This shift carries a movement from the “natural” to the “artificial” and even so reproduces the dichotomy of norm and deviation.

All these ambivalent ideas of genome editing and its implications for society affect the understanding of nature and humankind. A predominant idea among the participants is that culture will abolish nature and these ideas are always disadvantageous to people. Moreover, the participants envision two developments, in which nature and culture merge or work together, i.e., where money and nature rule the world, which will be most harmful for poor people. A third development of naturecultures is the high appreciation of the desire to have children. This wish seems to be “naturally given” and of such a high societal value that it justifies genome editing as a medical tool to facilitate having children without genetically caused diseases. Only together, nature and culture are able to legitimate genome editing over all its imagined perils and disadvantages. This case also shows that the concept of a natural given thrive for procreation still represents a fundamental and strong value.

**Conclusions**

Starting with the question about the everyday myths of juveniles and young adults concerning genetically engineered health, we reconstructed new and, compared to the results in Gebhard (2004), modified everyday myths about humankind, nature, and societal structures. As intuitive basic core beliefs, they influence views on genome editing.

A new insight is that the participants’ discussions are characterized by fears that established societal and social structures change—partly right up to their dissolution. Particularly noticeable in such dystopic perceptions is a widening of the gulf between rich and poor, in the course of which there no longer seems to be a middle class and poor people are being misused and dehumanized by rich people. A second basic change that is anticipated in all group discussions concerns the bio-genetic parent–child relationship. The biologically rooted wishes for a child of one’s own and its unlimited care are quoted as the main arguments for using genome editing. At the same time, however, the unconditional love
of a parent gives way to a commercialization led by superficiality and a decline in values, which is accompanied by a loss of supposedly “natural” emotions between parent and child.

These dystopic imaginations are undergirded by several social, cultural, and scientific narrations, like the Fall of Man in Christianity, anthropogenic environmental destruction, demographic social developments, social inequality, economic and neoliberal values, changing family structures, normalization processes, emotional commitments, and evolutionary theories. They are part of a complex structure of rational and intuitive elements, with which the participants imagine the future.

The participants only articulate negative fantasies; new supporting ideas about co-operations, alliances, cohesion, solidarity, or resistance, that might help to cope with the mentioned deprivations, are missing.

Moreover, the participants do not consider initially positively connoted values and promises out of context but re-evaluate and “demystify” them, which is also a new finding compared to Gebhard (2004). By contextualizing abstract concepts and values in their sociocultural connections, their positive dimensions change into negative implications for society. This applies to the genetic promise of salvation of a healthy humankind as well as the fantasies of immortality and perfection. These demystifications of perceived ideals result, together with the imagined changes in societal and social structures and intuitive ties, in a perspective of a scarcely hopeful society characterized by genome editing.

Concerning our question about the current implication for the understanding of nature, similarly to Gebhard (2004), ambivalent and contradictory perceptions become apparent. The participants continue to regard nature as a meaningful and normative authority that offers security. They formulate a quasi-religious understanding of nature that includes the extensive acceptance of standards and practices legitimized as natural as well as retribution for the disregard of nature’s will. In their imaginations, the naturally given desire for a genetically related child justifies the use of genome editing in case of genetically determined diseases. Simultaneously, cultural achievements, like genome editing, and social normalization processes take over nature’s function to provide norms and displace nature.

Connected with this envisioned development, humans lose their natural status through genome editing, harm the authority of “Nature,” and destroy the Earth. Our data show that the participants equate genome editing with “playing nature” and “imitating nature” and thus crossing the boundaries of nature, forcing human’s will on nature, replacing nature’s principle or taking over nature. Since they understand genes as core element of life, genome editing operates on the basis of life and has far-reaching consequences. Ultimately, conditioned by genome editing, humans would lose the meaningful and normalizing entity of nature or even eliminate themselves. Against this background, it is not surprising that the participants fear to lose their basic orientation and security. With Daston, we argue that genome editing acts against one of the deepest and strongest intuitions of humans by robbing them of their natural order—a point that was not made in Gebhard (2004).

Moreover, the participants in this study fear that genome editing turns humans into more cultural than natural beings, because biotechnical possibilities increasingly intervene into the basic bio-genetic structures of the natural human being. The bioethicist Kurt Bayertz put this interpretation of the dialectic self-definition of humans as follows: “What a human being is, what he [sic] can do and what he [sic] looks like will, in the future, be less and less dependent on biological facts but more and more on the progress made in medicine and biotechnology. In other words, human nature will become technologically contingent” (Bayertz 2002, p. 7, translation by the authors).
All these mostly dystopic imaginations related to genome editing demand orientation and new values mediated by cultural narratives and social structures. Yet, they were not present in our data. Narratives that open up and remake dated understandings may offer new orientations and foster “response-ability” (Haraway, 2016). For example, naturecultures may be investigated for their potential to redesign invariableness and taboos, designability and flexibility, security and reliability, competition and assertiveness, cooperation and solidarity, diversity and individuality, as well as kinship.

Everyday myths also have implications for biology didactics. As part of the worldview and self-understanding of pupils and students, they affect their decision-making about socio-scientific issues, like genome editing. Knowledge about the intuitive dimension of students’ thinking supports a sensitive attitude of teachers towards those dimensions and towards the cultural range of science. The intuitive dimensions and the teachers’ attitudes are often disregarded in the classroom due to their supposedly irrational or rambling character (Dittmer and Gebhard 2020, 2015). Moreover, according to Dittmer and Gebhard, explicit reflections on associative and intuitive beliefs in the classroom—in our case on cultural values and societal structures, like health, immortality, childhood, kinship, uniqueness, perfection, and fortune—help to intensify students’ engagement with the object of study, i.e., genome editing. These reflections may transform a scientific content like genome editing into a subjectively significant aspect and foster learning processes.

Due to the specific, sociocultural setting of our study and the sampling of the participants, our results have some limitations. Since everyday myths are culturally produced, we allocate our findings only to the scrutinized cultural context. Future investigations that compare everyday myths of young adults in different cultures would certainly yield culturally differentiated results.

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